



FINAL DRAFT BAHAMAS NATIONAL STANDARD

Geographic information — Geospatial API for Features Part 1: Core

FDBNS ISO 19168-1:2020

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BBSQ Foreword

This draft national standard is identical to the International Organization for Standardization Geographic information — Geospatial API for Features – Part 1: Core. The national committee responsible for reviewing this standard is Technical Committee 17 Geographic Information System. The standard contains the requirements relevant for The Bahamas.

BBSQ Committee Representation

This Bahamas National Standard was adopted as a national standard under the supervision of the National Technical Committee for Geographic Information System (NTC 17) hosted by The Bahamas Bureau of Standards and Quality which at the time comprised of the following members:

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SCOPE

This document specifies the behaviour of Web APIs that provide access to features in a dataset in a manner independent of the underlying data store. This document defines discovery and query operations.

Discovery operations enable clients to interrogate the API, including the API definition and metadata about the feature collections provided by the API, to determine the capabilities of the API and retrieve information about available distributions of the dataset.

Query operations enable clients to retrieve features from the underlying data store based upon simple selection criteria, defined by the client.



**International
Standard**

ISO 19168-1

**Geographic information —
Geospatial API for features —**

**Part 1:
Core**

*Information géographique — API géospatiale pour les entités —
Partie 1: Profil minimal*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

ISO draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). ISO takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, ISO had not received notice of (a) patent(s) which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at www.iso.org/patents. ISO shall not be held responsible for identifying any or all such patent rights.

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 211, *Geographic information/geomatics*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 287 *Geographic Information*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement), and in collaboration with the Open Geospatial Consortium (OGC).

This second edition cancels and replaces the first edition (ISO 19168-1:2020), which has been technically revised.

The main changes are as follows:

- the link schema has been updated to make the "rel" attribute required to align with IETF RFC 8288;
- the bounding box schemas have been updated to require 4 or 6 numbers (2D or 3D);
- the XML Schema core.xsd has been aligned with the corresponding schema for the JSON representation;
- normative references have been updated to reference newer editions (HTTP and OpenAPI);
- the definition of "dataset" has been updated;
- the definitions of the terms "landing page" and "OGC Web API" have been added;
- the IANA link relation type has been corrected to "describedby", rather than "describedBy";
- requirement /req/core/fc-limit-response-1 has been updated to clarify the behaviour if the value of the "limit" parameter is higher than the maximum value;
- recommendation /rec/core/fc-extent has been added to clarify that the bounding box of a feature collection response should be the bounding box of a matched feature, not only the features in the current page;
- recommendations /rec/core/fc-md-self-links and /rec/core/sfc-md-links have been added to clarify that "self" links should be added;
- the value of the "profile" attribute in the GML media type has been modified to be in quotation marks;

- a new requirement /req/core/fc-md-extent-multi has been added to clarify that the first bounding box in a collection extent array contains all other bounding boxes in the array;
- the use of the attributes "spatial"/"temporal" in a collection extent has been clarified;
- it has been clarified that the "itemType" attribute should be included for each collection;
- the interpretation of a degenerated bounding box in the "bbox" parameter has been clarified;
- it has been clarified that a "next" link can return no additional features;
- it has been clarified that the feature identifier is mapped to the "id" attribute in GeoJSON and "@gml:id" in GML;
- missing test cases have been added;
- some specification URIs have been updated;
- various editorial corrections and updates have been applied in the document.

NOTE For more details on the changes listed, see the OGC release notes.^[13]

A list of all parts in the ISO 19168 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

OGC API standards^[10] define modular API building blocks to spatially enable Web APIs in a consistent way. The OpenAPI specification is used to define the API building blocks.

ISO has published a subset of the OGC API family of standards. To reflect that only a subset of the OGC API standards will be published by ISO and to avoid using organization names in the titles of ISO standards, standards from the "OGC API" series are published by ISO as "Geospatial API." For example, the title of this document in OGC is "OGC API - Features - Part 1:Core" and the title in ISO is "Geographic Information — Geospatial API for Features — Part 1: Core."

For simplicity, this document consistently uses:

- "OGC API" to refer to the family of standards for geospatial Web APIs that in ISO is published as "Geospatial API";
- "OGC API - Features" to refer to the multipart standard for features of which certain parts are published by ISO as the ISO 19168 series/"Geographic Information — Geospatial API for Features"; and
- "this document" to refer to "OGC API - Features - Part 1: Core", which is published by ISO as ISO 19168-1/"Geographic Information — Geospatial API for Features — Part 1: Core".

OGC API is organized by resource type. OGC API - Features specifies the fundamental API building blocks for interacting with features. The spatial data community uses the term "feature" for things in the real world that are of interest.

NOTE For those not familiar with the term "feature," the explanations on Spatial Things, Features and Geometry in the W3C/OGC Spatial Data on the Web Best Practice document^[7] provide more detail.

OGC API - Features provides API building blocks to create, modify and query features on the Web. The series is comprised of multiple parts, each of them a separate standard. This document (ISO 19168-1), which corresponds to one such part, the "Core", specifies the core capabilities and is restricted to fetching features where geometries are represented in the coordinate reference system (CRS) WGS 84 with axis order longitude/latitude. Additional capabilities that address more advanced needs will be specified in additional parts. Examples include support for creating and modifying features, more complex data models, richer queries, additional CRS, multiple datasets and collection hierarchies.

By default, every API implementing this document will provide access to a single dataset. Rather than sharing the data as a complete dataset, OGC API - Features offers direct, fine-grained access to the data at the feature (object) level.

The API building blocks specified in this document are consistent with the architecture of the Web. In particular, the API design is guided by the IETF HTTP/HTTPS RFCs, the W3C Data on the Web Best Practices,^[8] the W3C/OGC Spatial Data on the Web Best Practices,^[7] and the emerging OGC Web API Guidelines. A particular example is the use of the concepts of datasets and dataset distributions as defined in DCAT^[9] and used in schema.org.

This document specifies discovery and query operations that are implemented using the HTTP GET method. Support for additional methods (in particular POST, PUT, DELETE, PATCH) is specified in additional parts.

Discovery operations enable clients to interrogate the API, including the API definition and metadata about the feature collections provided by the API, to determine the capabilities of the API and retrieve information about available distributions of the dataset.

Query operations enable clients to retrieve features from the underlying data store based upon simple selection criteria, defined by the client.

This document defines the resources listed in [Table 1](#). For an overview of the resources, see [7.1](#).

Table 1 — Overview of resources, applicable HTTP methods and links to the document sections

Resource	Path	HTTP method	Subclause
Landing page	/	GET	7.2 API landing page
Conformance declaration	/conformance	GET	7.4 Declaration of conformance classes
Feature collections	/collections	GET	7.13 Feature collections
Feature collection	/collections/{collectionId}	GET	7.14 Feature collection
Features	/collections/{collectionId}/items	GET	7.15 Features
Feature	/collections/{collectionId}/items/{featureId}	GET	7.16 Feature

Geographic information — Geospatial API for features —

Part 1: Core

1 Scope

This document specifies the behaviour of Web APIs that provide access to features in a dataset independently of the underlying data store. This document defines discovery and query operations.

Discovery operations enable clients to interrogate the API, including the API definition and metadata about the feature collections provided by the API, to determine the capabilities of the API and retrieve information about available distributions of the dataset.

Query operations enable clients to retrieve features from the underlying data store based upon simple selection criteria, defined by the client.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

OPENAPI INITIATIVE (OAI), OpenAPI Specification 3.0 [online]. 2020 [viewed 2020-03-16]. The latest patch version at the time of publication of this standard was 3.0.3, available at <https://spec.openapis.org/oas/v3.0.3>

INTERNET ENGINEERING TASK FORCE (IETF), RFC 2818: HTTP Over TLS [online]. Edited by E. Rescorla. 2000 [viewed 2020-03-16]. Available at <https://www.rfc-editor.org/rfc/rfc2818.html>

INTERNET ENGINEERING TASK FORCE (IETF), RFC 3339: Date and Time on the Internet: Timestamps [online]. Edited by G. Klyne, C. Newman. 2002 [viewed 2020-03-16]. Available at <https://www.rfc-editor.org/rfc/rfc3339.html>

INTERNET ENGINEERING TASK FORCE (IETF), RFC 7230 to RFC 7235: HTTP/1.1 [online]. Edited by R. Fielding, J. Reschke, Y. Lafon, M. Nottingham. 2014 [viewed 2020-04-28]. Available at <https://www.rfc-editor.org/rfc/rfc7230.html>, <https://www.rfc-editor.org/rfc/rfc7231.html>, <https://www.rfc-editor.org/rfc/rfc7232.html>, <https://www.rfc-editor.org/rfc/rfc7233.html>, <https://www.rfc-editor.org/rfc/rfc7234.html>, and <https://www.rfc-editor.org/rfc/rfc7235.html>

INTERNET ENGINEERING TASK FORCE (IETF), RFC 8288: Web Linking [online]. Edited by M. Nottingham. 2017 [viewed 2020-03-16]. Available at <https://www.rfc-editor.org/rfc/rfc8288.html>

OPEN GEOSPATIAL CONSORTIUM (OGC), OGC 10-100r3: Geography Markup Language (GML) Simple Features Profile [online]. Edited by L. van den Brink, C. Portele, P. Vretanos. 2012 [viewed 2020-03-16]. Available at http://portal.opengeospatial.org/files/?artifact_id=42729

INTERNET ENGINEERING TASK FORCE (IETF). RFC 7946: The GeoJSON Format [online]. Edited by H. Butler, M. Daly, A. Doyle, S. Gillies, S. Hagen, T. Schaub. 2016 [viewed 2020-03-16]. Available at <https://www.rfc-editor.org/rfc/rfc7946.html>

WHATWG. HTML, Living Standard [online, viewed 2020-03-16]. Available at <https://html.spec.whatwg.org/>

SCHEMA.ORG. Schema.org [online, viewed 2020-03-16]. Available at <https://schema.org/docs/schemas.html>

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1 Terms and definitions

3.1.1

dataset

collection of data

Note 1 to entry: Published or curated by a single agent, and available for access or download in one or more serializations or formats.

Note 2 to entry: The use of "collection" in this definition is broader than the use of the term collection throughout the rest of this document. See the definition of "feature collection."

[SOURCE: DCAT,^[9] 6.6, modified — Definition has been split into definition and Note 1 to entry; Note 2 to entry has been added.]

3.1.2

distribution

specific representation of a *dataset* ([3.1.1](#))

EXAMPLE A downloadable file, an RSS feed or an API.

[SOURCE: DCAT,^[9] 6.7, modified — Definition has been shortened.]

3.1.3

feature

abstraction of real-world phenomena

Note 1 to entry: Further details about the term "feature" can be found in Reference [\[7\]](#).

[SOURCE: ISO 19101-1:2014, 4.1.11, modified — Note 1 to entry has been added.]

3.1.4

feature collection

collection

set of *features* ([3.1.3](#)) from a *dataset* ([3.1.1](#))

3.1.5

resource

entity that might be identified

Note 1 to entry: The term "resource", when used in the context of an OGC API standard, means a *web resource* ([3.1.7](#)) unless otherwise indicated.

[SOURCE: ISO 15836-2:2019, 3.1.10, modified — Notes 1 and 2 have been removed and replaced with a new Note 1 to entry.]

3.1.6

Web API

API using an architectural style that is founded on the technologies of the Web

Note 1 to entry: See Reference [\[8\]](#) for further detail.

Note 2 to entry: Definition adapted from Reference [\[8\]](#), 8.10.1. Modified by being rephrased for clarity.

3.1.7**web resource**

resource ([3.1.5](#)) that is identified by a HTTP URI

3.2 Abbreviated terms

API	application programming interface
CORS	cross-origin resource sharing
CRS	coordinate reference system
HTTP	hypertext transfer protocol
HTTPS	hypertext transfer protocol secure
IANA	Internet Assigned Numbers Authority
IRI	internationalized resource identifier
OGC	Open Geospatial Consortium
RFC	request for comment
TRS	temporal coordinate reference system
URI	uniform resource identifier
WSDL	web service description language
YAML	YAML Ain't Markup Language

4 Conformance

This document defines six requirements/conformance classes.

The standardization targets of all conformance classes are "Web APIs."

The main requirements class is:

- Core.

The Core requirements class specifies requirements that all Web APIs have to implement.

The Core requirements class does not mandate a specific encoding or format for representing features or feature collections. Four requirements classes depend on the Core requirements class and specify representations for these resources in commonly used encodings for spatial data on the Web:

- HTML,
- GeoJSON,
- Geography Markup Language (GML), Simple Features Profile, Level 0, and
- Geography Markup Language (GML), Simple Features Profile, Level 2.

None of these encodings are mandatory and an implementation of the Core requirements class can also decide to implement none of them, but to implement another encoding instead.

That said, the Core requirements class includes recommendations to support, where practical, HTML and GeoJSON as encodings. [Clause 6](#) includes a discussion about the recommended encodings.

The Core requirements class does not mandate any encoding or format for the formal definition of the API. One option is the OpenAPI 3.0 specification and a requirements class has been specified for OpenAPI 3.0, which depends on the Core requirements class:

- OpenAPI Specification 3.0.

As with the feature encodings, an implementation of the Core requirements class can decide to use other API definition representations in addition or instead of an OpenAPI 3.0 definition. Examples for alternative API definitions include: OpenAPI 2.0 (Swagger), future versions of the OpenAPI specification, an OWS Common 2.0 capabilities document or WSDL.

The Core requirements class is intended to be a minimal useful API for fine-grained read-access to a spatial dataset where geometries are represented in the CRS WGS 84 with axis order longitude/latitude.

Additional capabilities such as support for transactions, complex data structures, rich queries, other CRS, subscription/notification, returning aggregated results, etc. can be specified in future parts of OGC API - Features or as vendor-specific extensions.

Conformance with this document shall be checked using all the relevant tests specified in [Annex A](#) of this document. The framework, concepts, and methodology for testing, and the criteria to be achieved to claim conformance are specified in the OGC Compliance Testing Policies and Procedures and the OGC Compliance Testing web site.

Table 2 — Conformance class URIs

Conformance class	URI
Core	http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/core
HTML	http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/html
GeoJSON	http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/geojson
GML, Simple Features Profile, Level 0	http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/gmlsf0
GML, Simple Features Profile, Level 2	http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/gmlsf2
OpenAPI Specification 3.0	http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/oas30

5 Conventions

5.1 Identifiers

The normative provisions in this document are denoted by the URI:

<http://www.opengis.net/spec/ogcapi-features-1/1.0>

All requirements and conformance tests that appear in this document are denoted by partial URIs which are relative to this base.

5.2 Link relations

To express relationships between resources, RFC 8288 (Web Linking) is used.

The following registered link relation types^[3] are used in this document.

- **alternate**: Refers to a substitute for this context.
- **collection**: The target IRI points to a resource which represents the collection resource for the context IRI.
- **describedby**: Refers to a resource providing information about the link's context.
- **item**: The target IRI points to a resource that is a member of the collection represented by the context IRI.
- **next**: Indicates that the link's context is a part of a series, and that the next in the series is the link target.

- licence: Refers to a licence associated with this context.
- prev: Indicates that the link's context is a part of a series, and that the previous in the series is the link target.
 - This relation is only used in examples.
- self: Conveys an identifier for the link's context.
- service-desc: Identifies service description for the context that is primarily intended for consumption by machines.
 - API definitions are considered service descriptions.
- service-doc: Identifies service documentation for the context that is primarily intended for human consumption.

In addition, the following link relation types are used for which no applicable registered link relation type could be identified.

- items: Refers to a resource that is comprised of members of the collection represented by the link's context.
- conformance: Refers to a resource that identifies the specifications to which the link's context conforms.
- data: Refers to the root resource of a dataset in an API.

Each resource representation includes an array of links. Implementations are free to add additional links for all resources provided by the API. For example, an "enclosure" link could reference a bulk download of a collection. Or a "related" link on a feature could reference a related feature.

5.3 Use of HTTPS

For simplicity, this document in general only refers to the HTTP protocol. This is not meant to exclude the use of HTTPS and is simply a shorthand notation for "HTTP or HTTPS." In fact, most servers are expected to use HTTPS, not HTTP.

5.4 HTTP URIs

This document does not restrict the lexical space of URIs used in the API beyond the requirements of the HTTP and URI Syntax IETF RFCs. If URIs include reserved characters that are delimiters in the URI subcomponent, these have to be percent-encoded. See RFC 3986, Clause 2^[2] for details.

5.5 API definition

5.5.1 General remarks

Good documentation is essential for every API so that developers can more easily learn how to use the API. Ideally, documentation will be available in HTML and in a format that can be processed by software to connect to the API.

This document specifies requirements and recommendations for APIs that share feature data and that want to follow a standard way of doing so. In general, APIs will go beyond the requirements and recommendations stated in this document (or other parts of OGC API) and will support additional operations, parameters, etc. that are specific to the API or the software tool used to implement the API.

5.5.2 Role of OpenAPI

This document uses OpenAPI 3.0 fragments as examples and to formally state requirements. However, using OpenAPI 3.0 is not required for implementing a server.

Therefore, the Core requirements class only requires that an API definition is provided and linked from the landing page.

A separate requirements class is specified for API definitions that follow the OpenAPI specification 3.0. This does not preclude that in the future or in parallel other versions of OpenAPI or other API descriptions are provided by a server.

NOTE This approach is used to avoid lock-in to a specific approach to defining an API, as it is expected that the API landscape will continue to evolve.

In this document, fragments of OpenAPI definitions are shown in YAML (YAML Ain't Markup Language)^[1] since YAML is easier to read than JSON and is typically used in OpenAPI editors. YAML is described by its authors as a human-friendly data serialization standard for all programming languages.

5.5.3 References to OpenAPI components in normative statements

Some normative statements (requirements, recommendations, and permissions) use a phrase that a component in the API definition of the server has to be "based upon" a schema or parameter component in the OGC schema repository.

In such a case, the following changes to the pre-defined OpenAPI component are permitted.

- If the server supports an XML encoding, XML properties may be added to the relevant OpenAPI schema components.
- The range of values of a parameter or property may be extended (additional values) or constrained (if a subset of all possible values are applicable to the server). An example for a constrained range of values is to explicitly specify the supported values of a string parameter or property using an enum.
- The default value of a parameter may be changed or added unless a requirement explicitly prohibits this.
- Additional properties may be added to the schema definition of a Response Object.
- Informative text may be changed or added, like comments or description properties.

For API definitions that do not conform to the OpenAPI Specification 3.0, the normative statement has to be interpreted in the context of the API definition language used.

5.5.4 Paths in OpenAPI definitions

All paths in an OpenAPI definition are relative to a base URL of the server.

EXAMPLE 1 URL of the OpenAPI definition

If the OpenAPI Server Object looks like this:

```
servers:  
- url: https://dev.example.org/  
  description: Development server  
- url: https://data.example.org/  
  description: Production server
```

The path "/mypath" in the OpenAPI definition of a Web API would be the URL https://data.example.org/mypath for the production server.

5.5.5 Reusable OpenAPI components

Reusable components for OpenAPI definitions for implementations of OGC API - Features are referenced from this document.

6 Overview

6.1 Design considerations

Fine-grained access to features over the Web has been supported by the OGC Web Feature Service (WFS) standard (in ISO: ISO 19142) and many implementations of that standard for many years. WFS uses a Remote-Procedure-Call-over-HTTP architectural style using XML for any payloads. When the WFS standard was originally designed in the late 1990s and early 2000s, this was the state-of-the-art.

OGC API - Features supports similar capabilities, but using a modernized approach that follows the current Web architecture and in particular the W3C/OGC best practices for sharing Spatial Data on the Web as well as the W3C best practices for sharing Data on the Web.

Beside the general alignment with the architecture of the Web (e.g. consistency with HTTP/HTTPS, hypermedia controls), another goal for OGC API Features is modularization. This goal has several facets, as described below.

- Clear separation between core requirements and more advanced capabilities. This document specifies the core requirements that are relevant for almost everyone who wants to share or use feature data on a fine-grained level. Additional capabilities that several communities are using today will be specified as extensions in additional parts of OGC API - Features.
- Technologies that change more frequently are decoupled and specified in separate modules ("requirements classes" in OGC terminology). This enables, for example, the use/re-use of new encodings for spatial data or API descriptions.
- Modularization is not just about features as resources, but about providing building blocks for fine-grained access to spatial data that can be used in Web APIs in general. In other words, a server supporting OGC API - Features is not intended to implement just a standalone Features API. A corollary of this is that the same Web API can also implement other standards of the OGC API family that support additional resource types; for example, tile resources could provide access to the same features, but organized in a spatial partitioning system; or map resources could process the features and render them as map images.

Implementations of OGC API - Features are intended to support two different approaches as to how clients can use the API.

In the first approach, clients are implemented with knowledge about this standard and its resource types. The clients navigate the resources based on this knowledge and based on the responses provided by the API. The API definition can be used to determine details (e.g. on filter parameters), but this is not always necessary depending on the needs of the client. These are clients that are in general able to use multiple APIs, provided they implement OGC API Features.

The other approach targets developers that are not familiar with the OGC API standards, but want to interact with spatial data provided by an API that happens to implement OGC API Features. In this case the developer will study and use the API definition - typically an OpenAPI document - to understand the API and implement the code to interact with the API. This assumes familiarity with the API definition language and the related tooling, but it is not necessary to study the OGC API standards.

6.2 Encodings

This document does not mandate any encoding or format for representing features or feature collections. In addition to rules for HTML, the standard encoding for Web content, rules for commonly used encodings for spatial data on the Web are provided (GeoJSON, GML).

None of these encodings is mandatory and an implementation of the Core requirements class can implement none of them but implement another encoding instead.

Support for HTML is recommended as HTML is the core language of the World Wide Web. A server that supports HTML will support browsing the data with a web browser and will enable search engines to crawl and index the dataset.

GeoJSON is a commonly used format that is simple to understand and well supported by tools and software libraries. Since most Web developers are comfortable with using a JSON-based format, this version of OGC API - Features recommends supporting GeoJSON for encoding feature data, if the feature data can be represented in GeoJSON for the intended use.

Some examples for cases that are out-of-scope of GeoJSON are:

- when solids are used for geometries (e.g. in a 3D city model);
- geometries that include non-linear curve interpolations that cannot be simplified (e.g. use of arcs in authoritative geometries);
- geometries that have to be represented in a CRS that is not based on WGS 84 longitude/latitude (e.g. an authoritative national CRS); or
- features that have more than one geometric property.

In addition to HTML and GeoJSON, a significant volume of feature data is available in XML-based formats, notably GML. GML supports more complex requirements than GeoJSON and does not have any of the limitations mentioned in the above list, but as a result GML is more complex to handle for both servers and clients. Requirements classes for GML are, therefore, included in this document. It is expected that these requirements classes will typically be supported by servers where users are known to expect feature data in XML/GML.

The recommendations for using HTML and GeoJSON reflect the importance of HTML and the current popularity of JSON-based data formats. As the practices in the Web community evolve, the recommendations will probably be updated in future versions of this document to provide guidance on using other encodings.

This document does not provide any guidance on other encodings. The supported encodings, or more precisely the media types of the supported encodings, can be determined from the API definition. The desired encoding is selected using HTTP content negotiation.

For example, if the server supports GeoJSON text sequences, an encoding that is based on JSON text sequences and GeoJSON to support streaming by making the data incrementally parseable, the media type `application/geo+json-seq` would be used.

In addition, HTTP supports compression and therefore the standard HTTP mechanisms can be used to reduce the size of the messages between the server and the client.

6.3 Examples

This document uses a simple example throughout the document: The dataset contains buildings and the server provides access to them through a single feature collection ("buildings") and two encodings, GeoJSON and HTML.

The buildings have a few (optional) properties: the polygon geometry of the building footprint, a name, the function of the building (residential, commercial or public use), the floor count and the timestamp of the last update of the building feature in the dataset.

In addition to the examples included in the document, additional and more comprehensive examples are available at <http://schemas.opengis.net/ogcapi/features/part1/1.0/examples>.

7 Requirements class "Core"

7.1 Overview

Requirements class

<http://www.opengis.net/spec/ogcapi-features-1/1.0/req/core>

Target type	Web API
Dependency	RFC 7230 to RFC 7235 (HTTP/1.1)
Dependency	RFC 2818 (HTTP over TLS)
Dependency	RFC 3339 (Date and Time on the Internet: Timestamps)
Dependency	RFC 8288 (Web Linking)

A server that implements this requirements class provides access to the features in a dataset.

NOTE 1 Other parts of OGC API - Features can define API extensions that support multiple datasets. The statement that the features are from "a dataset" is not meant to preclude such extensions. It just reflects that this document does not specify how the API publishes features or other spatial data from multiple datasets.

The entry point is a Landing page (path /).

NOTE 2 All paths (e.g. /) are relative. If the API covers other resources beyond those specified in this document, the landing page can also be, for example, a sub-resource of the base URL of the API.

The Landing page provides links to:

- the API definition (link relations service-desc and service-doc),
- the Conformance declaration (path /conformance, link relation conformance), and
- the Collections (path /collections, link relation data).

The API definition describes the capabilities of the server that can be used by clients to connect to the server or by development tools to support the implementation of servers and clients. Accessing the API definition using HTTP GET returns a description of the API. The API definition can be hosted on the API server(s) or a separate server.

The Conformance declaration states the conformance classes from standards or community specifications, identified by a URI, that the API conforms to. Clients can but are not required to use this information. Accessing the Conformance declaration using HTTP GET returns the list of URIs of conformance classes implemented by the server.

The data is organized into one or more collections. Collections provide information about and access to the collections.

This document specifies requirements only for collections consisting of features. That is, each collection considered by this document is a feature collection. Other OGC API standards can add requirements for other types of collections.

NOTE 3 To support the future use of datasets with items that are not features, the term "feature" has not been added in the names of the resource types or their paths.

This document does not include any requirements about how the features in the dataset have to be aggregated into collections. A typical approach is to aggregate by feature type but any other approach that fits the dataset or the applications using this distribution can also be used.

Accessing Collections using HTTP GET returns a response that contains at least the list of collections. For each Collection, a link to the items in the collection (Features, path /collections/{collectionId}/items, link relation items) as well as key information about the collection. This information includes:

- a local identifier for the collection that is unique for the dataset;

- a list of CRS in which geometries may be returned by the server: the first CRS is the default CRS (in the Core requirements class, the default is always WGS 84 with axis order longitude/latitude);
- an optional title and description for the collection;
- an optional extent that can be used to provide an indication of the spatial and temporal extent of the collection, typically derived from the data;
- an optional indicator about the type of the items in the collection (the default value, if the indicator is not provided, is "feature").

The Collection resource is also available at path/collections/{collectionId}, often with more details than included in the Collections response.

Each Collection that is a feature collection consists of features. This document only discusses the behaviour of feature collections.

Each feature in a dataset is part of exactly one collection.

Accessing the Features using HTTP GET returns a document consisting of features in the collection. The features included in the response are determined by the server based on the query parameters of the request. To support access to larger collections without overloading the client, the API supports paged access with links to the next page, if more features are selected than the page size.

A bbox or datetime parameter can be used to select only a subset of the features in the collection (the features that are in the bounding box or time interval). The bbox parameter matches all features in the collection that are not also associated with a location. The datetime parameter matches all features in the collection that are not also associated with a time stamp or interval.

The limit parameter can be used to control the subset of the selected features that will be returned in the response, the page size.

Each page can include information about the number of selected and returned features (numberMatched and numberReturned) as well as links to support paging (link relation next).

Each Feature (path/collections/{collectionId}/items/{featureId}) is also a separate resource and can be requested individually using HTTP GET.

In addition to the simple path structures described above, where all features are organized in a one-level collection hierarchy, additional parts of OGC API - Feature are expected to provide alternate access to the features served by the API via additional, deeper collection hierarchies.

7.2 API landing page

7.2.1 Operation

Requirement 1

/req/core/root-op

- A The server shall support the HTTP GET operation at the path /.

7.2.2 Response

Requirement 2

/req/core/root-success

- A A successful execution of the operation shall be reported as a response with a HTTP status code 200.
- B The content of that response shall be based upon the OpenAPI 3.0 schema landingPage.yaml and include at least links to the following resources:
- the API definition (relation type "service-desc" or "service-doc")
 - /conformance (relation type "conformance") /collections (relation type 'data')

Recommendation 1 /req/core/root-links

- A A 200-response should include the following links in the links property of the response:
- a link to this response document (relation: self),
 - a link to the response document in every other media type supported by the server (relation: alternate).

NOTE Version 1.0.0 of this specification did not include self and alternate links for the landing page while the links are required in other resources. The recommendation above has been added to encourage implementations to add these links on the landing page, too.

Schema for the landing page (landingPage.yaml)

```
type: object
required:
  - links
properties:
  title:
    type: string
  description:
    type: string
  links:
    type: array
    items:
      $ref: http://schemas.opengis.net/ogcapi/features/part1/1.0/openapi/schemas/link.yaml
```

EXAMPLE Landing page response document

```
{
  "title": "Buildings in Bonn",
  "description": "Access to data about buildings in the city of Bonn via a Web API that conforms to the OGC API Features specification.",
  "links": [
    { "href": "http://data.example.org/",
      "rel": "self", "type": "application/json", "title": "this document" },
    { "href": "http://data.example.org/?f=html",
      "rel": "alternate", "type": "text/html", "title": "this document as HTML" },
    { "href": "http://data.example.org/api",
      "rel": "service-desc", "type": "application/vnd.oai.openapi+json;version=3.0",
      "title": "the API definition" },
    { "href": "http://data.example.org/api.html",
      "rel": "service-doc", "type": "text/html", "title": "the API documentation" },
    { "href": "http://data.example.org/conformance",
      "rel": "conformance", "type": "application/json", "title": "OGC API conformance classes implemented by this server" },
    { "href": "http://data.example.org/collections",
      "rel": "data", "type": "application/json", "title": "Information about the feature collections" }
  ]
}
```

7.2.3 Error situations

See [7.5.1](#) for general guidance.

7.3 API definition

7.3.1 Operation

Every OGC Web API is expected to provide a definition that describes the capabilities of the server and which can be used by developers to understand the API, by software clients to connect to the server, or by development tools to support the implementation of servers and clients.

Requirement 3 /req/core/api-definition-op

A The URIs of all API definitions referenced from the landing page shall support the HTTP GET method.

Permission 1 /per/core/api-definition-uri

A The API definition is metadata about the API and strictly not part of the API itself, but it may be hosted as a sub-resource to the base path of the API, for example, at path /api. There is no need to include the path of the API definition in the API definition itself.

NOTE Multiple API definition formats can be supported.

7.3.2 Response

Requirement 4 /req/core/api-definition-success

A A GET request to the URI of an API definition linked from the landing page (link relations service-desc or service-doc) with an Accept header with the value of the link property type shall return a document consistent with the requested media type.

Recommendation 2 /rec/core/api-definition-oas

A If the API definition document uses the OpenAPI Specification 3.0, the document should conform to the OpenAPI Specification 3.0 requirements class.

If the server hosts the API definition under the base path of the API (for example, at path /api), there is no need to include the path of the API definition in the API definition itself.

The idea is that any OGC API Features implementation can be used by developers that are familiar with the API definition language(s) supported by the server. For example, if an OpenAPI definition is used, it is possible to create a working client using the OpenAPI definition. The developer will potentially need to learn a little bit about geometry data types, etc. but it is not necessary to read this document to access the data via the API.

If the API definition is based on OpenAPI 3.0, consider the two approaches discussed in OpenAPI requirements class.

7.3.3 Error situations

See [7.5.1](#) for general guidance.

7.4 Declaration of conformance classes

7.4.1 Operation

To support "generic" clients that want to access multiple OGC API Features implementations, and not "just" a specific API/server, the server has to declare the conformance classes it implements and conforms to.

Requirement 5 /req/core/conformance-op

A The server shall support the HTTP GET operation at the path /conformance.

7.4.2 Response

Requirement 6 /req/core/conformance-success

- A A successful execution of the operation shall be reported as a response with a HTTP status code 200.
- B The content of that response shall be based upon the OpenAPI 3.0 schema `confClasses.yaml` and list all OGC API conformance classes that the server conforms to.

Schema for the list of conformance classes (`confClasses.yaml`):

```
type: object
required:
  - conformsTo
properties:
  conformsTo:
    type: array
    items:
      type: string
```

EXAMPLE Conformance declaration response document

This example response in JSON is for a server that supports OpenAPI 3.0 for the API definition and HTML and GeoJSON as encodings for features.

```
{
  "conformsTo": [
    "http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/core",
    "http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/oas30",
    "http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/html",
    "http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/geojson"
  ]
}
```

7.4.3 Error situations

See [7.5.1](#) for general guidance.

7.5 HTTP 1.1

Requirement 7 /req/core/http

- A The server shall conform to HTTP 1.1.
- B If the server supports HTTPS, the server shall also conform to HTTP over TLS.
- NOTE 1 This includes the correct use of status codes, headers, etc.

Recommendation 3 /rec/core/head

- A The server should support the HTTP 1.1 method HEAD for all resources that support the method GET.
- NOTE 2 Supporting the method HEAD in addition to GET can be useful for clients and is simple to implement.
- NOTE 3 Servers implementing CORS will implement the method OPTIONS, too.

7.5.1 HTTP status codes

This API standard does not impose any restrictions on which features of the HTTP and HTTPS protocols can be used. API clients have to be prepared to handle any legal HTTP or HTTPS status code.

The “Status Codes” listed in [Table 3](#) are of particular relevance to implementors of this document. Status codes 200, 400 and 404 are called out in API requirements. Therefore, support for these status codes is mandatory for all compliant implementations. The remainder of the status codes in [Table 3](#) are not

mandatory, but are important for the implementation of a well-functioning API. Support for these status codes is strongly encouraged for both client and server implementations.

Table 3 — Typical HTTP status codes

Status code	Description
200	A successful request.
304	An entity tag was provided in the request and the resource has not been changed since the previous request.
400	The server cannot or will not process the request due to an apparent client error. For example, a query parameter had an incorrect value.
401	The request requires user authentication. The response includes a WWW-Authenticate header field containing a challenge applicable to the requested resource.
403	The server understood the request, but is refusing to fulfil it. While status code 401 indicates missing or bad authentication, status code 403 indicates that authentication is not the issue, but the client is not authorized to perform the requested operation on the resource.
404	The requested resource does not exist on the server. For example, a path parameter had an incorrect value.
405	The request method is not supported. For example, a POST request was submitted, but the resource only supports GET requests.
406	Content negotiation failed. For example, the Accept header submitted in the request did not support any of the media types supported by the server for the requested resource.
500	An internal error occurred in the server.

More specific guidance is provided for each resource, where applicable.

Permission 2 /per/core/additional-status-codes

A Servers may support other capabilities of the HTTP protocol and, therefore, may return other status codes than those listed in [Table 3](#).

The API Description Document describes the HTTP status codes generated by that API. This is not an exhaustive list of all possible status codes. It is not reasonable to expect an API designer to control the use of HTTP status codes which are not generated by their software. Therefore, it is recommended that the API Description Document limit itself to describing HTTP status codes relevant to the proper operation of the API application logic. Client implementations have to be prepared to receive HTTP status codes in addition to those described in the API Description Document.

7.6 Unknown or invalid query parameters

Requirement 8 /req/core/query-param-unknown

A The server shall respond with a response with the status code 400, if the request URI includes a query parameter that is not specified in the API definition.

If a server wants to support vendor-specific parameters, these have to be explicitly declared in the API definition.

If OpenAPI is used to represent the API definition, a capability exists to allow additional parameters without explicitly declaring them. That is, parameters that have not been explicitly specified in the API definition for the operation will be ignored.

OpenAPI schema for additional "free-form" query parameters:

```
in: query
name: vendorSpecificParameters
schema:
  type: object
  additionalProperties: true
style: form
```

Note that the name of the parameter does not matter as the actual query parameters are the names of the object properties. For example, if the value of `vendorSpecificParameters` is this object:

```
{
  "my_first_parameter": "some value",
  "my_other_parameter": 42
}
```

In the request URI this would be expressed as:
`&my_first_parameter=some%20value&my_other_parameter=42.`

Requirement 9 **/req/core/query-param-invalid**

A The server shall respond with a response with the status code 400, if the request URI includes a query parameter that has an invalid value.

This is a general rule that applies to all parameters, whether they are specified in this document or in additional parts. A value is invalid if it violates the API definition or any other constraint for that parameter stated in a requirement.

7.7 Web caching

Entity tags are a mechanism for web cache validation and for supporting conditional requests to reduce network traffic. Entity tags are specified by RFC 7232 (HTTP 1.1).^[14]

Recommendation 4 **/rec/core/etag**

A The service should support entity tags and the associated headers as specified by HTTP/1.1.

7.8 Support for cross-origin requests

Access to data from an HTML page is by default prohibited for security reasons, if the data is located on another host than the webpage ("same-origin policy"). A typical example is a web-application accessing feature data from multiple distributed datasets.

Recommendation 5 **/rec/core/cross-origin**

A If the server is intended to be accessed from the browser, cross-origin requests should be supported. Note that support can also be added in a proxy layer on top of the server.

Two common mechanisms to support cross-origin requests are:

- Cross-origin resource sharing (CORS); and
- JSONP (JSON with padding).

7.9 Encodings

While OGC API - Features does not specify any mandatory encoding, support for the following encodings is recommended. See [Clause 6](#) for a discussion.

Recommendation 6 **/rec/core/html**

A To support browsing the dataset and its features with a web browser and to enable search engines to crawl and index the dataset, implementations should consider supporting an HTML encoding.

Recommendation 7 **/rec/core/geojson**

A If the feature data can be represented for the intended use in GeoJSON, implementations should consider supporting GeoJSON as an encoding for features and feature collections.

Requirement /req/core/http implies that the encoding of a server response is determined using content negotiation as specified by the HTTP RFC.

The section Media Types includes guidance on media types for encodings that are specified in this document.

Note that any server that supports multiple encodings will have to support a mechanism to mint encoding-specific URIs for resources in order to express links, for example, to alternate representations of the same resource. This document does not mandate any particular approach as to how this is supported.

As clients simply need to dereference the URI of the link, the implementation details and the mechanism how the encoding is included in the URI of the link are not important. Developers interested in the approach of a particular implementation, for example, to manipulate ("hack") URIs in the browser address bar, can study the API definition.

NOTE Two common approaches are:

- an additional path for each encoding of each resource (this can be expressed, for example, using format specific suffixes like ".html");
- an additional query parameter (for example, "accept" or "f") that overrides the Accept header of the HTTP request.

7.10 String internationalization

If the server supports representing resources in multiple languages, the usual HTTP content negotiation mechanisms apply. The client states its language preferences in the Accept-Language header of a request and the server responds with responses that have linguistic text in the language that best matches the requested languages and the capabilities of the server.

Recommendation 8 /rec/core/string-i18n

A For encodings that support string internationalization, the server should include information about the language for each string value that includes linguistic text.

EXAMPLE If JSON-LD is used as an encoding, the built-in capabilities to annotate a string with its language can be used.

The link object based on RFC 8288 (Web Linking) includes a hreflang attribute that can be used to state the language of the referenced resource. This can be used to include links to the same data in, for example, English or French. Just like with multiple encodings, a server that wants to use language-specific links will have to support a mechanism to mint language-specific URIs for resources in order to express links to, for example, the same resource in another language. Again, this document does not mandate any particular approach as to how such a capability is supported.

7.11 Coordinate reference systems

As discussed in Chapter 9 of the W3C/OGC Spatial Data on the Web Best Practices document,^[7] how to express and share the location of features in a consistent way is one of the most fundamental aspects of publishing geographic data and it is important to be clear about the CRS that coordinates are in.

For the reasons discussed in the Best Practices, OGC API - Features uses WGS 84 longitude and latitude as the default CRS for spatial geometries.

Requirement 10 /req/core/crs84

A Unless the client explicitly requests a different coordinate reference system, all spatial geometries shall be in the coordinate reference system <http://www.opengis.net/def/crs/OGC/1.3/CRS84> (WGS 84 longitude/latitude) for geometries without height information and <http://www.opengis.net/def/crs/OGC/0/CRS84h> (WGS 84 longitude/latitude plus ellipsoidal height) for geometries with height information.

Implementations compliant with the Core requirements class are not required to support publishing feature geometries in CRS other than <http://www.opengis.net/def/crs/OGC/1.3/CRS84> (for coordinates without

height) or <http://www.opengis.net/def/crs/OGC/0/CRS84h> (for coordinates with ellipsoidal height); i.e. the (optional) third coordinate number is always the ellipsoidal height.

The Core requirements class also does not specify a capability to request feature geometries in a different CRS. Such a capability will be specified in another part of the OGC API - Features.

The same principles apply for temporal geometries, which are measured relative to a temporal CRS. OGC API - Features uses the Gregorian calendar and all dates or timestamps discussed in this document are in the Gregorian calendar and conform to RFC 3339.

Recommendation 9 **/rec/core/rfc3339**

A RFC 3339 should also be used for feature properties that are temporal instants or intervals, where applicable, but feature properties may be represented in another format or in other temporal coordinate reference systems, too.

7.12 Link headers

Recommendation 10 **/rec/core/link-header**

A Links included in payload of responses should also be included as Link headers in the HTTP response according to RFC 8288, Clause 3.
This recommendation does not apply if there are a large number of links included in a response or a link is not known when the HTTP headers of the response are created.

7.13 Feature collections

7.13.1 Operation

Requirement 11 **/req/core/fc-md-op**

A The server shall support the HTTP GET operation at the path /collections.

7.13.2 Response

Requirement 12 **/req/core/fc-md-success**

A A successful execution of the operation shall be reported as a response with a HTTP status code 200.
B The content of that response shall be based upon the OpenAPI 3.0 schema collections.yaml.

Schema for the collections resource (collections.yaml):

```
type: object
required:
  - links
  - collections
properties:
  links:
    type: array
    items:
      $ref:
        _http://schemas.opengis.net/ogcapi/features/part1/1.0/openapi/schemas/link.yaml
  collections:
    type: array
    items:
      $ref:
        _http://schemas.opengis.net/ogcapi/features/part1/1.0/openapi/schemas/collection.yaml
```

Requirement 13 /req/core/fc-md-links

- A A 200-response shall include the following links in the links property of the response:
- a link to this response document (relation: self);
 - a link to the response document in every other media type supported by the server (relation: alternate).
- B All links shall include the rel and type link parameters.

Recommendation 11 /rec/core/fc-md-descriptions

- A If external schemas or descriptions for the dataset exist that provide information about the structure or semantics of the data, a 200-response should include links to each of those resources in the links property of the response (relation: describedby).
- B The type link parameter should be provided for each link. This applies to resources that describe the whole dataset.
- C For resources that describe the contents of a feature collection, the links should be set in the links property of the appropriate object in the collections resource.
- D Examples for descriptions are: XML Schema, Schematron, JSON Schema, RDF Schema, OWL, SHACL, a feature catalogue.

Recommendation 12 /rec/core/fc-md-licence

- A For each feature collection included in the response, the links property of the collection should include a link to the applicable license (relation: license).
- B Alternatively, if all data shared via the API is available under the same license, the link may instead be added to the top-level links property of the response.
- C Multiple links to the license in different media types may be provided. At least a link to media type text/html or text/plain should be provided.

Requirement 14 /req/core/fc-md-items

- A For each feature collection provided by the server, an item shall be provided in the property collections.

Permission 3 /per/core/fc-md-items

- A To support servers with many collections, servers may limit the number of items in the property collections.

This document does not specify mechanisms for how clients can best access all collections from servers with many collections. Such mechanisms can be specified in additional parts of OGC API - Features. Options include support for paging and/or filtering.

Recommendation 13 /rec/core/fc-md-self-links

- A For each feature collection included in the response, the links property of the collection should include a link to the URI of the feature collection (relation: self).

NOTE Including the self link in each collection is strongly recommended. It is an oversight that no requirement has been included in the original release of the standard. To avoid a breaking change, this statement is only a recommendation in this document version. Note that the URI can be inferred by clients using the member id of the feature collection, if it is missing, but parsing URIs is not a good practice.

Requirement 15 **/req/core/fc-md-items-links**

- A For each feature collection included in the response, the links property of the collection shall include an item for each supported encoding with a link to the features resource (relation: items).
- B All links shall include the rel and type properties.

Requirement 16 **/req/core/fc-md-extent**

- A For each feature collection, the extent property, if provided, shall provide bounding boxes that include all spatial geometries and time intervals that include all temporal geometries in this collection. The temporal extent may use null values to indicate an open time interval.
- B If a feature has multiple properties with spatial or temporal information, it is the decision of the server whether only a single spatial or temporal geometry property is used to determine the extent or all relevant geometries.

The member spatial only needs to be provided in the extent object if features in the feature collection have spatial properties. The same applies to temporal and features with temporal properties. For example, a feature collection where features have a spatial, but no temporal property will only provide the spatial member.

The spatial and temporal extents support multiple bounding boxes (bbox array) and time intervals (interval array).

The first bounding box/time interval describes the overall spatial/temporal extent of the data. All subsequent bounding boxes and time intervals describe more precise extents, e.g. to identify clusters of data. Clients only interested in the overall extent will only access the first item in each array.

The bbox and interval properties will typically be derived automatically from the feature data and be the exact minimal bounding box/time interval containing the features in the collection (or cluster).

Requirement 17 **/req/core/fc-md-extent-multi**

- A If the extent property includes a member spatial, each feature in the collection shall be inside the extent described by the first bounding box in the bbox array.
- B If the extent property includes a member spatial and the bbox array has more than one item, each feature in the collection shall be inside the extent described by one of the other bounding boxes in the bbox array.
- C If the extent property includes a member temporal, each feature in the collection shall be inside the extent described by the first time interval in the interval array.
- D If the extent property includes a member temporal and the interval array has more than one item, each feature in the collection shall be inside the extent described by one of the other time intervals in the interval array.

Recommendation 14 **/req/core/fc-md-extent-single**

- A While the spatial and temporal extents support multiple bounding boxes (bbox array) and time intervals (interval array) for advanced use cases, implementations should provide only a single bounding box or time interval unless the use of multiple values is important for the use of the dataset and agents using the API are known to be support multiple bounding boxes or time intervals.

Requirement "/req/core/fc-md-extent-multi" and recommendation "/rec/core/fc-md-extent-single" reflect that most clients will only be interested in a single extent, for example, to set the map view or a time slider. They will only have to look at the first item in each array.

At the same time, for some data and for some use cases, a more fine-grained description of the extent will be useful. In that case, the first bounding box/time interval is a union of all the other bounding boxes/time intervals. Clients can then choose whether they want to use the simpler or the more detailed extent information.

EXAMPLE Spatial extent with multiple bounding boxes

The following extent can describe feature data in the United States of America (excluding Territories). The first bounding box of the four bounding boxes is the union of the three other bounding boxes representing the 48 contiguous states, Alaska and Hawaii respectively – from the west-bound longitude of Alaska to the east-bound longitude of the 48 contiguous states.

Note that the overall bounding box as well as the bounding box of Alaska crosses the anti-meridian.

```
{
  "spatial": {
    "bbox": [
      [172.461667, 18.910361, -66.9513812, 71.365162],
      [-124.7844079, 24.7433195, -66.9513812, 49.3457868],
      [172.461667, 51.214183, -129.979511, 71.365162],
      [-178.334698, 18.910361, -154.806773, 28.402123]
    ]
  }
}
```

As can be seen in the example, there can be multiple ways to construct the overall bounding box from its component bounding boxes since longitudes are cyclic (that is, -180° is equal to 180°). Another union of the component bounding boxes for the 48 contiguous states, Alaska and Hawaii would be $[-124.7844079, 18.910361, -129.979511, 71.365162]$, from the west-bound longitude of the 48 contiguous states to the east-bound longitude of Alaska. The typical approach in such cases is to select the option with the smallest area, as was done in the example.

Permission 4 **/per/core/fc-md-extent-extensions**

- A The Core requirements class only specifies requirements for spatial and temporal extents. However, the extent object may be extended with additional members to represent other extents, for example, thermal or pressure ranges.
- B The Core requirements class only supports spatial extents in WGS 84 longitude/latitude and temporal extents in the Gregorian calendar (these are the only enum values in extent.yaml).
- C Extension to the Core requirements class may add additional reference systems to the extent object.

Schema for a feature collection:

```
type: object
required:
  - id
  - links
properties:
  id:
    description: identifier of the collection used, for example, in URIs
    type: string
  title:
    description: human readable title of the collection
    type: string
  description:
    description: a description of the features in the collection
    type: string
  links:
    type: array
    items:
      $ref: http://schemas.opengis.net/ogcapi/features/part1/1.0/openapi/schemas/link.yaml
  extent:
    description: >-
      The extent of the features in the collection. In the Core only spatial and temporal
      extents are specified. Extensions can add additional members to represent other
      extents, for example, thermal or pressure ranges.
```

```

type: object
properties:
  spatial:
    description: >-
      The spatial extent of the features in the collection.
    type: object
    properties:
      bbox:
        description: >-
          One or more bounding boxes that describe the spatial extent of the dataset.
          In the Core only a single bounding box is supported. Extensions can support
          additional areas. If multiple areas are provided, the union of the bounding
          boxes describes the spatial extent.
        type: array
        minItems: 1
        items:
          description: >-
            Each bounding box is provided as four or six numbers, depending on
            whether the coordinate reference system includes a vertical axis
            (height or depth):

            * Lower left corner, coordinate axis 1
            * Lower left corner, coordinate axis 2
            * Minimum value, coordinate axis 3 (optional)
            * Upper right corner, coordinate axis 1
            * Upper right corner, coordinate axis 2
            * Maximum value, coordinate axis 3 (optional)

            If the value consists of four numbers, the coordinate reference system is
            WGS 84 longitude/latitude (http://www.opengis.net/def/crs/OGC/1.3/CRS84)
            unless a different coordinate reference system is specified in `crs`.

            If the value consists of six numbers, the coordinate reference system is
            longitude/latitude/ellipsoidal height (http://www.opengis.net/def/crs/OGC/0/CRS84h)
            unless a different coordinate reference system is specified in `crs`.

            For WGS 84 longitude/latitude the values are in most cases the sequence of
            minimum longitude, minimum latitude, maximum longitude and maximum
            latitude.

            However, in cases where the box spans the antimeridian the first value
            (west-most box edge) is larger than the third value (east-most box edge).

            If the vertical axis is included, the third and the sixth number are
            the bottom and the top of the 3-dimensional bounding box.

            If a feature has multiple spatial geometry properties, it is the decision
            of the server whether only a single spatial geometry property is used to determine
            the extent or all relevant geometries.
          type: array
          oneOf:
            - minItems: 4
              maxItems: 4
            - minItems: 6
              maxItems: 6
          items:
            type: number
          example:
            - -180
            - -90
            - 180
            - 90
        crs:
          description: >-
            Coordinate reference system of the coordinates in the spatial extent
            (property `bbox`). The default reference system is WGS 84 longitude/latitude.
            In the Core the only other supported coordinate reference system is
            WGS 84 longitude/latitude/ellipsoidal height for coordinates with height.
            Extensions can support additional coordinate reference systems and add
            additional enum values.

```

```

    type: string
    enum:
      - 'http://www.opengis.net/def/crs/OGC/1.3/CRS84'
      - 'http://www.opengis.net/def/crs/OGC/0/CRS84h'
    default: 'http://www.opengis.net/def/crs/OGC/1.3/CRS84'
  temporal:
    description: >-
      The temporal extent of the features in the collection.
    type: object
    properties:
      interval:
        description: >-
          One or more time intervals that describe the temporal extent of the dataset.
          The value `null` is supported and indicates an unbounded interval end.
          In the Core only a single time interval is supported. Extensions can support
          multiple intervals. If multiple intervals are provided, the union of the
          intervals describes the temporal extent.
        type: array
        minItems: 1
        items:
          description: >-
            Begin and end times of the time interval. The timestamps are in the
            temporal coordinate reference system specified in `trs`. By default
            this is the Gregorian calendar.
          type: array
          minItems: 2
          maxItems: 2
          items:
            type: string
            format: date-time
            nullable: true
          example:
            - '2011-11-11T12:22:11Z'
            - null
      trs:
        description: >-
          Coordinate reference system of the coordinates in the temporal extent
          (property `interval`). The default reference system is the Gregorian
          calendar.
          In the Core this is the only supported temporal coordinate reference system.
          Extensions can support additional temporal coordinate reference systems and
          additional enum values.
        type: string
        enum:
          - 'http://www.opengis.net/def/uom/ISO-8601/0/Gregorian'
        default: 'http://www.opengis.net/def/uom/ISO-8601/0/Gregorian'
    itemType:
      description: indicator about the type of the items in the collection (the default value
      is 'feature').
      type: string
      default: feature
    crs:
      description: the list of coordinate reference systems supported by the service
      type: array
      items:
        type: string
      default:
        - http://www.opengis.net/def/crs/OGC/1.3/CRS84

```

NOTE 1 The `itemType` property is optional with a default value "feature" to be compatible with implementations that existed before the property was introduced. It is recommended that all implementations explicitly state the `itemType` in the collection object. Other standards that specify other types of data items have to require that the `itemType` is included so there is no ambiguity.

NOTE 2 The CRS property of the collection object is not used by this requirements class, but reserved for future use.

EXAMPLE Feature collections response document.

This feature collections example response in JSON is for a dataset with a single collection "buildings". It includes links to the features resource in all formats that are supported by the service (link relation type: "items").

There is a link to the feature collections response itself (link relation type: "self"). Representations of this resource in other formats are referenced using link relation type "alternate".

An additional link is to a GML application schema for the dataset, using link relation type "describedby".

A bulk download of all the features in the dataset is referenced using link relation type "enclosure".

Finally there are also links to the licence information for the building data (using link relation type "licence").

Reference system information is not provided as the service provides geometries only in the default systems (spatial: WGS 84 longitude/latitude; temporal: Gregorian calendar).

```
{
  "links": [
    { "href": "http://data.example.org/collections.json",
      "rel": "self", "type": "application/json", "title": "this document" },
    { "href": "http://data.example.org/collections.html",
      "rel": "alternate", "type": "text/html", "title": "this document as HTML" },
    { "href": "http://schemas.example.org/1.0/buildings.xsd",
      "rel": "describedby", "type": "application/xml", "title": "GML application schema
for Acme Corporation building data" },
    { "href": "http://download.example.org/buildings.gpkg",
      "rel": "enclosure", "type": "application/geopackage+sqlite3", "title": "Bulk
download (GeoPackage)", "length": 472546 }
  ],
  "collections": [
    {
      "id": "buildings",
      "title": "Buildings",
      "description": "Buildings in the city of Bonn.",
      "extent": {
        "spatial": {
          "bbox": [ [ 7.01, 50.63, 7.22, 50.78 ] ]
        },
        "temporal": {
          "interval": [ [ "2010-02-15T12:34:56Z", null ] ]
        }
      },
      "itemType": "feature",
      "links": [
        { "href": "http://data.example.org/collections/buildings",
          "rel": "self", "title": "This collection" },
        { "href": "http://data.example.org/collections/buildings/items",
          "rel": "items", "type": "application/geo+json",
          "title": "Buildings" },
        { "href": "https://creativecommons.org/publicdomain/zero/1.0/",
          "rel": "license", "type": "text/html",
          "title": "CC0-1.0" },
        { "href": "https://creativecommons.org/publicdomain/zero/1.0/rdf",
          "rel": "license", "type": "application/rdf+xml",
          "title": "CC0-1.0" }
      ]
    }
  ]
}
```

7.13.3 Error situations

See [7.5.1](#) for general guidance.

7.14 Feature collection

7.14.1 Operation

Requirement 18	/req/core/sfc-md-op
A	The server shall support the HTTP GET operation at the path /collections/{collectionId}.
B	The parameter collectionId is each id property in the feature collections response (JSONPath: \$.collections[*].id).

7.14.2 Response

Requirement 19	/req/core/sfc-md-success
A	A successful execution of the operation shall be reported as a response with a HTTP status code 200.
B	The content of that response shall be consistent with the content for this feature collection in the /collections response. That is, the values for id, title, description, extent and item-Type shall be identical and links shall include all links included for this feature collection in the /collections response.

NOTE This requirement implies that the content of that response is based upon the OpenAPI 3.0 schema collection.yaml and that the response can include additional properties or additional links. Note that the property CRS is not included in sub-requirement A since the property is specified by ISO 19168-2.

Recommendation 15	/req/core/sfc-md-links
A	A 200-response should include the following links in the links property of the response: — a link to this response document (relation: self), — a link to the response document in every other media type supported by the server (relation: alternate).
B	All links should include the rel and type link parameters.

NOTE Including the self and alternates links in each collection is strongly recommended. It is an oversight that no requirement has been included in the original release of the standard. To avoid a breaking change, this statement is only a recommendation in this document version.

7.14.3 Error situations

See [7.5.1](#) for general guidance.

If the parameter collectionId does not exist on the server, the status code of the response will be 404 (see [Table 3](#)).

7.15 Features

7.15.1 Operation

Requirement 20	/req/core/fc-op
A	For every feature collection identified in the feature collections response (path /collections), the server shall support the HTTP GET operation at the path /collections/{collectionId}/items.
B	The parameter collectionId is each id property in the feature collections response (JSON-Path: \$.collections[*].id).

7.15.2 Parameter limit

Requirement 21 **/req/core/fc-limit-definition**

A The operation shall support a parameter limit with the following characteristics (using an OpenAPI Specification 3.0 fragment):

```
name: limit
in: query
required: false
schema
  type: integer
  minimum: 1
  maximum: 10000
  default: 10
style: form
explode: false
```

Permission 5 **/per/core/fc-limit-default-minimum-maximum**

A The values for minimum, maximum and default in requirement /req/core/fc-limit-definition are only examples and may be changed.

Requirement 22 **/req/core/fc-limit-response-1**

A The response shall not contain more features than specified by the optional limit parameter.

B If the API definition specifies a maximum value for limit parameter, the response shall not contain more features than this maximum value.

C If the value of the limit parameter is larger than the maximum value, this shall not result in an error (instead use the maximum as the parameter value).

D Only items are counted that are on the first level of the collection. Any nested objects contained within the explicitly requested items shall not be counted.

See [7.15.7](#) for more discussion about the limit parameter.

Permission 6 **/per/core/fc-limit-response-2**

A The server may return less features than requested (but not more).

A template for the definition of the parameter in YAML according to OpenAPI 3.0 is available at [limit.yaml](#).

7.15.3 Parameter bbox

Requirement 23

/req/core/fc-bbox-definition

A The operation shall support a parameter bbox with the following characteristics (using an OpenAPI Specification 3.0 fragment):

```
name: bbox
in: query
required: false
schema:
  type: array
  oneOf:
    - minItems: 4
      maxItems: 4
    - minItems: 6
      maxItems: 6
  items:
    type: number
style: form
explode: false
```

B The bounding box shall be provided as four or six numbers, depending on whether the coordinate reference system includes a vertical axis (height or depth):

- Lower left corner, coordinate axis 1
- Lower left corner, coordinate axis 2
- Minimum value, coordinate axis 3 (optional)
- Upper right corner, coordinate axis 1
- Upper right corner, coordinate axis 2
- Maximum value, coordinate axis 3 (optional)

C If the bounding box consists of four numbers, the coordinate reference system of the values shall be interpreted as WGS 84 longitude/latitude (<http://www.opengis.net/def/crs/OGC/1.3/CRS84>) unless a different coordinate reference system is specified in a parameter bbox-crs.

D If the bounding box consists of six numbers, the coordinate reference system of the values shall be interpreted as WGS 84 longitude/latitude/ellipsoidal height (<http://www.opengis.net/def/crs/OGC/0/CRS84h>) unless a different coordinate reference system is specified in a parameter bbox-crs.

NOTE ISO 19168-2 adds support for other coordinate reference systems that can be used in the bbox parameter through a [parameter bbox-crs] (http://www.opengis.net/doc/IS/ogcapi-features-2/1.0#_parameter_bbox_crs).

Requirement 24

/req/core/fc-bbox-response

A Only features that have a spatial geometry that intersects the bounding box shall be part of the result set, if the bbox parameter is provided.

B If a feature has multiple spatial geometry properties, it is the decision of the server whether only a single spatial geometry property is used to determine the extent or all relevant geometries.

C The bbox parameter shall match all features in the collection that are not also associated with a spatial geometry.

D The coordinate values shall be within the extent specified for the coordinate reference system.

"Intersects" means that the rectangular area specified in the parameter bbox includes a coordinate that is part of the (spatial) geometry of the feature. This includes the boundaries of the geometries (e.g. for curves the start and end position and for surfaces the outer and inner rings).

In case of a degenerated bounding box, the resulting geometry is used. For example, if the lower left corner is the same as the upper right corner, all features match where the geometry intersects with this point.

This standard does not specify requirements for the parameter `bbox-crs`, which adds support for other CRS that can be used in the `bbox` parameter. See ISO 19168-2 for the specification of the [parameter `bbox-crs`] (http://www.opengis.net/doc/IS/ogcapi-features-2/1.0#_parameter_bbox_crs).

For WGS 84 longitude/latitude the bounding box is in most cases the sequence of minimum longitude, minimum latitude, maximum longitude and maximum latitude. However, in cases where the box spans the anti-meridian the first value (west-most box edge) is larger than the third value (east-most box edge).

EXAMPLE The bounding box of the New Zealand Exclusive Economic Zone

The bounding box of the New Zealand Exclusive Economic Zone in WGS 84 (from 160.6°E to 170°W and from 55.95°S to 25.89°S) would be represented in JSON as [160.6, -55.95, -170, -25.89] and in a query as `bbox=160.6,-55.95,-170,-25.89`.

Note that according to the requirement to return an error for an invalid parameter value, the server will return an error if a latitude value of 160.0 is used.

If the vertical axis is included, the third and the sixth number are the bottom and the top of the 3-dimensional bounding box.

A template for the definition of the parameter in YAML according to OpenAPI 3.0 is available at `bbox.yaml`.

7.15.4 Parameter `datetime`

Requirement 25 `/req/core/fc-time-definition`

A The operation shall support a parameter `datetime` with the following characteristics (using an OpenAPI Specification 3.0 fragment):

```
name: datetime
in: query
required: false
schema:
  type: string
style: form
explode: false
```

Requirement 25 `/req/core/fc-time-response`

A Only features that have a temporal geometry that intersects the temporal information in the `datetime` parameter shall be part of the result set, if the parameter is provided.

B If a feature has multiple temporal properties, it is the decision of the server whether only a single temporal property is used to determine the extent or all relevant temporal properties.

C The `datetime` parameter shall also match all features in the collection that are not associated with a temporal geometry.

- D Temporal geometries are either a date-time value or a time interval. The parameter value shall conform to the following syntax (using ABNF):
- ```

interval-closed = date-time "/" date-time
interval-open-start = [".."] "/" date-time
interval-open-end = date-time "/" [".."]
interval = interval-closed / interval-open-start / interval-open-end
datetime = date-time / interval

```
- E The syntax of date-time is specified by RFC 3339, 5.6.
- F Open ranges in time intervals at the start or end are supported using a double-dot (..) or an empty string for the start/end.

"Intersects" means that the time (instant or interval) specified in the parameter `datetime` includes a timestamp that is part of the temporal geometry of the feature (again, a time instant or interval). For time intervals this includes the start and end time.

NOTE The interval notation is taken from ISO 8601-2. ISO 8601-2 distinguishes between bounded start/end timestamps (double-dot) and unknown start/end timestamps (empty string). For queries, an unknown start/end has the same effect as an unbounded start/end.

EXAMPLE 1 A date-time

February 12, 2018, 23:20:52 UTC:

`datetime=2018-02-12T23%3A20%3A52Z`

For features with a temporal property that is a timestamp (like `lastUpdate` in the building features), a date-time value would match all features where the temporal property is identical.

For features with a temporal property that is a date or a time interval, a date-time value would match all features where the timestamp is on that day or within the time interval.

EXAMPLE 2 Intervals

February 12, 2018, 00:00:00 UTC to March 18, 2018, 12:31:12 UTC:

`datetime=2018-02-12T00%3A00%3A00Z%2F2018-03-18T12%3A31%3A12Z`

February 12, 2018, 00:00:00 UTC or later:

`datetime=2018-02-12T00%3A00%3A00Z%2F..` or `datetime=2018-02-12T00%3A00%3A00Z%2F`

March 18, 2018, 12:31:12 UTC or earlier:

`datetime=..%2F2018-03-18T12%3A31%3A12Z` or `datetime=%2F2018-03-18T12%3A31%3A12Z`

For features with a temporal property that is a timestamp (like `lastUpdate` in the building features), a time interval would match all features where the temporal property is within the interval.

For features with a temporal property that is a date or a time interval, a time interval would match all features where the values overlap.

A template for the definition of the parameter in YAML according to OpenAPI 3.0 is available at <https://schemas.opengis.net/ogcapi/features/part1/1.0/openapi/parameters/datetime.yaml>.

### 7.15.5 Parameters for filtering on feature properties

#### Recommendation 16 /rec/core/fc-filters

A If features in the feature collection include a feature property that has a simple value (for example, a string or integer) that is expected to be useful for applications using the service to filter the features of the collection based on this property, a parameter with the name of the feature property and with the following characteristics (using an OpenAPI Specification 3.0 fragment) should be supported:

```
in: query
required: false
style: form
explode: false
```

The schema property should be the same as the definition of the feature property in the response schema.

EXAMPLE 1 An additional parameter to filter buildings based on their function.

```
name: function
in: query
description: >-
 Only return buildings of a particular function.\

 Default = return all buildings.
required: false
schema:
 type: string
 enum:
 - residential
 - commercial
 - public use
style: form
explode: false
example: 'function=public+use'
```

EXAMPLE 2 An additional parameter to filter buildings based on their name.

```
name: name
in: query
description: >-
 Only return buildings with a particular name. Use '*' as a wildcard.\

 Default = return all buildings.
required: false
schema:
 type: string
style: form
explode: false
example: 'name=A*'
```

For string-valued properties, servers could support wildcard searches. The example included in the OpenAPI fragment would search for all buildings with a name that starts with "A."

### 7.15.6 Combinations of filter parameters

Any combination of bbox, datetime and parameters for filtering on feature properties is allowed. Note that the requirements on these parameters imply that only features matching all the predicates are in the result set; i.e. the logical operator between the predicates is "AND."

### 7.15.7 Response

#### **Requirement 27** /req/core/fc-response

- A A successful execution of the operation shall be reported as a response with a HTTP status code 200.
- B The response shall only include features selected by the request.

The number of features returned depends on the server and the parameter limit.

- The client can request a limit it is interested in.
- The server likely has a default value for the limit, and a maximum limit.
- If the server has any more results available than it returns (the number it returns is less than or equal to the requested/default/maximum limit) then the server will include a link to the next set of results.

So (using the default/maximum values of 10/10000 from the OpenAPI fragment in requirement /req/core/fc-limit-definition):

- asking for 10 will return 0 to 10 (as requested) and if there are more, a next link;
- asking without a limit will return 0 to 10 (default) and if there are more, a next link;
- asking for 50000 will return up to 10000 (server-limited) and if there are more, a next link;
- following the next link from the previous response will return up to 10000 additional features and if there are more, a next link.

#### **Requirement 28** /req/core/fc-links

- A A 200-response shall include the following links:
- a link to this response document (relation: self),
  - a link to the response document in every other media type supported by the service (relation: alternate).

#### **Recommendation 17** /rec/core/fc-next-1

- A A 200-response should include a link to the next "page" (relation: next), if more features have been selected than returned in the response.

#### **Recommendation 18** /rec/core/fc-next-2

- A De-referencing a next link should return additional features from the set of selected features that have not yet been returned.

#### **Recommendation 19** /rec/core/fc-next-3

- A The number of features in a response to a next link should follow the same rules as for the response to the original query and again include a next link, if there are more features in the selection that have not yet been returned.

This document does not mandate any specific implementation approach for the next links.

An implementation could use opaque links that are managed by the server. It is up to the server to determine how long these links can be de-referenced. Clients have to be prepared to receive a 404 response.

Another implementation approach is to use an implementation-specific parameter that specifies the index within the result set from which the server begins presenting results in the response, like the startIndex parameter that was used in WFS 2.0 (and which could be added again in additional parts of the OGC API Features series).

The API will return no next link, if it has returned all selected features, and the server knows that. However, the server can be unaware that it has already returned all selected features. For example, if the request states limit=10 and the query to the backend datastore returns 10 features, the server will potentially not know if there are more features or not (in most cases there will be more features), unless the total number of matches is also computed, which can be too costly. The server will then add the next link, and if there are no more features, dereferencing the next link will return an empty feature collection and no next link. This behaviour is consistent with the statements above.

Clients cannot assume that paging is safe against changes to dataset while a client iterates through next links. If a server provides opaque links these could be safe and maintain the dataset state during the original request. Using a parameter for the start index, however, will not be safe.

Additional requirements classes for safe paging or an index parameter may be added in extensions to this specification.

**Permission 7**                      **/per/core/fc-prev**

A                                      A response to a next link may include a prev link to the resource that included the next link.

Providing prev links supports navigating back and forth between pages. But, depending on the implementation approach, it can be too complex to implement.

**Requirement 29**    **/req/core/fc-rel-type**

A                                      All links shall include the rel and type link parameters.

**Requirement 30**    **/req/core/fc-timeStamp**

A                                      If a property timeStamp is included in the response, the value shall be set to the time stamp when the response was generated.

**Requirement 31**    **/req/core/fc-numberMatched**

A                                      If a property numberMatched is included in the response, the value shall be identical to the number of features in the feature collections that match the selection parameters like bbox, datetime, or additional filter parameters.

B                                      A server may omit this information in a response, if the information about the number of matching features is not known or difficult to compute.

**Requirement 32**    **/req/core/fc-numberReturned**

A                                      If a property numberReturned is included in the response, the value shall be identical to the number of features in the response.

B                                      A server may omit this information in a response, if the information about the number of features in the response is not known or difficult to compute.

**Recommendation 20**    **/rec/core/fc-extent**

A                                      If the response is a partial, paged response (i.e. the number of features in the response is less than the number of features that match the selection parameters) and the response includes information about the extent of the response (e.g. the member bbox in a GeoJSON feature collection), the extent should be the extent of the complete result set, not the extent of the features in the response/page.

**NOTE**            The representation of the links and the other properties in the payload depends on the encoding of the feature collection.

**EXAMPLE**            Links

If the request is to return building features and "10" is the default limit, the links in the response could be as follows (in this example represented as link headers and using an additional parameter offset to implement next links, and the optional prev links):

```
Link: <http://data.example.org/collections/buildings/items.json>;
rel="self"; type="application/geo+json"
Link: <http://data.example.org/collections/buildings/items.html>;
rel="alternate"; type="text/html"
Link: <http://data.example.org/collections/buildings/items.json?offset=10>;
rel="next"; type="application/geo+json"
```

Following the next link could return:

```
Link: <http://data.example.org/collections/buildings/items.json?offset=10>;
rel="self"; type="application/geo+json"
Link: <http://data.example.org/collections/buildings/items.html?offset=10>;
rel="alternate"; type="text/html"
Link: <http://data.example.org/collections/buildings/items.json?offset=0>;
rel="prev"; type="application/geo+json"
Link: <http://data.example.org/collections/buildings/items.json?offset=20>;
rel="next"; type="application/geo+json"
```

If an explicit limit of "50" is used, the links in the response could be:

```
Link: <http://data.example.org/collections/buildings/items.json?limit=50>;
rel="self"; type="application/geo+json"
Link: <http://data.example.org/collections/buildings/items.html?limit=50>;
rel="alternate"; type="text/html"
Link: <http://data.example.org/collections/buildings/items.json?limit=50&offset=50>;
rel="next"; type="application/geo+json"
```

Following the next link could return:

```
Link: <http://data.example.org/collections/buildings/items.json?limit=50&offset=50>;
rel="self"; type="application/geo+json"
Link: <http://data.example.org/collections/buildings/items.html?limit=50&offset=50>;
rel="alternate"; type="text/html"
Link: <http://data.example.org/collections/buildings/items.json?limit=50&offset=0>;
rel="prev"; type="application/geo+json"
Link: <http://data.example.org/collections/buildings/items.json?limit=50&offset=100>;
rel="next"; type="application/geo+json"
```

## 7.15.8 Error situations

See [7.5.1](#) for general guidance.

If the path parameter `collectionId` does not exist on the server, the status code of the response will be 404.

A 400 will be returned in the following situations:

- if query parameter `limit` is not an integer or not between minimum and maximum;
- if query parameter `bbox` does not have 4 (or 6) numbers or they do not form a bounding box;
- if parameter `datetime` is not a valid time stamp or time interval.

## 7.16 Feature

### 7.16.1 Operation

#### Requirement 33 /req/core/f-op

A For every feature in a feature collection (path `/collections/{collectionId}`), the server shall support the HTTP GET operation at the path `/collections/{collectionId}/items/{featureId}`.

B The parameter `collectionId` is each `id` property in the feature collections response (JSONPath: `$.collections[*].id`). `featureId` is a local identifier of the feature.

NOTE The representation of the `featureId` in the response payload depends on the feature encoding.

**Permission 8** `/per/core/f-id`

A The Core requirements class only requires that the feature URI is unique. Implementations may apply stricter rules and, for example, use unique `id` values per dataset or collection.

## 7.16.2 Response

**Requirement 34** `/req/core/f-success`

A A successful execution of the operation shall be reported as a response with a HTTP status code 200.

**Requirement 34** `/req/core/f-links`

A A 200-response shall include the following links in the response:

- a link to the response document (relation: self),
- a link to the response document in every other media type supported by the service (relation: alternate), and
- a link to the feature collection that contains this feature (relation: collection).

B All links shall include the `rel` and `type` link parameters.

NOTE The representation of the links in the payload will depend on the encoding of the feature.

**EXAMPLE 12** Links

The links in a feature could be (in this example represented as link headers):

```
Link: <http://data.example.org/collections/buildings/items/123.json>;
rel="self"; type="application/geo+json"
Link: <http://data.example.org/collections/buildings/items/123.html>;
rel="alternate"; type="text/html"
Link: <http://data.example.org/collections/buildings.json>;
rel="collection"; type="application/json"
Link: <http://data.example.org/collections/buildings.html>;
rel="collection"; type="text/html"
```

## 7.16.3 Error situations

See [7.5.1](#) for general guidance.

If the path parameter `collectionId` or the path parameter `featureId` do not exist on the server, the status code of the response will be 404.

# 8 Requirements classes for encodings

## 8.1 Overview

This clause specifies four pre-defined requirements classes for encodings to be used by an OGC API - Features implementation. These encodings are commonly used encodings for spatial data on the Web:

— HTML

- GeoJSON
- Geography Markup Language (GML), Simple Features Profile, Level 0
- Geography Markup Language (GML), Simple Features Profile, Level 2

None of these encodings are mandatory and an implementation of the Core requirements class can also implement none of them but implement another encoding instead.

The Core requirements class includes recommendations to support HTML and GeoJSON as encodings, where practical. [Clause 6](#) includes a discussion about recommended encodings.

## 8.2 Requirements class "HTML"

Geographic information that is only accessible in formats like GeoJSON or GML has two issues:

- The data is not discoverable using the most common mechanism for discovering information, that is the search engines of the Web.
- The data cannot be viewed directly in a browser. Additional tools are required to view the data.

Therefore, sharing data on the Web will benefit from also publishing the data in HTML. To maintain consistency with the Web, it is important to execute this in a manner that allows both users and search engines to access all data (this is discussed in detail in Reference [7]). This document therefore recommends supporting HTML as an encoding.

### Requirements class

<http://www.opengis.net/spec/ogcapi-features-1/1.0/req/html>

|             |                           |
|-------------|---------------------------|
| Target type | Web API                   |
| Dependency  | Requirements class "Core" |
| Dependency  | HTML5                     |
| Dependency  | schema.org                |

### Requirement 36 /req/html/definition

- A Every 200-response of an operation of the server shall support the media type text/html.

### Requirement 37 /req/html/content

- A Every 200-response of the server with the media type text/html SHALL be a HTML 5 document that includes the following information in the HTML body:
- all information identified in the schemas of the Response Object in the HTML <body>, and
  - all links in HTML <a> elements in the HTML <body>.

### Recommendation 21 /rec/html/schema-org

- A A 200-response with the media type text/html should include schema.org annotations.

## 8.3 Requirements class "GeoJSON"

GeoJSON is a commonly used format that is simple to understand and well supported by tools and software libraries. Since most Web developers are comfortable with using a JSON-based format, supporting GeoJSON is recommended, if the feature data can be represented in GeoJSON for the intended use.

## Requirements class

<http://www.opengis.net/spec/ogcapi-features-1/1.0/req/geojson>

|             |                           |
|-------------|---------------------------|
| Target type | Web API                   |
| Dependency  | Requirements class "Core" |
| Dependency  | GeoJSON                   |

### Requirement 38 /req/geojson/definition

- A 200-responses of the server shall support the following media types:
- application/geo+json for resources that include feature content, and
  - application/json for all other resources.

### Requirement 39 /req/geojson/content

- A Every 200-response with the media type application/geo+json shall be:
- a GeoJSON FeatureCollection Object for features, and
  - a GeoJSON Feature Object for a single feature.
- B The id member of the GeoJSON feature object that is the response to a GET request to a Feature resource shall be the same as the featureId path parameter in the request.
- C The links specified in the requirements /req/core/fc-links and /req/core/f-links shall be added in an extension property (foreign member) with the name links.
- D The schema of all responses with the media type application/json shall conform with the JSON Schema specified for the resource in the Core requirements class.

Templates for the definition of the schemas for the GeoJSON responses in OpenAPI definitions are available at featureCollectionGeoJSON.yaml and featureGeoJSON.yaml. These are generic schemas that do not include any application schema information about specific feature types or their properties.

#### EXAMPLE 1 A GeoJSON FeatureCollection Object response

In the example below, only the first and tenth feature is shown. Coordinates are not shown.

```
{
 "type" : "FeatureCollection",
 "links" : [{
 "href" : "http://data.example.com/collections/buildings/items?f=json",
 "rel" : "self",
 "type" : "application/geo+json",
 "title" : "this document"
 }, {
 "href" : "http://data.example.com/collections/buildings/items?f=html",
 "rel" : "alternate",
 "type" : "text/html",
 "title" : "this document as HTML"
 }, {
 "href" : "http://data.example.com/collections/buildings/items?f=json&offset=10&limit=10",
 "rel" : "next",
 "type" : "application/geo+json",
 "title" : "next page"
 }],
 "timestamp" : "2018-04-03T14:52:23Z",
 "numberMatched" : 123,
 "numberReturned" : 10,
```

```

"features" : [{
 "type" : "Feature",
 "id" : "123",
 "geometry" : {
 "type" : "Polygon",
 "coordinates" : [...]
 },
 "properties" : {
 "function" : "residential",
 "floors" : "2",
 "lastUpdate" : "2015-08-01T12:34:56Z"
 }
}, { ...
}, {
 "type" : "Feature",
 "id" : "132",
 "geometry" : {
 "type" : "Polygon",
 "coordinates" : [...]
 },
 "properties" : {
 "function" : "public use",
 "floors" : "10",
 "lastUpdate" : "2013-12-03T10:15:37Z"
 }
}]
}

```

#### EXAMPLE 2 A GeoJSON Feature Object response

In the example below, coordinates are not shown.

```

{
 "type" : "Feature",
 "links" : [{
 "href" : "http://data.example.com/collections/buildings/items/123?f=json",
 "rel" : "self",
 "type" : "application/json",
 "title" : "this document"
 }, {
 "href" : "http://data.example.com/collections/buildings/items/123?f=html",
 "rel" : "alternate",
 "type" : "text/html",
 "title" : "this document as HTML"
 }, {
 "href" : "http://data.example.com/collections/buildings",
 "rel" : "collection",
 "type" : "application/json",
 "title" : "the collection document"
 }],
 "id" : "123",
 "geometry" : {
 "type" : "Polygon",
 "coordinates" : [...]
 },
 "properties" : {
 "function" : "residential",
 "floors" : "2",
 "lastUpdate" : "2015-08-01T12:34:56Z"
 }
}

```

## 8.4 Requirements class "Geography Markup Language (GML), Simple Features Profile, Level 0"

In addition to HTML and GeoJSON, a significant volume of feature data is available in XML-based formats, notably GML. Therefore, this document specifies requirements classes for GML. The Simple Features Profile, Level 0, is the simplest profile of GML and is typically supported by tools.

The GML Simple Features Profile is restricted to data with 2D geometries with linear/planar interpolation (points, line strings, polygons). In addition, the Level 0 profile is limited to features that can be stored in a tabular data structure.

## Requirements class

<http://www.opengis.net/spec/ogcapi-features-1/1.0/req/gmlsf0>

|             |                                                                   |
|-------------|-------------------------------------------------------------------|
| Target type | Web API                                                           |
| Dependency  | Requirements class "Core"                                         |
| Dependency  | Geography Markup Language (GML), Simple Features Profile, Level 0 |

### Requirement 40 /req/gmlsf0/definition

- A 200-responses of the server shall support the following media types:
- application/gml+xml; version=3.2; profile=<http://www.opengis.net/def/profile/ogc/2.0/gml-sf0> for resources that include feature content,
  - application/xml for all other resources.

### Requirement 41 /req/gmlsf0/content

- A [Table 4](#) specifies the XML document root element that the server shall return in a 200-response for each resource.
- B The gml:id XML attribute of a GML feature element that is the response to a GET request to a Feature resource shall be the same as the featureId path parameter in the request.
- C Every representation of a feature shall conform to the GML Simple Features Profile, Level 0 and be substitutable for gml:AbstractFeature.
- D The schema of all responses with a root element in the core namespace shall validate against the OGC API Features Core XML Schema.

### Requirement 42 /req/gmlsf0/headers

- A If a property timeStamp is included in the response, its value shall be reported using the HTTP header named Date (see RFC 7231, 7.1.1.2).
- B If a property numberMatched is included in the response, its value shall be reported using an HTTP header named OGC-NumberMatched.
- C If a property numberReturned is included in the response, its value shall be reported using an HTTP header named OGC-NumberReturned.
- D If links are included in the response, each link shall be reported using an HTTP header named Link (see RFC 8288, Clause 3).

Note that the requirement /req/gmlsf0/headers exists for GML-SF0 (and /req/gmlsf2/headers for GML-SF2), but not for GeoJSON, because the rules for feature collections in the GML Simple Features Profile does not allow this information to be included in the payload. The information, therefore, has to be provided in the HTTP headers. An implementation can provide these headers for other encodings, too.

**Table 4 — Media types and XML elements for each resource**

| Resource                | Path                                          | XML root element                                                      |
|-------------------------|-----------------------------------------------|-----------------------------------------------------------------------|
| Landing page            | /                                             | core:LandingPage                                                      |
| Conformance declaration | /conformance                                  | core:ConformsTo                                                       |
| Feature collections     | /collections                                  | core:Collections                                                      |
| Feature collection      | /collections/{collectionId}                   | core:Collections, with just one entry for the collection collectionId |
| Features                | /collections/{collectionId}/items             | sf:FeatureCollection                                                  |
| Feature                 | /collections/{collectionId}/items/{featureId} | substitutable for gml:Abstract-Feature                                |

The namespace prefixes used above and in the OGC API Features Core XML schemas are:

- core: <http://www.opengis.net/ogcapi-features-1/1.0>
- sf: <http://www.opengis.net/ogcapi-features-1/1.0/sf>
- gml: <http://www.opengis.net/gml/3.2>
- atom: <https://www.w3.org/2005/Atom>
- xlink: <https://www.w3.org/1999/xlink>

The mapping of the content from the responses specified in the Core requirements class to the XML is straightforward. All links have to be encoded as HTTP header Link.

See [6.3](#) for links to example responses in XML.

## 8.5 Requirements class "Geography Markup Language (GML), Simple Features Profile, Level 2"

The difference between this requirements class and the Level 0 requirements class is that non-spatial feature properties are not restricted to atomic values (strings, numbers, etc.).

### Requirements class

<http://www.opengis.net/spec/ogcapi-features-1/1.0/req/gmlsf2>

Target type Web API

Dependency Requirements class "Core"

Dependency Geography Markup Language (GML), Simple Features Profile, Level 2

### Requirement 43 /req/gmlsf2/definition

A 200-responses of the server shall support the following media types:

- application/gml+xml; version=3.2; profile=<http://www.opengis.net/def/profile/ogc/2.0/gml-sf2> for resources that include feature content,
- application/xml for all other resources.

### Requirement 44 /req/gmlsf2/content

A The requirement /req/gmlsf0/content applies, too, with the following changes:

- All references to media type application/gml+xml; version=3.2; profile= <http://www.opengis.net/def/profile/ogc/2.0/gml-sf0> are replaced by application/gml+xml; version=3.2; profile=<http://www.opengis.net/def/profile/ogc/2.0/gml-sf2>.
- All references to "GML Simple Features Profile, Level 0" are replaced by "GML Simple Features Profile, Level 2".

**Requirement 45**      **/req/gmlsf2/headers**

A                      The requirement /req/gmlsf0/headers applies.

## 9 Requirements class "OpenAPI 3.0"

### 9.1 Basic requirements

Servers conforming to this requirements class define their API by an OpenAPI Document.

**Requirements class**

<http://www.opengis.net/spec/ogcapi-features-1/1.0/req/oas30>

|             |                           |
|-------------|---------------------------|
| Target type | Web API                   |
| Dependency  | Requirements class "Core" |
| Dependency  | OpenAPI Specification 3.0 |

**Requirement 46**      **/req/oas30/oas-definition-1**

A                      The content of the response of the HTTP GET operation at the landing page shall include the following links to the API definition:

- relation type service-desc and content type application/vnd.oai.openapi+json;version=3.0,
- relation type service-doc and content type text/html.

The requirements /req/core/root-success and /req/core/api-definition-success in the Core requirements class require that the API definition documents are referenced from the landing page.

**Requirement 47**      **/req/oas30/oas-definition-2**

A                      The JSON representation shall conform to the OpenAPI Specification, version 3.0.

OpenAPI definitions can be created using different approaches. A typical example is the representation of the feature collections. One approach is to use a path parameter collectionId, i.e. the API definition has only a single path entry for all feature collections. Another approach is to explicitly define each feature collection in a separate path and without a path parameter, which allows the specification of filter parameters or explicit feature schemas per feature collection. Both approaches are valid.

**Requirement 48**      **/req/oas30/oas-impl**

A                      The server shall implement all capabilities specified in the OpenAPI definition.

## 9.2 Complete definition

### Requirement 49 /req/oas30/completeness

- A The OpenAPI definition shall specify for each operation all HTTP Status Codes and Response Objects that the server uses in responses.
- B This includes the successful execution of an operation as well as all error situations that originate from the server.

Note that servers that, for example, are access-controlled (see Security), support web cache validation, CORS, or that use HTTP redirection will make use of additional HTTP status codes beyond regular codes such as 200 for successful GET requests and 400, 404 or 500 for error situations. See HTTP status codes.

Clients have to be prepared to receive responses not documented in the OpenAPI definition. For example, additional errors can occur in the transport layer outside of the server.

## 9.3 Exceptions

### Requirement 50 /req/oas30/exceptions-codes

- A For error situations that originate from the server, the API definition shall cover all applicable HTTP Status Codes.

EXAMPLE An exception response object definition

```
description: An error occurred.
content:
 application/json:
 schema:
 $ref:
```

```
http://schemas.opengis.net/ogcap/features/part1/1.0/openapi/schemas/exception.yaml
text/html:
 schema:
 type: string
```

## 9.4 Security

### Requirement 51 /req/oas30/security

- A For cases where the operations of the server are access-controlled, the security scheme(s) shall be documented in the OpenAPI definition.

The OpenAPI specification currently supports the following security schemes:

- HTTP authentication,
- an API key (either as a header or as a query parameter),
- OAuth2's common flows (implicit, password, application and access code) as defined in RFC 6749, and
- OpenID Connect Discovery.

## 9.5 Features

### Recommendation 22 /rec/oas30/f-key-properties

- A The schema for the Response Objects of the HTTP GET operation for features should include key feature properties of the features in that feature collection.  
This is particularly helpful if filter parameters are defined for the collection (see recommendation /rec/core/fc-filters).

## 10 Media types

JSON media types that would typically be used in a server that supports JSON are:

- application/geo+json for feature collections and features, and
- application/json for all other resources.

XML media types that would typically occur in a server that supports XML are:

- application/gml+xml;version=3.2 for any GML [3.2](#) feature collections and features,
- application/gml+xml;version=3.2;profile="<http://www.opengis.net/def/profile/ogc/2.0/gml-sf0>" for GML [3.2](#) feature collections and features conforming to the GML Simple Feature Level 0 profile,
- application/gml+xml;version=3.2;profile="<http://www.opengis.net/def/profile/ogc/2.0/gml-sf2>" for GML [3.2](#) feature collections and features conforming to the GML Simple Feature Level 2 profile, and
- application/xml for all other resources.

The typical HTML media type for all "web pages" in a server would be text/html.

The media type for an OpenAPI 3.0 definition is application/vnd.oai.openapi+json;version=3.0 (JSON) or application/vnd.oai.openapi;version=3.0 (YAML).

NOTE The OpenAPI media types have not been registered yet with IANA and can change in the future.

## 11 Security Considerations

### 11.1 General

A Web API is a powerful tool for sharing information and analysis resources. It also provides many avenues for unscrupulous users to attack those resources. Designers and developers of Web APIs should be familiar with the potential vulnerabilities and how to address them.

A valuable resource is the Common Weakness Enumeration (CWE) registry at <https://cwe.mitre.org/data/index.html>. The CWE is organized around three views; Research, Architectural and Development.

- Research: facilitates research into weaknesses and can be leveraged to systematically identify theoretical gaps within CWE.
- Architectural: organizes weaknesses according to common architectural security tactics. It is intended to assist architects in identifying potential mistakes that can be made when designing software.
- Development: organizes weaknesses around concepts that are frequently used or encountered in software development.

API developers are expected to focus on the Development view. These vulnerabilities primarily deal with the details of software design and implementation.

API designers are expected to focus primarily on the Architectural view. However, there are critical vulnerabilities described in the Development view which are also relevant to API design. Vulnerabilities described under the following categories are particularly important:

- Pathname Traversal and Equivalence Errors,
- Channel and Path Errors, and
- Web Problems.

Many of the vulnerabilities described in the CWE are introduced through the HTTP protocol. API designers and developers are expected to be familiar with how the HTTP 1.1 addresses these vulnerabilities. This information can be found in the "Security Considerations" sections of the IETF RFCs 7230 to 7235.

The following subclauses describe some of the most serious vulnerabilities which can be mitigated by the API designer and developer. These are high-level generalizations of the more detailed vulnerabilities described in the CWE.

## 11.2 Multiple access routes

APIs deliver a representation of a resource. OGC Web APIs can deliver multiple representations (formats) of the same resource. An attacker can find that information which is prohibited in one representation can be accessed through another. API designers are expected to take care that the access controls on their resources are implemented consistently across all representations. That does not mean that they have to be the same. For example, consider the following.

- HTML vs. GeoTIFF – The HTML representation could consist of a text description of the resource accompanied by a thumbnail image. This has less information than the GeoTIFF representation and could be subject to more liberal access policies.
- Data Centric Security – This describes techniques to embed access controls into the representation itself. A GeoTIFF with Data Centric Security would have more liberal access policies than a GeoTIFF without.

In a properly secured Web API, the information content of the resources exposed by an API is protected to the same level across all access routes.

## 11.3 Multiple servers

The implementation of an API can span a number of servers. Each server is an entry point into the API. Without careful management, information which is not accessible through one server can be accessible through another.

The information flows through the API has to be understood. It has to be verified that information is properly protected along all access paths.

## 11.4 Path manipulation on GET

RFC 2626, 15.2 states "If an HTTP server translates HTTP URIs directly into file system calls, the server must take special care not to serve files that were not intended to be delivered to HTTP clients." The threat is that an attacker could use the HTTP path to access sensitive data, such as password files, which could be used to further subvert the server.

All GET URLs have to be verified to make sure the request is not trying to access resources that are not meant to be accessed.

## 11.5 Path manipulation on PUT and POST

A transaction operation adds new resources or updates existing resources on the API. This capability provides a whole new set of tools to an attacker.

Many of the resources exposed through an OGC API include hyperlinks to other resources. API clients follow these hyperlinks to access new resources or alternate representations of a resource. Once a client authenticates to an API, they tend to trust the data returned by that API. However, a resource posted by an attacker could contain hyperlinks which contain an attack. For example, the link to an alternate representation could require the client to re-authenticate prior to passing them on to the original destination. The client sees the representation they asked for and the attacker collects the clients' authentication credentials.

APIs which support transaction operations are expected to validate that an update does not contain any malignant content prior to exposing it through the API.

## Annex A (normative)

### Abstract test suite

#### A.1 General

OGC API - Features is not a Web Service in the traditional sense. Rather, it defines the behaviour and content of a set of Resources exposed through a Web Application Programming Interface (Web API). Therefore, an API can expose resources in addition to those defined by this document. A test engine is expected to be able to traverse the API, identify and validate test points, and ignore resource paths which are not to be tested.

#### A.2 Conformance class core

##### Conformance class

<http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/core>

Target type

Web API

Requirements class

Requirements Class "Core"

##### A.2.1 General tests

###### A.2.1.1 HTTP

###### Abstract test 1 /conf/core/http

Test purpose Validate that the resource paths advertised through the API conform with HTTP 1.1 and, where appropriate, TLS.

Requirement /req/core/http

- Test method
- 1) All compliance tests have to be configured to use the HTTP 1.1 protocol exclusively.
  - 2) For APIs which support HTTPS, all compliance tests have to be configured to use HTTP over TLS (RFC 2818) with their HTTP 1.1 protocol.

###### A.2.1.2 CRS 84

###### Abstract test 2 /conf/core/crs84

Test purpose Validate that all spatial geometries provided through the API are in the CRS84 or CRS84h coordinate reference system unless otherwise requested by the client.

Requirement /req/core/crs84

- Test method
- 1) Do not specify a coordinate reference system in any request. All spatial data is expected to be in the CRS84 or CRS84h reference system.
  - 2) Validate retrieved spatial data using the CRS84 reference system (for 2D geometries) or the CRS84h reference system (for 3D geometries).

### A.2.2 Landing page {root}/

**Abstract test 3**      **/conf/core/root-op**

Test purpose      Validate that a landing page can be retrieved from the expected location.

Requirement      /req/core/root-op

Test method      1) Issue an HTTP GET request to the URL {root}/.

2) Validate that a document was returned with a status code 200.

3) Validate the contents of the returned document using test /conf/core/root-success.

**Abstract test 4**      **/conf/core/root-success**

Test purpose      Validate that the landing page complies with the require structure and contents.

Requirement      /req/core/root-success

Test method      Validate the landing page for all supported media types using the resources and tests identified in [Table A.1](#):

For formats that require manual inspection, perform the following:

- 1) Validate that the landing page includes a "service-desc" and/or "service-doc" link to an API Definition.
- 2) Validate that the landing page includes a "conformance" link to the conformance class declaration.
- 3)) Validate that the landing page includes a "data" link to the Feature contents.

The landing page can be retrieved in a number of different formats. The following table identifies the applicable schema document for each format and the test to be used to validate the landing page against that schema. Exercise all supported formats.

**Table A.1 — Schema and tests for landing pages**

| Format  | Schema document                    | Test ID               |
|---------|------------------------------------|-----------------------|
| HTML    | landingPage.yaml                   | /conf/html/content    |
| GeoJSON | landingPage.yaml                   | /conf/geojson/content |
| GMLSF0  | core.xsd, element core:LandingPage | /conf/gmlsf0/content  |
| GMLSF2  | core.xsd, element core:LandingPage | /conf/gmlsf2/content  |

### A.2.3 API definition path {root}/api (link)

**Abstract test 5**      **/conf/core/api-definition-op**

Test purpose      Validate that the API Definition document can be retrieved from the expected location.

Requirement      /req/core/api-definition-op

Test method      1) Construct a path for each API Definition link on the landing page.

2) Issue a HTTP GET request on each path.

3) Validate that a document was returned with a status code 200.

4) Validate the contents of the returned document using test /conf/core/api-definition-success.

|                        |                                                                                     |
|------------------------|-------------------------------------------------------------------------------------|
| <b>Abstract test 6</b> | <b>/conf/core/api-definition-success</b>                                            |
| Test purpose           | Validate that the API Definition complies with the required structure and contents. |
| Requirement            | /req/core/api-definition-success                                                    |
| Test method            | Validate the API Definition document against an appropriate schema document.        |

#### A.2.4 Conformance path {root}/conformance

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Abstract test 7</b> | <b>/conf/core/conformance-op</b>                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Test purpose           | Validate that a Conformance Declaration can be retrieved from the expected location.                                                                                                                                                                                                                                                                                                                                                                  |
| Requirement            | /req/core/conformance-op                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Test method            | <ol style="list-style-type: none"> <li>1) Construct a path for each "conformance" link on the landing page as well as for the {root}/conformance path.</li> <li>2) Issue an HTTP GET request on each path.</li> <li>3) Validate that a document was returned with a status code 200.</li> <li>4) Validate the contents of the returned document using test /conf/core/conformance-success.</li> </ol>                                                 |
| <b>Abstract test 8</b> | <b>/conf/core/conformance-success</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Test purpose           | Validate that the Conformance Declaration response complies with the required structure and contents.                                                                                                                                                                                                                                                                                                                                                 |
| Requirement            | /req/core/conformance-success                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Test method            | <ol style="list-style-type: none"> <li>1) Validate the response document against OpenAPI 3.0 schema confClasses.yaml.</li> <li>2) Validate that the document includes the conformance class "<a href="http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/core">http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/core</a>".</li> <li>3) Validate that the document lists all OGC API conformance classes that the API implements.</li> </ol> |

#### A.2.5 Feature collections {root}/collections

|                        |                                                                                                                                                                                                                                                                                         |
|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Abstract test 9</b> | <b>/conf/core/fc-md-op</b>                                                                                                                                                                                                                                                              |
| Test purpose           | Validate that information about the Collections can be retrieved from the expected location.                                                                                                                                                                                            |
| Requirement            | /req/core/fc-md-op                                                                                                                                                                                                                                                                      |
| Test method            | <ol style="list-style-type: none"> <li>1) Issue an HTTP GET request to the URL {root}/collections.</li> <li>2) Validate that a document was returned with a status code 200.</li> <li>3) Validate the contents of the returned document using test /conf/core/fc-md-success.</li> </ol> |

**Abstract test 10** /conf/core/fc-md-success

Test purpose Validate that the Collections content complies with the required structure and contents.

Requirement /req/core/fc-md-success, /req/core/crs84

- Test method
- 1) Validate that all response documents conform to /conf/core/fc-md-links.
  - 2) Validate that all response documents conform to /conf/core/fc-md-items.
  - 3) In case the response includes a "crs" property, validate that the first value is either "<http://www.opengis.net/def/crs/OGC/1.3/CRS84>" or "<http://www.opengis.net/def/crs/OGC/0/CRS84h>".
  - 4) Validate the collections content for all supported media types using the resources and tests identified in [Table A.2](#).

The Collections content can be retrieved in a number of different formats. [Table A.2](#) identifies the applicable schema document for each format and the test to be used to validate the content against that schema. Exercise all supported formats.

**Table A.2 — Schema and tests for collections content**

| Format  | Schema document                    | Test ID               |
|---------|------------------------------------|-----------------------|
| HTML    | collections.yaml                   | /conf/html/content    |
| GeoJSON | collections.yaml                   | /conf/geojson/content |
| GMLSF0  | core.xsd, element core:Collections | /conf/gmlsf0/content  |
| GMLSF2  | core.xsd, element core:Collections | /conf/gmlsf2/content  |

**Abstract test 11** /conf/core/fc-md-links

Test purpose Validate that the required links are included in the Collections Metadata document.

Requirement /req/core/fc-md-links

Test method Verify that the response document includes:

- 1) a link to this response document (relation: self),
- 2) a link to the response document in every other media type supported by the server (relation: alternate).

Verify that all links include the rel and type link parameters.

**Abstract test 12** /conf/core/fc-md-items

Test purpose Validate that each collection provided by the server is described in the Collections Metadata.

Requirement /req/core/fc-md-items

- Test method
- 1) Verify that there is an entry in the collections array of the Collections Metadata for each feature collection provided by the API.
  - 2) Verify that each collection entry includes an identifier.
  - 3) Verify that each collection entry includes links in accordance with /conf/core/fc-md-items-links.
  - 4) Verify that if the collection entry includes an extent property, that that property complies with /conf/core/fc-md-extent.
  - 5) Validate each collection entry for all supported media types using the resources and tests identified in [Table A.3](#).

The collection entries can be encoded in one or more different formats. [Table A.3](#) identifies the applicable schema document for each format and the test to be used to validate the content against that schema. Exercise all supported formats.

**Table A.3 — Schema and tests for collection entries**

| Format  | Schema document | Test ID               |
|---------|-----------------|-----------------------|
| HTML    | collection.yaml | Manual Inspection     |
| GeoJSON | collection.yaml | /conf/geojson/content |
| GMLSF0  | core.xsd        | /conf/gmlsf0/content  |
| GMLSF2  | core.xsd        | /conf/gmlsf2/content  |

**Abstract test 13** /conf/core/fc-md-items-links

**Test purpose** Validate that each Feature Collection metadata entry in the Collections Metadata document includes all required links.

**Requirement** /req/core/fc-md-items-links

- Test method**
- 1) Verify that each Collection item in the Collections Metadata document includes a link property for each supported encoding.
  - 2) Verify that the links properties of the collection includes an item for each supported encoding with a link to the features resource (relation: items).
  - 3) Verify that all links include the rel and type link parameters.

**Abstract test 14** /conf/core/fc-md-extent

**Test purpose** Validate the extent property, if it is present

**Requirement** /req/core/fc-md-extent

- Test method**
- 1) Verify that the extent, if present, provides bounding boxes that include all spatial geometries in this collection.
  - 2) Verify that the extent, if present, provides time intervals that include all temporal geometries in this collection. A temporal boundary of null at start or end indicates a half-bounded interval.

**Abstract test 15** /conf/core/fc-md-extent-multi

**Test purpose** Validate the "extent" property, if it is present and includes multiple bounding boxes or intervals

**Requirement** /req/core/fc-md-extent-multi

- Test method**
- 1) If the member "spatial" in the "extent" is present, verify that the first bounding box includes all spatial geometries in this collection.
  - 2) If the member "spatial" in the "extent" is present and if it includes more than one bounding box, verify that all spatial geometries in this collection are inside one for the second to last bounding boxes.
  - 3) If the member "temporal" in the "extent" is present, verify that the first interval includes all temporal geometries in this collection.
  - 4) If the member "temporal" in the "extent" is present and if it includes more than one interval, verify that all temporal geometries in this collection are inside one for the second to last intervals.

## A.2.6 Feature collection {root}/collections/{collectionId}

### Abstract test 16 /conf/core/sfc-md-op

|              |                                                                                                                                                                                                                                                                                                                                                      |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Validate that the Collection content can be retrieved from the expected location.                                                                                                                                                                                                                                                                    |
| Requirement  | /req/core/sfc-md-op                                                                                                                                                                                                                                                                                                                                  |
| Test method  | For every Feature Collection described in the Collections content, issue an HTTP GET request to the URL /collections/{collectionId} where {collectionId} is the id property for the collection. Validate that a Collection was returned with a status code 200. Validate the contents of the returned document using test /conf/core/sfc-md-success. |

### Abstract test 17 /conf/core/sfc-md-success

|              |                                                                                                                                                                                                                                                                                                                       |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Validate that the Collection content complies with the required structure and contents.                                                                                                                                                                                                                               |
| Requirement  | /req/core/sfc-md-success                                                                                                                                                                                                                                                                                              |
| Test method  | Verify that the content of the response is consistent with the content for this Feature Collection in the /collections response. That is, the values for id, title, description, extent and itemType are identical and all links included for this feature collection in the /collections response are also included. |

## A.2.7 Features {root}/collections/{collectionId}/items

### Abstract Test 18 /conf/core/fc-op

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Validate that features can be identified and extracted from a Collection using query parameters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Requirement  | /req/core/fc-op                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Test method  | <ol style="list-style-type: none"> <li>For every feature collection identified in Collections, issue an HTTP GET request to the URL /collections/{collectionId}/items where {collectionId} is the id property for a Collection described in the Collections content.</li> <li>Validate that a document was returned with a status code 200.</li> <li>Validate the contents of the returned document using test /conf/core/fc-response.</li> </ol> <p>Repeat these tests using the following parameter tests:</p> <p><b>Bounding box:</b></p> <ul style="list-style-type: none"> <li>Parameter /conf/core/fc-bbox-definition</li> <li>Response /conf/core/fc-bbox-response</li> </ul> <p><b>Limit:</b></p> <ul style="list-style-type: none"> <li>Parameter /conf/core/fc-limit-definition</li> <li>Response /conf/core/fc-limit-response</li> </ul> <p><b>DateTime:</b></p> <ul style="list-style-type: none"> <li>Parameter /conf/core/fc-time-definition</li> <li>Response /conf/core/fc-time-response</li> </ul> <p><b>Error conditions:</b></p> <ul style="list-style-type: none"> <li>Query Invalid /conf/core/query-param-invalid</li> <li>Query Unknown /conf/core/query-param-unknown</li> </ul> <p>Execute requests with combinations of the "bbox" and "datetime" query parameters and verify that only features are returned that match both selection criteria.</p> |

**Abstract test 19 /conf/core/fc-bbox-definition**

Test purpose Validate that the bounding box query parameters are constructed correctly.

Requirement /req/core/fc-bbox-definition

Test method Verify that the bbox query parameter complies with the following definition (using an OpenAPI Specification 3.0 fragment):

```
name: bbox
in: query
required: false
schema:
 type: array
 one of:
 - minItems: 4
 maxItems: 4
 - minItems: 6
 maxItems: 6
 items:
 type: number
style: form
explode: false
```

Use a bounding box with four numbers in all requests, if the collection has spatial geometries in 2D:

- Lower left corner, WGS 84 longitude
- Lower left corner, WGS 84 latitude
- Upper right corner, WGS 84 longitude
- Upper right corner, WGS 84 latitude

Use a bounding box with six numbers in all requests, if the collection has spatial geometries in 3D:

- Lower left corner, WGS 84 longitude
- Lower left corner, WGS 84 latitude
- Minimum value, WGS 84 ellipsoidal height
- Upper right corner, WGS 84 longitude
- Upper right corner, WGS 84 latitude
- Maximum value, WGS 84 ellipsoidal height

**Abstract test 20 /conf/core/fc-bbox-response**

Test purpose Validate that the bounding box query parameters are processed correctly.

Requirement /req/core/fc-bbox-response

- Test method
- 1) Verify that only features that have a spatial geometry that intersects the bounding box are returned as part of the result set.
  - 2) Verify that the bbox parameter matched all features in the collection that were not associated with a spatial geometry (this is only applicable for datasets that include features without a spatial geometry).
  - 3) Verify that the coordinate reference system of the geometries is WGS 84 longitude/latitude ("<http://www.opengis.net/def/crs/OGC/1.3/CRS84>" or "<http://www.opengis.net/def/crs/OGC/0/CRS84h>") since no parameter bbox-crs was specified in the request.

**Abstract test 21**    **/conf/core/fc-limit-definition**

Test purpose    Validate that the bounding box query parameters are constructed correctly.

Requirement    /req/core/fc-limit-definition

Test method    Verify that the limit query parameter complies with the following definition (using an OpenAPI Specification 3.0 fragment):

```
name: limit
in: query
required: false
schema:
 type: integer
style: form
explode: false
```

NOTE    The API can define values for "minimum", "maximum" and "default".

**Abstract test 22**    **/conf/core/fc-limit-response**

Test purpose    Validate that the limit query parameters are processed correctly.

Requirement    /req/core/fc-limit-response

- Test method    1) Count the Features which are on the first level of the collection. Any nested objects contained within the explicitly requested items shall not be counted.
- 2) Verify that this count is not greater than the value specified by the limit parameter.
- 3) If the API definition specifies a maximum value for limit parameter, verify that the count does not exceed this maximum value.
- 4) If the API definition specifies a maximum value for limit parameter, submit another request with a limit value that is greater than the maximum and verify that the response is not an error and that the count does not exceed this maximum value.

**Abstract test 23**    **/conf/core/fc-time-definition**

Test purpose    Validate that the datetime query parameters are constructed correctly.

Requirement    /req/core/fc-time-definition

Test method    Verify that the datetime query parameter complies with the following definition (using an OpenAPI Specification 3.0 fragment):

```
name: datetime
in: query
required: false
schema:
 type: string
style: form
explode: false
```

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Abstract test 24</b> | <b>/conf/core/fc-time-response</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Test purpose            | Validate that the datetime query parameters are processed correctly.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Requirement             | /req/core/fc-time-response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Test method             | <ol style="list-style-type: none"> <li>1) Verify that only features that have a temporal geometry that intersects the temporal information in the datetime parameter were included in the result set</li> <li>2) Verify that all features in the collection that are not associated with a temporal geometry are included in the result set.</li> <li>3) Validate that the datetime parameter complies with the syntax described in /req/core/fc-time-response.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Abstract test 25</b> | <b>/conf/core/query-param-invalid</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Test purpose            | Validate that the API correctly deals with invalid query parameters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Requirement             | /req/core/query-param-invalid                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Test method             | <ol style="list-style-type: none"> <li>1) Enter an HTTP request with an invalid query parameter.</li> <li>2) Verify that the API returns the status code 400.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Abstract test 26</b> | <b>/conf/core/query-param-unknown</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Test purpose            | Validate that the API correctly deals with unknown query parameters.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Requirement             | /req/core/query-param-unknown                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Test method             | <ol style="list-style-type: none"> <li>1) Enter an HTTP request with a query parameter that is not specified in the API definition.</li> <li>2) Verify that the API returns the status code 400.</li> </ol>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Abstract test 27</b> | <b>/conf/core/fc-response</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| Test purpose            | Validate that the Feature Collections complies with the require structure and contents.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Requirement             | /req/core/fc-response                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Test method             | <ol style="list-style-type: none"> <li>1) Validate that the type property is present and has a value of FeatureCollection.</li> <li>2) Validate that the features property is present and that it is populated with an array of feature items.</li> <li>3) Validate that only Features which match the selection criteria are included in the Feature Collection.</li> <li>4) If the links property is present, validate that all entries conform to with /conf/core/fc-links.</li> <li>5) If the timeStamp property is present, validate that it complies with /conf/core/fc-timeStamp.</li> <li>6) If the numberMatched property is present, validate that it complies with /conf/core/fc-numberMatched.</li> <li>7) If the numberReturned property is present, validate that it complies with /conf/core/fc-numberReturned.</li> <li>8) Validate the collections content for all supported media types using the resources and tests identified in <a href="#">Table A.4</a>.</li> </ol> |

The collections metadata can be retrieved in one or more different formats. [Table A.4](#) identifies the applicable schema document for each format and the test to be used to validate the content against that schema. Exercise all supported formats.

Table A.4 — Schema and tests for feature collections

| Format  | Schema document                           | Test ID               |
|---------|-------------------------------------------|-----------------------|
| HTML    | featureCollectionGeoJSON.yaml             | /conf/html/content    |
| GeoJSON | featureCollectionGeoJSON.yaml             | /conf/geojson/content |
| GMLSF0  | core-sf.xsd, element sf:FeatureCollection | /conf/gmlsf0/content  |
| GMLSF2  | core-sf.xsd, element sf:FeatureCollection | /conf/gmlsf2/content  |

Supporting tests:

**Abstract test 28**      **/conf/core/fc-links**

Test purpose      Validate that the required links are included in the Collections document.

Requirement      /req/core/fc-links, /req/core/fc-rel-type

Test method      Verify that the response document includes:

- 1) a link to this response document (relation: self),
- 2) a link to the response document in every other media type supported by the server (relation: alternate).

Verify that all links include the rel and type link parameters.

**Abstract test 29**      **/conf/core/fc-timeStamp**

Test purpose      Validate the timeStamp parameter returned with a Features response

Requirement      /req/core/fc-timeStamp

Test method      Validate that the timeStamp value is set to the time when the response was generated.

**Abstract test 30**      **/conf/core/fc-numberMatched**

Test purpose      Validate the numberMatched parameter returned with a Features response

Requirement      /req/core/fc-numberMatched

Test method      When a property "numberMatched" is included in the response, validate that the value of the numberMatched parameter is identical to the number of features in the feature collections that match the selection parameters like bbox, datetime or additional filter parameters.

**Abstract test 31**      **/conf/core/fc-numberReturned**

Test purpose      Validate the numberReturned parameter returned with a Features response.

Requirement      /req/core/fc-numberReturned

Test method      When a property "numberReturned" is included in the response, validate that the numberReturned value is identical to the number of features in the response.

## A.2.8 Feature

### Abstract test 32 /conf/core/f-op

Test purpose Validate that a feature can be retrieved from the expected location.

Requirement /req/core/f-op

- Test method
- 1) For a sufficiently large subset of all features in a feature collection (path /collections/{collectionId}), issue an HTTP GET request to the URL /collections/{collectionId}/items/{featureId} where {collectionId} is the id property for the collection and {featureId} is the id property of the feature (the representation in the feature content depends on the encoding).
  - 2) Validate that a feature was returned with a status code 200.
  - 3) Validate the contents of the returned feature using test /conf/core/f-success.

### Abstract test 33 /conf/core/f-success

Test purpose Validate that the Feature complies with the required structure and contents.

Requirement /req/core/f-success

- Test method
- 1) Validate that the Feature includes all required link properties using /conf/core/f-links
  - 2) Validate the Feature for all supported media types using the resources and tests identified in [Table A.5](#).

The Features can be retrieved in one or more different formats. [Table A.5](#) identifies the applicable schema document for each format and the test to be used to validate the content against that schema. Exercise all supported formats.

**Table A.5 — Schema and tests for features**

| Format  | Schema document                                        | Test ID               |
|---------|--------------------------------------------------------|-----------------------|
| HTML    | featureGeoJSON.yaml                                    | /conf/html/content    |
| GeoJSON | featureGeoJSON.yaml                                    | /conf/geojson/content |
| GMLSF0  | gml.xsd, element substitutable for gml:AbstractFeature | /conf/gmlsf0/content  |
| GMLSF2  | gml.xsd, element substitutable for gml:AbstractFeature | /conf/gmlsf2/content  |

Note that in the case of GMLSF0/GMLSF2 it is not sufficient to validate against gml.xsd as the feature will be defined in a GML application schema. Determine the XML Schema Document for the namespace of the feature to validate the XML document.

Supporting tests are as follows:

### Abstract test 34 /conf/core/f-links

Test purpose Validate that the required links are included in a Feature.

Requirement /req/core/f-links

Test method Verify that the returned Feature includes:

- 1) a link to this response document (relation: self),
- 2) a link to the response document in every other media type supported by the server (relation: alternate),
- 3) a link to the feature collection that contains this feature (relation: collection).

Verify that all links include the rel and type link parameters.

### A.3 Conformance class GeoJSON

#### A.3.1 Conformance class

| Conformance class                                                                                                                           |                              |
|---------------------------------------------------------------------------------------------------------------------------------------------|------------------------------|
| <a href="http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/geojson">http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/geojson</a> |                              |
| Target type                                                                                                                                 | Web API                      |
| Requirements class                                                                                                                          | Requirements class "GeoJSON" |
| Dependency                                                                                                                                  | Conformance class "Core"     |

#### A.3.2 GeoJSON definition

##### Abstract test /conf/geojson/definition 35

|              |                                                                                                                                                                                                                                                                                                                                                                                                |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify support for JSON and GeoJSON                                                                                                                                                                                                                                                                                                                                                            |
| Requirement  | /req/geojson/definition                                                                                                                                                                                                                                                                                                                                                                        |
| Test method  | <ol style="list-style-type: none"> <li>1) A resource is requested with response media type of application/geo+json.</li> <li>2) All 200-responses are expected to support the following media types: <ul style="list-style-type: none"> <li>— application/geo+json for resources that include feature content, and</li> <li>— application/json for all other resources.</li> </ul> </li> </ol> |

#### A.3.3 GeoJSON content

##### Abstract test 36 /conf/geojson/content

|              |                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify the content of a GeoJSON document given an input document and schema.                                                                                                                                                                                                                                                                                                                                    |
| Requirement  | /req/geojson/content                                                                                                                                                                                                                                                                                                                                                                                            |
| Test method  | <ol style="list-style-type: none"> <li>1) Validate that the document is a GeoJSON document.</li> <li>2) Validate the document against the schema using a JSON Schema validator.</li> <li>3) For a GeoJSON document that is the response of a GET request to a Feature resource, verify that the id member of the GeoJSON feature object is identical to the featureId path parameter of the request.</li> </ol> |

### A.4 Conformance class GML simple features level 0

#### A.4.1 Conformance class

##### Conformance class

<http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/gmlsf0>

|                    |                                                                                        |
|--------------------|----------------------------------------------------------------------------------------|
| Target type        | Web API                                                                                |
| Requirements class | Requirements class "Geography Markup Language (GML), Simple Features Profile, Level 0" |
| Dependency         | Conformance class "Core"                                                               |

#### A.4.2 GML simple features 0 definition

##### Abstract test 37 /conf/gmlsf0/definition

|              |                                                                                                                                                                                                                                                                                                                                                 |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify support for GML Simple Features level 0.                                                                                                                                                                                                                                                                                                 |
| Requirement  | /req/gmlsf0/definition                                                                                                                                                                                                                                                                                                                          |
| Test method  | Verify that every 200-response of an operation of the API where XML was requested is of media type application/gml+xml; version=3.2; profile=" <a href="http://www.opengis.net/def/profile/ogc/2.0/gml-sf0">http://www.opengis.net/def/profile/ogc/2.0/gml-sf0</a> " (resources: Features and Feature) or application/xml (all other resources) |

### A.4.3 GML simple features 0 content

**Abstract test 38**     **/conf/gmlsf0/content**

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify the content of an GML Simple Features 0 document given an input document and schema.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Requirement  | /req/gmlsf0/content, /req/gmlsf0/headers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Test method  | <ol style="list-style-type: none"> <li>1) For the resources "Features" and "Feature", validate that the document is a GML Simple Features level 0 document.</li> <li>2) Verify that the document has the expected root element.</li> <li>3) Validate the document against the schema using an XML schema validator.</li> <li>4) If the API supports the GeoJSON encoding, too, and the response to the same request, but with a different Accept header includes the properties timeStamp, numberMatched, numberReturned and/or links in the payload, verify that the same information is included as HTTP headers in the GML response.</li> <li>5) For a GML document that is the response of a GET request to a Feature resource, verify that the gml:id XML attribute of the GML feature element is identical to the featureId path parameter of the request.</li> </ol> |

## A.5 Conformance class GML simple features level 2

### A.5.1 Conformance class

**Conformance class**

<http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/gmlsf2>

|                    |                                                                                        |
|--------------------|----------------------------------------------------------------------------------------|
| Target type        | Web API                                                                                |
| Requirements class | Requirements class "Geography Markup Language (GML), Simple Features Profile, Level 2" |
| Dependency         | Conformance class "Core"                                                               |

### A.5.2 GML simple features 2 definition

**Abstract test 39**     **/conf/gmlsf2/definition**

|              |                                                                                                                                                                                                                                                                                                                                                      |
|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify support for GML Simple Features level 2.                                                                                                                                                                                                                                                                                                      |
| Requirement  | /req/gmlsf2/definition                                                                                                                                                                                                                                                                                                                               |
| Test method  | <p>Verify that every 200-response of an operation of the API where XML was requested is of media type application/gml+xml; version=3.2; profile="<a href="http://www.opengis.net/def/profile/ogc/2.0/gml-sf2">http://www.opengis.net/def/profile/ogc/2.0/gml-sf2</a>" (resources: Features and Feature) or application/xml (all other resources)</p> |

### A.5.3 GML simple features 2 content

**Abstract test 40** /conf/gmlsf2/content

|              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify the content of an GML Simple Features level 2 document given an input document and schema.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| Requirement  | /req/gmlsf2/content, /req/gmlsf2/headers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| Test method  | <ol style="list-style-type: none"> <li>1) For the resources "Features" and "Feature", validate that the document is a GML Simple Features level 2 document.</li> <li>2) Verify that the document has the expected root element.</li> <li>3) Validate the document against the schema using an XML schema validator.</li> <li>4) If the API supports the GeoJSON encoding, too, and the response to the same request, but with a different Accept header includes the properties timeStamp, numberMatched, numberReturned and/or links in the payload, verify that the same information is included as HTTP headers in the GML response.</li> <li>5) For a GML document that is the response of a GET request to a Feature resource, verify that the gml:id XML attribute of the GML feature element is identical to the featureId path parameter of the request.</li> </ol> |

## A.6 Conformance class HTML

### A.6.1 Conformance class

**Conformance class**

<http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/html>

|                    |                           |
|--------------------|---------------------------|
| Target type        | Web API                   |
| Requirements class | Requirements class "HTML" |
| Dependency         | Conformance class "Core"  |

### A.6.2 HTML definition

**Abstract test 41** /conf/html/definition

|              |                                                                                                                   |
|--------------|-------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify support for HTML.                                                                                          |
| Requirement  | /req/html/definition                                                                                              |
| Test method  | Verify that every 200-response of every operation of the API where HTML was requested is of media type text/html. |

### A.6.3 HTML content

**Abstract test 42** /conf/html/content

|              |                                                                                                                                                                      |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify the content of an HTML document given an input document and schema.                                                                                           |
| Requirement  | /req/html/content                                                                                                                                                    |
| Test method  | <ol style="list-style-type: none"> <li>1) Validate that the document is an HTML 5 document.</li> <li>2) Manually inspect the document against the schema.</li> </ol> |

## A.7 Conformance class OpenAPI 3.0

### Conformance class

<http://www.opengis.net/spec/ogcapi-features-1/1.0/conf/oas30>

|                    |                                                |
|--------------------|------------------------------------------------|
| Target type        | Web API                                        |
| Requirements class | Requirements class "OpenAPI Specification 3.0" |
| Dependency         | Conformance class "Core"                       |

#### Abstract test 43 /conf/oas30/completeness

|              |                                                                                                                                           |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify the completeness of an OpenAPI document.                                                                                           |
| Requirement  | /req/oas30/completeness                                                                                                                   |
| Test method  | Verify that for each operation, the OpenAPI document describes all HTTP Status Codes and Response Objects that the API uses in responses. |

#### Abstract test 44 /conf/oas30/exceptions-codes

|              |                                                                                                             |
|--------------|-------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify that the OpenAPI document fully describes potential exception codes.                                 |
| Requirement  | /req/oas30/exceptions-codes                                                                                 |
| Test method  | Verify that for each operation, the OpenAPI document describes all HTTP Status Codes that can be generated. |

#### Abstract test 45 /conf/oas30/oas-definition-1

|              |                                                                                                                                                                                                                                                                                                                                                        |
|--------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify that JSON and HTML versions of the OpenAPI document are available.                                                                                                                                                                                                                                                                              |
| Requirement  | /req/oas30/oas-definition-1                                                                                                                                                                                                                                                                                                                            |
| Test method  | <ol style="list-style-type: none"> <li>1) Verify that an OpenAPI definition in JSON is available using the media type application/vnd.oai.openapi+json;version=3.0 and link relation service-desc.</li> <li>2) Verify that an HTML version of the API definition is available using the media type text/html and link relation service-doc.</li> </ol> |

#### Abstract test 46 /conf/oas30/oas-definition-2

|              |                                                                                         |
|--------------|-----------------------------------------------------------------------------------------|
| Test purpose | Verify that the OpenAPI document is valid JSON.                                         |
| Requirement  | /req/oas30/oas-definition-2                                                             |
| Test method  | Verify that the JSON representation conforms to the OpenAPI Specification, version 3.0. |

#### Abstract test 47 /conf/oas30/oas-impl

|              |                                                                                                                                                                                                                                                                                                                                   |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Test purpose | Verify that all capabilities specified in the OpenAPI definition are implemented by the API.                                                                                                                                                                                                                                      |
| Requirement  | /req/oas30/oas-impl                                                                                                                                                                                                                                                                                                               |
| Test method  | <ol style="list-style-type: none"> <li>1) Construct a path from each URL template including all server URL options and all enumerated path parameters.</li> <li>2) For each path defined in the OpenAPI document, validate that the path performs in accordance with the API definition and the API-Features standard.</li> </ol> |

|                         |                                                                                                                                                                                                                                                                                                  |
|-------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Abstract test 48</b> | <b>/conf/oas30/security</b>                                                                                                                                                                                                                                                                      |
| Test purpose            | Verify that any authentication protocols implemented by the API are documented in the OpenAPI document.                                                                                                                                                                                          |
| Requirement             | /req/oas30/security                                                                                                                                                                                                                                                                              |
| Test method             | <ol style="list-style-type: none"><li>1) Identify all authentication protocols supported by the API.</li><li>2) Validate that each authentication protocol is described in the OpenAPI document by a Security Schema Object and its use is specified by a Security Requirement Object.</li></ol> |

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