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European Commission

ELISE Knowledge Transfer: Location Interoperability for Digital Transformation, ABCIV-000152-6000184687-REQ-01

EC Joint Research Centre – Unit B6

Rapid Study: Persistent Identifiers (PID)

15/07/2019

ELISE

ISA² Action: ELISE

The EC Joint Research Centre is leading the **European Location Interoperability Solutions for E-government (ELISE)** Action. ELISE is a package of legal/policy, organisational, semantic and technical interoperability solutions to facilitate efficient and effective electronic cross-border or cross-sector interaction between European public administrations and between them and citizens and businesses, in the domain of location information and services.

ELISE Knowledge Transfer - Location Interoperability for Digital Transformation*:* To support knowledge transfer and capacity building in the context of location interoperability and digital transformation.

Rapid studies: brief but detailed analysis aimed at generating and sharing knowledge about location interoperability and digital government transformation from both research and practice.

Before we start (1/2)

About me

Danny Vandenbroucke

- **Position**: Research Manager at KU Leuven (SADL)
- **Education:** MSc in Geography (KU Leuven)
- **Roles:** Co-chair of the OGC Metadata & Catalogue DWG (2017 – Present) - External Innovation Expert in the Council for Information and ICT Policy of the Flemish Government (2017 – Present) – Member of the Board of Directors of the Agency for Geographic Information Flanders, AGIV (2014-2016) - Chair of the Belgian Mirror Committee of ISO/TC 211 & CEN/TC 287 – (2010 - Present)
- **Projects**: More than 90 small and bigger (applied) research projects, studies … INSPIRE State of Play (2002-2011) - SPATIALIST (2007-2011) – EULF (2013-2016) – GI-N2K (2013-2016) – EO4GEO (2018 – present) – ELISE Knowledge Transfer (2019) – Mozambique SDI-Standards (2019 - present) – EEA Framework Contract on Geospatial Standards and UML modelling (2016 – 2019)
- **Teaching:** Various courses, mainly vocational training
- **Publications:** various publications on SDI and standardisation, INSPIRE, with focus on the *"Impact of geospatial standards on the performance of Business Processes"*

Before we start (2/2)

Key messages of this presentation

- **Persistent identifiers (PID) are a key-component of SDI and DT**
  - There different kind of (persistent) identifiers, of which URI's are mostly used in the geospatial and other fields, in particular on the web
  - Poorly implemented and managed PID's lead to problems in geospatial data exploitation and sharing
  - PID's are essential for linking spatial data to other data/information on the web
  - Member States should carefully consider all aspects of PID implementation: Governance, Architecture (design) and Management

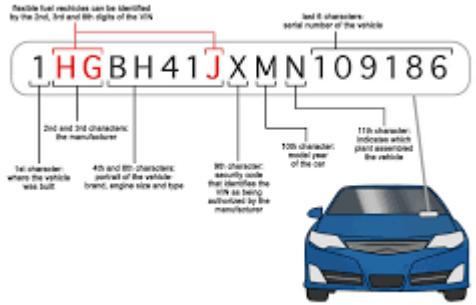
Persistent Identifiers

What are they ?
Different types of PID’s
Why are they important?
PID’s in the context of SDI

Persistent Identifiers

What are identifiers?

"An identifier is a name that identifies (that is, labels the identity of) either a unique object or a unique class of objects, where the "object" or class may be an idea, physical [countable] object (or class thereof), or physical [non-countable] substance (or class thereof)" (OMG, 2015)



The abbreviation **ID** is often used and *"refers to identity, identification (the process of identifying), or an identifier (that is, an instance of identification). An identifier may be a word, number, letter, symbol, or any combination of those." (Wikipedia, 2019)*

A **unique identifier (UID)** is a numeric or alphanumeric string that is associated with a single entity within a given system. UIDs make it possible to address that entity, so that it can be accessed and interacted with (Rouse, 2019).

Identifiers are everywhere

Persons
Companies
Buildings
Cars, (motor) bikes
Data sets
Data objects
Cadastral Parcels

Identifiers on the back of a statue in the Louvre

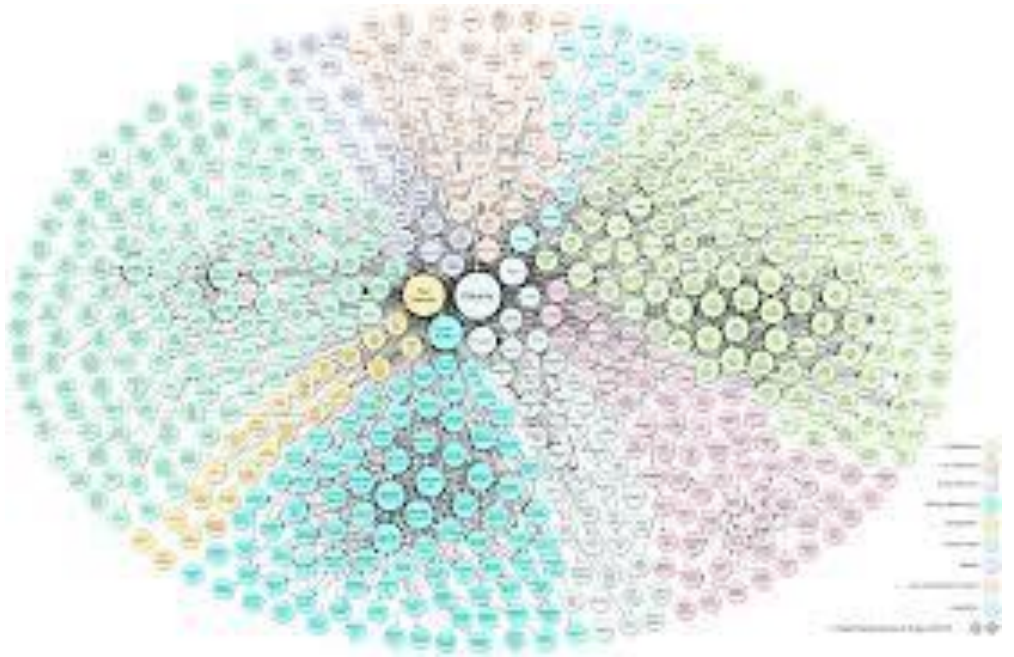
Identifiers can refer to **real things**, i.e. 'physical' objects (e.g. a person) or even 'virtual' objects (e.g. the name of a municipality). But they can also refer to their **representation in information systems,** more particularly on the web

Persistent Identifiers

The challenges in the context of the WWW

The web contains divers information, information that often changes, which makes it difficult to publish and share all sources of information in an accurate and meaningful way. This challenge requires the creation of special **mechanisms to correctly identify the data sets and parts thereof**. This is the basis for the concept of linked data (Vasilescu et al., 2015).

In the context of INSPIRE and SDI in general, Identifiers are not only important at **data set level**, but also the level of **the objects they contain**. Moreover also other components of INSPIRE and SDI need a mechanism of identifiers such as metadata, web services, code lists, data specifications, etc.



When publishing (spatial) data on the web, independently of the time when publishing takes place, it is important that the **identifiers refer unambiguously to the same recource over time** (Vasilescu et al., 2015).

A **persistent identifier** is a long-lasting reference to a digital resource (ORCID, 2019).

Persistent Identifiers

Different types of PID’s

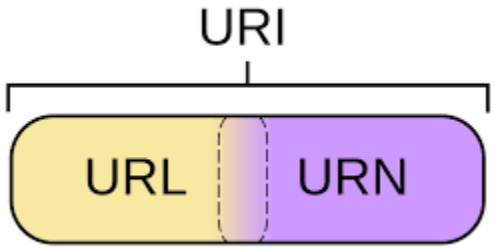
Most common used types of identifiers on the web

URI - A Uniform Resource Identifier is a unique identifier that makes content addressable on the Internet by uniquely targeting items, such as text, video, images and applications.

URN – A Uniform Resource Name is a URI that uses the urn scheme designed to complement URLs by providing a mechanism for the identification of resources in particular namespaces.

URL - A Uniform Resource Locator is a particular type of URI that targets Web pages so that when a browser requests them, they can be found and served to users. It refers to the place where the resource can be found.

UUID - A Universal Unique Identifier is a 128-bit number used to uniquely identify some object or entity on the Internet.



Examples of identifier mechanisms

ISBN - International Standard Book Number – ISBN Agency

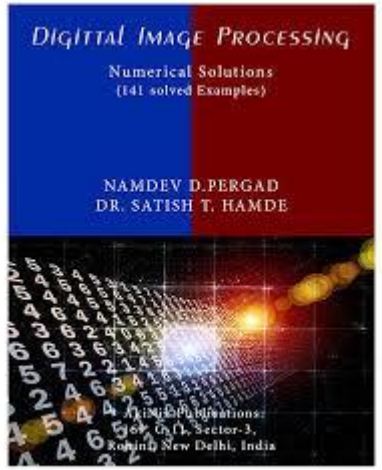
DOI - Digital Object Identifier – DOI Foundation

ARK – Archival Resource Key – IFLA

ORCID - Open Researcher and Contributor ID – ORCID.org

PURL – Persistent Uniform Resource Locator

(Barnes, 2012)



Persistent Identifiers

Requirements for PID's

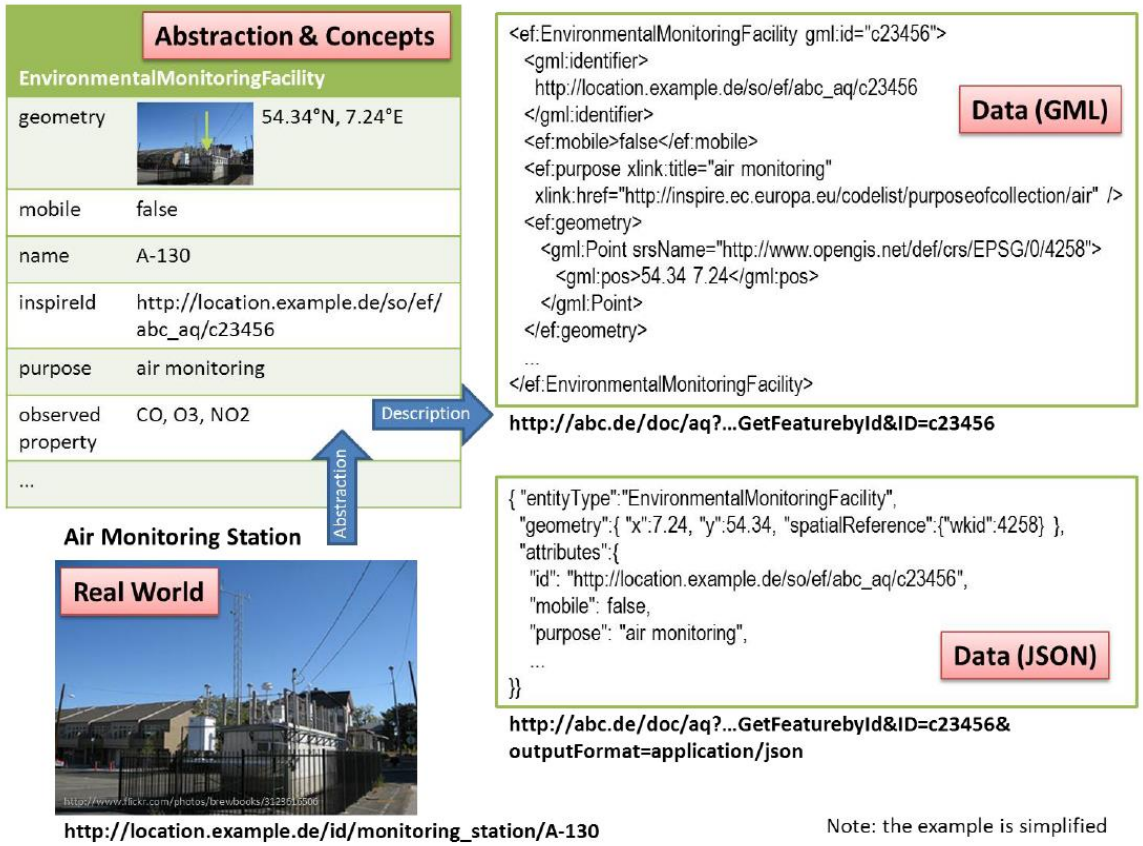
ID #	Requirement	Description
R1	Globally unique	The identifier should be unique in the INSPIRE domain and also beyond the domain of INSPIRE. Additionally, organizations should document and make public in which domain/sub-domain/context their PIDs are unique.
R2	Persistent	The identifier should be permanently assigned to a resource. Additionally, organizations should document and make public what they mean by 'persistent' and how this is implemented.
R3	Resolvable	The choice for PIDs doesn't imply that the users can have access to resources. As there might be situations where not all resources are accessible, organizations should make clear and publish information about which of their PIDs resolve to an available resource.
R4	Reliable	The organisations that manage PIDs should commit that the identifiers are persistent. The identifier should ensure that the resource is what it is said to be (its authenticity).
R5	Provenance	The PID solution should give guarantee over time about its origin, meaning the organization that has issued the identifier.

(McKenna, 2011; Richards, 2011: Vasilescu et al., 2015)

ID #	Requirement	Description
R6	Cost effective	The PID solution should be cost effective – free of charge, or very low cost in relationship to their available resources.
R7	Supported by policy	The use of PIDs should be part of the written policy of the organization
R8	Managed by embedded processes and procedures	The management of an organization's PID system should be part of the written processes and procedures of the organization. These processes and procedures should take into account the events that impact an existing Persistent Identifier scheme and the associated requirements to be met
R9	Interoperability	Syntactic, semantic and community interoperability
R10	Granularity	Granularity refers to the level of detail at which persistent identifiers will need to be assigned. The granularity requirement influences the complexity of the PID solution.
R11	Versioning	The PID solution should support the changes that can affect an object or its context: the authority (e.g. organisation is restructured), context (e.g. the datasets are transferred to a different authority) and Object (e.g. the metadata of the object is changed).

Persistent Identifiers

PID’s in the context of INSPIRE and SDI



INSPIRE: identified benefits of using URI’s

URI’s play a key role in data exchange over the web with several **benefits**. They are:

- A key part of web technology
- Based on proven technology
- Based on a common framework for all kinds of data
- Machine readable
- Easy to deploy and having a simple familiar structure
- Enabling the deployment of federated governance procedures

Moreover, identifying spatial objects through URI’s provide access to individual objects (so not only full datasets); they also provide access to the whole web infrastructure (e.g. access to alternate formats) and they allow efficient management of shared data within and into business systems.

(INSPIRE, 2013)

Challenges in PID management

What others have experienced
Referencing geospatial objects

Former studies

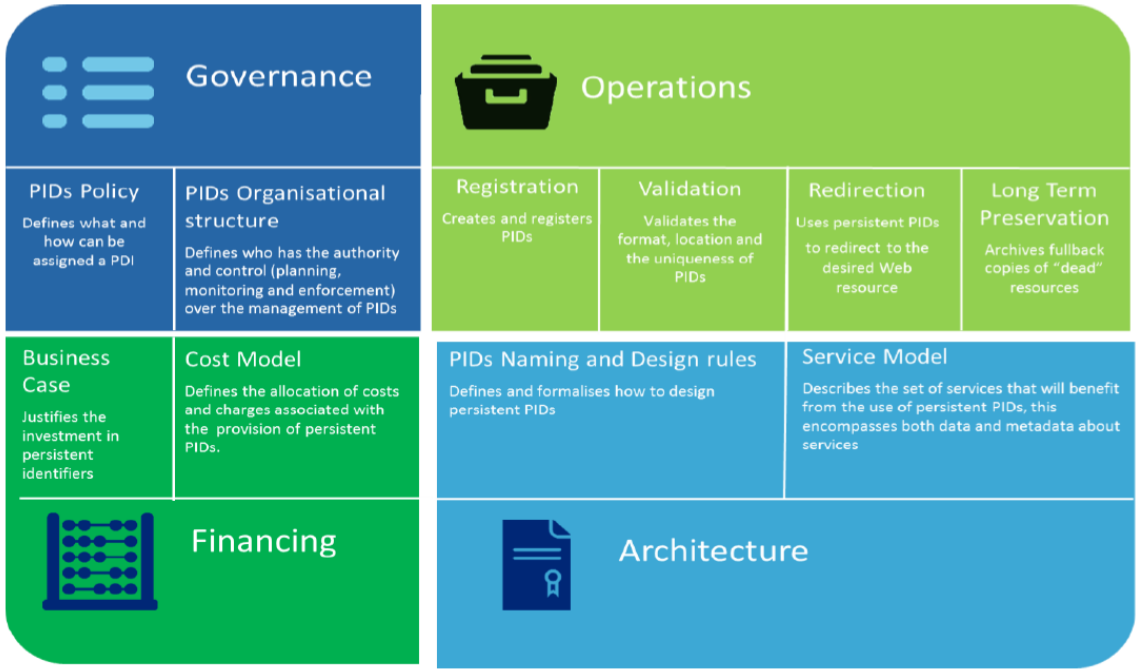
Governance, Operations and Architecture of Persistent Identifiers

ARe³NA

Conclusions and recommendations

- **Governance** of PID's entails a lot of aspects to take into consideration for the medium- and long-term. Governance should start as early as possible.
  - Define processes and procedures, and roles, responsibilities and liabilities
  - Ensure flexibility and inclusiveness, as well as the presence of expertise and decision-making power
- **Operations** of PID's consist of the registration of PID's, their validation, redirection and long-term preservation.
  - Using SLA's to guarantee high level of availability, performance and reliability of the PID system
  - Provide guidelines for the organisations that should manage the PID's
- **Architecture** includes PID's naming and design rules, and a service model
  - There are several PID design options used and currently the interoperability between the different solutions is yet unclear

- Develop a PID specific Interoperability Framework, something similar to the work performed by APARSEN (APARSEN, 2013)
- Assessing PID management tools and services



Vasilescu et al., 2015

A current problem (challenge)

Echo's from the workshop on making spatial data discoverbale through mainstream search engines

In several Member States, efforts are made to make data and 'things' more discoverable and easy to use via 'regular' search engines. In July 2019 experts from all over Europe discussed a Linked Data approach for achieving this (EC JRC, 2019).

Finland (NLS) – Working on national recommendations for spatial data URI's following the pattern:

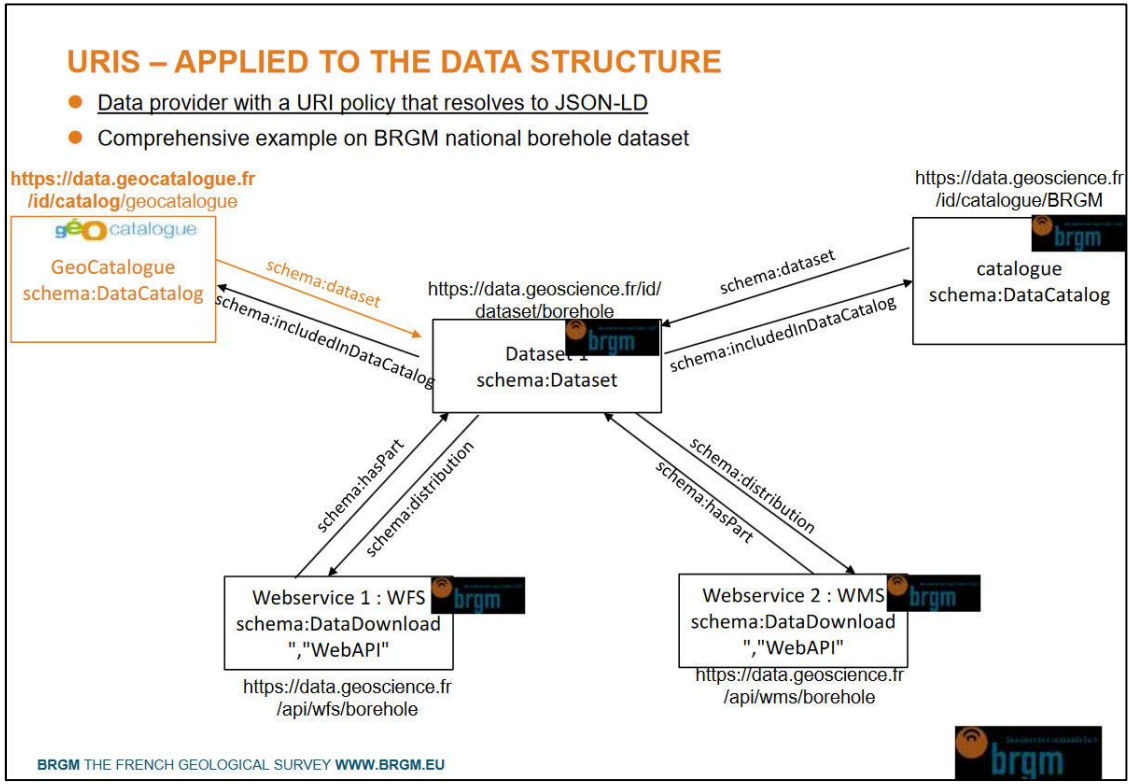
http://paikkatiedat.fi/type/{datasetId}/{localId}

France (BRGM) – Not all data providers currently have a URI policy. A national URI architecture is being prepared with several scenarios (types of data providers) that should be applied for datasets, services and their metadata.

Italy (AGID) – There is limited use of URI's in general, as well as for particular cases such as the format of metadata elements, the types of data licenses, etc. A URI policy and specific guidelines are in the make.

GeoSeer, a tool for searching spatial data and services – *"A UUID would help to avoid the problem of duplication of metadata records"* (Moules, 2019).

Poland (PZGIK) – Follows a policy to define URI's for individual objects.



Feliachi et al., 2019

The Netherlands (GEOCAT/Geonovum) – *"The problem is that users can't know whether data is authorative or not".*

Experiences within Reportnet

Referencing geospatial objects

European Environment Agency

Context

The **feasibility study** was performed in the context of the modernisation efforts of EEA's electronic infrastructure for data collection, **Reportnet**. It contributes to the actions to streamline environmental reporting published by the European Commission as a result as part of the regulatory fitness check of environmental legislation

Objectives

1. To use data harvesting as a technological solution for the EU institutions to access data at national or local level without requesting Member States to actively report them.

2. To access the spatial data through INSPIRE standard web services.

More specific objectives were:

1. to demonstrate the viability of the **harvesting workflow** of complete datasets for environmental reporting

2. to test the possibility to **reference, find and download specific spatial objects** required by environmental obligations through the INSPIRE infrastructure

Natura 2000 network (Birds and habitatt Directives)

Experiences within Reportnet

Finding the right WFS, harvesting the Natura 2000 data

Lessons learned from the data harvesting

The feasibility study used and evaluated the existing **INSPIRE metadata, datasets and download services** related to Natura 2000 sites provided by data providers in Member States / countries.

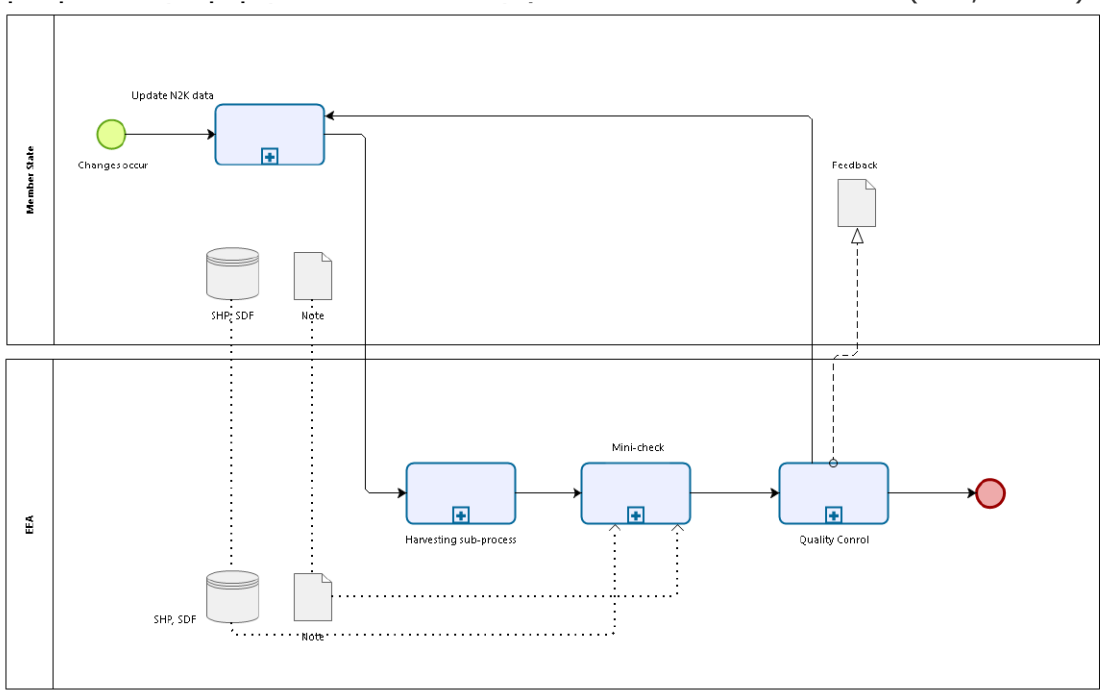
The **INSPIRE Geoportal** provides an entry point to the INSPIRE downloadable datasets in the Members States / countries and it can be used as a starting point to identify downloadable datasets in the data harvesting process. Different methods can be used to find datasets for environmental reporting obligations - from using the INSPIRE Geoportal application to a more **programmable search** on the INSPIRE Geoportal catalogue service.

The search results revealed **sometimes ambiguous or incomplete results**: e.g. several services, also of different types, for the same dataset; disaggregated national datasets; datasets with mixed and non-related content to the reporting obligation; … These required **additional search refinements**, and ultimately the **confirmation** of service end points by the **national reporter** before starting the harvesting process. Protected services presented another obstacle in the automatizing of the process.

Despite the obstacles, the harvesting could be set-up and the services, data and metadata were checked on some quality aspects.

The study demonstrates a positive outcome in harvesting the Natura 2000 sites datasets using the INSPIRE infrastructure, but it also shows the need for a **high quality implementation of the INSPIRE requirements** regarding the metadata, services and harmonized datasets. A loose implementation of INSPIRE would make it more difficult to discover and use the data.

(EEA, 2019a)



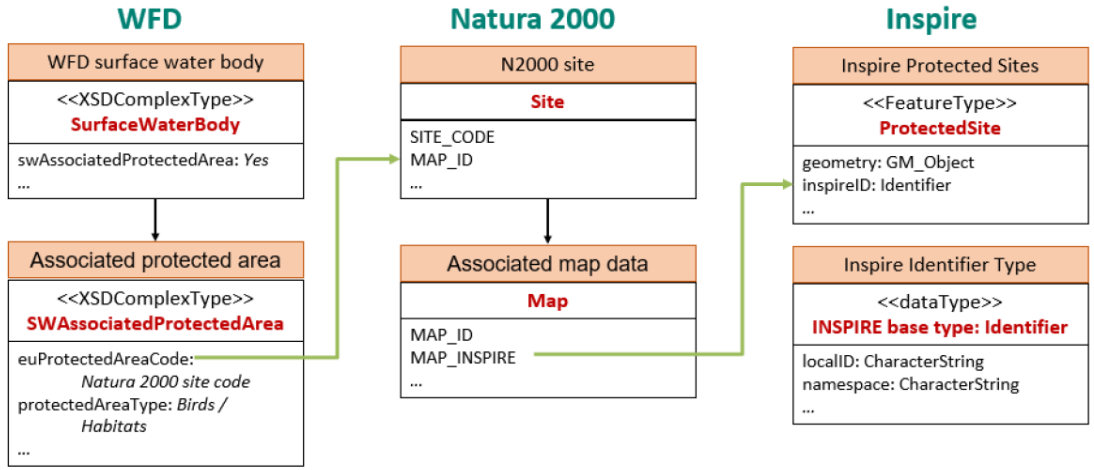
Experiences within Reportnet

Referencing geospatial objects

Besides the spatial data harvesting techniques, another use case was to **search for particular spatial objects**, in this case Natura 2000 sites, making use of INSPIRE network services. Several **steps** were carried out:

- **Analyse** the Natura 2000 data, especially the field for the INSPIRE external object identifier;
- Analyse the link between Water Framework Directive (WFD) reported data and Natura 2000 data,
- Analyse INSPIRE Protected sites datasets available through INSPIRE download services WFS;
- Analyse the link between Natura 2000 data and datasets available through INSPIRE download services WFS;
- Analyse the capabilities of available INSPIRE download services WFS in relation to direct access download services;
- **Testing** INSPIRE direct download services WFS for downloading all Natura 2000 features;
- Testing different linking alternatives using INSPIRE download services WFS to download a single selected Natura 2000 feature.

(EEA, 2019b)



The **data structures** of all three main data sources, protected areas under WFD, Natura 2000 Standard Data Form (SDF) and INSPIRE Protected sites datasets, include elements that allow data linking and referencing.

WFD – Natura 2000 site code

N2K SDF – *MAP_INSPIRE*

INSPIRE – *inspireID*

Experiences within Reportnet

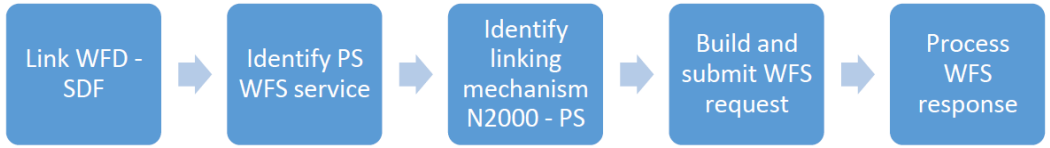
Referencing geospatial objects

Workflow

The applied methodology started with **analysing** the available **data** in **different sources**, continued with the **analysis** of the INSPIRE download services **WFS** to be tested and concluded with the **retrieval** of specific spatial **objects** from the WFS using **different matching options**.

- the link between WFD reported data and the Natura 2000 SDF database is successful and reliable (99.8%).
- The link between the Natura 2000 SDF database and INSPIRE datasets requires several types of evaluation:
  - at object level in both data sources and
  - At the level of the INSPIRE download services WFS

  One of the first requirements is therefore to ensure the correct INSPIRE download service WFS is available, works correctly and provides the relevant dataset(s).



Examples of issues encountered

- The analysis of the Natura2000.MAP.MAP_INSPIRE values in the database shows that **only** approximately **a third of all Natura 2000 sites** reported at the end of 2017 **include values for INSPIRE spatial object identifiers** (9902 out of 27.758 records).
  - Some countries provided this information for each Natura 2000 site
  - Other countries left this field empty
- **Structure of INSPIRE spatial object identifier**: The INSPIRE Identifier is a complex element composed of *localId*, *namespace* and (optionally) *versionId*
  - Most Member States include only the localId part of the INSPIRE spatial object identifier
  - Others concatenate the namespace (from INSPIRE) and site code (from Natura 2000) in the MAP_INSPIRE field

Experiences within Reportnet

Referencing geospatial objects

Lessons learned and a few recommendations

1. When N2K data correctly includes *inspireID*, it is possible to harvest the target spatial objects using the INSPIRE WFS.
2. While INSPIRE defines a complex data type identifier (three attributes), N2K SDF defines a single field, which is done in different ways. Better guidance would bring the solution.
3. Errors might still occur. Therefore, the reporting data flow would need to include a check of the link for each individual N2K site.
4. Better reporting guidelines and quality control checks should improve the number of filled *inspireID* in N2K datasets.
5. The Natura 2000 SDF defines a unique site code (SITECODE) of each site that can be used as a link if included in the INSPIRE datasets (as some data providers have already done).
6. Seven WFS using the INSPIRE Protected Site Simple application schema, provided data with *inspireID* containing a reference to the Natura 2000 site codes.
7. Four WFS services provided data according to alternative schemas.

Referencing would improve by …

- Reporting or pointing out in the INSPIRE Geoportal to the relevant INSPIRE direct access download services;
- Better guidelines on how to encode the reference information of the datasets, in particular inspireID in the N2K SDF;
- Timely synchronisation between the N2K data and INSPIRE datasets;
- Quality checks both at object and dataset/service level to ensure the references are correct.

EEA, 2019b

Best Practices for PID

The Flemish and Dutch case

Best Practices for PID's
Flemish URI approach

Vlaamse overheid
INFORMATIE VLAANDEREN

Several organisational units involved

Steering Committee for Flemish Information and ICT Policy

- ☞ Different working groups involved (data, standards …)

OSLO – Open Standards for Linking Organisations

Co-creation approach:

- Local authorities
- Departments of the Flemish administration
- Private partners
- Academia

The development of the URI Standard and URI Guidelines followed a roadmap with different **milestones**: a literature study; the set-up of different public working groups with stakeholders from different sectors; drafting of the URI Standard and Guidelines followed by a public review period; application of the standard in basic registries such as addresses, organisations, road register and public service register; publication of the translated version of the standard and guidelines (EN) on Joinup and organisation of a public webcast.

URI-standard
(03/2017)

↓

URI-Guidelines
for data.vlaanderen.be
(12/2017)

↓

URL-Strategy
(12/2018)

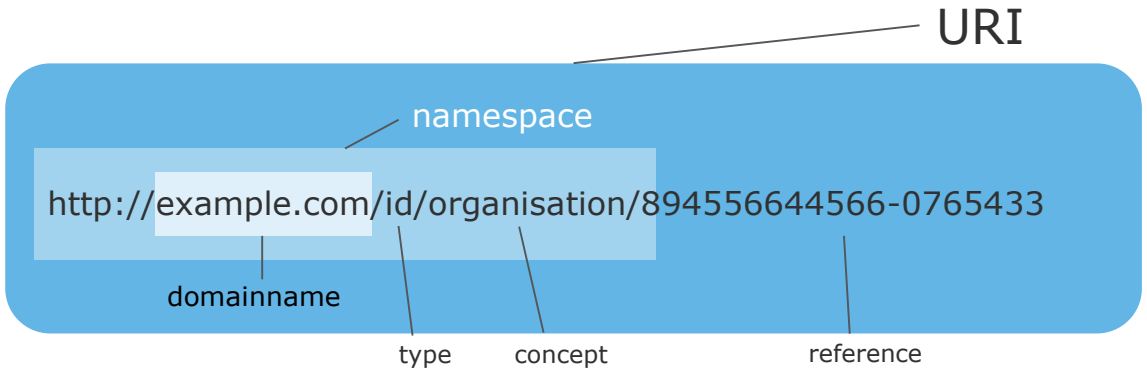
Flemish URI approach consists of

A URL Strategy
URI-Guidelines
A URI Standard

Best Practices for PID's

URI-Standard for data resources

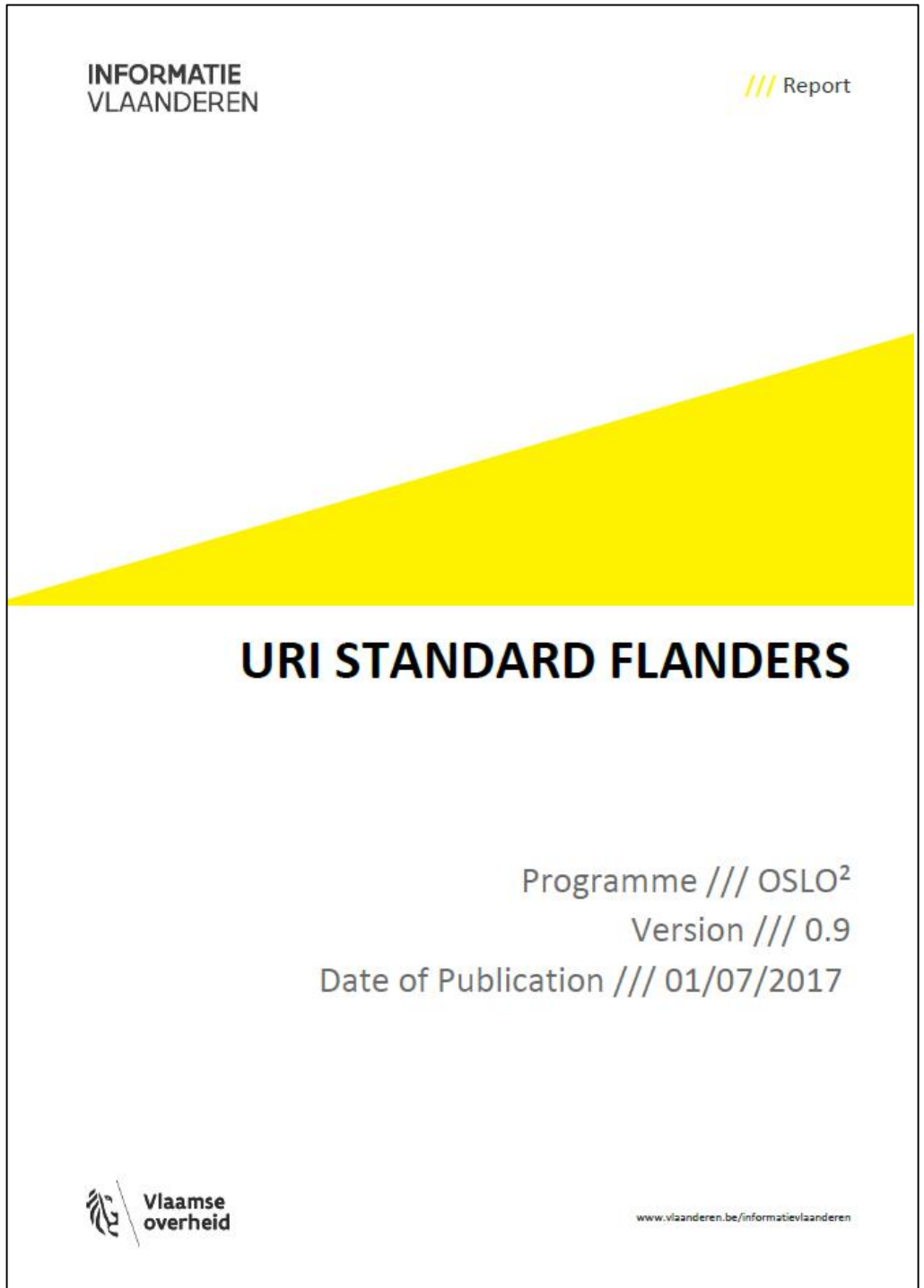
The Flemish **URI-Standard** describes mainly how to design correct URI's following **18 rules and sub-rules**. The standard makes dictinction between two types of resources: information resources and non-information resources. Information resources can be data, (web)-services, ontologies or documents. Non-information resources can refer to events or 'things' in the real world.



Pattern for a persistent URI

The URI is the formal way to refer to a resource (an URL is one way of doing this). URI's should be **resolvable** in order to find the resource back. A service can do this by interpreting the URI and responding to it by providing the description of its content, or redirect to another service that can describe the URI.

(Information Flanders, 2017a)



Best Practices for PID’s

URI-Standard for data resources

Rules in the URI-standard

The rules relate to general **design** aspects and specific rules on how to define the **domain**, the **type** (of resource), the **concept** (category of the resource) and its **reference**. There are 7 high level rules:

R1 – HTTPS or HTTP must be used as the basis for the definition of URI’s

R2 – URI’s must follow following pattern:

http(s)://{domain}/{type}/{concept}(/{reference})*

R3 – The name of the {domain}, and all sub-domains, shall be independant from organisation, product, brand or time

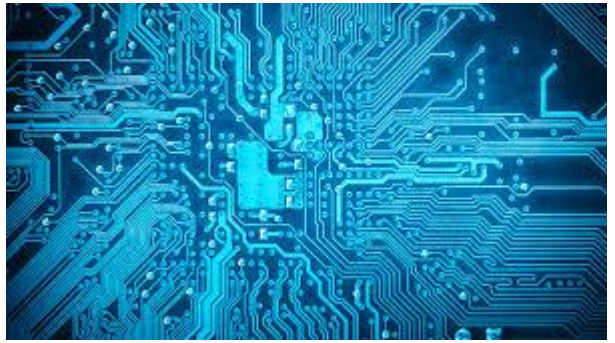
R4 – The {type} provides at least distinction between: 1) the object/concept itself, 2) its digital representation and 3) a term belonging to a vocabulary or ontology

R5 – The {concept} as part of the URI-pattern represents the category of the resource. It can use a (hierarchical) classification list, but this is not mandatory

(Information Flanders, 2017a)

R6 – The (/{reference})* in the URI-pattern refers to the resource itself. The {reference} element can be used more than ones to form a hierarchical structure

R7 – Each {reference} can be used in two ways: {reference-basis} or {reference-basis}/{reference-version}. Reference-version will not always be present



Example of sub-rule in the URI-standard

Some of the rules are sub-divided in **more detailed rules** (11 in total). We provide one example here:

R4.3 – For each URI of type id (reference to an object of the real world) a similar URI of type doc must exist. This doc URI might eventually refer to an URI where the actual document can be found. The latter should not necessarily follow the design rules.

Best Practices for PID's

Flemish URI-Guidelines

The guidelines for the design and management of URI's in Flanders consists of 8 recommendations or guidelines and examples:

Guideline 1 – The URI domain should be the responsibility of the organisation that provides the resource

Guideline 2 – In Flanders the top-level domain is data.vlaanderen.be

Guideline 3 – It is recommended that domain/subdomain refers to subdomain.domain via the top-level domain (e.g. data.vlaanderen.be/wegen = wegen.data.vlaanderen.be)

Guideline 4 – Use always the same types within the top-level domain and the list should also be used for all subdomains. Fix the list ones and keep it to a minimum

Guideline 5 – A {concept} gets its meaning within a (sub)domain. The resource is a {concept}{type} with content {reference}

Guideline 6 – The {reference} is a code identifying the resource

Guideline 7 – The {reference-version} indicates the version of one instance of the resource

Guideline 8 – For dates and time in the {reference-version} the W3C Data Time format must be used (ISO 8601)

(Information Flanders, 2017b)

Example. Flemish Open Data Portal – Overview of all datasets of the City of Ghent regarding birds

http://opendata.vlaanderen.be/dataset?g=vogel&organization=stad-gent

Better:

http://opendata.vlaanderen.be/doc/dataset?g=vogel&organization=stad-gent

Best Practices for PID's

URL Strategy

It is not always clear for users whether a **website** is an **official** website **or** a **commercial** website. Since most users go to websites via google, it is important to have an URL that scores high.

With an URL strategy for its websites and other applications, the Flemish Government wants to make all information as much as possible accessible through the URL www.vlaanderen.be. This results in a **high ranking on Google**.

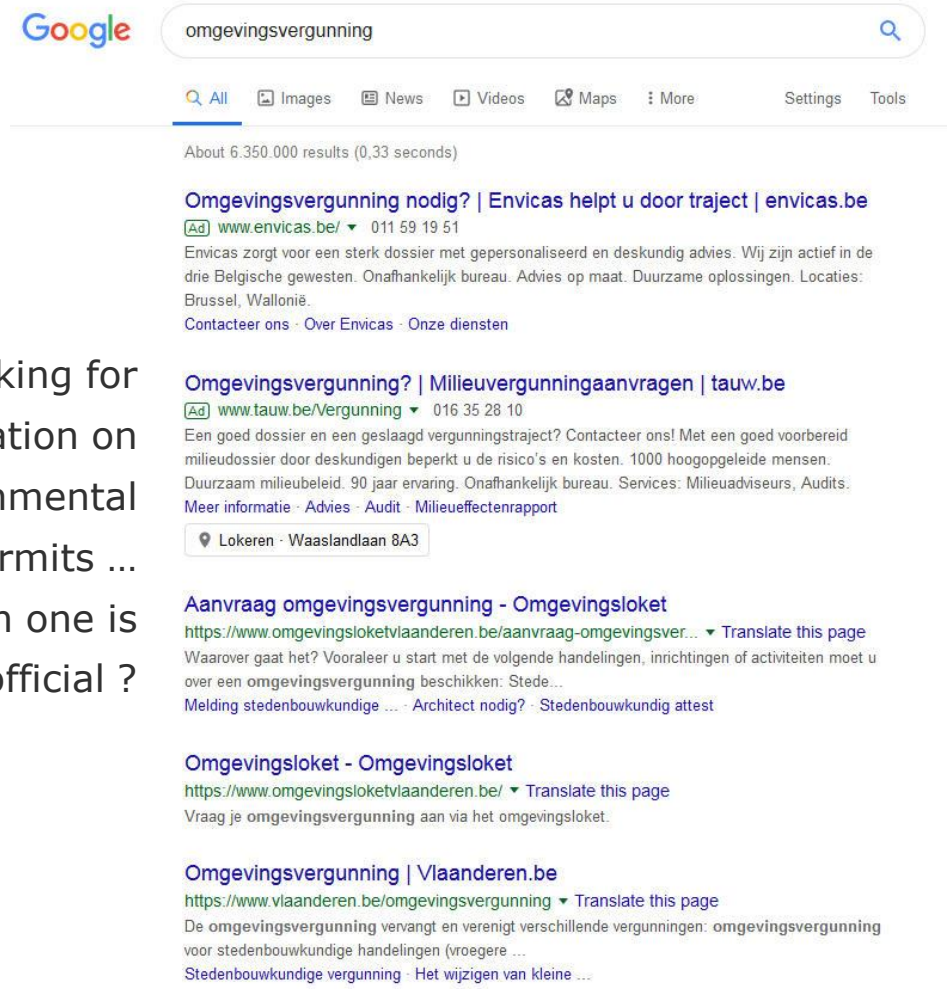
The **strategy** was adopted by the Flemish Government on 21 December 2018 and **entered into force on 1 July 2019**. A transition period of 4 years is foreseen to make the necessary adaptations.

All **entities must comply** with this strategy although existing applications for which the transfer towards the URL would be too complex can work with a subdomain. The request for setting-up a sub-domain should always be submitted to the Agency Information Flanders (AIV).

As technology **Akamai** has been chosen and procedures have been set-up for the development of new web-sites. AIV offers a development and test environment. The entity involved can manage not only the production environment, but also these development and test environments.

(Information Flanders, 2018)

Looking for information on environmental permits … Which one is official ?



Certain **conditions** should be met regarding style, security (HTTPS, minimum TLS 1.2, no shared hosting), privacy and accessibility (WCAG 2.1)

Best Practices for PID’s

The use of URI’s in the context of INSPIRE

In the context of the implementation of the INSPIRE Directive the Belgian Regions and the Federal Government looked, amonst others, into the **obligations of data harmonization**. INSPIRE makes it mandatory to apply unique indentifiers and therefore they are an important aspect of making Belgian spatial datasets compliant with the INSPIRE Implementing Rules for data and service interoperability.

The **Belgian inter-federal INSPIRE coordination committee** set-up a **Working Group on Identifiers** on demand of the Walloon Region. It was based on the fact that the INSPIRE Generic Conceptual Model[1] was revised. Where in the original document only URN-schemas were allowed, the new version also supports the URI-schema.

[1] https://inspire.ec.europa.eu/documents/inspire-generic-conceptual-model

Implementation in Flanders

When participating entities are making their data in conformity with the INSPIRE data specifications as defined in articles 12, 1°, 2° and 4° of the GDI (SDI) Decree, they **apply to all the data objects of the data resources the URI schema**. The Flemish URI standard is advised, but **not mandatory** (already published URI’s might continue to exist). Furthermore, the prescription is only applicable for the (parts of the) datasets that are being harmonized/transformed. A public consultation round revealed that the (fiancial/HRM) **impact** of the prescription is limited.

Principles agreed upon

- Application of a federated governance model for defining, managing and maintaining identifiers (made possible by applying the URI approach).
- Consultation and coordination of the efforts of the three Regions and the Federal level following agreed Best Practices.
- Need for making an agreement between all the stakeholders within the country to apply the same standard.
- The application and adaptation towards the URI standard can be done as part of the INSPIRE data harmonization efforts.

Best Practices for PID's

Similar approach in The Netherlands

In The Netherlnds, the URI Strategy has been developed as part of the ***"Digital Framework for Environmental Law"*** ("Digitaal Stelsel Omgevingswet"). The document on the strategy has been developed and adopted by the Framework Architecture Board (SAB) in March 2018. Many **stakeholders** were **involved**: environmental and other national departments and agencies, the provinces, municipalities, regional water authorities, … The application of the Digital Framework affects all public authorities, but also citizens and businesses, and ICT developers in particular.

The initiative builds further on a first strategy document from Geonovum ***"Towards a national URI-Strategy for Linked Data of the Dutch public sector"*** (Overbeek & van den Brink, 2013).

The URI Strategy describes following elements:

- Basic **design of URI's** including: schema, authority, path, query and fragment
- The application of the design rules in case of webpages of user **applications**
- Rules for **SOAP web services** and for **REST API's**
- Rules for **Linked Data** implementations
- Details about the individual **components**
  - Authority
  - Sub-domain
  - Security
  - Domain
  - Type
  - Collection and reference
- **Versioning** issues
- **Format** issues
- General agreements

The strategy contains 39 requirements Examples are provided on how to implement

Event: 'Get started with the environmental law'

Best Practices for PID’s

URI strategy in The Netherlands

Examples of requirements

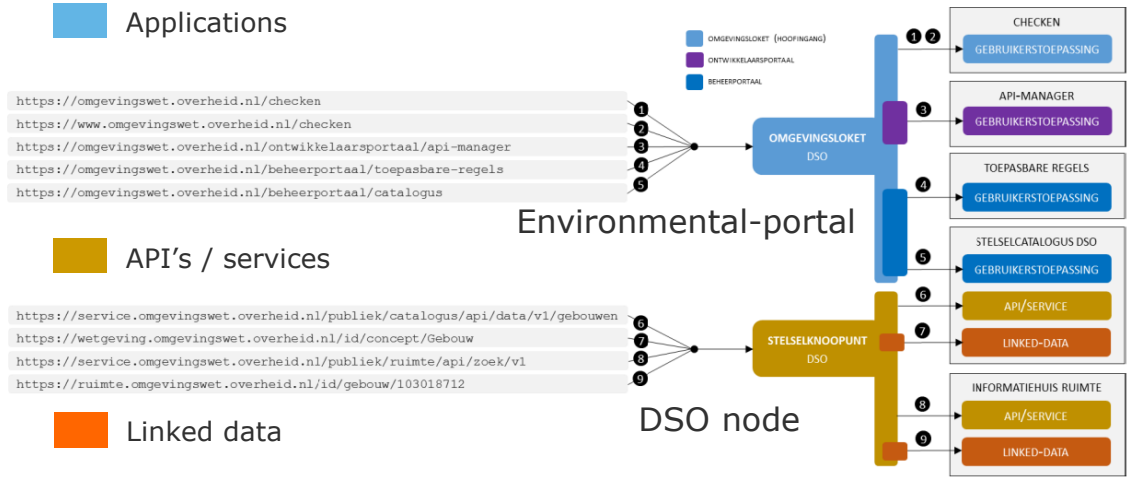
URI-01 – The design of URI’s follows the Internet standard RFC3986

URI-12 – The URI of a REST API defines an explicit security context

URI-21 – The URI for Linked Data defines the URI type (possible values are “id”, “doc” and “resource”)

URI-29 – URI’s define optionally the staging environment within an authority (e.g. ont [development], tst [test])

URI-34 – A domain within an URI is a functional identification (e.g. water, air, law, standards, …)



URI-30 – Only one framework component (DSO-node) is responsible for offering a resource

DSO pays particular attention to the **aspect of time**. As part of the strategy it is agreed that: 1) in case there is no specific date given, then the most actual information for a resource is provided; 2) in case the date is given, it is provided as part of the query component and 3) in case a specific date is given, distinction is made between validOn, availableOn and activeOn (based on RFC3339 / ISO 8601).

Regarding the **formats**, a mechanism of content negotiation is applied, i.e. the http accept header is used to indicate the format used. The mime-type is used to do so: tekst/html, JSON, XML, turtle for Linked Data. For API’s JSON and XML.

(Sloos et al., 2018)

Conclusions

Conclusions

PID and Geospatial's role towards digital transformation

- Geospatial actors have been engaging with **PIDs for some time driven by needs to better manage and share data**, leading to defined technical and governance approaches, including considerations for linking with other data and real-world objects
- This experience **often involves transformative activities, especially the multi-actor activities** including collaborations joint strategies, agreed standards and consultations
- Well managed PIDs in locally-sourced data enable data reuse for many applications. Recent engagement with **data on the web** concerns shows a **readiness to share data with a wider community**. **User-driven** and **co-creation** approaches could further these efforts.
- **Geospatial has a lot of experience to offer**, especially in the context of Spatial Data Infrastructures and the **testing/experimentation approaches** could be vital in both adapting to new needs both technically and coordinating activities, including across borders.

Next steps

Next steps

ELISE Rapid Studies

- Rapid Study on the role of Persistent Identifiers: collection and processing of stakeholders' feedback
- Previous Rapid Studies
  - The role of geospatial in the digital government transformation
  - APIs: benefits and governance models for the public sectors
- Planned Rapid Studies (end of Summer):
  - The contribution of Citizens Science to the DT of Governments
- Other rapid studies will follow:
  - What else should we investigate?

https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government/elise-rapid-studies-and-webinars

Bibliography

References
Relevant links

Bibliography

References

Abbas, S. & Ojo, A. (2014). Applying Design Patterns in URI Strategies - Naming in Linked Geospatial Data Infrastructure. https://www.deri.ie/content/applying-design-patterns-uri-strategies-naming-linked-geospatial-data-infrastructure

Archer, P., Goedertier, S. & Loutas, N. (2012). 10 Rules for Persistent URIs. https://joinup.ec.europa.eu/community/semic/document/10-rules-persistent-uris

Davidson, P., Murray, K. & Williams, S. (2011). Designing URI Sets for Location. Version 1.0. http://data.gov.uk/sites/default/files/Designing_URI_Sets_for_Location-V1.0_10.pdf

Davidson, P. (2010). Designing URI sets for the UK public sector. Version 1.0. Interim paper. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/60975/designing-URI-sets-uk-public-sector.pdf

DOI (2019). Digital Object Identifier System (DOI). http://www.doi.org/

European Commission, DG JRC (2018). Implementation of Identifiers using URIs in INSPIRE – Frequently Asked Questions. http://inspire.ec.europa.eu/index.cfm/pageid/5120

European Environment Agency (2018). Reportnet and data harvesting using INSPIRE infrastructure (Feasibility study) - Report 1: Data harvesting using INSPIRE network services

European Environment Agency (2018). Reportnet and data harvesting using INSPIRE infrastructure (Feasibility study) - Report 2: Referencing spatial objects using INSPIRE network services

EZID (Easy ID) (2019) – Long Term Identifiers Made Easy. http://n2t.net/ezid/

Feliachi, A., Grellet, S. and Vilmus, T. (2019). Making INSPIRE data discoverable and findable through popular search engines. https://inspire.ec.europa.eu/sites/default/files/presentations/0945_20180921_making_inspire_catalogue_searchable.pdf

Folmer, E., Reuvers, M., & Wilko, Q. (2013). Pilot Linked Open Data Nederland (NL). http://www.pilod.nl/doc/boek2.pdf

Handle (2018). The Handle System. http://www.handle.net/

Hart, G., & Dolbear, C. (2013). Linked Data: a Geographic Perspective. Boca Raton: CRC Press, Taylor & Francis Group.

Infomatie Vlaanderen (2017b). URI-Richtlijnen voor data.vlaanderen.be.

Bibliography

References

Informatie Vlaanderen (2017a). Vlaamse URI-Standaard voor data.

Informatie Vlaanderen (2018a). URL Strategie (powerpoint and internal note to the Steering Committee Flemish Information and ICT Policy)

Informatie Vlaanderen (2018b). Voorschrift 'Gebruik van URI's bij geharmoniseerde INSPIRE data'

Koistinen, K. & Tiainen, E. (2014). URI design for semantics with ontology approach (Powerpoint)

Loutas, N., De Keyzer, M. & Goedertier, S. (2013). TM2.3. Design & Manage Persistent URIs (en). https://joinup.ec.europa.eu/community/ods/document/tm23-design-manage-persistent-uris-en

McKenna, C.T. G. (2011). Persistent identifiers (pids): recommendations for institutions. Villa Adriana - Tivoli (Roma): Repro Stampa Ind. Grafica.

Overbeek, H. & Brentjes, T. (2013). Concept URI Strategy for the NL Public Sector. http://www.geonovum.nl/sites/default/files/2013-03-12_uri-strat.pdf

Overbeek, H. & van den Brink, L. (2013). Towards a national URI Strategy for Linked Data of the Dutch public sector. http://www.pilod.nl/images/a/aa/D1-2013-09-19_Towards_a_NL_URI_Strategy.pdf

Moules, J. (2019). GeoSeer, A Global Search Engine for OGC Services. https://webgate.ec.europa.eu/fpfis/wikis/display/InspireMIG/Workshop+Programme?preview=/364446739/368608218/1-5-2019-07-03_ispra_-_geoseer-_a_global_search_engine_for_ogc_services.pdf

Portele, C. et al. (2013). INSPIRE Generic Conceptual Model, Version 3.4rc3. INSPIRE Drafting Team "Data Specifications".

Portele, C. (2013). URI strategy of INSPIRE. http://www.geonovum.nl/sites/default/files/4clemensportele.pdf

Richards, R.W. K. (2011). A Beginner's Guide to Persistent Identifiers, version 1.0. Copenhagen: Global Biodiversity Information Facility.

Rouse (2019). Unique Identifier (UID). https://internetofthingsagenda.techtarget.com/definition/unique-identifier-UID

Sauermann, L. & Cyganiak, R. (2008). Cool URIs for the Semantic Web. W3C Interest Group Note. http://www.w3.org/TR/cooluris/

Bibliography

References

Sauermann, L. & Cyganiak, R. (2008). Cool URIs for the Semantic Web. W3C Interest Group Note. http://www.w3.org/TR/cooluris/

Sloos, T., Brattinga, M. and Oostenbrink, S. (2018). URI-Strategie. DSO, The Netherlands.

UK CTOC (2014). URI patterns for identifiers proposal. http://standards.data.gov.uk/proposal/uri-patterns-identifiers-proposal

Vanbockryck, J. & Robbrecht, J. (2012). Concepts of Meta-SDI. http://www.poweredbyinspire.eu/documents/0403-linkeddata-robbrechtvanbockryck.pdf

Vasilescu, A., Hauschildt, C., Smith R.S. & Lutz, M. (2015). Study on RDF & PIDs for INSPIRE: Governance of Persistent Identifiers.

Vasilescu, A. & Vandenbroucke, D. (2015). Study on RDF & PIDs for INSPIRE: State of Play.

W3C (2012). 223 Best Practices URI Construction. W3C GLD WG wiki. http://www.w3.org/2011/gld/wiki/223_Best_Practices_URI_Construction

Bibliography

Relevant links

- http://www.vlaanderen.be/informatievlaanderen
- https://www.omg.org/
- http://purl.org/
- https://orcid.org/
- http://www.alliancepermanentaccess.org/
- https://www.ifla.org/best-practice-for-national-bibliographic-agencies-in-a-digital-age/node/8793
- http://inspire.ec.europa.eu/index.cfm/pageid/5120
- http://n2t.net/ezid/
- http://www.doi.org/
- http://www.handle.net/
- https://www.isbn-international.org/
- https://joinup.ec.europa.eu/collection/elise-european-location-interoperability-solutions-e-government

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