Open Geospatial Consortium

Submission Date: 2018-02-23

Approval Date: 2018-06-08

Publication Date: 2019-01-09

External identifier of this OGC® document: http://www.opengis.net/doc/dp/GeoDCAT-AP

Internal reference number of this OGC® document: 18-001r1

Category: OGC® Discussion Paper

Editors: Lieven Raes, Danny Vandenbroucke,
Tomas Reznik

GeoDCAT-AP

Warning

This document is not an OGC Standard. This document is an OGC Discussion Paper and is therefore not an official position of the OGC membership. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an OGC Standard. Further, an OGC Discussion Paper should not be referenced as required or mandatory technology in procurements.

License Agreement

Document type:	OGC® Discussion Paper
Document subtype:	
Document stage:	Approved for Public Release
Document language:	English

Table of Contents

i. Abstract

Improving discoverability of open geo-data and information is vital to increasing the use of these data in- and outside the geospatial expert community.

In this document we start to compare existing metadata standards, e.g., Dublin Core, ISO 19115/57/19, and INSPIRE, in the geospatial- and open data context. We also describe related linked open data initiatives such as RDF, SPARQL, and metadata publication initiatives, e.g., schema.org and Atom feeds. GeoDCAT is an initiative with the potential to integrate DCAT metadata as they are used in the open data and e-government community with EN ISO 19115/57/19 standards and INSPIRE metadata as they are used in the Geospatial community. GeoDCAT has - because it is based on RDF- the ability to publish metadata directly on the web without open and geospatial data portals.

To respond to the interest of different communities to preserve geospatial metadata resources and to support the uptake of GeoDCAT-AP implementations, best practices from different countries were identified and studied. The best practice cases focus on four domains (focus areas): metadata input (manually or automatically harvested), metadata publication into an integrated geo/open data portal, publication of metadata as Linked Open Data (LOD), and information mapping (ISO 19115, INSPIRE, DCAT, etc.).

GeoDCAT-AP is a mature solution for mapping metadata from the open data and geospatial domain. GeoDCAT helps to integrate and to publish metadata in data portals and directly on the world wide web. To conclude a GeoDCAT alignment exercise has been done with ISO 19115/19 and INSPIRE to improve the open data and geospatial metadata alignment in the future.

ii. Keywords

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

- Metadata;
- Geospatial metadata;
- OGC Best Practice;
- GeoDCAT-AP.

iii. Preface

Improving the discoverability of (open) geo-information is one of the most important approaches to increasing the use of geospatial data in- and outside the geospatial expert community. Nowadays metadata are often published on open data portals and geoportals. Both type of portals are using different standards to describe metadata.

Integrating data portals and publishing metadata on the web in a linked open data format is a first step in making data more discoverable. Several communities that develop and/or use geospatial data along with other information have expressed their interest in DCAT based solutions for geospatial datasets. These communities want to preserve their methods and formats for managing and publishing metadata, while at the same being able to make them discoverable in other environments.

This Discussion Paper was initiated with the help of a number of underlying initiatives such as the EU Open Transport Net project and the activities on DCAT under the EU ISA² programme[1].

The EU-funded "Open Transport Networks" project (OTN)[2] (2014-2017) tried to find solutions to integrate open transport and mobility data coming from open data portals and (INSPIRE) geo-portals without losing information. OGC and W3C, associated partners in OTN, were both aware of the lack of integration of metadata standards between the open data 'universe' and the geo 'universe.'

The EU-funded H2020 project "Policy Development based on Advanced Geospatial Data Analytics and Visualisation" project (PoliVisu)[3], (2017-2020) changes the way urban policy making is created by supporting cities (with limited resources) in making effective, informed, data-driven decisions. Metadata integration of geospatial and non-geospatial resources is one of the primary concerns of the project. DCAT metadata integration including "SensorDCAT" should be one of the desired achievements.

The ISA² programme supports the development of digital solutions that enable public administrations, businesses and citizens in Europe to benefit from interoperability across borders and sectors through public services[4]. One of the ISA initiatives is the DCAT Application Profile (DCAT-AP) for data portals in Europe[5]. Specific profiles for the geospatial and statistical communities have been developed as well.

Information Flanders and KU Leuven, with the support of OGC, took the initiative to organize an ad hoc meeting at the OGC Dublin TC in June 2016 to discuss the issue based on interest shown from the OGC members during the OGC TC in Sydney (December 2015). The meeting in Dublin attracted more than 50 experts. It was decided to organize a 'DCAT Geospatial' subgroup under the OGC Metadata DWG. During the Taichung TC in December 2016, the subgroup decided to collect examples of GeoDCAT-AP implementations and write a Discussion Paper as a first outcome.

iv. Submitting organisations

The following organizations submitted this Document to the Open Geospatial Consortium, Inc.

- AIV - Information in Flanders Agency (BEL)

[1] https://ec.europa.eu/isa2/isa2_en

[2] CIP Competitiveness and innovation framework programme 2007-2013 – Open TransportNet – Spatially Referenced Data Hubs for Innovation in the Transport Sector – Grant agreement no. 620533

[3] European Union Horizon 2020 Programme - PoliVisu "Policy Development based on Advanced Geospatial Data Analytics and Visualisation" - under grant agreement no. 769608.

[4] https://ec.europa.eu/isa2/isa2_en

[5] https://ec.europa.eu/isa2/solutions/dcat-application-profile-data-portals-europe_en

- GeoNovum (NLD)
- GIM NV (BEL)
- HSRS (CZE)
- EC JRC - Joint Research Centre of the European Commission (EU)
- LINZ (NZL)
- Ordonance survey (GBR)
- SADL/KU Leuven - Spatial Applications Division of the University of Leuven (BEL)
- SPACEBEL / ESA (BEL/EU)
- Masaryk University (CZE)
- University of Colorado - HDF Group (USA)

v. Submitters

All questions regarding this submission should be directed to the editor or the submitters:

Name	Affiliation
Lieven Raes	Information Flanders (Submitter)
Danny Vandenbroucke	KU Leuven - SADL (Submitter)
Tomas Reznik	Masaryk University (Submitter)
Andrea Della Vecchia	ESA
Linda van den Brinck	GeoNovum
Steven Smolders	GIM
Stijn Goedertier	GIM
Karel Charvat	HSRS
Stepan Kafka	HSRS
Geraldine Nolf	Information Flanders

Andrea Perego	JRC
Byron Cochrane	LINZ
Bart Delathouwer	OGC
Gobe Hobana	OGC
Peter Parslow	Ordnance survey
Yves Coene	SPACEBEL
Ted Habermann	University of Colorado - HDF Group

vi. List of used terminology

Term	Description
Application profile	An application profile consists of a set of metadata elements, policies, and guidelines defined for a particular application.
ebRIM	ebRIM is the electronic business Registry Information Model from the OASIS standards organization
EPSG	EPSG Geodetic Parameter Dataset is a collection of definitions of coordinate reference systems and coordinate transformations which may be global, regional, national or local in application.
Lambert 72	Belgian National Terrestrial Reference System 1972
Manifest file	A manifest file in computing is a file containing metadata for a group of accompanying files that are part of a set or coherent unit. (wikipedia)
Metadata	Information about a resource (ISO 19115)
MICKA	MicKa is a complex system for metadata management used for building Spatial Data Infrastructure (SDI) and geoportal solutions.

vii. Abbreviations

Abbreviation	Description
ADMS	Asset Description Metadata Schema

AP	Application Profile
API	Application Programming Interface
ATOM	Atom Syndication Format
BLOB	Binary large object
CENIA	Czech Environmental Information Agency
CKAN	Comprehensive Kerbal Archive Network
CSV	Comma Separated Values
CSW	Catalogue Services for the Web
DCAT	Data Catalog Vocabulary
DCAT-AP	DCAT Application Profile for Datasets in Europe
DCMI	Dublin Core Metadata Initiative
DDMS	Department of Defense Discovery Metadata Specification
DGIWG	Defence Geospatial Information Working Group (OGC)
DMF	DGIWG Metadata Foundation
DWG	Domain Working Group (OGC)
E-GMS	e-Government Metadata Standard
E-GOV	Electronic Government
ESA	European Space Agency
EU	European Union
FedEO	Federated Earth Observation
GDI	Geospatial Data Infrastructure
GeoDCAT	Geospatial Data Catalog Vocabulary
GeoSPARQL	Geospatial SPARQL Protocol and RDF Query Language
GIS	Geographic Information System

HTML	HyperText Markup Language
HTTP	Hypertext Transfer Protocol
INSPIRE	Infrastructure for Spatial Information in Europe
ISA	Interoperability Solutions for European public Administrations
ISA²	ISA follow up programme
ISO	International Standards Organisation
IV	Information Flanders
JRC	Joint Research Centre
JSON	JavaScript Object Notation
JSON-LD	JavaScript Object Notation for Linked Data
KU Leuven	Catholic University of Leuven
LOD	Linked Open Data
MD	Metadata
NISO	National Information Standards Organisation
NMF	NSG Metadata Foundation
NMIS	Network Management Information System
NSG	National Geospatial-Intelligence Agency
OBEOS	Ontology Based Earth Observation Search
OGC	Open GeoSpatial Consortium
OTN	Open Transport Network
OWL	Web Ontology Language
RDF	Resource Description Framework
RDFa	Resource Description Framework in Attributes
SADL	Spatial Applications Division Leuven (KU Leuven)

SDI	Spatial Data Infrastructure
SHACL	Shapes Constraint Language
SOSA	Simple Set of Concepts
SPARQL	SPARQL Protocol and RDF Query Language
SSN	Semantic Sensor Network
StatDCAT	Statistical Data Catalog Vocabulary
TC	Technical Committee (OGC)
UML	Unified Modeling Language
URI	Unique Resource Identificator
URN	Uniform Resource Name
W3C	World Wide Web Consortium
XML	Extensible Markup Language
XSD	XML Schema Definition
XSLT	eXtensible Stylesheet Language Transformations

1. Introduction

Building a metadata catalogue requires answers to a series of questions:

- Which metadata standards are available?
- Which metadata standards are suitable for my needs?
- Which metadata standard should I use?
- How can I present metadata to my users (professionals, occasional users)?
- How can I exchange metadata between different catalogues (formats)?

The answers to these questions will be different for an e-government or a GIS department, even when working with the same datasets.

From a data provider perspective (typically a government agency), it looks obvious to make a distinction between dataset types: geographical data, open data, statistical data, sensor data, etc. This difference sometimes depends on the purpose of the data, but also on the software used and the availability of appropriate standards. The difference made between open datasets and geospatial datasets, despite the possible overlap, is a typical example of an organization and software-based approach. In reality it is quite difficult to overcome this kind of problem because of the strong link between thematic-oriented organizational thinking, available software and standards.

Metadata is often described as "**data about data**." ISO speaks about information about a resource. "Resource" is a purposely general term aimed at emphasizing the generality of the ISO metadata standards (and models). A resource can be a service, a collection site, software, a repository, or many other things. The NISO based Wikipedia definition "**Metadata is data [information] that provides information about other data**"[6] describes distinct metadata types: descriptive metadata, structural metadata and administrative metadata[7]. The difference between these metadata types is important as they can make discussing metadata more complicated than needed when people have different definitions of metadata in mind.

Metadata for spatial data and spatial services are nowadays mostly created according to some standard. However, descriptions concerning titles, abstracts, publication dates, formats, and publishers, etc. are the same across all standards. It may be even stated that the basic set of metadata items is the same for geographical data/services as for any human product known in daily life, as depicted in Figure 1.

[6] https://en.wikipedia.org/wiki/Metadata

[7] Zeng, Marcia (2004). "Metadata Types and Functions". NISO. Archived from the original on 7 October 2016. Retrieved 5 October 2016.

Figure 1: The basic set of metadata items required for the description of geospatial information is the same for any human product known in daily life[8]

[8] Řezník, T., Chudý, R., Mičietová, E. 2016. Normalized evaluation of the performance, capacity and availability of catalogue services: a pilot study based on INfrastruture for SPatial InfoRmation in Europe. In International Journal of Digital Earth, Vol. 9, No. 4, pp. 325-341.

Figure 2: More advanced set of metadata items on products - human and machine readable, standard and non-standard representations

The three NISO based distinct types of metadata descriptive metadata, structural metadata, and administrative metadata[9] are defined as follow:

- **Descriptive metadata** describe a resource for purposes such as discovery and identification. It can include elements such as title, abstract, author, and keywords.

- **Structural metadata** is metadata about containers of data and indicate how compound objects are put together, for example, how pages are ordered to form chapters. It describes the types, versions, relationships and other characteristics of digital materials.

- **Administrative metadata** provide information to help manage a resource, such as when and how it was created, file type and other technical information, and who can access it.

In practice, metadata are not only relevant for describing data, but also for other resources that allow access to those data (e.g., web services) or resources that allow data processing (e.g., software tools).

[9] In the context of INSPIRE and SDI implementation, distinction is made between discovery metadata (used to search and find data/service resources), evaluation metadata (to evaluate whether the data/services are 'fit-for-purpose') and usage metadata (for understanding the data/services correctly when using them).

In this Discussion Paper, we are focusing on descriptive metadata used for resource discovery and identification.

The NISO, Wikipedia based typology focuses on the different types of metadata that exist but misses a link with metadata use cases. Four use cases are of particular importance: discovering metadata, accessing metadata, metadata usage and evaluation.

- **Discovering** data: The automatic detection of devices and services offered by these devices on a computer network[10];
- **Accessing** data: The steps, processes, tools and authorizations needed to use data;
- **Using** data: The terms of use and licensing, the appropriateness of the dataset;
- **Evaluating** data: Evaluating the data quality and usefulness to the purposes described in the metadata.

The figure below gives an overview of some tools and formats that people are using in different communities (Geo, Open-data & E-GOV, Developers, and Archiving) to handle descriptive metadata. The figure below is a typical result of a sectoral organization-oriented approach.

[10] https://en.wikipedia.org/wiki/Service_discovery

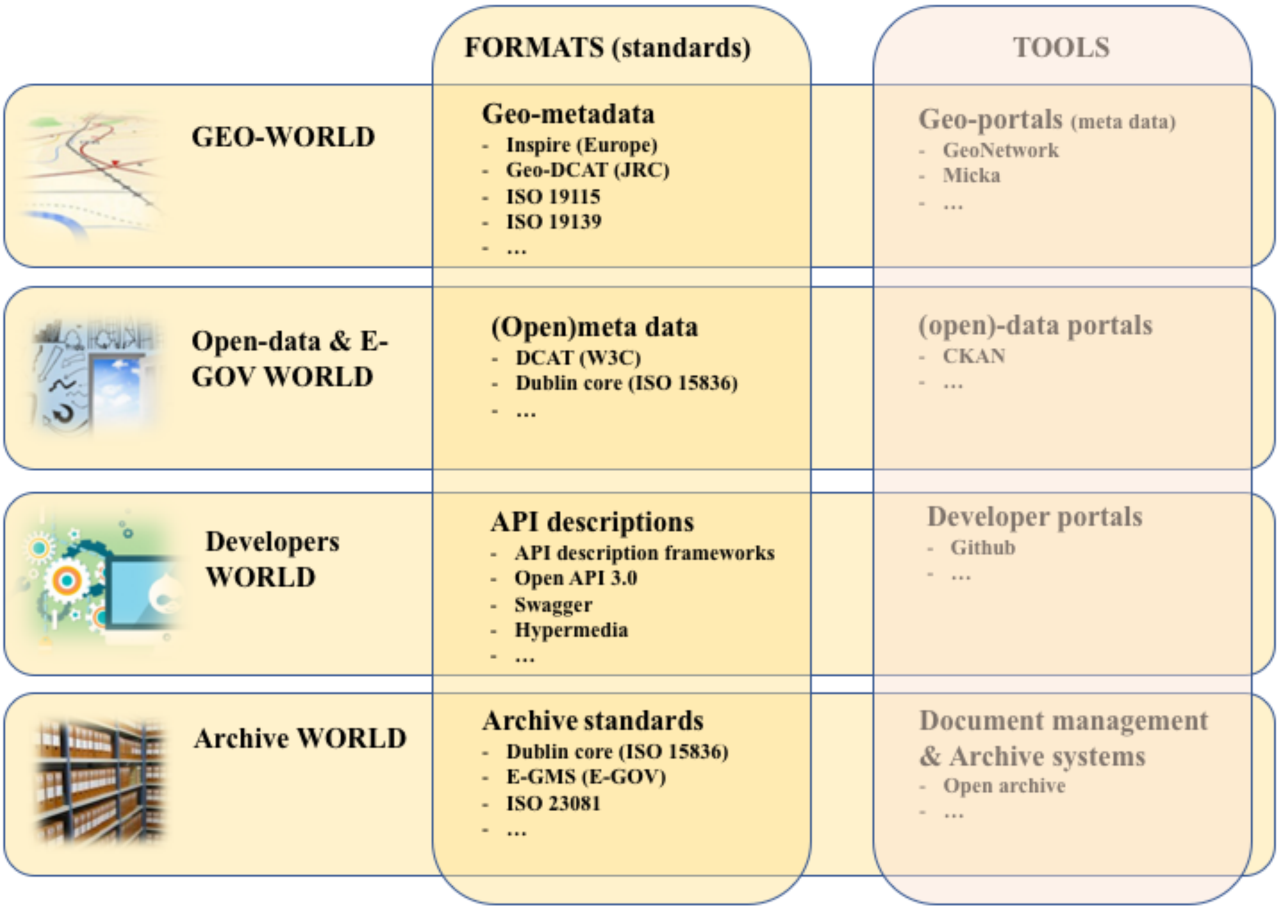


Figure 3: Overview scheme (metadata elements)

What strategies can be used to overcome the current sectoral oriented situation?

Theoretically, there are several options. The list below describes a number of single approach solutions.

1. Integrating software solutions that make use of the different standards, so that different types of metadata can be published in one single portal;
2. Defining one “new” comprehensive metadata standard and build an integrated portal to publish metadata using this new standard;
3. Publish the metadata as Linked Open Data (LOD) so that the data is easily discoverable on the web (e.g., Via Search Engine Optimization techniques);
4. The application of mappings to translate metadata from one standard to another so that the metadata can be (re-)used in existing software solutions.

Integrating software solutions (1) and defining new comprehensive standards (2) can be considered as long-term solutions. Direct publishing as linked open data (3) and making use of mapping techniques (4) are valuable solutions that can be used in the short term. Publishing metadata as linked open data requires metadata mapping and using ontologies and vocabularies.

Sharing of geospatial metadata via data mapping techniques appears to be the most achievable approach to meeting the goal of metadata integration. From a geospatial perspective, mappings from ISO 19115 (worldwide standard for geospatial metadata) to RDF using general-purpose vocabularies makes sense. The added value of RDF based vocabularies lies in its ability to publish metadata directly on the web by using e.g., JSON-LD and to exchange information between data portals supporting DCAT based RDF documents.

GeoDCAT-AP defines mappings from ISO 19115 to DCAT-AP and other general-purpose RDF vocabularies that can be used to produce Linked Open Data (LOD). In an EU context, GeoDCAT-AP can also be used to map INSPIRE metadata. GeoDCAT-AP is well described and already implemented in Geodata portals today. This makes GeoDCAT-AP an interesting best practice candidate. Another interesting aspect is the fact that GeoDCAT-AP doesn't stand on its own. First of all, it is built on the well-known DCAT W3C recommendation (which is the synonym of a standard in W3C terminology)[11]. On the other hand, there are also similar initiatives in the statistical domain such as StatDCAT-AP. Other DCAT based similar initiatives can be added in the future.

DCAT together with GeoDCAT and StatDCAT are using a multidomain approach covering Geo, Open-data, Statistical and potentially metadata from other communities. This document will describe best practices to combine metadata on the input side by using harvesting and/or manual input. The Discussion Paper will also look for standards that can be used to make the combined metadata more discoverable via data portals and search engines.

To improve the discoverability of geo-information, GeoDCAT-AP provide an extension on the DCAT-Application profile. GeoDCAT-AP makes it possible to publish INSPIRE[12] metadata as RDF. The underlying standard is DCAT, which became a W3C recommendation[13][14] in January 2014.

DCAT is an RDF vocabulary designed to facilitate interoperability between data catalogues published on the Web. This document defines the schema and provides examples for its use.

[11] At the time of writing (March 2018), a new version of DCAT is under preparation (version 1.1) by the W3C Data Exchange Working Group (DXWG) - https://www.w3.org/2017/dxwg/charter.

[12] The INSPIRE Directive aims to create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment. This European Spatial Data Infrastructure will enable the sharing of environmental spatial information among public sector organisations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries. - http://inspire.ec.europa.eu/

[13] W3C Data Catalog Vocabulary (DCAT) - W3C Recommendation 16 January 2014 - https://www.w3.org/TR/vocab-dcat/

[14] The World Wide Web Consortium, W3C, publishes documents that define Web technologies. These documents follow a formal, open process designed to promote consensus, fairness, public accountability, and quality. At the end of this process, W3C publishes Royalty Free Web standards as Recommendations. Like OGC, W3C has submitter status with ISO, meaning its standards are of equal weight.

By using DCAT to describe datasets in data catalogues, publishers increase discoverability and enable applications to easily consume metadata from multiple catalogues. It further allows decentralized publishing of catalogues and facilitates federated dataset search across sites. Aggregated DCAT metadata can serve as a manifest file to facilitate digital preservation.

DCAT-AP[15] (Application Profile) is the de-facto EU standard metadata interchange format. Most of the EU (open) data portals are using DCAT-AP. DCAT-AP does not support necessary metadata elements needed for geospatial datasets. The EU Programme "Interoperability Solutions for European Public Administrations" (ISA) developed DCAT-AP as a generic core set of metadata that can be extended to more specific uses.

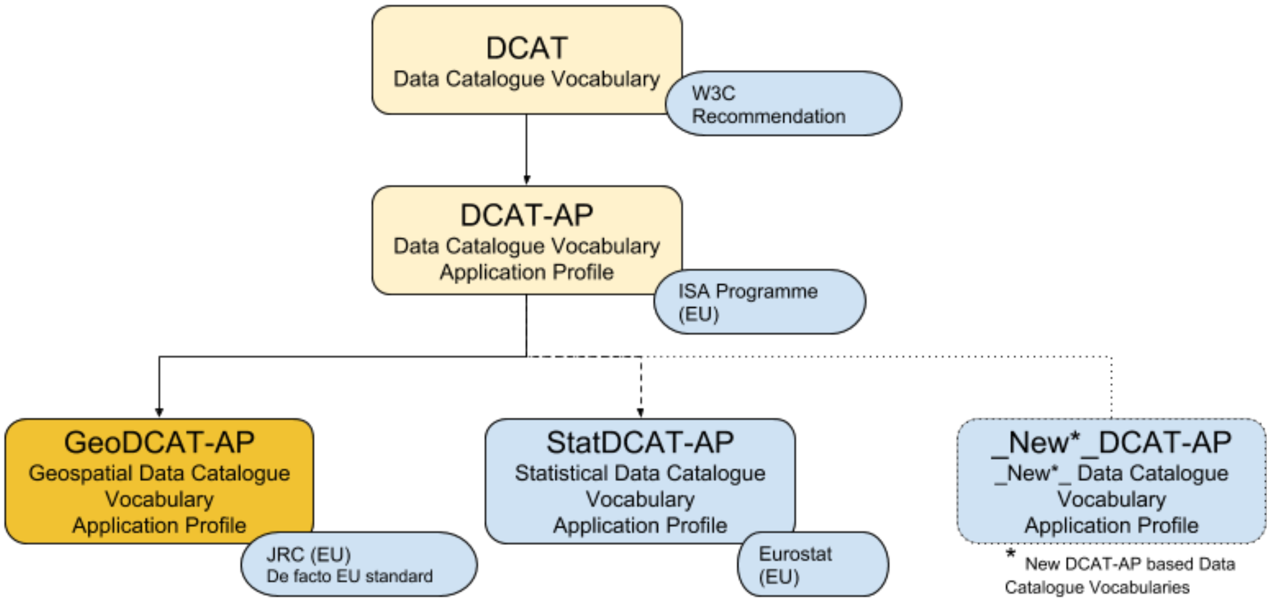


Figure 4: DCAT overview (relation between DCAT initiatives).

GeoDCAT-AP extends DCAT-AP to enable descriptions of geospatial datasets. GeoDCAT-AP translates most of the ISO 19115[16] elements necessary for INSPIRE. GeoDCAT-AP does NOT replace the actual geospatial metadata standards but allows the exchange of the most relevant metadata elements between different domains.

DCAT-AP can also be extended to other domains. Other extensions of DCAT-AP also exist. StatDCAT-AP[17] is another extension on DCAT-AP for statistical use. Figure 2 provides an overview of the different profiles and how they build upon DCAT.

---

[15] "DCAT application profile for data portals in Europe" (DCAT-AP) - https://joinup.ec.europa.eu/asset/dcat_application_profile/

[16] ISO 19115 Geographic information - ISO 19115-1:2014 defines the schema required for describing geographic information and services by means of metadata. It provides information about the identification, the extent, the quality, the spatial and temporal aspects, the content, the spatial reference, the portrayal, distribution, and other properties of digital geographic data and services.

[17] StatDCAT-AP aims at providing a commonly-agreed dissemination vocabulary for the documentation of statistical data.StatDCAT-AP defines a certain number of additions to the DCAT-AP model that can be used to describe datasets in any format, for example, those published in the Statistical Data and metadata eXchange

2. Overview of relevant metadata standards and related initiatives

2.1 Open metadata standards

2.1.1 Dublin core

The Dublin Core Schema is a small set of terms that can be used to describe documents, web resources (video, images, web pages, etc.), physical resources such as books or CDs, and objects like artworks. Dublin Core Metadata may be used for multiple purposes, from simple resource description to combining metadata vocabularies of different metadata standards, to providing interoperability for metadata vocabularies in Linked Data Cloud and Semantic Web implementations.

The Dublin Core standard has almost no strict regulations. Each Dublin Core element is optional and may be repeated. There is also no prescribed order for presenting or using the elements[18]. The Dublin Core Metadata Initiative (DCMI) Metadata Terms provides an abbreviated reference version of the fifteen element descriptions that have been formally endorsed in the ISO Standard 15836:2009[19]. We also may identify 18 metadata terms, 55 metadata terms respectively, designated as qualified Dublin Core, full Dublin Core respectively.

2.1.2 DCAT

DCAT is an RDF[20] vocabulary designed to facilitate interoperability between data catalogues published on the Web. By using DCAT to describe datasets in data catalogues, publishers increase discoverability and enable applications to consume metadata from multiple catalogues. It further enables decentralized publishing of catalogues and facilitates federated dataset search across sites. Aggregated DCAT metadata can serve as a manifest file to facilitate digital preservation. DCAT makes extensive use of terms from other vocabularies, in particular, Dublin Core.

DCAT uses a layered concept: Catalog, consisting of one or more datasets and one or more distributions for each dataset.

(SDMX) format, a standard for the exchange of statistical data. The StatDCAT-AP specification is available at: https://joinup.ec.europa.eu/asset/stat_dcat_application_profile/

[18] https://en.wikipedia.org/wiki/Dublin_Core

[19] https://www.iso.org/standard/52142.html

[20] RDF Schema (Resource Description Framework Schema, variously abbreviated as RDFS, RDF(S), RDF-S, or RDF/S) is a set of classes with certain properties using the RDF extensible knowledge representation data model, providing basic elements for the description of ontologies, otherwise called RDF vocabularies, intended to structure RDF resources. See for more details on RDF section 2.2.2

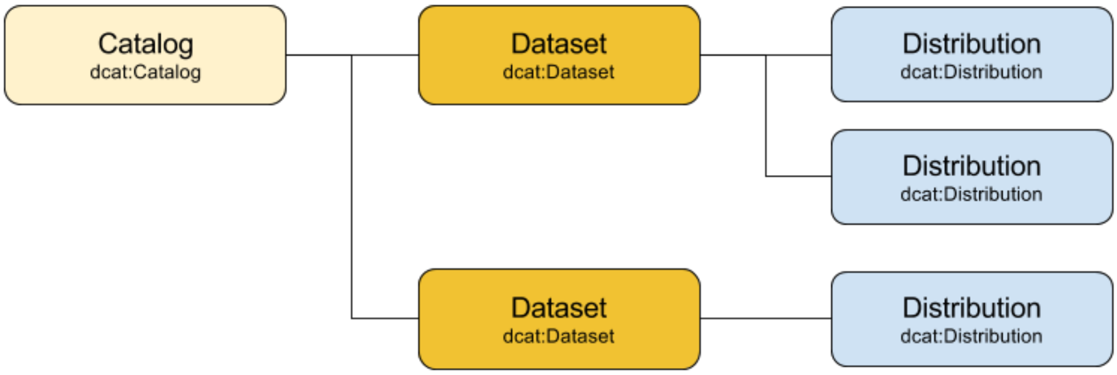


Figure 5: DCAT data-structure

A dataset in DCAT is defined as a "collection of data, published or curated by a single agent, and available for access or download in one or more formats." A dataset does not have to be available as a downloadable file. For example, a dataset that is available via an API can be defined as an instance of dcat:Dataset and the API can be defined as an instance of dcat:Distribution. DCAT itself does not define properties specific to API descriptions. These are considered out of scope for this version of the vocabulary. Nevertheless, this can be defined as a profile of the DCAT vocabulary.

Although DCAT (1.0) was only released in January 2014, a revised version (1.1) is currently being prepared by the W3C Data Exchange Working Group (DXWG)[21]. The revision is a response to a new set of Use Cases and Requirements submitted on the basis of experience gained with the DCAT vocabulary from the time of the original version, and new applications originally not considered. The new version may deprecate, but will not delete existing terms. The work of the DXWG also looks into the development of guidance for the publication of application profiles of vocabularies as well as in the principle of content negotiation by application profile. It is expected that DCAT 1.1 and the work of the DXWG in general will have an impact on the derived profiles such as DCAT-AP and GeoDCAT-AP.

[21] https://w3c.github.io/dxwg/dcat/

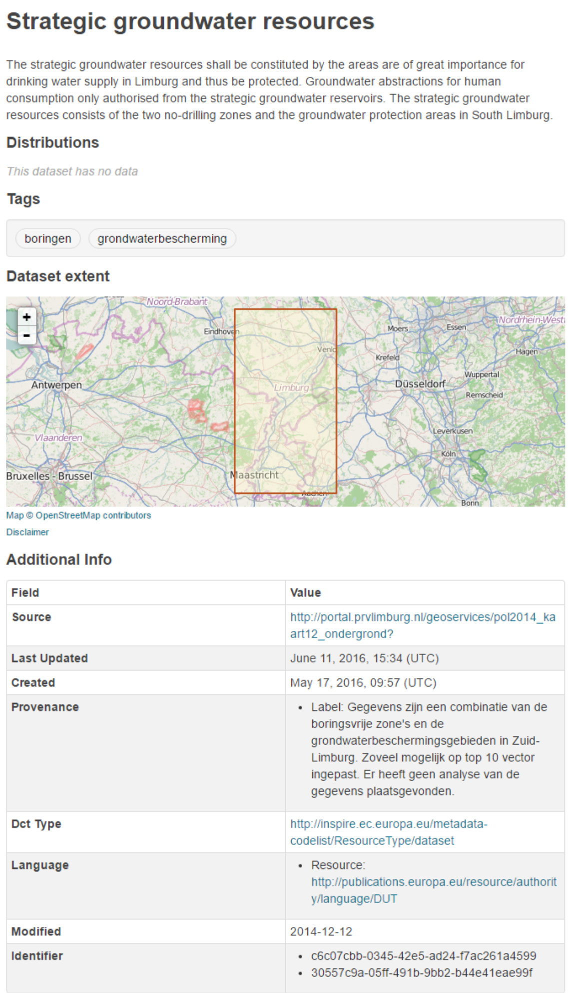
2.1.3 DCAT-AP

The DCAT Application Profile (DCAT-AP) for data portals in Europe is a specification based on DCAT for describing public sector datasets in Europe. It is used to enable cross-data portal search for data sets and improve public sector data search across borders and sectors.

The DCAT-AP consists of a set of metadata elements, policies and guidelines defined for a particular application. An application profile is not complete without documentation that defines the used policies and best practices appropriate to the application.

DCAT-AP is very common in many European data portals, including the EU data portal. DCAT-AP suggests the use of specific categorizations and describes which fields are mandatory, recommended, or optional.

A good example of a DCAT-AP profile defining the policies is the Belgian DCAT-AP profile: http://dcat.be/ where the Federal level, the regions and individual cities are using the same DCAT-AP profile to describe their datasets.


Strategic groundwater resources

The strategic groundwater resources shall be constituted by the areas are of great importance for drinking water supply in Limburg and thus be protected. Groundwater abstractions for human consumption only authorised from the strategic groundwater reservoirs. The strategic groundwater resources consists of the two no-drilling zones and the groundwater protection areas in South Limburg.

Distributions

This dataset has no data

Tags

boringen grondwaterbescherming

Dataset extent

Map © OpenStreetMap contributors

Disclaimer

Additional Info

Field	Value
Source	http://portal.prvlimburg.nl/geoservices/pol2014_kaart12_ondergrond?
Last Updated	June 11, 2016, 15:34 (UTC)
Created	May 17, 2016, 09:57 (UTC)
Provenance	• Label: Gegevens zijn een combinatie van de boringsvrije zone's en de grondwaterbeschermingsgebieden in Zuid-Limburg. Zoveel mogelijk op top 10 vector ingepast. Er heeft geen analyse van de gegevens plaatsgevonden.
Dct Type	http://inspire.ec.europa.eu/metadata-codelist/ResourceType/dataset
Language	• Resource: http://publications.europa.eu/resource/authority/language/DUT
Modified	2014-12-12
Identifier	• c6c07cbb-0345-42e5-ad24-f7ac261a4599 • 30557c9a-05ff-491b-9bb2-b44e41eae99f

Figure 6: DCAT-AP example EU data portal

Other European countries like Italy, Netherlands, UK, Germany, Sweden, and Norway have also implemented their own DCAT-AP profiles.

A formal definition of DCAT-AP and related extensions is underway[22].

The DCAT-AP profile is vital to make sure that the data portals can harvest metadata from other portals without losing information.

An application profile typically arranges:

- Mandatory, Recommended and Optional fields in the dataset and distribution;
- Controlled input of mandatory fields.

22 https://github.com/SEMICeu/dcat-ap_shacl

To enhance the harvesting process a thesaurus mapping is available for the EU member state languages[23]. Also, alignments are available between the controlled vocabularies used in ISO 19115 / INSPIRE metadata and those used in DCAT-AP[24].

2.2 Linked (Open) Data

In addition to the open data metadata standards, other relevant non-thematic initiatives have a strong link with metadata standards and metadata publication. Linked Open Data (LOD) and Schema.org are related initiatives to make metadata more discoverable on the web.

The term Linked Data refers to a set of best practices for publishing structured data on the Web. These principles have been coined by Tim Berners-Lee in the design issue note Linked Data. The principles are:

1. Use URIs as names for things;
2. Use HTTP URIs so that people can look up those names;
3. When someone looks up a URI, provide useful information;
4. Include links to other URIs. so that they can discover more things.

The idea behind these principles is, on one hand, to use standards for the representation and access to data on the Web. On the other hand, the principles propagate to create hyperlinks between data from different sources. These hyperlinks connect all Linked Data into a single global data graph, as the hyperlinks on the classic Web connect all HTML documents into a single global information space. Thus, Linked Data is to spreadsheets and databases what the Web of hypertext documents is to word processor files[25]. Linked Open Data allows access to entire datasets on a metadata level and on the level of the data itself.

2.2.1 Linked data versus open data

Linked data is per definition open, in a way that the data is available under an open data license. "Linked data" refers to data that is machine-readable, semantic data or in other words data that a machine can 'understand'. The "semantic meaning" comes from the links to other data that provide context to your data. "Open Data" refers to data that is accessible to anyone with a permissive license on reuse.

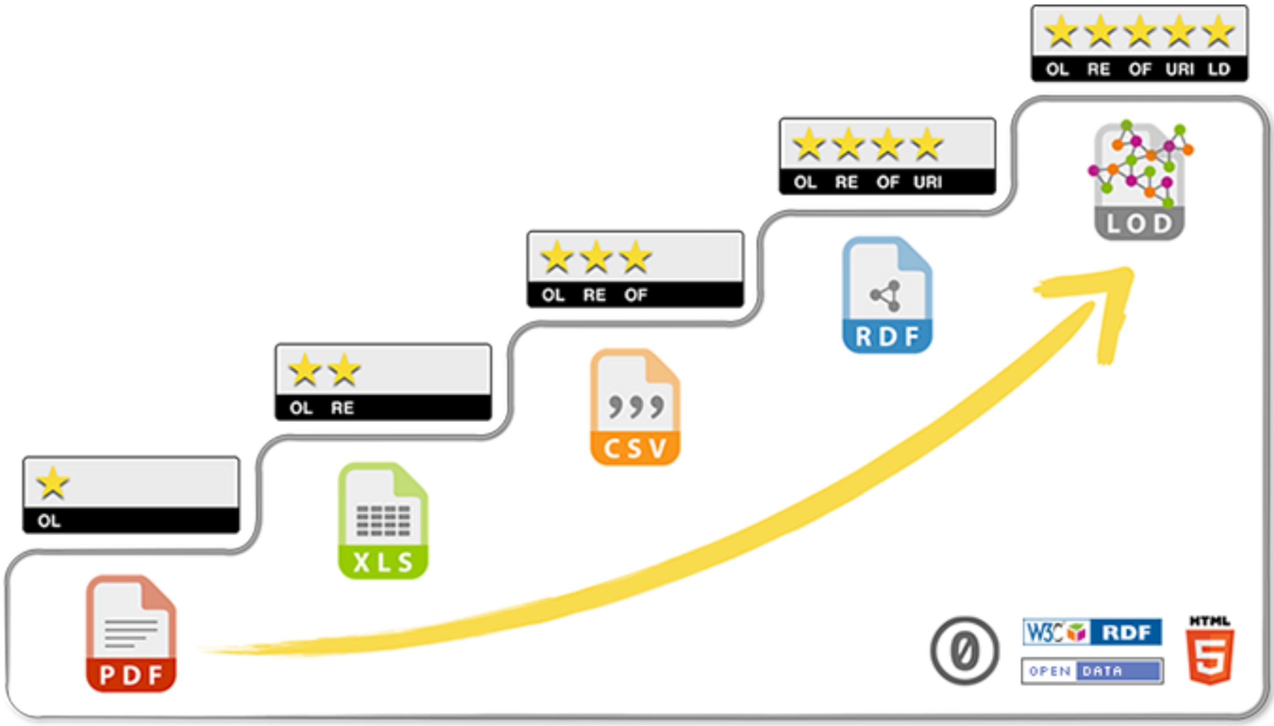
The 5 star linked data rating system by Tim Berners-Lee (especially Star 1 and 3) describes the relation between open data and linked data[26].

[23] http://publications.europa.eu/mdr/eurovoc/

[24] https://webgate.ec.europa.eu/CITnet/stash/projects/ODCKAN/repos/iso-19139-to-dcat-ap/browse/alignments

[25] https://www.w3.org/wiki/LinkedData

[26] http://5stardata.info/en/



★ make your stuff available on the Web (whatever format) under an open license

★★ make it available as structured data (e.g., Excel instead of image scan of a table)

★★★ use non-proprietary formats (e.g., CSV instead of Excel)

★★★★ use URIs to denote things, so that people can point at your stuff

★★★★★ link your data to other data to provide context

Figure 7: Tim Berners Lee, 5 star open data deployment scheme[27]

2.2.2 RDF, SPARQL and OWL Standards to create linked open data

RDF (Resource Description Framework) is a W3C recommendation and standard model for data interchange on the Web. The purpose of RDF is to provide a structure for describing identified “things.” To make meaningful descriptions of "things," an open structure called triples is used. A triple is made up of a resource (the thing that you want to describe), a property (explain the relation between things), and the class (the bucket used to describe things). RDF uses URIs (Uniform Resource Identifiers) to represent things. RDF makes it possible to describe almost every object e.g., public transport stops, books, postal addresses, etc. in a structured way.

Using this simple model, RDF allows structured and semi-structured data to be mixed, exposed, and shared across different applications. This linking structure forms a directed,

[27] http://5stardata.info/en/

labelled graph, where the edges represent named links between two resources, represented by graph nodes. This graph view is the easiest possible mental model for RDF and is often used in easy-to-understand visual explanations[28].

As mentioned before, DCAT is an example of an RDF vocabulary designed to facilitate interoperability between data catalogues with metadata on resources, published on the Web.

SPARQL is also a W3C recommendation and is used to query data stored in RDF. SPARQL can be used to express queries across diverse data sources, whether the data is stored natively as RDF or viewed as RDF via middleware.[29] OGC has developed GeoSPARQL which supports representing and querying geospatial data on the Semantic Web. GeoSPARQL defines a vocabulary for representing geospatial data in RDF, and it defines an extension to the SPARQL query language for processing geospatial data. In addition, GeoSPARQL is designed to accommodate systems based on qualitative spatial reasoning and quantitative spatial computations.

The W3C Web Ontology Language (OWL) is a Semantic Web language designed to represent rich and complex knowledge about things, groups of things, and relations between things. OWL is a computational logic-based language such that knowledge expressed in OWL can be exploited by computer programs, e.g., to verify the consistency of that knowledge or to make implicit knowledge explicit. OWL documents, known as ontologies, can be published in the World Wide Web (WWW) and may refer to or be referred from other OWL ontologies. OWL is part of the W3C's Semantic Web technology stack, which also includes RDF and SPARQL.

To provide context to your objects, you can make use of your own or existing OWL vocabularies. You can connect your object to other objects using existing ontologies. The more popular the used vocabularies[30] are, the more your data objects become Linked Open Data (LOD).

2.2.3 SHACL - Shapes Constraint Language

SHACL (Shapes Constraint Language) is a language for describing and constraining the contents of RDF graphs. SHACL groups these descriptions and constraints into "shapes," which specify conditions that apply at a given RDF node. Shapes provide a high-level vocabulary to identify predicates and their associated cardinalities, data types and other constraints. Additional constraints can be associated with shapes using SPARQL and similar extension languages. These extension languages can also be used to define new high-level vocabulary terms. SHACL shapes can be used to communicate information about data structures associated with some process or interface, generate or validate data, or drive user interfaces[31]. SHACL became a W3C Recommendation in July 2017.

[28] https://www.w3.org/RDF/

[29] https://www.w3.org/TR/rdf-sparql-query/

[30] http://lov.okfn.org/dataset/lov/

[31] https://www.w3.org/standards/techs/shacl#w3c_all

2.2.4 DQV - Data Quality Vocabulary meta-information

The Data Quality Vocabulary[32] is a recommendation from the W3C Data on the Web Best Practice Working Group. The Data Quality Vocabulary defines concepts such as measures and metrics to assess the quality for each quality dimension. The Web Best Practice Working Group states that: “Data quality affect the suitability of data for specific applications, including applications very different from the purpose for which the data was originally generated. Documenting data quality significantly eases the process of dataset selection, increasing the chances of reuse. Independently from domain-specific peculiarities, the quality of data should be documented and known quality issues should be explicitly stated in metadata.”[33]

The goal of DQV is to provide a standard useful for humans and software agents to assess the quality and suitability of a dataset for their application. The Data Quality Vocabulary (DQV)[34]is foreseen as an extension to the DCAT vocabulary [vocab-dcat][35] to cover the quality of the data, how frequently it is updated, whether it accepts user corrections, persistence commitments, etc. When used by publishers, this vocabulary will foster trust in the data amongst developers.

The DQV vocabulary is based on DCAT [vocab-dcat] that it extends with a number of additional properties and classes suitable for expressing the quality of a dataset[36].

The quality of a given dataset or distribution is assessed via a number of observed properties. For instance, one may consider a dataset to be of high quality because it conforms to a specific standard while for other use-cases the quality of the data will depend on its level of interlinking with other datasets. To express these properties an instance of a dcat:Dataset[37] or dcat:Distribution[38] can be related to five different types of quality information represented by the following classes:

- dqv:QualityAnnotation[39] represents feedback and quality certificates given about the dataset or its distribution;
- dcterms:Standard[40] represents a standard the dataset or its distribution conforms to;

---

32 https://www.w3.org/TR/vocab-dqv/#intro

33 https://www.w3.org/TR/2017/REC-dwbp-20170131/#quality

34 https://www.w3.org/TR/vocab-dqv/

35 https://www.w3.org/TR/vocab-dqv/#bib-vocab-dcat

36 The ESA FedEO/OBEOS Series response (in Atom) - see the ESA best-practice case - includes access/availability metrics information expressed in this vocabulary.

37 http://www.w3.org/TR/vocab-dcat/#Class:_Dataset

38 http://www.w3.org/TR/vocab-dcat/#Class:_Distribution

39 https://www.w3.org/TR/vocab-dqv/#dqv:QualityAnnotation

40 http://purl.org/dc/terms/Standard

- dqv:QualityPolicy[41] represents a policy or agreement that is chiefly governed by data quality concerns;
- dqv:QualityMeasurement[42] represents a metric value providing quantitative or qualitative information about the dataset or distribution; and
- prov:Entity[43] represents an entity involved in the provenance of the dataset or distribution.

2.3 Metadata publication

2.3.1 Schema.org

Schema.org describes itself as “a collaborative, community activity with a mission to create, maintain, and promote schemas for structured data on the Internet, on web pages, in email messages, and beyond.”

Schema.org vocabulary can be used with many different encodings, including RDFa, Microdata, and JSON-LD. These vocabularies cover entities, relationships between entities and actions, and can easily be extended through a well-documented extension model.”[44]

Schema.org makes your data more discoverable on the web by adding more contextual information interpretable by search engines like google, bing, yahoo, and yandex. The search results can also be displayed in a better way by using new visualizations like Rich Snippets and Rich cards. This can lead to a better visualization of your dataset metadata.

To publish your DCAT metadata on the web using schema.org a mapping is needed. The W3C, OGC supported ‘Spatial Data on the Web’ working group has a draft document describing the mapping between ISO 19115, DCAT and Schema.org[45]. The JRC also published a draft report describing the mapping from DCAT-AP to Schema.org[46].

---

41 https://www.w3.org/TR/vocab-dqv/#dqv:QualityPolicy

42 https://www.w3.org/TR/vocab-dqv/#dqv:QualityMeasurement

43 http://www.w3.org/ns/prov#Entity

44 http://schema.org/

45 https://www.w3.org/2015/spatial/wiki/ISO_19115_-_DCAT_-_Schema.org_mapping

46 https://webgate.ec.europa.eu/CITnet/stash/projects/ODCKAN/repos/dcat-ap-to-schema.org/browse

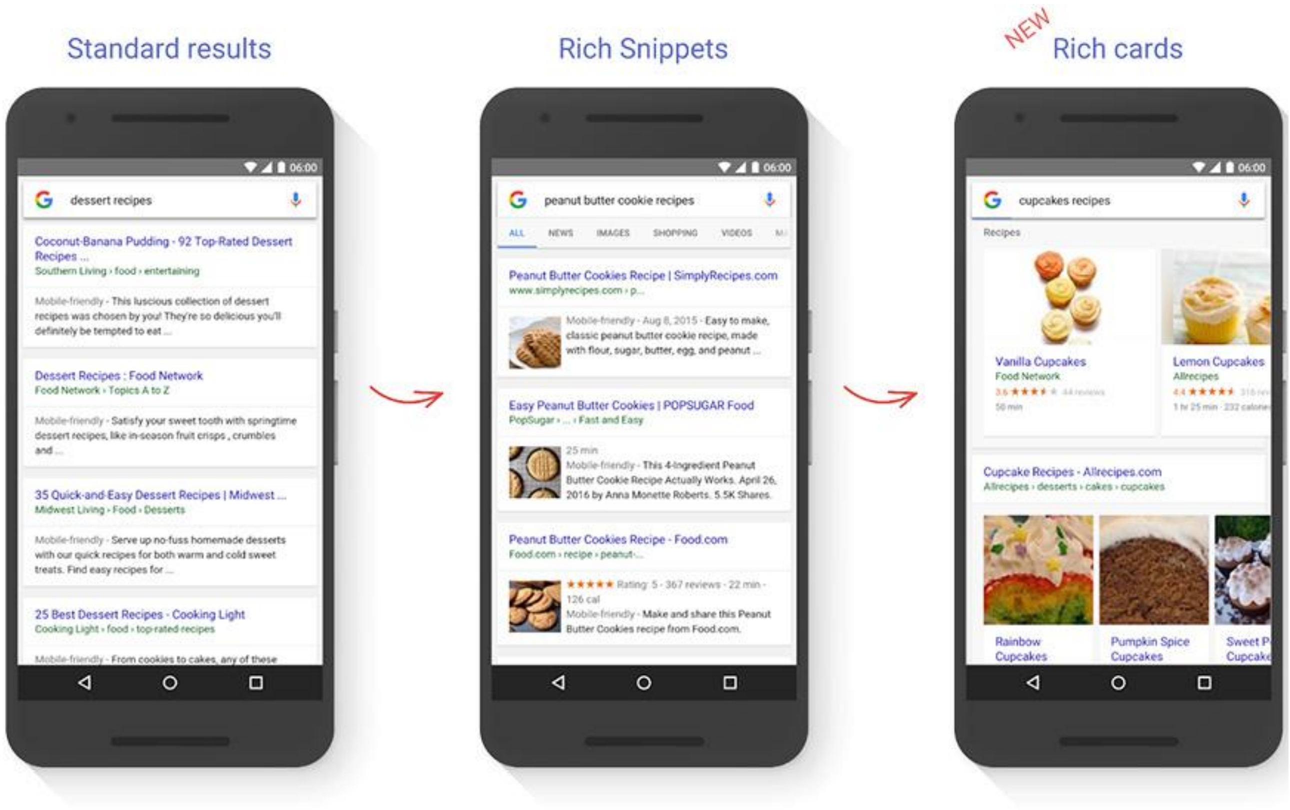


Figure 8: Metadata presentation by using schema.org as a basis for Rich Snippets and Rich cards

The power of schema.org lies in its vocabularies developed by an open community process. The schema.org core plus extension vocabularies contain already specific properties for describing data sets, data feeds, data catalogues and digital documents.

2.3.2 Atom feeds

Atom refers to a pair of related web standards. The Atom Syndication Format is an XML format used for web feeds, and the Atom Publishing Protocol is a HTTP-based protocol used for web feeds. Atom is used to create web feeds that allow software programs to check for updates published on a website. The feeds can be downloaded by programs that use it, e.g., Websites that syndicate software from the feed or reader programs that allow internet users to subscribe to feeds.

Feeds are composed of items, known as "entries," each with an extensible set of attached metadata. For example, each entry has a title. Atom was developed as an alternative to RSS.

Atom was a proposed standard by the Internet Engineering Task Force (IETF)[47] as RFC 4287[48] in December 2005, and the Atom Publishing Protocol was published as RFC 5023[49] in October 2007.

An Atom feed typically exists of a feed that acts as a container for metadata associated with the feed. An Atom entry represents an individual entry, acting as a container for metadata and data associated with the entry. The atom content element contains or links to the content of the entry and is also language-sensitive.

Compared to DCAT and Dublin Core, Atom contains most of the metadata elements. The Atom elements match almost one on one to the DCAT and Dublin core terms. Atom also has the opportunity to add extensions by using simple- and structured extension elements.

It is worthwhile noting that in the context of INSPIRE, Atom feeds can be used for providing downloads of the data[50].

2.4 Geospatial standards

2.4.1 ISO standards[51]

2.4.1.1 ISO 19115:2003 and ISO 19115:2014 - Geographic information metadata

ISO 19115 is a standard of the International Organization for Standardization (ISO). The standard is part of the ISO geographic information Suite of Standards (19100 series). ISO 19115 and its parts define how to describe geographical information and associated services, including contents, spatial-temporal purchases, data quality, access, and rights to use.

The objective of this International Standard is to provide a clear procedure for the description of digital geographic datasets and services so that users will be able to determine whether the data in a holding will be of use to them and how to access the data. By establishing a common set of metadata terminology, definitions, and extension procedures, this standard promotes the proper use and effective retrieval of geographic data.

ISO 19115 was revised in 2013 to accommodate growing use of the internet for metadata management, as well as to add many new categories of metadata elements (referred to as code lists) and the ability to limit the extent of metadata use temporally or by the user.

In 2016 ISO/TS 19115-3:2016 was adopted. It defines an integrated XML implementation of ISO 19115-1, ISO 19115-2, and concepts from ISO/TS 19139.

47 https://en.wikipedia.org/wiki/Internet_Engineering_Task_Force

48 https://tools.ietf.org/html/rfc4287

49 https://tools.ietf.org/html/rfc5023

50 The other way is through the setup of WFS.

51 Most of the standards of the ISO 19100 series were also adopted as CEN standards, they are usually indicated with EN and then the ISO name.

2.4.1.2 **ISO 19119:2005 and ISO 19119:2016 - Geographic information services**

ISO 19119:2005 identifies and defines the architecture patterns for service interfaces used for geographic information, defines its relationship to the Open Systems Environment model, presents a geographic services taxonomy and a list of example geographic services placed in the services taxonomy.

It also prescribes how to create a platform-neutral service specification, how to derive conformant platform-specific service specifications, and provides guidelines for the selection and specification of geographic services from both platform-neutral and platform-specific perspectives[52].

ISO 19119:2005 was revised and resulted in ISO 19119:2016. The 2016 version defines requirements for how platform neutral and platform-specific specification of services shall be created, in order to allow for one service to be specified independently of one or more underlying distributed computing platforms. Is also defines requirements for a further mapping from platform neutral to   service specifications, in order to enable conformant and interoperable service implementations[53]. The service metadata model and requirements have been moved to ISO 19115-1: 2014 (clause 6.5.14). So this new version only speaks in very general terms about the need for service metadata.

The INSPIRE Metadata specifications or Implementing Rules and the 'INSPIRE Metadata Technical Guidelines' are based on EN ISO 19115 and EN ISO 19119:2005 for describing metadata for data sets, data sets series and services[54].

2.4.1.3 ISO 19110:2005 and 2016 Geographic information methodology for feature cataloguing.

ISO 19110:2016 the successor of the 2005 version defines the methodology for cataloguing feature types. This document specifies how feature types can be organized into a feature catalogue and presented to the users of a set of geographic data. This document is applicable to creating catalogues of feature types in previously uncatalogued domains and to revise existing feature catalogues to comply with standard practice. This document applies to the cataloguing of feature types that are represented in digital form. Its principles can be extended to the cataloguing of other forms of geographic data[55].

2.4.1.4 ISO/TS 19139:2007 Geographic information - Metadata - XML Schema Implementation

Defines Geographic MetaData XML (gmd) encoding, an XML Schema implementation derived from ISO 19115[56]. Geographic metadata is represented in ISO 19115 as a set of UML packages containing one or more UML classes. ISO 19115 provides a universal, encoding-independent view of geographic information metadata. ISO/TS 19139 provides a universal

---

[52] https://www.iso.org/standard/39890.html

[53] https://www.iso.org/standard/59221.html

[54] http://inspire.ec.europa.eu/file/1705/download?token=iSTwpRWd

[55] https://www.iso.org/standard/57303.html

[56] https://www.iso.org/standard/32557.html

implementation of ISO 19115 through an XML schema encoding that conforms to the rules described in ISO 19118 (Encoding).

ISO/TS 19139 is currently under review and will be replaced by ISO/NP TS 19139-1. Also here, the specific metadata XML encoding will be removed and is now part of ISO/TS 19115-3: 2016 which defines an integrated XML implementation of ISO 19115-1 and ISO 19115-2 (for gridded data).

2.4.1.5 ISO 19150 Rules for developing ontologies in the Web Ontology Language (OWL)

ISO/TS 19150-1:2012 defines the framework for semantic interoperability of geographic information. This framework defines a high-level model of the components required to handle semantics in the ISO geographic information standards with the use of ontologies[57].

ISO 19150-2:2015 defines rules and guidelines for the development of ontologies to support better the interoperability of geographic information over the Semantic Web. The Web Ontology Language (OWL) is the language adopted for ontologies.

It defines the conversion of the UML static view modeling elements used in the ISO geographic information standards into OWL. It further defines conversion rules for describing application schemas based on the General Feature Model defined in ISO 19109 into OWL.

It does not define semantics operators, rules for service ontologies, and does not develop any ontology[58].

2.4.2 INSPIRE specification

The INSPIRE Directive aims to create a European Union spatial data infrastructure for the purposes of EU environmental policies and policies or activities which may have an impact on the environment. This European Spatial Data Infrastructure will enable the sharing of environmental spatial information among public sector organizations, facilitate public access to spatial information across Europe and assist in policy-making across boundaries.

The INSPIRE Directive also emphasizes priorities for the development of the European spatial data infrastructure: *"the infrastructures for spatial information in the Member States should be designed to ensure that [...] it is easy to discover available spatial data, to evaluate their suitability for the purpose and to know the conditions applicable to their use."*

INSPIRE is based on the infrastructures for spatial information established and operated by the Member States of the European Union. The Directive addresses 34 spatial data themes needed for environmental applications.

---

[57] https://www.iso.org/standard/57465.html

[58] https://www.iso.org/standard/57466.html

The Directive came into force on 15 May 2007 and is implemented in various stages[59], with full implementation required by 2021[60].

To make the thematic information sources coming from the 28 EU member states interoperable on the metadata level, INSPIRE established metadata implementing rules (= legislation) and metadata technical guidelines.

The 'INSPIRE Metadata Implementing Rules'[61] is a EU Regulation[62] which establishes the obligations under which public sector bodies in the EU should publish descriptive metadata on geographic data sets (series) and services. It describes a set of twenty-one metadata elements to be used to describe geographic datasets, dataset series and services. Such set of INSPIRE metadata elements was extended by five in 2010 and one more in 2013[63]. In order to further harmonize the implementation of these obligations, the (non-binding) 'INSPIRE Metadata Technical Guidelines'[64] were defined. These technical guidelines show how the metadata elements in the Regulation match metadata elements in ISO 19115: 2003 and ISO 19119: 2007. The specification also contains examples how metadata records can be transformed into XML. Although the Technical Guidelines are not binding, it is strongly advised to follow them as otherwise it is very difficult to demonstrate that the metadata provided in a different model / format is in accordance with the INSPIRE Metadata Implementing Rules (which themselves are binding)[65].

These technical Guidelines prescribe the use of ISO19115:2003. However, a metadata record that complies with the ISO19115: 2003 core elements is not fully compliant with the INSPIRE Metadata Implementing Rules and its derived Technical Guidelines. There are some additional metadata elements that INSPIRE requires on top of the ISO19115: 2003 core profile, e.g., the (degree of) 'conformity' of spatial datasets with the INSPIRE Data specifications.

2.5 Conclusion and overview

Closing the gap between open data standards and geospatial standards isn't an easy process because of the organic growth of standards over the past decades. Because of a lack of knowledge of each other' standards, there is a lot of redundancy between metadata information, and there is a need for data mapping to allow re-using metadata and to make

[59] See inspire roadmap: http://inspire.ec.europa.eu/inspire-roadmap/61

[60] http://inspire.ec.europa.eu/about-inspire/563

[61] http://inspire.ec.europa.eu/documents/Metadata/MD_IR_and_ISO_20131029.pdf

[62] COMMISSION REGULATION (EC) No 1205/2008 of 3 December 2008 implementing Directive 2007/2/EC of the European Parliament and of the Council as regards metadata

[63] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ%3AL%3A2013%3A331%3A0001%3A0267%3AEN%3APDF

[64] http://inspire.ec.europa.eu/documents/Metadata/MD_IR_and_ISO_20131029.pdf

[65] Part 2.1.5. of the Information Flanders "metadata study", Information Flanders, May 2017

data and other resources discoverable over the web, independently of the portal that hosts the metadata of the resource.

The figure below gives an overview of the most important standards and initiatives in the Geospatial and Open-data fields. The standards section (metadata specifications) below, shows that these initiatives are clearly divided between specific geospatial oriented metadata standards (ISO 19115 & 19) and non-geospatial standards as Dublin Core. The ISO 19115 based EU oriented INSPIRE data specifications are also part of the family of Geospatial metadata standards.

The machine to machine communication layer contains standards and initiatives to exchange information between data portals or business software with a data catalogue included. The most common formats are XML and RDF including JSON-LD. Where ISO 19139 and DCAT are respectively geospatial and open-data oriented formats, the very general RDF triples and more particular GeoDCAT-AP format are multisectoral. (Meta)data publication as linked open data and GeoDCAT-AP can integrate open non-geospatial metadata and geospatial metadata in a way that it can be used for publication on the web. Both initiatives (GeoDCAT-AP and more general the publication of RDF triples) are intermediary formats/technologies.

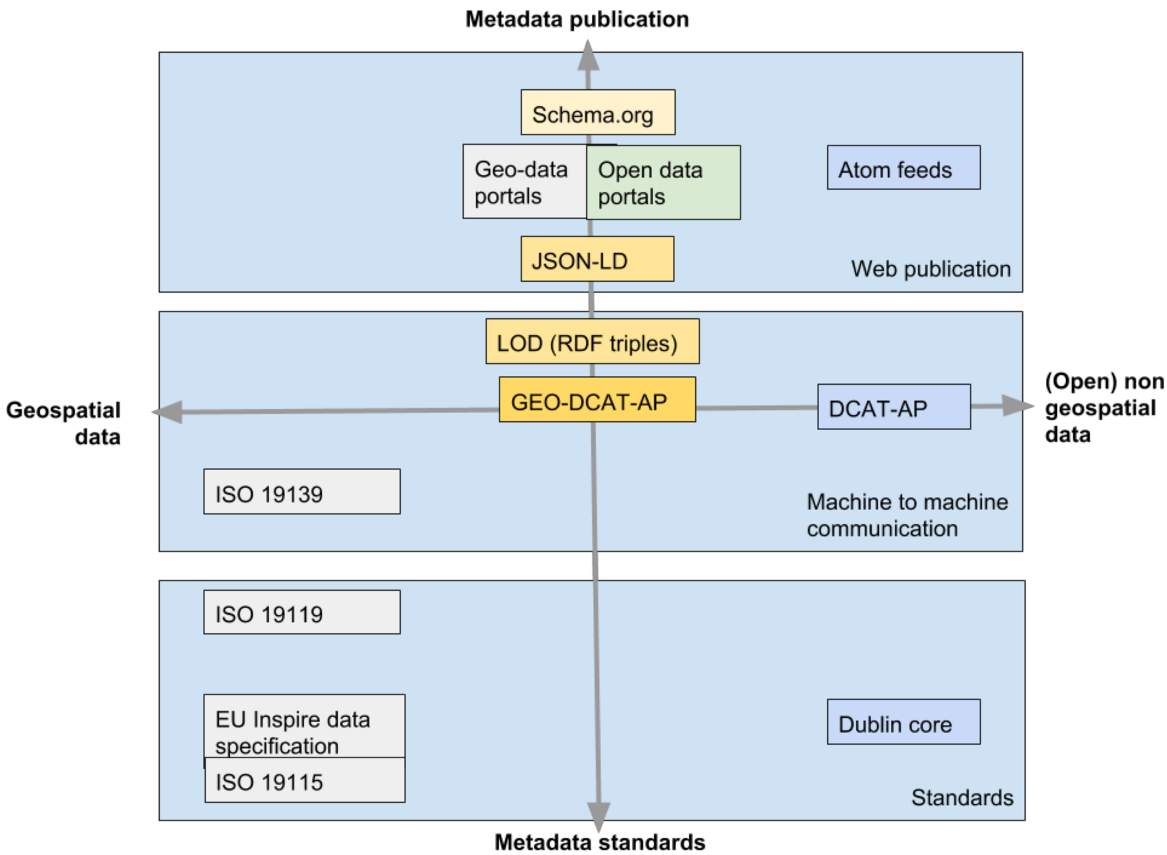


Figure 9: Metadata standards Quadrant overview

The web publication of geospatial and open datasets is nowadays done by using geodata portals or open data portals. The latter have in some cases also a basic geo-visualization function often displaying a bounding box. Another technique is using information feeds like Atom. The most commonly used feeds don’t have a geospatial element included. Schema.org is an interesting format to publish all the metadata directly on the web. Schema.org can also contain some basic geospatial data. The power of Schema.org lies in the fact that data can be found directly using a search engine.

GeoDCAT-AP as an extension on DCAT-AP is a very powerful intermediary format to translate ISO 19100 or Inspire stored metadata into an RDF compatible format that can be used to publish metadata on (geo)data portals and on the web. GeoDCAT-AP as an intermediary format today can exchange open data and geospatial data in a well-defined format.

In the next chapter, we will elaborate some best practices examples of the use of GeoDCAT-AP. We will look at how GeoDCAT-AP handles the information mapping, the publication and exchange between systems and publication on the web using LOD.

3. GeoDCAT-AP best practices implementations

3.1 Intro

The GeoDCAT-AP best practices describe successful GeoDCAT-AP initiatives. These initiatives could be a full implementation in production, a pre-production implementation with test results or just a test or proof of concept. Pure theoretical cases without any implementation are excluded.

We are focusing on two elements divided into four focus areas:

- **Integrated metadata management**: Management of open data- and Geo metadata via one interface (harvesting interface and/or manual input interface);
- **Integrated publication**: Publication of open data- and geo metadata via one interface (data portal or publication on the web).

Four focus areas are of particular interest. Each of the pilots covers at least one of the focus areas as a primary goal.

- Metadata input (manually or automatically harvested);
- Metadata publication into an integrated geo/open data portal;
- Publication of metadata as Linked Open Data (LOD);
- Information mapping (ISO 19115, INSPIRE, DCAT, etc.).

In this chapter, you will find a brief best practice story describing the goals and final results in a nontechnical way. The primary focus lies on the role GeoDCAT-AP has played in the implementation process. More information for each of the best practices is available in the annexes.

In the conclusion section we compare each of the best practices in a form of summarizing table. This table allows us to elaborate if and how GeoDCAT-AP implementations cover the focus areas.

3.2 ESA FedEO/OBEOS - GeoDCAT-AP implementation

The ESA OBEOS (Ontology Based Earth Observation Search) project aimed to extend the operational ESA FedEO (Federated Earth Observation) Gateway with Linked Data interfaces compliant with W3C LDP 1.0[66] and W3C DCAT and GeoDCAT-AP interfaces to facilitate discovery of Earth Observation Collection Metadata. Through the additional RESTful FedEO API, all EO collection metadata accessible through FedEO become immediately accessible as Linked Data. For product metadata discovery, a similar approach was implemented. The original W3C DCAT encoding evolved recently to a GeoDCAT-AP encoding.

The objectives of the OBEOS demonstrator included:

- Publication of EO metadata for collections and products using the Linked Data paradigm;
- Provision of a fully standards-based implementation and use commonly accepted vocabularies;
- Link to recognized authorities providing Linked Data URI for satellites, instruments, science keywords, coordinate reference systems etc.;
- Investigation enrichment of EO collection metadata landing pages using schema.org annotations (JSON-LD);
- Provision of selected components of the demonstrator as open-source; and
- Being easily integrated in the operational FedEO Clearinghouse at ESA.

The OBEOS Project showed the feasibility of Linked Data encoding (JSON-LD) of EO collection metadata using W3C DCAT and the evolution towards GeoDCAT-AP. GeoDCAT-AP allowed for the main EO Collection properties to be mapped.

Further work and possibly changes are needed to GeoDCAT-AP 1.0.1 and/or OGC 14-055r2 to allow specifications to be based on both simultaneously and use a JSON-LD @context document for interpretation of JSON as JSON-LD (RDF)[67].

3.3 OGC Testbed 12

OGC Testbed-12 developed a crosswalk to evaluate interoperability between different metadata specifications. The metadata specifications included the OGC I15 (ISO19115 Metadata) Extension Package of the CSW ebRIM Profile 1.0, NSG Metadata Foundation (NMF), DGIWG Metadata Foundation (DMF), DoD Discovery Metadata Specification (DDMS) and the W3C Data Catalog (DCAT) specification.

The OGC Testbed-12 metadata crosswalk was developed within a work package focusing on Catalogue and SPARQL services. The goal of the Testbed-12 work was to:

---

66 https://www.w3.org/TR/ldp/

67 See annex one for more details.

- Improve understanding of the potential for semantic enablement of OGC catalogue services;
- Improve interoperability between OGC catalogue standards and open search standards currently adopted by several general search engines;
- Increase awareness of registry capabilities such as change control management, which are supported by specific profiles of OGC catalogue standards.

The testbed found that DCAT on its own has a limited geospatial vocabulary. However, when integrated with GeoSPARQL to create GeoDCAT-AP it provides a geospatial vocabulary capable of supporting catalogue federation. The testbed recommended that the OGC should standardize the GeoDCAT-AP specification. The testbed also found that the metadata returned by the different catalogues ranged from ISO 19139 XML, NMIS, DDMS, ebRIM ExtrisicObjects etc. The testbed recommended that catalogue services should be enabled to offer a GeoSPARQL service endpoint that publishes metadata in GeoDCAT-AP and can receive federated SPARQL queries from other GeoSPARQL services.

3.4 OTN Open Transport Net - GeoDCAT-AP implementation

Open geospatial data is the focus of the OTN (Open Transport Networks) EU funded project. OTN aims to integrate (metadata) of INSPIRE compatible transport related geospatial datasets with open transport related datasets. To integrate and display open and geospatial (meta)data OTN has built a so-called OTN hub that allows cities to manage and display their open and geospatial transport related datasets in one single catalogue.

The OTN Hub has several non-trivial requirements. The Hub is dealing with a mix of spatial and non-spatial data, and these data need to be discoverable through its metadata.

The metadata must be easily searchable using one single and easy to use interface. The most important element to achieve this goal is the metadata harmonization of spatial and non-spatial datasets and services. These are essential to enable a uniform way of querying metadata. GeoDCAT-AP was an obvious choice due to the combination of geospatial and open data practices.

The combined solution used in OTN combines the open data portal CKAN and Micka. CKAN is used as the entry point for new datasets (spatial or non-spatial), either as a file upload or as a harvest from other data portals. Webhooks, a CKAN extension scans for changes and notifies an intermediate CKAN2CSW module, which was created for the scope of OTN. This module requests the full details of any changed dataset and translates these into CSW transactions that are pushed to Micka. In this way, Micka is kept synchronized with CKAN. Micka serves as metadata catalogue and is the single point of entry for the portal. GeoDCAT-AP can be generated on the fly for the various queries. Following existing standards is vital for interoperability. Both the open data and the geospatial world have stable standards, and GeoDCAT-AP is the first attempt in combining the two. Combining several software packages seems to be the best approach until GeoDCAT-AP gets better adoption in metadata management tools.

3.5 Data Bio metadata visualization project

“Traditional” ways of metadata visualization represent a burden for a user who would like to focus on his/her work, however, needs to deal with metadata in a special application. The Data Bio project approach aims to a more user-friendly work with metadata in a commonly used application, Google Earth (in the KML format). The idea behind this metadata approach is that “The best/most user-friendly metadata platform is the one not shown to a user.”

The main goals are:

- Define transformations from GeoDCAT into the KML;
- Develop mechanisms for user-friendly visualizations of (Sentinel-1, Deimos and Cryosat-2) dataset series in the Google Earth application;
- Make the converter for GeoDCAT to KML publicly accessible for further re-use; and
- In general, user-friendly visualization of satellite images collections (dataset series).

The main achievement was the developed converter that transforms GeoDCAT into KML format that is publicly available (https://dev.bnhelp.cz/projects/dcatconv/). The result is a user-friendly visualization of GeoDCAT metadata from earth observation satellite data without the necessity of a metadata platform.

3.6 Czech National Inspire Geoportal

The Czech National INSPIRE Geoportal is a single access point for INSPIRE based spatial data and make use of GeoDCAT-AP. Beside INSPIRErelated datasets the portal can also handle metadata coming from other open- and geo- related datasets.

The GeoDCAT-AP implementation has several goals:

- Testing the GeoDCAT-AP implementation on the existing metadata catalogue (CSW 2.0.2);
- Online tool for transformation INSPIRE metadata to GeoDCAT-AP;
- Platform for automatic translation between Czech INSPIRE geoportal and Czech Open Data Portal (harvesting INSPIRE metadata as Geo-DCAT-AP feeds);
- CENIA (Czech Environmental Information Agency) is responsible for portal operation; and
- The portal is intended for INSPIRE support at national level.

In the future the Czech National Inspire Geoportal will be extended with:

- Continuous updates according to changes in INSPIRE metadata profiles, services, etc.; and
- Communication with Czech national Open Portal.

The Czech INSPIRE Geoportal make extensive use of GeoDCAT-AP.

- The Czech geoportal has included a CSW client with GeoDCAT-AP RDF/XML output (available on the top bar at metadata detail panel).
- A RDF compatible HTML page is available for every dataset. This page offers a structured overview of the metadata.

- On-line tool for data conversion from INSPIRE metadata format to the GeoDCAT-AP metadata format.

- A connection to the Czech Open Data Portal is needed as well. Therefore, the Open Data Portal should support GeoDCAT-AP as well.

3.7 Dutch testbed Geonovum

The central question of the spatial data on the web test setup was how to use the power of the World Wide Web to make geo-information more accessible? This testbed was organized in 2015-2016. Starting with some relevant research questions, commercial parties began to experiment with publishing geodata on the web.

GeoDCAT-AP was tested as one of the tools/techniques to translate INSPIRE, ISO 19139 metadata records to a format that can be picked up by the most commonly used search engines on the web.

Finding, accessing and using data disseminated through spatial data infrastructures (SDI) based on OGC web services is difficult for non-expert users. The Geonovum research has investigated how to improve this while keeping the current spatial data infrastructures intact: i.e., "we have been exploring ideas how to realize synergies between the existing spatial data infrastructures and the developments on the Web of data."

Different techniques have been tested. One of the work items was to transform ISO 19139 records to GeoDCAT-AP compatible RDF.

The focus of the testbed can be summarized as a number of test implementations to test and improve:

- The crawlability and linkability, i.e., making each resource available via a persistent URI and ensure that all resources can be reached via links from a "landing page" for a data set;

- Classification of the resources using vocabularies supported by the main search engines on the Web;

- Discovery of spatial data by search engines;

- Representations of data for consumption by humans (HTML), web-developers (JSON) and search engine crawlers (HTML with annotations); and

- Establishing and maintaining links between data.

To a large extent the Geonovum testbed was successful implementing the intermediate proxy layer as an interface between the Dutch SDI and open data portals, search engine crawlers and the web developers community. The main results are:

- The (meta)data resources were made available by the used proxies;

- The mapping of the data and metadata resources to the schema.org vocabulary (plus the GeoDCAT-AP vocabulary for metadata) are achieved with a minimum of lost metadata elements;

- The strategy for assigning URIs to the resources was achieved and tested;
- The representations (formats), in which each resource are available;
- New experiences with establishing links across data sets and between data and metadata; and
- New experiences with search engines crawling and indexing the resources.

There are still some challenges to improve the data findability on the web:

- Improve existing infrastructure to support dynamic linking between resources (features) in the dataset and to avoid incomplete and inconsistent metadata; and
- Web related challenges to make search engines more open in a way to understand how you can deliver your data in the best possible way and the implementation of a scheme-based content negotiation besides a media based content negotiation.

3.8 Information Flanders (IV) implementation

Information Flanders (Belgium) is integrating their open-data metadata and geo metadata in one single end-user portal and one integrated metadata management system. As EU member, Belgium and Information Flanders as one of the regional public agencies, must apply the INSPIRE metadata profiles. This means that IV is dependent on different metadata standards (DCAT-AP) for open data and (Geo DCAT-AP, ISO19115) for Geodata.

This section describes how Information Flanders integrates Open Data metadata records (DCAT-AP) and SDI (the Spatial Data Infrastructure of Flanders) metadata records (Geo DCAT-AP, INSPIRE, ISO 19115) using a schema-based approach.

- DCAT-AP support based on the ISO19139 Scheme; and
- DCAT-AP support DCAT based on a new scheme.

The general approach used in both experiments is to start from a GIS metadata management system and adapt this system to handle open metadata in a way that is also convenient for open data specialists without encumbering the system with extra geo-related fields. The two implementation scenarios were tested in the context of a metadata study[68].

The idea behind was to make metadata editing as simple as possible for the data provider. The ‘once only’ principle whereby data must be inputted one single time is a critical element in this simplification approach. The idea behind both experiments was to use the same metadata management system to bridge the gap between geographic- and open data and to elaborate methods to reduce costs and to increase efficiency compared to wholly separated geo- and open-data metadata systems.

[68] The scenarios are part of the Flanders metadata study, Information Flanders, May 2017

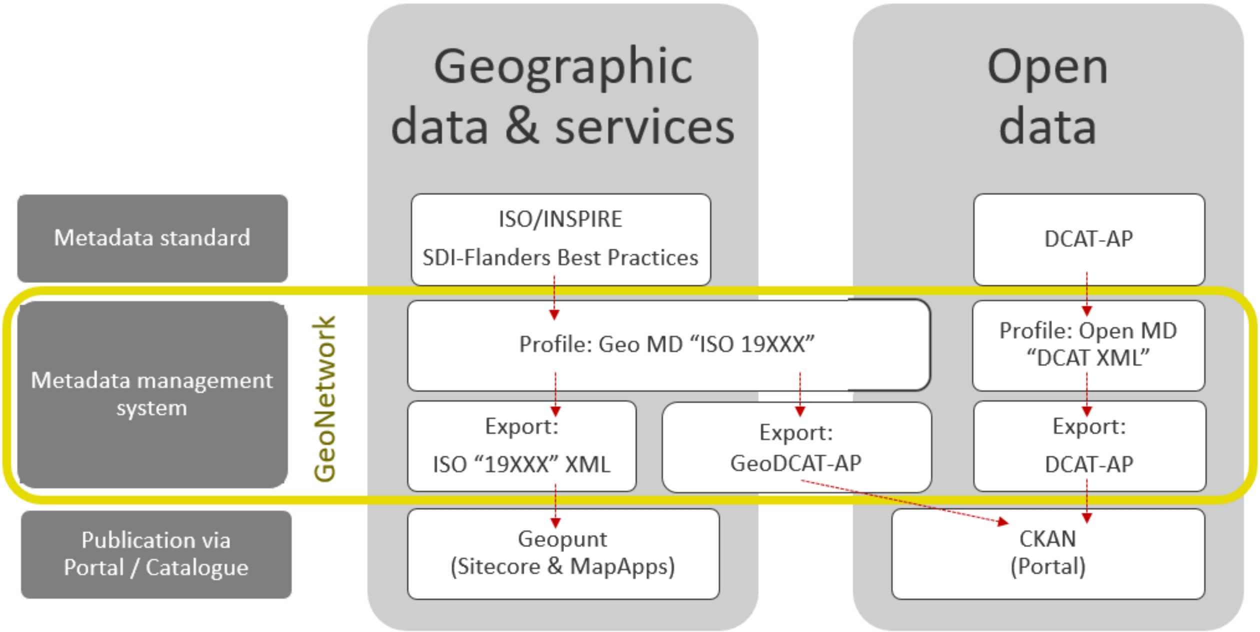


Figure 10: Bridging the gap between metadata standards, systems and portals[69]

More specific, two different experiments to store and export metadata based on ISO19139 Geographic information -- Metadata -- XML schema implementation were carried out to test a smooth metadata management.

- Experiment 1: Support of GeoDCAT-AP metadata based on the existing ISO 19139 scheme; and
- Experiment 2: Support of GeoDCAT AP schema based on a new developed GeoDCAT-AP based schema plugin.

The first experiment shows that it is technically feasible to manage both GeoDCAT-AP metadata records and metadata records for SDI Flanders using a Geo Metadata management solution. The GeoDCAT-AP metadata records can also be made available as Linked Data.

When using the ISO option metadata schema, it is less easy to reconstruct a pure DCAT based graphical user environment for open data metadata.

To avoid discouraging Open Data users who need an input interface that is adapted to the information they need (without GIS specialist related fields), preference was given to implement “GeoNetwork Schematic Plugin for DCAT-AP” as described in the second experiment.

The second experiment shows that it is technically feasible to manage both GeoDCAT-AP metadata records and metadata records for SDI Flanders using a single metadata management solution. The DCAT-AP metadata records can be made available as Linked Data.

As indicated above, this option offers the advantage of having a high degree of freedom regarding the customization of the graphical user environment. Therefore, this option was

[69] Figure by Informatie Vlaanderen, 2018, Geraldine Nolf.

preferred. A minor disadvantage is the fact that the metadata database stores different XML schemas. This requires some attention when a bulk update of, e.g. address information or licenses would occur. But here too, the use of code lists that refer to a set of predefined organizations and licensing conditions is the best solution.

3.9 Outcomes and conclusions

The cases shows a broad interest in GeoDCAT-AP. Several independent international and national organizations and research initiatives have already tested GeoDCAT-AP in several domains (metadata input, portal integration, linked open data publication and information mapping). Each of the 4 domains are at least once considered as the primary focus area of the implemented or tested solution.

Case	Status	Focus area			
		Metadata input	Metadata publication	Publication as LOD	Information mapping
1. ESAFedEO/OBEOS	Pre-Prod	S	S	P	S
2. OGC testbed 12	Test	S	S	S	P
3. OTN project Geo DCAT-AP implementation	Prod	P	P	P	S
4. DataBio project GeoDCAT to KML convertor	Prod	S	P	S	S
5. Czech republic Geo Portal	Prod	S	P	S	P
6. Dutch testbed Geonovum	Test	-	P	P	P
7. Information Flanders Geo DCAT-AP implementation	Test	P	P	S	P

Status: Prod = Production; Pre = Pre production; Test = Test

Focus area: P = Primary focus; S = Secondary focus; N = No focus area

Table 1: Comparative table of the Geo DCAT-AP best practices

Beside the GeoDCAT-AP examples as discussed here, there is a non-exhaustive overview of GeoDCAT-AP implementations and initiatives available at: https://joinup.ec.europa.eu/document/geodcat-ap-implementations.

3.9.1 Focus & goals

The Information Flanders and Open Transport Net (OTN) cases both focus on **metadata input**. Where OTN is primary focusing on automatic harvesting data from open- and geospatial portals to integrate the metadata in one single searchable catalogue, the

Information Flanders best practice focuses on inputting metadata using DCAT and Geospatial metadata using INSPIRE/ISO by implementing tailored input schemes.

Metadata publication on an integrated geo/open data portal is a focus area of the Czech data portal, Information Flanders, Open Transport Net & dataBio project. The Czech best practice focuses on the automatic data exchange and transformation between the Czech Inspire geoportal and the Czech open data portal by harvesting the INSPIRE metadata as Geo-DCAT feed. The OTN best practice integrates INSPIRE/ISO metadata and DCAT metadata into one single portal where DCAT contains the basic information about each dataset. The Information Flanders best practice also focuses on metadata publication in an open data and compatible geospatial format based on GeoDCAT-AP/INSPIRE. The DataBio best practice goal is to gather and display metadata without the need for a specific metadata catalogue integrating metadata directly into GIS tools.

The Dutch Geonovum testbed has a strong focus on **publishing metadata as linked open data (LOD)** by transforming ISO 19139 records to GeoDCAT-AP compatible RDF and by assigning URI's and establishing links across datasets and metadata. OTN focusses on defining and loading SPARQL endpoints for the OTN (meta)data as a first step towards the publication of linked open data. The ESA OBEOS (Ontology Based Earth Observation Search) project aimed to extend the operational ESA FedEO Gateway with Linked Data interfaces compliant with W3C LDP 1.0 and W3C DCAT and GeoDCAT-AP interfaces to facilitate discovery of Earth Observation Collection Metadata. The focus is on the publication of EO metadata for collections and products using the Linked Data, more specific to link recognized authorities providing Linked Data URI for satellites, instruments, science keywords, and coordinate reference systems.

Information mapping towards GeoDCAT-AP has been primarily tested in the Information Flanders best practice case and the Czech best practice. Information Flanders used schemas to support GeoDCAT-AP metadata based on ISO19139 and a DCAT-AP schema plugin while the Czech case worked with an online tool for data conversion from Inspire metadata format to GeoDCAT. The OGC testbed 12 was primarily focusing on aligning OGC catalogue services and SPARQL services to improve semantics and adoption by search engines.

3.9.2 Outcomes

The primary outcomes on **metadata input** were the implementation of two schemes to handle DCAT based open data metadata and ISO 19115/INSPIRE based metadata in Flanders (Information Flanders best practice). Both schemas make it possible to input DCAT and ISO 19115/INSPIRE metadata in the same portal adapted to the specific DCAT and ISO/INSPIRE standards. A significant advantage is that DCAT records can be entered without the extra ISO/Inspire requirements. The OTN best practice case shows that it is possible by integrating an open data metadata solution and a geospatial metadata solution to build an integrated catalogue using automated harvesting mechanisms. Both best practices prove that metadata coming from different sources (open data DCAT feeds and Geospatial ISO 19115/INSPIRE feeds) and that was manually entered, or automatically harvested, can be used to publish metadata in GeoDCAT-AP.

On the **Metadata publication** side, the Czech geoportal achieved to build a CSW client that produces a GeoDCAT RDF/XML output. The RDFa compatible output has been used to create HTML pages containing metadata and/or KML visualization as depicted in Figure 8. Search engines index these pages and make them directly available on the web. OTN uses the same approach to produce GeoDCAT RDF/XML from existing ISO 19139/INSPIRE metadata in the catalogue according to the rules defined by the GeoDCAT-AP specification.

Information Flanders achieved to successfully implement two schemes that make it possible to publish DCAT-AP and ISO 19119/INSPIRE metadata in a single publication environment. The Dutch SDI testbed achieved to map and publish data and metadata resources to the schema.org vocabulary and the GeoDCAT-AP vocabulary for metadata with a minimum loss of metadata elements. The DataBio convertor transforms GeoDCAT into KML that can be directly displayed in a GIS application without the need of a specific metadata catalogue.

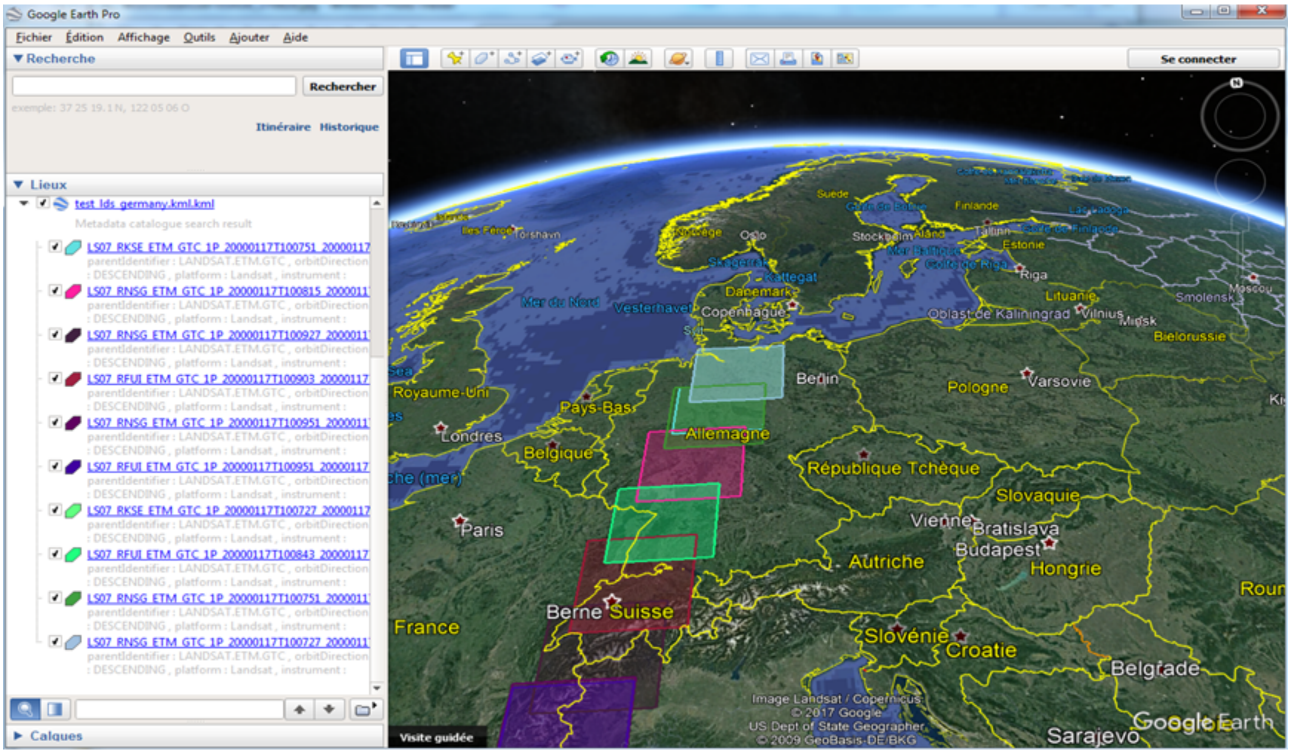


Figure 11: KML visualization of INSPIRE metadata for Sentinel-1 dataset series, originally published in the GeoDCAT/RDF[70].

Publication of metadata as linked open data was the primary goal of the Dutch GDI (Geonovum). The strategy for assigning URIs to the resources was achieved. The representations (formats) for each resource are available. New experiences with establishing links across data sets and between data and metadata and new experiences with search engines crawling and indexing the resources were successful. OTN was able to set up a triple store and SPARQL endpoint for the datasets. Relevant datasets were linked to Datex II, and GTFS based semantic catalogues to publish the dataset as linked open data. The Linked Data interface of the ESA FedEO Gateway was fully implemented and deployed at ESA and Spacebel. It provides access to all metadata available through the operational FedEO Gateway but uses Linked Data RDF metadata encodings instead. Several encodings were tested, and the GeoDCAT-AP turns out as very relevant for the EO Collection Metadata encoding.

Last but not least, there are several interesting outcomes on **information mapping** towards GeoDCAT-AP. The Information Flanders best practice proves that it is feasible to transform Metadata records from ISO 19119 and INSPIRE and translate these to GeoDCAT-AP with a

[70] Horizon 2020 project "Data-driven Bioeconomy (DataBio)" - grant agreement No 732064 https://www.databio.eu/

minimum loss of information and to publish DCAT-AP records as GeoDCAT-AP. The Czech GeoPortals have managed to automate the conversion of INSPIRE & ISO 19119 records to GeoDCAT-AP. The Geonovum testbed achieved a successful mapping of ISO 19139 metadata records to GeoDCAT-AP by using an XSLT.

And the OGC testbed was able to align OGC catalogue services and SPARQL services to improve semantics and adoption by search engines.

3.9.3 Conclusions

The best practice cases show satisfactory results in each of the four focus areas using GeoDCAT-AP. At least two best practice cases have a primary focus on each of the focus areas. The added value of GeoDCAT-AP was proved to integrate metadata from open datasets using DCAT-AP and geospatial datasets using ISO 19115/19119 and INSPIRE. The cases are showing the added value of GeoDCAT-AP and the mature implementation status.

GeoDCAT-AP is a recent initiative (version 1.0.1 is available at the time of writing this Discussion Paper) and needs further integration and alignment. This is a logical evolution for every standardization initiative. In chapter 4 we describe the results of a comparative analysis between GeoDCAT-AP and ISO/INSPIRE XML. We also focus on future requirements and issues.

GeoDCAT-AP plays an important and unique intermediate role connecting metadata standards and metadata publication and connecting Geospatial data and (open) non-geospatial data[71].

4. GeoDCAT-AP alignment and future integration

The first three chapters focus on the existing GeoDCAT-AP initiative and study the role of GeoDCAT-AP in the metadata landscape. The best practice cases describe some successful GeoDCAT-AP implementations. Some of the cases formulate also future improvements and requirements. In this chapter, we focus entirely on how GeoDCAT-AP fills the gap between the ISO metadata, in particular the ISO metadata elements used by INSPIRE, formats and the exchange of metadata between portals and the publication of ISO/INSPIRE metadata on the web.

The first part of this chapter describes a comparative analysis between GeoDCAT-AP and ISO/INSPIRE XML. The second part discuss future requirements of GeoDCAT-AP.

A full set of namespaces and prefixes for RDF vocabularies used in this document is shown in the table below.

prefix	**namespace**
adms	http://www.w3.org/ns/adms#

[71] See figure 9.

dcat	http://www.w3.org/ns/dcat#
dct	http://purl.org/dc/terms/
foaf	http://xmlns.com/foaf/0.1/
gsp	http://www.opengis.net/ont/geosparql#
locn	http://www.w3.org/ns/locn#
rdf	http://www.w3.org/1999/02/22-rdf-syntax-ns#
rdfs	http://www.w3.org/2000/01/rdf-schema#

Similarly, the following prefixes and namespaces are used in the ISO/INSPIRE metadata formats.

prefix	**namespace**
gmd	http://www.isotc211.org/2005/gmd
gco	http://www.isotc211.org/2005/gco

4.1 Comparative analysis between GeoDCAT-AP and ISO XML

This part describes the results of the comparative analysis between GeoDCAT-AP and ISO/INSPIRE XML reference implementations based on ISO 19139 (and ISO 19115, ISO 19119)[72]. Where relevant, the ISO 19139 XML can be converted automatically to GeoDCAT-AP, via the XSLT script 'xslt script 'iso-19139-to-dcat-ap.xsl.'

A recent article[73] from the EU ISA program explains how DCAT-AP can be implemented. This article also addresses a number of ISO/INSPIRE specific issues.

[72] The analysis is part of the metadata study, Information Flanders, May 2017

[73] https://joinup.ec.europa.eu/node/150652

4.1.1 Multi language support

The use of multiple languages is mentioned in the GeoDCAT-AP specification, and its reference implementation supports it[74].Recognizing different metadata documents, in different languages, is supported by DCAT-AP and ISO 19139 XML.

The way in which different languages for the text values are used is encoded as follows in XML and RDF:

- In RDF it's arranged at attribute level by annotation of literal values. The RDF Data Model provides for language-tagged strings.

- In the ISO 19139 XML Schema implementation, it is done by using a special textual type (gmd:LocalisedCharacterString) that allows multiple languages.

The xslt script 'iso-19139-to-dcat-ap.xsl' provides an automated conversion of multilingual text fields from an ISO 19139 record into a DCAT record.

The distinction between the language of the metadata and the language of the actual resource and of its distribution is done differently but is supported by GeoDCAT-AP (through the distinction between meta-metadata along: primaryTopicOf and the resource itself).

4.1.2 Access Rights, Legal Constraints, Access Limitations

In DCAT-AP licensing is specified at the level of data catalogs or at dataset distributions level, but not at the dataset level itself.

This way different dataset distributions can have different licensing terms.

DCAT-AP proposes to work with Access Rights (dct:accessRights) to specify those conditions and uses dct:license (from Dublin Core) for use limitations related to intellectual property rights.

Since the range of those properties is not a literal but a resource (of type dct:LicenseDocument or dct:RightsStatement) respectively, a URI is preferably used to identify the resource:

[] a dcat:Distribution;
dct:license <https://creativecommons.org/publicdomain/zero/1.0/>.

In the absence of a URI, RDF allows a resource to be represented as a blank node. A blank node in combination with the use of an rdf:label property allows to map a literal, this is a free text field, which is commonly used in ISO19139 (identificationInfo//resourceConstraints//accessConstraints). For example:

[74] (https://webgate.ec.europa.eu/CITnet/stash/projects/ODCKAN/repos/iso-19139-to-dcat-ap/ & http://joinup.ec.europa.eu/mailman/archives/dcat_application_profile-geo/2016-November/000397.html)

```
[] a dcat:Distribution;

  dct:license [

                  a dct:LicenseDocument;

                            rdfs:label "CC0 1.0 Universal (CC0 1.0) Public Domain Dedication"@en;

          ]
```

4.1.3 Dataset, Dataset Series, and Services

GeoDCAT-AP considers both ISO data sets and ISO data sets series as DCAT data sets **(rdf:type)**.

Therefore, it is impossible to derive from the DCAT description whether this **rdf:type**, is a dataset or a dataset series.

To address this problem, an additional term has been added to GeoDCAT-AP **dct:type** (from Dublin Core terms) in which it is explicitly stated whether it is a data set or a data set series. So, two types are needed to correctly identify a resource in GeoDCAT-AP.

As far as the INSPIRE notion of **service** is concerned, DCAT and DCAT-AP foresee a single class, namely, dcat:Catalog, which only matches the notion of 'discovery service' in INSPIRE. GeoDCAT proposes to encode other service types with the term dctype:Service from the DCMI Type Vocabulary. Additionally, the spatial data service type can be specified by using dct:type with the corresponding code lists operated by the INSPIRE Registry.

```
<rdf:type rdf:resource="http://www.w3.org/ns/dcat#Catalog"/>

AND

<dc:type rdf:resource="http://inspire.ec.europa.eu/metadata-codelist/ResourceType/service"/>

<rdf:type rdf:resource="http://purl.org/dc/dcmitype/Service"/>

<rdf:type rdf:resource="http://www.w3.org/ns/dcat#Dataset"/>

<dct:type rdf:resource="http://inspire.ec.europa.eu/metadata-codelist/ResourceType/dataset"/>

OR

<dct:type rdf:resource="http://inspire.ec.europa.eu/metadata-codelist/ResourceType/datasetseries"/>
```

A separate code list has been provided by INSPIRE[75]

Within ISO / INSPIRE, there is a fairly strict distinction between services and data sets (series) while DCAT-AP works with different types of resources; And two attributes are required to enable the mapping: 'rdf:type' and 'dct:type'.

In a guidance document by the EU ISA Programme[76], the following way of working is proposed:

- When interested in the individual parts of the dataset series:
  - Describe these as separate data sets;
  - DCAT and DCAT-AP do not have a mechanism for expressing relationships between data sets. GeoDCAT-AP suggests: A data set description is created using http://inspire.ec.europa.eu/metadata-codelist/ResourceType/series as' dct: type ', linking to the components with' dct:hasPart ;' and
  - The individual members of the series link back to the series with 'dct:isPartOf'.
- When interested in the series as such, it is recommended to describe the members as multiple distributions of the same dataset. To provide distribution coverage information spatial (Spatial) or temporary ('dct:temporal') metadata may be provided to the distribution.

If it is not clear that it concerns a data set or whether it is a data set distribution, then it is best to combine the two ISA methods as described above.

To indicate sequences, DCAT-AP suggests to work with 'dct:hasVersion / dct:isVersionOf' and through the underlying 'owl: versionInfo'. The "adms:versionNotes" element can then indicate the difference between the different versions[77].

4.1.4 Coordinate reference systems

In ISO/INSPIRE metadata, the coordinate reference system is not guaranteed to be expressed as a URN or HTTP URI, as opposed to the srsName attribute in GML[78].

```
<gml:Polygon srsName="urn:ogc:def:crs:EPSG:6.6:26986">

        <gml:exterior>

                <gml:LinearRing>

                        <gml:posList> 45.256 -110.45 46.46 -109.48 43.84 -109.86 45.256 -110.45
```

75 http://inspire.ec.europa.eu/metadata-codelist/ResourceType

76 Source: https://joinup.ec.europa.eu/release/dcat-ap-how-model-dataset-series

77 More information is available on this page: https://joinup.ec.europa.eu/node/150348

78 Source: http://www.georss.org/gml.html

```
                    </gml:posList>
              </gml:LinearRing>
        </gml:exterior>
</gml:Polygon>
```

In ISO/INSPIRE metadata it often occurs like a text blob. For example:

```
      <gmd:RS_Identifier>
            <gmd:code>
                  <gco: CharacterString> Belge_Lambert_1972 (31370) </gco:CharacterString>
            </gmd:code>
            <gmd:codeSpace>
                  <gco:CharacterString> EPSG </gco:CharacterString>
            </gmd:codeSpace>
      </gmd:RS_Identifier>
```

While it seems appropriate to use the HTTP URI definition corresponding to a recognized coordinate reference system.

For example, for the Belgian Lambert72 this should be noted as http://www.opengis.net/def/crs/EPSG/0/31370. GeoDCAT-AP provisionally uses the (overloaded) property dct:conformsTo to denote the coordinate reference system.

```
[]  a dcat:Dataset ;
      dct:conformsTo <http://www.opengis.net/def/crs/EPSG/0/31370> .
```

4.1.5 X Spatial extent

The encoding of spatial extent is metadata vocabularies requires further attention.

The 'gmd:extent' is not always formatted in the same way, usually in 'EX_GeographicBoundingBox'.

```
<gmd:geographicElement>
        <gmd:EX_GeographicBoundingBox>
                <gmd:westboundLongitude>
                        <gco:Decimal> 2.4 </gco:Decimal>
                </gmd:westboundLongitude>
                <gmd:eastboundLongitude>
                        <gco:Decimal> 5.9 </gco:Decimal>
                </gmd:eastboundLongitude>
                <gmd:southboundLatitude>
                        <gco:Decimal> 50.6</gco:Decimal>
                </gmd:southboundLatitude>
                <gmd: northBoundLatitude>
                        <gco:Decimal> 51.5 </gco:Decimal>
                </gmd:northBoundLatitude>
        </gmd:EX_GeographicBoundingBox>
</gmd:geographicElement>
```

For example:

If a "BoundingPolygon" is given instead of "GeographicBoundingBox," the metadata may originate from a source conforming to the American model NIEM[79].

As there is no agreement on a preferred format for encoding geometries in RDF, GeoDCAT-AP adopts the approach taken by GeoSPARQL and the W3C location vocabulary (locn) to encode them as literals. Geometry literals can be provided in one or more encodings, at least one of which must be GML or WKT. The above bounding box can for example be represented as a WKT polygon or a GML envelope.

```
[] dct:spatial [ a dct:Location ;
    locn:geometry "POLYGON((2.4 50.6,2.4 51.5,5.9 51.5,5.9 50.6,
            2.4 50.6))"^^gsp:wktLiteral ;
    locn:geometry "<gml:Envelope srsName=\"http://www.opengis.net/def/crs/EPSG/0/4326\">
            <gml:lowerCorner>2.4 50.6</gml:lowerCorner>
```

[79] http://www.datypic.com/sc/niem21/e-gmd_EX_Extent.html

```
            <gml:upperCorner>5.9 51.5</gml:upperCorner>
          </gml:Envelope>"^^gsp:gmlLiteral ] .
```

It sometimes occurs that no information about the coordinate reference system has been provided. In principle, this only occurs when the coordinates are in 'WGS84'.

GeoDCAT-AP also caters for the concept of geographic identifier, which could be represented for example as

[] dct:spatial <https://publications.europa.eu/resource/authority/country/CZE>

in RDF.

4.1.6 Metadata status

For mapping the status codes, there is the option in (Geo)DCAT-AP to map on the controlled vocabulary for status[80] defined in the context of the Asset Description Metadata Schema[81] (ADMS), which is a metadata application profile to describe data models and reference data. The URIs for these statuses are no longer dereferenceable. Furthermore, not all (exactly) overlap with the ISO / INSPIRE statuses:

http://xml.fmi.fi /namespace/woml/swo/2011/11/15/index337.html.

For example:

```
<gmd:status>

        <gmd:MD_ProgressCode codeList =
        "http://www.isotc211.org/2005/resources/Codelist/gmxCodelists.xml#MD_ProgressCode" codeSpace
        = "ISOTC211 / 19115" codeListValue = "" />

        ...

</ gmd:status>
```

ADMS status vs. ISO status:

- http://purl.org/adms/status/1.0 (4 possibilities)
- http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/resources/codelist/gmxCodelists.xml (at least 7 possibilities)

ADMS	ISO 19115
Under development	Under development

[80] http://purl.org/adms/status/1.0

[81] https://www.w3.org/TR/vocab-adms/#adms_status

	Required
	Planned
	Ongoing
Deprecated	Obsolete
	Historical archive
	Completed
Withdrawn	Withdrawn (ISO 19115-1)

According to https://geo-ide.noaa.gov/wiki/index.php?title=ISO_19115_and_19115-2_CodeList_Dictionaries#MD_ProgressCode, additional fields have been added to ISO 19115-1.

4.1.7 Maintenance frequency

Not all values are mapped from ISO / INSPIRE to (Geo) DCAT-AP, Sometimes information will be lost.

See table below (source: GeoDCAT-AP 1.0 annex):

ISO 19115 - MD_MaintenanceFrequencyCode	Dublin Core Collection Description Frequency Vocabulary [CLD-FREQ]	MDR Frequency Named Authority List [MDR-FREQ]
continual	continuous	UPDATE_CONT / CONT
daily	daily	DAILY
weekly	weekly	WEEKLY
fortnightly	biweekly	BIWEEKLY
monthly	monthly	MONTHLY
quarterly	quarterly	QUARTERLY
biannually	semiannual	ANNUAL_2
annually	annual	ANNUAL
asNeeded	-	-
Irregular	irregular	IRREG
notPlanned	-	-
unknown	-	UNKNOWN
-	triennial	TRIENNIAL
-	biennial	BIENNIAL
-	threeTimesAYear	ANNUAL_3
-	bimonthly	BIMONTHLY
-	semimonthly	MONTHLY_2
-	threeTimesAMonth	MONTHLY_3
-	semiweekly	WEEKLY_2
-	threeTimesAWeek	WEEKLY_3
-	-	OTHER

GeoDCAT-AP uses an 'adms:accrualPeriodicity' property here.

The range of this property is a resource (often identified with a URI) and not a mere codelist value.

For example:

```
<http://purl.org/linked-data/sdmx/2009/code#freq-W> a skos:Concept, sdmx:Concept,

sdmx-code:Freq;

        skos:topConceptOf sdmx-code:freq;

        skos:inScheme sdmx-code:freq;

        skos:prefLabel "Weekly"@en ;

        skos:notation "W" ;
```

4.1.8 Spatial representation type

In ISO / INSPIRE, the 'SpatialRepresentationType' uses different code lists. In ISO / INSPIRE, these are recognized code lists. In GeoDCAT, the lists are proposed by the EU, but strictly speaking, not binding, as other possibilities may occur.

See also: [https://joinup.ec.europa.eu/asset/dcat_application_profile/issue/geodcat-ap-how-encode-spatial-representation-type.](https://joinup.ec.europa.eu/asset/dcat_application_profile/issue/geodcat-ap-how-encode-spatial-representation-type)

Example:

Example

```
# Resource metadata in GeoDCAT-AP

[] a dcat:Dataset ;
  dcat:distribution [ a dcat:Distribution
    adms:represenationTechnique <http://inspire.ec.europa.eu/metadata-codelist/SpatialRepresentationTypeCode/vector>
  ] .


<!-- Resource metadata in ISO19139 -->
<gmd:spatialRepresentationType>
  <gmd:MD_SpatialRepresentationTypeCode codeListValue="vector" codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/resources/codelist/gmxCodelists.xml#MD_SpatialRepresentationTypeCode">vector</gmd:MD_SpatialRepresentationTypeCode>
</gmd:spatialRepresentationType>
```

The "spatialRepresentationType" is usually defined at ISO / INSPIRE dataset level, while it is defined in GeoDCAT at the Distribution level.

4.1.9 Distributions

Information about the 'function' of a particular distribution (link) does not appear to be evident in any way.

Example:

```
<gmd:MD_Metadata …
…
  <gmd:distributionInfo>
    <gmd:MD_Distribution>
…
      <gmd:transferOptions>
        <gmd:MD DigitalTransferOptions>
          <gmd:onLine>
            <gmd:CI OnlineResource>
              <gmd:linkage>
  <gmd:URL>http://edo.jrc.ec.europa.eu/chm/ows.php?VERSION=1.3.0&SER
VICE=WMS&REQUEST=GetCapabilities</gmd:URL>
              </gmd:linkage>
        <!—Name and description are optional elements not required
      by INSPIRE -->
              <gmd:name>
                <gco:CharacterString>JRC EDO (European Drought
Observatory) - Drought Indexes WMS</gco:CharacterString>
              </gmd:name>
              <gmd:description>
                <gco:CharacterString>WMS delivering maps of
drought indexes provided by the European Drought Observatory
(EDO)</gco:CharacterString>
              </gmd:description>
              <gmd:function>
                <gmd:CI OnLineFunctionCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/IS
O 19139 Schemas/resources/codelist/ML gmxCodelists.xml#CI OnLineFunct
ionCode"
codeListValue="information">information</gmd:CI_OnLineFunctionCode>
              </gmd:function>
            </gmd:CI_OnlineResource>
          </gmd:onLine>
        </gmd:MD_DigitalTransferOptions>
      </gmd:transferOptions>
    </gmd:MD_Distribution>
  </gmd:distributionInfo>
…
</gmd:MD_Metadata>
```

It's impossible to "check" which exact function has a specific URL based upon the GeoDCAT-AP specification for all possible features.

See the mapping table below:

For services	foaf:homepage	- (dcat:Catalog (M))	foaf:Document
For dataset and data series (function code not provided)	dcat:landingPage (O)	dcat:Dataset (M)	foaf:Document
For dataset and data series ('download' function code)	dcat:accessURL (M)	dcat:Distribution (R)	rdfs:Resource
For dataset and data series ('information' function code)	foaf:page (not in DCAT-AP!)	- (dcat:Dataset (M))	foaf:Document
For dataset and data series ('offlineAccess' function code)	dcat:accessURL (M)	dcat:Distribution (R)	rdfs:Resource
For dataset and data series ('order' function code)	dcat:accessURL (M)	dcat:Distribution (R)	rdfs:Resource
For dataset and data series ('search' function code)	foaf:page	- (dcat:Dataset)	foaf:Document

The general 'download' seems to be a good default option (download> offline access, order) if 'accessUrl' has been given. 'Information' seems to be a good alternative for both search and information if 'foaf: page' Is given. In any case, some information is lost (especially the data about: 'offline access', 'order' and 'search').

The conversion through the standard XSLT procedure has problems with the distributions, especially if no "function" has been provided for a specific distribution. For services (i.e. "dcat: catalog") this problem does not occur.

4.1.10 Spatial resolution

In GeoDCAT-AP, spatial resolution is only available under "human-readable" format while in ISO / INSPIRE, it is primarily machine-readable format.

Example:

Example

```
# Resource metadata in GeoDCAT-AP

# Spatial resolution as equivalent scale

[]  a dcat:Dataset ;
    rdfs:comment "Spatial resolution (equivalent scale): 1:10000"@en .

# Spatial resolution as distance

[]  a dcat:Dataset ;
    rdfs:comment "Spatial resolution (distance): 5 km"@en .
```

```
<!-- Resource metadata in ISO19139 -->

<gmd:MD_Resolution>
    <gmd:equivalentScale>
        <gmd:MD_RepresentativeFraction>
            <gmd:denominator>
                <gco:Integer>10000</gco:Integer>
            </gmd:denominator>
        </gmd:MD_RepresentativeFraction>
    </gmd:equivalentScale>
</gmd:MD_Resolution>
```

If the resolution represents a scale, this may be converted. But when the resolution shows a distance, it is not clear whether this can be converted in a standardized manner.

In the GDI-Vlaanderen Best Practices for Metadata, the following is prescribed:

- Scale: is always the denominator of the fraction (1: xxx); and
- Distance: we take Best Practices-wise in meters.

Because no existing terms were found at the time of writing GeoDCAT-AP and no new RDF terms are minted by GeoDCAT-AP, it has also been chosen to represent scale (spatial resolution) as a 'rdfs: comment' property in GeoDCAT-AP, which has little semantics.

The spatial resolution property of http://def.seegrid.csiro.au/isotc211/iso19115/2003/metadata # d4e2105 offers more possibilities for the Resolution class. But this term/representation is currently not part of GeoDCAT-AP.

4.1.11 Metadata codelists

Some code lists have been released for GeoDCAT-AP lists through the EU portal. These code lists[82] are compatible with ISO / INSPIRE. These lists contain mappings to the official ISO code lists.

This may cause compatibility issues if changes occur in the official lists that are not immediately implemented in the mappings to the ISO / INSPIRE metadata code lists.

[82] http://inspire.ec.europa.eu/metadata-codelist/

These lists are used, among other things, for roles, themes, etc.

4.1.12 Additional information

For additional information from ISO / INSPIRE, no direct mapping is provided to GeoDCAT-AP.

Example:

```
<gmd:supplementalInformation>
        <gco:CharacterString> DOV -Geology - Geological 3D Model of Flanders, version 2 | http:
        //dov.vlaanderen.be/dovweb/html/2geologisch3Dmodel.html and ... / gco:CharacterString>
</gmd:supplementalInformation>
```

In order to get this up, it is possible to use a vocabulary: http://def.seegrid.csiro.au/isotc211/iso19115/2003/metadata#d4e3338.

This vocabulary has made an OWL / RDF representation of a selection of elements contained in the ISO / INSPIRE standards.

However, this vocabulary is not used in GeoDCAT-AP and thus has no "official" character.

4.1.13 Format

In GeoDCAT-AP, the format may be a URI that redirects to the description of the format or a blank node with a label that describes the format.

4.1.14 Contact information

Contact information is optional in RDF, but required in ISO INSPIRE. Through validation against the ISO XSDs contact information can be enforced. In the case of GeoDCAT-AP, or DCAT for that matter, SHACL is a standardized way of validation (see 2.2.3). At present, only a SHACL expression of DCAT-AP[83] exists.

Responsible party (M) *Dataset responsible party (O)	dct:creator	- (dcat:Dataset (M))	dct:Agent	See Annex II, Section II.16.
	prov:qualifiedAttribution	prov:Entity (dcat:Dataset (M))	prov:Attribution	
Responsible party role (M)	dct:type	- (prov:Attribution)	rdfs:Class	See Annex II, Section II.16 and controlled vocabulary for responsible party role in Section 6.
*Metadata file identifier (O)	dct:identifier	- (dcat:CatalogRecord (O))	rdfs:Literal	See Annex II, Section II.17. In RDF, this could also be represented as the URI of the metadata / catalogue record.
Metadata point of contact (M) *Metadata point of contact (M)	prov:qualifiedAttribution	- (dcat:CatalogRecord (O))	prov:Attribution	See Annex II, Section II.16.
	dcat:contactPoint	- (dcat:CatalogRecord (O))	vcard:Kind	See Annex II, Section II.16.

83 https://github.com/semiceu/dcat-ap_shacl

4.2 Conclusions

The GeoDCAT-AP specification does not replace the INSPIRE Metadata Regulation nor the INSPIRE Metadata technical guidelines based on ISO 19115 and ISO19119. Its purpose is to give owners of geospatial metadata the possibility to achieve more visibility by providing an additional RDF syntax binding. There is a huge interest from different communities (meteorologic, statistics, defense because of NATO) and the EU Member States alike. The major use case is indeed the fact that EU Member States/organizations want their spatial data sets to be visible within geospatial and open data portals.

GeoDCAT-AP is developed under the EU ISA Programme and needs to be compliant with the ISO/INSPIRE regulation (ISO 19139, 19115, 19119). This compatibility is essential for the implementation of GeoDCAT-AP by the 28 EU Member States. For the non-EU Member States, it is essential that GeoDCAT-AP is also compatible with ISO 19139, 19115, 19119 and DCAT.

The comparative analysis between GeoDCAT-AP and ISO/INSPIRE/XML makes clear that it is possible to encode metadata records according to the GeoDCAT-AP that can describe ISO and INSPIRE metadata records with only a partial loss of information.

Because there is no complete coverage from GeoDCAT-AP to deliver all possible ISO or INSPIRE metadata elements in an exact 1 to 1 conversion in both directions, it is only possible to have a 100% mapping for a subset of ISO/INSPIRE metadata. Nevertheless, GeoDCAT-AP is a very mature initiative to bring metadata on the web and to integrate the metadata semantics used in the open data sector and the Geospatial sector.

5. Annex 1: ESA FedEO/OBEOS GeoDCAT-AP implementation

Guidelines:

- Maximum 4-5 pages for each best practice case
- Technical implementation details must be in annex
- Overwrite the blue text

5.1 Title

Best practice title	ESA FedEO/OBEOS GeoDCAT-AP implementation

5.2 Details

Place of implementation:	Italy (Frascati), Belgium (Brussels)
Organisation(s) involved:	European Space Agency (ESRIN, Italy), Spacebel s.a. (Belgium), Space Applications Services n.v. (Belgium).
Status:	Pre-productional extension to an Operational Data Portal
Contact person	Yves Coene, yves.coene@spacebel.be, Spacebel s.a. Andrea Della Vecchia, Andrea.Della.Vecchia@esa.int, European Space Agency
URL	http://fedeo.esa.int/opensearch/readme.html (Operational) http://geo.spacebel.be/opensearch/readme.html (Test) http://ceos.org/ourwork/workinggroups/wgiss/access/fedeo/

5.3 Focus area

Focus: Only one item can be selected. A best practice must focus on at least one focus area.

Metadata input (manually or automatically harvested)	Secondary

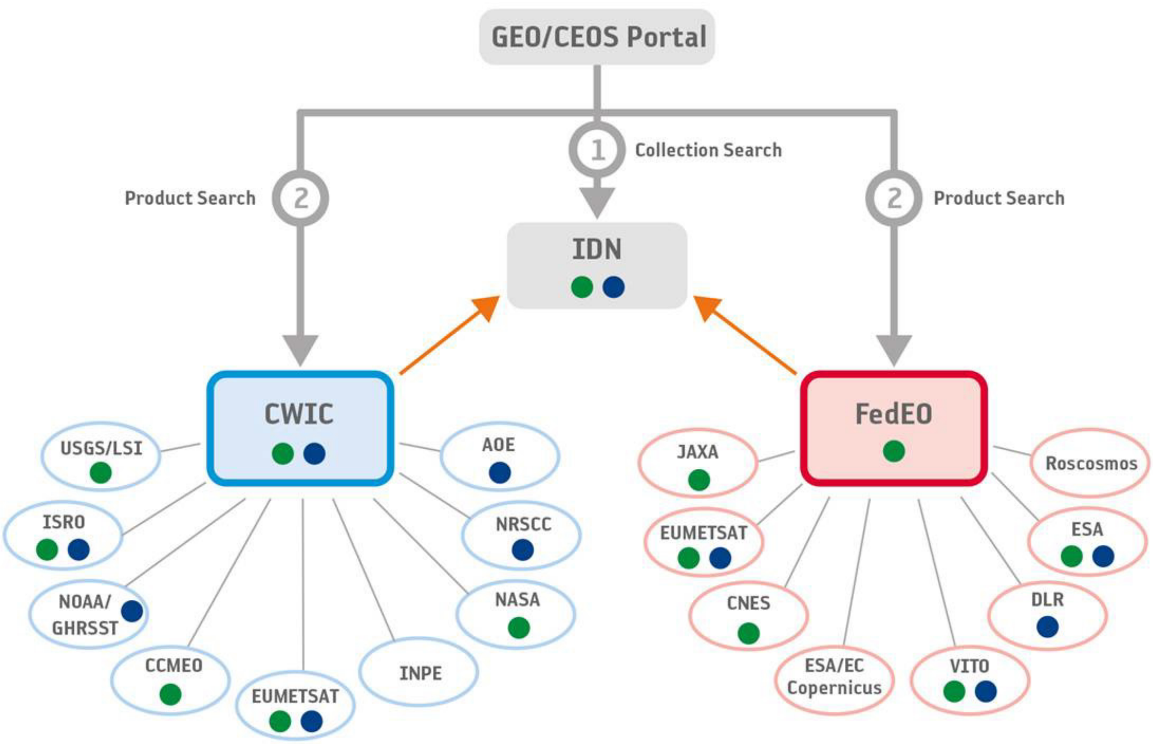
Metadata publication into an integrated geo/open data portal	Secondary
Publication of metadata as Linked Open Data (LOD)	Primary
Information mapping (ISO 19115, Inspire, DCAT,...)	Secondary

5.4 Intro

Intro: (Max 4 paragraphs)

General introduction about the initiative, project,... (Focus on only general goals and the pure business story). More specific GeoDCAT-AP related goals must be integrated into the "Goals" section below.

The ESA OBEOS (Ontology Based Earth Observation Search) project aimed to extend the operational ESA FedEO Gateway with Linked Data interfaces compliant with W3C LDP 1.0 and W3C DCAT and GeoDCAT-AP interfaces to facilitate discovery of Earth Observation Collection Metadata.



Through this additional RESTful FedEO API, all EO collection metadata accessible through FedEO (based on various formats including OGC 11-035r1 and ISO 19139-2), including metadata from NASA CMR, NASA CWIC, JAXA, DLR, EUMETSAT, VITO, CNES and many other EO data providers behind FedEO become immediately accessible as Linked Data. For product metadata discovery, a similar approach was implemented, but the CSIRO OM-Lite vocabulary (See OGC 15-100r1) was used to model Observation and Measurements product metadata based on OGC 10-157r4. The original W3C DCAT encoding evolved recently to a GeoDCAT-AP encoding through additional developments performed during an INSPIRE Hackaton (September 2017) in the context of the H2020 DataBio[84] project.

The OBEOS project also implemented an open-source CKAN extension able to interact with the above FedEO API.

5.5 Goal

Goal: Description of the best practice goal(s) (max 3 lines or a 5 point bullet list).

The objectives of the OBEOS demonstrator included:

- Publication of EO metadata for collections and products using the Linked Data paradigm.
- Provision of a fully standards-based implementation and use commonly accepted vocabularies
- Link to recognised authorities providing Linked Data URI for satellites, instruments, science keywords, coordinate reference systems etc.
- Investigation enrichment of EO collection metadata landing pages using schema.org annotations (JSON-LD)
- Provision of selected components of the demonstrator as open-source.
- Being easily integrated in the operational FedEO Clearinghouse at ESA.

5.6 Approach

Approach: (Max 2 pages)

- Description of the approach followed to achieve the pilot goals.
- Description of the implementation and reasoning why decisions were taken.
- The implementation details like detailed code lists or extensive data model descriptions can be integrated into the annexes.

A W3C LDP 1.0 and LDP 1.0 Paging compliant interface was defined allowing for two-step search (EO Collections followed by EO products). It has the same capabilities as the operational

[84] https://www.databio.eu/en/

FedEO interfaces which are SRU-based and return Atom responses. It allows specifying the expected media type as a request parameter or via content-negotiation. The interface was wrapped in OpenSearch Description Documents compliant with OGC 10-032r8 and OGC 13-026r8, and the “void” vocabulary was used to provide the information about the product search interface inside the EO collection metadata. It supported the media types RDF/XML, Turtle and JSON-LD.

The metadata for an EO collection is encoded as a dcat:Dataset and mappings of the other attributes can be found in OGC 16-074. Also RDF encodings for OpenSearch responses and EO Product metadata are proposed in this document and implemented in the demonstrator.

Information in the metadata about topic category, science keywords, satellite or instrument refers by URI to the corresponding definitions (in RDF) by GEMET, GCMD and other authorities.

No metadata harvesting is performed. The various RDF encodings are generated on-the-fly as-needed based on the legacy metadata provided by the distributed catalog endpoints in response to OpenSearch requests (which can be a single URI).

5.7 Results

Results: (Max 1 page)

Description of the achieved results. Description of the importance. Pros and cons (Because this is a best practice it is important that the *pros are more prominent than the cons*).

The Linked Data interface of the FedEO Gateway was fully implemented and deployed at ESA and Spacebel. It provides access to all metadata available through the operational FedEO Gateway, but uses Linked Data RDF metadata encodings instead.

The RDF encoding implemented as part of the demonstrator/project was documented in the OGC document OGC 16-074 “EO Metadata Discovery using Linked Data” available on the OGC Pending documents list. Some of the project software was published as open-source software[85].

The encodings presented in the above document served as input to actual implementation specifications (in JSON and JSON-LD) for EO Product Metadata (OGC 17-003), EO Collection Metadata (OGC 17-047) and EO OpenSearch Responses (OGC 17-084) which are currently being prepared by a dedicated EO Product Metadata and OpenSearch SWG at OGC, supported by the CEOS WGISS[86] community. As JSON-LD is also a possible encoding of RDF, care is being taken to define the JSON(-LD) encodings to allow for compatibility through normative JSON-LD contexts with widely accepted vocabularies. In particular GeoDCAT-AP is very relevant for EO Collection Metadata encoding.

[85] See https://github.com/SpaceApplications/ckanext-obeos-ldp

[86] http://ceos.org/ourwork/workinggroups/wgiss/

5.8 Conclusions

Conclusions: (Max 5 lines)

A brief description of the overall conclusion of the test. Conclusions about the ease of implementation, ease of use, repeatability.

The OBEOS Project showed the feasibility of LInked Data encoding (JSON-LD) of EO collection metadata using W3C DCAT and the evolution towards GeoDCAT-AP. GeoDCAT-AP allowed for the main EO Collection properties to be mapped. The analysis is currently continuing during work on OGC 17-084, analysing required mappings for NASA UMM-C metadata as well. However, the JSON/JSON-LD approaches for metadata encoding proposed in the recent OGC 17-003, OGC 17-047 and OGC 17-084 are based on GeoJSON and OWS Context (OGC 14-055r2). Further work and possibly changes are needed to GeoDCAT-AP 1.0.1 and/or OGC 14-055r2 to allow specifications to be based on both simultaneously and use a JSON-LD @context document for interpretation of JSON as JSON-LD (RDF). The following are just examples of current inconsistencies (a full analysis is to be performed still):

- OGC 14-055r2 encodes the time interval as a single "date" property including both start and stop. GeoDCAT-AP uses two separate subproperties (of dct:temporal): schema:startDate and schema:endDate.
- OGC 14-055r2 uses simplified encoding for "publisher" and "creator" (string) which are not compatible with the GeoDCAT-AP definitions of these properties.

We would recommend to update OGC 14-055r2 to have its property definitions/types inline with the equivalent GeoDCAT properties.

GeoDCAT-AP (via the locn:geometry property) uses an obsolete version of GeoJSON to encode GeoJSON literals and an obsolete media type for GeoJSON. It should be updated to use RFC 7946 instead. It might be considered to allow for GeoJSON(-LD) to be included (not only as literal) as well.

It would also be useful for GeoDCAT-AP to define a "profile"[87] identifier which can be used to identify the RDF vocabulary that clients can expect in responses from (OpenSearch) service endpoints. In OBEOS, we used the following media type and profile identifier to refer to JSON-LD compliant with GeoDCAT 1.0.1.
application/ld+json;profile=https://joinup.ec.europa.eu/node/154143/

[87] Uses "profile" to indicate RDF vocabulary as proposeded in "Negotiating Profiles in HTTP", draft-svensson-accept-profile-00, available at http://profilenegotiation.github.io/I-D-Accept--Schema/I-D-accept-schema.

5.9 Annex

Annex:

- Technical implementation details
- More in detail reasonings

Example 1: DCAT Catalog

Request:

http://geo.spacebel.be/EOP:ESA:FEDEO

Response:

```
<?xml version="1.0" encoding="UTF-8"?>

<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:dcat="http://www.w3.org/ns/dcat#" xmlns:dct="http://purl.org/dc/terms/"
xmlns:foaf="http://xmlns.com/foaf/0.1/" xmlns:rdfs="http://www.w3.org/2000/01/rdf-
schema#" xmlns:void="http://rdfs.org/ns/void#">

    <dcat:Catalog>

        <dct:publisher>

            <foaf:Agent>

                <foaf:homepage rdf:resource="http://www.esa.int/"/>

                <foaf:name>European Space Agency</foaf:name>

            </foaf:Agent>

        </dct:publisher>

        <dct:title>FEDEO Clearinghouse</dct:title>
```

```
        <dct:description>Provides interoperable access, following ISO/OGC interface
guidelines, to Earth Observation metadata.</dct:description>

        <dct:language>en-us</dct:language>

        <dcat:themeTaxonomy/>

        <dcat:dataset>

               <dcat:Dataset rdf:about="http://geo.spacebel.be/EOP:ESA:FEDEO">

                      <dct:title>FEDEO Clearinghouse Collections</dct:title>

                      <dct:description>Provides interoperable access, following
ISO/OGC interface guidelines, to Earth Observation metadata.</dct:description>

                      <dct:identifier>EOP:ESA:FEDEO</dct:identifier>

                      <dcat:distribution>

                             <dcat:Distribution>

                                    <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:ESA:FEDEO/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>
                                    <dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>
                                    <dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>

                             </dcat:Distribution>

                      </dcat:distribution>

                      <dct:hasPart>

                             <dcat:Dataset
rdf:about="http://geo.spacebel.be/EOP:VITO:PDF">

                                    <dct:title>VITO OS PDF</dct:title>

                                    <dct:description>VITO OS PDF</dct:description>

                                    <dct:identifier>EOP:VITO:PDF</dct:identifier>
```

```
                                    <dcat:distribution>

                                          <dcat:Distribution>

                                                <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:VITO:PDF/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>

<dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>

<dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>

                                                <dct:format>

                                                      <dct:IMT>

<rdf:value>http://www.isotc211.org/2005/gmd</rdf:value>

<rdfs:label>iso</rdfs:label>

                                                      </dct:IMT>

                                                </dct:format>

                                          </dcat:Distribution>

                                    </dcat:distribution>

                              </dcat:Dataset>

                        </dct:hasPart>

                        <dct:hasPart>

                              <dcat:Dataset
rdf:about="http://geo.spacebel.be/EOP:ESA:GPOD-EO">

                                    <dct:title>ESA G-POD</dct:title>

                                    <dct:description>ESA G-POD</dct:description>
```

```
<dcat:landingPage>http://gpod.eo.esa.int</dcat:landingPage>
                                  <dct:identifier>EOP:ESA:GPOD-EO</dct:identifier>
                                  <dcat:distribution>
                                        <dcat:Distribution>
                                              <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:ESA:GPOD-EO/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>

<dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>

<dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>
                                              <dct:format>
                                                    <dct:IMT>

<rdf:value>http://www.isotc211.org/2005/gmd</rdf:value>

<rdfs:label>iso</rdfs:label>
                                                    </dct:IMT>
                                              </dct:format>
                                        </dcat:Distribution>
                                  </dcat:distribution>
                            </dcat:Dataset>
                      </dct:hasPart>
                      <dct:hasPart>
                            <dcat:Dataset
rdf:about="http://geo.spacebel.be/EOP:ESA:EO-VIRTUAL-ARCHIVE4">
```

```
                                  <dct:title>Virtual Archive 4
Supersite</dct:title>

                                  <dct:description>Virtual Archive 4
Supersite</dct:description>

                                  <dcat:landingPage>http://eo-virtual-
archive4.esa.int</dcat:landingPage>

                                  <dct:identifier>EOP:ESA:EO-VIRTUAL-
ARCHIVE4</dct:identifier>

                                  <dcat:distribution>

                                        <dcat:Distribution>

                                              <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:ESA:EO-VIRTUAL-ARCHIVE4/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>

<dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>

<dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>

                                              <dct:format>

                                                    <dct:IMT>

<rdf:value>http://www.isotc211.org/2005/gmd</rdf:value>

<rdfs:label>iso</rdfs:label>

                                                    </dct:IMT>

                                              </dct:format>

                                        </dcat:Distribution>

                                  </dcat:distribution>

                            </dcat:Dataset>
```

```
                     </dct:hasPart>

                     <dct:hasPart>

                            <dcat:Dataset
rdf:about="http://geo.spacebel.be/EOP:ESA:SMOS">

                                   <dct:title>ESA SMOS</dct:title>

                                   <dct:description>ESA SMOS</dct:description>

                                   <dct:identifier>EOP:ESA:SMOS</dct:identifier>

                                   <dcat:distribution>

                                          <dcat:Distribution>

                                                 <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:ESA:SMOS/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>

<dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>

<dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>

                                                 <dct:format>

                                                        <dct:IMT>

<rdf:value>http://www.isotc211.org/2005/gmd</rdf:value>

<rdfs:label>iso</rdfs:label>

                                                        </dct:IMT>

                                                 </dct:format>

                                          </dcat:Distribution>

                                   </dcat:distribution>
```

```
                    </dcat:Dataset>
            </dct:hasPart>
            <dct:hasPart>
                    <dcat:Dataset
rdf:about="http://geo.spacebel.be/EOP:NASA:CMR">
                            <dct:title>NASA CMR</dct:title>
                            <dct:description>NASA CMR</dct:description>
                            <dct:identifier>EOP:NASA:CMR</dct:identifier>
                            <dcat:distribution>
                                    <dcat:Distribution>
                                            <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:NASA:CMR/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>

<dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>

<dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>
                                            <dct:format>
                                                    <dct:IMT>

<rdf:value>http://www.isotc211.org/2005/gmd</rdf:value>

<rdfs:label>iso</rdfs:label>
                                                    </dct:IMT>
                                            </dct:format>
                                    </dcat:Distribution>
```

```
                                        </dcat:distribution>
                                </dcat:Dataset>
                        </dct:hasPart>
                        <dct:hasPart>
                                <dcat:Dataset
rdf:about="http://geo.spacebel.be/EOP:JAXA:CATS-I">
                                        <dct:title>JAXA CATS-I</dct:title>
                                        <dct:description>JAXA CATS-I</dct:description>
                                        <dct:identifier>EOP:JAXA:CATS-I</dct:identifier>
                                        <dcat:distribution>
                                                <dcat:Distribution>
                                                        <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:JAXA:CATS-I/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>

<dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>

<dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>
                                                        <dct:format>
                                                                <dct:IMT>

<rdf:value>http://www.isotc211.org/2005/gmd</rdf:value>

<rdfs:label>iso</rdfs:label>
                                                                </dct:IMT>
                                                        </dct:format>
```

```
                    </dcat:Distribution>
                </dcat:distribution>
            </dcat:Dataset>
        </dct:hasPart>
        <dct:hasPart>
            <dcat:Dataset
rdf:about="http://geo.spacebel.be/EOP:DLR:GEOSERVICE">
                <dct:title>DLR Collection Catalogue</dct:title>
                <dct:description>DLR Collection
Catalogue</dct:description>

<dct:identifier>EOP:DLR:GEOSERVICE</dct:identifier>
                <dcat:distribution>
                    <dcat:Distribution>
                        <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:DLR:GEOSERVICE/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>

<dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>

<dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>
                        <dct:format>
                            <dct:IMT>

<rdf:value>http://www.isotc211.org/2005/gmd</rdf:value>

<rdfs:label>iso</rdfs:label>
```

```
                                                </dct:IMT>
                                        </dct:format>
                                </dcat:Distribution>
                        </dcat:distribution>
                </dcat:Dataset>
        </dct:hasPart>
        <dct:hasPart>
                <dcat:Dataset
rdf:about="http://geo.spacebel.be/EOP:ESA:FEDEO:COLLECTIONS">
                        <dct:title>FEDEO Collection Catalogue</dct:title>
                        <dct:description>FEDEO Collection
Catalogue</dct:description>

<dct:identifier>EOP:ESA:FEDEO:COLLECTIONS</dct:identifier>
                        <dcat:distribution>
                                <dcat:Distribution>
                                        <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:ESA:FEDEO:COLLECTIONS/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>

<dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>

<dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>
                                        <dct:format>
                                                <dct:IMT>

<rdf:value>http://www.isotc211.org/2005/gmd</rdf:value>
```

```
<rdfs:label>iso</rdfs:label>
                                                    </dct:IMT>
                                             </dct:format>
                                      </dcat:Distribution>
                               </dcat:distribution>
                        </dcat:Dataset>
                 </dct:hasPart>
                 <dct:hasPart>
                        <dcat:Dataset
rdf:about="http://geo.spacebel.be/EOP:EUMETSAT">
                               <dct:title>EUMETSAT OS Catalog</dct:title>
                               <dct:description>EUMETSAT OS
Catalog</dct:description>
                               <dct:identifier>EOP:EUMETSAT</dct:identifier>
                               <dcat:distribution>
                                      <dcat:Distribution>
                                             <dcat:accessURL
rdf:resource="http://geo.spacebel.be/EOP:EUMETSAT/description"/>

<dcat:mediaType>application/atom+xml</dcat:mediaType>

<dcat:mediaType>application/sru+xml</dcat:mediaType>

<dcat:mediaType>text/html</dcat:mediaType>

<dcat:mediaType>application/rdf+xml</dcat:mediaType>

<dcat:mediaType>application/ld+json</dcat:mediaType>

<dcat:mediaType>text/turtle</dcat:mediaType>

<dcat:mediaType>application/geo+json</dcat:mediaType>

<dcat:mediaType>application/rdf+xml;profile=https://joinup.ec.europa.eu/node/154143
/</dcat:mediaType>
                                             <dct:format>
                                                    <dct:IMT>
```

```
<rdf:value>http://www.isotc211.org/2005/gmd</rdf:value>

<rdfs:label>iso</rdfs:label>
                                                  </dct:IMT>
                                            </dct:format>
                                      </dcat:Distribution>
                                </dcat:distribution>
                          </dcat:Dataset>
                    </dct:hasPart>
              </dcat:Dataset>
        </dcat:dataset>
    </dcat:Catalog>
</rdf:RDF>
```


Example 2A: EO Collection Search (RESTful)

Request:

http://obeos.spacebel.be/series/LANDSAT.ETM.GTC?httpAccept=application/ld%2Bjson;profile=https://joinup.ec.europa.eu/node/154143/

Response:


```
{
    "@context": {
        "dcat": "http://www.w3.org/ns/dcat#",
        "dct": "http://purl.org/dc/terms/",
        "os": "http://a9.com/-/spec/opensearch/1.1/",
        "void": "http://rdfs.org/ns/void#",
        "atom": "http://www.w3.org/2005/Atom/",
        "rdfs": "http://www.w3.org/2000/01/rdf-schema#",
        "eo": "http://a9.com/-/opensearch/extensions/eo/1.0/",
        "geo": "http://a9.com/-/opensearch/extensions/geo/1.0/",
        "time": "http://a9.com/-/opensearch/extensions/time/1.0/",
        "sru": "http://a9.com/-/opensearch/extensions/sru/2.0/",
        "semantic": "http://a9.com/-/opensearch/extensions/semantic/1.0/",
```

```
        "prov": "http://www.w3.org/ns/prov#",

        "foaf": "http://xmlns.com/foaf/0.1/",

        "locn": "http://www.w3.org/ns/locn#",

        "gsp": "http://www.opengis.net/ont/geosparql#",

        "iana": "http://www.iana.org/assignments/relation/",

        "schema": "http://schema.org/",

        "wsse": "http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-
wssecurity-secext-1.0.xsd/"

    },

    "@id":
"http://obeos.spacebel.be/series/LANDSAT.ETM.GTC?httpAccept=application/ld%2Bjson;p
rofile=https://joinup.ec.europa.eu/node/154143/",

    "dct:creator": "FEDEO Clearinghouse",

    "dct:date": "2017-11-07T08:34:40Z",

    "os:itemsPerPage": "10",

    "os:startIndex": "1",

    "os:totalResults": "1",

    "os:Query": {

        "os:role": "request",

        "os:count": "10",

        "os:startIndex": "1",

        "dc:type": "collection",

        "eo:parentIdentifier": "EOP:ESA:FEDEO",

        "geo:uid": "LANDSAT.ETM.GTC",

        "sru:recordSchema": "server-choice"

    },

    "iana:first": {

        "@type": "iana:link",

        "@id":
"http://obeos.spacebel.be/series/LANDSAT.ETM.GTC?httpAccept=application/ld%2Bjson;p
rofile=https://joinup.ec.europa.eu/node/154143/&startRecord=1"

    },

    "iana:last": {

        "@type": "iana:link",
```

```
        "@id":
"http://obeos.spacebel.be/series/LANDSAT.ETM.GTC?httpAccept=application/ld%2Bjson;p
rofile=https://joinup.ec.europa.eu/node/154143/&startRecord=1"

    },

    "void:openSearchDescription": {

        "@id": "http://obeos.spacebel.be/description"

    },

    "rdfs:member": [

        {

              "@id":
"http://obeos.spacebel.be/series/LANDSAT.ETM.GTC?httpAccept=application/ld%2Bjson",

              "@type": "dcat:Dataset",

              "dct:identifier": "LANDSAT.ETM.GTC",

              "dct:title": "LANDSAT 7 ETM+ (Enhanced Thematic Mapper Plus)
Geolocated Terrain Corrected Systematic processing (LANDSAT.ETM.GTC)",

              "dct:description": "This dataset contains all the Landsat 7 Enhanced
Thematic Mapper high-quality ortho-rectified L1T dataset over Kiruna, Maspalomas
and Matera visibility masks. The Landsat 7 ETM+ scenes typically covers 185 x 170
km. A standard full scene is nominally centred on the intersection between a Path
and Row (the actual image centre can vary by up to 100m). Each band requires 50MB
(uncompressed), and Band 8 requires 200MB (panchromatic band with resolution of 15m
opposed to 30m).",

              "dct:modified": "1999-07-01",

              "dct:language": {

                     "@id":
"http://publications.europa.eu/resource/authority/language/ENG"

              },

              "dcat:theme": [

                     {

                            "@id": "http://www.eionet.europa.eu/gemet/concept/3650"

                     },

                     {

                            "@id": "http://www.eionet.europa.eu/gemet/concept/4612"

                     },

                     {

                            "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/03f0c0a3-04a7-4ef8-8ec0-
3c2266510815"
```

},

{

"@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/68c2baba-b9b9-41d4-89bf-07488728bc4f"

},

{

"@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/f342683b-94ee-4ef6-8915-b18a473fafbd"

},

{

"@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/3e822484-c94a-457b-a32f-376fcbd6fd35"

},

{

"@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/b5cb1fab-7281-478f-bb3b-ff04f900b3fc"

},

{

"@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/3526afb8-0dc9-43c7-8ad4-f34f250a1e91"

},

{

"@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/a246a8cf-e3f9-4045-af9f-dc97f6fe019a"

},

{

"@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/cd7a7748-7231-4a73-b85c-b5696066230a"

},

{

"@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/d138302a-03b3-4cf7-95db-ac98f863c04f"

```
                    },

                    {

                          "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/5e3c573f-a787-4afa-80a4-
047c2c5d83f2"

                    },

                    {

                          "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/0fcce7dc-496f-4078-96f0-
2035a73563fb"

                    },

                    {

                          "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/68eed887-8008-4352-b420-
949457ab59ab"

                    },

                    {

                          "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/dee57819-62c7-4f89-87e5-
90a87a07820a"

                    },

                    {

                          "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/9a4715a7-1847-4fef-8116-
494b36420fb7"

                    },

                    {

                          "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/c7b5c02c-724d-4a19-b824-
98180f3900c95"

                    },

                    {

                          "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/8d1157c4-d36b-40db-aa82-
3603716f9988"

                    }

              ],

              "dcat:keyword": [

                    "FedEO",
```

```
                "ESA LDS"
        ],
        "dct:subject": [
                {
                        "@id": "http://inspire.ec.europa.eu/metadata-
codelist/TopicCategory/geoscientificInformation"
                }
        ],
        "dct:temporal": {
                "@type": "dct:PeriodOfTime",
                "schema:startDate": {
                        "@type": "xsd:date",
                        "@value": "1999-07-01"
                },
                "schema:endDate": {
                        "@type": "xsd:date",
                        "@value": "2003-12-31"
                }
        },
        "dct:spatial": {
                "locn:geometry": [
                        {
                                "@type": "gsp:gmlLiteral",
                                "@value": "<gml:Envelope
srsName=\"http://www.opengis.net/def/crs/OGC/1.3/CRS84\"><gml:lowerCorner>-180 -
90</gml:lowerCorner><gml:upperCorner>180 90</gml:upperCorner></gml:Envelope>"
                        },
                        {
                                "@type": "gsp:wktLiteral",
                                "@value": "POLYGON ((-180 -90, -180 90, 180 90,
180 -90, -180 -90))"
                        },
                        {
```

```
                                    "@type": "https://www.iana.org/assignments/media-
types/application/vnd.geo+json",

                                    "@value":
"{\"type\":\"Polygon\",\"crs\":{\"type\":\"name\",\"properties\":{\"name\":\"urn:og
c:def:crs:OGC:1.3:CRS84\"}},\"coordinates\":[[[-180,-90],[-180,90],[180,90],[180,-
90],[-180,-90]]]}"

                              }

                       ]

               },

               "dct:provenance": [

                       {

                              "@type": "dct:ProvenanceStatement",

                              "rdfs:label": {

                                    "@language": "eng",

                                    "@value": "This dataset contains all the Landsat
7 Enhanced Thematic Mapper high-quality ortho-rectified L1T dataset over Kiruna,
Maspalomas and Matera visibility masks. The Landsat 7 ETM+ scenes typically covers
185 x 170 km. A standard full scene is nominally centred on the intersection
between a Path and Row (the actual image centre can vary by up to 100m). Each band
requires 50MB (uncompressed), and Band 8 requires 200MB (panchromatic band with
resolution of 15m opposed to 30m)."

                              }

                       }

               ],

               "prov:wasUsedBy": {

                       "@type": "prov:Activity",

                       "prov:qualifiedAssociation": {

                              "prov:hadPlan": {

                                    "prov:wasDerivedFrom": {

                                           "dct:title": {

                                                  "@language": "eng",

                                                  "@value": "COMMISSION REGULATION
(EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the
European Parliament and of the Council as regards interoperability of spatial data
sets and services"

                                           },

                                           "dct:issued": {

                                                  "@type": "xsd:date",
```

```
                                        "@value": "2010-12-08"
                                }
                        }
                }
        },
        "prov:generated": {
                "dct:type": {
                        "@id": "http://inspire.ec.europa.eu/metadata-
codelist/DegreeOfConformity/notConformant"
                },
                "dct:description": {
                        "@language": "eng",
                        "@value": "not tested"
                }
        }
},
"foaf:page": [
        {
                "@id": "https://earth.esa.int/web/guest/data-
access/browse-data-products/-/asset_publisher/y8Qb/content/landsat-7-etm-enhanced-
thematic-mapper-plus-geolocated-terrain-corrected-systematic-processing-over-
kiruna-and-masplomas",
                "@type": "foaf:Document"
        },
        {
                "@id":
"http://geo.spacebel.be/opensearch/description.xml?parentIdentifier=LANDSAT.ETM.GTC
&sensorType=OPTICAL",
                "@type": "foaf:Document",
                "dct:description": {
                        "@language": "eng",
                        "@value": "FedEO Clearinghouse"
                },
                "dct:title": {
```

```
                    "@language": "eng",
                    "@value": "FedEO Clearinghouse"
                }
            }
        ],
        "prov:qualifiedAttribution": {
            "@type": "prov:Attribution",
            "prov:agent": {
                "@type": "foaf:Organization",
                "foaf:mbox": {
                    "@id": "mailto:eohelp@eo.esa.int"
                },
                "foaf:name": {
                    "@language": "eng",
                    "@value": "ESA/ESRIN"
                },
                "foaf:phone": {
                    "@id": "tel:+39 06 94180777"
                },
                "foaf:workplaceHomepage": {
                    "@id": "http://www.earth.esa.int"
                },
                "locn:address": {
                    "@type": "locn:Address",
                    "locn:adminUnitL1": "Italy",
                    "locn:postCode": "00044",
                    "locn:postName": "Frascati",
                    "locn:thoroughfare": "Via Galileo Galilei CP. 64"
                }
            },
            "dct:type": {
```

```
                              "@id": "http://inspire.ec.europa.eu/metadata-codelist/ResponsiblePartyRole/originator"
                        }
                }
        }
    ]
}
```


Example 2B: EO Collection Search (SRU-Style)

Request:

http://obeos.spacebel.be/opensearch/request?uid=LANDSAT.ETM.GTC&httpAccept=application/ld%2Bjson;profile=https://joinup.ec.europa.eu/node/154143/

Response:


```
{
    "@context": {
        "dcat": "http://www.w3.org/ns/dcat#",
        "dct": "http://purl.org/dc/terms/",
        "os": "http://a9.com/-/spec/opensearch/1.1/",
        "void": "http://rdfs.org/ns/void#",
        "atom": "http://www.w3.org/2005/Atom/",
        "rdfs": "http://www.w3.org/2000/01/rdf-schema#",
        "eo": "http://a9.com/-/opensearch/extensions/eo/1.0/",
        "geo": "http://a9.com/-/opensearch/extensions/geo/1.0/",
        "time": "http://a9.com/-/opensearch/extensions/time/1.0/",
        "sru": "http://a9.com/-/opensearch/extensions/sru/2.0/",
        "semantic": "http://a9.com/-/opensearch/extensions/semantic/1.0/",
        "prov": "http://www.w3.org/ns/prov#",
        "foaf": "http://xmlns.com/foaf/0.1/",
        "locn": "http://www.w3.org/ns/locn#",
        "gsp": "http://www.opengis.net/ont/geosparql#",
        "iana": "http://www.iana.org/assignments/relation/",
        "schema": "http://schema.org/",
```

```
        "wsse": "http://docs.oasis-open.org/wss/2004/01/oasis-200401-wss-
wssecurity-secext-1.0.xsd/"

    },

    "@id":
"http://obeos.spacebel.be/opensearch/request?uid=LANDSAT.ETM.GTC&httpAccept=applica
tion/ld%2Bjson;profile=https://joinup.ec.europa.eu/node/154143/",

    "dct:creator": "FEDEO Clearinghouse",

    "dct:date": "2017-11-03T13:17:05Z",

    "os:itemsPerPage": "10",

    "os:startIndex": "1",

    "os:totalResults": "1",

    "os:Query": {

        "os:role": "request",

        "os:count": "10",

        "os:startIndex": "1",

        "dc:type": "collection",

        "eo:parentIdentifier": "EOP:ESA:FEDEO",

        "geo:uid": "LANDSAT.ETM.GTC",

        "sru:recordSchema": "server-choice"

    },

    "iana:first": {

        "@type": "iana:link",

        "@id":
"http://obeos.spacebel.be/opensearch/request?uid=LANDSAT.ETM.GTC&httpAccept=applica
tion/ld%2Bjson;profile=https://joinup.ec.europa.eu/node/154143/&startRecord=1"

    },

    "iana:last": {

        "@type": "iana:link",

        "@id":
"http://obeos.spacebel.be/opensearch/request?uid=LANDSAT.ETM.GTC&httpAccept=applica
tion/ld%2Bjson;profile=https://joinup.ec.europa.eu/node/154143/&startRecord=1"

    },

    "void:openSearchDescription": {

        "@id": "http://obeos.spacebel.be/opensearch/description.xml"

    },
```

```
    "rdfs:member": [
        {
              "@id":
"http://obeos.spacebel.be/opensearch/request/?httpAccept=application/ld%2Bjson&parentIdentifier=EOP%3AESA%3AFEDEO%3ACOLLECTIONS&uid=LANDSAT.ETM.GTC",
              "@type": "dcat:Dataset",
              "dct:identifier": "LANDSAT.ETM.GTC",
              "dct:title": "LANDSAT 7 ETM+ (Enhanced Thematic Mapper Plus)
Geolocated Terrain Corrected Systematic processing (LANDSAT.ETM.GTC)",
              "dct:description": "This dataset contains all the Landsat 7 Enhanced
Thematic Mapper high-quality ortho-rectified L1T dataset over Kiruna, Maspalomas
and Matera visibility masks. The Landsat 7 ETM+ scenes typically covers 185 x 170
km. A standard full scene is nominally centred on the intersection between a Path
and Row (the actual image centre can vary by up to 100m). Each band requires 50MB
(uncompressed), and Band 8 requires 200MB (panchromatic band with resolution of 15m
opposed to 30m).",
              "dct:modified": "1999-07-01",
              "dct:language": {
                    "@id":
"http://publications.europa.eu/resource/authority/language/ENG"
              },
              "dcat:theme": [
                    {
                          "@id": "http://www.eionet.europa.eu/gemet/concept/3650"
                    },
                    {
                          "@id": "http://www.eionet.europa.eu/gemet/concept/4612"
                    },
                    {
                          "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/03f0c0a3-04a7-4ef8-8ec0-
3c2266510815"
                    },
                    {
                          "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/68c2baba-b9b9-41d4-89bf-
07488728bc4f"
                    },
                    {
```

```
                    "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/f342683b-94ee-4ef6-8915-
b18a473fafbd"

                },

                {

                    "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/3e822484-c94a-457b-a32f-
376fcbd6fd35"

                },

                {

                    "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/b5cb1fab-7281-478f-bb3b-
ff04f900b3fc"

                },

                {

                    "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/3526afb8-0dc9-43c7-8ad4-
f34f250a1e91"

                },

                {

                    "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/a246a8cf-e3f9-4045-af9f-
dc97f6fe019a"

                },

                {

                    "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/cd7a7748-7231-4a73-b85c-
b5696066230a"

                },

                {

                    "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/d138302a-03b3-4cf7-95db-
ac98f863c04f"

                },

                {

                    "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/5e3c573f-a787-4afa-80a4-
047c2c5d83f2"

                },

                {
```

```
                              "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/0fcce7dc-496f-4078-96f0-
2035a73563fb"

                       },

                       {

                              "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/68eed887-8008-4352-b420-
949457ab59ab"

                       },

                       {

                              "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/dee57819-62c7-4f89-87e5-
90a87a07820a"

                       },

                       {

                              "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/9a4715a7-1847-4fef-8116-
494b36420fb7"

                       },

                       {

                              "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/c7b5c02c-724d-4a19-b824-
98180f3900c95"

                       },

                       {

                              "@id":
"http://gcmdservices.gsfc.nasa.gov/kms/concept/8d1157c4-d36b-40db-aa82-
3603716f9988"

                       }

                ],

                "dcat:keyword": [

                       "FedEO",

                       "ESA LDS"

                ],

                "dct:subject": [

                       {

                              "@id": "http://inspire.ec.europa.eu/metadata-
codelist/TopicCategory/geoscientificInformation"
```

```
                }
            ],
            "dct:temporal": {
                "@type": "dct:PeriodOfTime",
                "schema:startDate": {
                    "@type": "xsd:date",
                    "@value": "1999-07-01"
                },
                "schema:endDate": {
                    "@type": "xsd:date",
                    "@value": "2003-12-31"
                }
            },
            "dct:spatial": {
                "locn:geometry": [
                    {
                        "@type": "gsp:gmlLiteral",
                        "@value": "<gml:Envelope
srsName=\"http://www.opengis.net/def/crs/OGC/1.3/CRS84\"><gml:lowerCorner>-180 -
90</gml:lowerCorner><gml:upperCorner>180 90</gml:upperCorner></gml:Envelope>"
                    },
                    {
                        "@type": "gsp:wktLiteral",
                        "@value": "POLYGON ((-180 -90, -180 90, 180 90,
180 -90, -180 -90))"
                    },
                    {
                        "@type": "https://www.iana.org/assignments/media-
types/application/vnd.geo+json",
                        "@value":
"{\"type\":\"Polygon\",\"crs\":{\"type\":\"name\",\"properties\":{\"name\":\"urn:og
c:def:crs:OGC:1.3:CRS84\"}},\"coordinates\":[[[-180,-90],[-180,90],[180,90],[180,-
90],[-180,-90]]]}"
                    }
                ]
```

```
            },

            "dct:provenance": [

                   {

                          "@type": "dct:ProvenanceStatement",

                          "rdfs:label": {

                                 "@language": "eng",

                                 "@value": "This dataset contains all the Landsat
7 Enhanced Thematic Mapper high-quality ortho-rectified L1T dataset over Kiruna,
Maspalomas and Matera visibility masks. The Landsat 7 ETM+ scenes typically covers
185 x 170 km. A standard full scene is nominally centred on the intersection
between a Path and Row (the actual image centre can vary by up to 100m). Each band
requires 50MB (uncompressed), and Band 8 requires 200MB (panchromatic band with
resolution of 15m opposed to 30m)."

                          }

                   }

            ],

            "prov:wasUsedBy": {

                   "@type": "prov:Activity",

                   "prov:qualifiedAssociation": {

                          "prov:hadPlan": {

                                 "prov:wasDerivedFrom": {

                                        "dct:title": {

                                               "@language": "eng",

                                               "@value": "COMMISSION REGULATION
(EU) No 1089/2010 of 23 November 2010 implementing Directive 2007/2/EC of the
European Parliament and of the Council as regards interoperability of spatial data
sets and services"

                                        },

                                        "dct:issued": {

                                               "@type": "xsd:date",

                                               "@value": "2010-12-08"

                                        }

                                 }

                          }

                   },

                   "prov:generated": {
```

```
                              "dct:type": {
                                     "@id": "http://inspire.ec.europa.eu/metadata-codelist/DegreeOfConformity/notConformant"
                              },
                              "dct:description": {
                                     "@language": "eng",
                                     "@value": "not tested"
                              }
                       }
              },
              "foaf:page": [
                       {
                              "@id": "https://earth.esa.int/web/guest/data-access/browse-data-products/-/asset_publisher/y8Qb/content/landsat-7-etm-enhanced-thematic-mapper-plus-geolocated-terrain-corrected-systematic-processing-over-kiruna-and-masplomas",
                              "@type": "foaf:Document"
                       },
                       {
                              "@id": "http://geo.spacebel.be/opensearch/description.xml?parentIdentifier=LANDSAT.ETM.GTC&sensorType=OPTICAL",
                              "@type": "foaf:Document",
                              "dct:description": {
                                     "@language": "eng",
                                     "@value": "FedEO Clearinghouse"
                              },
                              "dct:title": {
                                     "@language": "eng",
                                     "@value": "FedEO Clearinghouse"
                              }
                       }
              ],
              "prov:qualifiedAttribution": {
```

```
                        "@type": "prov:Attribution",
                        "prov:agent": {
                               "@type": "foaf:Organization",
                               "foaf:mbox": {
                                      "@id": "mailto:eohelp@eo.esa.int"
                               },
                               "foaf:name": {
                                      "@language": "eng",
                                      "@value": "ESA/ESRIN"
                               },
                               "foaf:phone": {
                                      "@id": "tel:+39 06 94180777"
                               },
                               "foaf:workplaceHomepage": {
                                      "@id": "http://www.earth.esa.int"
                               },
                               "locn:address": {
                                      "@type": "locn:Address",
                                      "locn:adminUnitL1": "Italy",
                                      "locn:postCode": "00044",
                                      "locn:postName": "Frascati",
                                      "locn:thoroughfare": "Via Galileo Galilei CP. 64"
                               }
                        },
                        "dct:type": {
                               "@id": "http://inspire.ec.europa.eu/metadata-
codelist/ResponsiblePartyRole/originator"
                        }
                 }
          }
     ]
}
```

Example 3: EO Product Search

Requests:

•Sentinel 1:
http://geo.spacebel.be/opensearch/request/?httpAccept=application/rdf%2Bxml;profile=https://joinup.ec.europa.eu/node/154143/&parentIdentifier=EOP:IPT:Sentinel1

•Deimos:

http://geo.spacebel.be/opensearch/request?parentIdentifier=TropForest&platform=DEIMOS&instrument=SLIM6&httpAccept=application/rdf%2Bxml;profile=https://joinup.ec.europa.eu/node/154143/

•Cryosat-2:

http://geo.spacebel.be/opensearch/request?parentIdentifier=CR2_SIR&startDate=2014-01-01T00:00:00Z&endDate=2014-03-31T00:00:00Z&orbitDirection=DESCENDING&httpAccept=application/rdf%2Bxml;profile=https://joinup.ec.europa.eu/node/154143/

6. Annex 2: OGC Testbed-12 Metadata Crosswalk best practice

Guidelines:

- Maximum 4-5 pages for each best practice case
- Technical implementation details must be in annex
- Overwrite the blue text

6.1 Title

Best practice title	OGC Testbed-12 Metadata Crosswalk

6.2 Details

Place of implementation:	United Kingdom
Organisation(s) involved:	Envitia
Status:	Test
Contact person	Gobe Hobona; Roger Brackin

URL	http://docs.opengeospatial.org/per/16-062.html

6.3 Focus area

Focus: Only one item can be selected. A best practice must focus on at least one focus area.

Metadata input (manually or automatically harvested)	Secondary
Metadata publication into an integrated geo/open data portal	Secondary
Publication of metadata as Linked Open Data (LOD)	Secondary
Information mapping (ISO 19115, Inspire, DCAT,...)	Primary

6.4 Intro

Intro: (Max 4 paragraphs)

General introduction about the initiative, project,... (Focus on only general goals and the pure business story). More specific GeoDCAT-AP related goals must be integrated into the "Goals" section below.

OGC Testbed-12 developed a crosswalk to evaluate interoperability between different metadata specifications. The metadata specifications included the OGC I15 (ISO19115 Metadata) Extension Package of the CSW ebRIM Profile 1.0, NSG Metadata Foundation (NMF), DGIWG Metadata Foundation (DMF), DoD Discovery Metadata Specification (DDMS) and the W3C Data Catalog (DCAT) specification. Several initiatives have demonstrated interoperability between different metadata specifications through the development of crosswalks that provide mappings between the two specifications, for example Go-Geo. Whereas previous work has included ISO 19115, none of the crosswalks developed by previous initiatives have included the NMF, DMF, DDMS and DCAT. The crosswalk is described in the following engineering report http://docs.opengeospatial.org/per/16-062.html#_interoperability_in_multi_catalogue_environments

The NSG Metadata Foundation (NMF) defines the conceptual schema profile for specifying geospatial metadata in and for the US National System for Geospatial Intelligence (NSG). It is a profile of ISO 19115:2003/Cor 1:2006. The DGIWG Metadata Foundation (DMF) provides a general Defense metadata profile for the exchange of metadata between DGIWG member nations. It is a profile of ISO 19115:2003/Cor 1:2006. The DoD Discovery Metadata Specification (DDMS) specifies a set of metadata fields that are to be used for describing any information resource, that is to be made discoverable to the DoD Enterprise. It is a profile of the Dublin Core metadata specification. DCAT is a vocabulary based on the Resource Description Framework (RDF) and designed to facilitate interoperability between data catalogues published on the Web. It is a profile of the Dublin Core metadata specification.

6.5 Goal

Goal: Description of the best practice goal(s) (max 3 lines or a 5 point bullet list).

The OGC Testbed-12 metadata crosswalk was developed within a work package focusing on Catalogue and SPARQL services. The goal of the Testbed-12 work was to:

- Improve understanding of the potential for semantic enablement of OGC catalogue services
- Improve interoperability between OGC catalogue standards and open search standards currently adopted by several general search engines
- Increase awareness of registry capabilities such as change control management, which are supported by specific profiles of OGC catalogue standards

6.6 Approach

Approach: (Max 2 pages)

- Description of the approach followed to achieve the pilot goals.
- Description of the implementation and reasoning why decisions were taken.
- The implementation details like detailed code lists or extensive data model descriptions can be integrated into the annexes.

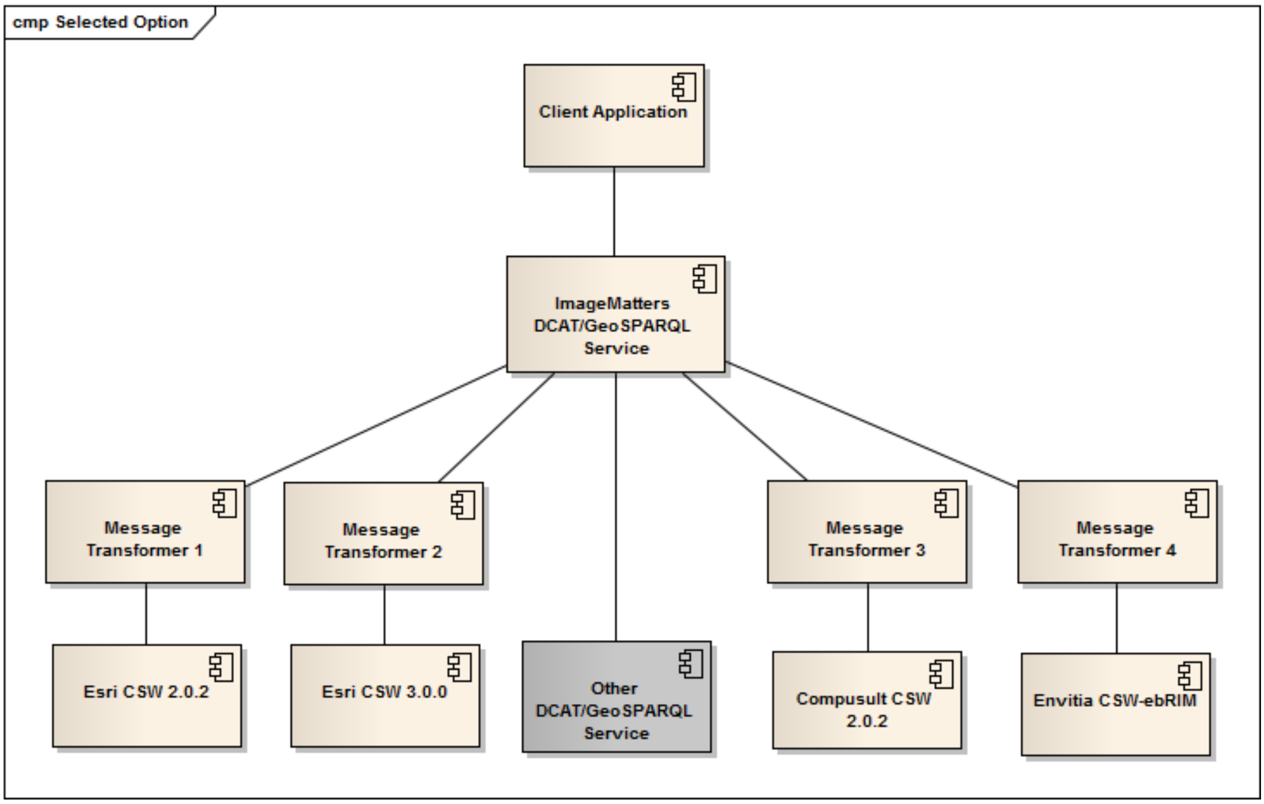
The overall requirement of the Catalogue and SPARQL aspect of the testbed was to advance use of the Catalogue Service for the Web (CSW) standard through evaluation of catalogue interoperability: This testbed would load the same dataset to a set of catalogues and test, using a multi-catalogue client, the interaction with each service to better understand interoperability aspects in multi-catalogue environments. The work would also evaluate the various DCAT contexts including RDF accessible via SPARQL endpoints, embedded in HTML pages as RDFa, or serialized as e.g. RDF/XML or Turtle and compare functionality, expressiveness and usability of CSW and DCAT.

To address this requirement, the testbed adopted the following approach. The testbed:

- Evaluated interoperability aspects in multi-catalogue type environments, including CSW featuring ISO based metadata and OpenSearch, a second CSW offering a SOAP binding, and a third DCAT implementation that described the same services and data sets using RDF. This was achieved through design and application of a functionality crosswalk.
- Evaluated how DCAT could describe the same service and data sets in RDF as the other

catalog services do using XML Schema Documents (XSD) compliant to ISO 1939 and ISO 19115. This was achieved through design and application of a metadata crosswalk.

- Implemented four different catalogues (CSW 3.0, CSW 2.0.2, CSW ebRIM, DCAT) and showed how they could interact. This demonstrated the role that DCAT could play in such a federation of catalogues, as well as supporting the assessment of the metadata crosswalks. An illustration of the implemented architecture is shown in the following figure.



6.7 Results

Results: (Max 1 page)

Description of the achieved results. Description of the importance. Pros and cons (Because this is a best practice it is important that the *pros are more prominent than the cons*).

The testbed found that dataset metadata from I15, NMF, DMF and DDMS could be mapped to the following DCAT Dataset metadata fields:

- dcat:Dataset property dcat:contactPoint
- dcat:Dataset property dct:temporal
- dcat:Dataset property dcat:accrualPeriodicity
- dcat:Dataset property dct:title
- dcat:Dataset property dct:description

- dcat:Dataset property dct:issued
- dcat:Dataset property dct:identifier
- dcat:Dataset property dcat:keyword
- dcat:Dataset property dcat:theme
- dcat:Dataset property dct:modified

The testbed also found that distribution metadata from from I15, NMF, DMF and DDMS could be mapped to the following DCAT Distribution metadata fields:

- dcat:Distribution property dct:format
- dcat:Distribution property dcat:downloadURL
- dcat:Distribution property dcat:byteSize
- dcat:Distribution property dct:rights
- dcat:Distribution property dcat:mediaType

The testbed also found that catalogues (feature catalogues and metadata catalogues) could be partially described through the dcat:Catalog class.

The testbed found that an extension to DCAT is required to allow for detailed descriptions of web services. This is because the focus of DCAT is on datasets and catalogues, rather than web services in general. OGC Testbed-12 therefore designed a Semantic Registry Information Model (SRIM) by extending DCAT. The SRIM is introduced in http://docs.opengeospatial.org/per/16-059.html

6.8 Conclusions

Conclusions: (Max 5 lines)

A brief description of the overall conclusion of the test. Conclusions about the ease of implementation, ease of use, repeatability.

The testbed found that DCAT on its own has a limited geospatial vocabulary. However, when integrated with GeoSPARQL to create GeoDCAT it provides a geospatial vocabulary capable of supporting catalogue federation. The testbed recommended that the OGC should standardize the GeoDCAT specification. The testbed also found that the metadata returned by the different catalogues ranged from ISO 19139 XML, NMIS, DDMS, ebRIM ExtrisicObjects etc. The testbed recommended that catalogue services should be enabled to offer a GeoSPARQL service endpoint that publishes metadata in GeoDCAT and can receive federated SPARQL queries from other GeoSPARQL services.

6.9 Annex

Annex:

- Technical implementation details
- More in detail reasonings

Please refer to Annex B of the OGC Testbed-12 Catalogue and SPARQL Engineering Report which is available at the following address.

http://docs.opengeospatial.org/per/16-062.html#_interoperability_in_multi_catalogue_environments

7. Annex 3: Open Transport NET - GeoDCAT-AP implementation best practice

Guidelines:

- Maximum 4-5 pages for each best practice case
- Technical implementation details must be in annex
- Overwrite the blue text

7.1 Title

Best practice title	**Open Transport Net - GeoDCAT-AP implementation**

7.2 Details

Place of implementation:	EU
Organisation(s) involved:	OTN Research consortium involved partners: CORVE (Information Flanders), HRSS, ATC, Intrasoft, Imec
Status:	Production
Contact person	Lieven Raes, Information Flanders (lieven.raes@bz.vlaanderen.be)
URL	http://www.opentnet.eu/

7.3 Focus area

Focus: Only one item can be selected. A best practice must focus on at least one focus area.

Metadata input (manually or automatically harvested)	Primary
Metadata publication into an integrated geo/open data portal	Primary
Publication of metadata as Linked Open Data (LOD)	Primary
Information mapping (ISO 19115, Inspire, DCAT,...)	Secondary

7.4 Intro

Intro: (Max 4 paragraphs) General introduction about the initiative, project, etc. (Focus on only general goals and the pure business story). More specific GeoDCAT-AP related goals must be integrated into the “Goals” section below.

Open geospatial data is the focus of OTN (Open Transport Networks) EU funded project. OTN aims to integrate (metadata) of Inspire compatible transport related geospatial datasets with open transport related datasets.

Both the open data world and the geospatial data world have long lived separately, but are now slowly drifting together. This is reflected in the conversion of standards describing open data and standards describing geographical data.

Recent activities are aiming to bridge the gap between the open data and geospatial worlds led to defining GeoDCAT-AP. GeoDCAT-AP is the first sector-specific extension of DCAT-AP and explains how to map the attributes defined in ISO 19115/19119 and INSPIRE to the DCAT-AP format. It was developed by a working group chartered in the framework of the EU Programme “Interoperability Solutions for European Public Administrations” (ISA).

GeoDCAT-AP has a core and an extended version; the former uses only the attributes provided by DCAT, while the extended version adds several geo-specific attributes. GeoDCAT-AP is not meant as a replacement for the ISO or INSPIRE standards, but is intended to enable users to distribute their metadata in a semantic way using DCAT and to facilitate the exchange of metadata between different portals. The OTN project aims to implement the profile and test its applicability, and so contribute to the standardisation process.

7.5 Goal

Goal: Description of the best practice goal(s) (max 3 lines or a 5 point bullet list).

The OTN Hub has several non-trivial requirements. The Hub is dealing with a mix of spatial and non-spatial data, and these data need to be discoverable through its metadata.

The metadata must be easily searchable using one single and easy to use interface.

Following the standards mentioned in the preceding section would ensure interoperability with other systems, which is vital. From a user point of view, we want an intuitive way of uploading and visualising data. Changes to the data by a user should be propagated through the system without delay.

Most of the requirements are related to metadata. Metadata harmonisation of spatial and non-spatial datasets and services is essential to enable a uniform way of querying metadata. GeoDCAT-AP was an obvious choice due to the combination of geospatial and open data practices.

7.6 Approach

Approach: (Max 2 pages)

- Description of the approach followed to achieve the pilot goals.
- Description of the implementation and reasoning why decisions were taken.
- The implementation details like detailed code lists or extensive data model descriptions can be integrated into the annexes.

To fulfill the OTN goals, it turned out that a combination of multiple software packages were needed to fulfill the requirements. OTN used a combination of software solutions specialized in SDI metadata management, DCAT data management & querying.

Though GeoDCAT-AP itself does not specify a querying mechanism, it can be queried if loaded in an SPARQL endpoint.

In OTN, a combination of multiple software packages to fulfil all requirements was chosen. In the following paragraphs, we will give an overview of all used packages.

MICKA is a system for metadata management used for building spatial data infrastructure (SDI) and geoportal solutions. It contains tools for editing and the management of spatial data and services metadata, and other sources (documents, websites, etc.). MICKA is used as metadata catalogue in the OTN project, and also for instance in the Czech national INSPIRE geoportal. GeoDCAT RDF/XML is generated from existing ISO 19139 / INSPIRE metadata in the catalogue according to the rules defined by the GeoDCAT-AP specification.

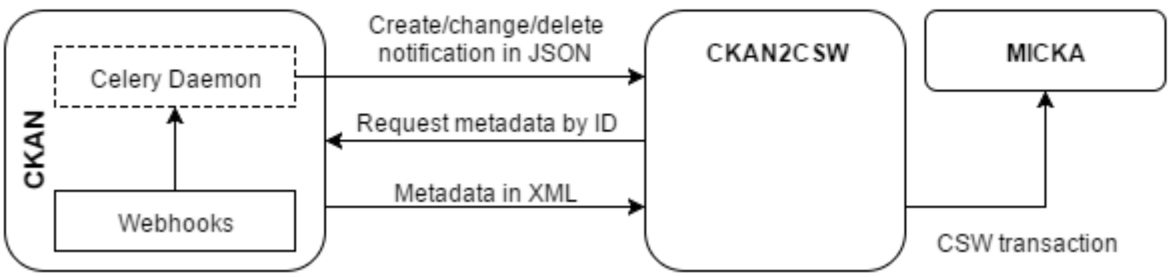
In addition to Micka, CKAN is also implemented. CKAN is an open source data management and publishing tool supporting DCAT. It is a deployable web portal that acts as a data catalogue, where users can search and view for datasets of their interest. Acting as a catalogue, CKAN keeps track of the location of the actual data and their metadata. Using an extension, CKAN supports DCAT to import or export its datasets. This support was further developed by contributions from the OTN project (as to being able to import the DataTank DCAT, see further in chapter 4). CKAN enables harvesting data from OGC CSW catalogues, but not all mandatory INSPIRE metadata elements are supported[88]. Unfortunately, the DCAT output does not fulfil all INSPIRE requirements, nor is GeoDCAT-AP fully supported.

7.7 Results

Results: (Max 1 page)

Description of the achieved results. Description of the importance. Pros and cons (Because this is a best practice it is important that the *pros are more prominent than the cons*).

The Open Transport NET - GeoDCAT-AP implementation best practice aimed at publication of DCAT to ISO, on the contrary to the previously described results. The combined solution used in OTN combines CKAN and Micka. CKAN is used as the entry point for new datasets (spatial or non-spatial), either as a file upload or as a harvest from another data portals. Webhooks a CKAN extension scans for changes and notifies an intermediate CKAN2CSW module, which was created for the scope of OTN. This module requests the full details of any changed datasets and translates these into CSW transactions that are pushed to Micka. In this way, Micka is kept synchronised with CKAN. Micka serves as metadata catalogue and is the single point of entry for the portal. GeoDCAT-AP can be generated on the fly for the various queries.



7.8 Conclusions

Conclusions: (Max 5 lines)

[88] https://github.com/ckan/ckanext-spatial

A brief description of the overall conclusion of the test. Conclusions about the ease of implementation, ease of use, repeatability.

Following existing standards is vital for interoperability. Both the open data and the geospatial world have stable standards, and GeoDCAT-AP is the first attempt in combining the two. Combining several software packages seems to be the best approach until GeoDCAT-AP gets better adoption.

Relevant datasets were linked to Datex II, and GTFS based semantic catalogues to publish the dataset as linked open data.

7.9 Annex

Annex:

- Technical implementation details
- More in detail reasonings

8. Annex 4: Databio project - metadata visualization in Google Earth (the GeoDCAT2KML converter)

Guidelines:

- Maximum 4-5 pages for each best practice case
- Technical implementation details must be in annex
- Overwrite the blue text

8.1 Title

Best practice title	GeoDCAT metadata visualization in Google Earth (the GeoDCAT2KML convertor)

8.2 Details

Place of implementation:	The Czech Republic (Brno, Kutná Hora), Belgium (Brussels)
Organisation(s) involved:	Lesprojekt Ltd. (The Czech Republic), Help Service Remote Sensing Ltd. (The Czech Republic), Masaryk University (The Czech Republic), Spacebel s.a. (Belgium)
Status:	Production
Contact person	Tomas Reznik, tomas.reznik@sci.muni.cz, Masaryk University
URL	https://dev.bnhelp.cz/projects/dcatconv/

8.3 Focus area

Focus: Only one item can be selected. A best practice must focus on at least one focus area.

Metadata input (manually or automatically harvested)	Secondary
Metadata publication into an integrated geo/open data portal	Primary
Publication of metadata as Linked Open Data (LOD)	Secondary

Information mapping (ISO 19115, Inspire, DCAT,...)	Secondary

8.4 Intro

Intro: (Max 4 paragraphs)

General introduction about the initiative, project,... (Focus on only general goals and the pure business story). More specific GeoDCAT-AP related goals must be integrated into the "Goals" section below.

Metadata are understood as something boring as well as a must originating from standardization and/or legislation. Such impression is several times emphasized by the fact that users, similarly to producers, need to work with a special application, i.e. a metadata catalogue and/or metadata editor. The GeoDCAT is not an exception. "Traditional" ways of metadata visualizations represent a burden for a user who would like to focus on his/her work, however needs to deal with metadata in a special application.

Our approach aims at really user friendly work with metadata in a commonly used application, the Google Earth (in the KML format). The motto of our slightly heretic Best practice is: *"The best metadata platform is the one not shown to a user"*. Such approach targets laymen while specialized metadata applications are still relevant for geospatial information professionals.

Metadata of Sentinel-1, Deimos and Cryosat-2 images were used for the Google Earth demo presented in this Best practice as one of the achievements of the European DataBio (Data-Driven Bioeconomy) research and development project (https://www.databio.eu/).

8.5 Goal

Goal: Description of the best practice goal(s) (max 3 lines or a 5 point bullet list).

- Define transformations from GeoDCAT into the KML.
- Develop mechanisms for user-friendly visualizations of (Sentinel-1, Deimos and Cryosat-2) dataset series in the Google Earth application.
- Make the convertor for GeoDCAT to KML publicly accessible for further re-use.
- In general, user friendly visualization of satellite images collections (dataset series).

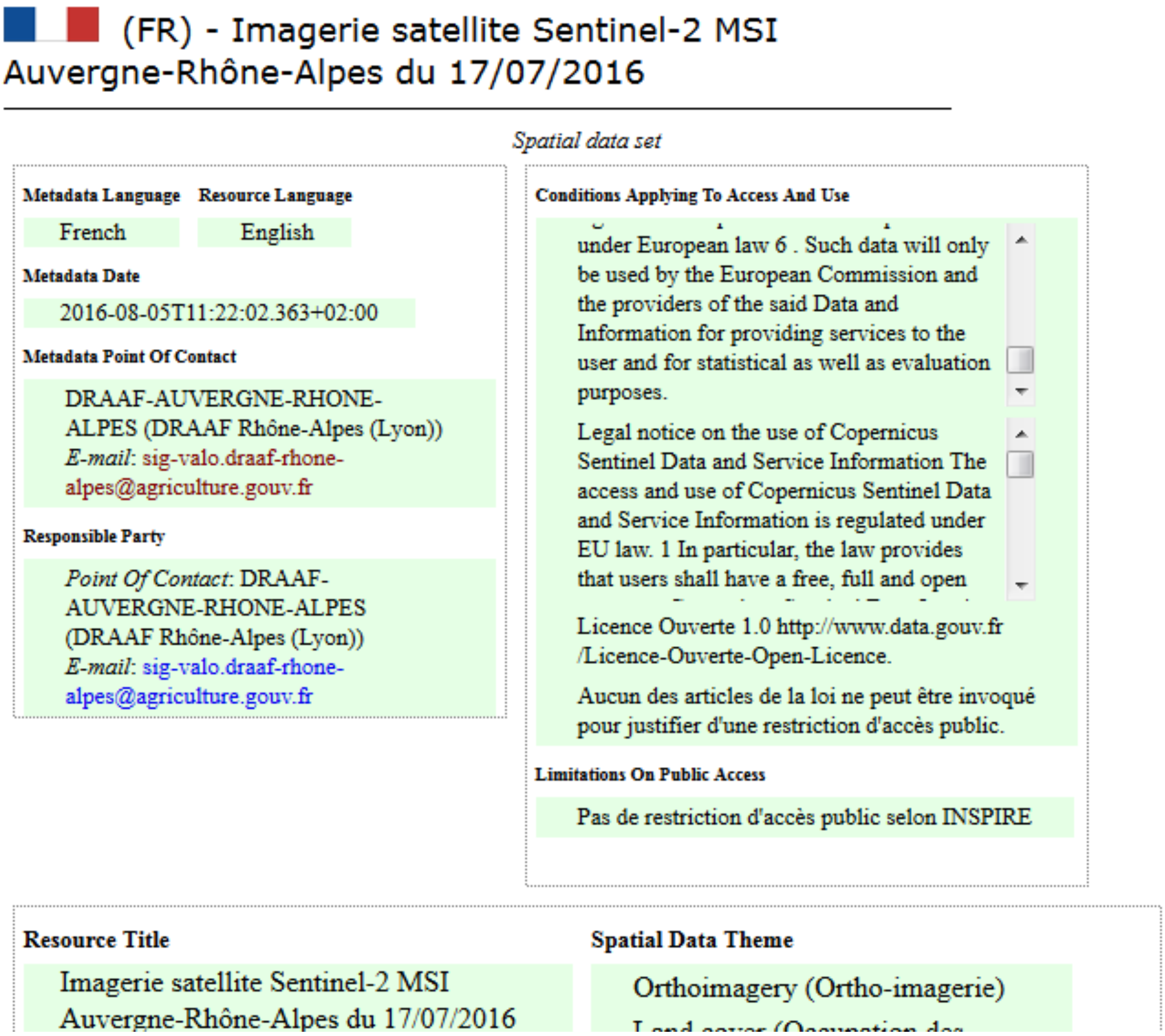
8.6 Approach

Approach: (Max 2 pages)

- Description of the approach followed to achieve the pilot goals.

- Description of the implementation and reasoning why decisions were taken.
- The implementation details like detailed code lists or extensive data model descriptions can be integrated into the annexes.

Metadata of Earth Observation resources are hard to be visualized in any metadata platform as they are heterogeneous as well as interconnected in several ways, such as series of satellite images vs. a mission. Consider viewing a dozen of metadata records, each representing a satellite image, in a form that is being used in geospatial domain as depicted in the following Figure.

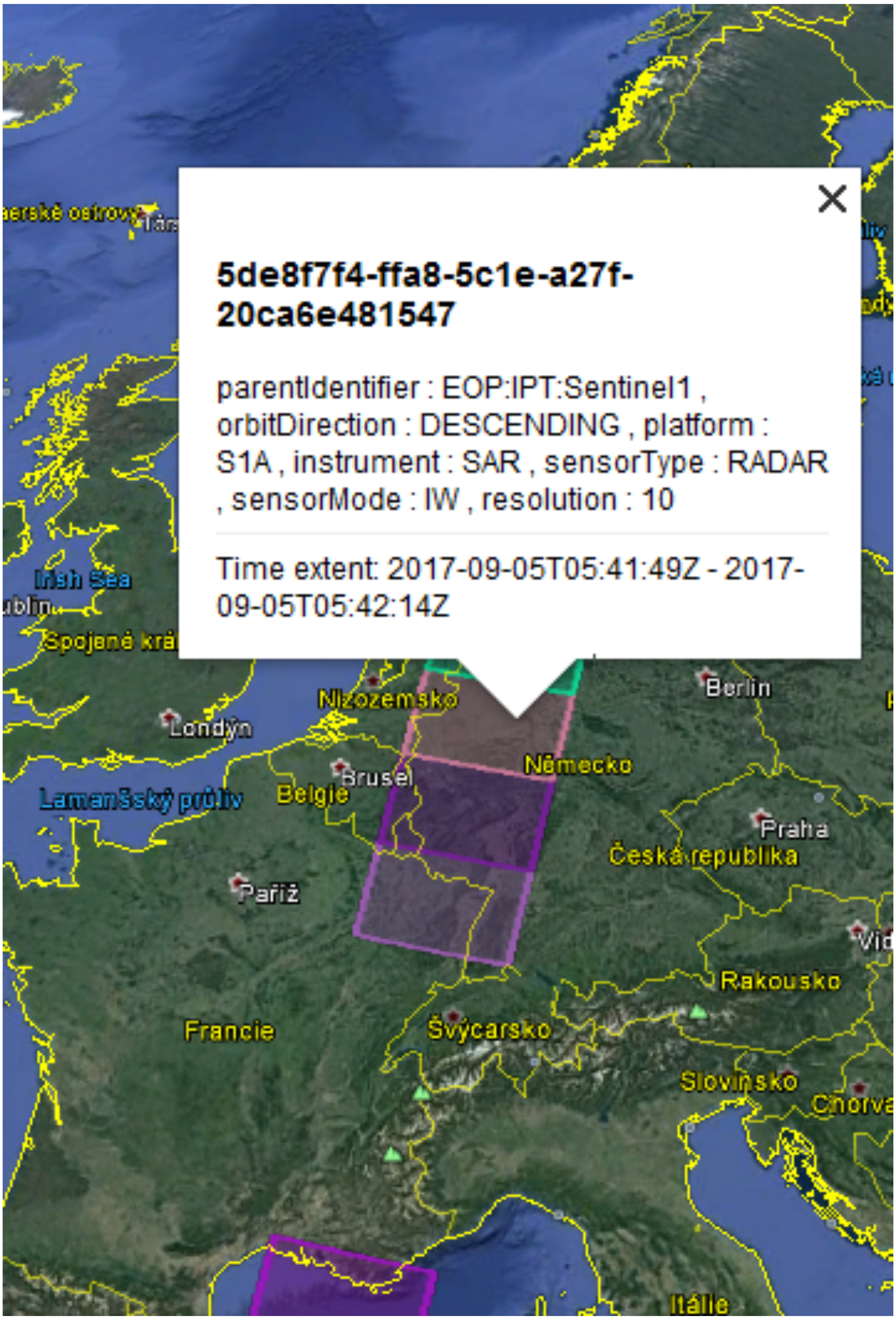


The SpaceBel company developed the FedEO Clearinghouse with several extensions as described in section 3.2. The GeoDCAT is one of the output formats besides the ISO 19139 compliant encoding known also for European metadata falling under the INSPIRE Directive.

The OpenSearch interface is available in the FedEO Clearinghouse under the URL http://geo.spacebel.be/opensearch/request/. An example query returning the GeoDCAT metadata for Sentinel-1 collection of satellite data may be found under this URL.

On the contrary, applications for GeoDCAT visualization are scarce. Even when a GeoDCAT visualization application is found, it is usually a non-user friendly one, intended for professionals to check whether a GeoDCAT file has an appropriate content and is valid.

Freely available convertor was developed for the transformations from the GeoDCAT into the KML format (https://dev.bnhelp.cz/projects/dcatconv/). The KML export may be then visualized in the Google Earth application for the whole collection as depicted in the following Figure.



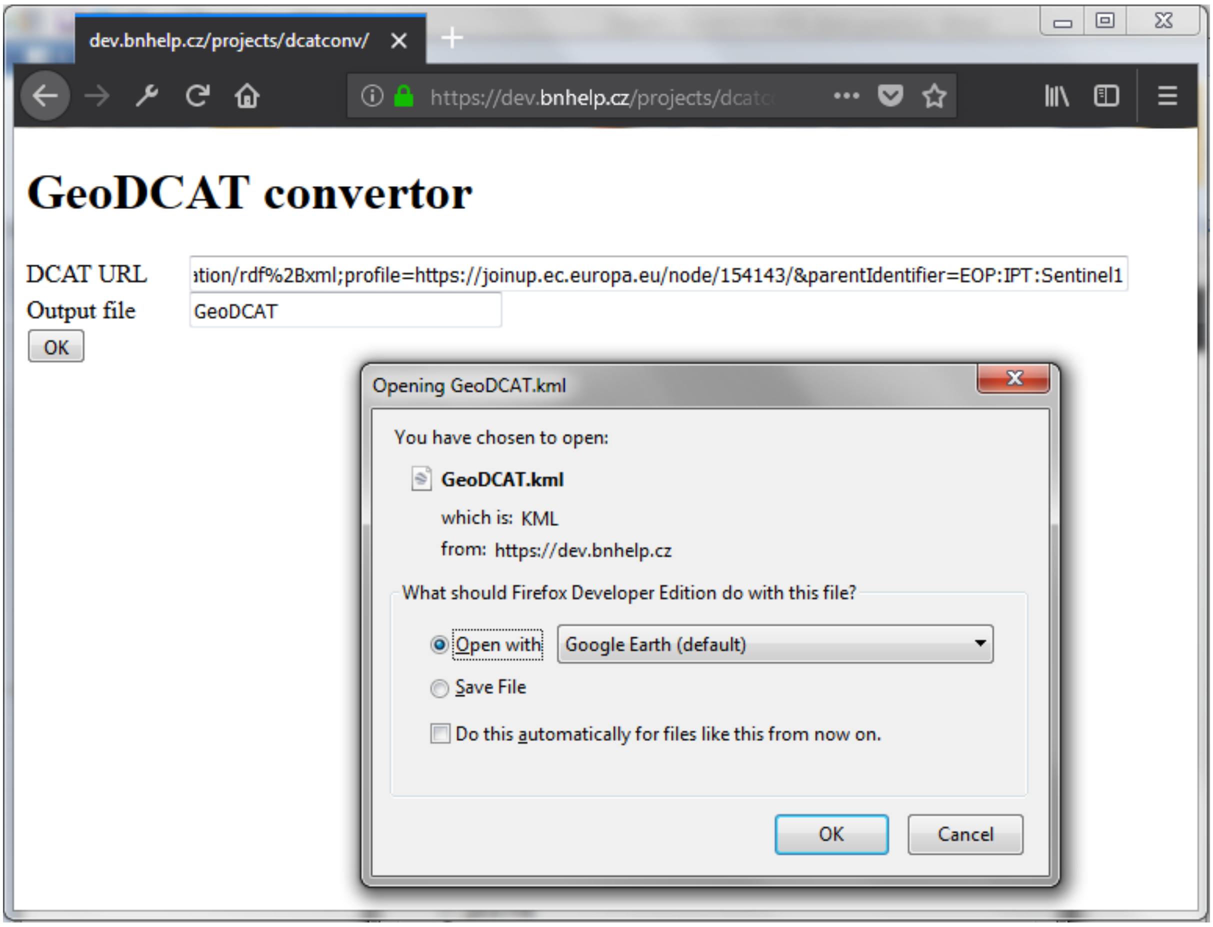
The geospatial extent of available satellite images is the primary information displayed to a user. When clicking in the satellite image extent, a bubble with further metadata appears. Note that the information shown in the bubble are customizable. For instance, a link displaying the full GeoDCAT metadata may be available.

8.7 Results

Results: (Max 1 page)

Description of the achieved results. Description of the importance. Pros and cons (Because this is a best practice it is important that the *pros are more prominent than the cons*).

The main achievement is the developed convertor from the GeoDCAT into the KML format that is publicly available (https://dev.bnhelp.cz/projects/dcatconv/).



The most important pros are:

- user-friendly visualization of GeoDCAT metadata in the Google Earth application;
- running for all kinds of metadata for satellite images including collections (dataset series);

- functional verification for Sentinel-1, Deimos and Cryosat-2 satellite images;
- easy to use tool as proven during the hackathon at INSPIRE 2017 conference in Strasbourg;
- freely available to all interested persons.

The most important cons are:

- the convertor is currently a "black-box";
- all customizations need to be managed by the originators.

8.8 Conclusions

Conclusions: (Max 5 lines)

A brief description of the overall conclusion of the test. Conclusions about the ease of implementation, ease of use, repeatability.

The DataBio project demonstrated the feasibility of user friendly GeoDCAT metadata visualization without a specialized metadata platform. It was verified that even metadata collections (metadata of dataset series) could be visualized in a way not overwhelming a user. The developed form of visualization is targeting metadata laymen to disseminate metadata of geospatial resources to the public.

The developed tool may be further customized in ways enabling:

(1) conversion to more formats than the KML;
(2) modifications of the information displayed to a user typically in a form of a bubble in the Google Earh API.

8.9 Annex

Sample input GeoDCAT file available under the URL:
http://geo.spacebel.be/opensearch/request/?httpAccept=application/rdf%2Bxml;profile=https://joinup.ec.europa.eu/node/154143/&parentIdentifier=EOP:IPT:Sentinel1

Sample output KML file:

```
<?xml version="1.0" encoding="utf-8"?>

<kml xmlns="http://www.opengis.net/kml/2.2"
xmlns:atom="http://www.w3.org/2005/Atom"
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
xmlns:alt="http://www.opengis.net/alt/2.1"
xmlns:atm="http://www.opengis.net/atm/2.1"
```

```
xmlns:dcat="http://www.w3.org/ns/dcat#"
xmlns:dct="http://purl.org/dc/terms/"
xmlns:eo="http://a9.com/-/opensearch/extensions/eo/1.0/"
xmlns:eop="http://www.opengis.net/eop/2.1"
xmlns:geo="http://a9.com/-/opensearch/extensions/geo/1.0/"
xmlns:ical="http://www.w3.org/2002/12/cal/ical#"
xmlns:lmb="http://www.opengis.net/lmb/2.1"
xmlns:media="http://search.yahoo.com/mrss/"
xmlns:oml="http://def.seegrid.csiro.au/ontology/om/om-lite#"
xmlns:opt="http://www.opengis.net/opt/2.1"
xmlns:org="http://www.w3.org/ns/org#"
xmlns:os="http://a9.com/-/spec/opensearch/1.1/"
xmlns:owl="http://www.w3.org/2002/07/owl#"
xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
xmlns:sar="http://www.opengis.net/sar/2.1"
xmlns:semantic="http://a9.com/-
/opensearch/extensions/semantic/1.0/"
xmlns:skos="http://www.w3.org/2004/02/skos/core#"
xmlns:sru="http://a9.com/-/opensearch/extensions/sru/2.0/"
xmlns:time="http://a9.com/-/opensearch/extensions/time/1.0/"
xmlns:vcard="http://www.w3.org/2006/vcard/ns#"
xmlns:void="http://rdfs.org/ns/void#"
xmlns:php="http://php.net/xsl"
xmlns:schema="http://schema.org/"
xmlns:wsse="http://docs.oasis-open.org/wss/2004/01/oasis-
200401-wss-wssecurity-secext-
1.0.xsd/"><Document><name>GeoDCAT.kml</name><description>Metad
ata catalogue search result</description><open>1</open><Style
id="bx"><PolyStyle><color>#7FFFFFFF</color><colorMode>random</
colorMode><fill>1</fill><outline>1</outline></PolyStyle><LineS
tyle><colorMode>random</colorMode><width>3</width></LineStyle>
</Style><Placemark><name>b3e8e7bb-2960-5a82-bdd9-
bc4e69d9232d</name><guid>b3e8e7bb-2960-5a82-bdd9-
bc4e69d9232d</guid><description><![CDATA[<style>body {font-
family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 ,
orbitDirection : ASCENDING , platform : S1A , instrument :
SAR , sensorType : RADAR , sensorMode : IW , resolution :
10<hr/>Time extent: 2017-12-19T12:36:23Z

                   - 2017-12-
19T12:36:51Z]]></description><pubDate/><styleUrl>#bx</styleUrl
><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoun
daryIs><LinearRing><coordinates>108.790794,-66.282623
113.426605,-65.078278 115.837677,-66.458336 111.047371,-
```

67.730042 108.790794,-
66.282623</coordinates></LinearRing></outerBoundaryIs></Polygo
n></Placemark><Placemark><name>4ffdfa88-235c-5dae-a659-
ad9652988dc7</name><guid>4ffdfa88-235c-5dae-a659-
ad9652988dc7</guid><description><![CDATA[<style>body {font-
family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 ,
orbitDirection : ASCENDING , platform : S1A , instrument :
SAR , sensorType : RADAR , sensorMode : IW , resolution :
10<hr/>Time extent: 2017-12-19T12:35:58Z

- 2017-12-
19T12:36:23Z]]></description><pubDate/><styleUrl>#bx</styleUrl
><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoun
daryIs><LinearRing><coordinates>111.047501,-67.730118
115.83979,-66.457825 118.247894,-67.671944 113.323441,-
69.011169 111.047501,-
67.730118</coordinates></LinearRing></outerBoundaryIs></Polygo
n></Placemark><Placemark><name>a3eb8bd6-58e3-5279-823b-
317413d2e660</name><guid>a3eb8bd6-58e3-5279-823b-
317413d2e660</guid><description><![CDATA[<style>body {font-
family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 ,
orbitDirection : ASCENDING , platform : S1A , instrument :
SAR , sensorType : RADAR , sensorMode : IW , resolution :
10<hr/>Time extent: 2017-12-19T12:35:33Z

- 2017-12-
19T12:35:58Z]]></description><pubDate/><styleUrl>#bx</styleUrl
><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoun
daryIs><LinearRing><coordinates>113.323586,-69.011246
118.250252,-67.671341 120.911064,-68.847374 115.867737,-
70.26049 113.323586,-
69.011246</coordinates></LinearRing></outerBoundaryIs></Polygo
n></Placemark><Placemark><name>0f1c919f-72c9-51ad-999b-
b6e694c0f3e2</name><guid>0f1c919f-72c9-51ad-999b-
b6e694c0f3e2</guid><description><![CDATA[<style>body {font-
family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 ,
orbitDirection : ASCENDING , platform : S1A , instrument :

SAR , sensorType : RADAR , sensorMode : IW , resolution :
10<hr/>Time extent: 2017-12-19T12:35:08Z

- 2017-12-
19T12:35:33Z]]></description><pubDate/><styleUrl>#bx</styleUrl
><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoun
daryIs><LinearRing><coordinates>115.867897,-70.260567
120.913101,-68.846855 123.861237,-69.977753 118.726166,-
71.471252 115.867897,-
70.260567</coordinates></LinearRing></outerBoundaryIs></Polygo
n></Placemark><Placemark><name>b9e0766a-cd2f-56b0-aee4-
6f1d7ad8c110</name><guid>b9e0766a-cd2f-56b0-aee4-
6f1d7ad8c110</guid><description><![CDATA[<style>body {font-
family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 ,
orbitDirection : ASCENDING , platform : S1A , instrument :
SAR , sensorType : RADAR , sensorMode : IW , resolution :
10<hr/>Time extent: 2017-12-19T12:34:43Z

- 2017-12-
19T12:35:08Z]]></description><pubDate/><styleUrl>#bx</styleUrl
><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoun
daryIs><LinearRing><coordinates>118.726349,-71.471321
123.863312,-69.977203 127.128822,-71.057648 121.942879,-
72.637993 118.726349,-
71.471321</coordinates></LinearRing></outerBoundaryIs></Polygo
n></Placemark><Placemark><name>1746cb64-b701-5bc9-b7c9-
672110822bf0</name><guid>1746cb64-b701-5bc9-b7c9-
672110822bf0</guid><description><![CDATA[<style>body {font-
family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 ,
orbitDirection : ASCENDING , platform : S1A , instrument :
SAR , sensorType : RADAR , sensorMode : IW , resolution :
10<hr/>Time extent: 2017-12-19T12:34:14Z

- 2017-12-
19T12:34:43Z]]></description><pubDate/><styleUrl>#bx</styleUrl
><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoun
daryIs><LinearRing><coordinates>121.943077,-72.638054
127.130722,-71.057121 131.371918,-72.235306 126.206505,-
73.923935 121.943077,-
72.638054</coordinates></LinearRing></outerBoundaryIs></Polygo
n></Placemark><Placemark><name>ce217dcf-2ef8-5647-b2c4-
8904e2c2b144</name><guid>ce217dcf-2ef8-5647-b2c4-

8904e2c2b144</guid><description><![CDATA[<style>body {font-family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 , orbitDirection : DESCENDING , platform : S1A , instrument : SAR , sensorType : RADAR , sensorMode : IW , resolution : 10<hr/>Time extent: 2017-12-19T12:02:13Z

- 2017-12-19T12:02:39Z]]></description><pubDate/><styleUrl>#bx</styleUrl><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoundaryIs><LinearRing><coordinates>-91.823822,14.209258 -94.11319,14.645583 -93.82795,16.181551 -91.521484,15.749113 -91.823822,14.209258</coordinates></LinearRing></outerBoundaryIs></Polygon></Placemark><Placemark><name>f3fcc517-c1fe-5101-8a56-8e627e9d3d94</name><guid>f3fcc517-c1fe-5101-8a56-8e627e9d3d94</guid><description><![CDATA[<style>body {font-family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 , orbitDirection : DESCENDING , platform : S1A , instrument : SAR , sensorType : RADAR , sensorMode : IW , resolution : 0<hr/>Time extent: 2017-12-19T12:02:13Z

- 2017-12-19T12:02:39Z]]></description><pubDate/><styleUrl>#bx</styleUrl><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoundaryIs><LinearRing><coordinates>-91.823822,14.209258 -94.113281,14.645601 -93.828041,16.181568 -91.521484,15.749113 -91.823822,14.209258</coordinates></LinearRing></outerBoundaryIs></Polygon></Placemark><Placemark><name>2d9df094-84ff-5baf-b599-fc5fbe056902</name><guid>2d9df094-84ff-5baf-b599-fc5fbe056902</guid><description><![CDATA[<style>body {font-family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 , orbitDirection : DESCENDING , platform : S1A , instrument : SAR , sensorType : RADAR , sensorMode : IW , resolution : 10<hr/>Time extent: 2017-12-19T12:01:48Z

- 2017-12-19T12:02:13Z]]></description><pubDate/><styleUrl>#bx</styleUrl><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoundaryIs><LinearRing><coordinates>-91.521461,15.749202 -

```
93.828293,16.181705 -93.524345,17.68758 -91.198425,17.258451 -
91.521461,15.749202</coordinates></LinearRing></outerBoundaryI
s></Polygon></Placemark><Placemark><name>35500c53-38e5-5711-
926e-c2a1f433092c</name><guid>35500c53-38e5-5711-926e-
c2a1f433092c</guid><description><![CDATA[<style>body {font-
family: sans-serif}

hr {border:0; border-bottom:1px solid #EEE; height: 0px;}

</style>parentIdentifier : EOP:IPT:Sentinel1 ,
orbitDirection : DESCENDING , platform : S1A , instrument :
SAR , sensorType : RADAR , sensorMode : IW , resolution :
10<hr/>Time extent: 2017-12-19T12:01:19Z

                    - 2017-12-
19T12:01:48Z]]></description><pubDate/><styleUrl>#bx</styleUrl
><Polygon><altitudeMode>clampToGround</altitudeMode><outerBoun
daryIs><LinearRing><coordinates>-91.19841,17.258541 -
93.524422,17.687687 -93.179604,19.437452 -90.829147,19.012207
-
91.19841,17.258541</coordinates></LinearRing></outerBoundaryIs
></Polygon></Placemark></Document></kml>
```


9. Annex 5: Czech National Inspire Geoportal GeoDCAT support

Guidelines:

- Maximum 4-5 pages for each best practice case
- Technical implementation details must be in annex
- Overwrite the blue text

9.1 Title

Best practice title	**Czech National INSPIRE Geoportal GeoDCAT support**

9.2 Details

Place of implementation:	Czech republic
Organisation(s) involved:	Help Service Remote Sensing, ltd., CENIA
Status:	Production
Contact person	Štěpán Kafka (stepan.kafka@gmail.com)

URL	https://geoportal.gov.cz/web/guest/catalogue-client

9.3 Focus area

Focus: Only one item can be selected. A best practice must focus on at least one focus area.

Metadata input (manually or automatically harvested)	Secondary
Metadata publication into an integrated geo/open data portal	Primary
Publication of metadata as Linked Open Data (LOD)	Secondary
Information mapping (ISO 19115, Inspire, DCAT,...)	Primary

9.4 Intro

Intro: (Max 4 paragraphs)

General introduction about the initiative, project,... (Focus on only general goals and the pure business story). More specific GeoDCAT-AP related goals must be integrated into the "Goals" section below.

The Czech Republic uses two independent portals providing metadata information. The Czech National INSPIRE Geoportal is a single access point for INSPIRE based spatial data, and the Czech central metadata catalogue provide information about non-INSPIRE datasets and services.

The Czech central metadata catalogue is using the Czech National Metadata profile. The central metadata catalogue is INSPIRE compliant but also supports some extensions.

9.5 Goal

Goal: Description of the best practice goal(s) (max 3 lines or a 5 point bullet list).

The Geo-DCAT implementation has several goals:

- Testing the Geo-DCAT implementation on the existing metadata catalogue (CSW 2.0.2)
- ON-LINE tool for transformation INSPIRE metadata to GeoDCAT

- Platform for automatic translation between Czech INSPIRE geoportal and Czech Open Data Portal (harvesting INSPIRE metadata as Geo-DCAT feed)
- CENIA (Czech Environmental Information Agency) is responsible for portal operation
- The portal is intended for INSPIRE support at national level

In the future the Czech National Inspire Geoportal will extended with:

- Continuous updates according to changes in INSPIRE metadata profiles, services etc…
- Communication with Czech national Open Portal.

9.6 Approach

Approach: (Max 2 pages)

- Description of the approach followed to achieve the pilot goals.
- Description of the implementation and reasoning why decisions were taken.
- The implementation details like detailed code lists or extensive data model descriptions can be integrated into the annexes.

The metadata catalogue used on Czech National Geoportal was extended to provide output of stored INSPIRE compatible metadata (ISO 19139 XML) as Geo-DCAT RDF/XML with use of XSL templates. The templates differ from the ones provided by JRC because multilingual support and additional mapping/vocabularies were required.

The modified CSW uses the same parameters and query mechanism as INSPIRE CSW, but Geo-DCAT outputSchema can be used for Geo-DCAT feed output. (No SPARQL endpoint is used now).

Also, RDFa HTML pages are generated for single metadata records to provide structured information for search engines.

Catalogue client was extended to provide the same transformation for predefined catalogues used on the geoportal or on the fly connected catalogues to get Geo-DCAT metadata.

ON-LINE INSPIRE to Geo-DCAT transformation tool was developed and placed on the geoportal for users who want to transform their metadata and don’t want to store them on the National Geoportal.

9.7 Results

Results: (Max 1 page)

Description of the achieved results. Description of the importance. Pros and cons (Because this is a best practice it is important that the *pros are more prominent than the cons*).

The Czech geoportal uses today GeoDCAT in several ways. You can test the output yourself (https://geoportal.gov.cz/web/guest/catalogue-client?query=geol*).

1. The Czech geoportal has included a CSW client with GeoDCAT RDF/XML output (available on the top bar at metadata detail panel).


```xml
▼<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#" xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#" xmlns:dc="http://purl.org/dc/elements/1.1/"
 xmlns:dct="http://purl.org/dc/terms/" xmlns:dcl="http://dclite4g.xmlns.com/schema.rdf#" xmlns:dcat="http://www.w3.org/ns/dcat#" xmlns:os="http://a9.com/-/spec/opensearch/1.1/"
 xmlns:gmd="http://www.isotc211.org/2005/gmd" xmlns:gco="http://www.isotc211.org/2005/gco" xmlns:srv="http://www.isotc211.org/2005/srv" xmlns:gml="http://www.opengis.net/gml"
 xmlns:locn="http://w3.org/ns/locn#" xmlns:vcard="http://www.w3.org/2006/vcard/ns#" xmlns:schema="http://schema.org/" xmlns:foaf="http://xmlns.com/foaf/0.1/"
 xmlns:prov="http://www.w3.org/ns/prov#" xmlns:skos="http://www.w3.org/2004/02/skos/core#" xmlns:xlink="http://www.w3.org/1999/xlink" xmlns:wdrs="http://www.w3.org/2007/05/powder-
 s#" xmlns:earl="http://www.w3.org/ns/earl#" xmlns:cnt="http://www.w3.org/2011/content#">
  <script/>
 ▼<rdf:Description xmlns:gmi="http://www.isotc211.org/2005/gmi" xmlns:owl="http://www.w3.org/2002/07/owl#">
  ▼<foaf:isPrimaryTopicOf>
   ▼<rdf:Description>
      <rdf:type rdf:resource="http://www.w3.org/ns/dcat#CatalogRecord"/>
      <dct:modified rdf:datatype="http://www.w3.org/2001/XMLSchema#date">2015-04-01</dct:modified>
      <dct:language rdf:resource="http://publications.europa.eu/resource/authority/language/CZE"/>
     ▼<dcat:contactPoint>
      ▼<vcard:Kind>
         <vcard:organization-name xml:lang="cs">Útvar rozvoje hl. m. Prahy</vcard:organization-name>
         <vcard:hasEmail rdf:resource="mailto:paduan@ipr.praha.eu"/>
         <vcard:tel>236005691</vcard:tel>
        ▼<vcard:adr rdf:parseType="Resource">
           <vcard:street-address>Vyšehradská 57/2077</vcard:street-address>
           <vcard:locality>Praha</vcard:locality>
           <vcard:postal-code>12800</vcard:postal-code>
         </vcard:adr>
       </vcard:Kind>
      </dcat:contactPoint>
     ▼<prov:qualifiedAttribution>
      ▼<prov:Attribution>
        ▼<prov:agent>
         ▼<vcard:Kind>
            <vcard:organization-name xml:lang="cs">Útvar rozvoje hl. m. Prahy</vcard:organization-name>
            <vcard:hasEmail rdf:resource="mailto:paduan@ipr.praha.eu"/>
            <vcard:tel>236005691</vcard:tel>
           ▼<vcard:adr rdf:parseType="Resource">
              <vcard:street-address>Vyšehradská 57/2077</vcard:street-address>
              <vcard:locality>Praha</vcard:locality>
              <vcard:postal-code>12800</vcard:postal-code>
            </vcard:adr>
          </vcard:Kind>
         </prov:agent>
         <dct:type rdf:resource="http://inspire.ec.europa.eu/metadata-codelist/ResponsiblePartyRole/pointOfContact"/>
       </prov:Attribution>
      </prov:qualifiedAttribution>
      <dct:identifier rdf:datatype="http://www.w3.org/2001/XMLSchema#string">DDBD51D9-CDF6-4288-8FAB-F049BB5ADFD9</dct:identifier>
     ▼<dct:source rdf:parseType="Resource">
       <cnt:characterEncoding rdf:datatype="http://www.w3.org/2001/XMLSchema#string">UTF-8</cnt:characterEncoding>
      ▼<dct:conformsTo rdf:parseType="Resource">
        ▼<dct:title>
           INSPIRE Metadata Implementing Rules: Technical Guidelines based on EN ISO 19115 and EN ISO 19119
```


2. A RDFa compatible HTML page is available for every dataset. This page offers a structured overview of the metadata. The example below is about the absolute height of the buildings in Prague (https://geoportal.gov.cz/php/micka5/page/DDBD51D9-CDF6-4288-8FAB-F049BB5ADFD9?lang=eng).

Národní geoportál INSPIRE

Basic metadata

Administrative division Czech Rep.

Abstract	Administrative border Czech Rep., regions, districts, councils with extended activities, cadastral territory.
Type	dataset
Resource Locator	http://geoportal.gov.cz
Identifier	CZ-00164801_ADMINISTRATIVNI_CLENENI
Language	Czech
Topic category	planning, cadastre
Keywords	***GEMET - INSPIRE themes, version 1.0:*** Administrative units ***GEMET:*** intrastate border territory/administrative border ***Free:*** Administrative division cadastrals Districts Regions
Bounding box	11.82950986213, 48.112088263333, 19.12764087445, 51.588317555611
Date	revision: 2007-05-25
Temporal extent	2003-01-01 -
Spatial Representation	vector

3. ON-LINE tool for data conversion from Inspire metadata format to the GeoDCAT metadata format: https://geoportal.gov.cz/web/guest/metadata/geodcat/

4. Till the end of 2017 also a connection to the Czech Open Data Portal is planned. Therefore a DCAT support on the Open Data Portal side is needed.

9.8 Conclusions

Conclusions: (Max 5 lines)

A brief description of the overall conclusion of the test. Conclusions about the ease of implementation, ease of use, repeatability.

The Czech GeoDCAT & Inspire implementation is a working example on how both initiatives

can be implemented and work together. Positive: ● Interoperability with Open Data initiatives; ● Transparent solution with no requirements from the user to change their data; ● Simple seamless implementation in CSW; ● Using vocabularies and registres improve quality and reusability of metadata. ● Use of GeoDCAT enables better interoperability with non-geospatial world. Improvements: ● The test is based on previous version of INSPIRE metadata profile (1.x) without use of gmx:Anchor, so many text elements are difficult to convert to URIs; It will be fixed as new metadata profile (2.0.1) is implemented (till end of 2017). ● Some metadata elements should be added to INSPIRE metadata profile for better implementation of semantic web (e.g. URIs for extent etc.). ● The GeoDCAT as it is, is not fully compatible with INSPIRE metadata (mapping denominator etc); ● GeoDCAT is not fully compatible with DCAT-AP (e.g. catalogue class), so we have problems with DCAT validators;

9.9 Annex

Annex:

- Technical implementation details
- More in detail reasonings

10. Annex 6: Spatial data on the web using the Dutch GDP best practice

Guidelines:

- Maximum 4-5 pages for each best practice case
- Technical implementation details must be in annex
- Overwrite the blue text

10.1 Title

Best practice title	Spatial data on the web using the Dutch GDI

10.2 Details

Place of implementation:	The Netherlands
Organisation(s) involved:	Geonovum

Status:	Test
Contact person	Linda van den Brink (l.vandenbrink@geonovum.nl) & Ine De Visser (i.devisser@geonovum.nl)
URL	• https://geo4web-testbed.github.io/topic4/#h.u8ras5wy1peo • https://www.geonovum.nl/onderwerp-artikel/testbed-locatie-data-het-web

10.3 Focus area

Focus: Only one item can be selected. A best practice must focus on at least one focus area.

Metadata input (manually or automatically harvested)	None
Metadata publication into an integrated geo/open data portal	Primary
Publication of metadata as Linked Open Data (LOD)	Primary
Information mapping (ISO 19115, Inspire, DCAT,...)	Primary

10.4 Intro

Intro: (Max 4 paragraphs)

General introduction about the initiative, project,... (Focus on only general goals and the pure business story). More specific GeoDCAT-AP related goals must be integrated into the “Goals” section below.

The central question in the whole Geonovum spatial data on the web test setup was how to use the power of the World Wide Web to make geo-information more accessible? This testbed was organised in 2015-2016. Starting with some relevant research questions, commercial parties began to experiment with publishing geodata on the web.

GeoDCAT-AP was tested as one of the tools/techniques to translate Inspire, ISO 19139 metadata records to a format that can be picked up by the most commonly used search engines on the web.

The text below is a partial representation of the description of the Geonovum testbed *results*[89]

10.5 Goal

Goal: Description of the best practice goal(s) (max 3 lines or a 5 point bullet list).

Finding, accessing and using data disseminated through spatial data infrastructures (SDI) based on OGC web services is difficult for non-expert users. The Geonovum research has investigated how to improve this while keeping the current spatial data infrastructures intact. I.e., “we have been exploring ideas how to realise synergies between the existing spatial data infrastructures and the developments on the Web of data”.

Different techniques have been tested. One of the work items was to transform ISO 19139 records to GeoDCAT-AP compatible RDF.

10.6 Approach

Approach: (Max 2 pages)

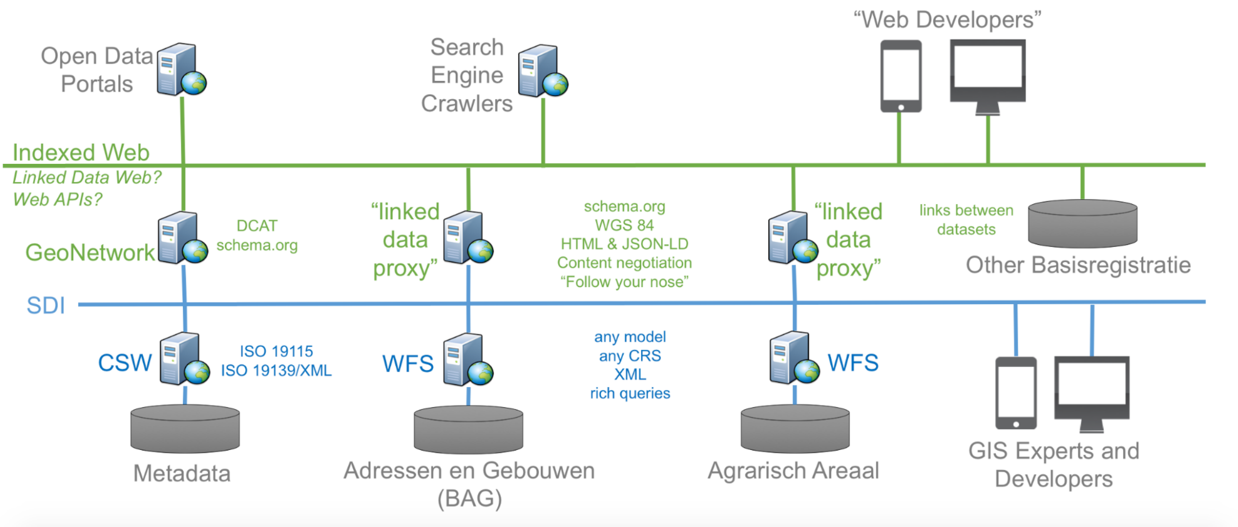
- Description of the approach followed to achieve the pilot goals.
- Description of the implementation and reasoning why decisions were taken.
- The implementation details like detailed code lists or extensive data model descriptions can be integrated into the annexes.

The approach was to design and implement an intermediate layer between the SDI and the Web using proxies that will make data and metadata from the OGC web services available using the following principles that were considered important from a Web perspective:

- All resources are identified using persistent HTTP URIs;
- All interaction is using the HTTP protocol and consistent with its design;
- All resources are discoverable via search engines;
- Resources can be accessed and understood by citizens and developers;
- Resources are either explicitly linked using HTTP URIs or data is structured so that links can be established dynamically.

[89] https://geo4web-testbed.github.io/topic4/#h.u8ras5wy1peo

The intermediate layer consists of a number of proxies introduced on top of the WFS (data service) and CSW (metadata service), making the contained resources available for other communities and supporting the practices they follow.



The proxy layer is intended to support:

- Search engines - Search engines generally use the schema.org ontology, use HTTP URLs as identifiers and limit their encodings to RDFa/Microdata and JSON-LD;
- Linked Open Data (LOD) community - Use a minimal set of common ontologies, such as those from the DBpedia project;
- e-government community - Require the use of authoritative ontologies (DCAT, "basisregistraties" (key registries), INSPIRE);
- Web API developer community - Don't use ontologies, but have additional best practices, such as GeoJSON, Swagger, CKAN, etc.

One of the used proxy approaches is the use of GeoDCAT-AP. In the context of the Geonovum testbed, a mapping of ISO 19139 metadata records to GeoDCAT-ap has been made. The approach is described in the geo4web-testbed[90].

Together with the GeoDCAT-AP specification, an XSLT has been released which can transform ISO 19139 metadata to GeoDCAT-AP. This XSLT was used to improve existing RDF export capabilities in GeoNetwork. Until recently RDF/XML could only be exported from GeoNetwork using an RSS type of search. In recent versions RDF/XML can also be exported using CSW and as a full catalogue dump. Only RDF/XML is supported, no transformations to turtle or JSON-ld are currently available.

The GeoDCAT-ap XSLT has been improved on a number of aspects:

[90] https://github.com/geo4web-testbed/topic4/blob/master/spatial-data-on-the-web-using-sdi-report.pdf

- *The GeoDCAT-ap XSLT tends to create frequent 'blank nodes', which is not forbidden, but a bad practice in linked data. Instead, GeoNetwork 'mints' URI's for new objects that are created as part of the mapping (e.g. organisations, locations, etc.).*
- *The GeoDCAT-ap XSLT is quite ambiguous on the type of data-links available in the metadata. The reason is that INSPIRE metadata does not require to indicate the type of resource behind a link and XSLT has no capabilities to probe a link, to derive the type of resource. The Dutch meta data profile, however, requires data providers to indicate the type of resource behind a link, which facilitates the mapping for the type of data link.*
- *The Dutch profile requires explicit conventions for stating types of open data licences. This facilitates the link to DCAT.*

An example of a transformed ISO 19139 document is available (see https://geo4web-testbed.github.io/topic4/#h.hx52qgd16l66)

Besides DCAT also the VOID ontology[91] *is relevant in the scope of our research. DCAT is widely used to describe traditional data sets in a structure other than RDF; VOID is used to describe datasets that are structured as RDF. As part of this research, we suggest ways to convert none RDF data structures to RDF. To make those structures discoverable on the semantic web, VOID is a relevant ontology.*

To facilitate Semantic Web Bots a SPARQL endpoint can be set up based on a (nightly) full RDF dump of the catalogue. Alternatively, semantic web users (bots and people) can follow links to metadata URI's from external sources (using a content negotiation accept header "application/rdf+xml").

Besides GeoDCAT some other approaches were tested to make metadata available on the web; notably, HTML with embedded Schema.org microdata.

GeoDCAT-AP is used as one of the representations of geodata on the web and has its value beside other representation techniques used. The primary value of GeoDCAT-AP lies in providing a machine readable RDF format of rich geo-metadata derived from ISO 19119 & Inspire metadata records without losing a lot of valuable (geo)information. Providing metadata records as GeoDCAT-AP is expected to improve discoverability in the open data / linked data communities because open data portals can harvest each others metadata using DCAT. The metadata records were also published as HTML+schema.org, because search engines will index this, thus improving discoverability of said metadata on the web.

10.7 Results & conclusions

Results & conclusions: (Max 1 page)

Description of the achieved results. Description of the importance. Pros and cons (Because this is a best practice it is important that the *pros are more prominent than the cons*).

[91] https://www.w3.org/TR/void/

The focus of the testbed can be summarized as a number of test implementations to test and improve:

- The crawlability and linkability, i.e. making each resource available via a persistent URI and ensure that all resources can be reached via links from a "landing page" for a data set;
- Classification of the resources using vocabularies supported by the main search engines on the Web;
- Discovery of spatial data by search engines;
- Representations of data for consumption by humans (HTML), web-developers (JSON) and search engine crawlers (HTML with annotations);
- Establishing and maintaining links between data.

To a large extent the Geonovum testbed was successful implementing the intermediate proxy layer as an interface between the Dutch SDI and open data portals, search engine crawlers and the web developers community. The main results are:

- The (meta)data resources were made available by the used proxies;
- The mapping of the data and metadata resources to the schema.org vocabulary (plus the GeoDCAT-ap vocabulary for metadata) are achieved with a minimum of loss metadata elements;
- The strategy for assigning URIs to the resources was achieved and tested;
- The representations (formats), in which each resource are available;
- New experiences with establishing links across data sets and between data and metadata;
- New experiences with search engines crawling and indexing the resources.

There are still some challenges to improve the data findability on the web:

- Improve existing infrastructure to support dynamic linking between resources (features) in the dataset and to avoid incomplete and inconsistent metadata;
- Web related challenges to make search engines more open in a way to understand how you can deliver your data in the best possible way and the implementation of a scheme based content negotiation besides a media based content negotiation.

10.8 Annex

Annex:

- GeoNovum testbed results: https://geo4web-testbed.github.io/topic4/#h.u8ras5wy1peo

11. Annex 7: Flanders integrated metadata portal proof of concept best practice

Guidelines:

- Maximum 4-5 pages for each best practice case
- Technical implementation details must be in annex
- Overwrite the blue text

11.1 Title

Best practice title	**Flanders integrated metadata portal proof of concept**

11.2 Details

Place of implementation:	Belgium (Flanders region)
Organisation(s) involved:	Information Flanders
Status:	Test
Contact person	Geraldine Nolf, geraldine.nolf@kb.vlaanderen.be
URL	https://www.vlaanderen.be/nl/contact/adressengids/diensten-van-de-vlaamse-overheid/administratieve-diensten-van-de-vlaamse-overheid/beleidsdomein-kanselarij-en-bestuur/agentschap-informatie-vlaanderen

11.3 Focus area

Focus: At least one area must be selected as primary. A best practice must focus on at least one focus area, but more primary focus areas are also possible.

Metadata input (manually or automatically harvested)	Primary
Metadata publication into an integrated geo/open data portal	Primary
Publication of metadata as Linked Open Data (LOD)	Secondary
Information mapping (ISO 19115, Inspire, DCAT,...)	Primary

11.4 Intro

Intro: (Max 4 paragraphs)

General introduction about the initiative, project etc. (Focus on only general goals and the pure business story). More specific GeoDCAT-AP related goals must be integrated into the "Goals" section below.

Information Flanders - (Belgium), is integrating their open-data metadata and geo metadata in one single end-user portal and one integrated metadata management system. As EU member, Belgium and Information Flanders as one of the regional public agencies has to follow the Inspire metadata profiles. This means that IV is dependent on different metadata standards (DCAT-AP) for open data and (Geo DCAT-AP, ISO19115) for Geodata.

The best practices below describe how Information Flanders integrates Open Data¨metadata records (DCAT-AP) and SDI (the Spatial Data Infrastructure of Flanders) metadata records (Geo DCAT-AP, INSPIRE, ISO 19115) using a schema-based approach.

- DCAT-AP support based on the ISO19139 Scheme;
- DCAT-AP support DCAT based on a new scheme.

The general approach used in both Information Flanders experiments is to start from a GIS metadata management system and adapt this system to handle open metadata in a way that is also convenient for open data specialists without encumbering with extra geo-related fields. Two implementation scenarios were tested[92].

11.5 Goal

Goal: Description of the best practice goal(s) (max 3 lines or a 5 point bullet list).

The main goal is to build an integrated data portal where geospatial metadata and non-geospatial metadata are managed and published via one single system. The main challenge is to handle different metadata (geospatial data, open data, etc.) via a number of compatible input and output formats. The long-term goal is the integration of other schemes to support other specific metadata sources like statistical information.

More specific, two different experiments to store and export metadata based on ISO19139 Geographic information -- Metadata -- XML schema implementation were carried out to test a smooth metadata management.

- Experiment 1: Support of GeoDCAT-AP metadata based on the existing ISO19139 scheme;
- Experiment 2: Support of GeoDCAT AP schema based on a new developed (GEO) DCAT based DCAT-AP schema plugin.

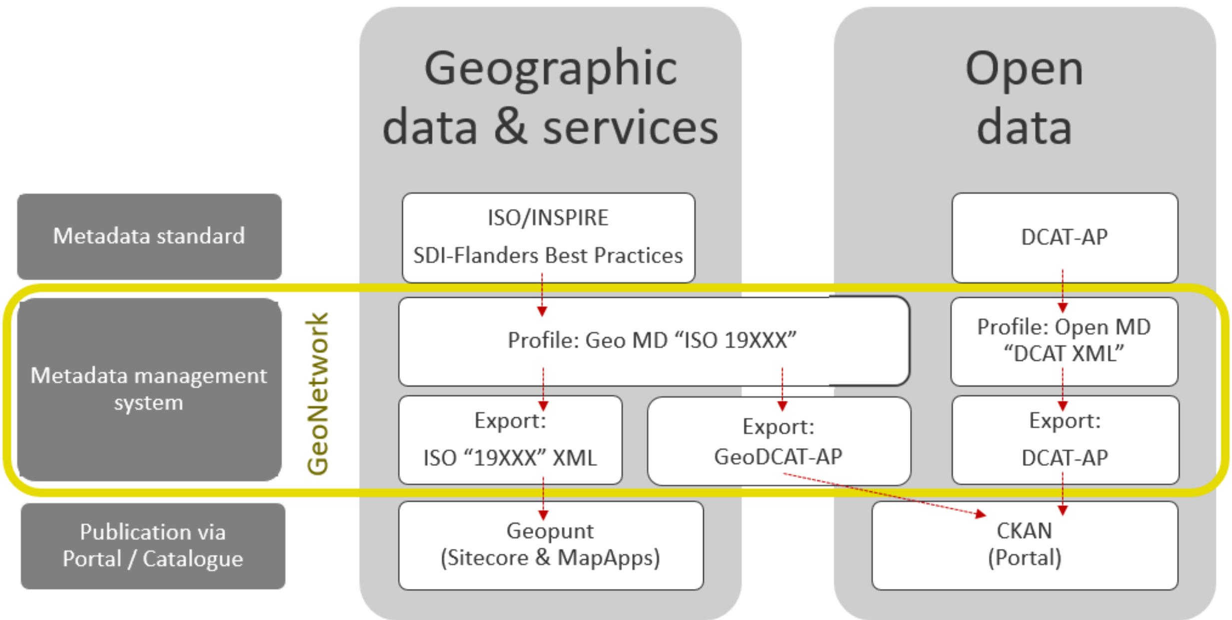
[92] The scenario’s are part of the Flanders metadata study, Information Flanders, May 2017

11.6 Approach

Approach: (Max 2 pages)

- Description of the approach followed to achieve the pilot goals.
- Description of the implementation and reasoning why decisions were taken.
- The implementation details like detailed code lists or extensive data model descriptions can be integrated into the annexes.

The idea behind was to make metadata editing as simple as possible for the data provider. The 'once only' principle whereby data must be inputted one single time is a critical element in this simplification approach. The idea behind both experiments was to use the same metadata management system to bridge the gap between geographic- and open data and to elaborate methods to reduce costs and to increase efficiency compared to wholly separated geo- and open data metadata systems. The general idea is to use a metadata management system for integrating metadata as a kind of middleware between the metadata standards itself and the publication via a data portal/catalogue[93].



A template-based approach using Geonetworks 3[94] was chosen. The advantage of a template based approach is that no code changes are needed, as long as the GUI remains the same for the used elements in ISO19139. This can be considered as a disadvantage because complex fields (for ex. Responsible authority) are based on the ISO metadata structure, and not on the DCAT-AP structure.

---

[93] Figure by Informatie Vlaanderen, 2018, Geraldine Nolf.

[94] http://geonetwork-opensource.org/

<u>Proof of concept scenario 1:</u>

GeoNetwork 3.0 delivers an out-of-the-box an ISO19139 metadata export to DCAT. ISO19139 can be used for internal metadata storing. On the front-end side it is also possible to deliver data in other metadata formats like DCAT-AP. What concerns data input it is also possible to use different templates. These templates supports:

- DCAT-AP based open data metadata template;
- SDI Flanders (Inspire & SDI Flanders best practice-based metadata template) for datasets, dataset series, services and objects;
- ISAD(G) based document metadata template.

In this scenario, only a template need to be added. There is no coding needed on the condition that no other than the available graphical elements than needed for the ISO19139 template are used.

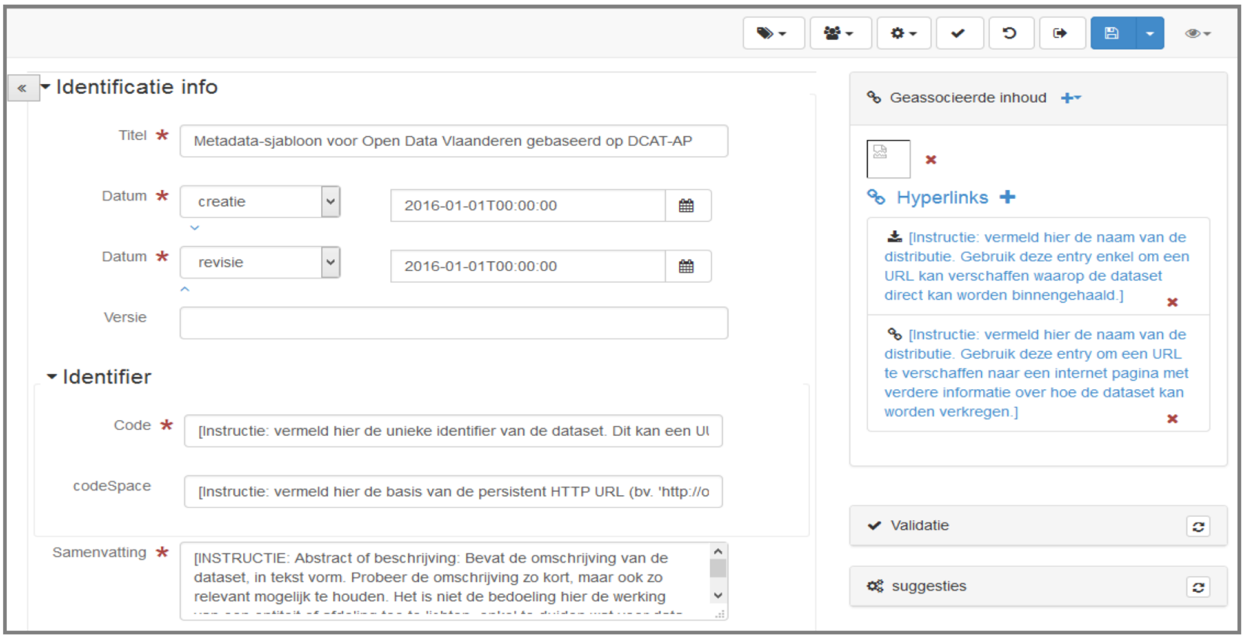
The latter can be seen as a disadvantage, as complex fields (e.g., responsible authority) are based on the ISO metadata structure, and not those of DCAT-AP.

In experiment 1, we create an Open Data metadata profile on GeoNetwork, illustrating how we can create, modify, and convert metadata records according to this profile to different formats.

Brief overview of the necessary steps:

- Setting up GeoNetwork version 3.0;
- User account creation (admin, metadata editor profiles);
- Import of existing metadata records;
- Setting up a DCAT-AP metadata template for open data records;
- Adding DCAT-AP metadata records;
- Metadata record conversion towards DCAT-AP;
- Making the http URI’s dereferenceable;
- CSW export;
- DCAT-AP metadata records validation;
- Setting up a SPARQL endpoint;
- Development of a SPARQL/XSL transformation to convert metadata to DCAT-AP XML.

Interface example:



Open Data Flanders DCAT-AP based metadata record

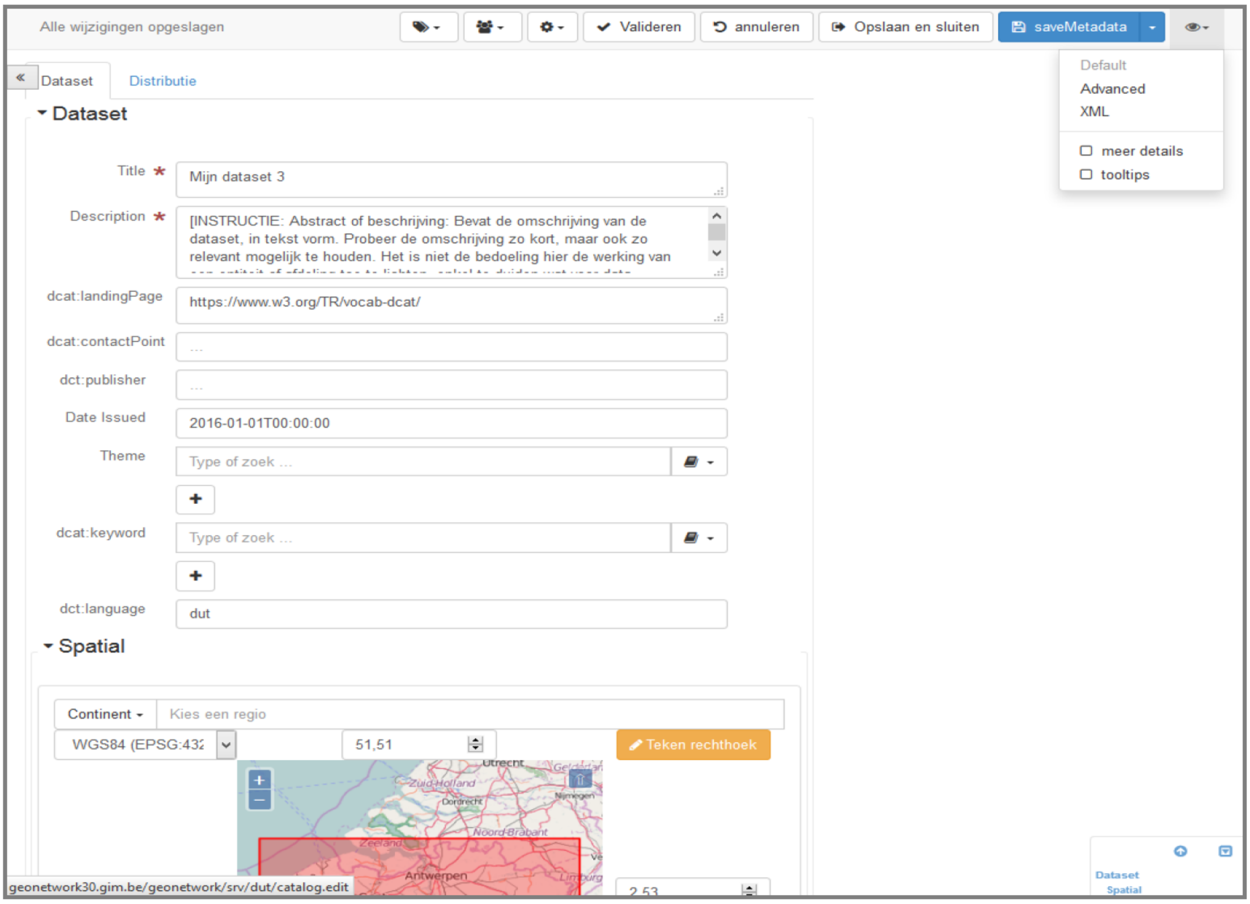
<u>Proof of concept scenario 2:</u>

This second proof of concept implements a GeoNetwork Schematic Plugin for DCAT-AP. The experiment follows the directions in the GeoNetwork tutorial 'Implementing Schedule Plugins.'

Brief overview of the necessary steps:

- Creating a DCAT-AP schema plugin;
- Defining a XML Schema for DCAT-AP;
- Implementing a metadata template for DCAT-AP;
- Development of XSL templates for visualising and editing metadata records;
- XSL transformation converting metadata to DCAT-AP RDF;
- Development of a SPARQL/XSL transformation to convert metadata to DCAT-AP XML.

Interface example:



(GEO)DCAT-AP-SCHEMA based metadata management interface

11.7 Results

Results: (Max 1 page)

Description of the achieved results. Description of the importance. Pros and cons (Because this is a best practice it is important that the *pros are more prominent than the cons*).

The first experiment shows that it is technically feasible to manage both DCAT-AP metadata records and metadata records for SDI Flanders (ISO / INSPIRE) using a Geo Metadata management solution. The DCAT-AP metadata records can also be made available as Linked Data.

If using the ISO option metadata structure is followed, it is less easy to reconstruct a pure DCAT based graphical user environment for open data metadata management completely.

To not discourage Open Data users who need an input interface that is adapted to the information they need (without GIS specialist related fields), preference is given to implementing

"GeoNetwork Schematic Plugin for DCAT-AP" as described in the second experiment.

The second experiment shows that it is technically feasible to manage both DCAT-AP metadata records and metadata records for SDI Flanders using a single metadata management solution. The DCAT-AP metadata records can be made available as Linked Data.

As indicated above, this option offers the advantage of having a high degree of freedom regarding the customization of the graphical user interface. A minor disadvantage is the fact that the metadata database stores in different XML Schemas. This requires some attention if a bulk update of, for example, address information or licenses should occur. But here too, the use of code lists that refer to a set of predefined organisations and licensing conditions is the best solution.

11.8 Conclusions

Conclusions: (Max 5 lines)

A brief description of the overall conclusion of the test. Conclusions about the ease of implementation, ease of use, repeatability.

Both experiments made clear that it is possible to make use of XML based schemes to handle metadata input coming from different standards (DCAT and ISO/INSPIRE) and to store and manage them in a single (geospatial)metadata management system. Such an approach avoid double input of metadata (once only principle) and makes metadata input and editing more convenient. Such an approach also can reduce costs (one integrated system instead of multiple partially overlapping systems).

This step could lead to further integration of open- and geospatial metadata portals. It is to be expected that such a portal integration based on an integrated metadata management system will increase the user experience.

This XML scheme & template based technical approach has the advantage that no code changes are needed, as long as the GUI remains the same for the used elements in ISO 19139.