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List of abbreviations

Abbrev.	Stands for
ADMS	Asset Description Metadata Schema, https://joinup.ec.europa.eu/solution/asset-description-metadata-schema-adms
ELI	European Legislation Identifier, http://eur-lex.europa.eu/eli-register/about.html
ESCO	Classification of European Skills, Competences, Qualifications and Occupations, https://ec.europa.eu/esco/
IETF	Internet Engineering Task Force, https://www.ietf.org/
JRC	Joint Research Centre, https://ec.europa.eu/info/departments/joint-research-centre_en
PD	Public Documents, http://ec.europa.eu/justice/civil/judicial-cooperation/document-circulation/index_en.htm
URI	Uniform Resource Identifier, https://tools.ietf.org/html/rfc3986
XML	Extensible Markup Language, https://www.w3.org/XML/

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1 INTRODUCTION

1.1 Background and context

In the context of Action 2016.07 "Promoting semantic interoperability among EU Member States", TASK-04 of this project aims, among others, to ensure that European Commission services and EU institutions are aware of ISA²[1] specifications. In turn, ISA² specifications should be well aligned with related efforts and help with capacity-building by providing expertise. The task foresees several support activities, including the provision of support for URI policy for EU institutions[2].

The current document is part of sub-task 04.02, and its aim is to identify good design practices for the local part of URIs under data.europa.eu. For this, the local URI policies of various organisations were analysed, to describe the patterns used in a uniform way and explain the rationale behind them.

1.2 Objective

This document should be treated as an additional resource or practice aid for URI creators. These guidelines could help them design URIs which stand the test of time. This is particularly important to well-regarded organisations like EU institutions, for whom it is important to avoid reputational damage resulting from broken links or missing resources. URI structures that are intuitively understandable to the human eye are an additional possible advantage, but the main goal is to create trust and dependability for URI consumers by making URIs persistent.

1.3 Structure of the document

The remainder of this document is structured as follows:

- In section 2, the local URI design patterns of five collections under data.europa.eu are analysed.
- Section 3 identifies a number of good practices observed throughout the analysis.
- In section 4, the report draws some overall conclusions.

[1] ISA: https://ec.europa.eu/isa2/home_en
[2] News item: https://joinup.ec.europa.eu/community/semic/news/eu-institutions-define-common-persistent-uri-service

2 LOCAL URI DESIGN PATTERNS

According to the IETF[3] definition, a URI is often used to identify a specific resource within a common space of similar resources, what is informally called a "URI space" [1]. For the purposes of this document and in the context of the Persistent URI Service, we distinguish between what is called "central" and "local" to differentiate between the parts of a URI assigned by a central entity, and the parts which can be determined by the organisation that owns the set of resources (the "collection"). In line with the objectives of this task, this report focuses on the local part of URIs. Therefore, for this document, the centrally-provided sections of a URI are out of scope.

Figure 1 presents the current situation being applied to all collections hosted on http://data.europa.eu. As the figure shows, the first part corresponding to the collection, the namespace string, is decided centrally by the URI committee. The tail, or the right side of the URI, is the local part of the URI, and the main focus of this report. The local ID or the tail is decided locally, with central guidance [2].

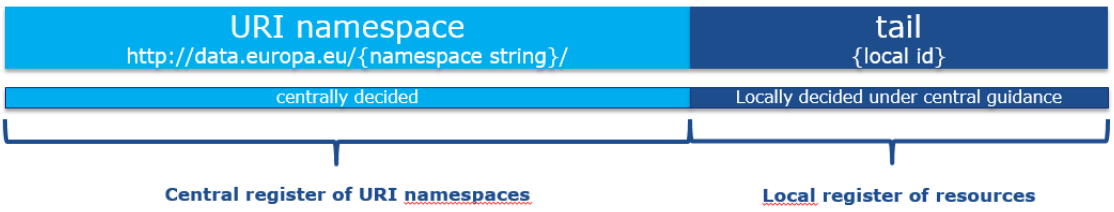

Figure 1: Representation of URI design differentiation between central and local URI design.

Five collections were selected for this analysis of local URI design policies. The goal was to select collections that provide an overview of URI design policies in different areas and for which redirection is maintained on data.europa.eu. The collections cover the following fields: the classifications of skills and competences, XML schemas for certain administrative documents, controlled vocabularies, legislation and datasets in a data catalogue. The collections included in the study are:

- The classification of European Skills, Competences, Qualifications and Occupations (ESCO[4]);
- The Public Documents[5] XML Schemas;
- The Asset Description Metadata Schema (ADMS[6]) Controlled Vocabularies;
- The European Legislation Identifiers (ELI[7]);
- The Joint Research Centre (JRC[8]) Data Catalogue.

[3] IETF: https://www.ietf.org/
[4] ESCO: https://ec.europa.eu/esco/portal/home
[5] Public Documents Regulation: http://ec.europa.eu/justice/civil/judicial-cooperation/document-circulation/index_en.htm
[6] ADMS Controlled Vocabularies: https://joinup.ec.europa.eu/svn/adms/ADMS_v1.00/ADMS_SKOS_v1.00.html
[7] ELI: http://eur-lex.europa.eu/eli-register/about.html
[8] JRC: https://ec.europa.eu/info/departments/joint-research-centre_en

2.1 Local URI design patterns for ESCO

ESCO is the multilingual classification of European Skills, Competences, Qualifications and Occupations [3]. The collection includes resources related to occupations, skills, qualifications, and awarding bodies. Each occupation, knowledge, skill and competence in ESCO is identified by a string of characters that follows a specific syntax, the URI [4].

Table 1: ESCO URI design structure

Level	Name	Description	Local ID
Namespace	ESCO	Meaningful string consisting of a well-known abbreviation	esco
1	Concept Scheme or Model or Pillar	This section describes what kind of resource the URI points to by using a meaningful string to denote it.	concept-scheme, model, skill, occupation, isco, skillTransversalGroups, etc.
2	Pillar	This section contains the pillar to which a resource belongs, like occupation or skill. This level applies only to URIs under the Concept Scheme or Model category above, since otherwise the pillar would have already been denoted at level 1.	occupation, isco, skill, skillTransversalGroups, etc.
3	Resource	This section contains an opaque string pointing to a specific resource such as a skill.	opaque string[9]

Example: The URI http://data.europa.eu/esco/occupation/04ba4d6c-957d-417f-bf63-5b9e015a9f86 corresponds to the occupation "software analyst" from the "occupation" pillar. From this URI, one can navigate to skills associated with this occupation, such as "analyse business processes", which has the URI http://data.europa.eu/esco/skill/56042303-972b-41be-9310-58467599ff7e.

2.2 Local URI design patterns for the Public Documents project

The Public Documents project is part of ISA² Action 2016.26[10] on electronic documents and electronic files. The Public Documents project aims to generate XML schemas corresponding to 11 administrative documents forms included in the Public Documents Regulation[11], as well as XML schemas corresponding to the versions of the forms specific to each EU Member State. Combined, redirection for more than

[9] In this context, "opaque string" refers to a string of characters that does not provide any information about the resource to which a URI points.
[10] ISA² Action 2016.26: https://joinup.ec.europa.eu/rdf_entity/http_e_f_fdata_ceuropa_ceu_fw21_f1ac380d6_bae2e_b4089_bb3b3_bdff0cf5727d6/about
[11] Public Documents Regulation: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32016R1191

300 XSD files occurs from data.europa.eu, along with documentation files corresponding to the XML schemas.

For this collection, the different versions need to be distinguished clearly, as this information is particularly important in order to ensure the compatibility of the resources (XML schemas) with the systems used by stakeholders. Therefore, to cover the version issue, the first locally-decided element of the URIs for this collection refers to the version of the schemas: 1, 2, (…). This situation is a notable exception to the general principle of avoiding the inclusion of version numbers in URI patterns.

Furthermore, there is a distinction made between XML schema files and documentation files: "ns" stands for "namespace" for XML schema files, or "doc" for HTML documentation. The next level structures the content by distinguishing between the different packages on which the schemas are based, followed by either the name of a generic form or the name of the country.

Table 2: Public Documents URI design structure

Level	Name	Description	Local ID
Namespace	Public Documents	Opaque string assigned centrally	edm
1	Version	This section of the URI denotes the version of the file using a meaningful string.	1, 2, (…)
2	Type	This section contains the type of resource the URI points to, either documentation or an XML schema, using meaningful abbreviations.	ns, doc
3	Package	This section contains the reference to a package of related resources using meaningful strings.	forms, pdc, formAustria, etc.
4	Resource	This section contains the title of the resource and is a specific, meaningful string.	birthForm, marriageForm, deathFormAustria, etc.

Example: http://data.europa.eu/edm/1.0/ns/forms is an URI leading to an overview of the generic forms from the Public Documents Regulation.

2.3 Local URI design patterns for the ADMS Controlled Vocabularies

The Asset Description Metadata Schema is a specification used for describing reusable solutions, such as data models and specifications, reference data, and open source

software. For the six existing ADMS Controlled Vocabularies, the URI pattern includes the centrally-defined URI namespace, which is "3b1", which is an opaque string.

Table 3 provides an overview of the different local IDs employed for URIs that identify terms in the ADMS controlled vocabularies. The section of the URI that is defined locally starts with one of six possible strings to indicate the controlled vocabulary, as shown in Table 4. Further levels of the ADMS Controlled Vocabularies URI are simply descriptive strings denoting what exactly the resource is, such as CodeList, CoreComponent, Mapping, etc.

Table 3: ADMS URI design structure

Level	Name	Description	Local ID
Namespace	ADMS	Opaque string	3b1
1	Controlled Vocabulary	This section of the URI shows to which one of the Controlled Vocabularies the resource belongs by using a meaningful string.	assettype, interoperabilitylevel, etc.
2	Resource	This section contains the name of the specific resource to which the URI points. This is a meaningful string.	Schema, Legal, etc.

Table 4 presents several examples of URIs of resources belonging to the ADMS Controlled Vocabularies.

Table 4: Examples of URIs for ADMS Controlled Vocabularies

ADMS Controlled Vocabulary	URI
Asset Type	http://data.europa.eu/3b1/assettype/Schema
Interoperability Level	http://data.europa.eu/3b1/interoperabilitylevel/Legal
Licence Type	http://data.europa.eu/3b1/licencetype/Attribution
Publisher Type	http://data.europa.eu/3b1/publishertype/Company
Representation Technique	http://data.europa.eu/3b1/representationtechnique/BPMN
Status	http://data.europa.eu/3b1/status/Completed

2.4 Local URI design patterns for ELI

The European Legislation Identifier is a system to uniquely identify legislation online in a standardised format, so that it can be accessed, exchanged and reused across borders. ELI includes technical specifications on web identifiers for legal information (URIs), metadata specifying how to describe legal information, and a specific language for exchanging legislation in machine-readable formats [5]. For this report, the focus is on web identifiers for legal information, i.e. URIs.

ELIs are HTTP URIs identifying online legal information officially published across Europe. The URIs are formally described using URI templates according to RFC 6570[12]. A URI template is a compact sequence of characters for describing a range of URIs through variable expansion.

Table 5 provides an overview of the ELI URI design pattern. It should be noted that all the components listed below are optional, and can be selected according to national requirements, without any pre-defined order imposed [6]. All elements of the URI pattern are meaningful strings, starting with the namespace and continuing through all the local ID levels. ELI uses abbreviations to denote the type of legislation that the URIs point to, such as "dir" for "directive". ELI also uses the year to organise the legislation by year of publication. In addition, resources receive a reference number or "natural number". Some resources also have publication dates or start dates associated with them.

Table 5: ELI URI design structure (EU)

Level	Name	Description	Local ID
Namespace	ELI	Meaningful string representing a commonly used abbreviation.	eli
1	Legislation	This section shows which type of legislation the URI points to, using meaningful abbreviations.	dir, reg, dec, etc.
2	Year	This section contains the year of publication of a piece of legislation expressed as a meaningful string.	{YYYY}
3	Natural identifier	This section contains a reference or number to distinguish an act of same nature signed or published on the same day	{sequence of digits}
4	OJ	This optional section points to the fact that the legislation has been published in the Official Journal by using a meaningful string abbreviation.	oj
5	Publication Date or Start Date	This optional section contains a meaningful string regarding the date a given piece of legislation has been published or the date legislation will go into effect.	{date}

Examples of ELIs for EU legislative texts are:

- Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC: http://data.europa.eu/eli/reg/2016/679/oj

[12] IETF. RFC 6570. URI Templates: https://tools.ietf.org/html/rfc6570

- Directive 2013/37/EU of the European Parliament and of the Council of 26 June 2013 amending Directive 2003/98/EC on the re-use of public sector information: http://data.europa.eu/eli/dir/2013/37/oj

2.5 Local URI design patterns for the JRC Data Catalogue

The Joint Research Centre[13] is the European Commission's science and knowledge service. Regarding data, the JRC policy is focused on transparency as a way to contribute to innovation [7]. The data policy complements the JRC Policy on Open Access to Scientific Publications and Supporting Guidance, and to promote open access to research data in the context of Horizon 2020 [8].

The URIs for datasets in the JRC Data Catalogue are redirected from the centrally-provided namespace http://data.europa.eu/89h/* to the actual location at http://data.jrc.ec.europa.eu/dataset/*. The string corresponding to the individual datasets in the catalogue does not follow a clear pattern.

Table 6: JRC Data Catalogue URI design structure

Level	Name	Description	Local ID
Namespace	JRC	Opaque string corresponding to the Joint Research Centre's Data Catalogue	89h
1	Resource	This section contains a string corresponding to a specific dataset. Several types of strings are encountered, ranging from meaningful strings to opaque strings with some strings showing a combination of meaningful and opaque parts.	{string}

Example of dataset URIs are:

- AIRMEX project: campaigns data: http://data.europa.eu/89h/jrc-airmex-campaigns-data (meaningful string)
- Aerated concrete block; mix of P2 04 and P4 05; production mix, at plant; average density 433 kg/m3 (Location: RER): http://data.europa.eu/89h/jrc-eplca-898618b5-3306-11dd-bd11-0800200c9a66 (combination of meaningful and opaque parts)
- Agriculture Assessment in the Gaza Strip (2014-09-18): http://data.europa.eu/89h/00a87831-3a64-4a08-a681-3929aeca1876 (fully opaque string)

[13] JRC: https://ec.europa.eu/jrc/en/about/jrc-in-brief

3 GOOD PRACTICES

3.1 URI patterns

Table 7 contains an overview of the approaches used by the five collections studied. As shown in the table, most collections use a meaningful string on the local levels which are under their control. It is more likely for collections to be assigned an opaque string as a namespace, which is a centrally-decided aspect.

Table 7: Overview of URI pattern approach

Collection	Namespace	Local ID
ESCO	esco (meaningful)	Meaningful string + opaque string
PD	edm (opaque)	Meaningful string
ADMS	3b1 (opaque)	Meaningful string
ELI	eli (meaningful)	Meaningful string
JRC Data Catalogue	89h (opaque)	Various types of strings, meaningful and/or opaque.

Among the collections studied, ELI has the most structured approach to defining URIs while allowing creators to retain power over the URIs they create. The use of URI templates mitigates the risk of confusion by providing a clear expectation of an URI structure. Additionally, the use of templates allows document creators to avoid complex, package-specific rules which become difficult to keep track of as the number of resources grows.

The analysis of the five local URI policies suggests that a consciously **pre-defined approach to URI design, using for example URI templates, can help organisations follow a logical structure**. When organisations choose and adhere to a URI design policy, it mitigates the risk of improvisation and potential need for change. This applies particularly well to highly structured collections, such as legislation-related ones, but for other cases it may be difficult to foresee the final structure of the resources in a collection.

3.1.1 Meaningful versus opaque strings

Some URI patterns use a mix of meaningful and opaque strings. While some simply take the opaque namespace string centrally assigned to them and switch to meaningful strings for the locally-decided sections, others combine meaningful strings on the first local level with opaque ones for further local levels. This **approach can be useful for groups of resources, where semantic shifts may occur over time**.

A good example of the risks associated with using meaningful strings could occur, for instance, in an organisation that classifies vehicles, and creates a register of passenger cars, assigning it the URI http://foo.bar/passenger_car/. If the organisation later needs to add vans to that same collection, they would be forced to assign it an odd URI such as http://foo.bar/passenger_car/van-001. If the collection

identifier had been opaque, for instance http://foo.bar/f7ql, adding http://foo.bar/f7ql/van-001 would not be as odd.

3.1.2 URI sub-divisions

Regarding the structuring of subdivisions used within a collection, there are some good practices aimed at avoiding complexity and confusion. Thus, **subdivisions should aim to follow a logical structure based on an existing situation**, such as the type of a resource, as in the ESCO collection. Furthermore, as far as possible, **collection owners should avoid creating too many sub-divisions, which could lead to overly long URIs** [9]. When basing sub-divisions on an existing specification, this **specification should be clear and readily available to the public**.

3.1.3 Versions in URIs

The **inclusion of versions in the URIs is generally not recommended**. That being said, the version can be part of the URI when the information is part of the internal logic or is a necessary marker in the internal logic. If a version number is used to mark different distributions of the same resource, it should not be part of the URI. As in the Public Documents project, an instance where the presence of the version number in the URI is justified, is one where the version number has significant impact on the compatibility of the resources and the systems used by stakeholders.

Furthermore, the appropriateness of including version numbers in URIs depends on the type of resource being identified by the URI. For some resources, the version is part of the data, as it is in the case of XML schemas, for instance. In others, the versioning is available at the distribution level, making it less relevant and therefore less of a good practice to include in a URI. **Error! Reference source not found.** llustrates this, as the inclusion of a version number can be essential and therefore "good practice" for XML resources.

Another important point regarding versions regards the use of the term "latest" as a way to identify the latest version of a resource. This is an obviously inappropriate term to use in a URI in terms of persistence, but it may appear in a URL as a way as a way to access the last update in a collection. While all URLs are URIs, the inverse is not valid and the distinction between a URL and a URI can be summarised as that between a person (the URI) and where they can be found (the URL)[14].

Table 8: Recommended pattern and anti-pattern in URI design: versioning

Resource	Recommended pattern	Anti-pattern
Vocabulary	http://data.europa.eu/89h/3b1/assettype/1.0 (versioning of vocabulary) http://data.europa.eu/3b1/assettype/Schema (no versioning of concepts)	http://data.europa.eu/3b1/assettype/1.0/Schema (versioning of concepts)

[14]The Difference Between URLs and URIs: https://danielmiessler.com/study/url-uri/

3.1.4 Sub-collection strings as context in URIs

Based on the five collections analysed in the context of this report, it appears that there is a common practice to **include a sub-collection string as the first locally-decided part of the URI**. This information could help to provide additional context for the resource and may include information regarding the type of resource identified by the URI. There is no "one size fits all" in practice, and some organisations may use such sub-collection strings, while others do not. In this case, the ELI approach is particularly interesting, since it provides the possibility for people to create URIs in line with how legislation is managed and cited.

3.1.5 The typical structure of a URI

We have seen that the typical URI format looks something like this: **http://data.europa.eu/{namespace}/{sub-collection_string}/{name},** but there are cases where the URI provides several levels of sub-collection strings, cases where there is no sub-collection string, and even cases of different approaches used within the same collection.

3.2 URI Persistence

Regarding URI design, the main consideration of creators should be that when a URI is created, all its parts should be resistant to change. For instance, locations and organisation names can change, and therefore should not be used in URIs. First and foremost, when introducing semantics in URIs, the strings used need to reflect what the resources are (i.e. intrinsic characteristics such as the type or nature), not who owns them or where they are.

As a caveat, it must be mentioned that there are inherent risks in using meaningful strings, no matter how stable they may seem at the time of conception. Over time, semantic shifts can occur, while differences in spelling (for instance, American versus British spelling) can also generate inconsistencies. Having any semantic information at all in an identifier can technically threaten its persistence. Any organisation creating URIs needs to find the balance between ensured URI persistence and ease of use. For instance, developers working with an organisation's URIs may have difficulties if they face completely opaque strings, which should also be a point of consideration.

When creating a URI, its owner can never be certain of who will be using it and can therefore not notify every concerned individual of future changes. It is therefore paramount that URIs are designed carefully with the specific goal of making them persistent, in theory forever [10]. Persistence is a vital component of URI design. Since the local part of a URI is under the control of the institution that owns it, it is up to the owners to **ensure that the way they design local IDs enables the persistence of the URI as a whole**.

Ensuring local URI persistence can be achieved by following the same policies as those intended for URI persistence in general. For instance, previous work around the subject includes specifications regarding content to be avoided, such as stating ownership, providing version numbers, using auto-increment, including query strings or file extensions in URIs [11].

Table 9 provides an overview of whether the five collections studied in the context of this report follow the 10 rules of URI persistence cited in various sources of information, including those published by the European Commission and W3C [11] [10].

Table 9: Analysis of persistent URI design rule implementation

Rule	ESCO	PD	ADMS	ELI	JRC	Comment
Follow the pattern	✓	✓	✓	✓	×	All collections, except for JRC, follow a clear pattern
Reuse existing identifiers	-	-	-	✓	-	ELI aims to be close to existing ways to reference legislation
Link multiple representations	-	-	-	-	-	This aspect was not investigated
Implement 303 redirects	×	×	×	×	×	The Persistent URI Service uses 302 redirects
Use a dedicated service	✓	✓	✓	✓	✓	All collections use the Persistent URI Service
Avoid stating ownership	✓	✓	✓	✓	✓	None of the patterns indicate ownership
Avoid version numbers	✓	×	✓	✓	✓	None of the patterns include version number, with the exception of PD due to the importance of versioning XML schemas
Avoid using auto-increment	✓	✓	✓	✓	✓	None of the patterns include auto-incremented numbers
Avoid query strings	✓	✓	✓	✓	✓	None of the patterns include query strings
Avoid file extensions	✓	✓	✓	✓	✓	None of the patterns include file extensions

4 CONCLUSION

The practices identified in this report rely on observations made by analysing a limited number of collections. While they indicate what appear to be the most suitable measures resource owners could take to ensure the persistence of their URIs, other approaches to local URI design patterns may also support persistence or otherwise serve the purposes of an organisation or project.

When URI patterns closely follow the resource (or information) management process of an organisation, the URI persistence benefits, as it makes the URI policy more inherently understandable and therefore easier to follow. URI creators should naturally have the freedom to create the local URI patterns most suited to their resources. For some domains, it is particularly important to facilitate the assignment of the most appropriate URI for that particular collection, regardless of some pre-defined pattern. As seen in this report, collections like ELI and others require a certain degree of adaptability, wherein a publishing system or at least a human data curator can easily assign the optimal URI to a resource.

Overall, the following recommendations for URI persistence and navigability may be derived from the analysis:

1. The local part of the URI should be designed carefully with long-term persistence in mind.
2. A good pattern that is understandable to the creators of the resources makes it easier to assign URIs, as it provides a well-defined structure.
3. When a collection contains sub-collections, the local pattern may include key information as sub-namespaces.
4. The elements of the local pattern may be opaque or meaningful strings.
5. Meaningful strings should be based on the intrinsic characteristics of a sub-collection or resource, i.e. their type or nature, and never be based on extrinsic characteristics such as ownership or location as those are prone to changes over time.

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