

OGC API-Tiles

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OGC API Tiles

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i. Abstract

The OGC has started a focused effort to extend their service standards into the Resource Oriented Architecture world. As part of this effort, this standard defines an API for Map Tiles.

The Map Tile API described in this standard builds on the Web Map Tile Service (WMTS) OGC standard. WMTS provides a scalable, high performance services for web based distribution of cartographic maps. WMTS, in turn, complements earlier efforts to develop services for the web based distribution of cartographic maps. In particular, it compliments the OGC Web Map Service (WMS). WMS focuses on rendering custom maps and is an ideal solution for dynamic data or custom styled maps (combined with the OGC Style Layer Descriptor (SLD) standard). WMTS trades the flexibility of custom map rendering for the scalability possible by serving of static data (base maps) where the bounding box and scales have been constrained to discrete tiles. Note that an API version of WMS is also under development.

ii. Keywords

The following are keywords to be used by search engines and document catalogues.

ogcdoc, OGC document, tiling, WMTS

iii. Preface

This document defines an OGC standard for a Web Map Tile API standard. A Map Tile enabled API can serve map tiles of spatially referenced data using tile images with predefined content, extent, and resolution. Suggested additions, changes and comments on this standard are welcome and encouraged. Such suggestions may be submitted using the online change request form on OGC web site: http://portal.opengeospatial.org/public_ogc/change_request.php

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Chapter 1. Scope

This International Standard specifies how to access maps and tiles in a manner independent of the underlying data store through [OpenAPI](<https://www.openapis.org/> [https://www.openapis.org/]). This standard specifies discovery and query operations.

1.1. Current scope:

- Discovery operations allow the API to be interrogated to determine its capabilities and retrieve information (metadata) about this distribution of tiles and maps. This includes the API definition as well as metadata about the feature collections provided through the API and the TileMatrixSets supported by this service.
- Retrieve of maps as defined by the WMS 1.3
- Retrieve of tiles as defined by the WMTS 1.0
- Query about a point in a map or a tile (GetFeatureInfo)
- Retrieve multiple tiles in a single request.

Chapter 2. Conformance

This standard defines **TBD** requirements / conformance classes.

The standardization targets of all conformance classes are "web services".

The main requirements class is:

- **Core.**

The *Core* specifies requirements that all Map Tile APIs have to implement.

TBD requirements classes depend on the *Core* and <enter their purpose here>:

Capture additional requirements classes here

Conformance with this standard shall be checked using all the relevant tests specified in Annex A (normative) 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.

In order to conform to this OGC® interface standard, a software implementation shall choose to implement: * Any one of the conformance levels specified in Annex A (normative). * Any one of the Distributed Computing Platform profiles specified in Annexes TBD through TBD (normative).

All requirements-classes and conformance-classes described in this document are owned by the standard(s) identified.

Chapter 3. References

The following normative documents contain provisions that, through reference in this text, constitute provisions of this document. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the normative document referred to applies.

OGC: OGC API (OAPI) Common Specification https://github.com/opengeospatial/oapi_common (in the process of elaboration)

OGC: OGC 17-083r2, OGC Two Dimensional Tile Matrix Set Standard (2019)

In addition, this standard is deeply inspired in concepts defined in the following documents. This standard offers an alternative interface to fulfill similar tasks included in these references.

OGC and ISO: OGC 06-042 1.3.0 OpenGIS Web Map Service (WMS) Implementation Specification

OGC: OGC 07-057, OpenGIS® Web Map Tile Service Implementation Standard (2010)

OGC: OGC 13-082, OGC® Web Map Tile Service (WMTS) Simple Profile (2016)

Chapter 4. Terms and Definitions

This document uses the terms defined in Sub-clause 5.3 of [OGC 06-121r8], which is based on the ISO/IEC Directives, Part 2, Rules for the structure and drafting of International Standards. In particular, the word “shall” (not “must”) is the verb form used to indicate a requirement to be strictly followed to conform to this standard.

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

4.1. term name

text of the definition

Chapter 5. Conventions

This sections provides details and examples for any conventions used in the document. Examples of conventions are symbols, abbreviations, use of XML schema, or special notes regarding how to read the document.

5.1. Identifiers

The normative provisions in this standard are denoted by the URI

<http://www.opengis.net/spec/{standard}/{m.n}>

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

Chapter 6. Overview

6.1. Evolution from OGC Web Services

OGC Web Service (OWS) standards have historically implemented a Remote-Procedure-Call-over-HTTP architectural style using Extensible Markup Language (XML) for payloads. This was the state-of-the-art when some of the initial versions of OGC Web Services were originally designed in the late 1990s and early 2000s. This architectural style has now a competing RESTful API style that is proposed as an alternative to RPC pattern. A RESTful API style is resource-oriented instead of service-oriented. This OGC API - Maps and Tiles draft specification specifies an API that follows this 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.

The OGC API – Common draft specification specifies the common kernel of an API approach to services that follows current resource-oriented architecture practices. The draft OGC API - Common specification is the foundation upon which OGC APIs will be built. This common API is to be extended by resource-specific API standards. This draft specification extends OGC API - Common to support Map and Tile resources.

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

- Clear separation between core requirements and more advanced capabilities. This OGC API – Maps and Tiles draft specification presents the requirements that are relevant for almost everyone who wants to share or use Tiled Map Data on a fine-grained level. Additional capabilities that several communities are using today will be specified as extensions to the Core API.
- 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 a single "service". OGC APIs will provide building blocks that can be reused in APIs in general. In other words, a server supporting the OGC API - Tiles should not be seen as a standalone service. Rather it should be viewed as a collection of API building blocks which together implement Map and Tile capabilities. A corollary for this is that it should be possible to implement an API that simultaneously conforms to conformance classes from the Feature, Coverage, Map, Tiles, and other future OGC Web API standards.

This approach intends to support two types of client developers:

- Those that have never heard about OGC. Developers should be able to create a client using the API definition without the need to adopt a specific OGC approach (they no longer need to read how to implement a GetCapabilities, allowing them to focus on the geospatial aspects).

- Those that want to write a "generic" client that can access OGC APIs. In other words, they are not specific for a particular API.

As a result of following a RESTful approach, OGC API implementations are not backwards compatible with OWS implementations per se. However, a design goal is to define OGC APIs in a way that an OGC API interface can be mapped to an OWS implementation (where appropriate). OGC APIs are intended to be simpler and more modern, but still an evolution from the previous versions and their implementations making the transition easy (e.g. by initially implementing facades in front of the current OWS services).

This document provides simple examples throughout the document. The examples are based on a dataset that contains buildings and the API provides access to the datasets via a single feature collection ("buildings") and two encodings: JSON and Hypertext Markup Language (HTML).

6.2. Tiles and maps

WMS and WMTS share the concept of a map and the capability to create and distribute maps at a limited resolution and size. In WMS the number of rows and columns can be selected by the user within limits and in WMTS the number of rows and columns of the response is predefined in the tile matrix set.

With time, the concept of a tile has been generalized to other data models such as feature data (some vendors use the expression *vector tiles*) and even to coverage data. This draft specification presents an approach to tiles that can be applied to almost every resource type that returns data representations. If applied in conjunction with the OGC API - Features standard and on top of a feature collection, the expected result is tiled feature data. If applied in conjunction with the OGC API - Maps draft specification and on top of a collection that is transformed into a map by applying a style, the result should be map tiles (usually in PNG or JPEG format).

In this draft specification the OGC API - Tiles is almost fully described. It includes the a core and extensions for defining tile matrix sets, tiles from more that one collection, multi-tiles and multitiles from more than one collection. And info extension is foreseen but not fully developed. In contrast, OGC API - Maps is only partially described based on Testbed-15 requirements. The Maps API is described only to the extent to allow for map tiles to be created on top of a map created by selecting a collection with style or multiple collections with styles. This draft specification contains a section for retrieving a map of an arbitrary number of rows and columns but is not fully formulated. Other extensions for maps are also foreseen. In the future, the WMS SWG could take this document and complete the missing capabilities.

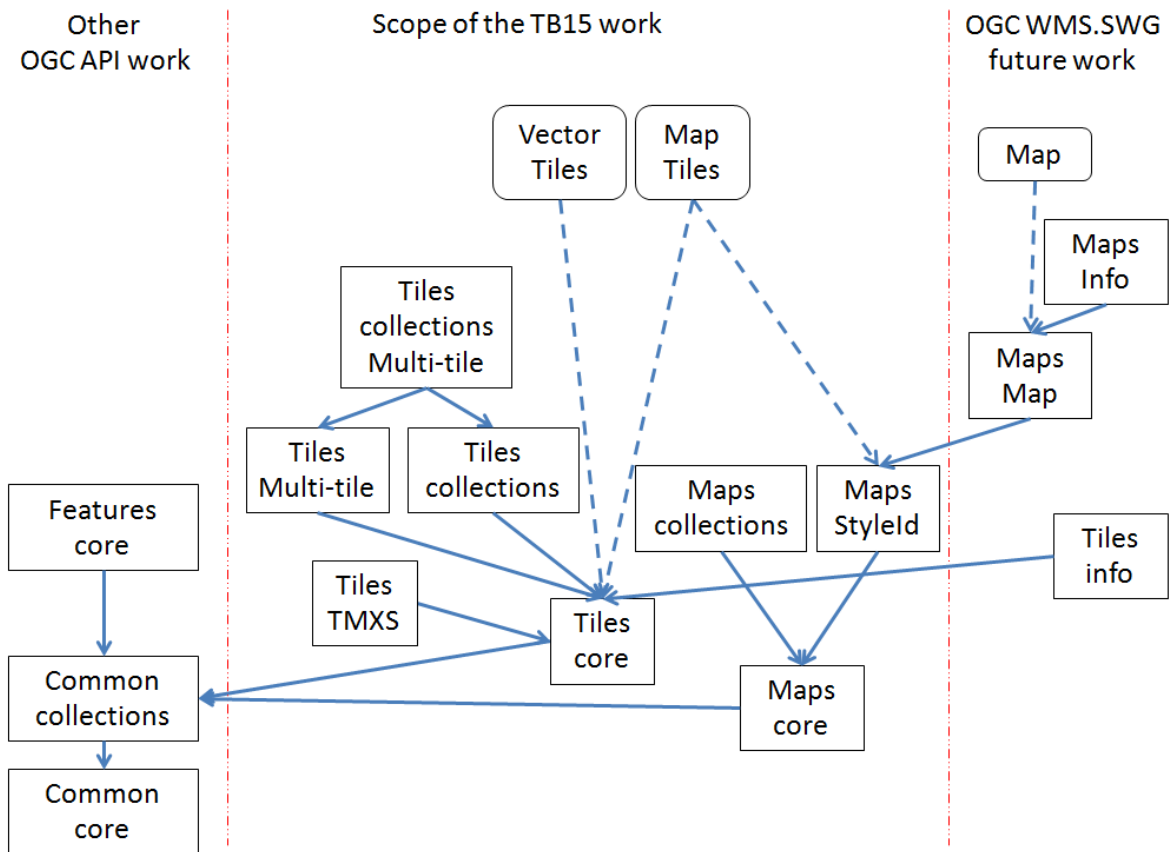


Figure 1. Modular approach in the Maps and Tiles draft specification

6.3. How to approach an OGC API

There are two ways to approach an OGC API.

- Read the landing page, look for links, follow them and discover new links until the desired resource is found
- Read an API definition document that will specify a list of paths to resources.

For the first approach, many resources in the API include links with rel properties to know the reason for this relation. The following figure illustrates does links.

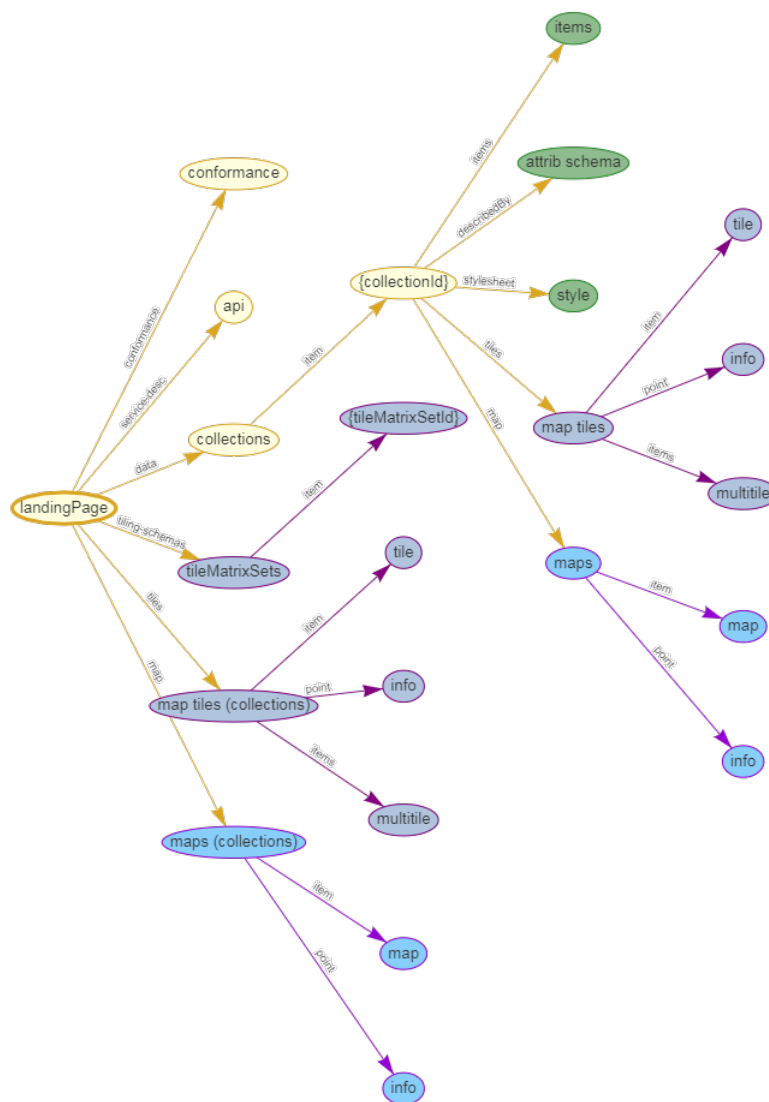


Figure 2. Resources and relations to them via links

For the second approach, the section [\[OpenAPIExamples\]](#) will provide some examples of OpenAPI definition documents that enumerate the paths to get to the necessary resources directly.

Resource name	Common path
Landing page	/
Conformance declaration	/conformance
Collections	/collections
Collection	/collections/{collectionId}
Tiling Schemas	/tileMatrixSets
Tiling Schema	/tileMatrixSets/{tileMatrixSetId}
Tiles	
Vector Tiles description	/collections/{collectionId}/tiles

Resource name	Common path
Vector Tiles description from collections	/tiles
Vector Tile	/collections/{collectionId}/tiles/{tileMatrixSetId}/{tileMatrix}/{tileRow}/{tileCol}
Vector tile collections ¹	/map/tiles/{tileMatrixSetId}/{tileMatrix}/{tileRow}/{tileCol}
Vector Multi-tiles	/collections/{collectionId}/tiles/{tileMatrixSetId}
Vector Multi-tiles collections ¹	/tiles/{tileMatrixSetId}
Map tiles	
Map tiles description	/collections/{collectionId}/map/
Map tiles description collections ¹	/map/tiles
Map tile	/collections/{collectionId}/map/{styleId}/tiles/{tileMatrixSetId}/{tileMatrix}/{tileRow}/{tileCol}
Map tile collections ¹	/map/tiles/{tileMatrixSetId}/{tileMatrix}/{tileRow}/{tileCol}
Map tile multi-tiles	/collections/{collectionId}/map/{styleId}/tiles/{tileMatrixSetId}
Map tile multi-tiles collections ¹	/map/tiles/{tileMatrixSetId}
Maps	
Maps description	/collections/{collectionId}/map
Maps description collections ¹	/map

Table 1. Overview of resources and common direct links defined in the API

¹: In first column of the table, the word "collections" means "from more than one collection"

Chapter 7. Requirement Class "Tiles Multi-tiles"

7.1. Overview

This requirement class opens the possibility exchange multiple tiles covering a bounding box and belonging to one or more scales with a single client-server interaction.

WARNING

Currently, this requirement class does not provide any way that clients or servers can limit the size of the multi-tile response. Even with a relatively small bounding box, the result of a multi-tile request (in particular to a collection that has tiles available at very small scale denominator values) could result in list of tiles too big for the server to generate or for the client to handle. The current specified default values for bounding box and scales range parameters will most probably incur in this problem. Before this requirement class is endorsed by the OGC, this issue should be addressed. One possible solution is to allow the server for specifying a maximum size limit (in kilobytes, or in number of tiles) and to force the server to start from the higher level of scale denominator and stop when the limit is reached. Adding a paging mechanism in the request could help on fragmenting big responses in smaller chunks that can be sequentially requested.

Requirements Class	
http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/multitiles	
Target type	Web API
Dependency	http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/core

In this requirements class, a mechanism to request more than one tile from a single collection in a single request. This mechanism is called a 'multi-tile' is defined. The result can be a document listing the needed tiles to cover a bounding box or a package with all tiles inside.

7.2. Declaration of conformance classes

7.2.1. Response

The conformance page mainly consists of a list of links. OGC API - Common already requires some links.

Requirement 18	/req/tiles/multitiles/conformance-success
----------------	---

A	The API conformance path SHALL advertise the capability of generating tiles from multiple collections adding the conformance class for this capability as a link to http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/multitiles .
---	---

In the conformance page (typically in JSON format) the links follow the link schema defined in the OGC API - Common. The following is an example fragment of the response to an OGC API - Tiles conformance information page with support for multi-tiles.

Example 1. Conformance Information Page fragment

```
{
  "conformsTo": [
    "http://www.opengis.net/spec/ogcapi-common-1/1.0/req/core",
    "http://www.opengis.net/spec/ogcapi-common-1/1.0/req/collections",
    "http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/core"
    "http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/multitiles"
  ]
}
```

7.3. Tiles description

The response to a tiles description request contains the necessary information to later formulate a tile or a multi-tile request for a collection.

7.3.1. Response

A successful response to a tiles request for a collection that can be retrieved as tiles will respond with a data structure with specific information necessary to get tiles representing the resource collection. This extension adds the URL template to a multi-tile.

Requirement 19	/req/tiles/multitiles/mtc-multitiles-examples
A	The content of the response to a successful execution SHALL include at least a link to a multi-tiles URI template (rel: items).

B	These links SHALL provide a URL template with the fragment /tiles followed by the variables {tileMatrixSetId}. Once the variables are substituted by their respective valid values, a URL to a multitiles is obtained.
C	There SHALL be a link to a multitile URI template for each format that the server supports (the format is indicated in the type attribute of the link)

One common order used in URL templates for tiles is ../tiles/{tileMatrixSetId} this draft specification allows for other URL template composition.

URL template variable	Meaning	Possible values
TileMatrixSetId	tile matrix set identifier	The identifiers included in Annex D of OGC 17-083r2 or defined by extensions of the core specification.

Table 2. URI template variables for tiles and possible values

Example 2. API tiles response fragment

```
links:
[
  {
    "href":
"http://data.example.com/collections/buildings/tiles/{tileMatrixSetId}"
    ,
    "rel": "items",
    "type": "image/png",
  }
]
```

7.4. Multiple tiles from one collection

The following requirements provide a mechanism to select and retrieve a set of tiles at once following a TileMatrixSet.

7.4.1. Operation

Requirement 20	/req/tiles/multitiles/mtc-op
A	Tiles SHALL be available as HTTP GET requests to a URI that will be composed by two parts: a initial part is the URI of a resource that can be represented as tiles and the final part follows the pattern /tiles/{tileMatrixSetId}
B	Only the resources or collections that advertise one of more links with type=tiles SHALL be requested as multiple tiles.

Typical resources that can be retrieved as tiles are: features (/collections/{collectionId}), coverages (/collections/{collectionId}/coverages/{coverageId} or /coverages/{coverageId}) or maps (/collections/{collectionId}/map/styleId).

7.4.2. Parameter tileMatrixSetId

Requirement 21	/req/tiles/multitiles/mtc-tilematrixsetid-definition
A	<p>The operation SHALL support a parameter <code>tileMatrixSetId</code> with the following characteristics (shown as OpenAPI Specification 3.0 fragment):</p> <pre> name: tileMatrixSetId in: path description: Identifier of a specific tiling scheme. It can be one of the specified in Annex D.1 of the OGC 17-083r2 standard or one defined in this service. required: true schema: type: string example: WebMercatorQuad </pre>

7.4.3. Parameter bbox

Requirement 22	/req/tiles/multitiles/mtc-bbox-definition
-----------------------	--

A

The operation SHALL support an optional parameter **bbox** to filter the area where tiles will be retrieved with the following characteristics (shown as OpenAPI Specification 3.0 fragment):

```
name: bbox
```

```
in: query
```

```
description:
```

```
  'Only elements that have a geometry that  
  intersects the bounding box are selected.'
```

```
  The bounding box is provided as four or six  
  numbers, depending on whether the coordinate  
  reference system includes a vertical axis  
  (elevation or depth):
```

```
    * Lower left corner, coordinate axis 1
```

```
    * Lower left corner, coordinate axis 2
```

```
    * Lower left corner, coordinate axis 3
```

```
(optional)
```

```
    * Upper right corner, coordinate axis 1
```

```
    * Upper right corner, coordinate axis 2
```

```
    * Upper right corner, coordinate axis 3
```

```
(optional)
```

```
  The coordinate reference system of the  
  values is WGS 84 longitude/latitude
```

```
(http://www.opengis.net/def/crs/OGC/1.3/CRS84)  
unless a different coordinate reference system is  
specified by another parameter in the API (e.g  
'bbox-crs').'
```

```
required: false
```

```
schema:
```

```
  type: array
```

```
  minItems: 4
```

```
  maxItems: 6
```

```
  items:
```

```
    type: number
```

```
    format: double
```

```
style: form
```

```
explode: false
```

B	A TileMatrixSet definition points to a CRS. The coordinates of the bbox SHALL be in the CRS as specified in the definition of the TileMatrixSet identified by the tileMatrixSetId
C	If the 'bbox' parameter is not specified, the server SHALL assume the whole extent of the tiles is requested.

This definition is inherited from OGC API - Common.

7.4.4. Parameter scaleDenominator

Requirement 23	/req/tiles/multitiles/mtc-scaledenominator-definition
A	<p>The operation SHALL support an optional parameter scaleDenominator to filter the scales where tiles will be retrieved with the following characteristics (shown as OpenAPI Specification 3.0 fragment):</p> <pre> name: scaleDenominator in: query description: A range of scale denominators (that can be used to generate a list of tileMatrix names). required: false style: form explode: false schema: type: array minItems: 2 maxItems: 2 items: type: number format: double </pre>
B	If the parameter is not specified, the server SHALL assume all TileMatrices (scales) SHALL be returned.

Recommendation 5	/rec/tiles/multitiles/mtc-scaledenominator-definition
-------------------------	--

A	To prevent mistakes identifying the scale denominator due to precision issues caused by lack of significant digits, the client should apply a tolerance to intervals. If the client wants to specify a single scale denominator, it will use a small interval with enough tolerance.
---	--

7.4.5. Parameter multiTileType

Requirement 24	/req/tiles/multitiles/mtc-multitiletype-definition
A	<p>The operation SHALL support an optional parameter multiTileType that determines the type of the response and with the following characteristics (shown as OpenAPI Specification 3.0 fragment):</p> <pre> name: multiTileType in: query description: 'When successful, the service will respond to a query in one of two ways. It can provide a file with links to each tile or or it will provide the tiles in a package. The package can still contain the description of each tile The allowed values for this parameter are `url`, `tiles` and `full`.' style: form schema: type: string default: tiles enum: - url - tiles - full example: full </pre>
B	If the value of the multiTileType parameter is set to url , the server SHALL return a list of the selected tiles in a format following the tileSet schema. Each tile description in the list will contain a URL to download the tile later.

C	If the value of the multiTileType parameter is set to tiles or if the parameter is not specified in the request, the server SHALL return a package (e.g. a ZIP file) that will include tiles as separated parts in the package.
D	If the value of the multiTileType parameter is set to full , the server SHALL return the tiles and a list of the selected tiles (in a format following the tileSet schema) as part of a package.

Permission 3	/per/tiles/multitiles/mtc-multitiletype-definition
A	The server MAY only implement a subset of the enumerated values (url, tiles, full) for the parameter multitileType and in this case it will only enumerate this subset in its schema.

7.4.6. Formats

In the cases of the multi-tile response, there are two formats involved. The multi-tile itself can be returned as a package (e.g. a ZIP file) that contains the tiles inside. The individual tiles also have their format. The format of the multi-tile is governed by the format procedure specified in the OGC API - Common. When the server supports multiple encoding for the individual tiles and the client has a preference for the tiles format, there is a need for communicating this preference to the server. This document does not mandate any particular approach how this is supported but provides the following recommendation.

Recommendation 6	/rec/tiles/multitiles/mtc-f-tile-definition
A	When the web interaction allows for HTTP format negotiation Accept: header is preferable to specify the required formats. In the case of multi-tile a composed format is recommended following the pattern <code>application/vnd.ogc.multipart;container={multitile-media-type};tiles={tile-media-type}</code> (example: <code>application/vnd.ogc.multipart;container=application/x-zip-compressed;tiles=image/png</code>)

B	When the web interaction does not allow for controlling the HTTP format negotiation (e.g. URL in a HTML link), the operation MAY support an optional parameter f-tile to specify the tile media type that the client prefers and a parameter f for the media type of the multi-tile response.
C	The content of these parameters should be specified by the server instance as an enumeration of supported media types in the API description.

7.4.7. Response

A successful response to a set of tiles will be consistent with the media type of resource requested.

Requirement 25	/req/tiles/multitiles/mtc-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 format requested and be inside or intersect with the spatial extent of the geographical area represented by the 'bbox' and scaleDenominator .

C

If a list of the tiles has been requested, the content of that response SHALL contain a tileSet document be based upon the following OpenAPI 3.0 schema:

```
tileSet:
  description: This is the response for a
multiple tiles request.
  type: object
  required: tileSet
  properties:
    tileSet:
      type: array
      items:
        $ref:
'#/components/schemas/tileSetEntry'
    tileSetEntry:
      description:
        This is an entry on a multiple tiles
request.
      type: object
      required:
        - tileURL
        - tileMatrix
        - tileRow
        - tileCol
      properties:
        tileURL:
          type: string
          format: uri
        tileMatrix:
          type: string
        tileRow:
          type: number
        tileCol:
          type: number
        width:
          type: number
          description:
            The width of the tile in rendering
device pixels. If it exceeds the visual display
area be should cut when displayed
        height:
          type: number
          description:
            The height of the tile in rendering
device pixels. If it exceeds the visual display
area be should cut when displayed
        top:
          type: number
```

D	<p>When a package is being returned and the package format supports expressing file paths of its parts (such as the ZIP file), each tile in the package SHALL have a path following the template:</p> <p><code>{tileMatrixSetId}/{tileMatrix}/{tileRow}/{tileCol}.{file-extension}</code>. {file-extension} is the file extension that corresponds to the media type (e.g "jpg" for image/jpeg).</p>
---	--

description:
Horizontal position from the left of the visual display area in pixels. Negative value means that the left side of the tile is outside the top-left corner of the display and should be cut when displayed

Mainly this extension suggests 3 possible alternatives for a multi-tile response being the last one (full) the combination of the first two (url and package).

List Response

This format assumes that the client has a viewport to represent an geographic area defined by the bounding box and the scale (that defines the pixel size of the viewport) in the screen. This area should be populated with tiles. The server is expected to enumerate the tiles needed to populate the viewport and optionally to provide information on how to position the tiles in the viewport.

In the following example, we assume that the bounding box and scale provided implies a viewport of 336x446 pixels (height by width). The viewport is covered by 4 tiles. The client has requested a url type of multi-tile and negotiated a response a JSON format. The URL of each tile is provided, accompanied with information on the position of the top left corner of each one in the viewport.

```
{
  "tileSet": [
    {
      "tileURL":
"http://data.example.com/collections/buildings/tiles/WebMercatorQuad/2/
0/0.png",
      "tileMatrix": 0,
      "tileRow": 0,
      "tileCol": 0,
      "width": 256,
      "height": 256,
      "top": -10,
      "left": -20
    },
    {
      "tileURL":
"http://data.example.com/collections/buildings/tiles/WebMercatorQuad/2/
0/1.png",
      "tileMatrix": 0,
      "tileRow": 0,
      "tileCol": 1,
      "width": 100,
      "height": 256,
      "top": -10,
      "left": 236
    },
    {
      "tileURL":
"http://data.example.com/collections/buildings/tiles/WebMercatorQuad/2/
1/0.png",
      "tileMatrix": 0,
      "tileRow": 1,
      "tileCol": 0,
      "width": 256,
      "height": 200,
      "top": 246,
      "left": -20
    },
    {
      "tileURL":
"http://data.example.com/collections/buildings/tiles/WebMercatorQuad/2/
1/1.png",
      "tileMatrix": 0,
      "tileRow": 1,
```

```

        "tileCol": 1,
        "width": 100,
        "height": 200,
        "top": 246,
        "left": 236
    }
]
}

```

Package Response

This format assumes that the client is interested in the tiles that cover a geographic area defined by the bounding box and the scale (or scales). The client knows what to do with the tiles and it is able to identify the tiles by their path using the URI template of the server as a pattern to extract the TileMatrix, TileRow and TileCol of each one.

Assuming that the client has requested a scale that fits with TileMatrix "2" and a bounding box that requires 2x2 tiles and that he client has requested a **package** type of multi-tile and negotiated a ZIP format, a ZIP file is produced and sent by the server with the following files and paths:

File	Path	TileMatrix	TileRow	TileCol
0.png	WebMercatorQuad/2/0	2	0	0
1.png	WebMercatorQuad/2/0	2	0	1
0.png	WebMercatorQuad/2/1	2	1	0
1.png	WebMercatorQuad/2/1	2	1	1

Table 3. Content of a package containing 4 tiles

7.4.8. Error conditions

A general summary of the HTTP status codes can be found in OGC API - Common.

If the parameter value **tileMatrixSetId** is not available by the server for this resource or the parameters values **bbox** or **scaleDenominator** are out-of-range, the status code of the response will be 404.

Chapter 8. Requirement Class "Tiles Collections Multi-tiles"

8.1. Overview

Requirements Class	
http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/cols-multitiles	
Target type	Web API
Dependency	http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/core
Dependency	http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/collections

This requirements class defines a mechanism to request more than one tile from more than one collection in a single request. The result can be a document listing the needed tiles to cover a bounding box or a package with all tiles inside. This section shares most of the content with the previous one and intends to provide similar mechanism. The main difference is the capability to request tiles that include elements of multiple collections provided by the parameter 'collections'.

8.2. API landing page

The landing page provides links to start exploring the resources offered by the API. It mainly consists of a list of links. The core requirement class of this draft specification does not add anything to the links required by OGC API - Common. The collections extension requires new link for the description of the tiles from more than one collection on top of the common ones that is inherited and needed by this extension.

8.3. Declaration of conformance classes

8.3.1. Response

The conformance page mainly consists of a list of links. OGC API - Common already requires some links.

Requirement 26	/req/tiles/cols-multitiles/conformance-success
A	The API conformance path SHALL advertise the capability of generating tiles from multiple collections adding the conformance class for this capability as a link to http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/cols-multitiles .

In the conformance page (typically in JSON format) the links follow the link schema defined in the OGC API - Common. The following is an example fragment of the response of an OGC API - Tiles conformance information page with links to the **collections** requirements class and this requirements class.

Example 4. Conformance Information Page fragment

```
{
  "conformsTo": [
    "http://www.opengis.net/spec/ogcapi-common-1/1.0/req/core",
    "http://www.opengis.net/spec/ogcapi-common-1/1.0/req/collections",
    "http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/core"
    "http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/collections"
    "http://www.opengis.net/spec/ogcapi-tiles-1/1.0/req/cols-
multitiles"
  ]
}
```

8.4. Tiles description

The response to this operation contains the necessary information to later formulate a tile request from more than one collection as described in the **collections** extension. This requirement class adds an extra link for the multi-tiles

8.4.1. Response

A successful response to a tiles request for more than on collection will respond with a data structure with specific information necessary to get tiles representing the resource collection. In this extension, the response informs about the URL template to retrieve multi-tiles.

Requirement 27	/req/tiles/cols-multitiles/mtcs-multitiles-examples
A	The content of the response to a successful execution SHALL include at least a link to a multi-tiles from multiple collections URI template (rel: items).
B	These links SHALL provide a URL template with the fragment /tiles followed by the variables {tileMatrixSetId}. Once the variables are substituted by their respective valid values, a URL to a multi-tiles endpoint is obtained.

C	There SHALL be a link to a multi-tile URI template for each format that the server supports (the format is indicated in the type attribute of the link)
---	--

One common order used in URL templates for tiles is `.../tiles/{tileMatrixSetId}`, but this draft specification allows for other URL template composition.

URL template variable	Meaning	Possible values
TileMatrixSetId	tile matrix set identifier	The identifiers included in Annex D of OGC 17-083r2 or defined by extensions of the core requirements class.

Table 4. URI template variables for tiles and possible values

Example 5. API tiles response fragment

```
links:
[
  {
    "href": "http://data.example.com/tiles/{tileMatrixSetId}",
    "rel": "items",
    "type": "image/png",
  }
]
```

8.5. Multiple tiles from more than one collection

This extension provides a mechanism to select and retrieve a set of tiles at once from a TileMatrixSet.

8.5.1. Operation

Requirement 28	/req/tiles/multitiles/mtcs-op
A	Tiles SHALL be available as HTTP GET requests to a URI that will be composed by two parts: the first part is the URI of a resource that can be represented as tiles and the second part follows the pattern <code>/tiles/{tileMatrixSetId}</code>

B	Only the resources or collections that advertise one of more links with type=tiles SHALL be requested as multiple tiles.
---	--

8.5.2. Parameter tileMatrixSetId

Requirement 29	/req/tiles/multitiles/mtcs-tilematrixsetid-definition
A	<p>The operation SHALL support a parameter tileMatrixSetId with the following characteristics (shown as OpenAPI Specification 3.0 fragment):</p> <pre> name: tileMatrixSetId in: path description: Identifier of a specific tiling scheme. It can be one of the specified in Annex D.1 of the OGC 17-083r2 standard or one defined in this service. required: true schema: type: string example: WebMercatorQuad </pre>

8.5.3. Parameter bbox

Requirement 30	/req/tiles/multitiles/mtcs-bbox-definition
----------------	--

A

The operation SHALL support an optional parameter **bbox** to filter the area where tiles will be retrieved with the following characteristics (shown as OpenAPI Specification 3.0 fragment):

```
name: bbox
```

```
in: query
```

```
description:
```

```
  'Only elements that have a geometry that  
  intersects the bounding box are selected.'
```

```
  The bounding box is provided as four or six  
  numbers, depending on whether the coordinate  
  reference system includes a vertical axis  
  (elevation or depth):
```

```
    * Lower left corner, coordinate axis 1
```

```
    * Lower left corner, coordinate axis 2
```

```
    * Lower left corner, coordinate axis 3
```

```
(optional)
```

```
    * Upper right corner, coordinate axis 1
```

```
    * Upper right corner, coordinate axis 2
```

```
    * Upper right corner, coordinate axis 3
```

```
(optional)
```

```
  The coordinate reference system of the  
  values is WGS 84 longitude/latitude
```

```
(http://www.opengis.net/def/crs/OGC/1.3/CRS84)  
unless a different coordinate reference system is  
specified by another parameter in the API (e.g  
'bbox-crs').'
```

```
required: false
```

```
schema:
```

```
  type: array
```

```
  minItems: 4
```

```
  maxItems: 6
```

```
  items:
```

```
    type: number
```

```
    format: double
```

```
style: form
```

```
explode: false
```

B	A TileMatrixSet definition points to a CRS. The coordinates of the bbox SHALL be in the CRS of specified in the definition of the TileMatrixSet identified by the tileMatrixSetId
C	If the parameter is not specified, the server SHALL assume the whole extent of the tiles are requested.

This definition is inherited from OGC API - Common.

8.5.4. Parameter scaleDenominator

Requirement 31	/req/tiles/multitiles/mtcs-scaledenominator-definition
A	<p>The operation SHALL support an optional parameter scaleDenominator to filter the scales where tiles will be retrieved with the following characteristics (shown as OpenAPI Specification 3.0 fragment):</p> <pre> name: scaleDenominator in: query description: 'A range of scale denominators (that can be used to generate a list of tileMatrix names).' required: false style: form explode: false schema: type: array minItems: 2 maxItems: 2 items: type: number format: double </pre>
B	If the parameter is not specified, the server SHALL assume all TileMatrices (scales) SHALL be returned.

Recommendation 7	/rec/tiles/multitiles/mtcs-scaledenominator-definition
-------------------------	---

A	To prevent mistakes identifying the scale denominator due to precision issues caused by lack of significant digits, the client should apply a tolerance to intervals. If the client wants to specify a single scale denominator, it will use a small interval with enough tolerance.
---	--

8.5.5. Parameter multiTileType

Requirement 32	/req/tiles/multitiles/mtcs-multitiletype-definition
A	<p>The operation SHALL support an optional parameter multiTileType that determines the type of the response and with the following characteristics (shown as OpenAPI Specification 3.0 fragment):</p> <pre> name: multiTileType in: query description: 'When successful, the service will respond to a query in one of two ways. It can provide a file with links to each tile or or it will provide the tiles in a package. The package can still contain the description of each tile The allowed values for this parameter are `url`, `tiles` and `full`.' style: form schema: type: string default: tiles enum: - url - tiles - full example: full </pre>
B	<p>If the value of the multiTileType parameter is set to url the server SHALL return a list of the selected tiles in a format following the tileSet schema. Each tile description in the list will contain a URL to download the tile later.</p>

C	If the value of the multiTileType parameter is set to tiles or if the parameter is not specified in the request, the server SHALL return a package (e.g. a ZIP file) that will include tiles as separated parts in the package.
D	If the value of the multiTileType parameter is set to full the server SHALL return the tiles and a list of the selected tiles (in a format following the tileSet schema) as part of a package.

Permission 4	/per/tiles/multitiles/mtcs-multitiletype-definition
A	The server MAY only implement a subset of the enumerated values (url, tiles, full) for the parameter multitileType and in this case the server will only enumerate this subset in its schema.

8.5.6. Parameter Collections

Requirement 33	/req/tiles/collections/mtcs-collections-definition
A	<p>The operation SHALL support an optional parameter collections with the following characteristics (shown as OpenAPI Specification 3.0 fragment)</p> <pre> name: collections in: query required: false style: form explode: false schema: type: array items: type: string </pre>
B	collections SHALL contain a comma-separated list of collection identifiers.
C	Only the collections that advertise a link type=tiles in the /collections/{collectionId} SHALL be included.

D	Only the collections that support the same TileMatrixSetId parameter value SHALL be included
C	If collections is missing, all collections supporting the TileMatrixSetId parameter value will be considered.

8.5.7. Formats

In the cases of the multi-tile response, there are two formats involved. The multi-tile itself can be returned as a package (e.g. a ZIP file) that contains the tiles inside. The individual tile also has its own format. The format of the multi-tile is governed by the format procedure specified in the OGC API – Common draft specification. When the server supports multiple encodings for the individual tiles and the client has a preference for the tiles format, there is a need for communicating this preference to the server. This document does not mandate any particular approach for how this is supported but provides the following recommendation.

Recommendation 8	/rec/tiles/multitiles/mtcs-f-tile-definition
A	The operation MAY support an optional parameter f-tile to specify the tile format that the client prefers as parts of the multi-tile response.
B	The content of this parameter should be specified by the server instance as an enumeration of supported media types.

8.5.8. Response

A successful response for a set of tiles will be consistent with the media type of the resource requested. This draft specification does not impose any media type but suggests the use of a package format.

Requirement 34	/req/tiles/cols-multitiles/mtcs-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 format requested and be inside or intersect with the spatial extent of the geographical area represented by the 'bbox' and scaleDenominator .

C

If a list of the tiles has been requested, the content of that response SHALL contain a tileSet document be based upon the following OpenAPI 3.0 schema:

```
tileSet:
  description: This is the response for a
multiple tiles request.
  type: object
  required: tileSet
  properties:
    tileSet:
      type: array
      items:
        $ref:
'#/components/schemas/tileSetEntry'
    tileSetEntry:
      description:
        This is an entry on a multiple tiles
request.
      type: object
      required:
        - tileURL
        - tileMatrix
        - tileRow
        - tileCol
      properties:
        tileURL:
          type: string
          format: uri
        tileMatrix:
          type: string
        tileRow:
          type: number
        tileCol:
          type: number
        width:
          type: number
          description:
            The width of the tile in rendering
device pixels. If it exceeds the visual display
area be should cut when displayed
        height:
          type: number
          description:
            The height of the tile in rendering
device pixels. If it exceeds the visual display
area be should cut when displayed
        top:
          type: number
```


D	<p>When a package is being returned and the package format supports expressing file paths of its parts (such as the ZIP file), each tile in the package SHALL have a path following the template:</p> <p><code>{tileMatrixSetId}/{tileMatrix}/{tileRow}/{tileCol}.{file-extension}</code>. {file-extension} is the file extension that corresponds to the media type (e.g "jpg" for image/jpeg).</p>
---	--

description:

8.5.9. Error conditions

Horizontal position from the left of the visual display area in pixels. Negative value

means that the left side of the tile is outside the top-left corner of the display and should be cut when displayed

If the parameter value of the parameter `tileMatrixSetId` is not available by the server for this resource or the values of the parameters `bbox` or `scaleDenominator` are out-of-range, the status code of the response will be 404.

Annex A: Conformance Class Abstract Test Suite (Normative)

NOTE

Ensure that there is a conformance class for each requirements class and a test for each requirement (identified by requirement name and number)

A.1. Conformance Class A

A.1.1. Requirement 1

Test id:	/conf/conf-class-a/req-name-1
Requirement:	/req/req-class-a/req-name-1
Test purpose:	Verify that...
Test method:	Inspect...

A.1.2. Requirement 2

Annex B: Revision History

Date	Release	Editor	Primary clauses modified	Description
2019-03-21	Template	C. Heazel	all	initial template

Annex C: Bibliography

- W3C/OGC: Spatial Data on the Web Best Practices, W3C Working Group Note 28 September 2017, <https://www.w3.org/TR/sdw-bp/>
- W3C: Data on the Web Best Practices, W3C Recommendation 31 January 2017, <https://www.w3.org/TR/dwbp/>
- W3C: Data Catalog Vocabulary, W3C Recommendation 16 January 2014, <https://www.w3.org/TR/vocab-dcat/>
- IANA: Link Relation Types, <https://www.iana.org/assignments/link-relations/link-relations.xml>