D3.1 Initial requirements for semantic assets

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Table of Contents

List of Tables

List of Figures

List of Acronyms

Abbreviation / Acronym	Description
ABR	Access to Base Registries
ADL	Architecture Description Language
ADMS	Asset Description Metadata Schema
BB	Building Block
BPMN	Business Process Model and Notation
BRIS	Business Registers Interconnection System
CA	Consortium Agreement
CEF	Connecting Europe Facility
CFS	Certificate on the Financial Statements
CPOV	Core Public Organization Vocabulary
CPSV	Core Public Services Vocabulary
CPSV-AP	Core Public Services Vocabulary - Application Profile
DC	Data Consumer
DCAT	Data Catalog Vocabulary
DE4A	Digital Europe for All
DoA	Description of Action
DP	Data Provider
DSI	Digital Service Infrastructure
Dx.y	Deliverable number y, belonging to WP number x
EC	European Commission
eID	Electronic Identification
eIDAS	Electronic Identification and Signature (EU regulation)
EIF	European Interoperability Framework
EIRA	European Interoperability Reference Architecture
FOAF	Friend of a Friend
IHU	International Hellenic University
IOP	Interoperability
ISA2	Interoperability solutions for public administrations, businesses, and citizens
ML	Machine Learning
OOP	Once-Only Principle
OWL	Web Ontology Language
PKI	Public Key Infrastructure
RDF	Resource Description Framework
RDFS	Resource Description Framework Schema
RP	Reporting Period
SCOOP4C	Stakeholder Community Once-Only Principle for Citizens
SDG	Single Digital Gateway
SDGR	Single Digital Gateway Regulation

Abbreviation / Acronym	Description
SEMIC	Semantic Interoperability Centre Europe
SKOS	Simple Knowledge Organization System
SPARQL	Protocol and RDF Query Language
TL	Task Leader
TOOP	The Once-Only Principle Project
W3C	World Wide Web Consortium
WP	Work Package
WPL	Work Package Leader
XML	Extensible Markup Language

Glossary

Term	Explanation
Co-creation	Co-creation is a process that brings together users and designers to work towards a shared goal [Prof. Thorsten at London Research and Consulting group]
Criterion	A standard on which a judgment or decision may be based (merriam-webster) a standard by which you judge, decide about, or deal with something (cambridge) a condition or fact used as a standard by which something can be judged or considered (cambridge)
Dictionary	List of terms about a particular subject with their meanings in the same or in another language
eDelivery	Delivery helps public administrations to exchange electronic data and documents with other public administrations, businesses and citizens, in an interoperable, secure, reliable and trusted way
Evidence	Any document or data, including text or sound, visual or audiovisual recording, irrespective of the medium used, required by a competent authority to prove facts or compliance with procedural requirements referred to Article 2.2.b (SDGR). Something legally submitted to a tribunal to ascertain the truth of a matter (merriam-webster) anything that helps to prove that something is or is not true (cambridge) objects, documents, official statements, etc. that are used to prove something is true or not true, especially for legal or insurance purposes (cambridge)
Federated OOP Architecture	One of the key innovative solutions to be developed within TOOP is a generic federated architecture that supports the interconnection and interoperability of national base registries across state borders. Such a generic, federated OOP architecture aims at providing consolidated reusable building blocks for the implementation of the “once-only” principle in public services in Europe. From a methodological point of view, such an architecture will not be developed from scratch. Efforts have been made in the development of generic building blocks for European cross-border public services.
Legal Entity	An association, corporation, partnership, proprietorship, trust, or individual that has legal standing in the eyes of law (website ‘business dictionary’)
Metadata Standard	A metadata standard is a high-level document which establishes a common way of structuring and understanding data and includes principles and implementation issues for utilizing the standard. (website ‘pitt.libguides’)
Once Only Principle	The public administrations should ensure that citizens and business can supply the same information only once to a public administration and administrations should be able to retrieve and share this data to serve the user, in accordance with data protection rules.
Ontology	An ontology – within the scope of computer and information sciences – can be defined as a formal specification for the purpose of delimiting and grouping instances/concepts (facts, events, entities, elements, etc.), based on their common class (types, properties, interrelationships, etc.), and thus formalising a full or a subset of a domain. (website -europa.eu). A formal model that allows knowledge to be represented for a specific domain. An ontology describes the types of things that exist (classes), the relationships between them (properties) and the logical ways those classes and properties can be used together (axioms).(website ‘w3.org’)

Term	Explanation
Person Legal	A legal person is a registered organization, having its registered office in a Member State. Reference: SDGR, 14401/1/17 REV 1, Brussels, 28 November 2017, Article 3(1)
Person, Natural	A natural person is a citizen of the Union or a human residing in a Member State. Reference: SDGR, 14401/1/17 REV 1, Brussels, 28 November 2017, Article 3(1)
Proof	Fact or piece of information that shows that something exists or is true (Cambridge), something that induces certainty or establishes validity (Merriam-webster) evidence operating to determine the finding or judgment of a tribunal (Merriam-webster)
Public Service	The concept of public service is twofold: it embraces both the bodies providing services and the services of general interest they provide. Public service obligations may be imposed by the public authorities on the body providing a service (airlines, road or rail carriers, energy producers and so on) either nationally or regionally. ('website 'eur-lex.europa.eu')
Relevant Only Principle	Users should be asked to provide only the information that is absolutely necessary to obtain a given public service (EIF)
Scenario	One typical way in which a system is used or in which a user carries out some activity.
Semantic Asset	A specific type of standard which involves highly reusable metadata (e.g. xml schemata, generic data models) and/ or reference data (e.g. code lists, taxonomies, dictionaries, vocabularies). (website 'w3.org')
Taxonomy	A systematic arrangement in groups or categories of concepts according to established criteria
Technical Coordinator	The Technical Coordinator is a senior technical expert who will facilitate the smooth execution of the whole development lifecycle within the DE4A project.
Thesaurus	A list of words and their synonyms about a domain of knowledge
TOOP	The Once-Only Principle Project (TOOP) was launched by the European Commission in January 2017 as an initiative of about 50 organizations' from 20 EU Member States and Associated Countries. The main objective of TOOP is to explore and demonstrate the once-only principle across borders, focusing on data from businesses. Doing this, TOOP wants to enable better exchange of business-related data or documents with and between public administrations and reduce administrative burden for both businesses and public administrations.
Use case	A specification of one type of interaction with a system. One use case may involve several scenarios (usually a main success scenario and alternative scenarios)
User	User is anyone who is a citizen of the Union, a natural person residing in a Member State or a legal person having its registered office in a Member State, and who accesses the information, the procedures, or the assistance or problem-solving services, referred to in Article 2(2), through the gateway. Reference: SDGR, 14401/1/17 REV 1, Brussels, 28 November 2017, Article 3(1)
Vocabulary	A collection of terms for a particular purpose. Vocabularies can range from simple, such as the widely used RDF schema, FOAF and DCMI element set, to complex vocabularies with thousands of terms, such as those used in healthcare to describe symptoms, diseases and treatments. Vocabularies play a very important role in linked data, specifically to help with data integration. For example, metadata vocabulary. The use of this term overlaps with that of 'ontology'. (website 'w3.org').
Zero knowledge proof	Method by which one party (the prover) can prove to another party (the verifier) that they know a value x without conveying any other information. This requires that the prover possesses some secret information, then the verifier will not be able to prove the statement to anyone else without possessing the secret information.

Executive Summary

This document assembles the initial requirements as far as semantic interoperability is concerned within the context of Digital Europe for All (DE4A) project. To achieve this, analysis of existing taxonomies and libraries of core vocabularies is performed. While this deliverable is focusing on the initial set of requirements for semantics in DE4A, it also defines a structured way of eliciting requirements with co-operation from other Work Packages (WPs), namely work package WP4 – "*Cross-border Pilots for Citizens and Business and Evaluation*" and work package WP2 – "*Architecture Vision and Framework*", to provide design decisions and implementation guidelines to work package WP5 – "*Common Component Design & Development*", and DE4A technical partners as well.

Semantic interoperability faces various common issues at national and at European Union (EU) level in terms of semantic and syntactic aspects as well. The example of such common issues include lack of harmonized or common data structures, minimal agreements on reference data, lack of common management metadata, and absence of unique identifiers for the public services and public organizations. Moreover, the semantic assets of EU ISA^2 (Interoperability solutions for public administrations, businesses and citizens) Programme have a good initiative in terms of academic rather than a practical view.

To tackle semantic interoperability common issues, work package WP3 – "*Semantic Interoperability Solutions*" module has tasked to **i)** analyse and extend the existing taxonomies and libraries of core vocabularies, **ii)** to design the semantic interoperability framework and **iii)** implement semantic tools.

The reason for this deliverable is that it is the initial set of requirements that will evolve later in the next deliverable "*D3.2 Final requirements for semantic assets*" by encompassing semantic interoperability related requirements identified in pilots through leader of work package WP4 – "*Cross-border Pilots for Citizens and Business and Evaluation*". A co-creation methodology is proposed to gather semantic interoperability requirements from the pilots for this deliverable and for other deliverables of work package WP3 - "*Semantic Interoperability Solutions*" like deliverable D3.3 "*Design of the semantic interoperability framework*". The reader of this document will aware about semantic assets related efforts at EU and worldwide level, in terms of initiatives, and projects, and standards, in the field of e-government emerging not only at the European level but also at a worldwide level. Moreover, such semantic assets related efforts will be a potential baseline to build a common repository of semantic models and business rules.

The main results achieved in this deliverable are **a)** the vocabularies to serve as input for the framework of work package WP3 - "*Semantic Interoperability Solutions*", **b)** the outcomes from relevant projects regarding semantics, **c)** Thus, existing core vocabularies from European Commission (EC) and domain specific ontology libraries identified are the ISA^2 Core vocabularies (Core Public Services Vocabulary - CPSV, Core Public Organisation Vocabulary - CPOV) and generic ontologies such as Asset Description Metadata Schema (ADMS), Dublin core, Friend of a Friend - FOAF. We will also gather additional requirements for piloting countries national semantic models, if any, and this will help work package WP3 - "*Semantic Interoperability Solutions*" to build a common repository of semantic models and business rules. The requirements of the semantic blocks and their dependencies needed for delivering integrated cross-border public services are collected focusing on the DE4A specific pilot scenarios. Moreover, the semantic outcomes from TOOP (The Once Only Principle project) form a potential baseline, to be extended by filling in the gaps identified by the pilots conducted therein. That is why in the current document we analyse relevant results of TOOP project. An agile approach to requirement elicitation is proposed, letting requirements incrementally grow with the experiences from pilots and emerging taxonomies and libraries. Iterations thereby correspond to the pilots conducted in the

project. This approach will feed the next deliverable "*Final requirements for semantic assets*" and provide architectural (WP2 – "*Architecture Vision and Framework*") and technical (WP5 – "*Common Component Design & Development*") requirements to DE4A.

Key messages of this deliverable are:

- Semantic interoperability is on the prime aspects to deliver integrated cross-border public services as per the DE4A pilots' scenarios.
- Sematic interoperability is linked to architectural decisions of DE4A
- Semantic interoperability requirements drive design and implementation decisions of work package WP5 - "*Common Component Design & Development*"
- Semantic standards to be re-used in DE4A originate from efforts around SDG efforts and ISA[2] standards (CPSV, CPOV etc.)
- More generic semantic assets are proposed to be also re-used (e.g. FOAF, ADMS, DCAT – Data Catalogue Vocabulary).
- The TOOP project semantic assets interoperability results will be considered in the DE4A strategy as a clear requirement of re-use, as deemed appropriate.
- An agile co-creation methodology for eliciting requirements regarding the semantic interoperability of services piloted in DE4A is proposed.

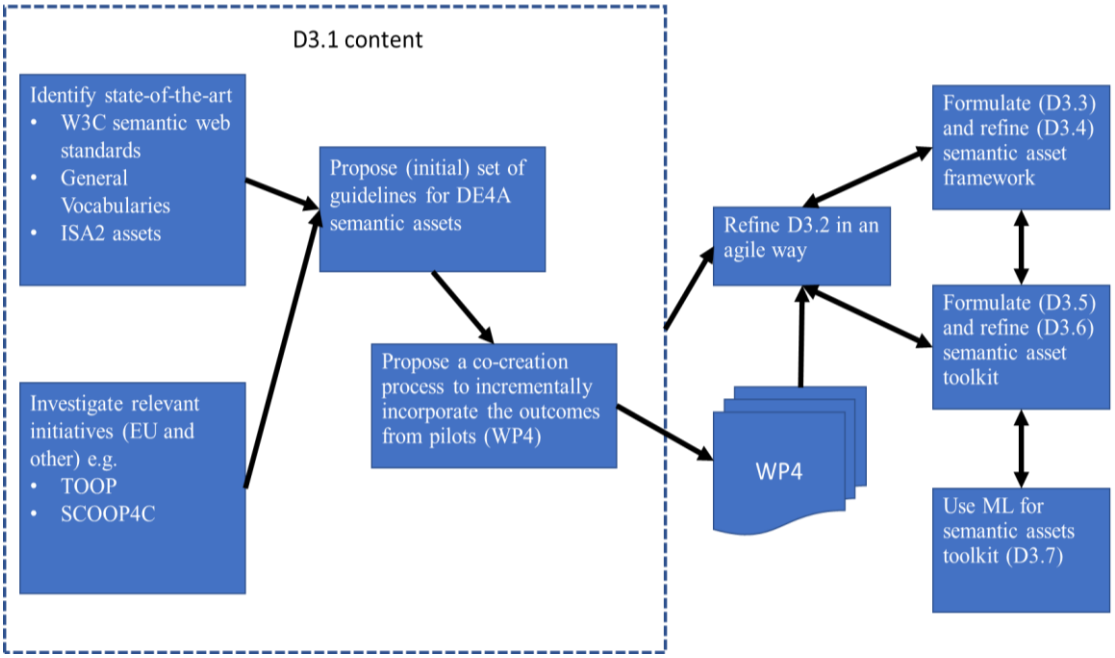

Figure 1: D3.1 in DE4A context

The outcomes of this deliverable are focusing on providing a set of guidelines which are requirements for the development of the semantic framework at work package WP3 – "*Semantic Interoperability Solutions*" deliverable D3.3 – "*Design of the semantic interoperability framework"*. The version 1 of the set is this deliverable, and this set is incrementally developed towards next deliverable "*D3.2 Final requirements for semantic assets*" by accommodating the outcomes from pilots (WP4 – "*Cross-border Pilots for Citizens and Business and Evaluation*"). This implementation process follows an agile methodology, by starting in a baseline level with this deliverable, and iteratively improves by adding the tools resulting from including the requirements from pilots and other emerging assets identified and added in next deliverable "*Final requirements for semantic assets*" live document. This document acts, therefore, as the starting point where it (see also Figure 1):

- Identifies state-of-the-art semantic assets
- Investigates relevant (EU and non-EU) initiatives to applying semantic assets in the public services field
- Proposes initial set of requirements and guidelines for DE4A, to be refined towards next deliverable "Final requirements for semantic assets"
- Proposes an agile co-creation approach to incorporate pilots' requirements in deliverables D3.2 – "*Final requirements for semantic assets*", and D3.3 – "*Design of the semantic interoperability framework*".

1 Introduction

1.1 European Semantic Interoperability

The Regulation 2018/1724 (EU) of 2 October 2018 establishing a single digital gateway to provide access to information, to procedures and to assistance and problem-solving services and amending Regulation (EU) No. 1024/2012. The SDGR (Single Digital Gateway Regulation 2018/1724 – EU) establishes the obligation on EU Member States to facilitate access to and completion of online administrative procedures by cross-border businesses and citizens. Such facilitation also includes direct exchange or verification of lawfully issued evidences between competent authorities of different Member States by electronic means in application of the once-only and relevant-only principles. This means that such cross-border evidences should be able to be processed in any Member State, which requires a sound semantic interoperability approach to be put into practice

Within the European context, several Semantic interoperability initiatives have been aimed at delivering integrated cross-border public services by developing taxonomies and vocabularies for certain issues. Some of them are for specific-domains and rely on real field tests, such as BRIS (Business Registers Interconnection System) data models, and others are for general-domain, such as the Core Vocabularies defined by the ISA^2 programme, although these only have lab concept tests. In consequence, there is no comprehensive semantic map that covers all the requirements for delivering integrated cross-border public services.

1.2 How are semantic assets related to DE4A

Within the European context, several Semantic interoperability initiatives have been aimed at delivering integrated cross-border public services by developing taxonomies and vocabularies for certain issues. Some of them are for specific-domains and rely on real field tests, such as BRIS data models, and others are for general-domain, such as the Core Public Service Vocabulary (CPSV), although these only have lab concept tests. CPSV aims to offer a technology neutral, generic representation of a service provided by public administration. It will emerge as a common denominator of existing national, regional and local public service models, providing a lingua franca that will enable the seamless exchange of services and information across different e-Government systems. On the other hand, there is not a comprehensive semantic map that covers all the requirements for delivering integrated cross-border public services.

The ambition of DE4A regarding semantics is to develop a comprehensive map of modular semantic blocks needed for delivering integrated cross-border public services, particularly in the context of the SDGR fully online public services. The requirements of these semantic blocks and their dependencies will be completely described by the work of the DE4A project, within an implementation guide where a comprehensive view will be explained with a practical approach. Furthermore, a complete testing and evaluation of each semantic block will be performed in the pilots involving real cross-border public service delivery; the discussion on the barriers found and the solutions validated in these pilots will be written down for further discussion when other integrated cross-border public services are implemented. Adequate semantic approaches, such as use of vocabularies adapted to the users, can help leveraging the potential of accessing increased data quality in governmental registries through once-only implementations

The main focus is not to provide novel semantic assets for interoperability but a full semantic layer for delivering cross-border public services that will reuse as much as possible the available ones. This layer will be defined by modular semantic assets and their relationships, widely described with complete requirement specifications and a practical implementation guide which will be tested in DE4A pilots. The inventory of these semantic assets along with their requirements, relationships and, when

applicable, implementations will be provided in a way that eases the maintainability of the coherence of the semantic layer. Ultimately, DE4A will help overcome the fragmented views of the public service concept (e.g. following different flavours of national, regional or local traditions) that impact on the quality and the efficiency of public service provision for cross-border users by increasing administrative burdens and making public service provision costly.

In consequence, the objectives of work package WP3 – "*Semantic Interoperability Solutions*" are as follows:

- **Analysis, integration and extension** of existing taxonomies and libraries into consistent semantic interoperability framework for evidence exchange across borders: by finding commonalities in documents and data structures, to build a common repository of semantic models and rules.
- **Design of an ontological framework and semantic components** required for technical pilot scope by creating a Toolbox of semantic data models -considering relevant domains- and tools to be included in the Toolbox of Solutions and BB of the Architecture Vision.
- **Investigation of the potential of machine learning and self-emerging ontologies** in providing efficient and effective semantic interoperability within European eGovernment supporting the Once Only Principle and the Zero Knowledge Proof methodology for a more efficient support of the Relevant Only Principle.

Within this context, this deliverable correlates with Pilots for Citizen & Business (work package WP4- "*Cross-border Pilots for Citizens and Business and Evaluation*"),work package WP5 – "*Common Component Design & Development*" and work package WP2 – "*Architecture Vision and Framework*" to jointly form the agile development factory within the project. The focus is to get the pilot implantations working and accepted in real life, while adhering to the agreed PSA from work package WP2 – "*Architecture Vision and Framework*" and adhering to design principles that ensure a maximum reusability beyond the project.

This deliverable incorporates a semantic requirement definition and looks beyond the Pilots in order to close the perceived gap in semantic interoperability today. Subject document and work package WP3 – "*Semantic Interoperability Solutions*" in general will build and expand on prior work from ISA (i.e. SEMIC, CPSV) and W3C and deliver semantic components, ready to use in the work package WP4 Pilots.

The work performed in this document is in accordance with the agile methodology followed in the whole DE4A project and is depicted in Figure 2.

This information will create a catalogue of building blocks (BB) and enablers (D3.5 – "*Semantic toolkit – Initial version*" & D3.6 – "*Semantic toolkit – Final version*") that will be refined and extended with specific work in work package WP2 – "*Architecture Vision and Framework*" and work package WP3 – "*Semantic Interoperability Solutions*", by existing and emerging BB, Digital Service Infrastructures (DSI), taxonomies, vocabularies and semantic libraries, incl. maturity assessment. This solution toolbox (D3.5 & D3.6) will be considered by work package WP5 or other relevant DE4A WPs, in order to identify the gaps that should be covered by the design and development of new components for the piloting phase.

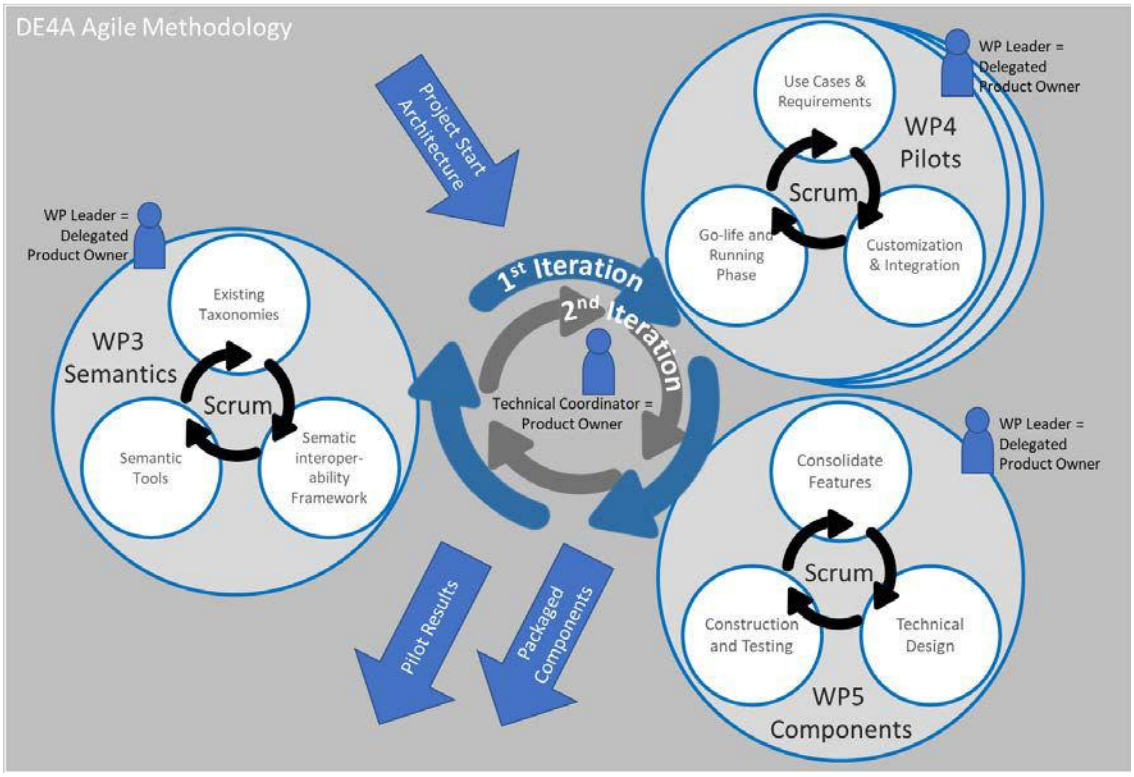

Figure 2: DE4A Agile Methodology

Moreover, deliverable "*Initial requirements for semantic assets*" has started investigating the relationship of semantic assets to blockchain technologies that are to be used in DE4A. Blockchain has become a pervasive technology in several sectors. In the last decade many tailored-domain problems have been solved thanks to the blockchain. Due to this reason, researchers expressed their interest in combining the blockchain with other well-known technologies, like semantic assets [1]. In the relevant literature, very little work has been presented in which semantic assets and blockchain can be combined, and the further benefits for both. Special scenarios for e-government field is something that DE4A will investigate.

1.3 Purpose and structure of the document

The purpose of the present document is to elicit and discuss the semantic interoperability requirements, known as a set of guidelines, which provide basis for the development of the DE4A semantic interoperability framework. The version 1 of the set is the subject deliverable, and the set is incrementally developed by accommodating the outcomes from pilots, analysis of results of other projects like TOOP and other requirements of emerging vocabularies, taxonomies, dictionaries, and libraries, ontologies. Additionally, this document includes an agile co-creation methodology, to bring together users (DE4A pilots) and designers (DE4A work package WP3 team) to capture and align semantic interoperability needs to define a DE4A semantic interoperability framework.

This deliverable is the first draft of a draft, though comprehensive and thorough requirements analysis, of semantic assets relevant for DE4A. Thus, initial set emerges from the experience of the domain experts leading the relevant tasks (i.e. IHU). In this context, it formulates the co-creation methodology (see chapter 5) to incorporate in an agile way new semantic requirement originating from DE4A pilots (through work package WP4) and communicating these back to architectural and implementation WPs

(i.e. work package WP2 – "*Architecture Vision and Framework*", and work package WP5 – "*Common Component Design & Development*").

Moreover, the integration of prior work, i.e. from SEMIC (see chapter 3), into an extensible, multi-domain, cross-border and cross-sector Semantic Interoperability Framework in work package WP3 – "*Semantic Interoperability Solutions*" provides the missing elements required to establish Semantic Interoperability across Europe.

The scope of work package WP3 – "*Semantic Interoperability Solutions*" is to propose a comprehensive semantic model that covers the requirements for delivering integrated cross-border public services and deliverable "*Initial requirements for semantic assets*" is a starting baseline of requirements integrating works of existing initiatives (e.g. SEMIC, ISA[2]) that will be iteratively improved by adding the tools resulting from including the requirements from pilots and other emerging assets identified. The output of this deliverable will feed D3.3 into an extendible multi-domain, cross-border and cross-sector semantic interoperability framework. Deliverables D3.2 – "Final requirements for semantic assets" and D3.3 – "*Design of the semantic interoperability framework*" will include results from this document by extending the assets contained in the framework to accommodate the needs of the pilots, as well as extending or ensuring the ability of the semantic framework to support the DE4A pilots. The main aim of the work package WP3 – "*Semantic Interoperability Solutions*" is thereby to close the currently perceived gap in semantic interoperability. Adequate semantic approaches can help leveraging the potential of accessing increased data quality in governmental registries through once-only implementations.

D3.1 implements the "reuse before adapt before develop"-principle to all software development activities. This means that, for any given feature, it must be investigated whether existing, preferably open source, solutions are available that can be reused or can be adapted to fulfil the requirements (D3.5 – "*Semantic toolkit – Initial version*" & D3.6 – "*Semantic toolkit – Final version*"). Any technical design document for bespoke software development in DE4A shall summarize this investigation in the introduction and explain why existing solutions were considered not fit for the purpose.

Moreover, it contributes in dealing with the challenge of availability and accessibility limitations of open data and semantic assets. Thus, it bridges the gaps of interoperability that may occur due to the limited availability and accessibility to data. Towards this, it identifies the semantics assets initially and creates a framework to get feedback by the pilots retrospectively.

Finally, this document has started investigating the relationship of semantic assets to blockchain technologies that are to be used in DE4A. Blockchain has become a pervasive technology in several sectors. In the last decade many tailored-domain problems have been solved thanks to the blockchain. Due to this reason, researchers expressed their interest in combining the blockchain with other well-known technologies, like semantic assets [1]. In the relevant literature, very little work has been presented in which semantic assets and blockchain can be combined, and the further benefits for these both areas. Special scenarios for e-government field is something that DE4A will investigate.

The structure of the document is the following:

Chapter 2 – State of the art semantic assets
Chapter 3 - The semantic interoperability inputs and results of other related projects
Chapter 4 – The initial requirements for DE4A assets
Chapter 5 - The co-creation methodology to gather semantic interoperability requirements for DE4A

2 State-of-the-art Semantic Assets

This chapter discusses the identification of the initial requirements for DE4A concerning semantic interoperability. To achieve this, section 2.1 sets the scene of how semantic assets are related to DE4A aims. Then, we proceed on analysing the semantic assets that are of interest for DE4A as reusable components. The investigation is based on relevant EU standardization efforts and generic semantic assets. More specifically, section 2.2 presents an overview of generic vocabularies and ontologies used as a common language/communication framework towards the interoperability between public administrations. Finally, section 2.3 analyses the Core Vocabularies endorsed by the European Commission's ISA program for interoperability solutions. A pictorial representation of literature semantic assets is shown in Figure 3 below:

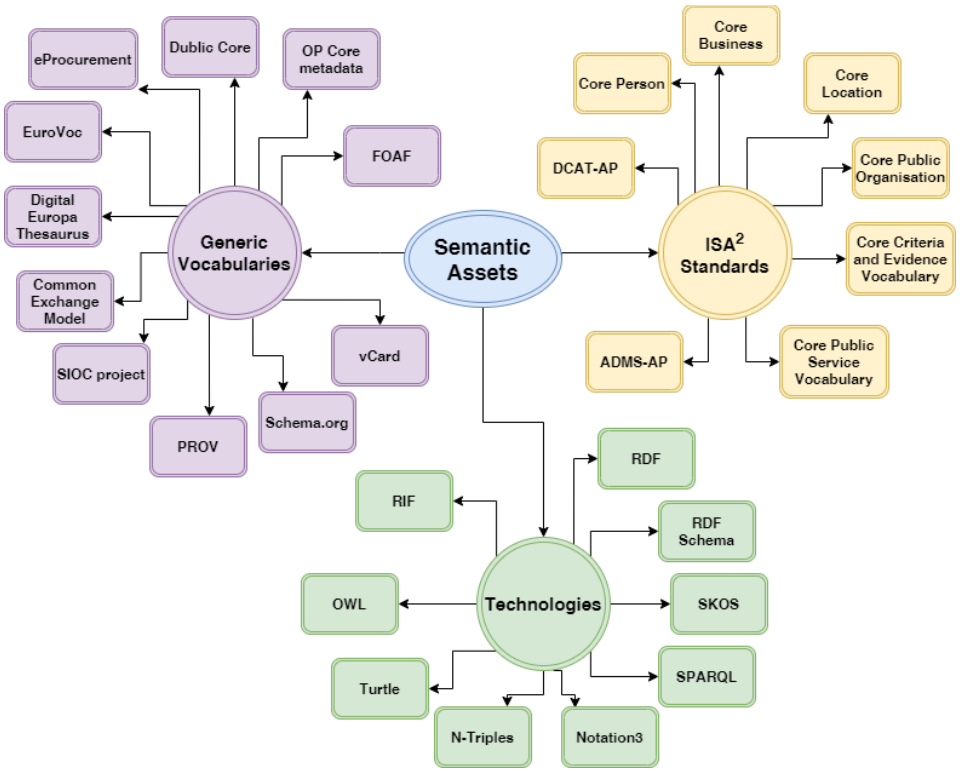

Figure 3: Semantic assets ecosystem - Generic Vocabularies, Technologies, ISA^2 Standards.

2.1 W3C semantic web approach and related vocabularies

This section discusses the relevant standards that act as initial input for requirements of DE4A as semantic assets are concerned.

In addition to the classic "Web of documents" W3C is helping to build a technology stack to support a "Web of data," the sort of data that can be found in databases [2]. The goal of the Web of data is to enable computers to do more useful work and to develop systems that can support trusted interactions over the network. The term "Semantic Web" refers to W3C's vision of the Web of linked data. Semantic Web technologies enable people to create data stores on the Web, build vocabularies, and write rules for handling data. Linked data are empowered by technologies such as RDF [3], SPARQL [4], OWL [5], and SKOS [6].

At times it may be important or valuable to organize data. Using RDF, RDFS and OWL (to build vocabularies, or “ontologies”) and SKOS (for designing knowledge organization systems) it is possible to enrich data with additional meaning, which allows more people (and more machines) to do more with the data. The term "Semantic Web" was coined by Tim Berners-Lee, the inventor of the World Wide Web and director of the World Wide Web Consortium ("W3C"), which oversees the development of proposed Semantic Web standards. He defines the Semantic Web as "a web of data that can be processed directly and indirectly by machines". Many of the technologies proposed by the W3C already existed before they were positioned under the W3C umbrella. These are used in various contexts, particularly those dealing with information that encompasses a limited and defined domain, and where sharing data is a common necessity, such as scientific research or data exchange among businesses. In addition, other technologies with similar goals have emerged, such as microformats (e.g. used for ontologies under schema.org).

Semantic HTML refers to the traditional HTML practice of markup following intention, rather than specifying layout details directly [7]. For example, the use of denoting "emphasis" rather than <i>, which specifies italics. Layout details are left up to the browser, in combination with Cascading Style Sheets. But this practice falls short of specifying the semantics of objects such as items for sale or prices. Microformats extend HTML syntax to create machine-readable semantic markup about objects including people, organizations, events and products. Similar initiatives include RDFa, Microdata and Schema.org. The Semantic Web takes the solution further. It involves publishing in languages specifically designed for data: Resource Description Framework (RDF), Web Ontology Language (OWL), and Extensible Markup Language (XML) [8]. HTML describes documents and the links between them. RDF, OWL, and XML, by contrast, can describe arbitrary things such as people, meetings, or airplane parts.

Tim Berners-Lee calls the resulting network of Linked Data the Giant Global Graph, in contrast to the HTML-based World Wide Web. Berners-Lee posits that if the past was document sharing, the future is data sharing. His answer to the question of "how" provides three points of instruction. One, a URL should point to the data. Two, anyone accessing the URL should get data back. Three, relationships in the data should point to additional URLs with data.

The collection, structuring and recovery of linked data are enabled by technologies that provide a formal description of concepts, terms, and relationships within a given knowledge domain. These technologies are specified as W3C standards and include:

- Resource Description Framework (RDF) [3], a general method for describing information
- RDF Schema (RDFS) [9]
- Simple Knowledge Organization System (SKOS) [6]
- SPARQL [4], an RDF query language
- Notation3 (N3) [10], designed with human-readability in mind
- N-Triples [11], a format for storing and transmitting data
- Turtle (Terse RDF Triple Language) [12]
- Web Ontology Language (OWL) [5], a family of knowledge representation languages
- Rule Interchange Format (RIF) [13], a framework of web rule language dialects supporting rule interchange on the Web
- Shapes Constraint Language (SHACL) [14], a language for validating RDF graphs against a set of conditions

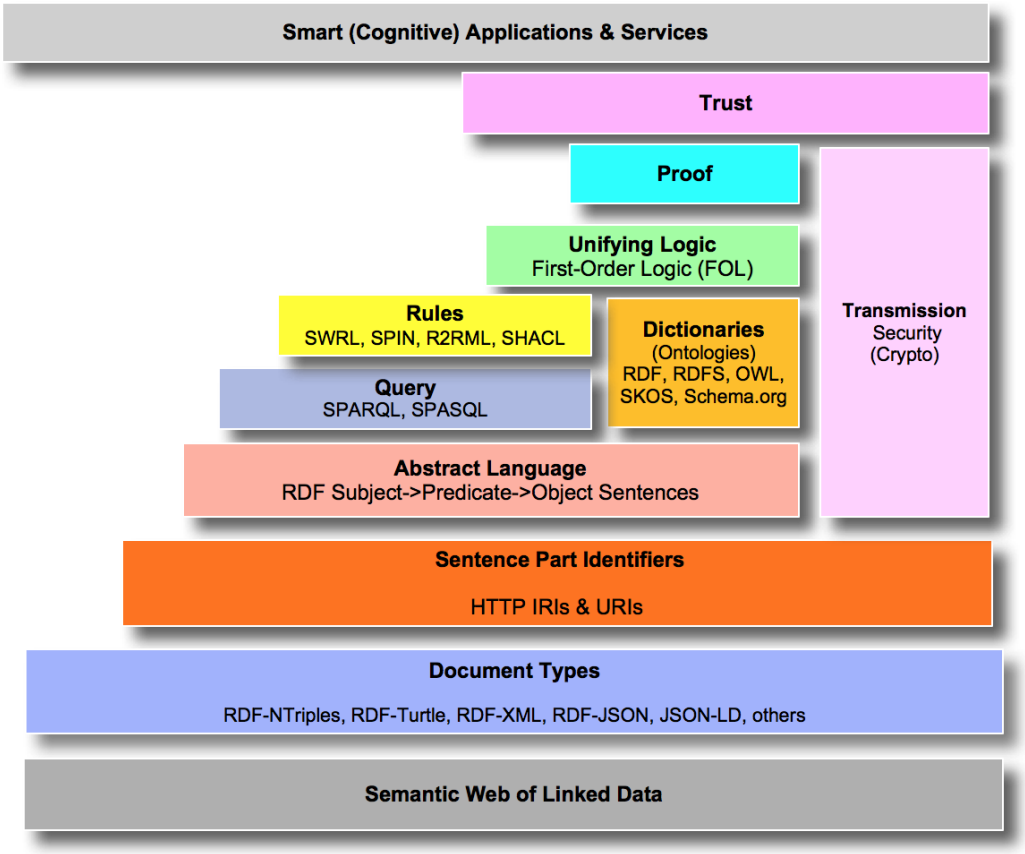

Figure 4: The Semantic Web Stack

The Semantic Web Stack (Figure 4) illustrates the architecture of the Semantic Web. The functions and relationships of the components can be summarized as follows:

- XML provides an elemental syntax for content structure within documents yet associates no semantics with the meaning of the content contained within. XML is not at present a necessary component of Semantic Web technologies in most cases, as alternative syntaxes exists, such as Turtle. Turtle is a de facto standard but has not been through a formal standardization process.
- XML Schema is a language for providing and restricting the structure and content of elements contained within XML documents [15].
- RDF is a simple language for expressing data models, which refer to objects ("web resources") and their relationships. An RDF-based model can be represented in a variety of syntaxes, e.g., RDF/XML, N3, Turtle, JSON-LD and RDFa. RDF is a fundamental standard of the Semantic Web.
- RDF Schema extends RDF and is a vocabulary for describing properties and classes of RDF-based resources, with semantics for generalized-hierarchies of such properties and classes.
- OWL adds more vocabulary for describing properties and classes: among others, relations between classes (e.g. disjointness), cardinality (e.g. "exactly one"), equality, richer typing of properties, characteristics of properties (e.g. symmetry), and enumerated classes.
- SPARQL is a protocol and query language for semantic web data sources.

- RIF is the W3C Rule Interchange Format. It's an XML language for expressing Web rules that computers can execute. RIF provides multiple versions, called dialects. It includes a RIF Basic Logic Dialect (RIF-BLD) and RIF Production Rules Dialect (RIF PRD).

'Semantic web" is a semantic resource that SDG can use for the front-end of eProcedures. So far, there has been limited use of semantic web standards and technologies in the context of the Once-Only Principle, which is the focus in the DE4A project. As per our scope of work, we may focus on related semantic assets aspects like semantic assets work, and semantic standards. We describe semantic assets aspects in the forthcoming sections.

2.2 Generic vocabularies

According to the Digital Agenda for Europe, interoperability between public administrations is a challenge, hindering the provision of digital public services across borders and across sectors. In order to facilitate interoperability between public administrations, this section presents an overview of generic vocabularies ontologies and standards used at the OOP. It will be thoroughly examined the feasibility of mapping these vocabularies to DE4A use cases in consultation with the DE4A Pilots. The outcomes will be incorporated in D3.2 “Final set of requirements for semantic assets”.

Vocabularies define the concepts and relationships used to describe and represent an area of concern. Making an analogy with everyday communication, we can see that each particular group of people uses specific vocabularies in their conversations and message exchanges. People group together for different reasons: geographic location, family, professional and social relationships, and in countless other situations, with a wide range of characteristics.

A set of reference vocabularies needs to be established, in order to facilitate the communication of those metadata. Readers need to be aware that for each specific publication, a search should be made regarding existing vocabularies that can be used. There are some catalogues that can help users find ontologies, such as LOV [16] and EIRA [17]. Every vocabulary is described by a document pointed to by a URI. The role of vocabularies is helpful for data integration when, for example, ambiguities may exist on the terms used in the different data sets, or when a bit of extra knowledge may lead to the discovery of new relationships.

A general example may help. A bookseller may want to integrate data coming from different publishers. The data can be imported into a common RDF model, e.g., by using converters to the publishers’ databases. However, one database may use the term “author”, whereas the other may use the term “creator”. To make the integration complete, an extra definition should be added to the RDF data, describing the fact that the relationship described as “author” is the same as “creator”. This extra piece of information is, in fact, a vocabulary (or an ontology), albeit an extremely simple one.

- **Dublin Core (DC)** [18]: Ontology for describing generic metadata. The vocabulary serves to describe resources (documents) and includes a basic set of fifteen generic, widely used elements; Creator, Contributor, Publisher, Title, Date, Language, Format, Subject, Description, Identifier, Relation, Source, Type, Coverage, and Rights. One of the uses of this vocabulary is the documentation of web pages. Metadata in this style uses Uniform Resource Identifiers (URIs) as global identifiers both for the things described by the metadata and for the terms used to describe them (vocabularies).
- **OP Core metadata element set** [19]: Based on the Dublin Core metadata element set, the Publications Office of the EU has defined its own OP Core metadata element set. It consists of 16 elements that any resource managed and published by the Publications Office –through the EU Vocabularies portal– can and should contain.
- **Friend of a Friend (FOAF)** [20]: This ontology defines metadata about **people and their interests, relationships, activities on the Web**. It is mostly focused on people's existence in the virtual world, with many properties related to online activity or identity: foaf:mbox,

foaf:skypeID, foaf:msnID, foaf:geekcode, etc. Nothing about family relations, physical address... It provides similar information on organisations or groups with a similar focus on their existence on the Web (workplace webpage, etc). In FOAF descriptions, there are only various kinds of things and links, which we call classes and properties respectively. FOAF is therefore defined as a dictionary of terms, each of which is either a class or a property.

- **vCard** [21]**:** vCard is an ontology developed by the IETF (Internet Engineering Task Force) aiming to promote the description of people and organisations utilising semantic web techniques and allowing compatibility with traditional vCard implementations.
- **Schema.org**: A collection of vocabularies that can be used to embed metadata in web pages and are understood by the main search engines: Google, Microsoft, Yandex and Yahoo!. The metadata can be embedded using microdata (or tags), RDFa or JSON-LD.
- **PROV** [22]: An important type of information about published data refers to the provenance of the data: Who generated it, how it was generated, and what the sources were. The PROV document ontology defines a model, corresponding serializations and other definitions to enable the exchange of information coming from the Web. The provenance model defined by PROV takes into account three basic elements: entities, activities and agents. These three elements are connected through a set of relationships. For example, "an entity (a web page, file, etc.) was generated by an activity associated with a particular agent."
- **SIOC project** [23]**:** This ontology is used to describe online communities such as forums, blogs, mailing lists, wikis. It complements FOAF by stressing on the description of the products of those communities (posts, replies, threads, etc).
- **Financial Industry Business Ontology (FIBO)** [24]: It defines the sets of things that are of interest in financial business applications and the ways that those things can relate to one. FIBO is developed as an ontology in the Web Ontology Language (OWL). The language is codified by the World Wide Web Consortium (W3C), and it is based on Description Logic.
- **Digital Europa Thesaurus** [25]: Multilingual thesaurus covering the main subject matters of the European Commission's public communications. It has been designed to describe and index web content from across the European Commission so that this content can be retrieved, aggregated, and managed. In line with the objectives of semantic interoperability, DET reuses EuroVoc concepts in combination with a few additional non-EuroVoc concepts necessary for describing web content subject matter.
- **EuroVoc** [26]: Multilingual, multidisciplinary thesaurus covering the activities of the EU, the European Parliament in particular. It contains terms in 23 EU languages.
- **eProcurement** [27]: Digital procurement is deeply linked to eGovernment. It is one of the key drivers toward the implementation of the 'once-only principle' in public administrations.
- **CommonProcurement Vocabulary (CPV)**: Establishes a single classification system for public procurement aimed at standardising the references used by contracting authorities and entities to describe procurement contracts (based on codes of up to 9 digits).

2.3 ISA^2 standards

The Semantic Interoperability Community (SEMIC) develops solutions to help European public administrations perform seamless and meaningful cross-border and cross-domain data exchanges [28]. The provision of digital cross-border public services requires the exchange of data between public administrations of different EU countries. Semantic interoperability is a fundamental enabler of such exchanges. It is crucial to agree on the use of common semantic standards, promote transparent and well-documented metadata policies and increase the visibility and reuse of existing semantic interoperability solutions.

Since its inception, SEMIC has contributed to the simplification of the environment in which EU countries exchange data for the delivery of electronic public services, addressing the issues and

barriers related to semantic interoperability in the EU. It is supported by the Action on Promoting semantic interoperability amongst the European Union Member States[1] of the Interoperability Solutions for European Public Administrations (ISA²) Programme.

SEMIC has the following objectives: One of the main objectives of SEMIC is to align and agree on common definitions and specifications at the semantic layer for public administrations in the Member States and the EU institutions. It promotes the use of ISA2 specifications; as e-Government Core Vocabularies[2], Asset Description Metadata Schema (ADMS) and DCAT Application Profile for Data Portals in Europe (DCAT-AP).

2.3.1 e-Government Core Vocabularies

The e-Government Core Vocabularies are simplified, re-usable and extensible data models that capture the fundamental characteristics of a data entity in a context-neutral fashion. They consist of the following vocabularies:

- Core Person
- Core Business
- Core Location
- Core Criterion and Core Evidence
- Core Public Organisation
- Core Public Service Vocabulary - Application Profile

Core Person-Business-Location vocabularies [29]

Core Person-Business-Location vocabularies are three concepts that are highly related. The vocabulary for describing a person relates to the natural person, i.e. the individual as opposed to any role they may play in society or the relationships they have to other people, organisations and property, all of which contribute significantly to the broader concept of identity. In describing businesses, the working group focused solely on legal entities, that is, trading bodies that are formally registered with the relevant authority and that appear in business registers. This excludes sole traders, virtual organizations and other types of 'agent' that can do business. The broadest vocabulary is that for location, which covers places, addresses, and geographical geometries. Table 1 describes the main classes of these vocabularies and presents some of the main properties of each class. More information can be found at [29]. Furthermore, a Unified Modelling Language (UML) diagram of the Core Person-Business-Location vocabularies is presented in Annex III.

Table 1: Main classes of Core Person, Business and Location Vocabularies

Core vocabulary	Class	Description	Properties
Person	PERSON	A natural person - a sub class of the more general 'Agent' class that encompasses organisations, legal entities, groups, etc. - any entity that is able to carry out actions	Full name, gender, date-country-place of birth-death
business	LEGAL ENTITY	represents a business that is legally registered	Legal name, company type-status, legal identifier

[1] https://ec.europa.eu/isa2/actions/improving-semantic-interoperability-european-egovernment-systems_en

[2] https://joinup.ec.europa.eu/solution/e-government-core-vocabularies

Core vocabulary	Class	Description	Properties
All	IDENTIFIER	The Identifier class represents any identifier issued by any authority, whether a government agency or not	Person-legal-location identifier
location	LOCATION	An identifiable geographic place. Locations can be described in three principal ways: by using a place name, a geometry or an address. The specific context will determine which method of describing a location is most appropriate. The Location Core Vocabulary provides structure for all three.	Geographic name-identifier, address
location	ADDRESS	INSPIRE Address Representation, full address, post code, etc.	Full address, post code, city, country
location	GEOMETRY	The Geometry Class denotes the notion of geometry at a conceptual level, and can be encoded in different formats	WKT, GML, KML, RDF+WKT/GML (GeoSPARQL), RDF (WGS84 lat/long, schema.org) and GeoHash URI references

Core Criterion and Core Evidence Vocabulary (CCCEV) [30]:

CCEV contains two basic and complementary core concepts:

- the criterion, something used as the basis for making a judgement or decision, e.g. a requirement set in a public tender or a condition that has to be fulfilled for a public service to be executed; and
- the evidence, something which proves that something else exists or is true, in particular an evidence is used to prove that a specific criterion is met by someone of by something.

CCEV was conceived in the domain of public eProcurement where these procedures are harmonized through EU Regulations. However, extending this to other domains may have severe limitations when in those domains, procedures are not harmonized. In this case, the focus would need to be on mapping the evidences to common semantic (canonical) models.

Table 2: Main classes of Core Criteria and Core Evidence Vocabulary

Class	Description	Properties
Criterion	The Criterion class represents the rule or principle used to judge, evaluate or assess something. Can be expressed as a set of requirements where every requirement must be valid.	Identifier, criterion type, fulfilled indicator, weight,
Formal framework	This class and its properties are defined in the Core Public Service Vocabulary11 Application Profile and may represent legislation, policy, or policies lying behind the rules that govern a criterion.	Core public service vocabulary application profile
Requirement group	A set of requirements that must be fulfilled together to validate a criterion	Identifier, description, has criterion requirement

Class	Description	Properties
Criterion requirement	A unique requirement that must be valid	Identifier, expected value, maximum-minimum value, type of translation, level of certification, type of copy quality
Requirement response	An assertion that responds to a criterion requirement	Identifier, value, proven by Evidence
Evidence	Any resource that can document or support a Requirement response	Identifier, evidence type, issued by Organisation, is supported by Document reference, belongs to Agent
Agent	An Organisation or Natural person providing a Requirement response that satisfies a Criterion. The Agent class is a generalisation of the Person and Organisation classes defined in the Core Person Vocabulary and the Organisation Ontology respectively.	Satisfies Criterion, provides Requirement response

By using the CCCEV, public organisations have the potential to implement new capabilities in their information systems to:

- Allow the use of criteria from common repositories, standardising the criteria used in different sectors and domains.
- Enable the automatic response to criteria, lowering the language barrier for cross-border processes and exchanges.
- Enable the automatic assessment through the analysis of criteria and provided evidences.
- Promote the standardisation of criteria and evidences among attestation and certificate providers, and across different Member States.
- Increase the transparency of the assessment and therefore the selection processes, reducing complaints and subjective assessment.

Table 2 describes the main classes of CCCEV and presents some of the main properties of each class. More information can be found at [30]. Furthermore, a UML diagram of CCCEV is presented in Annex III.

Core Public Organisation Vocabulary (CPOV) [31]

Public organisation is a body that is liable for a scope of government capacities. CPOV is intended to help the exchange of basic information about individual public organizations including relevant base registries like registry of competent authorities. Using the vocabulary, almost certainly augmented with sector- or country-specific information will encourage the process for institutions distributing data about public organizations to:

- share information G2G (government to government), G2B (government to business) and G2C (government to citizen)
- develop common information systems
- link data from public organizations to other data sets
- manage a cross-border repository of public services and organizations
- enable the creation of interoperable catalogues of public organization in Europe and beyond
- browse public organizations by its function

- link public service provided, budgets, and other types of resources with certain public organizations
- keep track of the evolution of public organizations
- increase efficiencies by spotting duplicated or overlapping functions.

The Core Public Organization Vocabulary is designed to describe the organization itself. Whilst the vocabulary may support links to descriptions of public services, members of staff or other resources such as relevant legislation, policies and jurisdictional coverage, it will not describe those resources in detail. Table 3 describes the main classes of CPOV and presents some of the main properties of each class. More information can be found at [31]. Furthermore, a UML diagram of CPOV is presented in Annex <III>.

Table 3: Main classes of Core Public Organisation Vocabulary

Class	Description	Properties
Public Organisation	The Public Organization class represents the organization. One organization may comprise several sub-organizations and any organization may have one or more organizational units. Each of these is described using the same properties and relationships.	Identifier, spatial, purpose, classification, homepage, logo, hasSubOrganisation, hasUnit, memberOf, contactPoint, address
Change event – Foundation event	Public organizations are formed and changed in response to events. This may be the result of new legislation, new policies, taking on new obligations etc. The CPOV captures this in its Change Event class but recognizes the specific case of an organization's foundation as being sufficiently distinct to require a sub class of Change Event.	resulting organization, original organization, hasFormalFramework
Formal Framework	This class and its properties are defined in the Core Public Service Vocabulary and may represent legislation or official policy that leads to a change event, including the establishment of the organization.	Core Public Service Vocabulary – Application Profile
Opening Hours Specification	The Core Public Organization Vocabulary makes full use of schema.org opening hours property to provide details of regular operations. The Opening Hours Specification class can be used to provide details of exceptional circumstances, such as being closed on public holidays	schema.org

2.3.2 Core Public Service Vocabulary – Application Profile (CPSV-AP)

At its simplest, a public service is the capacity to carry out a procedure and exists whether it is used or not. It is a set of deeds and acts performed by or on behalf of a public agency for the benefit of a citizen, a business or another public agency. Public services operate according to rules that are derived from some combination of legislation and policy which can be set at local, national or supranational level. A public service:

- is atomic, meaning that its use can be triggered by businesses, citizens or other public administrations

- usually requires information that is checked before the public administration issues an official decision that is registered in a system (in an automatic or manual way).

In case of DE4A project, it will be also studied how to describe public services that would be used to deliver fully online cross-border procedures like those specified in SDG regulation.

CPSV-AP combines information from all e-Government Core Vocabularies (Core Person-Business-Location, CCEV, CPOV) [32]. It is designed to make it easy to exchange basic information about individual public sector services. By using the vocabulary, almost certainly augmented with sector-specific information, organizations publishing data about their services will enable:

- easier discovery of those services with and between countries
- easier discovery of the legislation and policies that underpin service provision
- easier recognition of how services provided by a single organisation interrelate and are used either by other services or external users
- easier comparison of similar services provided by different organisations

CPSV-AP is an Application Profile, i.e. it is a specification that re-uses terms from one or more base standards, adding more specificity by identifying mandatory, recommended and optional elements to be used for a particular application, as well as recommendations for controlled vocabularies to be used.

Some specific use cases of CPSV-AP are listed as follows:

- Finding information about public services more easily
- Building user-centric catalogues of public services at all levels from regional to a European federated catalogue
- Managing portfolios of public services
- Finding information of generic and specialised public services

Table 4 describes the main classes of CPSV-AP and presents some of the main properties of each class. More information on the latest release of CPSV-AP can be found at [32]. Furthermore, a UML diagram of CPSV-AP is presented in Annex III.

Table 4: Main classes of Core Public Service Vocabulary – Application Profile (CPSV-AP)

Class	Description	Properties
Public Service	a mandatory or discretionary set of activities performed, or able to be performed, by or on behalf of a public organisation, publicly funded and arise from public policy. A European public service comprises any service provided by public administrations in Europe, or by other organisations on their behalf, to businesses, citizens or others public administrations	Identifier, name, sector, thematic area, type, language, status, requires, relation, hasCriterion, hasCompetentAuthority, etc.
Event	An event that can be of any type that triggers, makes use of, or in some way is related to, a Public Service. Subclasses: business event, life event)	Identifier, name, type, relatedService
Public Service Dataset	The Public Service Dataset is a specialisation of the Dataset class of the Data Catalog Vocabulary (DCAT) and inherits all its properties. The class describes the metadata of where the dataset is being described, for	Identifier, publisher, name, landing page

Class	Description	Properties
	instance on a regional public service portal and/or a national eGovernment portal.	
Participation	Supports the description of a user service or a service provider	Identifier, description, role
Criterion requirement	A unique requirement that must be valid. Belongs to core criterion and core evidence vocabulary.	Identifier, expected value, maximum-minimum value, type of translation, level of certification, type of copy quality
Output	Any resource - document, artefact – anything produced by the Public Service	Identifier, description, name, type
Cost	Any cost related to the execution of the Public Service that the Agent consuming it needs to pay	Identifier, value, currency, description, isDefinedBy
Channel	Represents the medium through which an Agent provides, uses or interacts in another way with a Public Service.	owned by, type, hasInput, openingHours, availability restriction
Rule	Represents a document that sets out the specific rules, guidelines or procedures that the Public Service follows	Identifier, description, name, language
Public Organisation	Core Public Organisation Vocabulary (CPOV)	

2.3.3 DCAT Application Profile for data portals (DCAT-AP)

DCAT-AP is used for describing public sector datasets in Europe to enable exchange of information among data portals [33]. It allows:

- Data catalogues to describe their dataset collections using a standardized description, while keeping their own system for documenting and storing them.
- Content aggregators, such as the European Data Portal, to aggregate such descriptions into a single point of access.
- Data consumers to find datasets more easily from a single point of access.

In relation with the scope of DE4A, DCAT-AP may provide a way for data consumers to easily find information about the data providers that use DCAT-AP to publish information about their (evidence) datasets.

Table 5 describes the main classes of DCAT-AP and presents some of the main properties of each class. More information on the latest release of DCAT-AP can be found at [33]. Furthermore, UML diagram of DCAT-AP is presented in Annex III.

Table 5: Main classes of Data Catalog Vocabulary – Application Profile (DCAT-AP)

Importance	Class	Description	Properties
Mandatory	Agent	An entity (person, legal entity, organisation) that is associated with Catalogues and/or Datasets.	foaf:Agent
	Catalogue	A catalogue or repository that hosts the Datasets being described.	dcat:Catalog
	Dataset	A conceptual entity that represents the information published.	dcat:Dataset
	Literal	A literal value such as a string or integer	rdfs:Literal

Importance	Class	Description	Properties
	Resource	Anything described by RDF	rdfs:Resource
Recommended	Category	A subject of a Dataset	skos:Concept
	Category scheme	A concept collection (e.g. controlled vocabulary) in which the Category is defined.	skos:ConceptScheme
	Distribution	A physical embodiment of the Dataset in a particular format.	dcat:Distribution
	License document	A legal document giving official permission to do something with a resource	dct:LicenseDocument

2.3.4 Asset Description Metadata Schema – Application Profile (ADMS-AP)

ADMS-AP is a specification used to describe interoperability solutions helping everyone to search and to discover them [34]. Therefore, ADMS-AP may be used as a foundation to describe our DE4A semantic assets. It allows:

- Solution providers, such as standardisation organisations and public administrations, to describe their interoperability solutions using the standardised descriptive metadata terms of ADMS while keeping their own system for documenting and storing them.
- Content aggregators, such as Joinup, to aggregate such descriptions into a single point of access.
- ICT developers to more easily explore, find, identify, select and obtain interoperability solutions from a single point of access.

Table 6 describes the main classes of ADMS-AP and presents some of the main properties of each class. More information on the latest release of ADMS-AP can be found at [34]. Furthermore, a UML diagram of ADMS-AP is presented in Annex III.

Table 6: Main classes of Asset Description Metadata Schema– Application Profile (ADMS-AP)

Importance	Class	Description	Properties
Mandatory	Asset	Abstract entity that reflects the intellectual content of an Asset and represents those characteristics that are independent of its physical embodiment.	dcat:Dataset
	Asset Type	Classification of an Asset according to a controlled vocabulary	skos:Concept
	Contact Information	Contact point for further information about an Asset	v:Kind
	Publisher	Organisation that makes information available	foaf:Agent
Recommended	Asset Distribution	Particular physical embodiment of an Asset. A Distribution is typically a downloadable computer file (but in principle it could also be a paper document or API response) that implements the intellectual content of an Asset.	dcat: Distribution

3 The semantic interoperability inputs from other related initiatives

This chapter presents additional input for formulating the initial requirements for semantic assets. This additional input stems from: a) related EU projects (TOOP and SCOOP4C) and b) from initiatives and standardization processes related to electronic government in EU and worldwide (OOP, SDG, BPMN). The target of this chapter is to elicit specific requirements emerging from relevant journeys and experiences in an attempt to re-use this knowledge and consolidate this information in the requirements for DE4A semantic assets. Thus, the reader should pay attention that in this document we are focusing on re-using experience and knowledge related to the semantic interoperability layer as coined and described by EIF [17].

3.1 Relation to other projects

This section initially identifies related EU projects to DE4A, namely TOOP and SCOOP4C. Then, it discusses the relevant results and outputs from these projects that can serve as input for the DE4A semantic assets requirements. That is, in this deliverable, we are focusing on the semantic interoperability aspects of the results of these projects.

3.1.1 TOOP

The Once-Only Principle Project (TOOP) was launched by the European Commission in January 2017 as an initiative of about 50 organisations from 20 EU Member States and Associated Countries [35]. The main objective of TOOP is to explore and demonstrate the once-only principle across borders, focusing on data from businesses. Doing this, TOOP wants to enable better exchange of business-related data or documents with and between public administrations and reduce administrative burden for both businesses and public administrations.

Technical and interoperability barriers were perceived as very important, especially around technical and semantic interoperability. It has been agreed upon by the interviewed stakeholders that there is a need for the realisation of a federated OOP architecture that supports the interconnection and interoperability of national registries at the EU level. However, public administrations are generally not willing to undertake major technological and organizational changes in order to enable the OOP at a cross-border level, so a very high level of compatibility with the existing technical solutions at national and organisational levels is expected. Looking more specifically at the development of e-government in the EU, Germanakos et al. [36] identify a number of different factors that aggravate e-government development, from technical, legal and social to the institutional environment. In the context of the implementation of the once only principle at the European level, the report by Cave et al. [37] outlines a number of different gaps and barriers; they are grouped into legal, organisational, semantic, technical and “other” issues (the latter category includes diverse factors ranging from political will to the difficulty of measuring the costs and benefits of OOP for end users).

Interoperability, the key element of cross-border OOP, is defined as the ability of different organisations to interact towards mutually beneficial and common goals, which involves the sharing of information and knowledge by means of the exchange of data between their respective ICT systems [37]. The European Interoperability Framework [38] distinguishes four layers of interoperability: technical, semantic, legal and organisational. Technical interoperability covers the applications and infrastructures linking systems and services. Semantic interoperability means that the precise format and meaning of exchanged data and information is preserved and understood throughout exchanges

between parties. Legal interoperability is about ensuring that organisations that operate under different legal frameworks, policies, and strategies can work together, and organisational interoperability refers to how public administrations align their business processes, responsibilities, and expectations to achieve commonly agreed goals.

In TOOP D2.1 [39], semantic interoperability is defined as the ability of software to accept data from external sources so that the software does not draw invalid conclusions about the state of affairs about the shared reality. According to the authors, the main challenge is to enable semantic interoperability between the IT systems of different governments. TOOP D2.5 provides an overview of the key legal principles with a basis in EU law, to identify horizontally applicable rules that govern the application of the OOP, and to create a legal assessment framework [41]. In sum, we also noted different semantic interoperability challenges from the relevant projects, including TOOP projects, IHU research team, and other reliable sources as well. We described these challenges in the forthcoming chapter 4.

3.1.2 SCOOP4C

The SCOO4C project [43] has identified that semantic interoperability, such as standards taxonomies, common terminology, etc. Data exchange across different institutions requires semantic enablers to be in place, such as standards for the data exchange, a common language, taxonomies to facilitate data exchange between various institutions, etc. Multilateral agreements on reference data in the form of taxonomies, controlled vocabularies, thesauri, code lists (e.g. for unique identifiers), and standardized data structures/models will help to ensure information interoperability [44].

A critical barrier is the lack of harmonisation of data structures and semantics. The lack of consistent standards will prevent data exchange and data re-use between public authorities, since systems will not be interoperable, and data cannot be processed automatically if the relevant semantic specifications for data exchange are not in place.

SCOP4C used IMAPS (formerly known as IMM) model to capture various levels of interoperability maturity in EY member states, including semantic interoperability.

3.1.3 Estonian Catalogue of Public Sector Information

Master data in registers properly described in Catalogue of Public Sector Information (RIHA). The unique personal identification code provides an opportunity to merge personal data from different registers. The unique company commercial registry code provides an opportunity to merge business data from different registers health use case, Semantic interoperability · Used international standards like DICOM40 and HL741 (because of medical devices). WP3 will study additional national initiatives that are relevant to addressing unique identifiers for registers and incorporate in D3.2 “Final requirements for semantic assets”.

3.1.4 CODEX (Evidence2E)

The project aims at creating a legally valid instrument to exchange digital evidence related to Mutual Legal Assistance (MLA) and European Investigation Order (EIO) in criminal matters procedures over e-CODEX by providing the legal and technical communities with ‘ready to use’ information on EIO, digital evidence and e-CODEX and a ‘true to life’ example of how electronic evidence can be shared over e-CODEX in a secure and standardized way to support MLA and EIO cases.

The said project introduced an e-Codex method for semantic interoperability to exchange evidences among the existing digital services including e-Justice services within Europe.

Other important initiative of the said project is the identification of real investigative cases and the representation of their meta data in UCO/CASE language. This has been the main motivation to develop a specific software, ‘caseGenerator’, being able to quickly generate the Evidence meta data in JSON-LD format.

In this project, they also developed a converter application 'caseConverter' to convert the output/report of some popular forensic tools in XML into UCO/CASE format.

3.1.5 e-SENS

The e-SENS project is a pan-European project to provide architecture driven solutions and technical specification on the state-of-the-art technologies to strengthen the EU Single Digital market and cross-border e-Government services. In this project, these solutions are implemented in pilot production environments where actual transactions, among public administrative bodies, or between these public bodies, European citizens and businesses, can take place. Aiming to an interoperable European infrastructure, the objective of e-SENS is to create comprehensive and re-usable components-building blocks (BBs)- with a strong focus on e-Delivery, e-Documents, e-ID, e-Signature, and Semantics [45].

The e-SENS project semantics Building Blocks are mostly focused on the semantic interoperability from a legal and official document (evidence, attestation) perspective. Moreover, in the e-SENS project, semantic assets intended as domain ontologies are leveraged to adjust the Generic Building Block with the addition of Domain Knowledge and to infer new knowledge or to integrate knowledge coming from different sources [46].

3.1.6 STORK

The vision of the STORK project is to simplify administrative formalities by providing secure online access to public services across EU borders. The mission of the project is to develop and test common specifications for secure and mutual recognition of national electronic identity (eID) between participating countries. The objectives of the project are to define common rules and specifications to assist mutual recognition of eIDs across national borders, and test in real life environments, secure and easy-to-use eID solutions for citizens and businesses.

The project consists of five pilots. One of the pilots is about 'eID student mobility' and other relevant pilot is about 'change of address'.

3.2 Relation to other initiatives

In this section we analyze activities and standardization efforts in the field of e-government emerging not only at the European but also at a worldwide level.

3.2.1 SDG

The single digital gateway [50] will facilitate online access to the information, administrative procedures and assistance services that citizens and businesses need to get active in another EU country. By the end of 2020, citizens and companies moving across EU borders will easily be able to find out what rules and assistance services apply in their new residency. By the end of 2023 at the latest, they will be able to perform a number of procedures in all EU member states without any physical paperwork, like registering a car or claiming pension benefits.

The single digital gateway will guide citizens and companies to information on national and EU rules, rights and procedures and the websites where they can carry out these procedures online. And users looking for assistance will be guided towards problem-solving services.

In practical terms, a search function on the 'Your Europe' portal will give access to:

- **Information**. Citizens will be able to easily find reliable, qualitative information on EU and national rules that apply to them when they want to exercise their Single Market rights

- **Procedures**. Citizens will find out exactly how to carry out administrative procedures and what steps they need to follow
- **Assistance services**. If users are still confused about which rules apply or have trouble with a procedure, they will be guided to the EU or national assistance service most suited to address their problem

The quality, user-friendliness and adequacy of the information provided by the European Commission and by authorities in EU countries will be monitored on the basis of user feedback. There are several studies that EU has performed towards achieving the goal of SDG.

3.2.2 OOP

The Once Only Principle [51] entails that citizens and businesses provide diverse data only once in contact with public administrations, while public administration bodies take actions to internally share and reuse these data – even across borders – always in respect of data protection regulations and other constraints. The Connecting Europe Facility's digital programme supports the application of this principle.

Once Only Principle has committed to reuse the eDelivery, eID and eSignature, blockchain [52] building blocks. A short but comprehensive analysis of the above buildings blocks is as under:

eDelivery helps public administrations to exchange electronic data and documents with other public administrations, businesses and citizens, in an interoperable, secure, reliable and trusted way. The CEF eDelivery Building Block helps users to exchange electronic data and documents with one another in a reliable and trusted way. The CEF eDelivery solution is based on a distributed model called the "4-corner model". An eDelivery use case is visually presented in Figure 5. In this model, the back-end systems of the users don't exchange data directly with each other but do this through Access Points. These Access Points are conformant to the same technical specifications and therefore capable of communicating with each other. As a result of this, users adopting CEF eDelivery can easily and safely exchange data even if their IT systems were developed independently from each other. eDelivery supports various use cases that are in general domain-neutral as eDelivery can be used for the exchange of any type of document and data. As an example, the first use case refers to a generic 'Message Exchange' instead of 'Invoices Exchange' or 'Claims Exchange'. The exchange of invoices or claims are domain-specific Use Cases and are examples specializations of the 'Message Exchange' Use Case. eDelivery is an enabler of a wide variety of services which will exchange specific types of documents and data, below are a few examples.

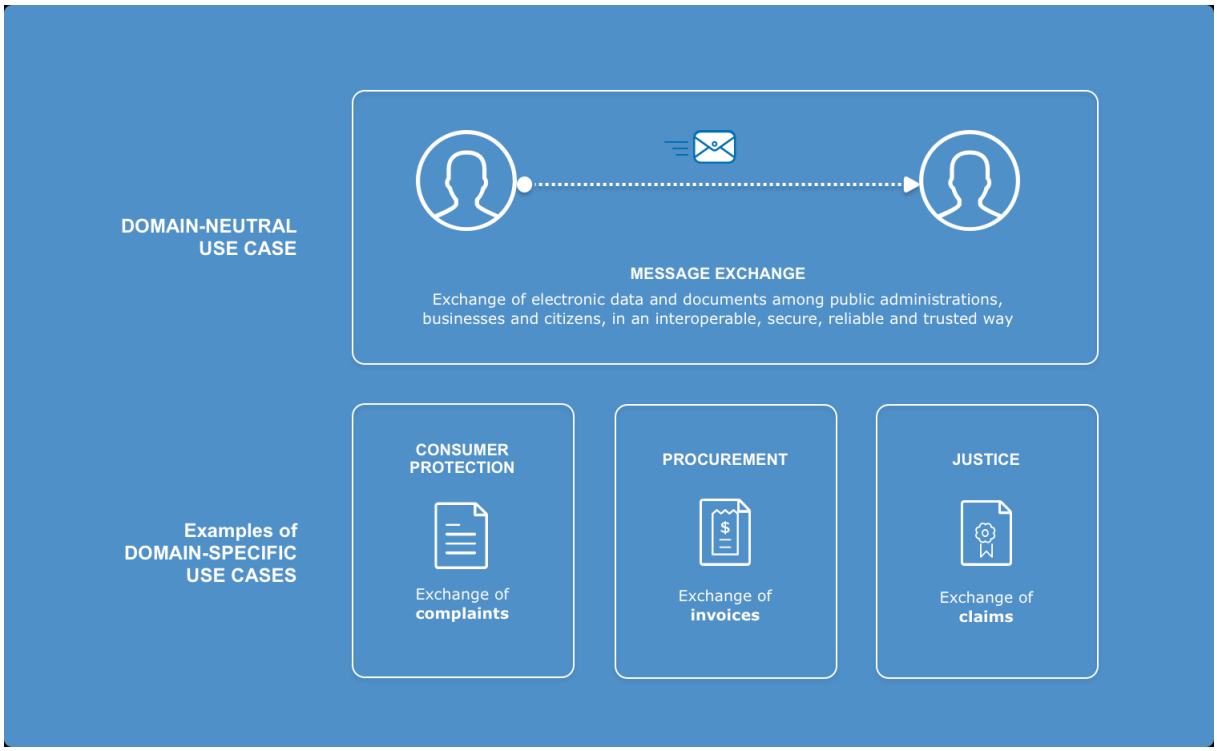

Figure 5: eDelivery Use Case

eID aims to offer digital services capable of electronically identifying users from all across Europe. The eIDAS Regulation (910/2014) and its implementing decisions set the legal framework overseeing electronic identification (eID). As a summary of the legislation, all public entities offering online services and authenticating users based on a national eID scheme must also recognise the notified eID schemes of other Member States. This obligation to recognise a foreign eID scheme applies to all online services that require a "substantial" or "high" level of identity assurance, but only if the foreign eID scheme provides the same level of identity assurance or higher as you. Compliance is voluntary for services with a “low” assurance level. The mutual recognition of different national eIDs is enabled by each Member State implementing an eIDAS-Node. These nodes are configured to recognise all notified eID schemes in Europe. Therefore, public sector service providers need only to connect to an eIDAS-Node in order to authenticate users from different Member States and offer them services. The specific steps required to connect to your national eIDAS-Node will depend on your Member State's chosen infrastructure and eID scheme(s). Read our country overview to learn more. Each Member State has also appointed a Single Point of Contact to get you started in the integration process. No matter what the chosen infrastructure and technology in your Member State, identify online services that are to be connected to eIDAS. Remember, these are services with an identity assurance level of "substantial" or "high", although you may also want to consider connecting services with level “low”. Your Single Point of Contact will refer you to the organisation responsible for managing eIDAS integrations in your Member State. Involving them in integration planning will make sure that their support and experience is available to you when needed. You may keep your plan brief with just enough information to give an idea of what will be delivered, when and by whom.

CEF eSignature is opening up the possibility to e-sign legal acts, transforming a paper-based procedure into a comprehensive end-to-end digital experience. There are different types of e-signatures with different trust levels: simple, advanced, and qualified. Qualified e-signatures, for example, feature the highest trust level and have the same legal standing as a handwritten signature. Assess which type of e-signature is appropriate in your case. To do so, take the practical details and legal risk into account, balance cost of implementation against risk of losing a legal challenge. Keep in mind that e-seals are

the same as e-signatures, but used by legal entities, such as a businesses or government organisations. To electronically sign a document, you need a digital application. You can choose to build your own solution in-house or find a solution provider that can adapt their product to your needs. Check out our documentation and support services to help you put together a solution. Consider the benefits of going digital with CEF eSignature and assess your eligibility for CEF funding . You can use the Digital Signature Software (DSS) open-source library to ensure that your e-signatures and e-seals are created and verified in line with European legislation and standards. You can adopt DSS as such or use it as a reference implementation.

The European Commission has a holistic approach to blockchain technologies and DLT, which aims at positioning Europe at the forefront of blockchain innovation and uptake. In this rapidly evolving context, the EU relies on the following main initiatives to enable globally inclusive governance, reinforce cooperation and investments in deploying blockchain/DLT based applications, support international standard setting and facilitate dialogue between industry stakeholders and regulators, notably for a regulatory framework, that builds on the EU SDG vision. Interoperable blockchains are needed for global deployment. The European Commission is thus supporting and is engaged in work on international standardisation, for DLT and blockchain, in particular, through a liaison with ISO TC 307 on Blockchain and Distributed Ledger Technologies.

3.2.3 BPMN

BPMN Business Process Modeling Notation is essentially a standardized graph that defines and describes the steps in a business process [61]. The BPMN standard is designed to illustrate business processes and communication between them and has been used as a tool for describing and visualizing a public service. Studies have shown that government agencies and their employees often deviate from the pre-defined procedures at work. At the same time, many times, services, and much more citizens and businesses, do not have a clear picture of administrative procedures. Standardizing a BPMN described process can help ensure that all employees follow the same process steps. In addition, standardizing a process through its description with BPMN is an opportunity for analysis and fruitful discussion in government agencies. The aim is to increase internal efficiency and productivity, citizen satisfaction and ensure consistent and predetermined results. In addition, relevant studies (e.g. [62]) indicate that promoting innovation and transparency in processes, e.g. through the use of modelling tools, are important components of wider reform efforts. Given the organizational complexity of the public sector, process modelling is a major challenge that must be addressed in order to enhance transparency and allow innovation. Business process management (BPM) can be seen as an appropriate tool to address this complexity in Public Administrations (PAs) and their processes, but also as a means of continually improving the quality of public services. At the same time, with the help of imprints, it is important to identify opportunities for simplifying and automating processes and using information technologies.

The relevant literature on the use of BPMN in administrative procedures (e.g. study [62]) has identified, within EU boundaries, initiatives to standardize the representation of the Public Service as processes with their associated objects (eg process steps, times, related data, etc.). The Public Administration Process and Data Documentation Model (DMPAPD), for example, [63] aims to define the rules and specifications that should guide design to produce BPMN-type activity charts. As an example, the Lithuanian Interoperability Information Platform (SIRIP) is mentioned. She describes that "In designing online services with SIRIP tools, an agreement has been signed on how to operate the online service and BPMN diagrams have been developed which form part of the SIRIP tools. Each institution is required to further substantiate its business processes before developing services or online services and to agree on how these processes will interfere with the provision of public service. " Another case where the BPMN standard is used in the EU public sector. [63] provides a map of business processes in Finland and business process models that describe them. Business process models are created using

commonly known standards of which BPMN is the most widely used. A public body managing information and services for the Portuguese Government is using a BPM solution to implement joint financial management and human resources services focusing on the optimization and benefits achieved through the implementation of shared services through a BPM solution [64]. In addition, 300 government and 100 business processes for Southeast Europe are already represented in BPMN [65].

In e-SENS project [47] it is mentioned that BPMN-like descriptions of processes and cross-reference tables are semantic assets and they can be intended as domain ontologies. In DE4A it is investigated whether domain-specific ontologies can be described in RDF or OWL when they cover concepts or in BPMN when they cover processes.

A relevant ISA2 document[3] describes how Core Vocabularies can be used to:

- design a new data model and either bind it to an existing syntax or create a new syntax for it
- create mappings from a data model to the Core Vocabularies' conceptual data model

Some member states[4] have already declared that many of their processes that serve citizens and businesses and are described by using BPMN. Technical efforts[5] [6] to combine CPSV and BPMN have also appeared in some member states. Also, in relevant literature there are efforts that attempt to combine semantic assets like CPSV with BPMN [59], [60].

3.2.4 eIDAS

In the semantic interoperability framework, there is essential need to cover the semantic related aspects for the authentication of the users through different parameters like user identification. To cover the user authentication aspects in our semantic interoperability framework, we will implement eIDAS - Electronic Identification, Authentication, and Trust Services. The eIDAS is an EU regulation on electronic identification and trust services for electronic transactions in the European Single Market. It regulates electronic signatures, electronic transactions, involved bodies, and their embedding processes to provide a safe way for users to conduct business online like electronic funds transfer or transactions with public services.

We will also consider the EU funded TOOP project efforts for the enactment of eIDAS in the TOOP federated architecture to ensure implementation of OOP in public administrations and supports the interconnection and interoperability, including semantic interoperability of national registries at the EU level. As shown in figure 6 below, In the TOOP project, an eID component is used to authenticate the user/data subject over the eIDAS network and to establish trust between the Public Authorities to exchange desired data, including evidence as well. To achieve this functionality, a minimum data set of eIDAS natural person identification attributes must be provided. The second objective of the eID component is the release and management of User Consent.

In the TOOP project, Evidence Exchange procedure requires the user to authenticate through eIDAS [53]. In order to authenticate the user, Data Consumer (DC) will be connected to eIDAS network through eIDAS node of their own Member State and authentication requests will be relayed to Node of Member State chosen by the user from a list displayed on the DC site. This node will verify if from

[3] https://ec.europa.eu/isa2/sites/isa/files/e-government_core_vocabularies_handbook.pdf

[4] https://joinup.ec.europa.eu/sites/default/files/document/2015-03/egov_in_greece_-_january_2015_-_v_17_0.pdf

[5] https://github.com/eellak/diadikasies-wiki-to-BPMN

[6] https://el.diadikasies.gr/BPMN/bpmn1.php

user is valid and relay back an authentication response to eIDAS node of DC Member State and finally to the DC.

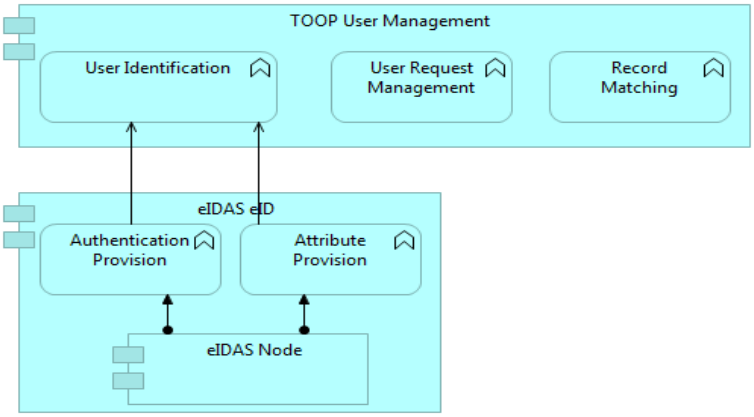

Figure 6: TOOP Architecture – Functional model and eID Component

3.2.5 PEPPOL

PEPPOL, originally an EU co-funded project under the ICT Policy Support Programme (PSP) in the Competitiveness Innovation framework Programme (CIP), set up to address interoperability issues in electronic public procurement, provides a framework enabling many-to-many connectivity and a set of technical specifications that can be implemented in existing eProcurement solutions. It has now evolved into an international non-profit association, OpenPEPPOL AISBL, with approximately 100 members from both private and public organisations.

3.2.6 Implementation of interoperability Initiatives/platforms/tools to exchange data

In this part, we will explain some national and cross-border data exchange initiatives/platforms/tools. Moreover, we will cover some semantic assets of these initiatives in next deliverable "*Final requirements for semantic assets*".

Cross-Border data Exchange initiatives/platforms/tools

1. **The Business Registers Interconnection System (BRIS)**: The Business Registers Interconnection System (BRIS), is an information system interconnecting the central, commercial and companies registers (business registers) of all Member States through the European Central Platform (ECP). The Action achieved the interconnection between the EU Member States (Austria, Spain, Italy, Lithuania, Norway, Romania, Hungary, Portugal, etc.) Business register with the European Central Platform (ECP). As a result of the Action, Each EU Member States business registers will be able to share respective Member State business information across borders with other commercial registers within the EU in a fast and secure way.
2. **Electronic Exchange of Social Security Information -EESSI:** The Electronic Exchange of Social Security Information (EESSI) is an IT system that supports social security institutions across the EU exchange information more rapidly and securely, as required by the EU rules on social security coordination [54]. All communication between national institutions on cross-border social security files will be performed through EESSI. The social security institutions in Europe will exchange structured electronic documents and adhere to commonly agreed procedures. These documents will be transmitted through EESSI to the correct target in another Member State. The central

EESSI system was made accessible by the Commission in July 2017. Following this, Member States have two-to-three years to finalize their national implementation of EESSI and to connect their social security institutions to the cross-border electronic exchanges. EESSI has more benefits that include fast and more efficient message exchange between social security institution, more accuracy in information exchange between EU member states authorities, and public administrations of social security institutions in Europe will utilize standard electronic documents, translated into local language.

3. **The European Criminal Records Information System –ECRIS:** The European Criminal Records Information System (ECRIS), established in 2012, is an electronic interconnection of Member States' criminal records databases which enables the exchange of information on criminal convictions between Member States [55]. All criminal records data of an individual are always stored in the national database of the country of their nationality, regardless of the country in which conviction took place. This data is exchanged electronically with other Member States upon request, allowing authorities to easily obtain a complete overview of an individual's criminal history from the person's state of nationality. This system also reduces the administrative burden for citizens, who can easily obtain an extract from their criminal record from one place when seeking employment in another EU Member State.
4. **EUDIN (European Data Interchange for Waste Notification Systems:** In the domain of business-related data, EUDIN (European Data Interchange for Waste Notification Systems) is an example of an initiative that has developed a standardized interface for the exchange of data on waste shipments. EUDIN replaces the previously paper-based procedure with a system of electronic data sharing and notifications system about waste shipments within, into and out of the EU. It is a "framework of standardized interfaces, business rules, and runtime system components that enable the seamless exchange of messages dealing with the transport, receipt, and recovery/disposal of waste across borders between the EU Member States of the European Union and other interested countries".
5. **The Central Permit Portal X-Trans.eu :** Due to the differences in the application forms and procedures for obtaining permits for heavy transport in different countries, the aim of the pilot was to create a central system which would save companies from submitting multiple applications to different local authorities for the same transport. The central permit portal x-trans.eu allowed applicants to provide their data only once for the specific transport. The collected information would then be shared with relevant agencies in the respective countries based on the application requirements in each country. The basis for the portal was a common data model that included all the information needed for a permit. Rules could then be formulated to describe the information and application formats required in each country. As such, the system was fully scalable to any European country. In the pilot phase, data exchange was successfully tested between Austria and Germany. However, due to organizational and political changes, the project was terminated in 2015**.**
6. **E-Certis :** The European Commission offers an e-Certis tool that supports identifying different certificates requested in procurement procedures across the Europe [56], [57]. The purpose of this system is to facilitate the exchange of certificates and other documentary evidence frequently required by contracting authorities. eCertis, as a service, will also act as the Criterion & Evidence Type Rule Base (CERB) system. Whereas the Criterion & Evidence Type Rule Base is a central service that publishes which types of evidence EU Member States can offer to confirm a necessity is met [58]. It gives metadata on the criteria related to a procedure and which evidence can be

used by the user to witness fulfilment. Currently, eCertis is under an updating process of its internal functionalities, in order to become multi-domain and to cover some other aspects as well [58]. eCertis provides a REST API that can be used to query various mappings between criteria and evidence. It will help Member States to push all the information related to certificates and national databases into eCertis. Through eCertis, services will be added to eCertis to permit Member States to link connect their own Information Technology systems, and base registries to push that information [Ref1]. As eCertis upgradation work is completed, we will consider eCertis as the CERB system in the relevant WP3 tasks, if deemed appropriate.

National Level data Exchange initiatives/platforms

7. **The Flemish Maximum Data Sharing between Administrations and Agencies – MAGDA :** The Flemish service integrator's platform MAGDA (Maximum Data Sharing between Administrations and Agencies), operational since 2004-2005, provides a common service-oriented data exchange infrastructure for the 190 agencies and 13 departments of the Flemish regional government, and 308 local governments.
8. **Austria Business Service portal "USP"**: The USP is a one-stop-shop for businesses operating in Austria, established in 2010 with the aim of reducing the administrative burden of companies. The USP offers information and transaction services that help businesses fulfil their legal obligations (e.g. various reporting duties) and conduct transactions with government authorities. The portal allows for the submission of requests of data in a standardized electronic format using online forms, it allows for data exchange with different registers, and also for a fully electronic process of founding a new company.
9. **Austria Citizen Service Portal – HELP:** HELP.gv.at is a one-stop-shop for citizens established with the aim to reduce administrative burden for citizens by offering full information and transaction services for various life events (e.g. moving, education, family and partnership).

3.2.7 Other Interoperability Frameworks

Despite EU – EIF, there are some well-known interoperability frameworks that are adopted in different countries of the world. We will also cover such interoperability Frameworks in next deliverable "*Final requirements for semantic assets*" in more detail:

- **Australia** - Australian Government Technical Interoperability Framework (AGTIF): This interoperability framework, developed by the Interoperability Framework Working Group (IFWG), respond to the developments in the ICT industry while supporting government, businesses, and citizens to be more interconnected. The Framework specifies a conceptual model and agreed technical standards that support collaboration between Australian Government agencies. Adopting common technical protocols and standards will ensure government ICT systems interoperate in a trusted way with partners from industry and other governments. Interoperability will improve efficiency, reduce costs to business and government and will support agencies' capacity to respond to public policy developments. AGTIF addresses following three main domains; business process, information domain, and technical domain. The last domains relate to the semantic interoperability. The information domain comprises elements that agencies use to align business processes and document payloads, and therefore generate common content interpretations. Elements include reference taxonomies and processes, code lists, data dictionaries, and industry-specific libraries. used to deliver content across a community of interest. Elements include transport

protocols, messaging standards, security standards, registry and discovery standards, syntax libraries, and service and process description languages.

- **Japan**: “Interoperability Framework for Information Systems”
- **Malaysia**: “Standards, Policies, and Guidelines -Malaysian Government Interoperability Framework”

4 Initial Requirements for DE4A semantic assets

This section provides the initial set of requirements from the semantic assets perspective that DE4A architecture and implementation decisions should critically consider as needed for DE4A pilots. To reach these requirements (under consideration of the deliverable D3.2 and pilots of work package WP4), a relevant analysis is provided, starting from EIF and including challenges for achieving semantic interoperability from EU projects that have run at a pan-European level (i.e. TOOP and SCOOP4C). We start our analysis from the DE4A architecture to scope deliverable "*Initial requirements for semantic assets*".

4.1 DE4A and Other EU Projects semantic assets

A high-level overview of the DE4A architecture follows, wherein semantic assets are one of the prime components to exchange data amongst EU member states. The scope and the focus of this deliverable (i.e. D3.1) is on the semantic layer and the re-use of relevant building blocks (please see bottom layer in the following Figure 7). This means that we are capturing initial requirements from available standards and other EU projects efforts (e.g. TOOP project [35]) only as far as semantic assets are concerned (e.g. CPSV, DCAT). This in turn means that this deliverable does not cater for efforts that try to technically solve trust (e.g. eIDAS) or transport (e.g. eDelivery) issues. However, in the context of DE4A needs, arising from foreseen pilots, this document will try to link those needs with relevant semantics when applicable. When this is not feasible, the next deliverable "*Final requirements for semantic assets*" will try to propose enhancements of available semantic assets.

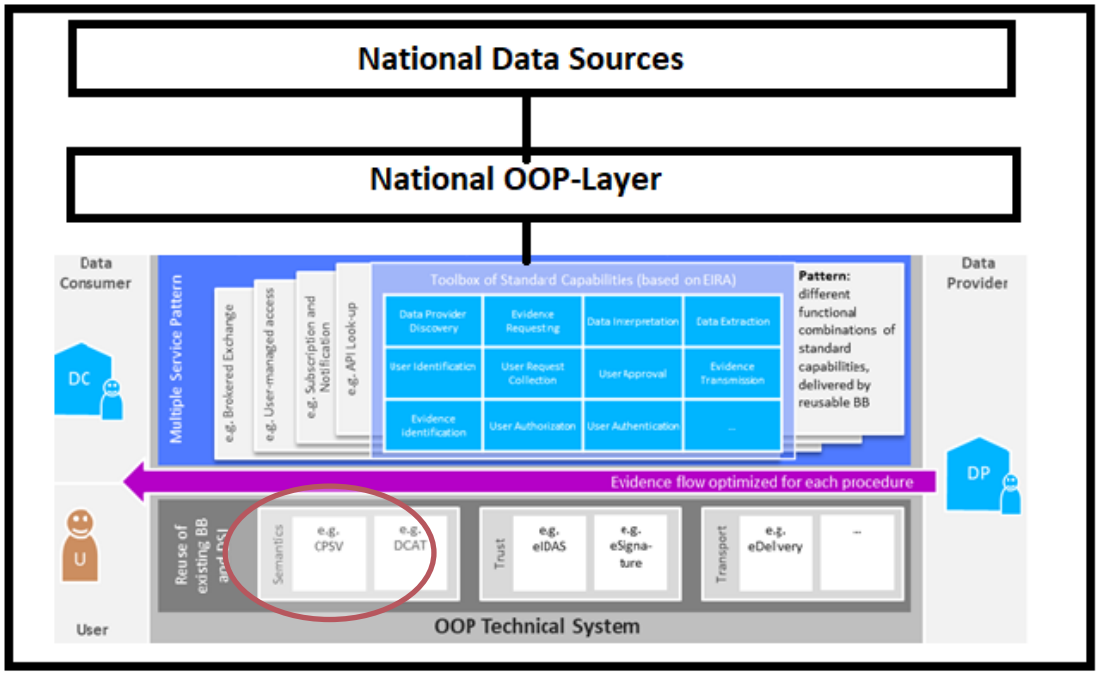

Figure 7: High-level DE4A Architecture and WP3 Semantic Assets

Work package WP3 semantic interoperability framework will include semantic aspects that handle cross-border exchange evidence between competent authorities in the roles of data consumer and data provider. The work package WP3 – "*Semantic Interoperability Solutions*" will consider other relevant EU projects (like TOOP) semantic assets efforts in various aspects including evidence exchange

between authorities. We explain a TOOP project efforts for semantic data model as a reference in the forthcoming paragraph.

The TOOP project illustrates the semantic data model and launches authoritative sources of information so that citizens and businesses provide their data or documents based on Once-only principle. As shown in figure 8, below, TOOP core architecture component "TOOP Connector" connects to a Competent Authority backend system and encapsulates several functions supporting the exchange of Evidence from one participant to another. his part handles the Semantic Mediation, Data Provider Discovery, Routing Metadata Discovery, and Evidence Exchange functions. Thus, its primary features are processing the TOOP Data Request from MS Interface, transforming the data input into a TOOP message, routing metadata discovery, and endpoint discovery.

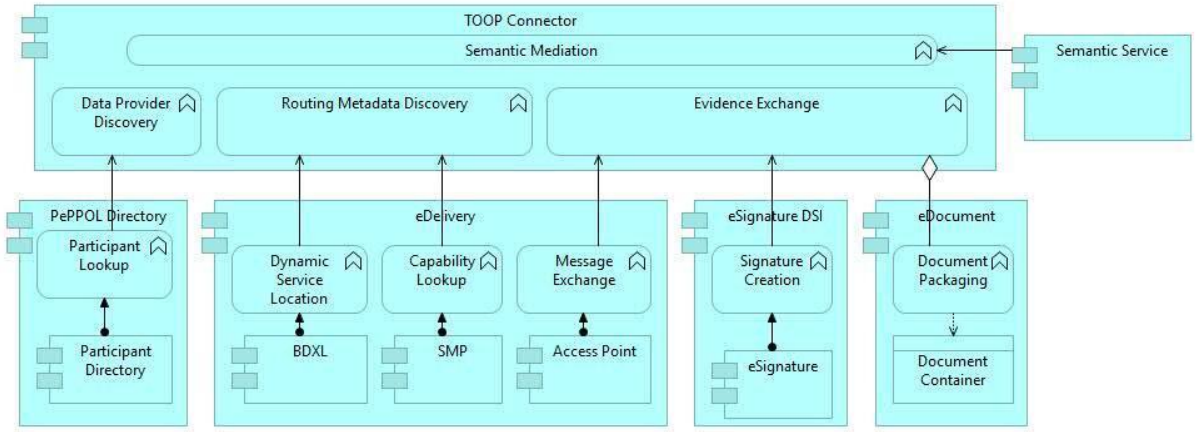

Figure 8: WP3 Semantic Assets and TOOP Components to Exchange of Evidences

As explained earlier, the other relevant EU projects (closed and open) will be studied, including the TOOP project efforts for semantic assets and will consider most relevant, and practicable outcomes in our next deliverable D3.2 – "*Final requirements for semantic assets*".

4.2 Analysis of the initial requirements list for DE4A assets

This section attempts to collect information from various sources to form a list of guidelines towards the initial set of requirements for DE4A semantic assets. We start by shortlisting the EIF [38] recommendations for semantic interoperability. Then, we analyse identified recommendations and barriers from relevant projects (i.e. TOOP and SCOOP4C [43]).

Table 7: EU-EIF - Semantic Interoperability Recommendations

Interoperability Framework	Recommendations	Remarks /References
EU - EIF	Perceive data and information as a public asset that should be appropriately generated, collected, managed, shared, protected, and preserved.	Recommendations 30
	Put in place an information management strategy at the highest possible level to avoid fragmentation and duplication. Management of metadata, master data, and reference data should be prioritized.	Recommendations 31
	Support the establishment of sector-specific and cross-sectoral communities that aim to create open information specifications and encourage relevant	Recommendations 32

Interoperability Framework	Recommendations	Remarks /References
	communities to share their results on national and European platforms.	

EIF argues that data and information are public assets that should be appropriately generated, collected, managed, shared, protected, and preserved. The appropriate description of citizen data in the catalogue of registers is essential for SCOOP4C. Such a description of data is a significant success factor for OOP across implementations in countries at the enabler 'semantic interoperability' layer.

We further investigated the results and outputs from major EU projects (TOOP and SCOOP4C). In the TOOP project, there is an important conclusion, that is public administrations are generally not willing to undertake major technological and organisational changes to enable OOP at the cross-border level, so a very high level of compatibility with the existing technical solutions at national and organisational levels is expected. The stakeholders that participated in the study fully agreed that the reuse of the existing frameworks and building blocks should be present in the generic federated OOP architecture. The TOOP generic federated OOP architecture, as presented in TOOP D2.1 [39], relies on frameworks such as the European Interoperability Reference Architecture (EIRA), the CEF Building Blocks and the e-SENS European Interoperability Reference Architecture, and the CEF Building Blocks are seen as drivers for European projects to deliver digital services across borders.

Also, TOOP regarding the key barriers has concluded that the successful implementation of the OOP assumes a comprehensive understanding of the interlinked issues, ranging from technical to legal, organisational, political, and demand-side factors. Of these, the key barriers for the OOP are associated with i) legal interoperability and compliance with legal requirements, ii) concerns related to technical and semantic interoperability and compatibility with existing systems, iii) lacking empirical evidence and low awareness of the benefits of the OOP, and iv) the difficulty of changing existing organisational processes, information systems, and service pricing policies. Technical and interoperability barriers were also perceived as very important, especially around technical and semantic interoperability. It has been agreed upon by the interviewed stakeholders that there is a need for the realisation of a federated OOP architecture that supports the interconnection and interoperability of national registries at the EU level.

SCOOP4C approached OOP mostly from a national level perspective. Thus, for instance, in Estonia, we have identified primary good results that can feed DE4A analysis for best practice guidance and mitigation of requirements from OOP point of view. For Technical interoperability/ Technical enablers, Estonian data exchange layer for information systems (X-Road) is used to provide the secure data exchange layer for confidential and legally binding data exchange. At the semantic interoperability, the Estonian Catalogue of Public Sector Information (RIHA) keeps master data in registers adequately described in this catalogue. The unique personal identification code provides an opportunity to merge personal data from different registers. Also, in Estonia, the unique company commercial registry code provides an opportunity to merge business data from different registers. It was identified that agreements about semantic interoperability were needed, and for this standardized code, lists were produced.

SCOOP4C best practices and recommendations are captured at the project's deliverables. Crucial factors/lessons learned from SCOOP4C mention that the provided system is supported by political commitment, legal provisions, technical and semantic interoperability enablers. All existing data is taken from base registers. Other countries are interested in reusing the case, which also has cross-

border elements. Semantic interoperability guidelines that emerge from SCOOP4C project can also use as a reference for relevant DE4A pilots use cases, if required[7].

Besides, the SDG regulation states the obligation to exchange evidences lawfully issued by competent authorities, in their own Member State and in an electronic format that allows automated exchange, that are relevant for the online procedures of other Member States. The exchange should happen upon an explicit, freely given, specific, informed and unambiguous request of the user concerned in application of the once-only and relevant-only principles. Moreover, the user has the possibility of previewing each evidence in order to allow its cross-border exchange. These cross-border exchanges should ensure a high level of security with respect to confidentiality and integrity of the data exchange. The SDG regulation also states that an adequate level of interoperability with other relevant systems (i.e. BRIS) should be ensured.

The SDG requirements for the cross-border exchange of evidences raise issues on interoperability that can be eased by semantic good practices and semantic agreements learned on the ground of cross-border domain-specific interoperability systems and other interoperability systems involving different public administrations.

4.3 The initial requirements for DE4A semantic assets

In order to identify the initial semantic requirements, DE4A follows the recommendations, guidelines and principles derived from EIF, SDG Regulation and from related EU projects/initiatives, aligned with DE4A principles mentioned in the deliverable "D2.1 Architecture Framework". The results are presented in Table 8. Worth mentioning is that this is a live working document. Table 8 will be extended based on a detailed investigation of other such guidelines in order to conclude a concrete list of (potential) semantic assets specific for DE4A. To cover initial subject aspects, the Table 8 below, starts by mapping EIF recommendations to DE4A requirements.

[7] https://scoop4c.eu/index.php/node/727

Table 8: Mapping of EIF Recommendations and TOOP and SCOOP4C Guidelines to DE4A Requirements

ID	Related Initiative	Guidelines/ Recommendation	Initial Requirement/Need	Potential semantic assets
SR-1	EIF	Recommendation (R) 30: Perceive data and information as a public asset that should be appropriately generated, collected, managed, shared, protected and preserved	Need for **semantic components as assets** in DE4A for preserving, collecting, managing and requesting related information by data actors (DC and DP)	DCAT-AP
SR-2	EIF	R31: Put in place an information management strategy at the highest possible level to avoid fragmentation and duplication. Management of metadata, master data and reference data should be prioritized	Overcome information sharing and interoperability problems and understand data assets across borders with **agreements on reference data**, in the form of taxonomies, controlled vocabularies, thesauri, code lists and reusable data structures/models	Use of W3C standards to provide taxonomies etc. Dublin Core OP Named Authority Lists (NALs[8]) FOAF SKOS
SR-3	EIF	R32: Support the establishment of sector-specific and cross-sectoral communities that aim to create open information specifications and encourage relevant communities to share their results on national and European platforms.	**Base registries** should provide such identifiers, which help to differentiate persons with the same name, allows to keep track of the company even if it changes the name, etc.	TOOP Exchange Data Model[9] e-Documents and Semantics Building Bocks provided by e-SENS eIDAS identification schemes
SR-4			**DE4A policy for identifiers**.	
SR-5			**Robust, coherent and universally applicable information standards** and specifications are needed to enable meaningful information exchange among piloting Member States, while considering the different linguistic, cultural, legal, and administrative environments between them.	
SR-6	EIF/DE4A	Openness principle: Ensure a level playing field for open-source software and demonstrate active and fair consideration of using open source software, taking into account the total cost of ownership of the solution.	Use of **open-source software** for pilot ontology serialization, management, editing and storage.	XML Altova[10], Vocbench 3[11]

[8] https://op.europa.eu/en/web/eu-vocabularies/authority-tables
[9] http://wiki.ds.unipi.gr/display/TOOPSA210CEF/TOOP+Exchange+Data+Model
[10] https://www.altova.com/xmlspy-xml-editor
[11] https://ec.europa.eu/isa2/isa2conf18/vocbench-3_en

ID	Related Initiative	Guidelines/ Recommendation	Initial Requirement/Need	Potential semantic assets
SR-7	EIF/DE4A	Reusability principle: Reuse and share solutions, and cooperate in the development of joint solutions when implementing European public services.	**Reuse of existing standards** for data models and vocabularies, as well as of data models from other related EU initiatives	ISA[2] Core Vocabularies, TOOP Registered Organization ontology[12]
SR-8	EIF/DE4A	User-centricity principle: Provide a single point of contact in order to hide internal administrative complexity and facilitate users' access to European public services.	Use of **central semantic components for identifying issuing authorities of evidence and the related evidence services**.	TOOP Criterion & Evidence Type Rule Base[13], TOOP Data Service Directory[14]
SR-9	EIF/DE4A	Security and privacy principle: Define a common security and privacy framework and establish processes for public services to ensure secure and trustworthy data exchange between public administrations and in interactions with citizens and businesses.	Use of **semantic component for supporting the DP to check if the DC has the required authorization** for making a request.	TOOP Registry of Authorities[15]
SR-10	EIF/DE4A	(DE4A: Inclusion & accessibility),EIF multilinguism principle: Use information systems and technical architectures that cater for multilingualism when establishing a European public service. Decide on the level of multilingualism support based on the needs of the expected users	Need for a **semantic component that will facilitate the multilingual representation of data models** for evidence to be exchanged by using multilingual controlled vocabularies.	TOOP Semantic Repository[16], EuroVoc
SR-11	EIF/DE4A	Assessment of effectiveness and efficiency principle: Evaluate the effectiveness and efficiency of different interoperability solutions and technological options considering user needs, proportionality and balance between costs and benefits	Use of **Semantic Web standards and ontology metrics for validating ontologies**.	SHACL

[12] http://wiki.ds.unipi.gr/display/CCTF/GBM+Ontology
[13] http://wiki.ds.unipi.gr/display/TOOPSA210CEF/Criterion+And+Evidence+Type+Rule+Base
[14] http://wiki.ds.unipi.gr/display/TOOPSA210CEF/Data+Services+Directory
[15] http://wiki.ds.unipi.gr/display/TOOPSA210CEF/Registry+of+Authorities
[16] http://wiki.ds.unipi.gr/display/TOOPSA210CEF/Semantic+Repository

ID	Related Initiative	Guidelines/ Recommendation	Initial Requirement/Need	Potential semantic assets
SR-12	TOOP	Build a Federated OOP Architecture. Support interconnection and interoperability of national registries at the EU level	**Support the interconnection and interoperability between DE4A piloting Member States registries** by using a standard data model / specification for base registries access and interconnection.	BRegDCAT-AP[17]
SR-13	TOOP	Development of an information exchange model for the payload specification of the messages to be exchanged between competent authorities	Need to **develop an information exchange model** for describing requests and responses for evidence exchange between piloting Member States. Additionally, such model needs to be agnostic to any technical implementation and domain.	TOOP Exchange Data Model, eIDAS SAML Attribute Profile, SEMIC Common data types XML Schema
SR-14	SCOOP4C	The unique personal identification code provides an opportunity to merge personal data from different registers	Need to **define an Identifier class that represents any identifier issued by any authority**, whether a government agency or not	ADMS
SR-15	RIHA	RIHA stores metadata of Estonian public sector databases, registers and information systems. Assets are available in human- and machine-readable format (XML, OWL), human-readable only format (PDF), and machine-readable only format (CSV, WSDL)	Need a **semantic repository for DE4A that stores DE4A semantic assets** so that such assets would be accessible in human and machine-readable format using different information exchange and knowledge representation languages.	TOOP Semantic Repository
SR 16	SDGR	Article 14 refers to exchange of lawfully issued evidence that allows automatic exchange of information. To allow automated exchange, the evidence should be structured	Need to **define a set of attributes (metadata) to enable cross-border** transfer of evidences	CCCEV, eIDAS
SR-17	SDGR and DE4A	Data minimization principle: Only the data or documents that are specifically required for the procedure by the requesting competent authority are transferred	Need to **define a minimum set of attributes** need by the procedure to be exchanged cross-border (canonical evidence).	SDG[18]

[17] https://joinup.ec.europa.eu/collection/access-base-registries/solution/abr-bregdcat-ap/release/200
[18] https://github.com/SEMICeu/SDG-sandbox

***Note**: *It is pertinent to mention that in Table 8, we described "SCOOP4C" as an initiative, although these guidelines are more specific to the educational-domain scenarios, that will be further examined in the next deliverable (D3.2) that is applicable for DE4A project pilots.*

All the above must be considered from DE4A and must be incorporated in a feedback loop with DE4A pilots. Thus, the list serves as an initial requirement set for DE4A pilots. It will be refined by appropriate input from pilots and when applicable deliverable D3.2 will provide new proposals for semantic assets or even extensions of them. The latter will occur in cases where semantic assets do not cover the requirements that will be raised by the DE4A pilots.

Moreover, we attempt to collect additional high-level information about the Information Desk from the DE4A architecture and pilots for the initial set of requirements for DE4A semantic assets as described in the next section.

4.3.1 The "Information Desk"

The "Information Desk" (IDK) has been introduced in the chapter 8 of the D2.1 Architecture Framework as a (collection of) central component(s) that provides information to Data Consumers (DC) and Data Providers (DP) needed to perform the evidence exchange. According to the above-mentioned document, the initial requirements for the IDK are:

1. Informs the DC what evidence types can be obtained
2. Informs the DC where the evidence can be obtained
3. Informs the DC about the data needed for building the request message
4. Informs the DP whether the request is allowed
5. Provide information that allows locating the routing information of the participants

Regarding the needs of the DE4A pilot use cases, IDK should contain the next information:

- What evidence types are available
- What cross-border evidence services are available per evidence type and Member State
- What issuing authority is providing the evidence data per evidence service
- What routing information is needed for invoking a particular evidence service

At this point, DE4A architecture and pilots are in a very initial phase, so the list of the initial requirements included in this section is a very preliminary version that should be further developed in accordance with the progress of the architecture and pilot details.

4.4 Common Issues in Semantic Assets

Semantic interoperability faces common issues both on semantic and syntactic aspects. Following are the common issues in the semantic assets at national and Europe level. We will further identify and examine subject issues that are most relevant to DE4A project in our forthcoming deliverable D3.2:

- **Use of different semantic assets at national level:** National level information on base registries has been compiled for each of the 28 EU Member States and the four European Free Trade Association (EFTA) countries (i.e. Norway, Liechtenstein, Iceland and Switzerland). These factsheets are aimed at providing a complete overview of each country's approach in terms

of: General strategy towards interoperability; Current interoperability levels including semantic interoperability based on the EIF layers; and e-Government public services that make use of data in base registries. The IHU research team reviewed and analysed such factsheets of eighteen countries. We observed that majority of the countries base registries are using common semantic assets (10 out of 18), however, still there are some countries (8 out 18) that base registries are not using common data format and semantic assets. So, due to this issue, it is difficult to achieve at national and international levels [69].

- **Semantic interoperability and language issues:** Since original data may, in many cases, only be available in the national language, the application of the OOP requires translation support for data, which would also enable the correct transliteration of characters, etc. The building blocks for translation exist at the EU level, but the translated information currently lacks legal value. The application of the OOP requires interpretation of data, which brings about the questions of correct transliteration and legal value of the translated text.
- **Differences in the ways to store data at EU Member States Level**: The format of ship and crew certificates is internationally standardized, however, at the national level, public administrations manage raw data in various formats and utilize different data management methods [71]. Moreover, they are also hosting multiple copies in many different repositories and often publishing it on portals throughout Europe with no harmonization in terms of content and presentation. Hence, such impediments often make the delivery of public services to citizens and businesses cumbersome and time-consuming at national and European level as well.
- **Minimal Agreements on reference data at EU level:** The report [70] study team indicated that there are minimal agreements on reference data in the forms of taxonomies, controlled vocabularies, thesauri, code lists, and reusable data structures/models.
  Sharing coded values can significantly reduce semantic conflicts when different languages are used for evidence contents. Some specific domains have these common coded lists, such as the list of codes of criminal sanctions and offences used by the ECRIS system.
- **Absence of EU-wide unique identifiers for businesses and natural persons:** The TOOP project team noted it as a potential barrier. Moreover, most of the SDG national coordinators see that this lack of unique identifiers is a barrier to find the required evidences in a Member State related to users identified by eID issued by other Member State.
- **Absence of unique identifiers for public services and public organizations**: Recommendation nº 29 of EIF is "*Clarify and formalise your organisational relationships for establishing and operating European public services*". In order to follow this recommendation, beyond the user consent, the evidence provider should ensure the legitimacy of the request that requires to recognized public units as valid partner to request some evidence in the context of some specific public service by using some kind of authorization register. This only can be automatically addressed by unique identifies for public services and their competent authorities for every Member State. However, due to the changing nature or public structures this is a challenging matter and there are Member States that do not have catalogues for public services and organizations with unique identifiers.
- **Lack of common management metadata:** interoperability platforms usually have audit and control systems that require metadata for such purposes. However, these systems are tailored maid and some required metadata could not be sent by other cross-border platforms, causing issues and inconsistencies on the audit and control mechanisms.

4.5 Good practices of Semantic Assets

This section will cover the good practices of Semantic Assets already identified by the previous initiatives in the EU and Member states, for e.g., in Austria, to exchange data between public

administrations at the EU level. Backed up by the European framework for interoperability few good practices are already identified in the level of basic registries [72]. ISA² specifications have also been successfully implemented by several users at different levels.

- Core Vocabularies itself, mainly ISA and BRIS are good practices for resolving the semantic conflicts and enhancing the semantic interoperability. Reuse of the semantic assets is promoted for increased impact. This will allow reducing investment and operational costs, and reduce the implementation and development costs of semantic specifications.
- Coded Values to reduce semantic conflicts due to the differences in vocabularies of EU languages. Controlled vocabularies that reduce ambiguous translations is overseen as a control measure for the conflicts. For e.g., ECRIS provides such an interconnection between the member state's registries of criminal records [55]. A multilingual glossary available online for understanding the semantics in land registries (EULIS) is another example.
- Ability to unambiguously identify entities across the borders. Approaches such as a well-defined identification schema allow unequivocally identify respective entities, such as exemplified by the Austrian Central register of residence. BRIS also provides such schema having unique identifiers for companies and their branches opened in other member states. This thus also ensure the "interconnection of business registers without establishing a centralized register and allowing Member States to keep their national registers and systems autonomous".

4.6 Risk Management

The risk management in DE4A work package WP3, including deliverable 3.1 that consists of possible risks (e.g. availability and accessibility limitations of open data and semantic assets) and associated proposed risk mitigation measures (e.g. The gaps in interoperability occur due to limited availability and accessibility to data, and the semantics assets are to be identified by the pilots retrospectively). A list of risks and associated proposed risk mitigation measures are described in a separate internal document. The access of this risk management internal document is restricted to the DE4A consortium. Work on risk management, in DE4A work package WP3, is on-going efforts and will continue until the closure of the project.

5 The Agile Co-creation Methodology to Gather Requirements for Semantic Assets

5.1 Introduction

The notion of agile co-creation is diverse from the traditional push and pull approaches, as it denotes that diverse parties actually 'create' something together, instead of one fragment developing something for the other one to use (push-approach) or expressing a clear request or need to the other (pull-approach). When parties are expected to create together, they must be equal partners with a similar level of resources and speak a common language towards a shared goal or value.

Agile is an iterative way to build a product, through stakeholder collaborative efforts, that is evolved on incremental basis instead of delivering it at once near the end of a project. Co-creation approach brings together users and designers to capture and align needs to design and test a product. The combination of these two aspects (Agile and Co-creation) will help work package WP3 (designer) to engage DE4A Pilots (users), through work package WP4, to capture their semantic assets requirements, and experiences about semantic interoperability. Moreover, DE4A Pilots, who will provide input and insights emerging from a diverse set of stakeholders, will richly influence the design and development of semantic assets.

This agile co-creation approach will help to bring together users (DE4A pilots) and designers (DE4A work package WP3 team) to capture and align semantic interoperability needs to build a common repository of semantic models and business rules (D3.1, and D3.2) and later to design a semantic interoperability framework (D3.3) that is one of the important elements for a completely working Digital Single Market across Europe.

In view of the above, we also suggested to pursue a co-creation approach within work package WP3 module of DE4A project to develop semantic assets (taxonomies, vocabularies, libraries) and integrate works of existing initiatives (e.g., SEMIC, ISA2) into an extendible multi-domain, cross-border and cross-sector semantic interoperability framework.

5.2 Alignment with Broader Projection

The objective of this approach gives a wide methodology for agile co-creation, that can be used as a template allowing work package WP3 partners (IHU, MPTFP-SGAD, DIGST, SU, SI-MPA) internal mechanism to be co-designed. This methodology will also serve as an outward-facing guideline when engaging with other DE4A Pilots , through work package WP4, in co-creation activities with the overarching goal to develop semantic assets and integrate works of existing initiatives like SEMIC, ISA2 into an extendible multi-domain, cross-border and cross-sector semantic interoperability framework.

This co-creation will be done internally within the work package WP3 and via liaison with expert groups on semantic assets while ensuring the agreed dependencies between WPs of the DE4A project particularly DE4A Pilots. The proposed co-creation sessions may be carried-out in the DE4A pilots through work package WP4. To do so, work package WP3 will have a close liaison with work package WP4 partners. The desired outcomes will be shared with work package WP5 – "Common Component Design & Development", DE4A Technical Coordinator, and with WPs (WP2-3-4-5) Technical Working Groups s for the design and development of the project architecture and other common components as per the scope of the project.

5.3 An agile co-creation methodology for requirements elicitation

This approach will also help to overcome the push and pull schism and stimulate a vibrant, competitive co-creation process within work package WP3. It is also important that governments, public administrations, and research institutions embrace entrepreneurial tactics. One of the main impediments to open and collaborative innovation is the complexity of having researchers and public officials speaking the same language and addressing the problems from a common perspective and with analogous resources and tools. It is a new way of driving research, with and for the market, at corporate and public-sector organizations. We describe the following iterative steps that define the methodology:

i. Identification of Point of Contacts from the relevant DE4A Pilots (through work package WP4), stakeholders within work package WP3, including piloting Member States (partners) of the DE4A project.
ii. Organize, some sort of events (online, offline), in DE4A Pilots, through work package WP4, to bring together users (DE4A pilots) and designers (DE4A work package WP3 team) to capture and align semantic interoperability. To achieve this goal, a ***list of exercises*** will also be suggested. Currently, we placed an exercise as an example in the forthcoming ***Section 'ANNEX', Annex-I***.
iii. Gather DE4A Pilots (through work package WP4) needs about semantic assets and propose some practical exercise to the pilots to gather valuable input locally. Some ***methods for interaction*** moments to capture DE4A Pilots semantic assets requirements for the development of the DE4A semantic framework is presented in the forthcoming section ***'ANNEX', Annex-II***.
iv. Consolidate all DE4A pilots' semantic assets needs
v. Prioritize semantic assets issues to be addressed in the proposed DE4A semantic interoperability framework
vi. Analysis, integration of existing taxonomies, vocabularies, and libraries based on relevant project stakeholders, including piloting member states' feedback.
vii. Through Co-design methodology, work package WP3 will design a DE4A semantic interoperability framework to deliver cross-border public services within the EU.
viii. Obtain ideas, testing, validation, and evaluation of the DE4A semantic interoperability framework through testbeds at DE4A Pilots.
ix. Share the final DE4A semantic interoperability framework with work package WP5 and DE4A technical coordinator who will facilitate the smooth execution of the whole DE4A development lifecycle.

One of the prime objectives is to create open innovation proposals and activities, like events, to at DE4A Pilots that include public and research institutions. The DE4A Pilots also have close liaison with respective civil societies and businesses as well and mobilize participation in the identification and prioritization of concrete societal goals.

Once the innovation is conceptualized, building from both technology-push and market-pull principles, and is understandable to all DE4A Pilots, through work package WP4, the co-creative process that will lead to its implementation can start, as long the necessary resources are gathered. We also suggest to testbeds at DE4A Pilots. The purpose of testbeds is to create a shared arena to obtain ideas, testing, validation, and evaluation of the DE4A semantic interoperability framework. About Quadruple Helix's model implementation, shown in Figure 10 below, it is indicated that there is an essential need to create innovation processes based semantic interoperability framework, that all DE4A Pilots should be an active part of these innovative procedures within work package WP3.

The implementation of work package WP3 objectives converges into a mentioned above nine-steps-methodology that deploys our approach to open, collaborative innovation. We believe that this approach fully captures the complexity of the process and allows for innovation to occur iteratively at every step along the way, contributing to the full achievement of objectives of work package WP3.

Figure 9: Quadruple Helix model implementation

From the above Figure 10, when we refer to ***culture***, it describes the way work package WP3 partners contribute and partners intrinsic connectivity within the ecosystem. By understanding the diverse cultures inside the diverse set of contributors, the ecosystem can reshape behaviours, and in turn, create a stronger intramural culture that supports the unique objectives as per the scope of the work package WP3. Developing a systematic approach to evaluate and familiarize the cultures, the ecosystem can maximize the potential within the co-creation process to build a common repository of semantic models and business rules. By ***practice***, we refer to the co-creation as well as the DE4A pilot's context needs, its public settings (rules and procedures), and finally, the current routines of interaction between actors. Then the ***structure*** is crucial to keep the motivation and production of the co-creation partners, promote interaction and innovation while linking the activities to the objectives. It is the main construct of the ecosystem that promotes value sharing and value acquisition. The structure includes technology, management, reports, and communications (internal and external). Finally, with ***evolution***, we refer to the feedback loop. Constant engagement and feedback mechanisms from the stakeholders, particularly DE4A pilots that are fed back to the semantic interoperability framework for adjustments and enhancements.

Furthermore, presented below are the key ingredients driving the process of value co-creation within innovation in the public sector. These include the ability to transform the perception of work package WP3 stakeholders, including pilots, as recipients of solutions to equal partners in the design process of semantic interoperability framework. The building of capabilities and a sense of mutual development, along with the blurring of traditional power roles, is what characterizes this process.

5.4 Work package WP3 stakeholders

The work package WP3 main stakeholders include IHU, Ministerio de Politica Territorial y Función Pública (ES), Finansministeriet (DK) , Stockholms University (SE), Ministry of Public Administrations (SI),

and the Piloting (EU) the Member States. The DE4A Pilots will also recruit stakeholders from the respective public administration, including public, academic institutions, businesses, and citizens. The DE4A partners that are working on other WPs of DE4A are also stakeholders of the work package WP3.

5.5 Stakeholder Mapping

Here we will detail mapping of our stakeholder groups according to their role and scope of an engagement within the DE4A work package WP3. We will incorporate this input, in-consultation with other DE4A partners for the next D3.2 deliverable in an agile manner soon.

5.6 Events Design

Here we will explain about co-created activities types, timings (half-day, full-day), number of times to happen, event mode (off-line, off-line), type of participants, number of participants. It is pertinent to mention that work package WP4 will be responsible for such an event at DE4A pilots. We will incorporate this input, in-consultation with other DE4A partners for the next D3.2 deliverable in an agile manner soon.

5.7 DE4A Pilots Context

The DE4A pilots are essential for work package WP3 to get needs about semantic assets, to define DE4A semantic interoperability framework, and to test, validate, and evaluate DE4A semantic interoperability framework. Work package WP4 is responsible for dealing with DE4A pilots. . It is pertinent to mention that DE4A Technical Coordinator and WPs (WP2-3-4-5) Technical Working Groups will manage such events at DE4A pilots. We will incorporate this input, in-consultation with other relevant DE4A partners for the next D3.2 deliverable in an agile manner soon.

5.8 Legal and Ethical Guidelines

We will follow the work package WP7 “Legal and ethical compliance and consensus building” deliverable D 7.1 “Overview of legal and ethical requirements“ for the subject guideline, that are in line with GDPR, for data collection, storage, and processing requirements from the work package WP3 stakeholders, including DE4A pilots and civil society. We will replicate some relevant subject guidelines in our next D3.2 deliverable, if required.

6 Conclusions

The results of this deliverable "*Initial requirements for semantic assets*" concentrate on a set of guidelines regarding semantic interoperability needs that provide foundations for the development of the DE4A semantic interoperability framework. Version 1 of the set of guidelines is the subject deliverable, and the set is incrementally developed by accommodating the outcomes from pilots, analysis of results of other projects like TOOP, and other requirements of emerging vocabularies, taxonomies, dictionaries, and libraries, ontologies. This implementation process follows an agile methodology by starting at a baseline level with D3.1. It iteratively improves by adding the tools resulting from including the requirements from pilots and other emerging assets identified and added in the next deliverable D3.2. The deliverable D3.1 acts, therefore, as the starting point for the DE4A work package WP3.

The DE4A work package WP3 team thoroughly examined the existing literature, relevant projects, like TOOP, SCOOP4C deliverables, related initiatives, like SDG, eIDAS, BPMN, and other related sources to describe the following deliverable D3.1 aspects: i) Defined all the concepts in the glossary section that is helpful for the readers for their understanding and work package WP3 team may also use the same terms across the whole process in the DE4A work package WP3. ii) list and explain semantic vocabularies, technologies, and standards that are somehow related to DE4A use cases, iii) propose an initial set of requirements and guidelines for DE4A, iv) highlighted common issues in semantic issues that are the key barriers to successfully achieve semantic interoperability at national and international level as well. Additionally, this document includes vi) an agile co-creation methodology, to bring together users (DE4A pilots) and designers (DE4A work package WP3) to capture and align semantic interoperability needs to define a DE4A semantic interoperability framework. The high-level requirements listed in Table 8 serves as the backbone of the further development of semantic models and the semantic interoperability framework DE4ASem.

There are some remaining aspects of semantic assets that are highlighted in the subject document, which needs more work. Work package WP3 team also require valuable input on these aspects from the DE4A stakeholders, including Pilots. The example of such aspects includes further analysis and mapping of semantic vocabularies as per DE4A use cases, good practices of semantic assets (national and cross-border level), a gathering of other common issues in semantic assets, and findings on semantic data models for evidence as per the scope of DE4A. The work package WP3 team will continue to cover the aforesaid pending aspects, through an agile methodology and iterative way, in the forthcoming deliverable D3.2.

The outcomes of this deliverable will provide a basis for selecting the semantic assets to be used in the DE4A initial versions of the Semantic Framework (D3.3) and the Semantic Toolkit (D3.5).

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8 Annexes

8.1 Annex I – Name Proposed Exercises for the Pilots

Exercise 1: Spotting the Paradox

The idea here is to characterize the current set of semantic interoperability elements (EC core vocabularies, domain-specific ontology libraries, semantic interoperability tools), and an ideal set of semantic interoperability elements. This exercise helps surface pilot MS frustrations with the current set of semantic interoperability elements and hopes for a different set of semantic interoperability elements. This "grounding" can take place before piloting MS begin developing their descriptions, or afterward as a "test" of the descriptions once they have been written. In the case of the latter, time would need to be given for revisions. Having characterized the current interoperability elements, attention turns 180 degrees as participants attempt to write a similar description for an alternative or ideal interoperability elements. In many instances, this description will be almost a direct opposite of the current interoperability elements. Suggesting this can provide a starting point for pilots MS.

After that, Piloting MS (through work package WP4) may be asked to reflect on the identity of the ideal set of semantic interoperability elements and develop some minimum specifications ("min specs") for that interoperability elements. It is proposed that we may adopt Min Specs are expressed as a set of simple rules or principles. Piloting countries may be encouraged to think of their ideal set of semantic interoperability elements in a coherent way without being overly specific.

Piloting MS should then reflect on the situations in which the values/character traits might be particularly useful. It is a preparatory exercise or softening up" exercise to allow Piloting MS to experience the importance of paradoxes – it allows Piloting MS to recognize the inherent tendency to see the world in black and white terms, where everything is either good or bad.

Note: we will describe other such exercises soon

8.2 Annex II. Proposed Methods for the Collection of Semantic Requirements

Following are the proposed methods for Interaction Moments to capture work package WP3 stakeholder including DE4A Piloting MS requirements for the development of the semantic framework:

Method 1: Opinion Survey

Initial purpose / Objective: Getting data, from work package WP3 stakeholders, including DE4A, in a structured way and through specific questions, often with procedures that allow analysis.

Recommended for: Define concepts/Generate ideas/Capture user requirements.

What it consists / Steps for its realization

i. Define the purpose and the information needs. Establish the objective of the study and dimension on analysis.
ii. Design the population simple to be surveyed.
iii. Design the questionnaire. The questionnaire is the instrument of the survey. It operates the studied variables. The questions collected in it are items that correspond with previously defined indicators to study the variables.
iv. To teach and to train the interviewers' team, is the questionnaire is provided.
v. Make a pre-test of the questionnaire questions.

vi. Apply the survey (face-to-face, by phone, telematics, etc.).
vii. Record the information.
viii. Make use and analyze the information.

Results of the application: We will get statistical data over the opinion of the surveyed DE4A Pilots.

Method 2: Brainstorming

Initial Purpose / Objective: To get quickly many ideas from a group without engaging in a detailed discussion, Thinking in the long term, beyond the daily problems.

Recommended for: Define concepts/Generate ideas/Capture user requirements

What it consists / steps for its realization:

i. Ask the group to reflect on exposing as many ideas as possible about the topic.
ii. Ask each person to briefly expose their idea (without discussing the others' ideas).
iii. Write your ideas.
iv. Hold a debate.
v. To group and choose the problems, issues, and topics that are brought up, to make easier the analysis.
vi. Establish a priority order if it would be necessary.

Results: i) Results of the application: mapping ideas to face a problem. List of topics to work with, ii) type of captured needs: explicit needs.

Method 3: Hats

Recommended for: Define concepts/Generate ideas/Capture user requirements.

Initial purpose / Objective: i) Quickly obtaining of many ideas from a group without engaging in a detailed discussion. ii) Thinking in the long term, beyond the immediate daily problems.

What it consists / Steps for its realization: It's a variation of the Brainstorming. In this case, different roles (hats) are distributed to each participant, which implies assuming a different perspective or point of view over the topic to work out:

i. Black hat: criteria, judgment or negative opinion; damages and criticism.
ii. White hat: pure facts, figures, sources of information.
iii. Blue hat: cold and control, thinking about thinking, processes.
iv. Red hat: emotions, feelings, forebodings, intuition.
v. Yellow hat: optimist, positive and constructive thinking.
vi. Green hat: creativity, movement, provocation, divergence.

Participants: One group consist of 6 people

Results: i) Results of its application: mapping ideas to face a problem. List of topics to be further examined. Ii) Type of captured needs: explicit needs.

There are other methods like What if, Empathy Map, Significant change that can be used to get semantic requirements from DE4A Pilots for the development of the DE4A semantic framework.

8.3 Annex III. UML Diagrams of ISA² Standards

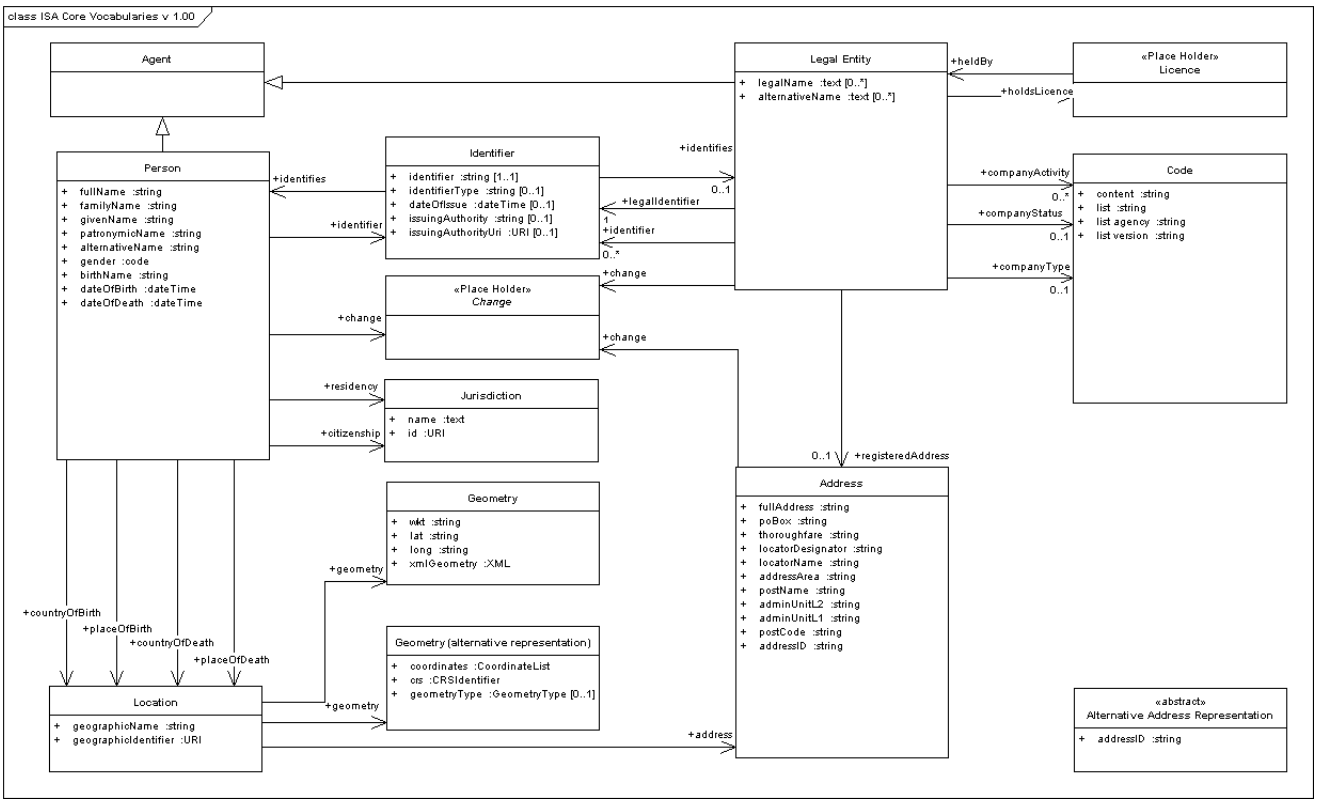

Figure III-a: UML diagram for Core Person-Business-Location Vocabularies

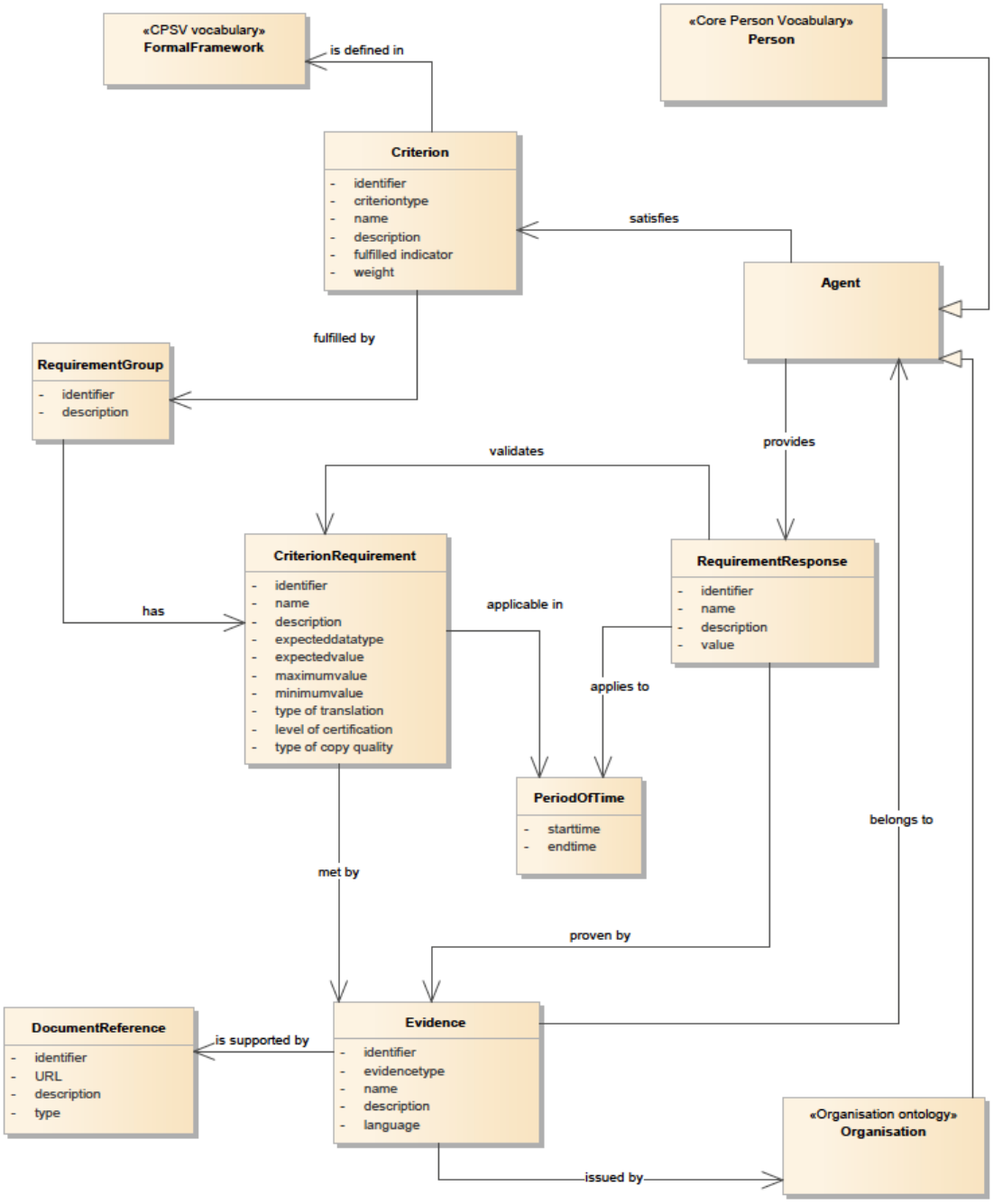

Figure III-b: UML diagram for Core Criterion and Core Evidence Vocabulary (CCCEV)

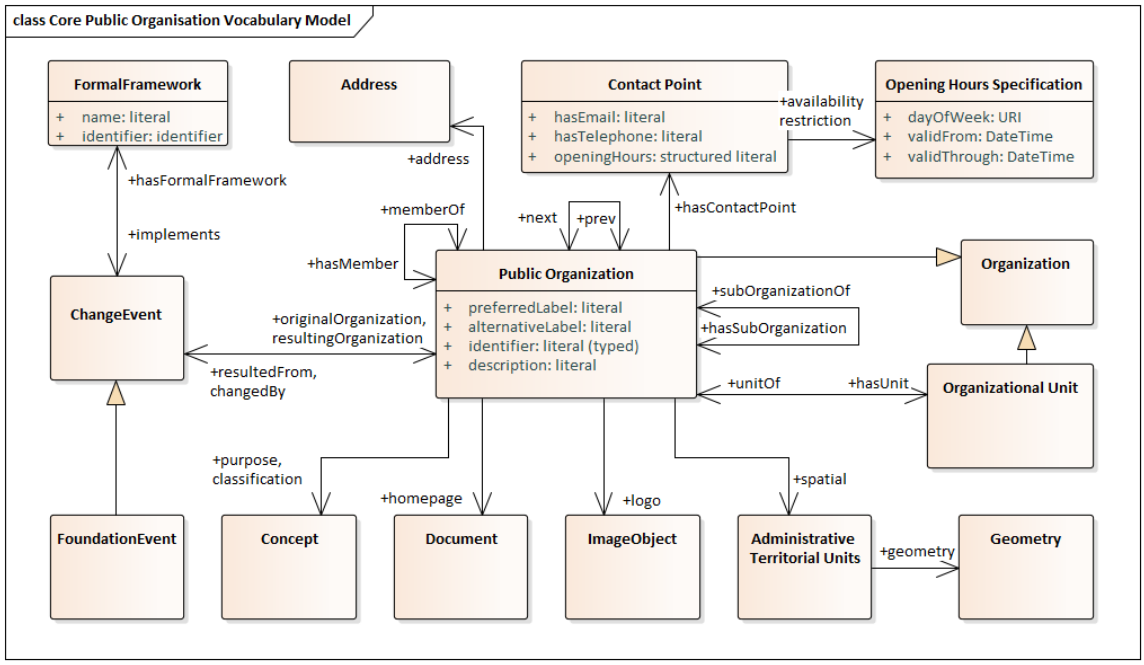

Figure III-c: UML diagram for Core Public Organisation Vocabulary (CPOV)

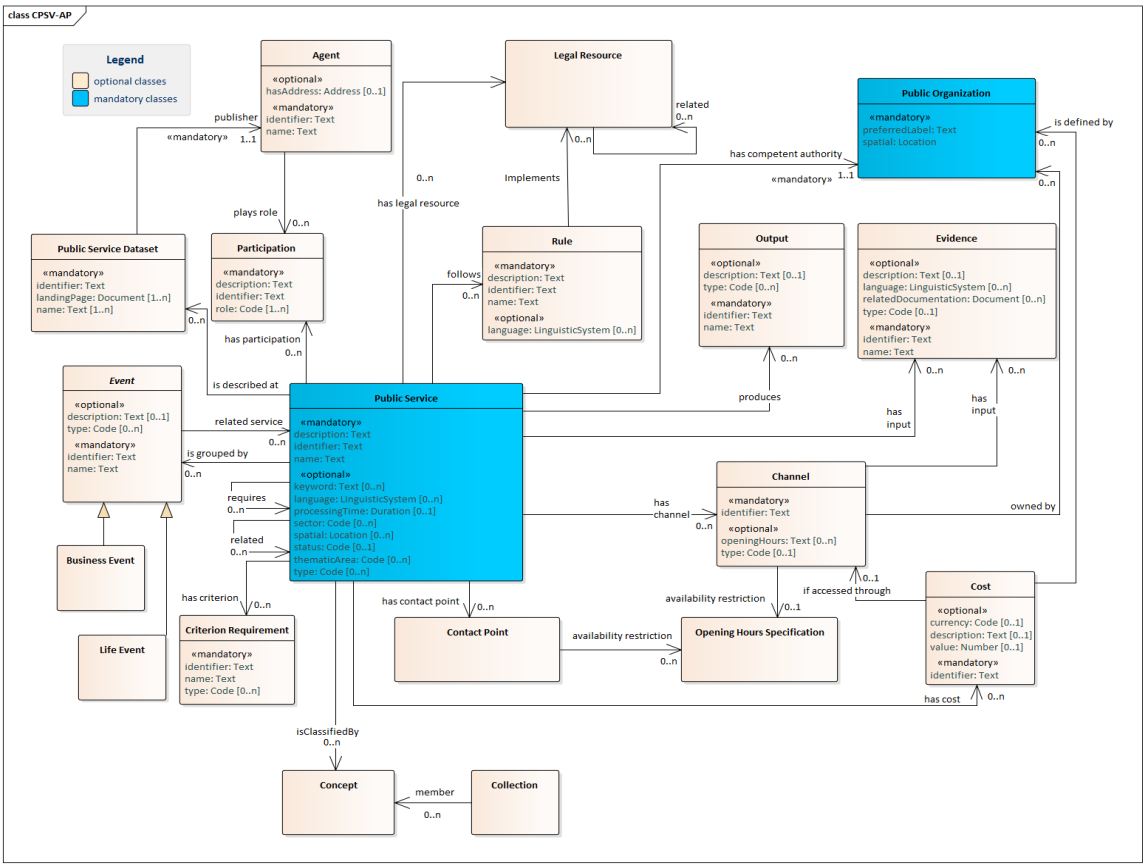

Figure III-d: UML diagram for Core Public Service Vocabulary – Application Profile (CPSV-AP)

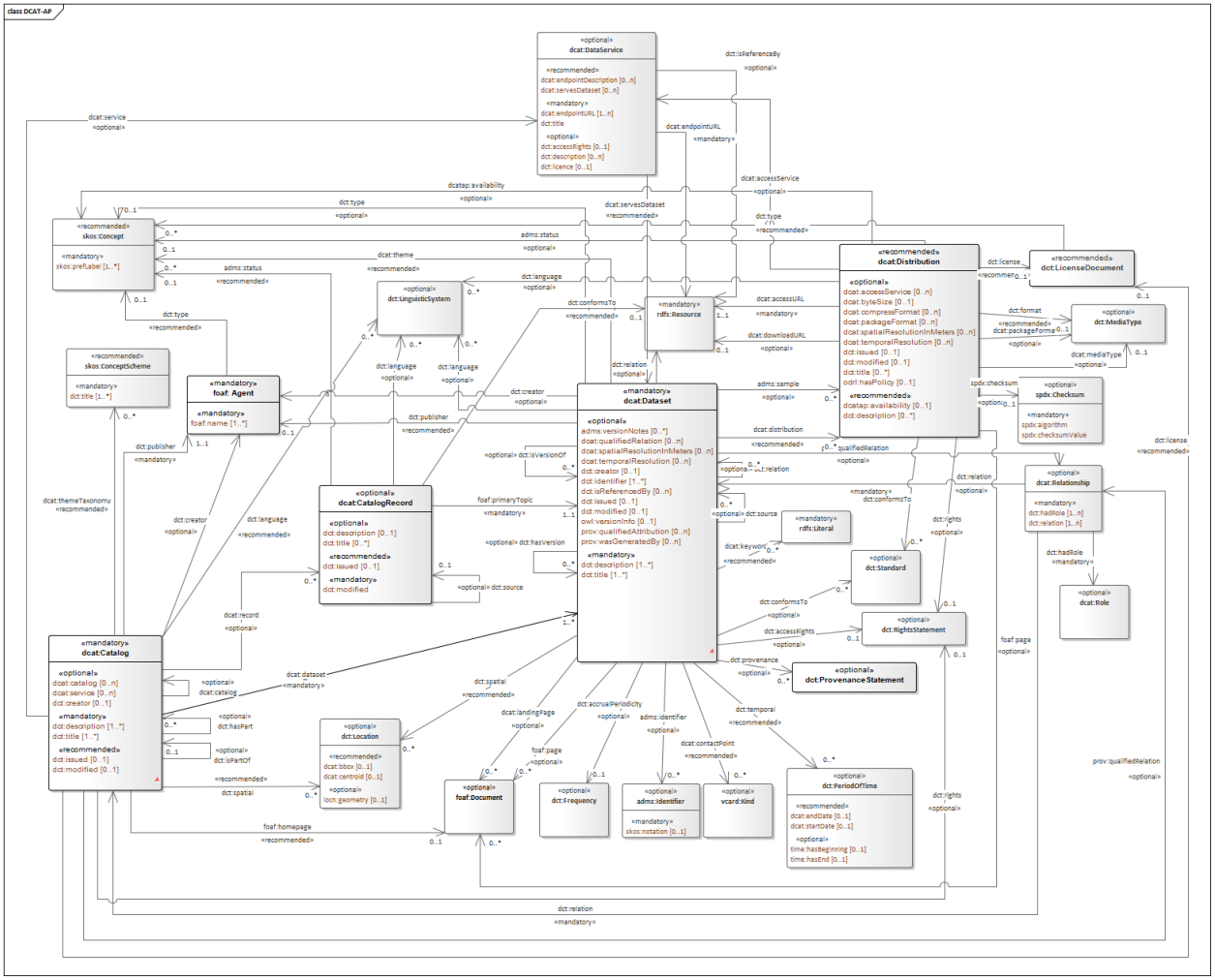

Figure III-e: UML diagram for Data Catalogue – Application Profile (DCAT-AP)

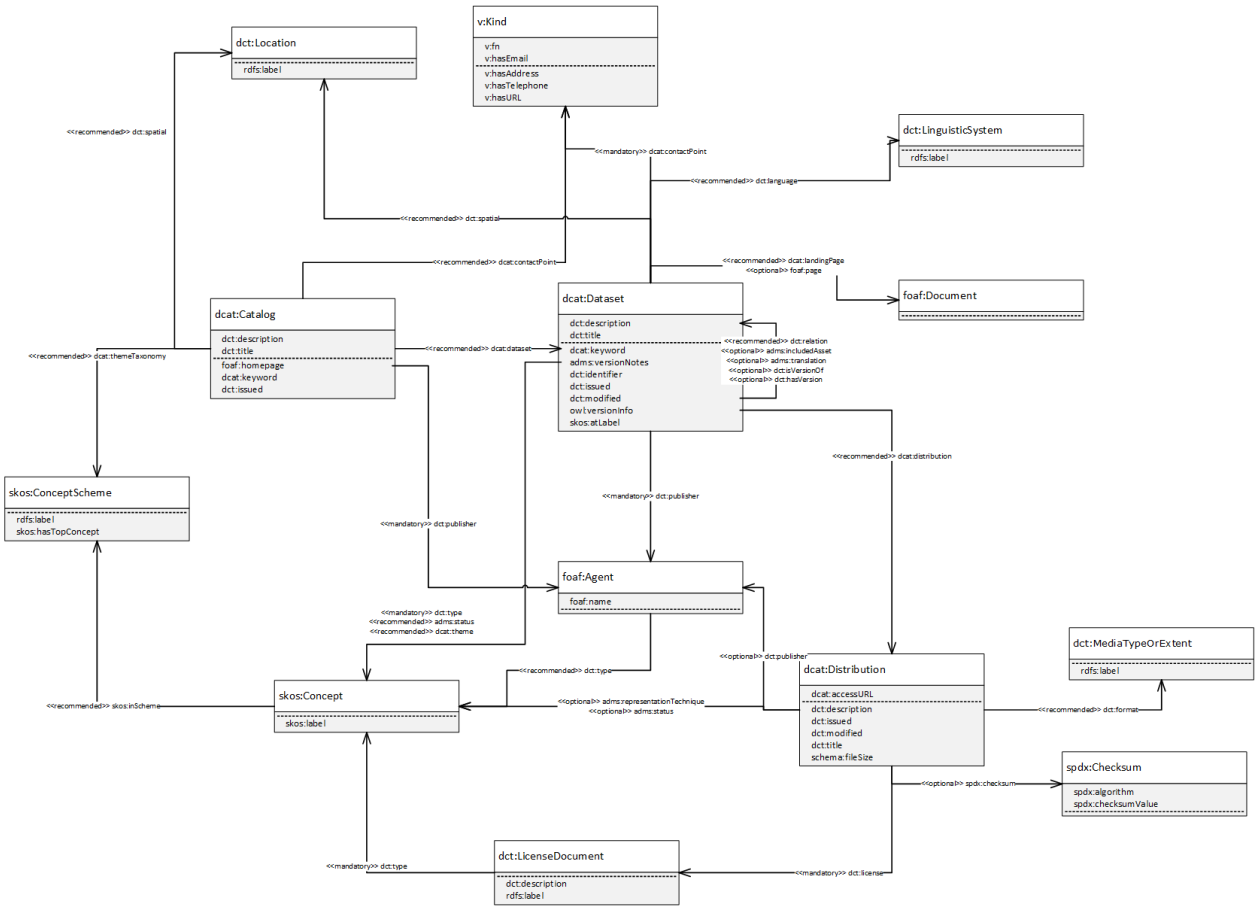

Figure III-f: UML diagram for Asset Description Metadata Schema – Application Profile (ADMS-AP)