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Analysis of the DCAT-AP extensions

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1. INTRODUCTION

The DCAT Application Profile for Data Portals in Europe (DCAT-AP)[1] is a specification for describing public sector datasets in data catalogues using metadata. It is based on the Data Catalog Vocabulary (DCAT)[2], which was developed under the auspices of the Government Linked Data Working Group at W3C. The objective behind DCAT is to facilitate data findability, cross-reference and interoperability between data catalogues on the web by adding a thin layer of agreed upon metadata, to ensure consistency.

The Interoperability solutions for public administrations, businesses and citizens programme of the European Commission (ISA²) supports the development of digital solutions that enable public administrations, businesses and citizens in Europe to benefit from interoperable cross-border and cross-sector public services[3]. In 2015, ISA (the predecessor of ISA²) started an activity to create an adapted version of DCAT, called DCAT-AP, which is a shorthand for *DCAT Application profile for data portals in Europe*. The idea is to create a so-called DCAT profile, meaning "a specification for data catalogues that adds additional constraints to DCAT"[4], in this case specifically applied to enabling interoperability between data portals in Europe. This activity is based on experience gained since the development of DCAT in 2013. The latest result of this effort is DCAT-AP v1.1[5] coordinated by PwC EU Services[6] for the European Commission ISA² programme and was released in November 2015. In the meantime several countries have started to use this specification for their national data portals. In some cases, a need for making further modifications and additions has been identified and official authorities have published their own, national application profiles.

In this report, we discuss and summarise these national DCAT-AP extensions. Our goal is to find out what kind of extensions/instantiations national efforts typically make and analyse, whether there are repetitive patterns that could be used as an input for future versions of the DCAT-AP v.1.1 and for the current work at W3C regarding the revision of DCAT[7].

Throughout this report, the different notations from the multiple DCAT-AP extensions were kept. The notation used in DCAT-AP v1.1 was added between brackets after the class/property if the extension's notation differed from the one of DCAT-AP v1.1.

In the remainder of this chapter, we present which national profiles were included in our analysis, the type of changes the national DCAT-AP profiles contain, and the analysis methodology.

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[1] https://joinup.ec.europa.eu/asset/dcat_application_profile/asset_release/dcat-ap-v11
[2] https://www.w3.org/TR/vocab-dcat/
[3] https://ec.europa.eu/isa2/
[4] Enabling Interoperability of Government Data Catalogues, Maali F., Cyganiak R., Peristeras V., Lecture Notes in Computer Science 6228, EGOV 2010: 339-350, Springer 2010, ISBN 978-3-642-14798-2
[5] https://joinup.ec.europa.eu/asset/dcat_application_profile/asset_release/dcat-ap-v11
[6] http://www.pwc.com/gx/en/services/european-union.html
[7] https://www.w3.org/2017/dxwg/wiki/Main_Page

1.1. Recommendation on DCAT-AP extensions

In order to promote a common approach, the ISA[2] Programme has published guidelines[8] on how to create DCAT-AP extensions, if needed. These rules can be categorized in two types: narrowing down or restricting the extension compared to the DCAT-AP. All rules in this recommendation follow the general idea that an extension of DCAT-AP needs to meet the minimum requirements described in section 6 of DCAT-AP v1.1. The rules are (descriptions verbatim from the recommendation):

- Extensions must not widen but may only narrow down the usage notes as specified in DCAT-AP v1.1, so that all information provided according to the extension remains valid for DCAT-AP v1.1
- Extensions may add classes that are not specified for DCAT-AP; however, an extension should not add classes that are similar to DCAT-AP classes
- Extensions may add properties that are not specified for DCAT-AP; however, an extension should not add properties that are similar to DCAT-AP properties
- Extensions may change the cardinalities for properties defined for DCAT-AP v1.1 respecting the following rules:
    - o Mandatory properties in DCAT-AP v1.1 must be mandatory in the extension
    - o Recommended properties in DCAT-AP v1.1 may be declared optional or mandatory in the extension
    - o Optional properties in DCAT-AP v1.1 may be declared recommended or mandatory in the extension
    - o Recommended and optional properties in DCAT-AP v1.1 may be removed from the extension
- Extensions must include all the mandatory controlled vocabularies as listed in section 5 of the specification of DCAT-AP v1.1
- Extensions may add mandatory controlled vocabularies

1.2. Considered National DCAT-AP extensions

In this work we analysed the national profiles below.

Belgium - Fedict, OpenKnowledgeBE
Web Address: http://dcat.be/
The information in this analysis is based on communication with Fedict. There is no specific information on the website.

Germany - Finanzbehörde - Geschäfts- und Koordinierungsstelle GovData
Web Address: http://dcat-ap.de/def/
Version/Update Date: V1.0 2017-06-21

Ireland - Open Data Unit - Dept of Public Expenditure & Reform,
Web Address: https://data.gov.ie/technical-framework
Version/Update Date: 2015-06-01

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[8] https://joinup.ec.europa.eu/node/150345/

Italy - AgID - Agenzia per l'Italia Digitale
Web Address: https://linee-guida-cataloghi-dati-profilo-dcat-ap-it.readthedocs.io/it/latest/
Version/Update Date: Release 1.0 2017-04-09 Revision 4e3c5e31

The Netherlands - Kennis- en Exploitatiecentrum Officiële Overheidspublicaties (KOOP)
Web Address: http://dcat-nl.info/nl/latest/
Version/Update Date: V 1.1 2017-06-01 Revision 120bc7b7

Norway - Agency for Public Management and eGovernment (Difi)
Web Address: https://doc.difi.no/dcat-ap-no/
Version/Update Date: 2016-10-11

Spain - APORTA INITIATIVE
Web Address: http://datos.gob.es/es/documentacion/guia-de-aplicacion-de-la-norma-tecnica-de-interoperabilidad-de-reutilizacion-de
Version/Update Date: 2016-07-28

Sweden - VINNOVA
Web Address: https://docs.google.com/document/d/17-vEfZXlu9kykcmjXZo1_Z8QKkr7-Prgwd6YUKLRrjk/edit (restricted access)
Version/Update Date: 2016-06-07

Switzerland - Open Government Data Switzerland
Web Address: https://handbook.opendata.swiss/en/library/ch-dcat-ap
Version/Update Date: 2016-02-09

1.3. Data Collection and Analysis Method

To start our analysis, we collected information about updated properties and classes in a spreadsheet. We compared the specification of each of the national profiles mentioned in the previous section with DCAT-AP v1.1 (last updated 2017-02-24). We tracked all changes, including changes in the ranges of properties, new properties and classes, as well as removed ones. DCAT-AP v1.1 specifies whether a property is optional, recommended, or mandatory. Hence, we also tracked whether national profiles have made changes to that aspect.

After the data collection, we analysed the results as follows: first, we looked at the changes by country and presented a short summary per country. Then we provided statistics on the number of changes performed for the mandatory properties. A similar analysis was performed for the optional and mandatory ones. The outcome of this analysis was then discussed and summarized. The table containing the original data can be found in the appendix. In these summaries, we used the following convention:

Number of Updates	Significance Level
≥3	Highly Significant
2	Significant
1	Insignificant

Then we checked which properties are excluded by which country. Further, we looked in more detail at properties related to language, licensing, and attributes related to the media type and format of distributions.

Next, we investigated which changes identified in the extensions were non-conformant. For example, a change whereby a mandatory property has been removed.

Finally, we looked in more detail at two interesting types of properties which were added in several national profiles. In particular, these are properties to specify geospatial information and properties to add additional relationship information.

2. PROPERTY UPDATES

Our analysis shows that the national profiles apply several changes in properties related to several classes. Each extension has extended properties according to the national needs by modifying cardinality and range restrictions.

In the first section of this chapter, we summarise the changes each of the national profiles have applied to the original DCAT-AP v1.1 specification.

In section 2.2, we summarise the applied changes in mandatory properties; and in section 2.3, we provide an overview of all updates made for recommended and optional properties. Section 2.4 focuses on exclusions of optional and recommended properties.

The final sections look more specifically at the language (2.5), licensing (2.6), and media types and format properties (2.7).

2.1. National DCAT-AP extensions

This analysis covers the national DCAT-AP extensions for Belgium, Germany, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, and Switzerland as displayed in Figure 1. The following map shows the countries which made a national DCAT profile. The colour

Figure 1 - Map of the different national DCAT-AP extensions
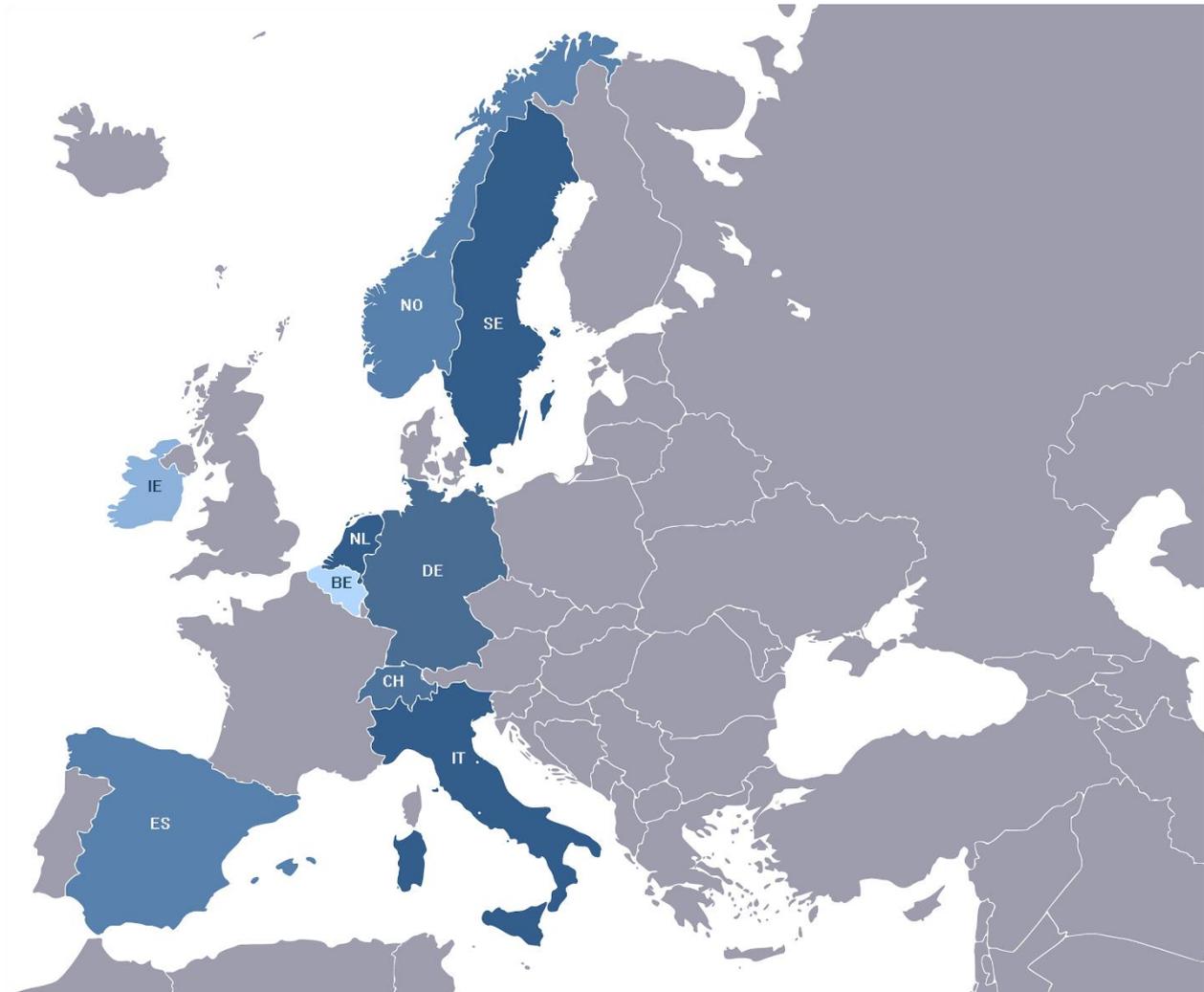
intensity corresponds to the total number of differences we observed in comparison with DCAT-AP v1.1. In this section we summarize the changes in each of these profiles briefly.

2.1.1. DCAT-AP.be (Belgium)[9]

Belgium follows DCAT-AP without additional properties. However, it is still allowed that additional properties are specified by the data producers. Each literal will get a language tag and it is recommended that keywords are mapped to the Data theme Named Authority List[10] of the Publications Office of the European Union. The organisations get an IRI based on the Belgian national company register, which also works as an organisation register. Belgium also chose to not use the *dcat:CatalogRecord* class.

2.1.2. DCAT-AP.de (Germany)[11]

DCAT-AP.de is currently in its first version and was officially released in the middle of June 2017. This extension focuses on licensing, copyright, and law restrictions in Germany.

2.1.3. DCAT-AP (Ireland)[12]

The open Data Technical Framework on DATA.GOV.IE specifies the data exchange framework (a profile based on DCAT v1.0). It has specified some extensions in the geospatial metadata properties for the class Dataset. While some of the properties have been added to DCAT-AP in version 1.1, *SpatialResolution* (*spatial Resolution*), *SpatialReferenceSystem* (*spatialResolutionSystem*) and *GeographicBoundingBox* (*geographicBoundingBox*) are not part of DCAT-AP v1.1.

2.1.4. DCAT-AP_IT (Italy)[13]

The DCAT-AP_IT metadata profile specifies in detail all the classes and properties for online exchange of metadata across Italy. In the Italian profile the optional *vCard:Kind* class is restricted to the class *dcatapit:Organization*, which is a subclass of *vCard:Organization* which in turn is a subclass of *vCard:Kind*. The *dcatapit:Organization* class has two mandatory properties *vCard:fn* and *vCard:hasEmail* to describe contact point's name and email. Two optional properties *vCard:hasTelephone* and *vCard:hasURL* are also specified for it. Besides these properties, there are additional properties for many other classes including *Dataset*, *Agent*, *LicenseDocument*, *Standard*, *Location*, *Catalogue*, *Distribution*, *PeriodOfTime*, *Location* and *Geometry*.

2.1.5. DCAT-AP-NL (the Netherlands)[14]

DCAT-AP-NL is the Dutch standard for online exchange of metadata among their data Catalogues. The latest updates were released in June 2017 with the version v1.1. This extension includes updates for the following classes: *Dataset*, *Agent*, *Catalogue*, *Record* and *Distribution*. The Dutch extension has also included all mandatory ISO 19115 Geo data into this specification. This extension introduces properties like (*Registration Holder*

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[9] This information is based on communication with Fedict.
[10] http://publications.europa.eu/mdr/authority/data-theme/
[11] http://dcat-ap.de/def/
[12] https://data.gov.ie/technical-framework
[13] http://www.dati.gov.it/sites/default/files/linee-guida-cataloghi-dati-profilo-dcat-ap-it-2.pdf
[14] http://dcat-nl.info/nl/latest/

(overheid:authority), *language*, *identifier* and *update/modificationdate (dct:modified)*, *mandatory for th*e class *Dataset*.

2.1.6. DCAT-AP-NO (Norway)[15]

In DCAT-AP-No v1.1, most of the property updates are for the class *Dataset*, while some changes have been made to the class *Distributio*n. The following properties are added to the class *Dataset*: *access right comment* (*dcatno:accessRightsComment*), *subject (dct:subject)*, and *creator* (*dct:creator*). Along with that, relationship properties have been added to represent relationships among different Datasets. Relationship properties include: *isPartOf*, *requires*, *requiredBy*, *replaces*, *replacedBy*, *references*, and *referencedBy* (all DCMI Metadata Terms). For the class Distribution, *dcat:mediaType* is considered equivalent to the *dct:format* property. Therefore, media type is excluded from the specification. A new property *dct:identifier* has been added to the class *Agent*.

2.1.7. DCAT-AP-Spain (Spain)[16]

DCAT-AP-Spain is somewhat exceptional in the sense that it is not an extension of DCAT-AP. Rather, the Spanish profile was created before the European one. As a consequence, several legacy features are still present in the current iteration of the standard. These will cause some interoperability issues when using Spanish metadata and assuming that it is in a DCAT-AP v1.1 format. Despite the chronological order, we will describe the differences as violations against DCAT-AP v1.1 as the chronological order is less important in practical deployments when taking the interoperability perspective.

2.1.8. DCAT-AP-SE (Sweden)[17]

DCAT-AP-SE extends DCAT-AP from the perspective of the Swedish national portal for open data öppnadata.se. Several properties for licensing, a class for *RightStatement*, and additional contact details have been added. Somewhat similar to Italy, Sweden has restricted the *vCard:Kind* to *vCard:Organization* or *vCard:Individual*.

2.1.9. CH-DCAT-AP (Switzerland)[18]

The opendata.swiss portal developed the Swiss standard for DCAT-AP called the *DCAT-AP for Switzerland*. The Swiss extension focuses on multilingualism. All text elements have to be provided and translated into French, German, Italian and English.

2.2. Mandatory Property Updates

Each extension has its own list of mandatory properties to serve national needs regarding online metadata exchange. Along with that each extension includes the mandatory properties of DCAT-AP v1.1. In some cases a recommended or optional property is moved to the set of mandatory properties by adding restrictions on it, while in other cases new

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[15] https://doc.difi.no/dcat-ap-no/
[16] http://datos.gob.es/es/documentacion/guia-de-aplicacion-de-la-norma-tecnica-de-interoperabilidad-de-reutilizacion-de
[17] https://docs.google.com/document/d/17-vEfZXlu9kykcmjXZo1_Z8QKkr7-Prgwd6YUKLRrjk/edit and https://docs.google.com/document/d/1A7OUPTqWIvKGdaArOORIJKlowFynA0UWBO1M4BnE4Ak/edit (restricted access)
[18] https://handbook.opendata.swiss/en/library/ch-dcat-ap

mandatory properties are introduced. Restrictions are made by adding cardinality constraints, language constraints, range constraints, and in some cases restricting semantics. We analysed these changes in the context of property, class, and the number of extensions.

The most often changed mandatory property is *dct:identifier*. The number of updates for this property is highly significant. It is changed for the class *Dataset* in four extensions, two times for the class *Agent*, and once for the class *Standard*. DCAT-AP v1.1 lists *dct:identifier* as an optional property for the Class *Dataset*. Since four countries have made it mandatory for that class, it seems to be worth having a discussion on making this a mandatory property for this class.

The property *dct:publisher* is changed in four extensions for class *Dataset* and is made mandatory. *Publisher (publisher)* is a recommended property for the class *Dataset* in DCAT-AP v1.1, but the number of updates suggest that also this property could be made mandatory.

The property *dct:license* is updated four times: three times for class *Distribution* and once for class *Catalogue*. This property is discussed further in section 2.6 below.

The *dcat:theme* property is updated three times for class *Dataset*. In all updates it is made mandatory, while it is an optional property in DCAT-AP v1.1; here also it seems worth discussing changing the status to mandatory at a higher level. *vcard:fn* is updated twice for class *Organization* and once for class *Contact*. *vCard:hasEmail* has been updated three times, out of which two updates concern the class *Organization* and once the class *Contact*. As mentioned above, both Italy and Sweden have restricted the type of vCards allowed. Italy restricted it to organizations only, while Sweden also allows individuals. These restrictions indicate that both saw no need to indicate vCards representing groups of vCards nor vCards representing a location object.

dct:modified is updated twice for *Dataset* and once for the class *Catalogue*. For properties *dct:issued*, *dcat:mediaType*, *rdf:type*, *dct:format* and *dcat:accessURL* there are two updates found in all analysed extensions. The number of updates made in these properties are not consistent, and each extension has changed them differently. For twenty-seven other mandatory properties, there is only one update found in all analysed DCAT-AP extensions. Therefore they are not considered significant changes, and the properties are unlikely candidates for further discussions on making properties mandatory at in DCAT or DCAT-AP.

2.3. Recommended and Optional Property Updates

Recommended properties represent the set of metadata attributes that could be left unspecified by a data publisher, but are better to be included according to EU data interoperability standards. There is also another category of metadata attributes called optional. These properties are completely optional, but if provided, these properties will increase the value of data, because some recipients might recognise it and use the extra information. However, they are considered of limited value on a wider level.

In this section we discuss both recommended and optional properties with respect to the frequency of changes made in different extensions. These properties are changed in national extensions according to interoperability needs. The type of changes include moving an optional property to become recommended or vice versa. Further, range, language, cardinality, and semantic restrictions are applied.

One of the most often updated property is *dct:spatial*. It is updated in three extensions for the class *Dataset* and in one extension for the class *Catalogue*. But the updates made are not consistent across all three extensions, therefore an updated recommendation from the three extensions should be subject to discussion as it cannot be made from this analysis. *dct:license* is updated twice for the class *Dataset* and once for each *Distribution* and *Catalogue*. We discuss this property in more detail in section 5. The property *dct:identifier* is updated in two different extensions, once for each of the classes *Agent* and *Catalogue*. The *dct:subject* definition is changed in three extensions for the class *Dataset*. *vCard:hasTelephone* is changed in two extensions for the class *Organization* and once for class *vCard Contact*. The property *dct:creator* is changed three times for the class *Dataset*, while *dct:description* is changed in two extensions for the class *Distribution* and once for the class *Standard*. *dct:type* is also updated in three extensions. In addition, there are sixty-three other recommended/optional properties that are changed once in one of the analysed extensions.

2.4. Optional and Recommended Property Exclusions

We observed the following exclusions of optional and recommended properties:
- In DCAT-AP_IT: Some recommended and optional properties are excluded, in particular for:
  - Class *Agent*: the recommended property *dct:type* is excluded.
  - Class *Distribution*: the following recommended and optional properties are excluded: *spdx:checksum*, *foaf:page*, *dct:language*, *dct:conformsTo*, *dct:rights*, *adms:status*, *dct:issued*, and *dcat:mediaType*.
  - Class *Dataset*: the following recommended and optional properties are excluded: *dct:relation*, *dct:source*, *dct:accessRights*, *dct:provenance*, *foaf:page*, *dct:hasVersion*, *adms:sample*, *dct:type*, and *adms:versionNotes*.
  - Class *Catalogue*: the following recommended and optional properties are excluded: *hasPart*, *isPartOf. dcat:record*, *dct:spatial*, *dct:license*, and *dct:rights*.
- In DCAT-AP-NL: the following recommended and optional properties are not part of the class *Distribution*: *license*, *conformsTo*, *language*, *page*, *checksum*, *type*, and *rights*.
- DACT-AP-NO: the optional property *mediaType* for class *Distribution* is excluded.

2.5. Language

All DCAT-AP extensions are kept compatible with multiple languages, which means that all new classes and properties were created considering to allow multiple languages. Some extensions, such as the DCAT-AP extension for Switzerland, extended DCAT-AP so that multi-lingual elements can contain an *xml:lang* attribute. The example presented in Figure 2 is taken from the official CH-DCAT-AP extension and shows how *xml:lang* can be used.

Figure 2 - Example of *xml:lang* usage in CH-DCAT-AP

```
<dct:title xml:lang="fr">FR Titre</dct:title>

<dct:title xml:lang="de">DE Titel</dct:title>

<dct:title xml:lang="it">IT Titolo</dct:title>

<dct:title xml:lang="en">EN Title</dct:title>
```

The Spanish DCAT-AP specification uses *dc:language* with range *rdfs:Literal* instead of *dct:language* with range *dct:LinguisticSystem*. The range of the literals are language codes as defined in RFC5646 (e.g., "es", "ga", "ca", "en", etc.). This difference may be due to the Spanish profile being defined before DCAT-AP v1.1, and can cause interoperability issues because software that expects DCAT-AP v1.1 data might not even check whether the *dc:language* property exists, and hence ignore the available language information.

2.6. Licence

For many national extensions, several changes were made to enable the documentation of licences and copyright information. It was also mentioned in the German extension specification that a future DCAT-AP version should foresee a solution for adding a licence attribution text. Until then, the attribute *dcatde:licenseAttributionByText* is used.

Germany, Italy and Switzerland have made *dct:license* a mandatory property for the class *Distribution* while the Netherlands has excluded it for the same class. Instead the Dutch extension has added a recommended licence attribute to the *Dataset* class with a limited number of possible values. The rationale seems to be that multiple distributions of the same dataset will have the same licence anyway. As mentioned in an issue report recorded on Joinup[19], in case the licence would be different this can be worked around by defining multiple datasets. The aforementioned change therefore does appear reasonable. However, any catalogue that harvests information from Dutch catalogues will not recognize this difference and discard the information, instead of 'inheriting' it from the dataset to the distributions, except if it has specific logic to handle this difference.

In DCAT, *dct:license* is specified as a sub-property of *dct:rights* and it is used to link a *Distribution* to a *LicenseDocument*. But DCAT also mentions that *dct:rights* allows linking a *RightsStatement*, which can also include licensing information, along with other supplementary information such as attribution.

The Spanish extension has made the *licence* property mandatory for *Catalogue*, while it remains recommended in other extensions and in DCAT-AP v1.1. Note that this property indicates under which licence the catalogue itself can be used or reused; this property *licence* is not inherited by the *Dataset* or *Distribution* classes. As Spain is the only country that defines this as a mandatory property for *Catalogue*, it seems that there is not sufficient ground for making this property mandatory on the DCAT or DCAT-AP level. On the other hand, there are much fewer catalogues than datasets and distributions. Hence, introducing this change would not imply a high overhead on data portals. Besides, also the catalogue itself would need a licence, depending on the jurisdiction. It might for

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[19] https://joinup.ec.europa.eu/asset/ogd2_0/issue/granularity-conflicts-license-and-status

example not be allowed to reproduce the catalogue or make any derived work from it unless an explicit permission is obtained.

2.7. dcat:mediaType and dct:format

The Swedish DCAT-AP recommendation suggested to avoid the *mediaType* property completely and use *dct:format* instead. The Swedish extension has identified *mediaType*, the sub-property of class *dct:format*, to be equivalent to *dct:format* for class *Distribution*. Therefore, the property *mediaType* is excluded from their specification.
Some other countries, such as Norway, removed the *dcat:mediaType* property and replaced it by using only *dct:format*. Switzerland in turn changed the *dcat:mediaType* from optional to recommended. All in all, it is an issue to be considered in the future work on DCAT-AP v1.1 and DCAT.

3. NON-CONFORMANT CHANGES

Generalizing properties and classes or relaxing (or removing) mandatory cardinalities to either optional or recommended are changes that create non-interoperable situations. In some cases however, there may be a meaningful reason for this. We summarize the violations of the analysed extensions and discuss them below:

- DCAT-AP-NL: There are two properties with same name *version* but different URI's. The extended property *version* has URI *adms:version*, while the other property *version*, *which* is part of DCAT-AP 1.1 and DCAT-AP-NL, has URI *owl:versionInfo*. As specified by the DCAT-AP v1.1, adding properties similar to existing ones is not allowed.
- CH-DCAT-AP: A new property *dcat:coverage*, that is similar to the DCAT property *spatial* was added. However, this seems to be an error in the Swiss profile, as there is no property *dcat:coverage* defined in the DCAT namespace. It is possible that the profile intended to add the property *dct:coverage*. It is not clear why the profile adds this property as it also recommends to avoid using it.
- DCAT-AP-Spain: The differences regarding languages of the Spanish extension, described in the previous section 2.5, cause problems for interoperability, and would be regarded as violating the recommendation.

4. GEOSPATIAL PROPERTIES

Some of the extensions have also added geospatial metadata elements. Ireland has included some geospatial elements for data interoperability across the nation. The extended properties are defined for the class *Dataset*, namely *GeographicBoundingBox*, *SpatialReference System*, and *Spatial Resolution*. The German extension added *politicalGeocodingLevelURI*, *politicalGeocodingURI*, and *geocodingText*. Italy included *geographicalIdentifier*, *geographicalName*, and *Geometry (geometry)*. If *loc:geometry* is specified, then the three mandatory items *CRS*, *coordinates*, and *geometry Type* must also be provided. The c*oordinates* represent coordinates of the geographic area covered by the dataset, *CRS* is the spatial reference system in which the data are represented, and *geometry Type* is the type of geometry that characterizes the spatial object used for the location of the dataset (e.g. point).

Spatial (*dct:spatial*) is a DCAT-AP property that represents the geographical area coordinates where the dataset applies. Norway, Spain, Sweden, Switzerland, and the Netherlands have added range restrictions on the property spatial for the class *Dataset*. Each extension has introduced its own type of restriction. Sweden has also added restrictions for the class *Catalogue*.

As several profiles decided to add new properties to describe geospatial properties, it seems to be a good candidate for future discussions on new features for DCAT or DCAT-AP.

5. RELATIONSHIPS BETWEEN CATALOGUES, DATASETS, AND DISTRIBUTIONS

In DCAT-AP v1.1 optional relationship properties exist for the class *Catalogue*. These properties indicate a parent/child or containment relationship for *Catalogue*. In particular, the property *dct:isPartOf* references a Catalogue of which this Catalogue is a physical or logical part. The inverse property *dct:hasPart* is used to show that another catalogue is the parent of the considered catalogue. For *Dataset*, DCAT-AP v1.1 provides the *dct:isVersionOf* property, which indicates a related dataset of which the described dataset is a *version*, *edition*, or adaptation. In general, we can imagine also other useful relationships between the *Catalogue*, *Dataset*, and *Distribution* classes. In this section we describe not only what we observed (mainly from the Norwegian and Spanish profile), but also indicate other paths we believe should be investigated.

At first, one can imagine that portals want to publish updated versions of these resources without breaking the old ones. Hence, for the three main classes (*Catalogue*, *Dataset*, and *Distribution*) it would be useful to be able to publish a new version and indicate that it is an updated version of the older one. The older one can then in turn indicate the newer (or newest) version. Note that *dct:versionOf* takes this role for *Dataset*, but its semantics are too broad. We observed that currently only the Norwegian profile includes a pair of properties called *replaces* and *isReplacedBy* for the *Dataset* class to indicate that a dataset has become obsolete.

DCAT has a top-down structure: a catalogue contains datasets, which in turn have distributions. Now, it is imaginable that we obtain the description of a dataset and then want to know which catalogue contains this one, perhaps in order to search for other datasets. What would be needed to achieve this is a 'backlink' from the dataset to the catalogue. Similarly, there could be such a reverse property from a distribution to a dataset. None of the profiles investigated has shown such properties.

A dataset is not always a standalone piece of information, but rather a part of a larger set. Hence, some sort of *isPartOf/hasPart* relation would also be useful for the class *Dataset*. Similarly, it is possible that, in order to interpret a dataset correctly, another dataset is needed. Norway proposes the properties *isPartOf* and *hasPart* for the first use case and *requires* and *isRequiredBy* to indicate the second relation.

Next, somewhat similar to the case above, there might be dataset instances which are referring to the one under consideration. Norway has chosen to add two properties to indicate this, namely *references* and *isReferencedBy.* Similarly, the Spanish adaptation has a property name *references*.

Another aspect of dataset which could be included in the metadata is a sort of succession relation. For example, a country publishing its water consumption report each year cannot use the *dct:isVersionOf* as it is too ambiguous. In practice, the new report would not really replace the earlier published ones, nor is it referring or requiring the previous ones. Rather, it is just a dataset in a sequence of datasets. Specialized properties to describe such temporal sequencing of datasets were not found in the extensions analysed. For *Distribution*, we found out that the Spanish profile includes a property called *dct:relation*. However, this property, with range any resource, points at resources which could provide more information about the format.

6. CONCLUSION

In this report, the analysis of national profiles implementing DCAT-AP v1.1 has been presented. In the process, we indicated several properties which could be discussed for inclusion in the next iteration of DCAT-AP or the W3C DCAT recommendation. Examples of already existing properties which have been modified frequently include, *dct:identifier*, *dct:publisher*, *dcat:theme*, and the way to use the *vCard* class. Furthermore, we identified a need to standardise more clearly how *license* and *mediaTypes/formats* are specified. New properties to be considered for future revisions of DCAT-AP include those related to spatial properties and relationships between the class *Dataset* and *Distribution*.

We also indicated several changes made by national profiles which limit interoperability or which only help implementations capable of dealing with these specific requirements, while other implementations ignore the information as they are unable to interpret it. In the future, the ISA² Programme could help DCAT-AP implementers overcome these interoperability challenges by, for example, creating additional guidelines that ensure the compatibility of extensions with DCAT-AP and the interoperability of extensions among each other, or by checking the compliance of national extensions with DCAT-AP.

7. APPENDIX

This annex contains the differences between DCAT-AP and the national application profiles. There are four tables representing different types of changes. Each table is structured so that changes are easy to understand.

Table 1 represents mandatory properties that already exist in DCAT-AP v1.1, but are somehow customized to meet the requirements of a national DCAT extension. Summarization of all these properties by class makes it possible to get an idea of the changes done to specific properties. The second column represents the property URI. The third column 'Change Type' shows the type of change made. The fourth column Range is included because for some properties the range is modified. The fifth column represents the cardinality of the property. The last column represents the country code of the national profile.

Table 2 represents newly added mandatory properties. This table is structured like Table 1, except for the Change Type, as this will be 'added' for all rows.

Table 3 represents class restrictions in national DCAT-AP extensions. In this table Class represents the class Name and URI represents the class' URI. Usage notes represents the use of the class and country represents the country code.

Table 4 lists changes for all properties except changes for mandatory properties. The table is made of 6 columns. Requirement describes whether the property is optional, recommended, to be avoided, and so on. Class represents the class which has the property, URI represents the property URI, Change type represents the type of change made, range represents the range of the property, cardinality represents property cardinality restrictions, and country represents the country that has made this change.

In these tables we indicate the country of the national profile where the change was observed. The country codes as are as follows: Belgium (BE), Germany (DE), Ireland (IE), Italy (IT), the Netherlands (NL), Norway (NO), Spain (ES), Sweden (SE), and Switzerland (CH).

7.1. Restricted Mandatory Properties

Table 1 - Restricted mandatory properties

Class	URI	Change Type	Range	Card.	Country
Agent	dct:identifier	1..n to 1	rdfs:Literal	1	IT
	dcat:dataset	1..n to 1	dcat:Dataset[20]	1	IT
	dct:issued	0..1 to 1	rdfs:Literal typed as xsd:date or xsd:dateTime	1	ES

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[20] This seems to be a mistake in the recommendation. The examples in the specification contradict this restriction.

Catalogue	dct:modified	0..1 to 1	rdfs:Literal typed as xsd:date or xsd:dateTime	1	ES
	dc:language	0..n to 1	rdfs:Literal? Literal. Standard values Labels to identify Languages defined in the RFC 5646 {"es", "ga", "ca", "eu", "En", "fr"}. A Tag for each property	1..n	ES
	dcat:themeTaxonomy	0..n to 1	skos:ConceptScheme	1..n	ES
	foaf:homepage	0..1 to 1	Recurso. URI que referencia a la portada del catálogo.	1	ES
	dct:license	0..n to 1	Recurso. URI que referencia al recurso que describe los términos de uso.	1	ES
Dataset	dct:publisher	0..1 to 1..1 unique IDs	foaf:Agent	1	NO
	dct:identifier	0..n to 1..n	rdfs:Literal	1..n	NO
	dcat:theme	0..n to 1..n	skos:Concept	1..n	NO
	dct:identifier	0..n to 1	rdfs:Literal	1	IT
	dcat:theme	0..n to 1..n	skos:Concept	1..n	IT
	dct:modified	0..1 to 1	date or datetime	1	IT

	dct:accrualPeriodicity	0..1 to 1	dct:Frequency	1	IT
	dcat:distribution	Obligatory only for open data	dcat:Distribution	1..n	IT
	dct:identifier	0..n to 1	rdfs:Literal	1	NL
	dct:language	0..n to 1	xml:lang	1	NL
	dct:modified	0..n to 1	xml:date	1	NL
	dct:identifier	0..1 to 1	rdfs:Literal	1	CH
	dct:title	text elements be translated in fr, ge, it, en	rdfs:Literal	1…n (each lang.)	CH
	dct:description	0..n to 1..n	rdfs:Literal	1..n	CH
	dct:publisher	0..n to 1..n	foaf:Agent	1..n	CH
	vCard:Organization	0..n to 1..n	vCard:Kind	1..n	CH
	dct:theme	0..n to 1..n	skos:Concept	1..n	CH
	dcat:theme	0..n to 1..n	skos:Concept	1..n	ES
	dct:publisher	0..1 to 1	foaf:Agent	1	ES
	dcat:Distribution	0..1 to 1..n	dcat:Distribution	1..n	ES
Distribution	dct:format	0..1 to 1	dct:MediaTypeOrExtent	1	IT
	dcat:accessURL	1..n to 1	rdfs:Resource	1	IT
	dct:license	0..1 to 1	dct:LicenseDocument	1	IT

	dct:license	0..1 to 1	dct:LicenseDocument	1	DE
	dct:issued	0..1 to 1	rdfs:Literal typed as xsd:date or xsd:dateTime	1	CH
	dct:rights	0..1 to 1	rdfs:Literal http://www.w3.org/TR/rdf-schema/#ch_literal	1	CH
	dct:mediaType	It is only mandatory if the distribution is available as data download	dct:MediaTypeOrExtent	0..1	CH
	rdf:Description	0..1 to 1	rdfs:label	1	CH
	dcat:accessURI	0..1 to 1	rdfs:Literal	1	ES
	dcat:mediaType	0..1 to 1	dct:MediaTypeOrExtent	1	ES
	dct:format	0..n to 1..n	dct:MediaTypeOrExtent	1..n	NO
License Document	dct:LicenseDocument	Mandatory class			DE
PeriodTime	dcatapit:startDate Has subpro. schema:startDate	0..1 to 1	date or datetime	1	IT

7.2. Added Mandatory Properties

Table 2 - Added mandatory properties

Class	URI	Range	Card.	Country
Agent	dct:identifier	rdfs:Literal	1	IT
Standard	dct:identifier	rdfs:Literal	1	IT
Organization	vCard:fn	rdfs:Literal	1	IT

	vCard:hasEmail	vCard:Email	1	IT
PeriodOfTime	dcatapit:startDate	xsd;date or xsd;dateTime	1	IT
Dataset	dct:rightsHolder	dcterms:Agent	1	IT
	dcatde:contributorID	rdfs:Literal	0..n[21]	DE
	overheid:authority	overheid:Agent (subclass of foaf:Agent)	1	NL

7.3. Class Restrictions

Table 3 - Class restrictions

Class	URI	Usage Notes	Country
Organization	dcatapit:Organization	In the Italian profile the optional vCard:Kind class is restricted to the class dcatapit:Organization, which is a subclass of vCard:Organization which in turn is subclass of vCard:Kind. The vCard:Organization has a set of properties defined as reported in https://joinup.ec.europa.eu/asset/dcat-ap_implementation_guidelines/asset_release/dcat-ap-how-describe-contact-information	IT

7.4. Optional and Recommended Properties

Table 4 - Optional and recommended properties

Requirement	Class	URI	Change Type	Range	Card.	Country
N/A	Dataset	gmd:EX_GeographicBoundingBox	added	gmd:EX_GeographicBoundingBox	0..1	IE
	Dataset	gmd:MD_ReferenceSystem	added	gmd:MD_ReferenceSystem	0..1	IE
	Dataset	gmd:MD_Resolution	added	gmd:MD_Resolution	0..1	IE

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[21] Note: this seems to be an error in the German profile.

	Dataset	dct:requires	added	dcat:Dataset	0..n	NO
	Dataset	dct:isReplacedBy	added	dcat:Dataset	0..n	NO
	Dataset	(no change)	Recommendation to use MDR vocabularies removed	(no change)	0..n	NO
	Dataset	dcat:coverage	added	dct:LocationPeriodOrJurisdiction	0..n	CH
avoid	Catalogue	dcat:themeTaxonomy	avoid	skos:ConceptScheme	0..n	SE
	Distribution	dcat:mediaType	restricted format	dct:MediaTypeOrExtent	0..1	SE
	Dataset	dct:type	avoid	skos:Concept	0..1	SE
	Distribution	dct:license	Left only for compatibility	dct:LicenseDocument	0..1	CH
full	vCard Address	rdf:type	added	vCard:Address (fixed value, must be present)	0..1	SE
optional	Dataset	dcatde:originator	added	foaf:Agent	0..n	DE
	Dataset	dcatde:maintainer	added	foaf:Agent	0..n	DE
	Dataset	dct:contributor	added	foaf:Agent	0..n	DE
	Dataset	dct:creator	added	foaf:Agent	0..n	DE
	Dataset	dcatde:geocodingText	added	rdfs:Literal	0..n	DE
	Dataset	dcatde:legalbasisText	added	rdfs:Literal	0..n	DE

	Distribution	dcatde:license AttributionByText	added	rdfs:Literal	0..n	DE
	Distribution	dcatde:license Attributi onByText	added	rdfs:Literal	0..n	DE
	Dataset	dct:type	Diese Eigenschaft bezieht sich auf den Typ der Datenstruktur.	skos:Concept	0..1	DE
	Distribution	dct:description	Diese Eigenschaft enthält eine Freitextbeschreib ung der Distribution.	rdfs:Literal	0..n	DE
	Dataset	dct:creator	added	dcatapit:Agent (subclass of foaf:Agent)	0..n	IT
	Dataset	dct:subject	added	skos:Concept	0..n	IT
	Licence Document	foaf:name	added	rdfs:Literal	0..n	IT
	Licence Document	owl:versionInfo	added	rdfs:Literal	0..1	IT
	Standard	dct:title	added	rdfs:Literal	0..n	IT
	standard	dct:description	added	rdfs:Literal	0..n	IT
	standard	dcatapit:refer enceDocumen tation	added	rdfs:Literal	0..n	IT
	Organization	vCard:hasTelephone	added	vCard:TelephoneType	0..1	IT

Organization	vCard:hasURL	added	owl:Thing	0..1	IT
Location	dcatapit:geographicalIdentifier	added	rdfs:Literal	0..1	IT
Contact Point	vCard:hasTelephone	added	Recommended to use an instance of a Telephone Type according to the vCard Ontology	0..1	IT
Contact Point	vCard:hasURL	added	Any URL related to the object	0..1	IT
Period OfTime	dcatapit:endDate	added	rdfs:Literal typed as xsd:date or xsd:dateTime	0..n	IT
Geometry	locn:geographicName	added	A proper noun applied to a spatial object.	0..1	IT
Geometry	loc:Geometry	added class		0..1	IT
Dataset	dcat:LandingPage	Cardinality changed	foaf:Document	0..1	IT
Dataset	dcat:keyword	recommended to optional	rdfs:Literal	0..n	IT
Dataset	dct:subject	added	skos:Concept	0..n	NO
Dataset	dct:creator	added	rdfs:Resource	0..n	NO
Dataset	dct:isPartOf	added	dcat:Dataset	0..n	NO
Dataset	dct:hasPart	added	dcat:Dataset	0..n	NO

	Dataset	dct:isRequired By	added	dcat:Dataset	0..n	NO
	Dataset	dct:replaces	added	dcat:Dataset	0..n	NO
	Dataset	dct: references	added	dcat:Dataset	0..n	NO
	Dataset	dct: isReferencedB y	added	dcat:Dataset	0..n	NO
	Catalog ue	dct:extent	added	dct:SizeOrDuratio n	0..1	ES
	Catalog ue	dct:identifier	added	xsd:anyURI	0..1	ES
	Dataset	dct:license	added	dct:LicenseDocu ment or similar	1..1	ES
	Dataset	dct:valid	added	rdfs:Literal ISO-8601: YYYY-MM-DD	0..1	ES
	Dataset	dct:references	added	Recurso. URI que identifica al recurso relacionado. Se pueden incluir tantas propiedades como referencias se conozcan.	0..n	ES
	Distribut ion	dcat:identifier	added	xsd:anyURI	0..1	ES
	Dataset	dc:language	restricted	rdfs:Literal? Literal. Standard values Labels to identify Languages defined in the RFC 5646 {"es", "ga", "ca", "eu", "En", "fr"}. A Tag for each property	1..n	ES

	Dataset	dct:spatial	restricted	Recurso. Puede tomar uno de los valores que representan las provincias españolas, según se expresan en el anexo V.	0..n	ES
	Distribut ion	dct:relation		Recurso. URI con una referencia a un recurso asociado con el formato. Se pueden incluir tantas propiedades como referencias a documentos adicionales se conozcan.	0..n	ES
	Catalog ue	dct:spatial	added	dct:Location	0..n	SE
	Agent	foaf:homepag e	added	foaf:Document	0..1	SE
	Agent	foaf:mbox	added	owl:Thing	0..n	SE
	RightsSt atement	odrs:copyright Notice	added	Literal with language code	0..1	SE
	Dataset		restricted	dct:spatial	0..n	SE
	Dataset	dct:accesssRi ght	restricted	dct:RightsStatem ent	1	SE
	Dataset	dct:provenanc e	restricted	dctProvenanceSta tement	0..n	SE
	Dataset	rdfs:seeAlso	added	rdfs:Literal	0..n	CH

	Dataset	dct:language	language restricted	rdfs:Literal	0..n (for each language)	CH
	Dataset	dcat:keyword	language restricted	rdfs:Literal	0..n	CH
	Distribution	dcat:title	language restricted	rdfs:Literal	0..n (one for each language)	CH
	Distribution	dct:description	language restricted	rdfs:Literal	0..n (one for each language)	CH
	Dataset	dcat:spatial	restricted	dct:Location	0..1	CH
	Distribution	dct:language	restricted	rdfs:Literal	0..n (for each language)	CH
	Distribution	dct:coverage	restricted	dct:LocationPerio dOrJurisdiction http://dublincore. org/documents/2 012/06/14/dcmi-terms/?v=terms# LocationPeriodOrJ urisdiction	0..n	CH
	Distribution	dcat:accessURL	restricted	http://www.w3.o rg/2001/XMLSche ma#anyURI	0..n	CH

	Distribution	dct:download URL	restricted	http://www.w3.org/2001/XMLSchema#anyURI	0..n	CH
	Dataset	dct:rights	added	overheid:VrijeTekst (subclass of rdfs:literal)	1	NL
	Dataset	overheid:grondslag	added	overheid:Regeling	0..n	NL
	Dataset	overheidds:doel	added	overheid:VrijeTekst (subclass of rdfs:literal)	0..1	NL
	Dataset	overheidds:kwaliteit	added	overheid:VrijeTekst (subclass of rdfs:literal)	0..1	NL
	Dataset	overheidds:LODStars	added	overheidds:Stars	0..1	NL
	Dataset	overheidds:doel	added	Free text	0..1	NL
	Dataset	adms:version	added	Free Text	0..1	NL
	Dataset	dcat: contactpoint	added	Not Specified	0..n	NL
recommended	Dataset	dcatde:qualityProcessURI	added	rdfs:Literal	0..1	DE
	Dataset	dcatde:politicalGeocodingLevelURI	added	rdfs:Literal	0..n	DE
	Dataset	dcatde:politicalGeocodingURI	added	rdfs:Literal	0..n	DE
	Dataset	dct:publisher	Semantically restricted	foaf:Agent	0..1	DE
	Distribution	dcatde:plannedAvailabilty	added	rdfs:Literal	0..1	DE

	Licence Document	dct:type	changed vocabulary	skos:Concept	0..1	DE
	Distribution	dct:title	Diese Eigenschaft bezeichnet den einer Distribution zugewiesenen Titel.	rdfs:Literal	0..n	DE
	Distribution	dct:modified	Diese Eigenschaft erfasst das Datum der letzten Aktualisierung bzw. Modifikation der Distribution.	rdfs:Literal typed as xsd:date or xsd:dateTi me	0..1	DE
		adms:status	Diese Eigenschaft bezieht sich auf den Status / Reifegrad der Distribution. Es MUSS das ADMS-Vokabular (http://purl.org/a dms/statu s/1.0) verwendet werden.	skos:Concept	0..2	DE
		dct:type	restricted vocabulary	skos:Concept	0..3	DE
	Dataset	dcatno:access RightsComme nt	added	skos:Concept	0..n	NO
	Agent	dct:identifier	added	rdfs:Literal	0..1	NO
	Dataset	dct:subject	added	SKOS: Concept	0..n	NO

	Dataset	(no change)	optional to recommended	(no change)	0..1	NO
	RightsStatement	odrs:AttributionText	added	Literal with language code	0..1	SE
	RightsStatement	odrs:AttributionURL	added	Link to document	0..1	SE
	RightsStatement	odrs:copyrightStatement	added	Link to document	0..1	SE
	RightsStatement	odrs:copyrightYear	added	A literal for the year.	0..1	SE
	RightsStatement	odrs:copyrightHolder	added	foaf:Organization with restrictions as for foaf:Agent in the SE recommendation	0..1	SE
	RightsStatement	odrs:jurisdiction	added	Country URI, use geonames.	0..n	SE
	RightsStatement	odrs:reuserGuidelines	added	Link to document	0..1	SE
	vCard contact	vCard:hasTelephone	added	Recommended to use an instance of a Telephone Type according to the vCard Ontology	0..n	SE
	vCard contact	vCard:hasAddress	added	The address of the object represented in structured parts according to the vCard Ontology	0..n	SE
	Catalogue	dct:license	restricted	dct:LicenseDocument	0..1	SE
	Dataset	dcat:theme	restricted	skos:Concept	0...n	SE
	Distribution	dct:format	restricted	dct:MediaTypeOrExtent	0..1	SE

	Distribution	dct:license	restricted	dct:LicenseDocument	0..1	SE
	Dataset	dct:license	added	Recommended lincenses: CCs. However, if other or proprietary licenses are to be specified, name and version can be potentially provided	1	NL
	Dataset	dcat:landingPage	optional to recommended	URL	1	NL
	Dataset	dct:spatial	optional to recommended	overheid:Spatial (complex type)	1	NL
	Dataset	dct:temporal	optional to recommended	overheid:Period (complex type)	0..n	NL
	Distribution	dcat:downloadURL	restricted	rdfs:Resource	0..n	NL
	Distribution	dct:modified	restricted	Xs:date	0..1	NL

8. GLOSSARY

Acronym	Entire expression	Definition
Fedict	Federal Public Service Policy and Support Information and Communication Technology	Fedict works for the Belgian Federal Government and is responsible for e-government.
IRI	Internationalized Resource Identifier	Internet standard to extend upon the existing Uniform Resource Identifier (URI) scheme. IRIs may contain characters from the Universal Character Set (Unicode/ISO 10646).
ISO	International Organization for Standardization	International standard-setting body composed of representatives from various national standards organisations
RFC	Request for Comments	Type of publication from the Internet Engineering Task Force (IETF) and the Internet Society (ISOC), the principal technical development and standards-setting bodies for the Internet.
URI	Uniform Resource Identifier	In information technology, it is a string of characters used to identify a resource.
W3C	World Wide Web Consortium	Main international standards organisation for the World Wide Web.