EPOS Metadata Training within Geo-INQUIRE

Rossana Paciello and Daniele Bailo

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Training Content

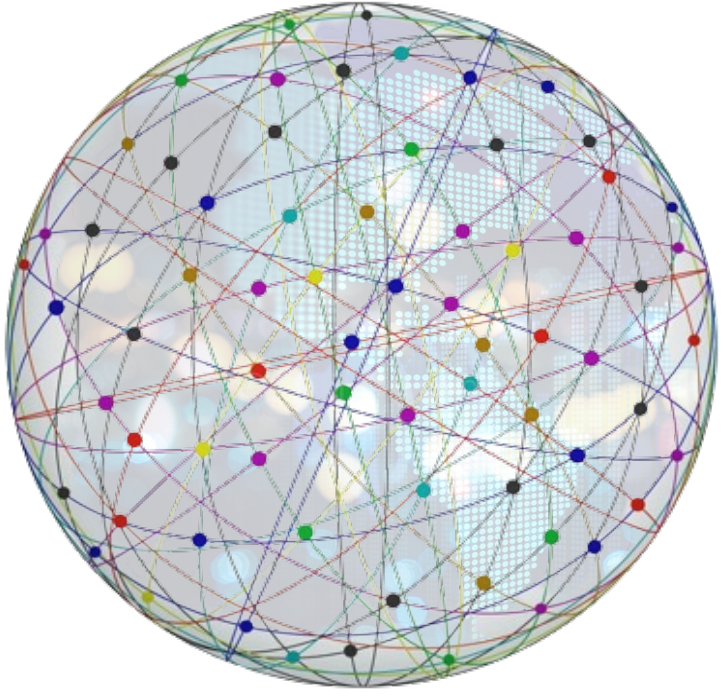
- Part I (**Daniele Bailo**)
  - Introduction
  - Achieving interoperability across systems
  - Approaches for achieving interoperability through Data, Metadata, Semantics, WebServices
  - EPOS: Making Data Interoperable
  - EPOS Technical Architecture
- Part II (**Rossana Paciello**)
  - INTEROPERABILITY LAYER
  - EPOS-DCAT-AP
  - EPOS-DCAT-AP Metadata Validation
  - EPOS Metadata Quality check
  - SHAPE*ness* Metadata Editor

Introduction

- Technological progress and **open data** in **environmental and life sciences** are fostering **research opportunities**.
- Such progress offers a wealth of data for **studying complex phenomena**.
- Challenges in **data management** emerge, necessitating solutions for **effective data sharing** and reuse (e.g., **FAIR** principles).
- **Interdisciplinary research** amplifies these challenges because of the diverse practices, formats, and metadata standards in different disciplines.

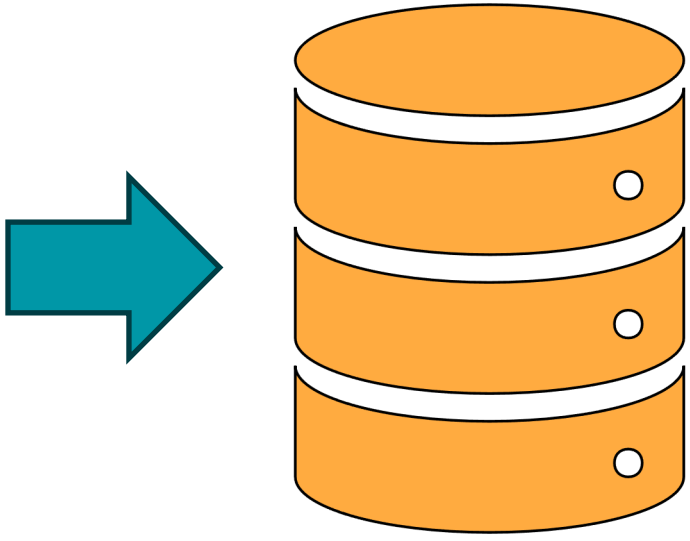
Achieving interoperability across systems

- The effective use of interdisciplinary data, requires implementing interoperability across different systems.
- The interoperability can be addressed at multiple levels:
  - Data
  - Metadata
  - Semantics
  - Services



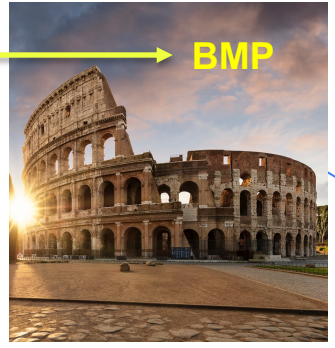
Interoperability

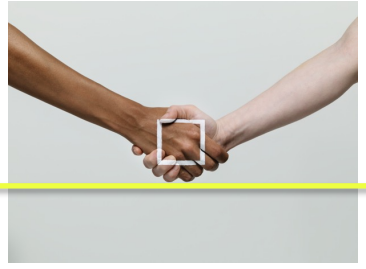
Example: *creating a database of European Cities images in BMP format FROM heterogeneous sources*



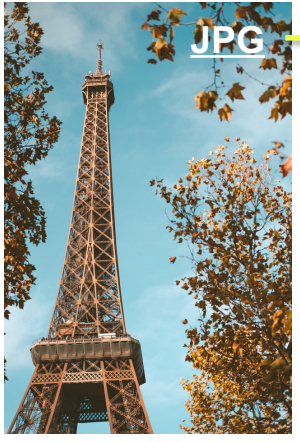
BMP Images database

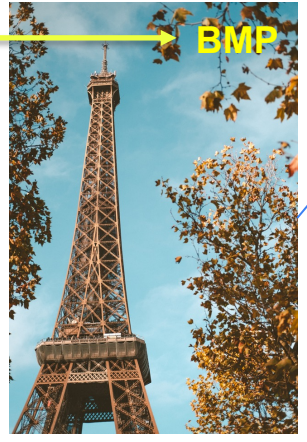
Approach 1. Achieving interoperability through Data (1)

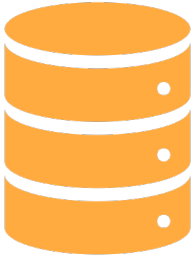




Agreement

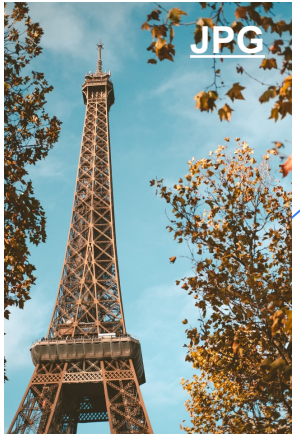






Images database

Approach 1. Achieving interoperability through Data (2)



Conversion Software

Images database

Approach 1. Achieving interoperability through Data

- ***DATA is Physical representation*** *of facts, atomic events, objective phenomena, information suitable for communication, interpretation and processing by human beings or automatic means*
- The goal in an interdisciplinary landscape is to **harmonize** the plethora of different data formats and representations.
- Data harmonization refers to the process of **aligning and integrating data from various sources** to create a unified and standardized representation.
- The main tasks to achieve interoperability are:
  - **Convergence of "similar" data towards same (standard) formats (e.g., fresh start)**
  - **Conversion or mapping across different formats (e.g., existing data)**
- *!! Requires coordination and consensus among different stakeholders*
- *!! Requires conversion of datasets towards one common format*

Approach 2. Achieving interoperability through Metadata

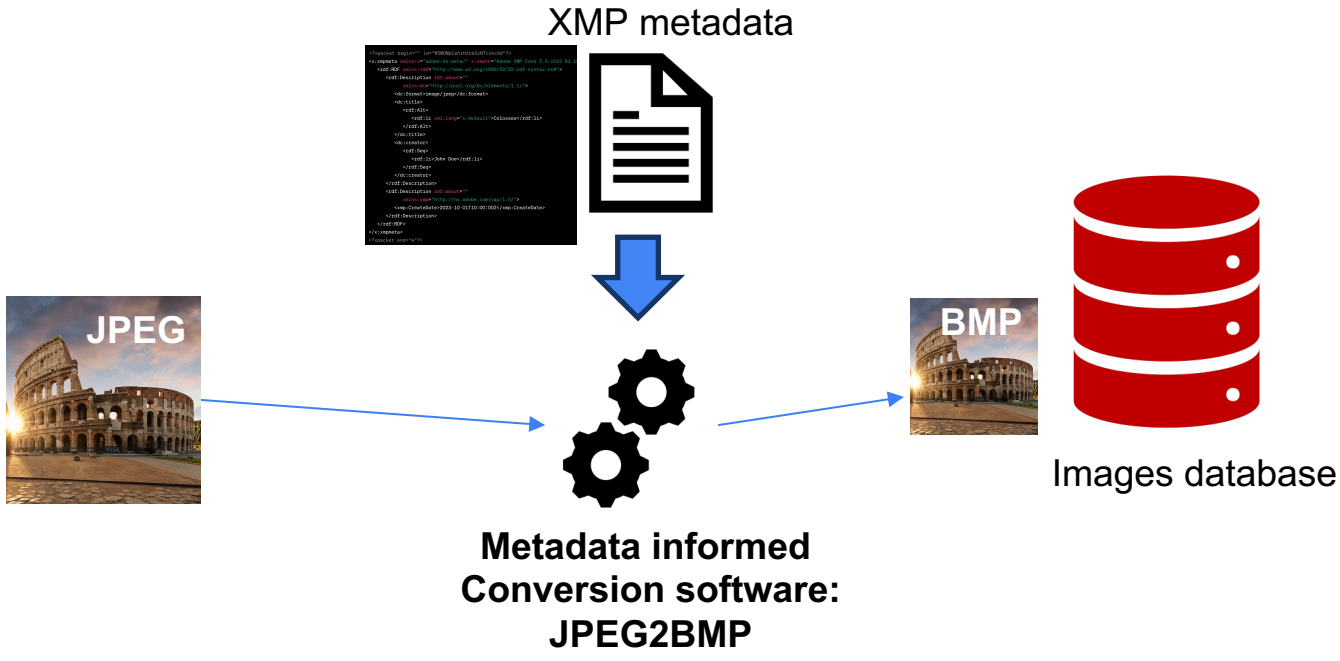
Metadata = data about data

Image
(e.g., .jpeg format)

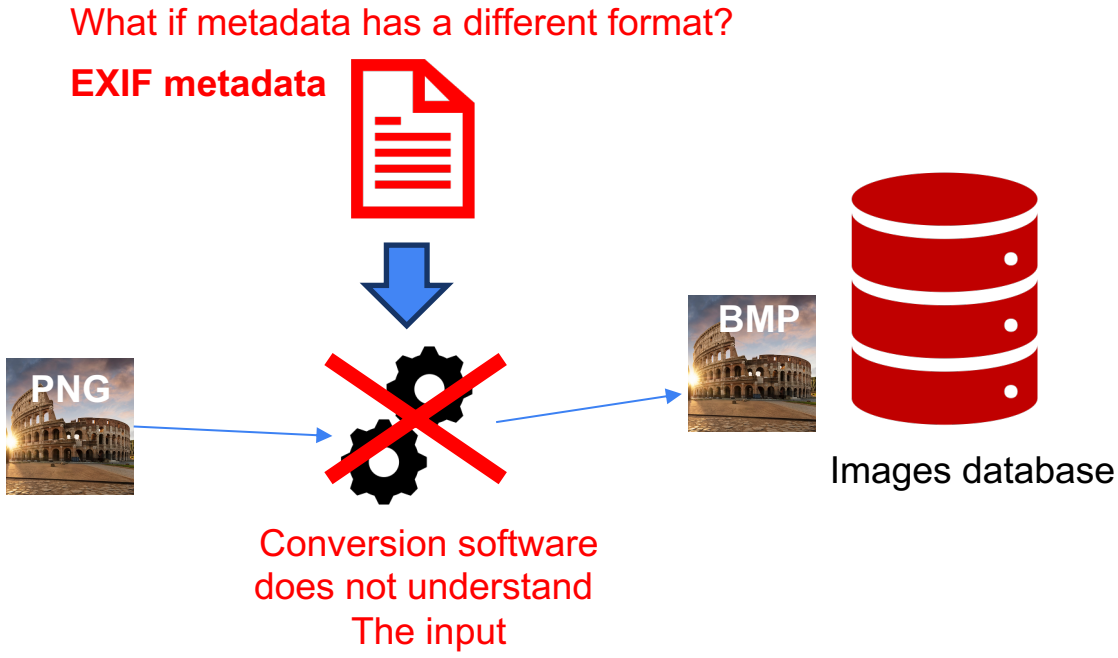
```
<?xpacket begin="" id="W5MOMpCehiHzreSzNTczkc9d"?>
<x:xmpmeta xmlns:x="adobe:ns:meta/" x:xmptk="Adobe XMP Core 5.6-c015 81.1
   <rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
      <rdf:Description rdf:about=""
            xmlns:dc="http://purl.org/dc/elements/1.1/">
         <dc:format>image/jpeg</dc:format>
         <dc:title>
            <rdf:Alt>
               <rdf:li xml:lang="x-default">Colosseo</rdf:li>
            </rdf:Alt>
         </dc:title>
         <dc:creator>
            <rdf:Seq>
               <rdf:li>John Doe</rdf:li>
            </rdf:Seq>
         </dc:creator>
      </rdf:Description>
      <rdf:Description rdf:about=""
            xmlns:xmp="http://ns.adobe.com/xap/1.0/">
         <xmp:CreateDate>2023-10-01T10:00:00Z</xmp:CreateDate>
      </rdf:Description>
   </rdf:RDF>
</x:xmpmeta>
<?xpacket end="w"?>
```

XMP Metadata Description

Approach 2. Achieving interoperability through Metadata



Approach 2. Achieving interoperability through Metadata



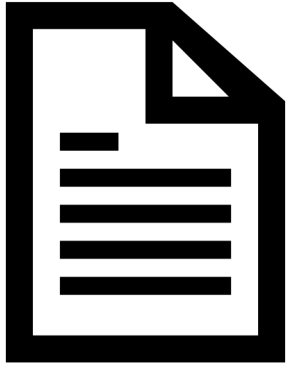
Approach 2. Achieving interoperability through Metadata

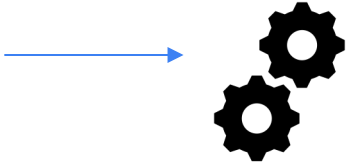
XMP

EXIF

Agreement

Common metadata format





Conversion software

Approach 2. Achieving interoperability through Metadata

- **METADATA is data that defines other data**. It provides essential contextual information, such as data source, format, authorship, and quality, making data more understandable and manageable.
- **Metadata improves data management by making data more discoverable** and understandable and providing insights into data source, quality, and usage.
- Metadata **specifies data standards and formats**, ensuring data adheres to common conventions, thus enabling machine readability.
- Metadata helps achieving Interoperability by offering context and details about the data **without directly altering the data itself.**
- Interoperability through metadata requires:
  - **Adoption of commonly accepted metadata standards (e.g., Dublin Core) or development of custom standards that can be interpreted by different machines**
  - **Define mappings between different metadata schemas or standards to ensure compatibility among sources**
- *!! Also requires coordination and consensus among different stakeholders*
- *!! Requires efforts for metadata creation and continuous curation to keep metadata up-to-date*

Approach 3. Achieving interoperability through Semantics

```
<?xpacket begin="" id="W5MOMpCehiHzreSzNTczkc9d"?>
<x:xmpmeta xmlns:x="adobe:ns:meta/" x:xmptk="Adobe XMP Core 5.6-c015 81.1
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      </rdf:Description>
   </rdf:RDF>
</x:xmpmeta>
<?xpacket end="w"?>
```
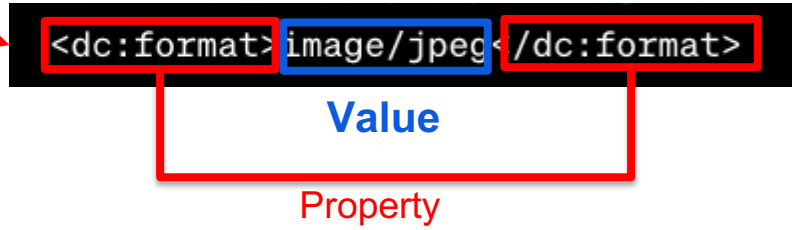

- **Semantics = meaning of data**

- **Semantics is embedded into the metadata**



Approach 3. Achieving interoperability through Semantics

- All properties (and classes) needs to be described (e.g., online vocabularies),
- so that machines can "understand" what they are about.

```
<?xpacket begin="" id="W5MOMpCehiHzreSzNTczkc9d"?>
<x:xmpmeta xmlns:x="adobe:ns:meta/" x:xmptk="Adobe XMP Core 5.6-c015 81.1
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      <rdf:Description rdf:about=""
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         <dc:format>image/jpeg</dc:format>
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      <rdf:Description rdf:about=""
            xmlns:xmp="http://ns.adobe.com/xap/1.0/">
         <xmp:CreateDate>2023-10-01T10:00:00Z</xmp:CreateDate>
      </rdf:Description>
   </rdf:RDF>
</x:xmpmeta>
<?xpacket end="w"?>
```

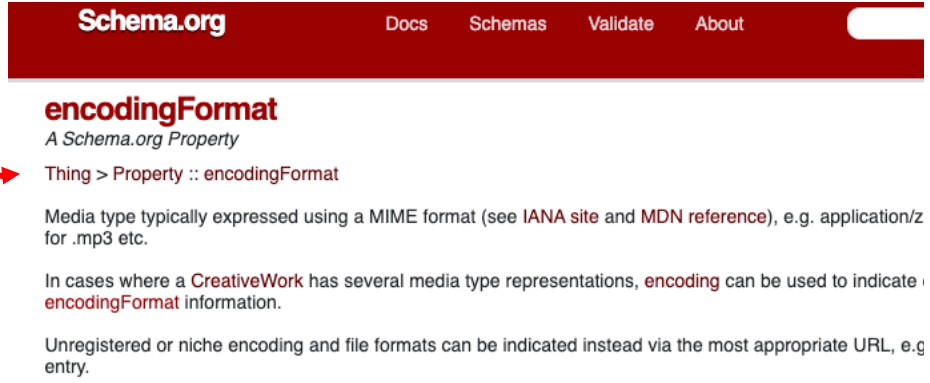
Term Name: format	Property description in rdf Dublin Core	More details
URI	http://purl.org/dc/terms/format	
Label	Format	
Definition	The file format, physical medium, or dimensions of the resource.	
Comment	Recommended practice is to use a controlled vocabulary where available. For example, for file formats one could use the list of Internet Media Types [MIME]. Examples of dimensions include size and duration.	
Type of Term	Property	Controlled vocabulary
Range Includes	http://purl.org/dc/terms/MediaType http://purl.org/dc/terms/Extent	
Subproperty of	Format (http://purl.org/dc/elements/1.1/format)	

Approach 3. Achieving interoperability through Semantics

Semantic can be expressed in different formats (rdf, JSON-LD etc.)

```
<script type="application/ld+json">
{
  "@context": "https://schema.org",
  "@type": "ImageObject",
  "description": "Colosseo",
  "encodingFormat": "image/jpeg",
}
</script>
```

JSON-LD description in schema.org



Approach 3. Achieving interoperability through Semantics

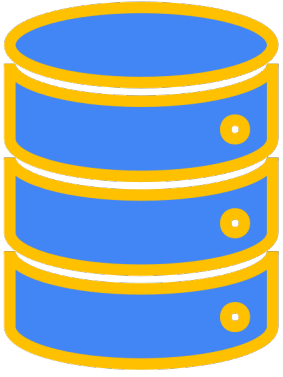
- **Semantics is used for defining the meaning** of (meta)data elements, relationships between data, and the intended use of data.
- Semantic interoperability involves **encoding knowledge in a machine-readable format (vocabularies, ontologies)**, making it possible to understand data beyond syntactical interpretation. Usually done within the metadata.
- Systems that achieve semantic interoperability can perform **sophisticated semantic queries that consider the meaning and context of data**, making data retrieval more precise and relevant.
- Semantics interoperability requires:
  - **Adopt semantic standards such as RDF (Resource Description Framework) and OWL (Web Ontology Language) to represent data in a machine-understandable format.**
  - **Create semantic mappings between ontologies or data models used by different organizations or systems, enabling data translation between different semantic schemas.**
- *!! Creating or adoptiong ontologies is quite effort consuming (is it worth it?)*
- *!! Ontologies and semantic mappings require continuous maintenance to ensure they are up to date and accurately reflect the evolving real world.*

Approach 3. Achieving interoperability through Semantics

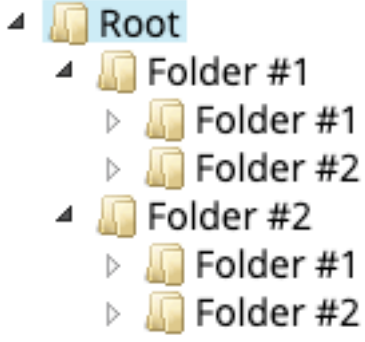
Mapping between two standards: DCAT-AP → schema.org

DCAT-AP Specification	Obl.	Label	QName	Schema.org	Comments
[DCAT-AP]	M	access URL	dcat:accessURL	schema:contentURL	
[DCAT-AP]	R	description	dct:description	schema:description	
[DCAT-AP]	R	availability	dcatap:availability	schema:??	TBD
[DCAT-AP]	R	format	dct:format	schema:encodingFormat	

Approach 4. Achieving interoperability through WebServices



EU Images database

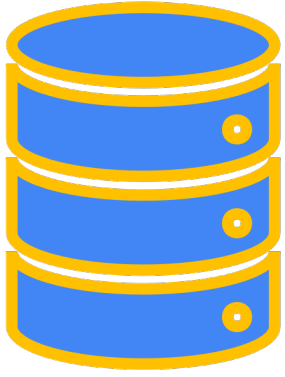


AU Images database

Approach 4. Achieving interoperability through WebServices

XMP

EXIF



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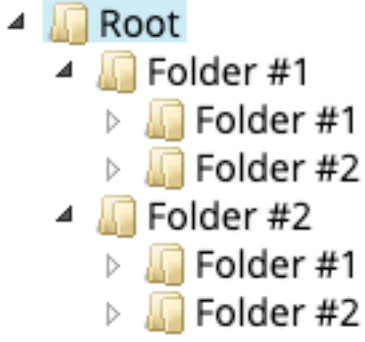
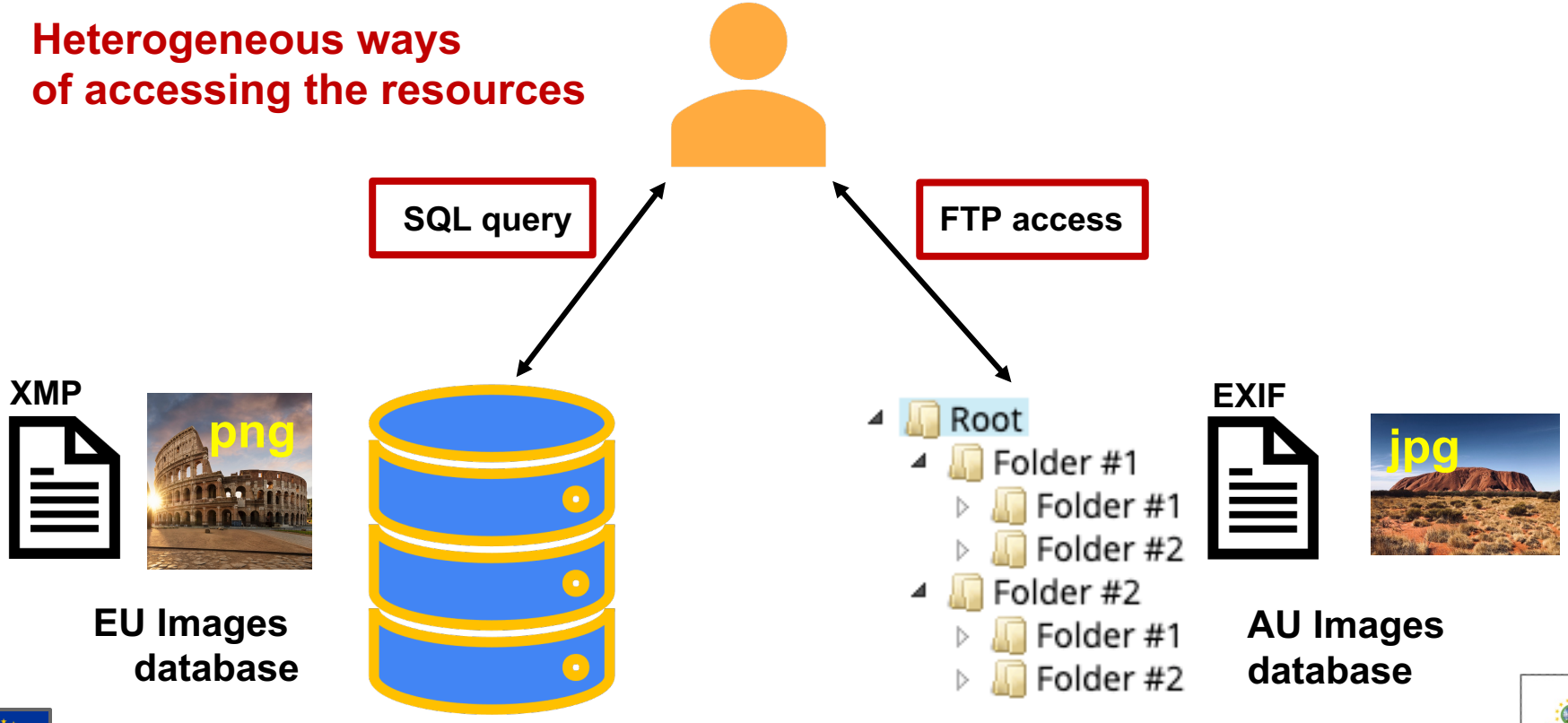


AU Images database

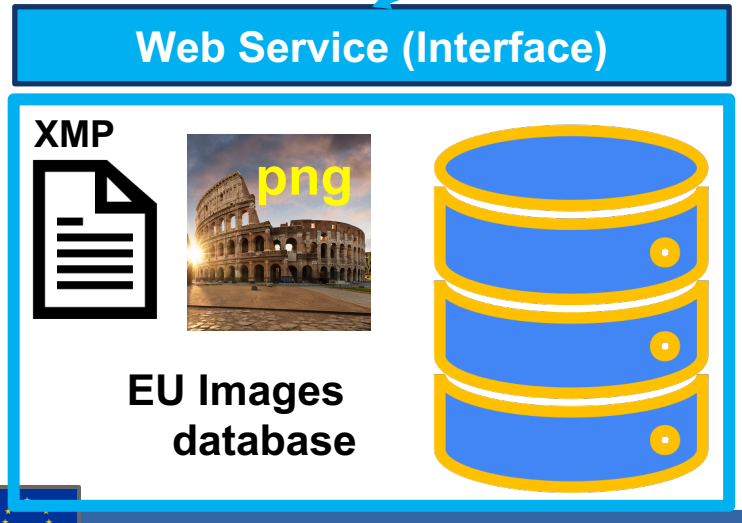
Approach 4. Achieving interoperability through WebServices

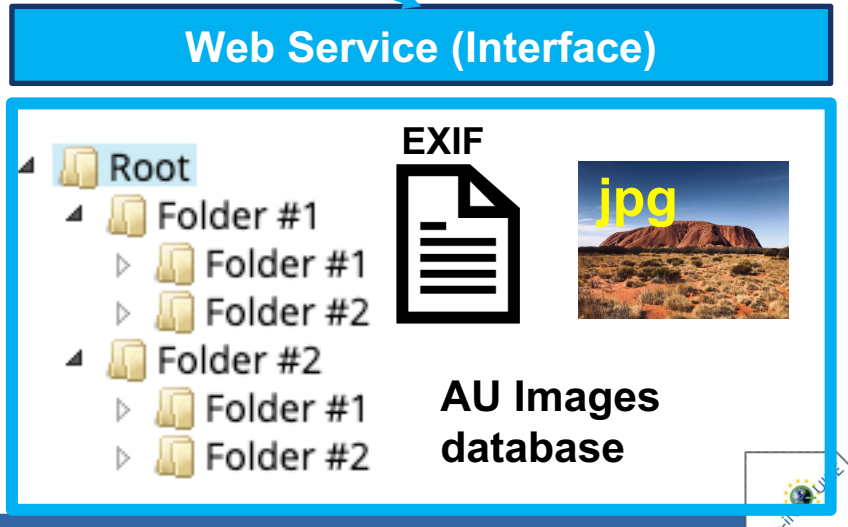
Heterogeneous ways of accessing the resources



Approach 4. Achieving interoperability through WebServices

Web Service = Common language

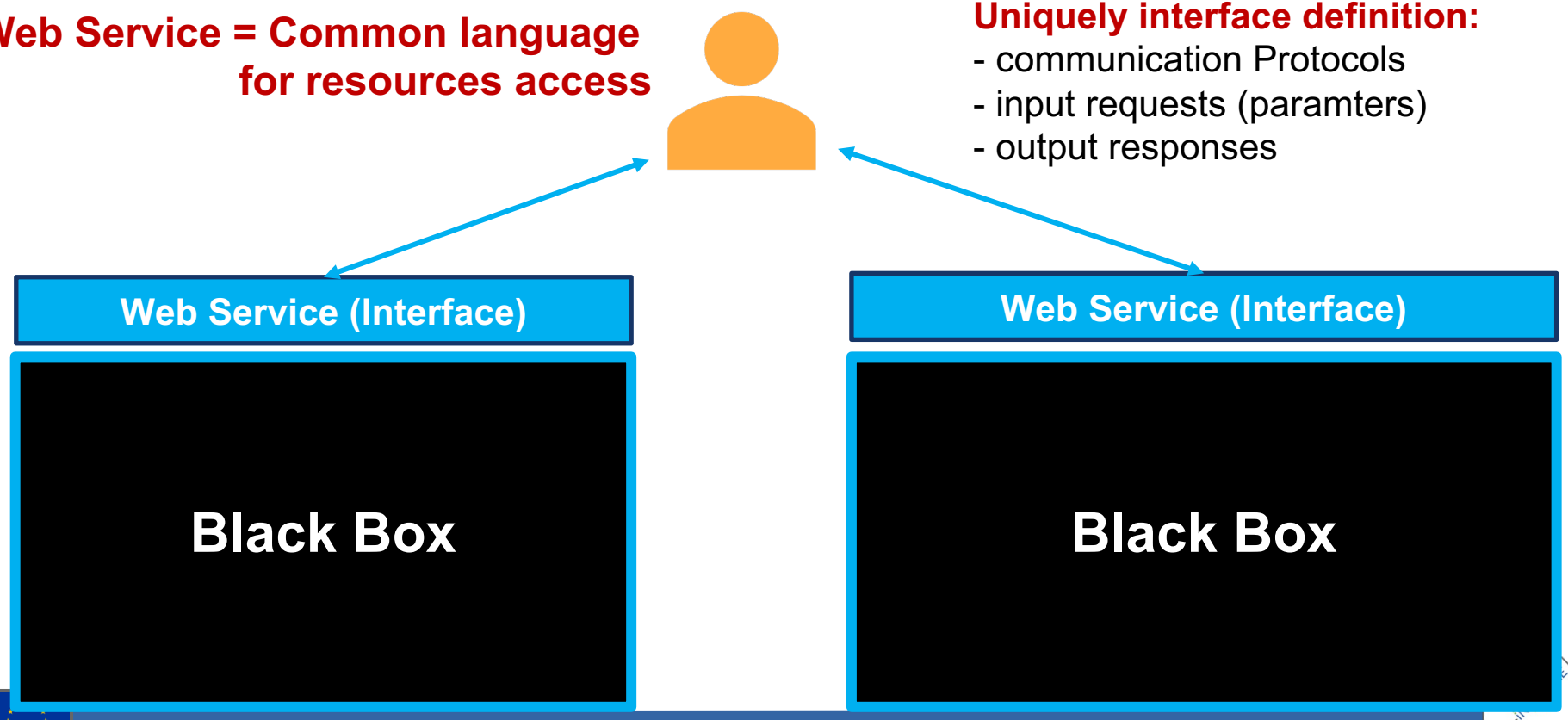




Approach 4. Achieving interoperability through WebServices

Web Service = Common language for resources access

Uniquely interface definition:
- communication Protocols
- input requests (paramters)
- output responses



Approach 4. Achieving interoperability through WebServices

- **A web service is a generic term for an interoperable machine-to-machine software** that is hosted at a network addressable location.
- A web service is an **interface, which hides the implementation details** so that it can be used independently of the hardware, software programming language by which it is implemented
- Interoperability through web services requires:
  - Decide on a communication protocol, commonly SOAP (Simple Object Access Protocol) or REST (Representational State Transfer).
  - Select Request/Response Format. Typically, XML or JSON (JavaScript Object Notation) is used to structure the data.
- *!! May require agreements about using same web service (same interface). Hard to achieve in multi disciplinary context*
- *!! Web services can be described through semantic rich metadata information. Homogenous access can then be achieved thorugh advanced software that adopts semantic crosswalks for parameters mappings*

Approach 4. Achieving interoperability through WebServices

Rich metadata and semantic description of web services parameter(s)

```
hydra:mapping[ a hydra:IriTemplateMapping;
  hydra:variable "minlatitude"^^xsd:string;
  hydra:property "epos:southernmostLatitude" ;
  rdfs:range "xsd:float";
  rdfs:label "Minimum Latitude";
  schema:minValue "-90.0";
  schema:maxValue "90.0";
  hydra:required "true"^^xsd:boolean;
  schema:defaultValue "36.61" ;
];
```

mapping

Semantic information

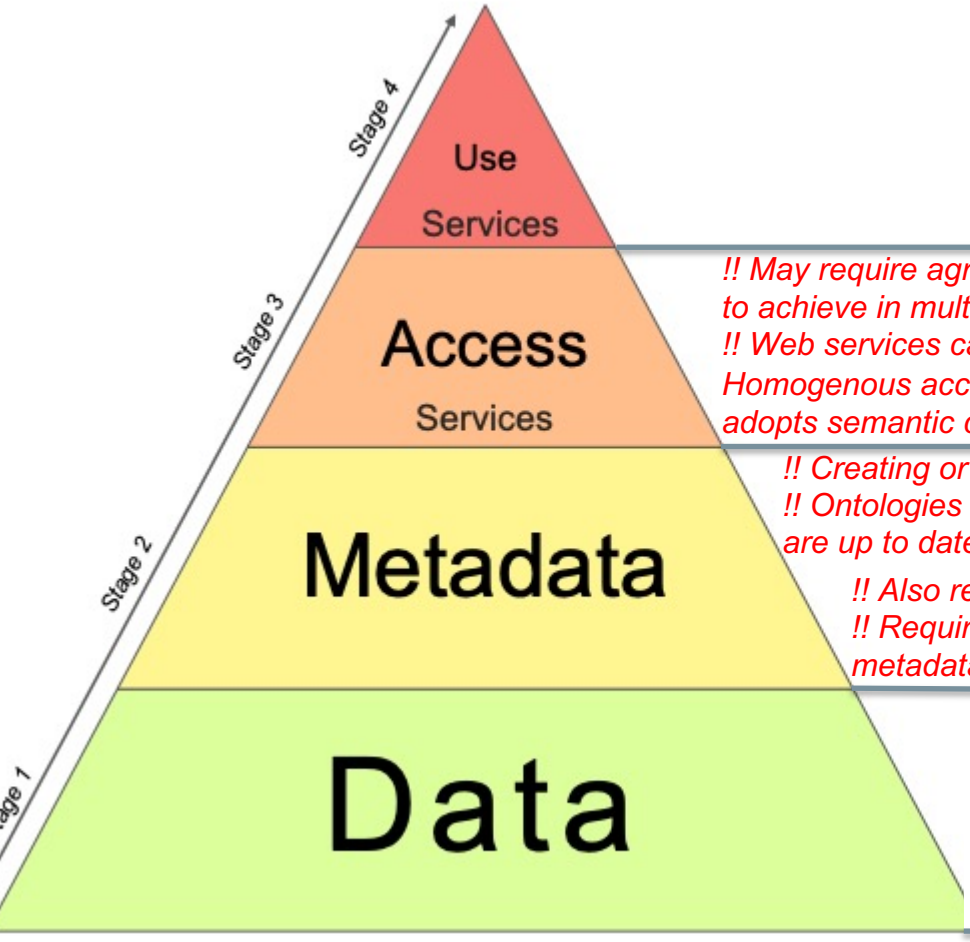
```
hydra:mapping[ a hydra:IriTemplateMapping;
  hydra:variable "minlt"^^xsd:string;
  hydra:property "epos:southernmostLatitude" ;
  rdfs:range "xsd:float";
  rdfs:label "Minimum Latitude";
  schema:minValue "-90.0";
  schema:maxValue "90.0";
  hydra:required "true"^^xsd:boolean;
  schema:defaultValue "34.61" ;
];
```

Web Service A (Interface)

Web Service B (Interface)

Black Box A

Black Box B



!! May require agreements about using same web service (same interface). Hard to achieve in multi disciplinary context

!! Web services can be described through semantic rich metadata information. Homogenous access can then be achieved thorugh advanced software that adopts semantic crosswalks for parameters mappings

!! Creating or adoptiong ontologies is quite effort consuming (is it worth it?)

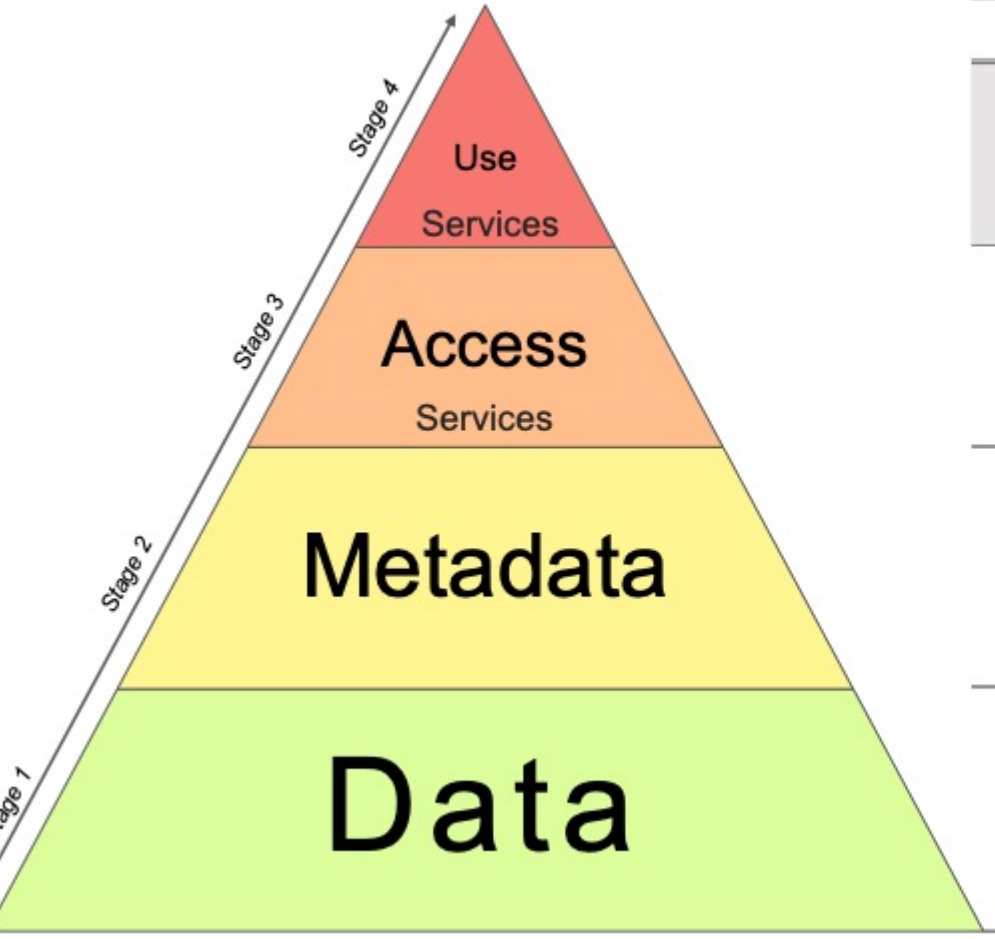
!! Ontologies and semantic mappings require continuous maintenance to ensure are up to date and accurately reflect the evolving real world

!! Also requires coordination and consensus among different stakeholders

!! Requires efforts for metadata creation and continuous curation to keep metadata up-to-date

!! Requires coordination and consensus among different stakeholders

!! Requires conversion of datasets towards one common format



FAIR PRINCIPLES

A1. (meta)data are retrievable by their identifier using a standardized communications protocol.
A1.1. the protocol is open, free, and universally implementable.
A1.2. the protocol allows for an authentication and authorization procedure, where necessary.
F4. (meta)data are registered or indexed in a searchable resource.

F1. Metadata are assigned a globally unique and eternally persistent identifier.
F2. data are described with rich metadata.
F3. metadata specify the data identifier.
F4. metadata are registered or indexed in a searchable resource.
A2. metadata are accessible, even when the data are no longer available.
I1. metadata use a formal, accessible, shared, and broadly applicable.
I2. metadata use vocabularies that follow FAIR principles.
I3. metadata include qualified references to other metadata.
R1 (R1.1 - R1.2 - R1.3) Metadata are richly described with a plurality of accurate attributes.

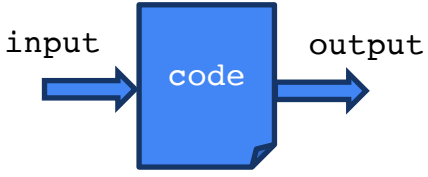
F1. Data are assigned a globally unique and eternally persistent identifier.
F4. Data are registered or indexed in a searchable resource.
I1. Data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
I2. Data use vocabularies that follow FAIR principles.
I3. Data include qualified references to other (meta)data.
R1.1. Data are released with a clear and accessible data usage license.
R1.3. Data meet domain-relevant community standards.

Bailo D, Paciello R, Sbarra M, Rabissoni R, Vinciarelli V and Cocco M (2020) Perspectives on the Implementation of FAIR Principles in Solid Earth Research Infrastructures. Front. Earth Sci. 8:3. doi: 10.3389/feart.2020.00003

From local Data Repositories to web services

Your Laptop

Local Data Storage

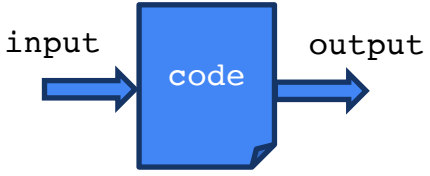


Local Software Processing

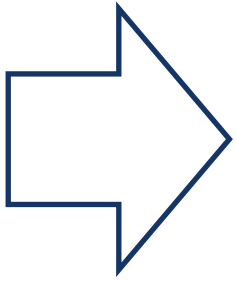
From local Data Repositories to web services

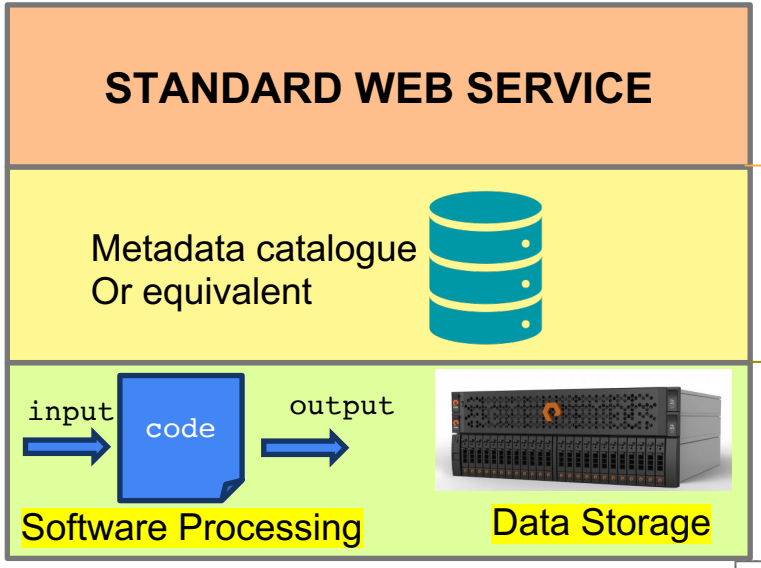
Your Laptop

Local Data Storage



Local Software Processing

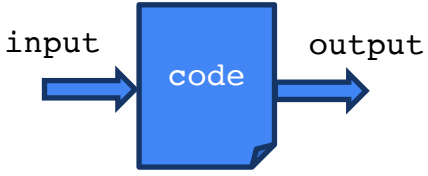




From local Data Repositories to web services

Your Laptop

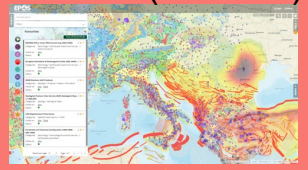
Local Data Storage



Local Software Processing

Machine Access

Portals (humans)



Users Services

STANDARD WEB SERVICE

ACCESS

Metadata catalogue
Or equivalent

META DATA

input code output

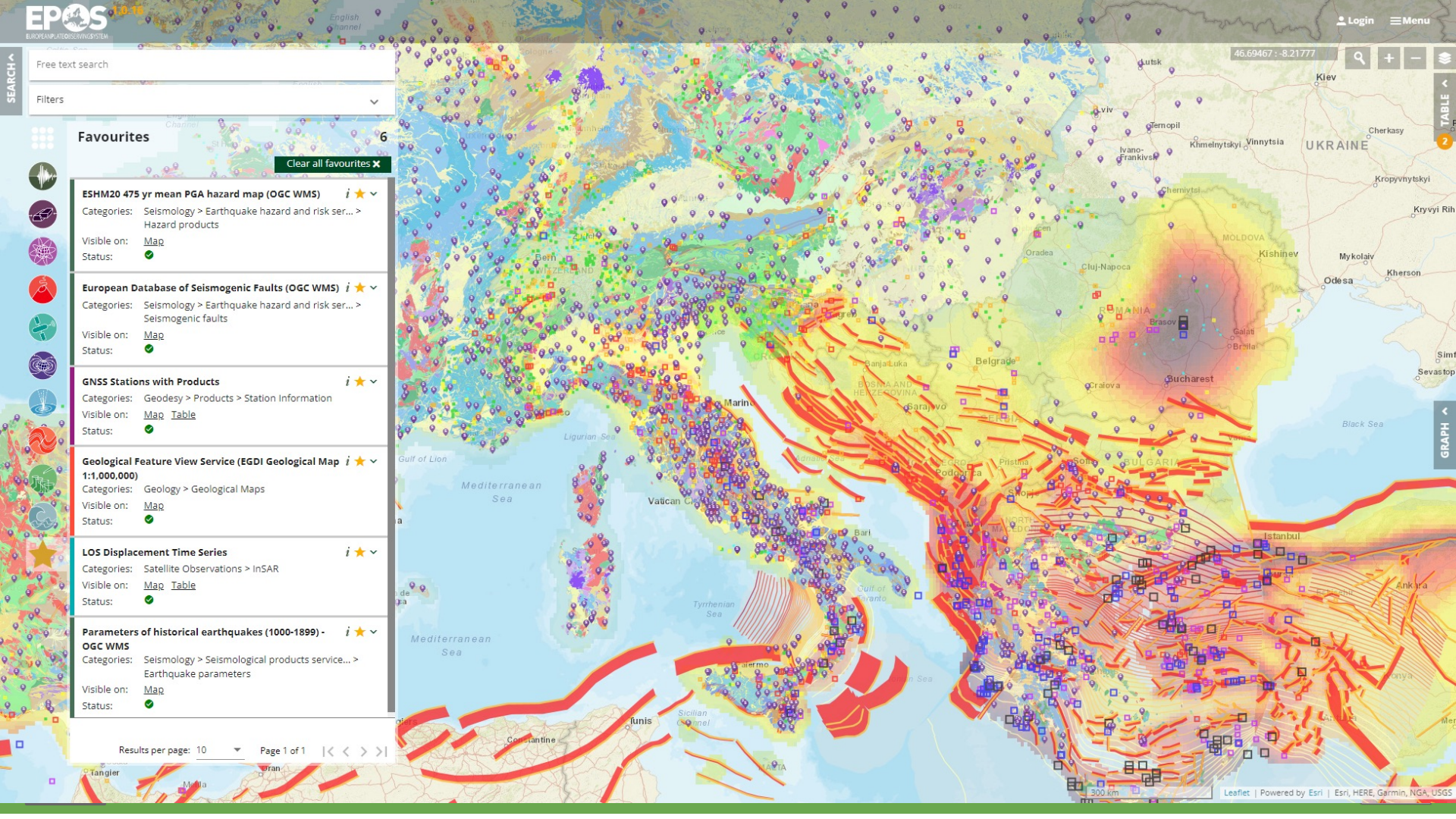
Software Processing

Data Storage

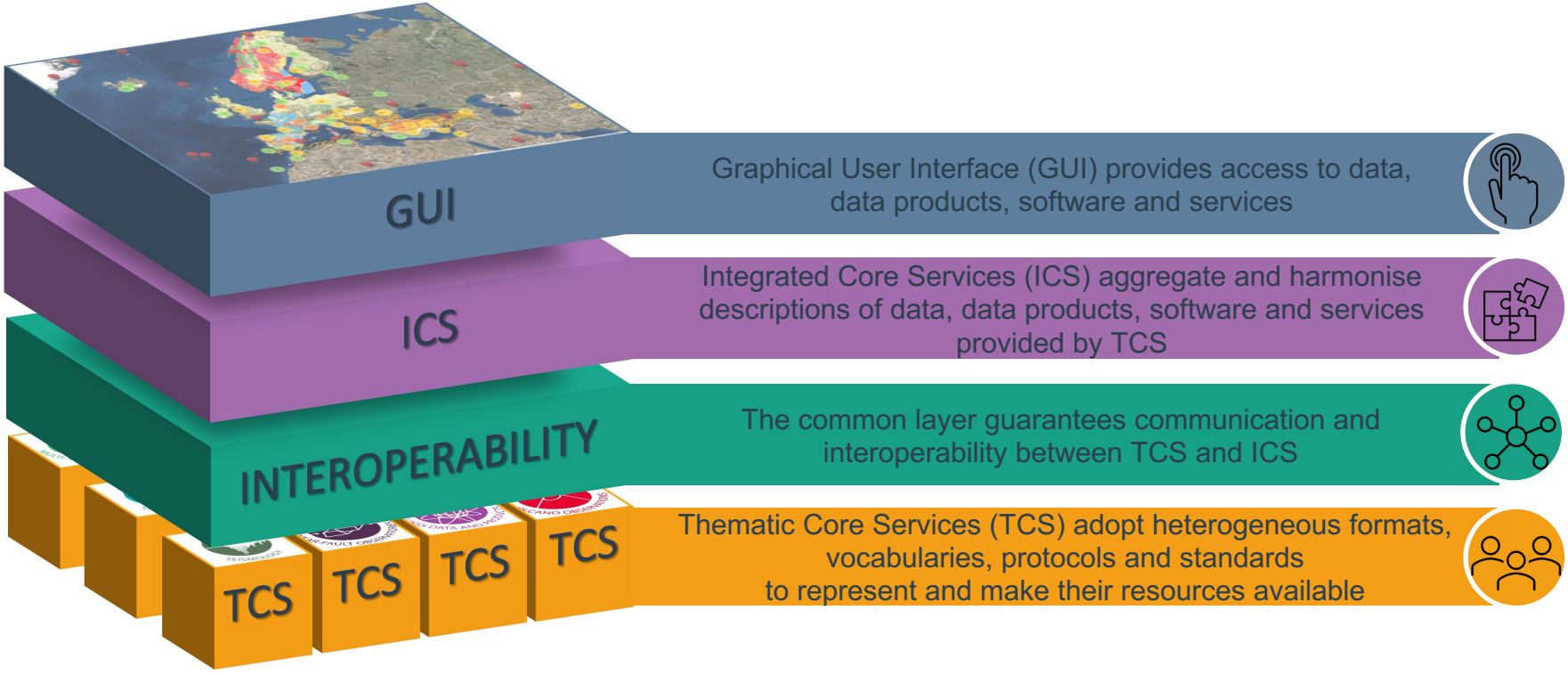
DATA

EPOS: Making Data Interoperable

- EPOS adopts the **combined** approach to provides true integration, offering a single data portal for accessing multidisciplinary data resources.
- **Semantic** descriptions in **metadata** enable adaptation to different Web Services APIs and data source complexities.
- **Data sources not forced to adopt one common standard** but only to implement basic recommendations based on the **FAIR** principles and providing metadata descriptions of the data sources.
- **Data consumers can use Web Services APIs to consume heterogeneous resources as if they were homogeneous** in terms of communication protocols, metadata description and data formats.


EPOS
Login
Menu
SEARCH
Free text search
Filters
Favourites
6
Clear all favourites
ESHM20 475 yr mean PGA hazard map (OGC WMS)
Categories: Seismology > Earthquake hazard and risk ser... > Hazard products
Visible on: Map
Status:
European Database of Seismogenic Faults (OGC WMS)
Categories: Seismology > Earthquake hazard and risk ser... > Seismogenic faults
Visible on: Map
Status:
GNSS Stations with Products
Categories: Geodesy > Products > Station Information
Visible on: Map Table
Status:
Geological Feature View Service (EGDI Geological Map 1:1,000,000)
Categories: Geology > Geological Maps
Visible on: Map
Status:
LOS Displacement Time Series
Categories: Satellite Observations > InSAR
Visible on: Map Table
Status:
Parameters of historical earthquakes (1000-1899) - OGC WMS
Categories: Seismology > Seismological products service... > Earthquake parameters
Visible on: Map
Status:
Results per page: 10
Page 1 of 1
46.69467 : -8.21777
TABLE
GRAPH
Kiev
UKRAINE
Belgrade
Bucharest
Istanbul
Ankara
Mediterranean Sea
Black Sea
Leaflet | Powered by Esri | Esri, HERE, Garmin, NGA, USGS

EPOS Technical Architecture

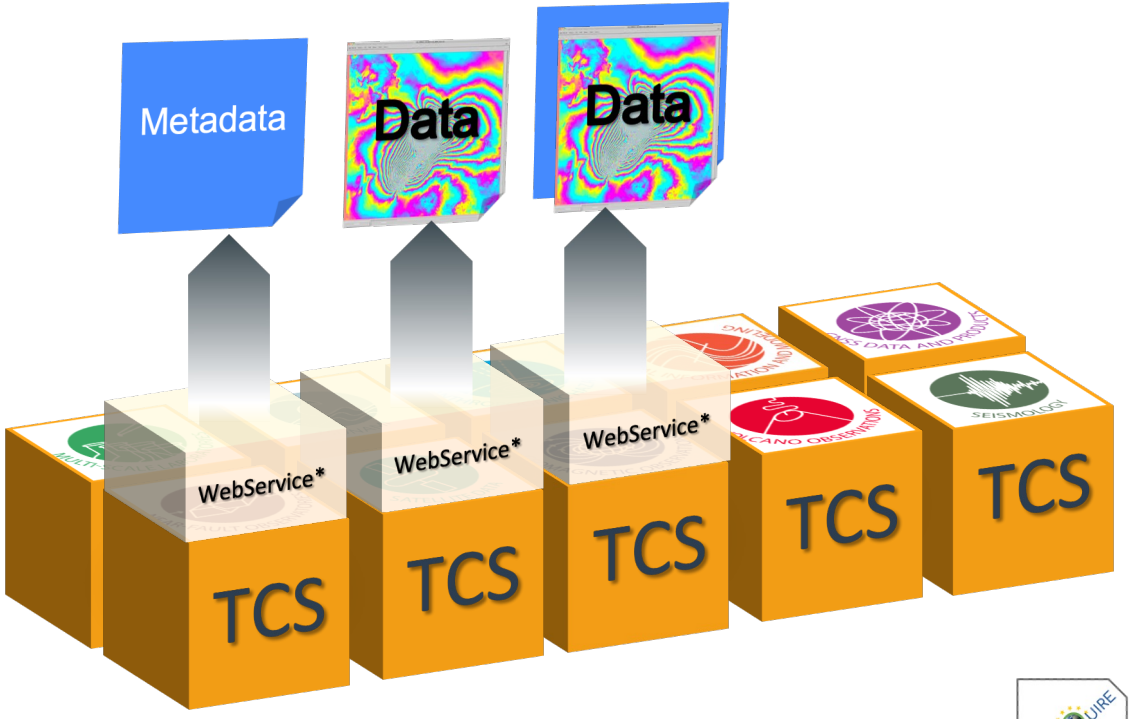


D. Bailo, K.G. Jeffery, K. Atakan, L. Trani, R. Paciello, V. Vinciarelli, J. Michalek, A. Spinuso, ***Data integration and FAIR data management in Solid Earth Science****, in Annals of Geophysics, vol. 65 No. 2 (2022), Special issue: EPOS a Research Infrastructure in solid Earth: open science and innovation. Doi: https://doi.org/10.4401/ag-8742*

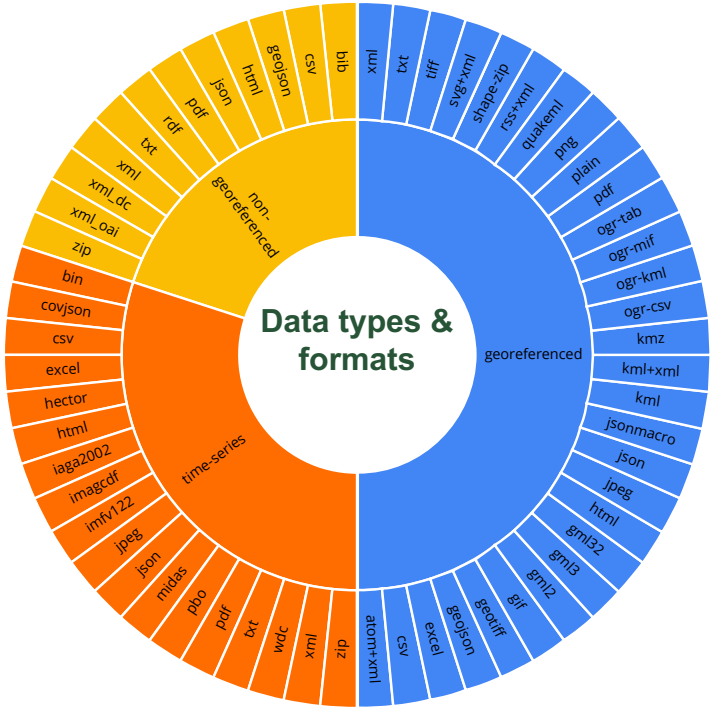
Thematic Core Services (TCS)

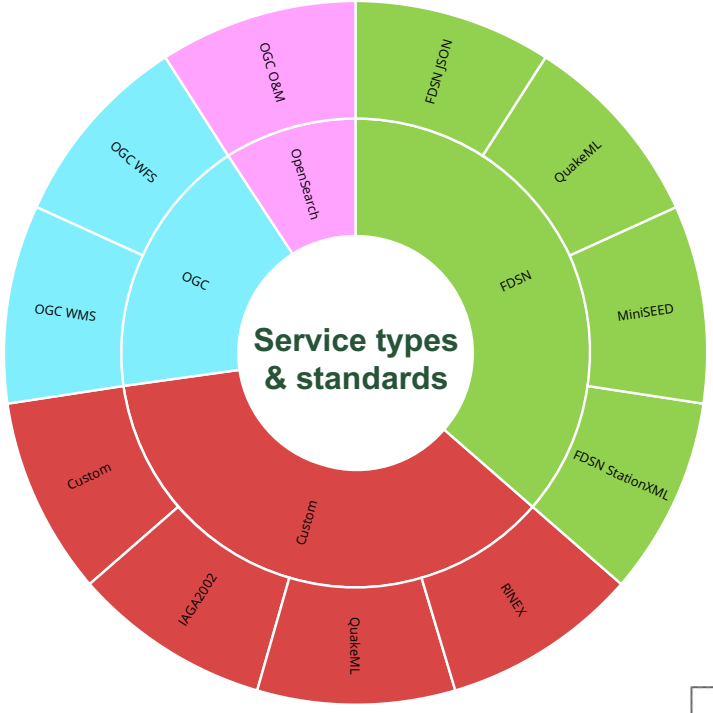
TCS= Data provider

- TCS represent datasets and services provided by domain specific communities.
- Datasets are produced by a heterogeneous set of data providers.
- Datasets are accessible by means of web services*.



Heterogeneity of TCS Data and Services

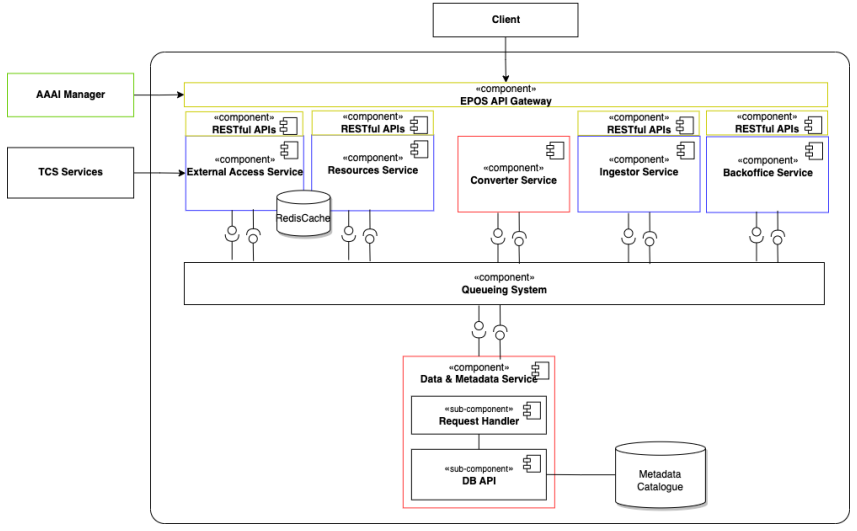




ICS= Central Integration HUB

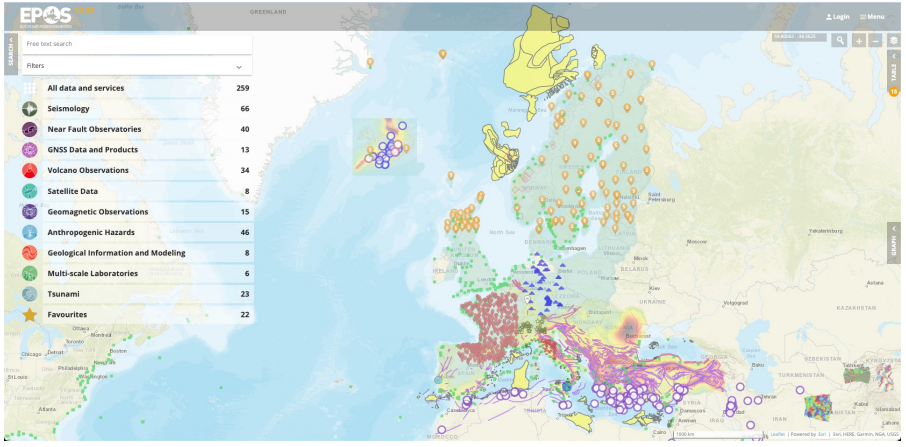
It consists of three sub tiers:

- **WebAPIs**, which provide a set of RESTful endpoints to enable the communication with GUI tier.
- **Micro-services**, which enable ICS to run in a distributed environment, properly scale specific system functionalities and enhance reliability.
- **Metadata Catalogue**, which is used to store information about data, data products, software, services, and other information associated with them.



Main features:

- **Search**, by specifying a set of search criteria (e.g., free-text search, spatio-temporal range).
- **Results Exploration**, browsing the retrieved results and previewing them in different ways (Map, Table, Graph).
- **Results Refinement**, results can be further refined through service-specific options.
- **Final Selection**, downloading the selected results or putting them into a list of favourites.



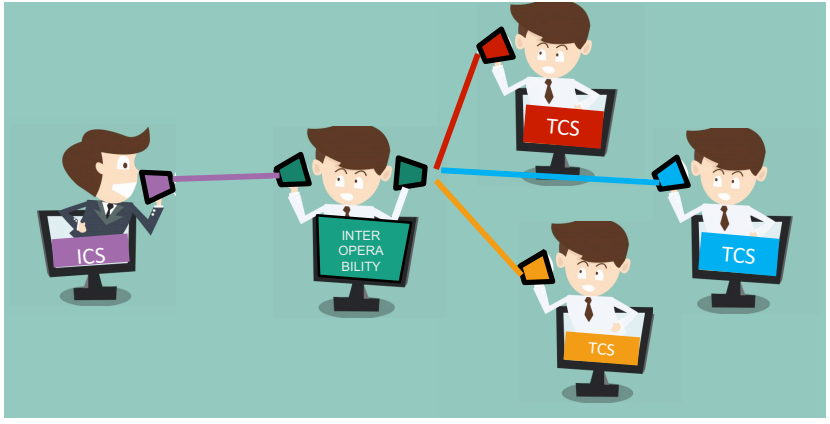
What is the **LAYER** where heterogeneous resources are harmonized to provide users with an integrated access?

Q&A

INTEROPERABILITY LAYER

Interoperability Layer

- It was developed to enable the interaction between **ICS** and **TCS.**
- It allows **TCS** to provide descriptions of their assets.
- It allows **ICS** to capture, organise and harmonise information from different sources.
- It adopts a common knowledge representation language defined in the form of application profile.

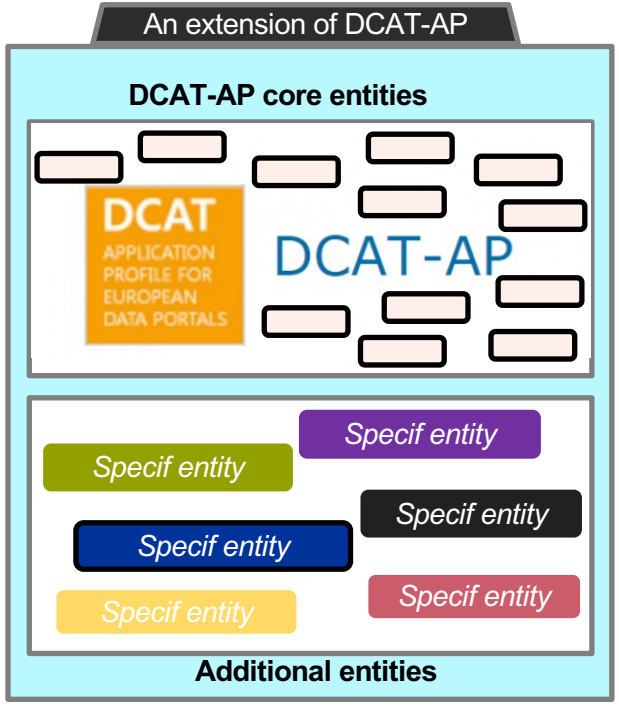


An Application Profile to exchange knowledge

- A profile supports a community interested in **interoperability** and **data exchange** within of specific context.
- It defines what **entities** are described, their **relationships**, the use of controlled **vocabularies**, cardinality of fields/properties and data types.
- The DCAT Application Profile (**DCAT-AP**) is a specification developed by W3C to enable the exchange of dataset descriptions between data portals in Europe.
- Several extensions of DCAT-AP have been created to address domain-specific requirements.

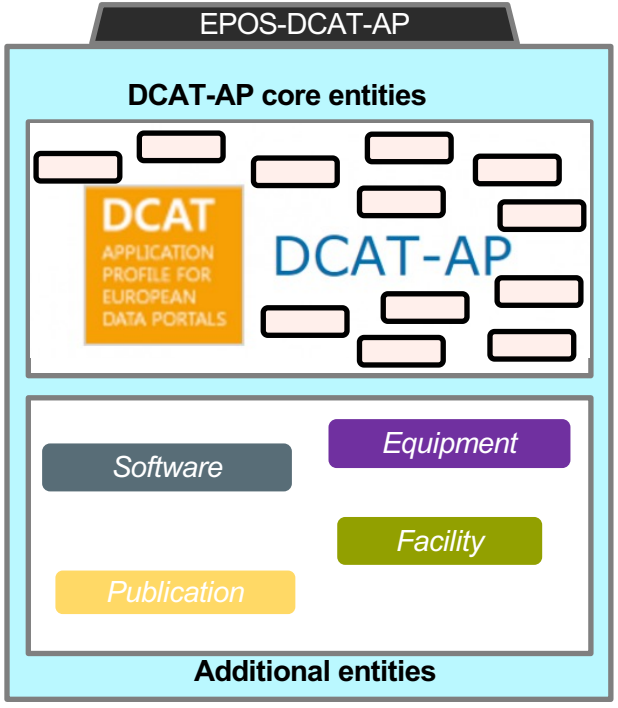
What is an extension of DCAT-AP?

- DCAT-AP defines a set of **classes and properties**.
- An extension of DCAT-AP address **domain-specific requirements** by adding classes and properties.
- An extension of DCAT-AP needs to meet the **minimum requirements** described in DCAT-AP specification.



EPOS-DCAT-AP: an extension of DCAT-AP for Research Infrastructures in the solid-Earth domain

- **EPOS-DCAT-AP extends DCAT-AP** to address the specific requirements of the EPOS communities.
- It **adds a set of classes and properties** that covers the main assets and resources useful in the EPOS context.
- It introduces **new relationships** and **roles**.
- It **reuses elements** of popular vocabularies (e.g., Schema.org and the Hydra Core Vocabulary).
- It enables integrity checks and validation (via **SHACL**).



EPOS-DCAT-AP Versions History

Version 0.9 — February 2018

Extension of the DCAT-AP v 1.1 for EPOS context taking into account the following criteria: (i) Identified the essential elements and attributes of EPOS-DCAT-AP in the EPOS context; (ii) Identified the controlled vocabularies to be used in the EPOS context; (iii) Identified the strict minimum description metadata to be exchanged between TCS and ICS.

Version 0.12 — July 2018

Revision of previous version taking into account the following criteria: (i) Ensure compliance with DCAT-AP v 1.1; (ii) update EPOS namespace.

Version 0.14 — February 2019

Revision of previous version taking into account the following criteria: (i) Ensure compliance with DCAT-AP v 1.1; (ii) In order to steer towards quality metadata descriptions, the implementation of a number of properties are recommended or made mandatory.

Version 0.15 — June 2019

The changes implemented in this version are related to the Software entities as well as requests coming from real-world implementations of the specification.

Version 1.0 — September 2020

This version addresses bugs identified by the previous versions and covers changes related to the Equipment and Facility entities.

Version 2.0 — May 2022

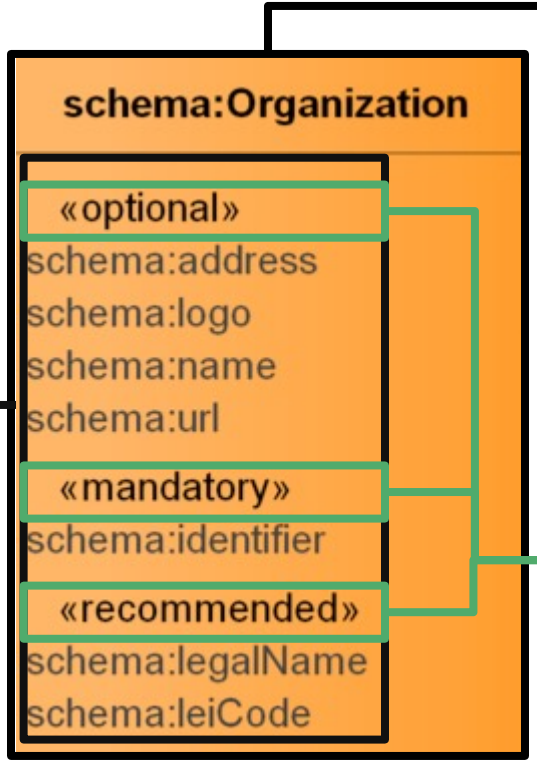
This version is based on DCAT-AP v 2.1.1 because some of the gaps identified by EPOS-DCAT-AP v 1.0 were filled by DCAT-AP v2 (e.g., introducing DataService class).

Version 3.0 — new — September 2023

This version is based on DCAT-AP v 3.0 introducing Dataset Series and DatasetInSeries classes.

Class and Properties definition

PROPERTIES: describe the structure and value of an instance of a class

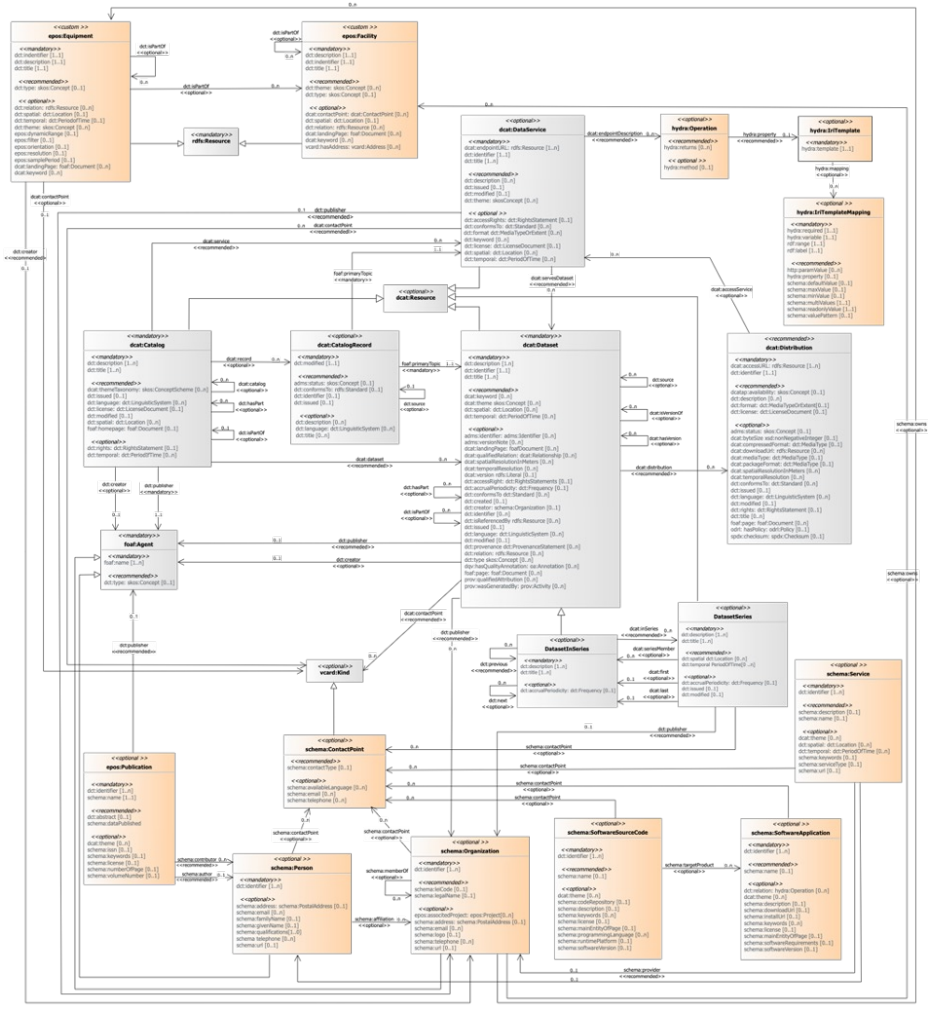


CLASS (or Entity): describes a set of objects that share the same features, constraints, semantics.

*Mandatory: information for class or property **must** be provided.*
*Recommended: information for class or property **should** be provided.*
*Optional: information for class or property **may** be provided.*

EPOS-DCAT-AP UML CLASS DIAGRAM

https://epos-eu.github.io/EPOS-DCAT-AP/v3/



DCAT-AP v 3.0 classes

EPOS-DCAT-AP v 3.0 additional classes

Classes characterizing EPOS-DCAT-AP

- **Operation:** a description of a web service operation.
- **IriTemplate:** it consists of a template literal and a set of mappings.
- **IriTemplateMapping:** a variable (parameter) used in the template.
- **Service:** a generic service.
- **Equipment:** a generic equipment (e.g., GPS sensor, seismic station).
- **Facility:** facility with resources and related services used by the scientific community to conduct top-level research in their respective fields, e.g., Seismic Network.
- **SoftwareApplication:** software packages, applications and programs.
- **SoftwareSourceCode:** computer programming source code.

EPOS-DCAT-AP: Syntactic and Semantic aspects

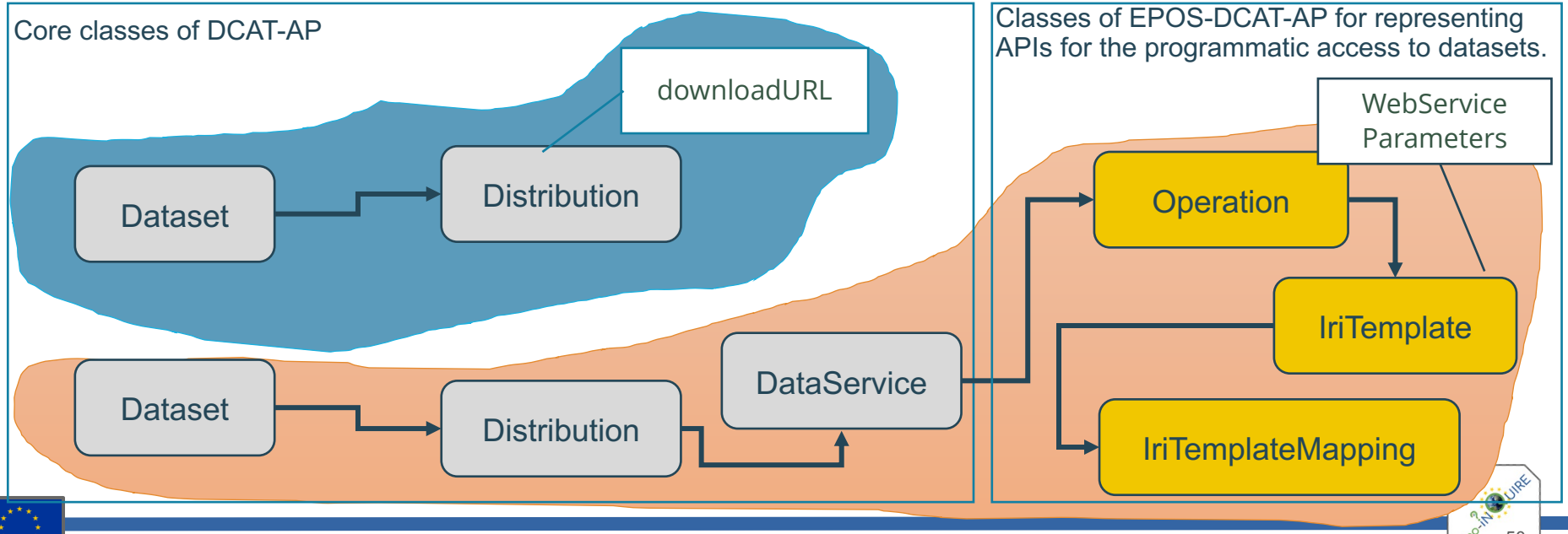
- EPOS-DCAT-AP allows to implement **syntactic** interoperability between ICS and TCS:
  - RDF/Turtle format is the encoding format used by TCS to provide metadata descriptions to ICS.

- EPOS-DCAT-AP allows to implement **semantic** interoperability between ICS and TCS:
  - TCS describe their main resources by using standard vocabularies (e.g., DCAT, Schema, Hydra) which allow ICS, and any machine, to capture the meaning associated with the metadata content.

Datasets and Web Services description through EPOS-DCAT-AP

The profile allows to describe Datasets distributed through:

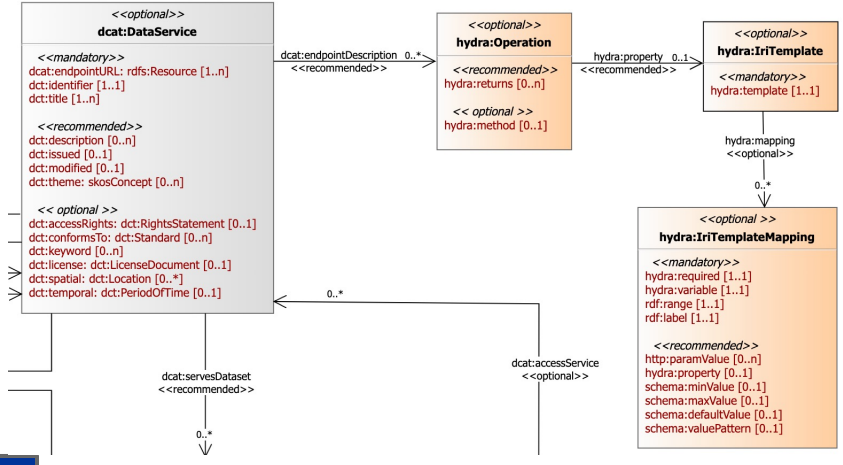
- **downloadable** files available from direct URLs;
- **web services** implemented according to global, well-established and community specific standards (e.g., OGC, RESTful, FDSN);



EPOS-DCAT-AP – Web Service description with semantics information

EPOS-DCAT-AP uses classes of **Hydra vocabulary** to describe access-specific properties for Application Programming Interface (API):

- ***Operation:*** IRI template
- ***IriTemplate:*** list of parameters that enable data access;
- ***IriTemplateMapping***, each parameter of the IRI template.




```
<https://www.epos-eu.org/epos-dcat-ap/example/Operation/001> a hydra:Operation;
  hydra:method "GET";
  hydra:returns "application/xml" ;

  hydra:property[ a hydra:IriTemplate ;
        hydra:template "http://www.test.org/{?param1,param2}"^^xsd:string ;
        hydra:mapping[ a hydra:IriTemplateMapping ;
                hydra:variable "param1"^^xsd:string ;
                rdfs:label "Start of the timespan" ;
                schema:valuePattern "YYYY-MM-DDThh:mm:ss» ;
                hydra:property "schema:startDate";
                hydra:required "true"^^xsd:boolean ;
                rdfs:range "xsd:dateTime" ;
                schema:minValue "2012-01-01T00:00:00" ;
                schema:maxValue "2017-12-01T00:00:00" ;

        ];
        hydra:mapping[ a hydra:IriTemplateMapping ;
                hydra:variable "param2"^^xsd:string ;
                rdfs:label "Output format" ;
                hydra:required "false"^^xsd:boolean ;
                rdfs:range "xsd:string" ;
                hydra:property "schema:encodingFormat";
                http:paramValue "xml";
                http:paramValue "text";
                http:paramValue "json";
        ];
    ];
.
```

Semantic tags

EPOS-DCAT-AP RDF/Turtle serialization

EXAMPLE

DATASET

```
<https://www.epos-eu.org/Seismology/Dataset/001> a
dcat:Dataset ;
    dct:title "Primary Seismic Waveform Data" ;
    dct:created "2016-01-01T00:00:00Z"^^xsd:dateTime ;
    dct:type
"http://purl.org/dc/dcmitype/Collection"^^xsd:anyURI ;
    dcat:contactPoint <http://orcid.org/0000-0001-0002-
0003/contactPoint>;
    dct:publisher <PIC:000518944> ;
    dcat:distribution <https://www.epos-
eu.org/Seismology/Distribution/001> ;
    ...
.
```

DISTRIBUTION

```
<https://www.epos-eu.org/Seismology/Distribution/001> a
dcat:Distribution ;
    dct:title "Title of Seismic Waveform Distribution" ;
    dct:description "Description of Seismic Waveform
Distribution";
    dct:format
"http://publications.europa.eu/resource/authority/file-
type/BIN"^^xsd:anyURI ;

    dcat:accessService<https://www.epos-
eu.org/Seismology/Operation/001> ;
    ...
.
```

DATASERVICE

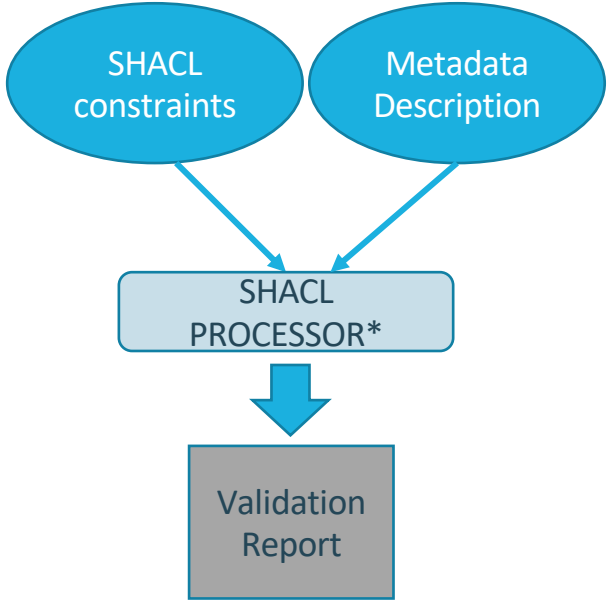
```
<https://www.epos-eu.org/Seismology/WebService/001> a
dcat:DataService ;
    dct:title "FDSN Dataselect - ORFEUS Data Center" ;
    dct:description "FDSN Standard webservice to download
waveform data" ;
    dcat:contactPoint <http://orcid.org/0000-0001-0002-
0003/contactPoint>;

    dcat:endpointDescription <https://www.epos-
eu.org/Seismology/Operation/001>
    ...
.
```

OPERATION

```
<https://www.epos-eu.org/Seismology/Operation/001> a
hydra:Operation;
    hydra:method "GET";
    hydra:returns "application/vnd.fdsn.mseed" ;
    hydra:property[ a hydra:IriTemplate ;
        hydra:template "http://www.orfeus-
eu.org/fdsnws/dataselect/1/query/{?starttime,endtime}"^^xs
d:string ;
          hydra:mapping[ a hydra:IriTemplateMapping ;
             hydra:variable "starttime" ;
             rdfs:label "Start of the timespan" ;
             schema:valuePattern "YYYY-MM-DDThh:mm:ss» ;
             hydra:required "true"^^xsd:boolean ;
             rdfs:range "xsd:dateTime" ;
             schema:minValue "2012-01-01T00:00:00" ;
             schema:maxValue "2017-12-01T00:00:00" ;
          ];
          ...
```

EPOS-DCAT-AP Metadata Validation

- EPOS-DCAT-AP enables integrity checks and validation of metadata content by using **SHACL constraints** (https://github.com/epos-eu/EPOS-DCAT-AP/blob/EPOS-DCAT-AP-shapes/epos-dcat-ap_shapes.ttl);
- SHACL is a W3C recommendation language for describing and validating RDF data graphs against a set of constraints;
- These constraints are provided as **shapes**;
- Shapes are used to define **classes** together with constraints on their **properties** such as:
  - cardinality (minCount and maxCount);
  - value type and allowed values;
  - more complex kinds of constraints.



* SHACL Processors available online:
https://shacl.org/playground/
https://shacl-play.sparna.fr/play/validate

SHACL VALIDATION

EXAMPLE

SHAPE

```
:DatasetShape a sh:NodeShape ;
    sh:targetClass dcat:Dataset;

    sh:property [
        sh:path dct:title ;
        sh:datatype xsd:string ;
        sh:minCount 1 ;
    ];
    sh:property [
        sh:path dct:description ;
        sh:datatype xsd:string ;
        sh:minCount 1 ;
        sh:maxCount 1 ;
    ]
.
```

PROPERTIES

METADATA SERIALIZED IN TURTLE FORMAT

```
<https://www.epos-eu.org/Seismology/Dataset> a
dcat:Dataset ;
     dct:title 123 ;
     dct:description "Continuous seismic waveforms" ;
.
```

METADATA IN TURTLE FORMAT

```
<https://www.epos-eu.org/Seismology/Dataset> a
dcat:Dataset ;
     dct:title "Seismic Waveform Data" ;
     dct:description "Continuous seismic waveforms" ;
     dct:description "Description of Dataset" ;

.
```

Metadata Quality check

- Filling in only the mandatory or recommended fields is not sufficient to ensure high-quality metadata.
- It is necessary to define a checklist of fields for verifying the accuracy, completeness, consistency, and relevance of metadata in a specific context.
- In addition, a set of fields are typically defined to assess compliance with the FAIR principles
  (i.e., **Findability, Accessibility, Interoperability, Reusability)**

EPOS Metadata Quality check

Categories

- Dataset entities need to be linked to one of the 'dcat:theme' defined for the EPOS context. These categories are used to categorize TCS assets, ensuring that they are presented as organized results in the Portal.

Spatio-temporal coverage

- These are used to enable ICS to query TCS web services in an interoperable way. Additionally, they play a key role in discovering data and products

Institutions/organizations

- Datasets and Web services need to be linked to the Organization entities in order to define data and service providers, respectively.

Keywords

- Keywords need to be associated with Dataset and Web service entities. Their proper definition is crucial for the correct functioning of the discovery features.

How Metadata contributes to data discovery features

Data Search

Search Refinement

Data Visualization

Data Download

Data Search

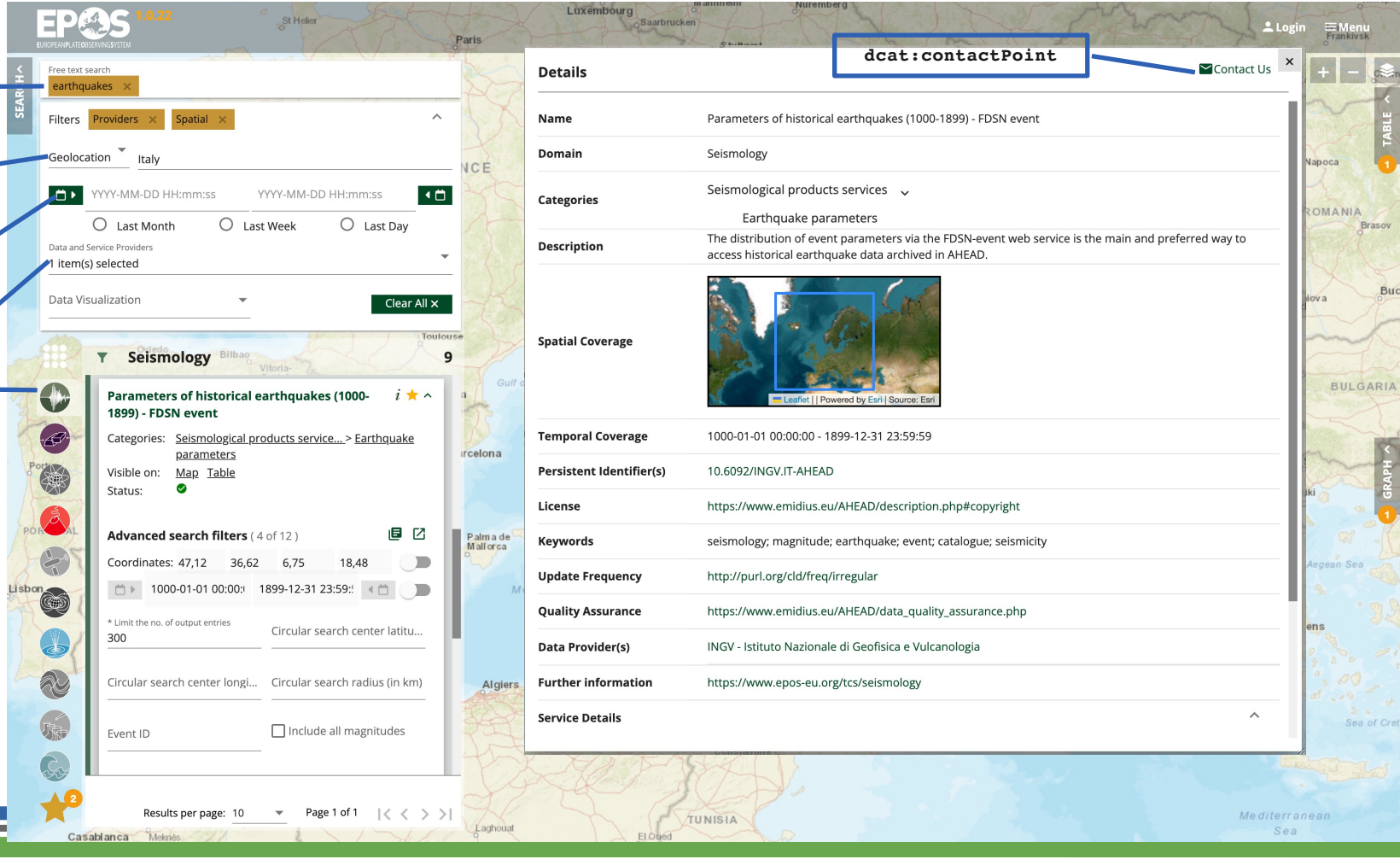
dcat:keyword

dct:spatial

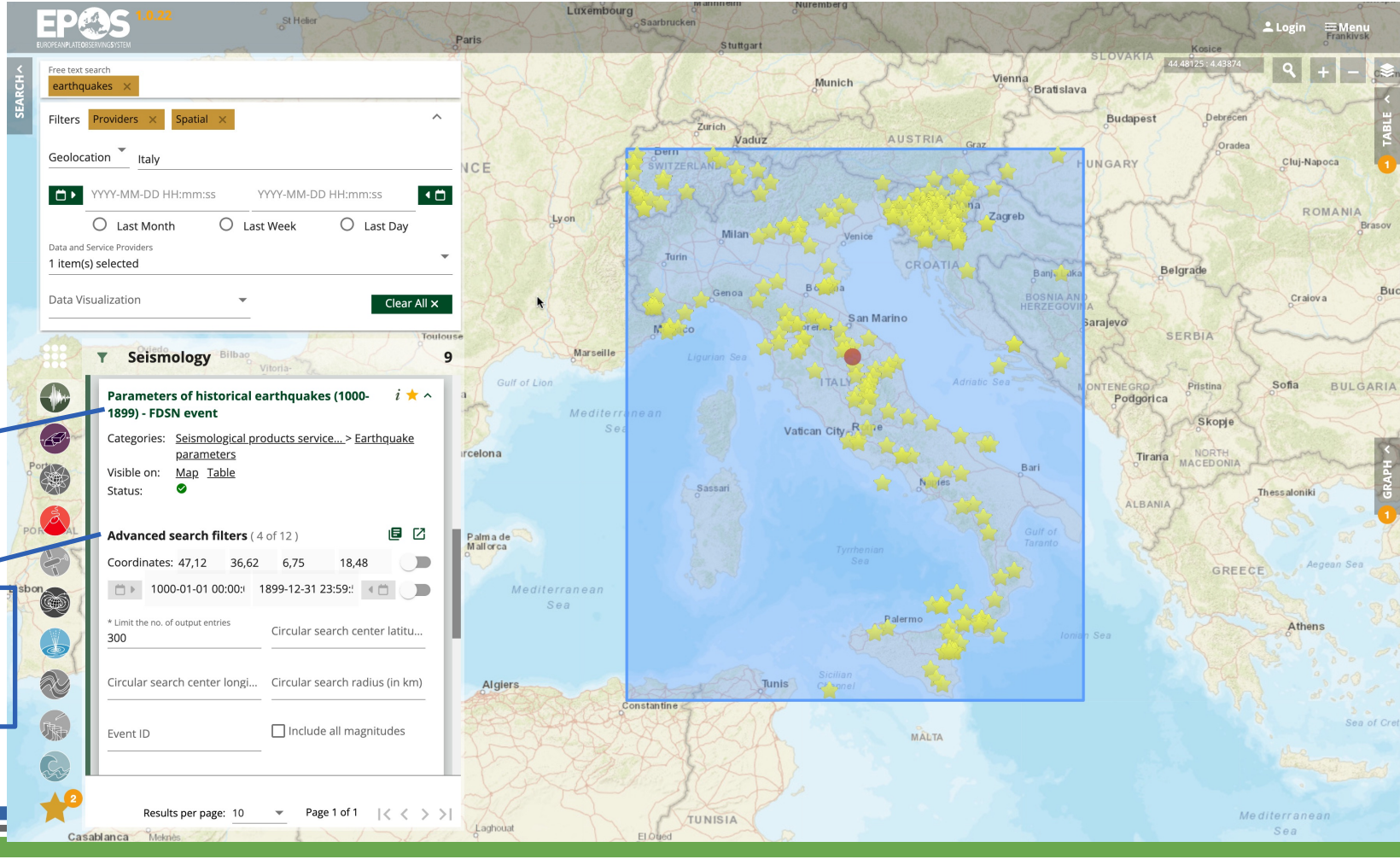
dct:temporal

dcat:publisher

dcat:theme



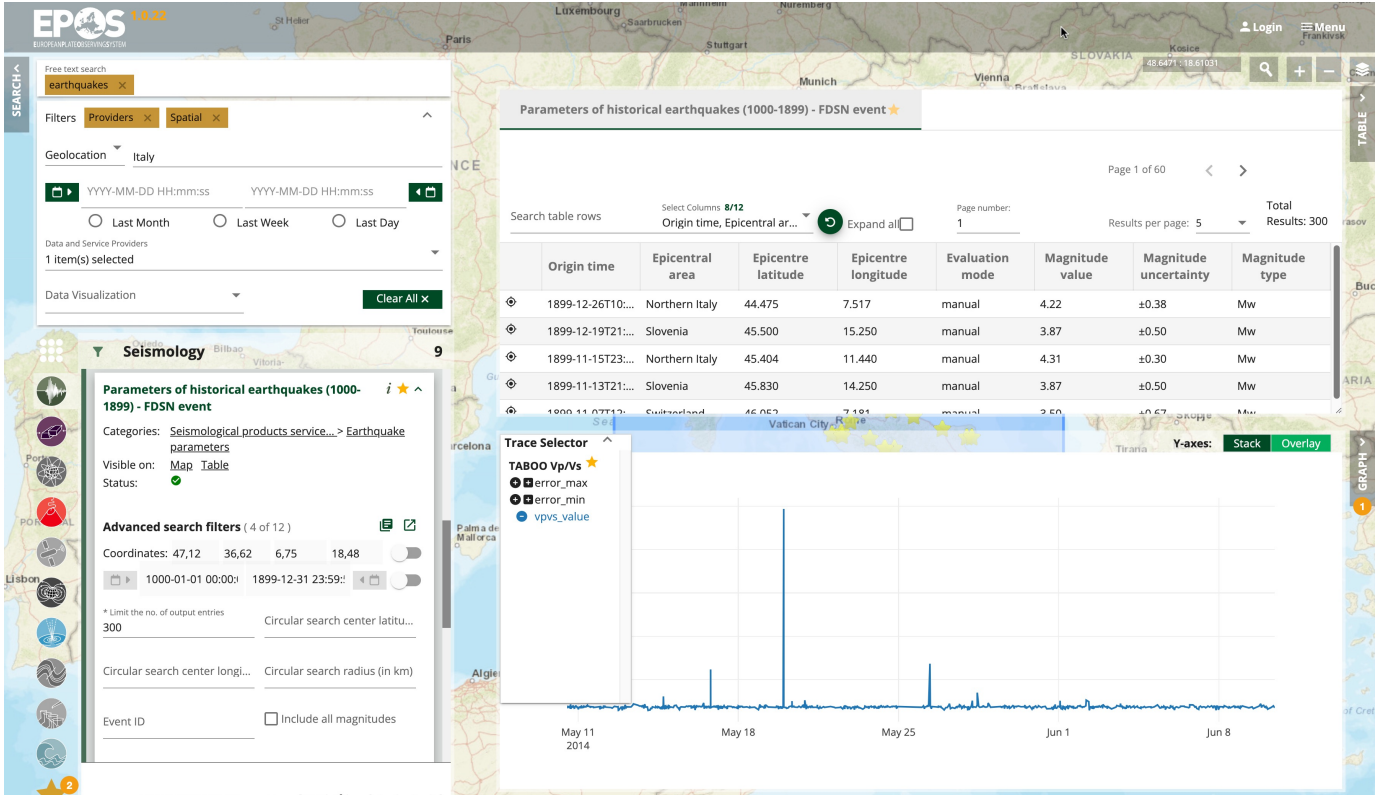
Search Refinement



dcat:Distribution

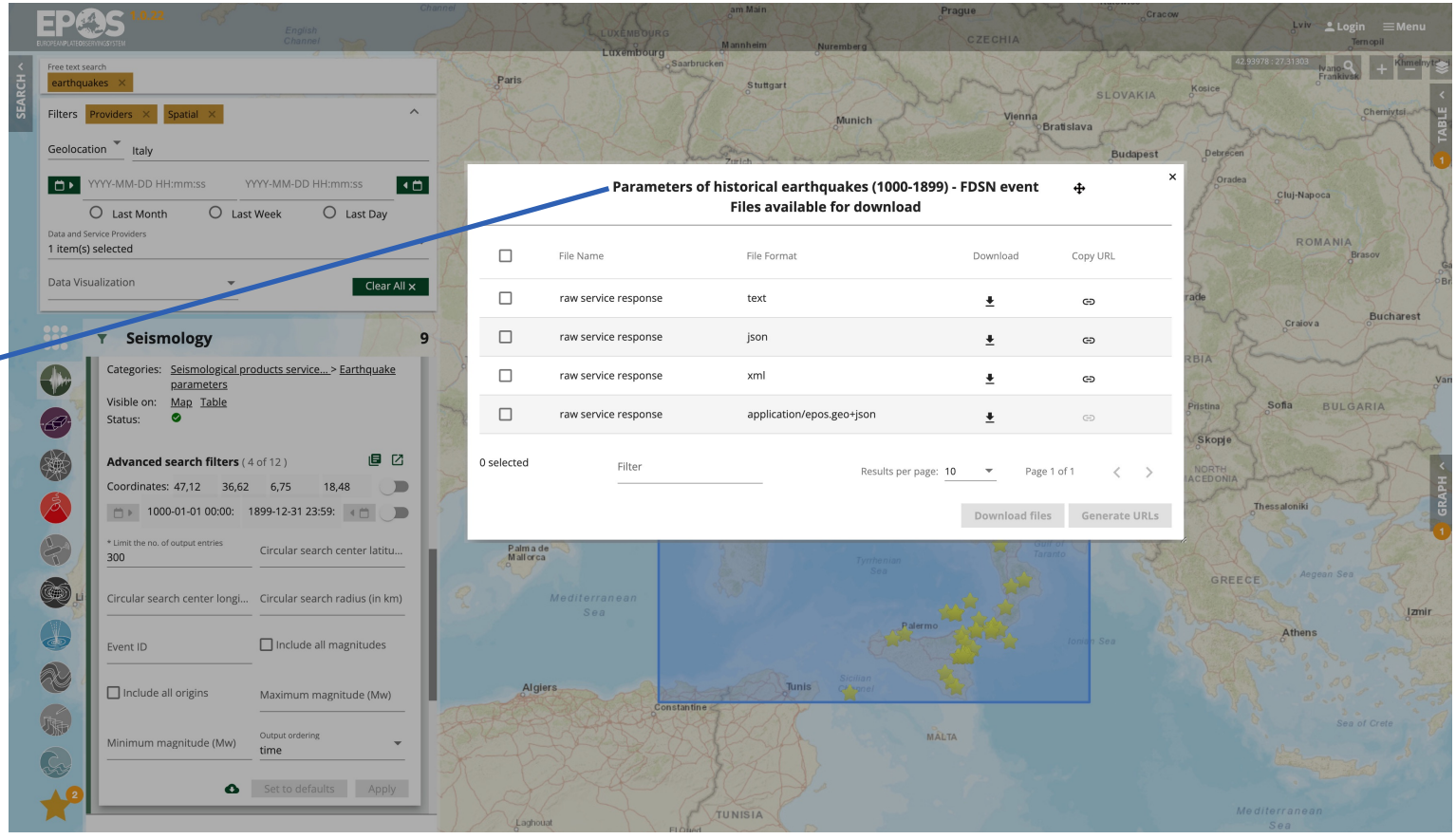
dcat:DataService
hydra:Operation,
hydra:IriTemplate
hydra:IriTemplate
Mapping

Data Visualization



Several software converters are described by using **schema:SoftwareApplication** and **schema:SoftwareSourceCode** classes

Data Download



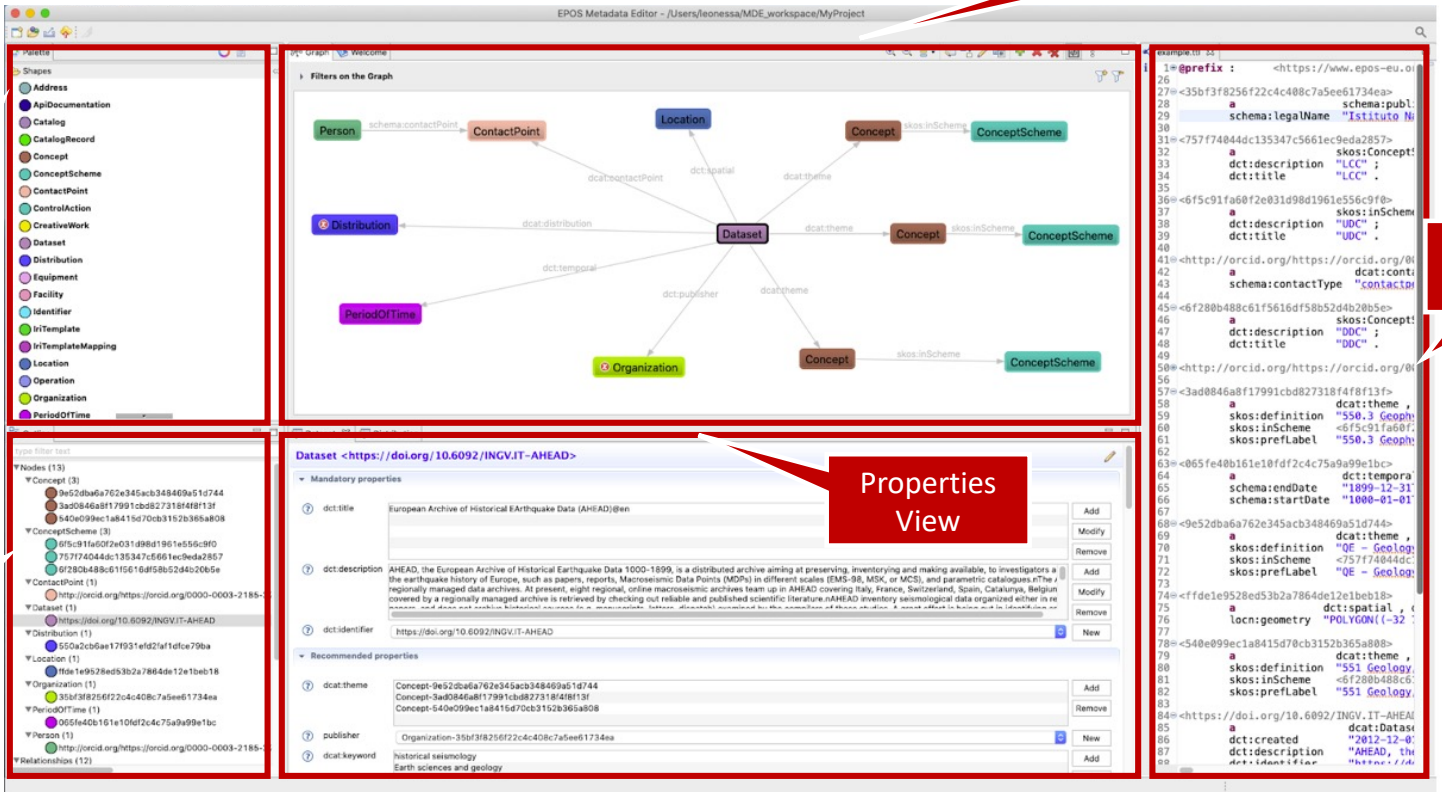
Distribution > dct:format
Hydra:Operation > schema:encodingFormat

SHAPE*ness:* a metadata management tool

- It is a Java desktop application conceived to help users creating and updating EPOS-DCAT-AP metadata descriptions.
- It provides a graph-based interface which allows users to:
  - Create or update metadata as data graphs;
  - validate metadata against SHACL constraints;
  - serialize metadata in RDF/Turtle format;
  - deposit metadata turtle file to a GitLab repository.
- The latest version of SHAPE*ness* is available on GitHub at https://epos-eu.github.io/SHAPEness-Metadata-Editor/gitpage/index.html

Paciello, R., Trani, L., Bailo, D., Vinciarelli, V., Sbarra, M. (2023). ***SHAPEness: A SHACL-Driven Metadata Editor****. In: Garoufallou, E., Vlachidis, A. (eds) Metadata and Semantic Research. MTSR 2022. Communications in Computer and Information Science, vol 1789. Springer, Cham. https://doi.org/10.1007/978-3-031-39141-5_23.*

SHAPE*ness* Metadata Editor



Q&A

References

- **EPOS-DCAT-AP:** https://epos-eu.github.io/EPOS-DCAT-AP/v3/
- **SHAPE*ness* Metadata Editor:** https://epos-eu.github.io/SHAPEness-Metadata-Editor/gitpage/index.html
- **DCAT-AP v3:** https://www.w3.org/TR/vocab-dcat-3/
- **RDF:** https://www.w3.org/RDF/
- **TURTLE:** https://www.w3.org/TR/turtle/
- **SHACL:** https://www.w3.org/TR/shacl/
- Bailo, D. et al. (2023). **Integrated Access to Multidisciplinary Data Through Semantically Interoperable Services in a Metadata-Driven Platform for Solid Earth Science**. In: Garoufallou, E., Vlachidis, A. (eds) Metadata and Semantic Research. MTSR 2022. Communications in Computer and Information Science, vol 1789. Springer, Cham. https://doi.org/10.1007/978-3-031-39141-5_20
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Thank you for your attention!

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