

# CEOS STAC Best Practices

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# 1. Introduction

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## 1.1 Purpose of document

The STAC ecosystem comprises both API-related and metadata-related specifications. This document provides server implementation Best Practices for STAC-based metadata publication and related discovery services allowing for standardized and harmonized access to metadata and data for CEOS agencies.

TBD.

## 1.2 Document overview

The document is organized as follows:

- Chapter 1 is the introduction of the document.
- [Chapter 2: Objectives and needs](#) gives an overview of objectives and needs.
- [Chapter 3: Best Practices](#) introduces the categories of Best Practices and presents best practices for catalogs and metadata applicable to collections and granules.

The following chapters present Best Practices for one particular topic:

- [Chapter 4: Granule Catalog Best Practices](#)
- [Chapter 5: Collection Catalog Best Practices](#)
- [Chapter 6: Granule Metadata Best Practices](#)
- [Chapter 7: Collection Metadata Best Practices](#)

## 1.3 Terms, definitions and abbreviated terms

### 1.3.1 Terms and Definitions

Analysis Ready Data	Satellite data that have been processed to a minimum set of requirements and organized into a form that allows immediate analysis with a minimum of additional user effort and interoperability both through time and with other datasets.
Granule	A granule is the finest granularity of data that can be independently managed. A granule usually matches the individual file of EO satellite data.
Collection	A collection is an aggregation of granules sharing the same product specification. A collection typically corresponds to the series of products derived from data acquired by a sensor on board a satellite and having the same mode of operation.
Interface	Named set of operations that characterize the behavior of an entity.
Metadata	Information about a resource <a href="#">[RD02]</a> .
Metadata element	Discrete unit of metadata <a href="#">[RD02]</a> .

### 1.3.2 Acronyms

API	Application Programming Interface
ARD	Analysis Ready Data
CEOS	Committee on Earth Observation Satellites
CQL	Common Query Language
DIF-10	Directory Interchange Format Version 10
EO	Earth Observation
GCMD	Global Change Master Directory
HATEOAS	Hypertext As The Engine Of Application State
IDN	International Directory Network
JSON	JavaScript Object Notation
OGC	Open Geospatial Consortium
OSDD	OpenSearch Description Document
STAC	Spatiotemporal Asset Catalog
WGISS	Working Group on Information Systems and Services

## 1.4 References

### 1.4.1 Applicable documents

ID	Title
AD01	<a href="#">STAC Catalog Specification</a>
AD02	<a href="#">STAC Collection Specification</a>
AD03	<a href="#">STAC Item Specification</a>
AD04	<a href="#">STAC API Specification</a>
AD05	<a href="#">STAC API - Item Search</a>
AD06	<a href="#">STAC API - Filter Extension</a>
AD07	<a href="#">STAC API - Collection Search</a>
AD08	<a href="#">OGC17-069r3, OGC API - Features - Part 1: Core</a>
AD09	<a href="#">OGC17-079r1, OGC API - Features - Part 3: Filtering</a>
AD10	<a href="#">OGC21-065, Common Query Language (CQL2)</a>
AD11	<a href="#">RFC 7946 - The GeoJSON Format</a>

ID	Title
AD12	<a href="#">JSON Schema: A Media Type for Describing JSON Documents, draft-handrews-json-schema-02</a>
AD13	<a href="#">STAC Scientific Citation Extension Specification, v1.0.0</a>
AD14	<a href="#">STAC Electro-Optical Extension Specification, v1.1.0</a>
AD15	<a href="#">STAC SAR Extension Specification, v1.0.0</a>
AD16	<a href="#">STAC Satellite Extension Specification, v1.0.0</a>
AD17	<a href="#">STAC Versioning Indicators Extension Specification, v1.2.0</a>
AD18	<a href="#">STAC View Geometry Extension Specification, v1.0.0</a>
AD19	<a href="#">STAC Projection Extension Specification, v1.0.0</a>
AD20	<a href="#">STAC Timestamps Extension Specification, v1.0.0</a>
AD21	<a href="#">STAC Processing Extension Specification, v1.1.0</a>
AD22	<a href="#">STAC Hyperspectral Imagery Extension Specification, draft</a>
AD23	<a href="#">STAC Landsat Extension Specification, v1.1.1</a>
AD24	<a href="#">STAC Alternate Assets Extension Specification, v1.1.0</a>
AD25	<a href="#">STAC Item Assets Definition Extension Specification, v1.0.0</a>

#### 1.4.2 Reference documents

ID	Title
RD01	<a href="#">CEOS OpenSearch Best Practice Document, Version 1.0, CEOS-OPENSEARCH-BP-V1.3</a>
RD02	<a href="#">ISO 19115-1:2014, Geographic Information – Metadata – Part 1: Fundamentals, First Edition 2014-04-01</a>
RD03	<a href="#">OGC23-038, Best Practice for Common Band Names of Optical and Radar Sensors - Expected but no draft available.</a>
RD04	<a href="#">OGC13-026r9, OpenSearch Extension for Earth Observation</a>

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## 2. Objectives and needs

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### Overview

The set of available STAC and STAC API specifications, the underlying OGC specifications and a growing set of related STAC and STAC API extensions can support many different use cases. However, the multiple implementation options for a given use case may cause organizations to implement different subsets of the specifications causing interoperability issues and preventing federation of catalogs provided by different organisations. The guidelines and recommendations presented in the current document aim to cover a number of recurrent use cases which are described below. Not all use cases apply to all organisations, but organisations with the need to cover one of these use cases should consider the corresponding recommendations.

### Use cases and scenarios

In the current scenario where organisations (i.e. Data Providers) implement the CEOS OpenSearch Best Practices, federation is performed by systems (i.e. Federating Entities) such as IDN, NASA CMR or FedEO. The use cases identified below aim to continue to support such federation, but through the use of STAC (JSON) instead of XML-based OpenSearch with Atom responses.

<b>User Story</b>	<b>As a</b>	<b>I want to</b>	<b>So that I can</b>
UC-1	Data Provider	Publish my granule metadata records, e.g. on the cloud, organised per collection, without implementing search interfaces.	provide access to the metadata records to my data users.
UC-2	Data Provider	Publish my granule metadata records, organised per collection, and provide granule search interfaces (API).	provide access to the metadata records to my data users and offer eearch interfaces (API) they can use via scripts, curl or Notebooks.
UC-3	Data Provider	Publish my granule and collection metadata records and provide collection and granule search interfaces (API).	provide access to the metadata records to my data users and offer eearch interfaces (API) for collection and granule search they can use via scripts, curl or Notebooks.
UC-4	Data Provider	Publish my granule and collection metadata records and provide two-step search interfaces (API) similar to my current OpenSearch two-step-search interfaces.	offer my data users a two-step search capability.

<b>User Story</b>	<b>As a</b>	<b>I want to</b>	<b>So that I can</b>
UC-5	Data Provider	Publish my collection metadata records	make them available for federation through CEOS IDN or similar federated systems (e.g. GEO) without additional effort.
UC-6	Data Provider	Publish my granule metadata records and search interfaces	make them available for federation through CEOS IDN or GEO without additional effort.
UC-7	Data Provider	Publish collection metadata records for my analysis ready datasets	make them available for my users as per CEOS-ARD guidelines.
UC-8	Data Provider	Publish granule metadata records for my analysis ready datasets	make them available for my users as per CEOS-ARD guidelines.
UC-9	Federating entity	Provide federated access to collections and granules from a data partner	offer my users access to collections of that data partner (including granule search capabilities/interfaces if available) without requiring additional changes/effort at the data provider side.
UC-10	Data Provider	Publish metadata records for granules available in cloud-native format e.g. on cloud storage	make them available for my users
UC-11	Data Provider	Publish metadata records for granules with associated service offerings (e.g OGC WMS, WMTS, WCS, API-Coverages)	make the metadata records available for my users and advertise the availability of the associated service endpoints

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## 3. Best Practices

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### 3.1 Introduction

There are three different levels of obligation for the Best Practices presented in the current document:

- "Requirements" (**REQ**) are mandatory and must be implemented,
- "Recommendations" (**REC**) are optional, but strongly recommended for interoperability.

In addition, "Permissions" (**PER**) indicate allowed deviations from one of more of the underlying specifications in cases where a subset of the original requirements is deemed sufficient in the context of CEOS.



**Put general requirements in this chapter that are applicable to multiple chapters (e.g. common for granule/collection to avoid repetition)**

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### 3.2 Catalog Best Practices

The Best Practices described in this section apply to **CEOS STAC Collection Catalogs** and **CEOS STAC Granule Catalogs**.

#### **CEOS-STAC-PER-3210 - API Feature paths [Permission]**

A CEOS STAC catalog implementation is allowed to not use fixed paths to navigate from resource to resource, but shall support discovering the actual path via the proper relation (rel="xyz") in the corresponding resource's representation.

For example, the rel="items" path for a collection is not necessarily the path towards the collection with "/items" appended but may be on a different server.

#### **CEOS-STAC-PER-3220 - API Feature relations [Permission]**

A CEOS STAC catalog implementation is not required to:

- Support the /api path or provide an OpenAPI description of its interface
- Support the rel="service-desc" from its landing page (root catalog)
- Support the /conformance path
- Support the rel="conformance" from its landing page (root catalog)

#### 3.2.1 Advertising additional search parameters

- rel="queryables", JSON Schema (optional)
- CQL (optional)

The STAC API and underlying OGC API specifications define the list of search parameters to be supported. Catalog implementations may however support additional parameters the meaning/interpretation of which is not defined by these specifications.

#### **CEOS-STAC-REQ-3230 - Additional search parameters [Requirement]**

A CEOS STAC collection/granule catalog supporting additional search parameters shall implement the "STAC API Filter Extension" [\[AD06\]](#), i.e.:

- Advertise the additional filter parameters via the corresponding Queryables responses (JSON Schema),
- Use the additional filter parameters inside the filter expression passed via the **filter** (HTTP) query parameter.

The endpoint to which the above additional parameters apply depends on the context: i.e. collection search, granule search via rel="items" endpoint or granule search via the rel="search" endpoint.

#### CEOS-STAC-REQ-3235 - Parameter Descriptions [Requirement]

The GET response for the rel=**queryables** endpoint in application/schema+json representation shall provide additional information about search parameters including:

- **type** of the parameter (e.g. array, string, integer, number, ...)
- **title** of the parameter providing a human readable title.
- **format** of the string parameter (e.g. "uri", "date-time")
- **enum** to enumerate valid (string) values
- **minItems**, **maxItems** to constrain the size of arrays
- **minimum**, **maximum** to constrain the range of a numerical parameter

TBD: allow using "minimum" and "maximum" in combination with "date-time" (string) although not allowed by JSON schema ?

#### CEOS-STAC-REQ-3240 - Additional search parameters [Requirement]

A CEOS STAC collection/granule catalog supporting additional search parameters via a filter expression shall support the following additional query parameters and advertise the corresponding conformance classes in the landing page (See also "STAC API Filter Extension" [\[AD06\]](#)).

- filter
- filter-lang

#### CEOS-STAC-REQ-3250 - CQL subset [Requirement]

A CEOS STAC collection/granule catalog supporting additional search parameters via a filter expression shall support at least the following conformance classes of CQL2 (See also "STAC API Filter Extension" [\[AD06\]](#) and "OGC21-065, Common Query Language (CQL2)" [\[AD10\]](#)).

- CQL2 Text
- Basic CQL2



**There is currently no mechanism allowing to advertise different CQL filtering capabilities at different endpoints.**

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OGC API Features Part 3 allows a **simpler way to add additional search parameters** allowing them to be used as HTTP query parameters directly. The same approach is not (yet) available in the STAC API Filtering extension. See <https://github.com/stac-api-extensions/filter/issues/15>

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**CEOS-STAC-REC-3260 - Additional search parameter names [Recommendation]**

A CEOS STAC collection/granule catalog supporting additional search parameters for collection search (e.g. search by platform, instrument, organisation) or granule search (e.g. by polarisation mode, orbit direction, orbit number, cloud cover, etc.) should by preference use names consistent with the names defined in the OpenSearch extension for Earth Observation OGC 13-026r9 [RD04].

**Should a STAC API extension be proposed covering available (OpenSearch) parameters allowing `queryables` responses to refer to these by reference ? An example is shown below. It would allow implementations to choose their parameter names and "connect" them to interoperable definitions from the OGC OpenSearch spec (with mappings to ISO, UMM, etc.) via `$ref`.**

```
"doi" : {
  "description" : "{eo:doi}",
  "$ref": "https://github.com/ceos-wgiss/opensearch-
eo/v1.1/schema.json#/properties/doi"
}
```

Extract of a possible STAC extension (YAML) with additional reusable parameter definitions as per OGC13-026r9.

```
"$schema": http://json-schema.org/draft-07/schema#
"$id": https://github.com/ceos-wgiss/opensearch-eo/v1.1/schema.json#
title: OpenSearch parameter declarations
type: object
properties:
  #
  # OGC13-026r9 Table 4
  #
  doi:
    description: "{eo:doi}"
    title: Doi
    type: string
  instrument:
    description: "{eo:instrument}"
    title: Instrument
    type: string
```

### 3.2.2 Search response

**CEOS-STAC-REQ-3270 - numberMatched [Requirement]**

A CEOS STAC catalog search response shall include the `numberMatched` property providing the number of items meeting the selection parameters, possibly estimated.

**CEOS-STAC-REC-3275 - numberReturned [Recommendation]**

A CEOS STAC catalog search response should include the `numberReturned` property.

Both properties are optional in <https://github.com/radiantearth/stac-api-spec/blob/main/fragments/itemcollection/README.md>. The above Best Practices apply to all available search endpoints e.g. at `rel="data"`, `rel="items"` or `rel="search"`.

#### CEOS-STAC-REQ-3280 - Result set navigation [Requirement]

The `$.links` array in a search response shall include Link objects for navigating the search result set when the result set is too large to fit a single response using hyperlinks `rel='next'`.

#### CEOS-STAC-REC-3290 - Result set navigation [Recommendation]

The `$.links` array in a search response should include Link objects for navigating the search result set when the result set is too large to fit a single response using hyperlinks `rel='self'`, `rel='prev'`, `rel='first'`, `rel='last'`.

#### CEOS-STAC-REC-3295 - Result set navigation [Recommendation]

Implementations may decide to only implement forward traversal via navigation/paging links. The `$.links` array in a search response should include Link objects for navigating the search result set when the result set is too large to fit a single response using hyperlinks `rel='self'`, `rel='prev'`, `rel='next'`, `rel='first'`, `rel='last'` per result page as shown below.

Use case	first	prev	self	next	last
First page	Optional	Not allowed	Mandatory	Mandatory	Optional
Middle pages	Optional	Optional	Mandatory	Mandatory	Optional
Last page	Optional	Optional	Mandatory	Not allowed	Optional
Empty result set	Not allowed	Not allowed	Mandatory	Not allowed	Not allowed
Single page	Optional	Not allowed	Mandatory	Not allowed	Optional

## 3.3 Metadata Best Practices

The Best Practices described in this section apply to [CEOS STAC Collection Metadata](#) and [CEOS STAC Granule Metadata](#).

#### CEOS-STAC-REQ-3305 - Common metadata [Recommendation]

CEOS implementations should encode the following [STAC common metadata properties](#) in granule or collection representations with a name corresponding to the preferred label defined in the corresponding GCMD keyword scheme:

Field name	GCMD keyword scheme
platform	<a href="#">GCMD platform</a>
instruments[]	<a href="#">GCMD instrument</a>
constellation	<a href="#">GCMD platform</a>
mission	TBD

### 3.3.1 Assets and roles

- what names (roles, media types) should be used for ...

#### CEOS-STAC-REQ-3310 - Resource associations [Requirement]

If a resource association can be encoded as Assets (e.g. role="metadata") or Link (e.g. rel="icon", rel="alternate"), STAC implementations shall give precedence to the encoding as Asset.

#### CEOS-STAC-REQ-3320 - Metadata assets [Requirement]

CEOS STAC implementations shall provide a URL of the collection or granule metadata encoding in a particular standard representation, via an Asset object with role=`metadata`.

#### CEOS-STAC-REC-3325 - Link and Asset type attributes [Recommendation]

CEOS STAC implementations shall specify the media (MIME) type of the artifact associated with a resource by specifying the "type" attribute of the Link object or Asset object. The media types (`type`) from the table below shall be used for assets/links to the corresponding resources.

The table below list some frequently used formats and the corresponding media type to be used for metadata assets.

Format	type
DIF10	<code>application/dif10+xml</code>
ISO19139	<code>application/vnd.iso.19139+xml</code>
ISO19139-2	<code>application/vnd.iso.19139-2+xml</code>
ISO19115-3	<code>application/vnd.iso.19115-3+xml</code>
ISO19157-2	<code>application/vnd.iso.19157-2+xml</code>
OGC 10-157r4	<code>application/gml+xml;profile=http://www.opengis.net/spec/EOMPOM/1.1</code>
OGC 17-003r2	<code>application/geo+json;profile=http://www.opengis.net/spec/geojson/1.0</code>
OGC 17-084r1	<code>application/geo+json;profile=http://www.opengis.net/spec/eoc-geojson/1.0</code>
Dublin Core	<code>application/xml</code>

#### CEOS-STAC-REC-3330 - Asset roles [Recommendation]

If additional asset roles are required (e.g. for cloud masks, snow masks etc), preference shall be given to the asset role names of the [corresponding Best Practices](#).

### 3.3.2 Links and relations

#### CEOS-STAC-REC-3340 - Root relation [Recommendation]

It is discouraged to use the rel="root" relation in STAC collection and item encodings as the original catalog/collections may be referenced or included in a federated catalog with a different root.

**CEOS-STAC-REC-3350 - Reference to metadata [Recommendation]**

STAC implementations should use Link objects with rel="alternate" or rel="via" for referencing detailed representation of the metadata for a collection or granule. (The "via" relation should be preferred to convey the authoritative resource or the source of the information from where the Collection/Item is made.)

**CEOS-STAC-REC-3360 - Reference to documentation [Recommendation]**

STAC implementations should use a Link object with rel="describedby" to reference from a collection or granule to its documentation.

Note: although some implementations use rel="about" for the same purpose, rel="describedby" is recommended by <https://docs.ogc.org/DRAFTS/20-024.html>.

The table below list some frequently used formats for documentation and their corresponding media type (**type**).

Format	type
Markdown	text/markdown
PDF	application/pdf

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# 4 Granule Catalog Best Practices

## 4.1 Overview

Explain main alternatives :

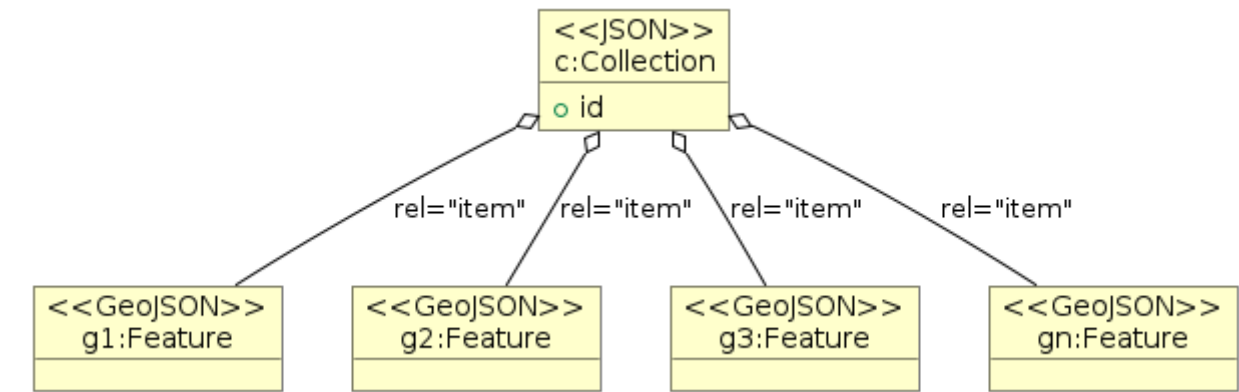
- static catalog (landing page, ..)
- catalog with search interface

## 4.2 Static catalog without search interface

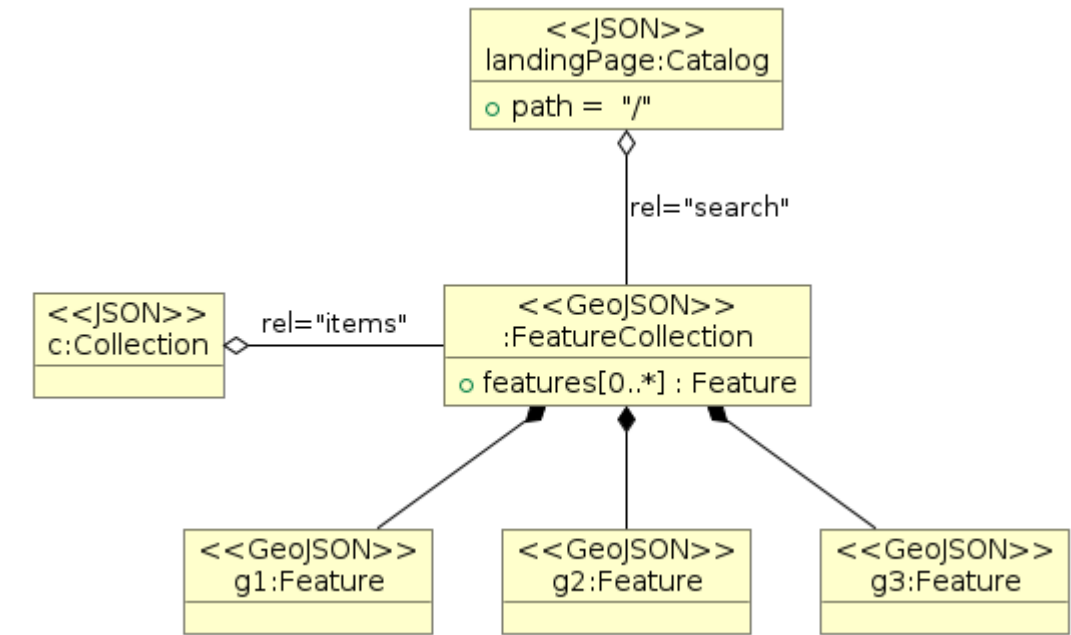
- rel="item"

EO granules represented as STAC items can be made available as:

- individual STAC items referenced from a STAC collection
- the result of a search interface



Method 1: Using rel="item"



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*Method 2: Via a search interface*

TBD: allow both ?

## 4.3 Catalog with search interface

### 4.3.1 Granule search request

#### Endpoints

##### **CEOS-STAC-REQ-4310 - Granule search endpoints [Requirement]**

CEOS STAC granule catalogs shall advertise and provide the endpoints for granule search per individual collection in the STAC Collection representation as a Link object with `rel="items"` and `type="application/geo+json"`.

##### **CEOS-STAC-PER-4320 - Cross-collection granule search endpoint [Permission]**

CEOS STAC granule catalogs may or may not advertise and provide a cross-collection endpoint for granule search, valid for all the collections in the STAC Catalog (typically the Landing Page) with `rel="search"` and `type="application/geo+json"` and may instead only provide individual granule search endpoints per collection via `rel="items"` in the collection representation.

The above permission avoids the implementation of multiple endpoints for granule search as a single implementation is sufficient. CEOS STAC catalog clients should thus not assume the existence of the cross-collection granule search endpoint.

##### **CEOS-STAC-REQ-4330 - Cross-collection granule search method [Requirement]**

CEOS STAC granule catalogs with cross-collection granule search endpoint shall support searches at the `endpoint` (`rel="search"`) using the HTTP `GET` method.

Support of the `POST` method at the cross-collection granule search endpoint (if available) is not required.

#### Search parameters

##### **CEOS-STAC-REQ-4340 - Supported granule search parameters [Requirement]**

The STAC-API and OGC API-Features specifications define a list of fundamental search parameters. From these specifications, a CEOS STAC granule catalog shall support the following minimum set of search parameters for "granule" search at the `rel="items"` endpoint:

- `limit`
- `bbox`
- `datetime`

##### **CEOS-STAC-REQ-4350 - Additional granule search queryables [Requirement]**

A CEOS STAC granule catalog supporting additional queryables for a collection shall return the link to the Queryables object with the list of queryables that can be used in a filter expression for that collection via a link object in the collection representation (metadata) with

rel="http://www.opengis.net/def/rel/ogc/1.0/queryables" and type="application/schema+json" (typically, but not necessarily, at '/collections/{collectionId}/queryables').

TBD: no requirements for cross-collection granule search endpoint is it is not required ?

## Other

- Asset-level search capability (STFC)

### 4.3.2 Granule search response

#### **CEOS-STAC-REQ-4630 - Item search response representation [Requirement]**

A granule search response shall be represented as a GeoJSON FeatureCollection according to version v1.0.0 of the ["STAC API ItemCollection Specification"](#).

#### **CEOS-STAC-REQ-4635 - Allow for granule search-by-id [Requirement]**

The \$.features[].id property in a granule search response shall allow to navigate to a single granule using the **id** as a path parameter appended to the granule search endpoint (rel='items') e.g. /collections/{collection-id}/items/{id}.

#### **CEOS-STAC-REQ-4640 - Item search response representation [Requirement]**

Granules included in a granule search response shall be represented according to the ["CEOS STAC Granule Metadata Best Practices"](#).



**this is a question**



**Take note of this**



**Take note of this**



**Take note of this**

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# 5. Collection Catalog Best Practices

## 5.1 Overview

Explain main alternatives :

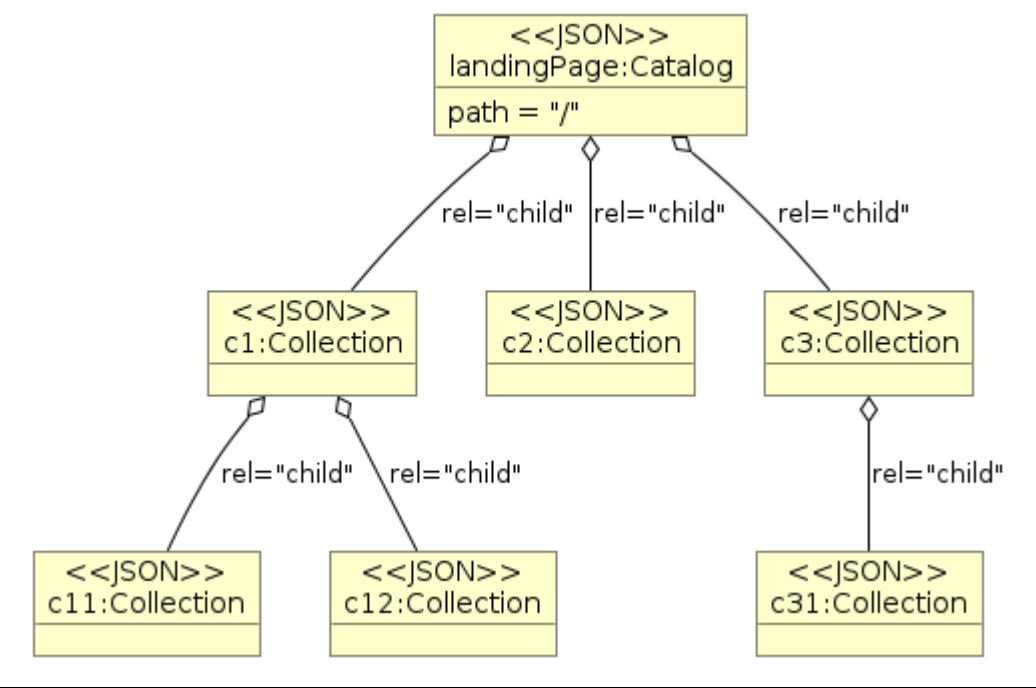
- static collection catalog (landing page, rel="child", rel="data", ..)
- collection catalog with search interface

The requirements in the current chapter only apply when TBD.

## 5.2 Collection catalog without search interface

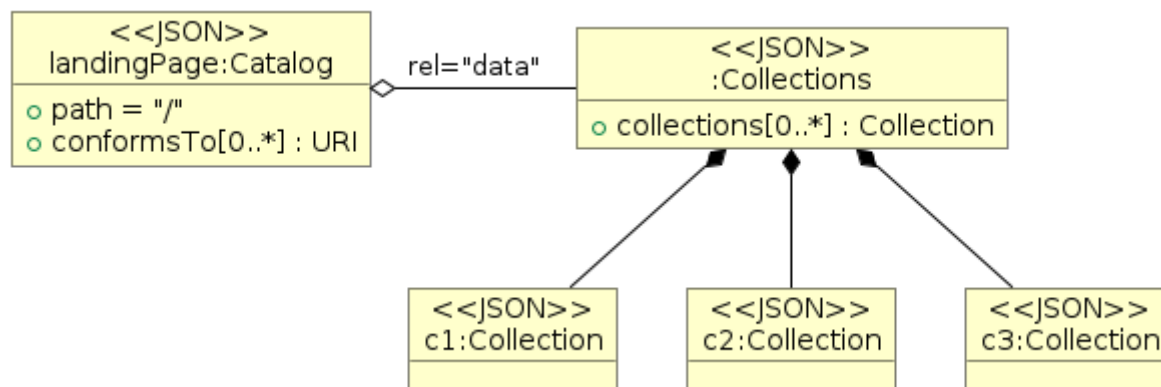
EO collections represented as STAC collections can be made available as a STAC Catalog in different ways as depicted below:

- Through a hierarchy of catalogs or collections with the rel="child" relation.
- As a list of collections available via the rel="data" relation.



Method 1: Using rel="child"





Method 2: Using rel="data"

Implementations may combine both mechanisms and allow the same EO collection to be found via the collection hierarchy or the collection list. Implementations intending to support collection search are to support at least Method 2 and the corresponding endpoint.

#### CEOS-STAC-REQ-5210 - Collection access [Requirement]

A CEOS STAC catalog shall support access to collection metadata from the catalog landing page using the rel="child" or rel="data" approach depicted above or both approaches combined.

Note: When publishing a single collection, the collection and the landing page may be combined in a single JSON file.

## 5.3 Collection catalog with search interface

#### CEOS-STAC-REQ-5320 - Collections endpoint [Requirement]

A CEOS STAC catalog supporting collection search shall advertise the search endpoint for collections in the landing page with rel="data" (most often `/collections`), type="application/json" and declare the corresponding collection search conformance classes in the landing page. See "STAC API Collection Search" [AD07].

The above endpoint is further referred to as the `collections endpoint`.

.Conformance encoding example

```

"conformsTo": [
  "http://www.opengis.net/spec/ogcapi-common-2/1.0/conf/collections",
  "http://www.opengis.net/spec/ogcapi-common-2/1.0/conf/simple-query",
  "http://www.opengis.net/spec/ogcapi-records-1/1.0/req/cql-filter",
  "https://api.stacspec.org/v1.0.0-rc.2/collection-search",
  "https://api.stacspec.org/v1.0.0-rc.2/collection-search#filter",
  "https://api.stacspec.org/v1.0.0-rc.1/collection-search#free-text",
  "http://www.opengis.net/spec/cql2/1.0/conf/cql2-text",
  "http://www.opengis.net/spec/cql2/1.0/conf/basic-cql2"
]
  
```

### 5.3.1 Collection search request

#### **CEOS-STAC-REQ-5330 - Collection search method [Requirement]**

A CEOS STAC collection catalog shall support collection searches at the `collections endpoint` (rel="data") using the HTTP `GET` method.

`/collections` is typically used for the above endpoint, but this is not required.

#### **Search parameters**

#### **CEOS-STAC-REQ-5340 - Supported search parameters [Requirement]**

The STAC-API and OGC API-Features specifications define a list of fundamental search parameters. From these specifications, a CEOS STAC collection catalog shall support the following minimum set of search parameters for "collection" search at the collections endpoint:

- `limit`
- `bbox`
- `datetime`

#### **CEOS-STAC-REC-5360 - Free text search [Recommendation]**

For supporting free text searches, a CEOS STAC collection catalog shall advertise support for the HTTP query parameter `q` as in "STAC API Collection Search" [\[AD07\]](#).

#### **CEOS-STAC-REQ-5370 - Collection queryables [Requirement]**

A CEOS STAC collection catalog supporting additional queryables for collection search shall return the link to the Queryables object with the list of queryables that can be used in a filter expression via a link object in the collection search response with rel="http://www.opengis.net/def/rel/ogc/1.0/queryables" and type="application/schema+json" (See also "STAC API Collection Search" [\[AD07\]](#)).

### 5.3.2 Collection search response

- optional list of collection search parameters (rel="http://www.opengis.net/def/rel/ogc/1.0/queryables", type="application/schema+json")
- search by 'id' (at /collections), which 'ids' can be used for searching ? 'id' from hierarchy ?
- content negotiation (alternative formats)

#### **CEOS-STAC-REQ-5372 - Collection search response representation [Requirement]**

A collection search response shall be represented as a JSON object according to the "STAC API - Collection Search" [\[AD07\]](#).

#### **CEOS-STAC-REQ-5373 - Allow for collection search-by-id [Requirement]**

The `$.collections[].id` property in a collection search response shall allow to navigate to a single collection using the `id` as a path parameter appended to the collection search endpoint (rel='data') e.g. `/collections/{id}`.

Search-by-id makes the following use cases possible:

- Put a link on a Web page pointing to a single catalog item (using a URL) to illustrate a particular event (e.g. an earthquake in the Himalaya).
- The ability to bookmark and retrieve a single item.

**CEOS-STAC-REQ-5374 - Collection search response representation [Requirement]**

Collections included in a collection search response shall be represented according to the ["CEOS STAC Collection Metadata Best Practices"](#).

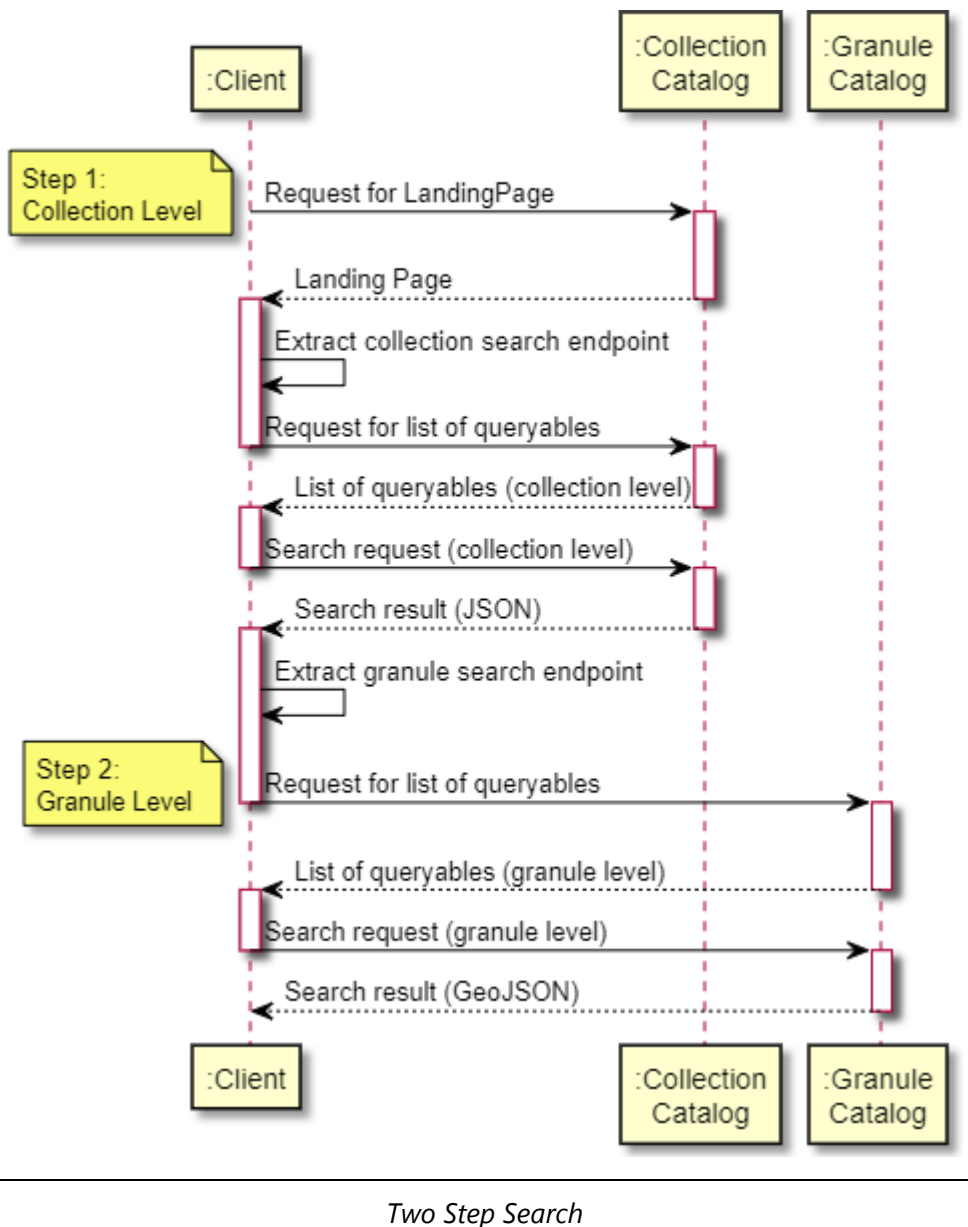
### 5.3.3 Two-step search

One serious hurdle to overcome in searching for data is the great number of data items to account for in responses, as well as the expected number of successful "hits" for a query. In ordinary web searches, the searcher is usually looking for a small number of web pages or documents. Relevance ranking typically does a good job of presenting these successful hits near the top of the returned list, followed by single point-and-click retrievals. However, when searching for Earth science data covering large time periods or spatial areas, a user will often specify a set of constraints to find an appropriate data collection together with space-time criteria for files within that data collection. Often, the precision of the data collections returned for the search is low, with many spurious hits. However, the space-time precision of the files is often quite high: that is, the user truly wants to use all the data files of a desirable data collection set that fall within the spacetime region of interest. Thus, searching for all data satisfying both dataset content and space-time region at the same time can produce a great many spurious hits, i.e., all the files for data collections that are not desired.

**CEOS-STAC-REC-5380 - Support for two step search [Recommendation]**

Support for a two-step search consisting of a collection level search followed by a corresponding granule level search is recommended.

The two-step search consists of a collection level search and the subsequent granule level search (or file-level search).



*Two Step Search*

In order to provide a well-defined search path from a collection of interest to granules associated with that collection, we advocate the use of two-step searching leveraging the following:

1. Link elements of relation items (rel='items') within collection entries. These links point to a granule-level endpoint specific to the collection entry.
2. Link elements of relation queryables (rel='queryables') within collection entries. These links point to available granule-level search parameters specific to the collection entry.
3. Granule level interface descriptions (i.e. endpoints and sets of search parameters) that can be tailored to a specific collection.

The advantages of this approach are as follows:

- A client can navigate from collection to granule with only an understanding of the STAC specification.
- A server links between collections and granules exploiting the relation between a STAC Collection and a STAC Item.
- It allows the client to determine what search parameters are available to the user at the granule level using the /queryables response.

Collections supporting two-step search shall contain a link with `rel="items"` in the STAC collection representation returned by the collection search.

#### **CEOS-STAC-REC-5392 - Support for two step search [Recommendation]**

Collections supporting two-step search shall contain a link with `rel="http://www.opengis.net/def/rel/ogc/1.0/queryables"` and `type="application/schema+json"` in the STAC collection representation returned by the collection search.

#### **CEOS-STAC-REQ-5393 - Support for two step search [Requirement]**

STAC Granule Catalogs shall advertise all "additional" collection specific search/filter parameters applicable for a granule search within a collection in the corresponding queryables object for that collection and not rely on a global set of queryables applicable to all collections made available via a link with `rel="http://www.opengis.net/def/rel/ogc/1.0/queryables"` from the landing page (typically `"/collections/{collectionId}/queryables"` instead of `"/queryables"`), to be combined with a collection-specific set (which may be empty).

#### **CEOS-STAC-REQ-5395 - Support for two step search [Requirement]**

Collections not supporting two-step search shall not contain a link `rel="items"` in the STAC collection representation returned by the collection search.

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## 6. Granule Metadata Best Practices

### 6.1 Overview

Explain main parts

### 6.2 Properties

- mandatory/recommended properties / extensions
- refer to mapping between STAC and OS-EO properties. (DLR)

#### CEOS-STAC-REQ-6210 - Granule representation [Requirement]

A(n EO) Granule metadata record shall be represented as a STAC Item according to version v1.0.0 of the "STAC Item Specification" [\[AD03\]](#).

#### CEOS-STAC-REC-6220 - Temporal extents [Recommendation]

STAC implementations should represent temporal extents in Items with the `start_datetime` and `end_datetime` properties and include the value for `start_datetime` also as `datetime` property.

#### CEOS-STAC-REQ-6230 - Geographical extents [Requirement]

STAC implementations shall represent geographical extents of Items with the `geometry` property (GeoJSON Geometry object or null if not available).

Geographical extents of Items are represented using GeoJSON geometry objects [RFC7946](#) in STAC item search responses. This representation can natively represent multi-point, multi-line and multi-polygon geometries, thus no additional guidance similar to [CEOS-BP-014B](#), [CEOS-BP-014C](#) and [CEOS-BP-014D](#) is required.

#### CEOS-STAC-REQ-6240 - Minimum-bounding rectangle [Requirement]

CEOS implementations should render spatial extents using a minimum-bounding rectangle (MBR) with a GeoJSON `bbox` property [RFC7946](#) in addition to the native more accurate representation of that extent with the `geometry` property. The value of the `bbox` element must be an array of length 4 (two long/lat pairs), with the southwesterly point followed by the northeasterly point.

The `bbox` item property is mandatory according to the STAC Item specification unless `geometry` is null.

#### CEOS-STAC-REQ-6250 - Granule representation extension [Recommendation]

A(n EO) Granule metadata record represented as a STAC Item should use applicable properties defined by the following STAC extensions:

Reference	STAC Extension	Example Properties
<a href="#">[AD14]</a>	<a href="#">EO Extension</a>	eo:cloud_cover, eo:snow_cover, eo:bands
<a href="#">[AD15]</a>	<a href="#">SAR Extension</a>	sar:instrument_mode, sar:polarizations, sar:product_type

Reference	STAC Extension	Example Properties
[AD16]	<a href="#">SAT Extension</a>	sat:orbit_state, sat:absolute_orbit, ...
[AD13]	<a href="#">Scientific Extension</a>	sci:doi
[AD17]	<a href="#">Version Extension</a>	version
[AD18]	<a href="#">View Extension</a>	view:azimuth, view:incidence_angle, ...
[AD19]	<a href="#">Projection Extension</a>	proj:espg
[AD20]	<a href="#">Timestamps Extension</a>	published, expires
[AD23]	<a href="#">Landsat Extension</a>	landsat:wrs_path, landsat:wrs_row
[AD21]	<a href="#">Processing Extension</a>	processing:level, processing:facility, ...
[AD22]	<a href="#">Hyperspectral Extension</a>	hsi:wavelength_min, hsi:wavelength_max

Additional guidance on how to encode OGC17-003r2 metadata properties with the above extensions is available in ["Mapping from OGC EO Dataset Metadata GeoJSON\(-LD\) Encoding Standard to STAC"](#).

```
{
  "stac_version": "1.0.0",
  "id":
  "AL1_OESR_AV2_OBS_1C_20060613T100220_20060613T100232_002047_0307_2730_0410",
  "bbox": [
    14.5302398,
    42.4746857,
    15.6508019,
    43.348489
  ],
  "geometry": {
    "coordinates": [
      [
        [
          14.7799437,
          43.348489
        ],
        [
          15.6508019,
          43.1791444
        ],
        [
          15.3915014,
          42.4746857
        ],
        [
          14.5302398,
          42.6427013
        ],
        [
          14.7799437,
```

```

        43.348489
    ]
  ],
  "type": "Polygon"
},
"collection": "ALOS.AVNIR-2.L1C",
"type": "Feature",
"stac_extensions": [
  "https://stac-extensions.github.io/sar/v1.0.0/schema.json",
  "https://stac-extensions.github.io/processing/v1.1.0/schema.json",
  "https://stac-extensions.github.io/projection/v1.1.0/schema.json",
  "https://stac-extensions.github.io/sat/v1.0.0/schema.json",
  "https://stac-extensions.github.io/view/v1.0.0/schema.json"
],
"properties": {
  "start_datetime": "2006-06-13T10:02:20.948Z",
  "end_datetime": "2006-06-13T10:02:32.786Z",
  "processing:facility": "ESR",
  "view:sun_azimuth": 147,
  "title":
"AL1_OESR_AV2_OBS_1C_20060613T100220_20060613T100232_002047_0307_2730_0410",
  "platform": "ALOS",
  "proj:epsg": 4326,
  "view:sun_elevation": 67,
  "datetime": "2006-06-13T10:02:20.948Z",
  "sar:instrument_mode": "OBS",
  "instruments": [
    "AVNIR-2"
  ],
  "constellation": "ALOS",
  "sar:product_type": "AV2_OBS_1C",
  "sat:orbit_state": "DESCENDING",
  "processing:software": {
    "AVNIR-2": "04.10"
  },
  "updated": "2023-03-28T18:01:51Z",
  "sat:absolute_orbit": 2047
}
}

```

### CEOS-STAC-PER-6255 - Granule representation extension validation [Permission]

A CEOS STAC implementation may include a subset of properties in the item encoding defined by any of the above STAC extensions, even though the STAC extension may require additional properties to be included to pass the corresponding STAC extension JSON schema validation.

## 6.3 Assets and roles

- what names (roles, media types) should be used for quicklooks, bands, ...

### CEOS-STAC-REC-6310 - Browse image [Recommendation]



STAC implementations should provide a URL to the granule's browse image when available, via an Asset object with role=**overview**.

### CEOS-STAC-REC-6320 - Thumbnail image [Recommendation]

STAC implementations should provide a URL to the granule's thumbnail image (smaller than the browse image) when available, via an Asset object with role=**thumbnail**.

```
"assets": {
  "quicklook": {
    "roles": [
      "overview"
    ],
    "href": "http://tpm-ds.eo.esa.int/oads/meta/PROBA1-CHRIS/browse/PR1_OPER_CHR_M02_1P_20020710T102800_N45-018_E012-003_0001.SIP.ZIP_BID.PNG",
    "type": "image/png",
    "title": "QUICKLOOK"
  },
  "thumbnail": {
    "roles": [
      "thumbnail"
    ],
    "href": "http://tpm-ds.eo.esa.int/oads/meta/PROBA1-CHRIS/thumbnail/PR1_OPER_CHR_M02_1P_20020710T102800_N45-018_E012-003_0001.SIP.ZIP_TIMG.jpg",
    "type": "image/png",
    "title": "THUMBNAIL"
  }
}
```

### CEOS-STAC-REC-6330 - Data access [Recommendation]

STAC implementations should provide the data access URL for the granule via an Asset object with role=**data**.

.Example: Asset object for Cloud Optimized GeoTIFF data

```
"assets": {
  "enclosure": {
    "roles": [
      "data"
    ],
    "href": "https://storage.googleapis.com/sample-cogs/cog/20210515_145754_03_245c_3B_AnalyticMS.tif",
    "type": "image/tiff; application=geotiff; profile=cloud-optimized",
    "title": "4-Band Analytic"
  }
}
```

.Example: Asset object for Zarr data

```
"assets": {
  "zmetadata": {
    "roles": [
      "data",
      "metadata",
      "zarr-consolidated-metadata"
    ],
    "description": "Consolidated metadata file for Zarr store",
    "href":
      "https://storage.sbg.cloud.ovh.net/v1/AUTH_d40770b0914c46bfb19434ae3e97ae19/hdsa-
      public/prisma_v2/20200410/.zmetadata",
    "type": "application/json"
  }
}
```

#### CEOS-STAC-REC-6340 - Data access to multiple files [Recommendation]

When data access to a granule in a granule search response is to be provided in multiple physical files, each file should be linked to via a separate Asset object with role=`data`.

#### CEOS-STAC-REC-6360 - Alternate locations [Recommendation]

When the same assets are available at multiple locations or via multiple protocols, they should be encoded as `alternate asset` as defined in the "STAC Alternate Assets Extension Specification" [\[AD24\]](#).

.Example: Use of alternate Asset object for data available on S3 storage

```
"assets": {
  "data": {
    "href":
      "https://storage.esa.int/store/TSX_OPER_SAR/2013/06/11/TSX_OPER_SAR_SC_MGD_2013061
      1T054228_N53-141_E011-048_0000_v0100/TSX_OPER_SAR_SC_MGD_20130611T054228_N53-
      141_E011-048_0000_v0100.zarr/.zmetadata",
    "title": "Zarr consolidated metadata",
    "type": "application/json"
  },
  "roles": [
    "data",
    "metadata",
    "zarr-consolidated-metadata"
  ],
  "alternate": {
    "s3": {
      "title": "S3 Access",
      "href":
        "s3://storage.esa.int/store/TSX_OPER_SAR/2013/06/11/TSX_OPER_SAR_SC_MGD_20130611T0
        54228_N53-141_E011-048_0000_v0100/TSX_OPER_SAR_SC_MGD_20130611T054228_N53-
        141_E011-048_0000_v0100.zarr/.zmetadata"
    }
  }
}
```

```
}  
}  
}  
}
```

### **CEOS-STAC-REC-6370 - Common band names [Recommendation]**

If access to individual bands is provided via assets, then [Common Band Names](#) should be used, preferably according to the forthcoming OGC Best Practice document [\[RD03\]](#).

## 6.4 Links and relations

- how to encode "offerings" (i.e. links to OGC or other service endpoints in a STAC item) ?
- how to encode cloud-native access (zarr, COG) in STAC item.
- how to encode different resource access methods e.g. http download link or S3 location url
- how/when to use the asset alternate links extension?
- Recommendation to properly link to all (raster) assets in an EO product. (VITO)

## 6.5 Facilitating catalog federation

## 6.6 CEOS-ARD

- TBD

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## 7. Collection Metadata Best Practices

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### 7.1 Overview

Explain main parts

### 7.2 Properties

- ...
- summaries (platform, instrument, science keywords, GCMD)
- organisation objects with names/URL from GCMD ?

#### **CEOS-STAC-REQ-7210 - Collection representation [Requirement]**

A(n EO) Collection metadata record shall be represented as a STAC Collection according to version v1.0.0 of the "STAC Collection Specification" [\[AD02\]](#).

#### **CEOS-STAC-REQ-7220 - Platform information [Requirement]**

A(n EO) Collection metadata record shall encode the platform name(s) as \$.summaries.platform property and use the platform name corresponding to the [GCMD platforms](#) preferred label.

#### **CEOS-STAC-REQ-7230 - Instrument information [Requirement]**

A(n EO) Collection metadata record shall encode the instrument name(s) as \$.summaries.instruments property and use the instrument names corresponding to the [GCMD instruments](#) preferred label.

#### **CEOS-STAC-REQ-7240 - Science keywords [Requirement]**

A(n EO) Collection metadata record shall encode related science keywords as \$.keywords property and use the science keywords corresponding to the [GCMD Earth Science](#) preferred label.

```
"keywords": [  
  "EARTH SCIENCE>AGRICULTURE",  
  "EARTH SCIENCE>BIOSPHERE>ECOSYSTEMS>TERRESTRIAL ECOSYSTEMS>FORESTS",  
  "EARTH SCIENCE>LAND SURFACE",  
  "EARTH SCIENCE>BIOSPHERE>VEGETATION" ],  
  
"summaries": {  
  "instruments": [  
    "AVNIR-2",  
    "SLIM6",  
    "MSC"  
  ],  
  "platform": [  
    "ALOS-1",  
    "GEOSAT-1",  
    "KOMPSAT-2"
```

```
]
}
```

### CEOS-STAC-REQ-7250 - DOI [Requirement]

The DOI of a collection, if available, shall be encoded according to the Scientific Citation Extension Specification, i.e. using the `sci:doi` property and a link object with `rel="cite-as"` [\[AD13\]](#).

### CEOS-STAC-REQ-7260 - Provider names [Requirement]

A(n EO) Collection metadata record shall encode provider information as `$.providers[]` *and use the [GCMD Provider](#) preferred label (`skos:prefLabel`) as `$.providers[].name`.*

```
"providers": [
  {
    "roles": [
      "producer"
    ],
    "name": "ESA/ESRIN",
    "url": "https://esa.int"
  }
]
```

## 7.3 Assets and roles

- what names (roles, media types) should be used for ...

### CEOS-STAC-REQ-7310 - Item assets [Requirement]

In case all granules of a collection contain the same asset types, these assets should be provided in the collection encoding as `Item asset` as defined in the "STAC Item Assets Definition Extension Specification" [\[AD25\]](#).

The example below indicates that all granules of this collection do have assets, representing a thumbnail of type PNG, a download location as .zip file and are also available as zarr, with an alternative download location on S3 object storage. Note that the keys used for the assets (e.g. "thumbnail", "enclosure", "data") are meaningless and can have any value.

```
"item-assets": {
  "thumbnail": {
    "roles": [
      "thumbnail"
    ],
    "type": "image/png",
    "title": "THUMBNAIL"
  },
  "enclosure": {
    "roles": [
      "data"
    ]
  }
}
```

```

    ],
    "type": "application/zip",
    "title": "Download"
  },
  "data": {
    "title": "Zarr consolidated metadata",
    "type": "application/json"
    "roles": [
      "data",
      "metadata",
      "zarr-consolidated-metadata"
    ],
    "alternate": {
      "s3": {
        "title": "S3 Access"
      }
    }
  }
}

```

## 7.4 Links and relations

- how to encode "offerings" (i.e. links to OGC or other service endpoints in a STAC collection) ?

### **CEOS-STAC-REC-7410 - Reference to license [Recommendation]**

CEOS STAC collection metadata should include a Link object with rel="license" to reference an external file describing the license information for the collection, unless the **license** property has a specific [SPDX license identifier](#).

## 7.5 Facilitating catalog federation

## 7.6 CEOS-ARD

- TBD