Standardisation gaps and roadmap

(1.2)

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Lead Beneficiary	DKE
Author(s)/Organisation(s)	Marvin Böll, DKE, Jens Gayko, DKE, Staffan Olsson, GS1, Jan Merckx, GS1, Daniel Schwartz, Textile Exchange
Contact Email	Marvin.boell@vde.com
Contributor(s)	Carolynn Bernier, CEA, Adrien Jousse, CEA, Abdelrahman Hesham Mohamed Abdelhalim Abdalla, Polimi, Anh Dao, CEI, Panagiotis Papadakos, ERCIM, Emily Crumley, Textile Exchange, Nicolas Pauvre, GS1, Rigo Wenning, ERCIM/W3C
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Abstract:	This report provides a gap analysis of the requirements and standardization landscape based on the CIRPASS proposal for the DPP-System. It aims to provide an overview of the system requirements and components which would require standardization work, by elaborating on the status of the standardization landscape, how it could evolve and where the standardization work should focus on.
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#	Participant Organisation Name	Short Name	Country
	CIRPASS Consortium		
1	COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES	CEA	FR
2	SLR ENVIRONMENTAL CONSULTING(IRELAND)LIMITED	SLR Consulting	IE
3	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV	Fraunhofer	DE
4	WUPPERTAL INSTITUT FUR KLIMA, UMWELT, ENERGIE GGMBH	WUPPERTALINSTIT	DE
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6	VDE VERBAND DER ELEKTROTECHNIK ELEKTRONIK INFORMATIONSTECHNIK EV	VDE	DE
7	GLOBAL TEXTILE SCHEME GMBH	GTS	DE
8	+IMPAKT LUXEMBOURG SARL	+IMPAKT	LU
9	F6S NETWORK IRELAND LIMITED	F6S	IE
10	GEIE ERCIM	ERCIM	FR
11	E CIRCULAR APS	CEI Society ApS	DK
12	GS1 IN EUROPE	GS1 in Europe	BE
13	POLITECNICO DI MILANO	POLIMI	IT
14	CIRCULAR.FASHION UG (HAFTUNGSBESCHRANKT)	circularfashion	DE
15	DIGITALEUROPE AISBL*	DIGITALEUROPE	BE
16	KIC INNOENERGY SE	KIC SE	NL
17	TECHNISCHE UNIVERSITEIT DELFT	TU Delft	NL
18	TALLINNA TEHNIKAÜLIKOOL	TalTech	EE
19	VELTHA IVZW	VELTHA	BE
20	Energy Web Stiftung (Energy Web Foundation)	EWF	CH
21	BUNDESANSTALT FUER MATERIALFORSCHUNG UND -PRUEFUNG	BAM	DE
22	SyncForce BV	SyncForce	NL
23	ASOCIACION DE EMPRESAS TECNOLOGICAS ES INNOVALIA	INNOVALIA	ES
24	Textile Exchange	TextileExchange	US
25	Responsible Business Alliance	RBA	US
26	WORLDLINE FRANCE	WORLDLINE	FR
27	RISE RESEARCH INSTITUTES OF SWEDEN AB	RISE	SE
28	IPOINT-SYSTEMS GMBH	iPoint	DE
29	Global Electronics Council	GEC	US/NL
30	Avery Dennison Atma GmbH	atma.io	AT
31	Global Battery Alliance	GBA	BE

Preparing the ground for the gradual piloting and deployment of DPPs from 2023 onwards, focusing on developing a roadmap for prototypes in three value chains: electronics, batteries and textiles.

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DPP	Digital Product Passport
EC	European Commission
ESPR	Ecodesign für Sustainable Products Regulation
JTC	Joined Technical Committee
PDP	Policy Decision Point
SR	Standardization Request

1 Introduction

1.1 Contents of this report

Identifying standardisation gaps for the DPP system is a complex task in an environment made dynamic due to ever changing requirements related to :

- The negotiations on the ESPR, before its adoption and publication in the Official Journal in June 2024[1];
- The iterations of the standardisation request of the EC to CEN and CENELEC for the development of the technical standards in digital product passports in support of the ESPR.
- The work performed by the JRC Ecodesign for Sustainable Products Regulation (ESPR) – preliminary study on new product priorities report of the European Commission
- Other regulations such as the EU Battery regulation and the Construction Product regulations.
- Clarification on the approach the Commission will take for Electronics (and the transition from actual Directive to the ESP-Regulation)
- The repositioning of the importance of the textile and footwear sector (considered as first delegated act to be developed)
- The work performed by other projects such as Battery Pass
- The consequences of the above on the development of the CIRPASS proposal for the DPP system.

This document starts by extracting essential requirements for the DPP system from the ESPR and from the Standardisation Request. It then builds on prior CIRPASS results[2] including:

- DPP User Stories
- DPP system Architecture (D3.2)
- Identification Schemes (D3.3)
- DPP Prototypes (D5.1)
- An extensive list of standards related to the DPP system, available:
  https://cirpassproject.eu/dpp-related-standards-dataset/

to provide an analysis of the standards landscape for the DPP system. It tries to consider the various aspects and perspectives, such as the system components, their interfaces as well as the information flow among them, that would affect the adoption of the EU-DPP by providing a preliminary gap analysis of the current standards landscape. Based on the gap analysis, the standardization roadmap will highlight aspects that need to be considered when setting up a DPP-System architectures, and which standards need to be developed for increase the interoperability between existing and upcoming systems.

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[1] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CONSIL:PE_106_2023_REV_1
[2] Available https://cirpassproject.eu/project-results/

1.2 Scope of this report

The scope of this report is limited to the DPP system architecture including the general, cross-sectoral information model. Discussion on methodology standards for providing some of the future DPP datapoints for specific product groups are excluded – as this work is delegated to the JRC and other expert groups. In relation to information models, this report adds general consideration of the standards which describe how these datapoints can be made available in a machine-readable environment (e.g. standards on open semantics or web vocabularies, ontologies, data models, standard attributes, etc.). However this will be very general, and it is presumed that this is common understanding, based on information provided in D3.2 and D5.1.

One of the challenges with entities using different system architectures is the exchange of data. Ideally users use data which have the same structure. However, the way data is structured varies between users. CIRPASS differentiates between information models, i.e. the way how data about a product is structured, and data models where products are actually described. CIRPASS is focuses on the data system, including the information structure requirements (core ontologies). Nonetheless, certain data models have to be looked into in order to understand the Ontology. The standardisation roadmap for **DPP information model or Ontology**, is based on the listed standards and preliminary studies for data points and vocabularies related to the categories discussed in CIRPASS. The following figures clarify which category of standards are in the scope of this report and which are not.
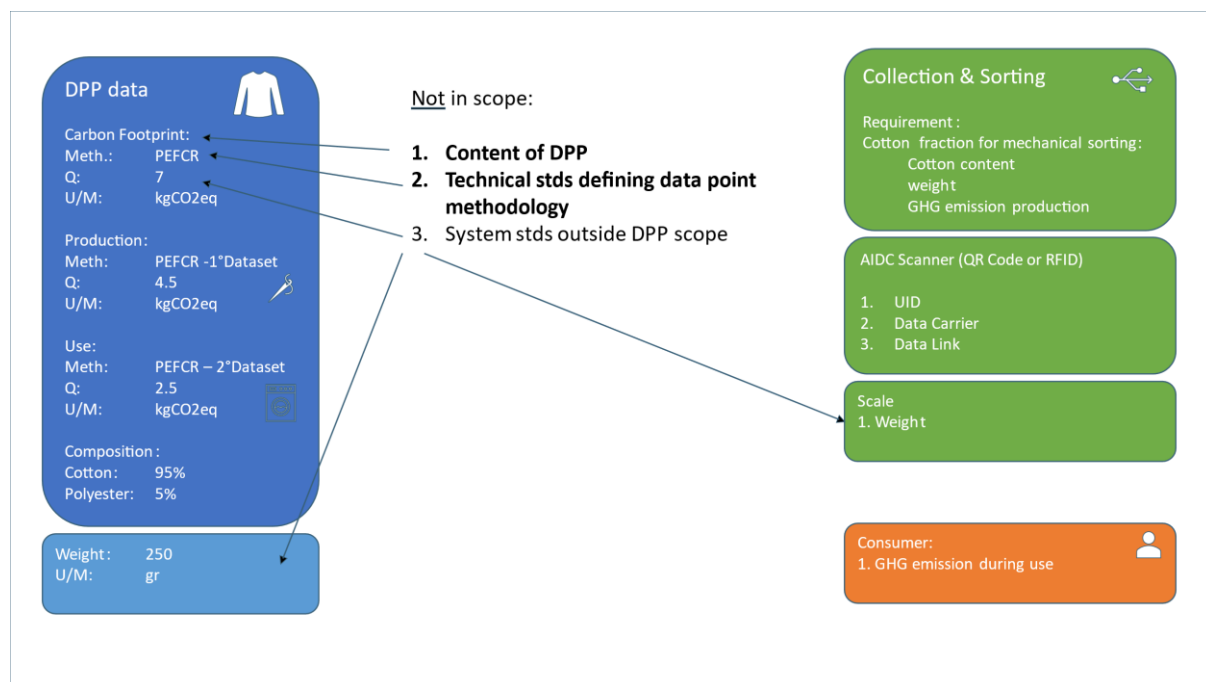
Figure 1: the example of DPP data on the example of textiles

We have taken as an example the following scenario in a textile collection and sorting facility: the collector has a demand for providing feedstock for recycling of cotton. The collector has a need to know the cotton content and the GHG emission levels of the production process of the clothing. On the other hand, there is the consumer who likes to know the GHG emission level during the use of the product.

The first figure clarifies the standards which are not in scope of CIRPASS. Both the data points (Carbon Footprint) and the standard used to describe these (PEFCR) are in the scope of this report.

Considering this specific example of the carbon footprint calculation the EU has a defined initiative for defining the methodology for a footprint calculation (as part of the PEFCR methodology). Today although recommended by the EU the use of PEF has still a limited use as it is voluntary. The exception is the Battery Regulation which requires the use of PEF. We can expect a similar approach for textiles and electronics, which means that the PEFCR most likely will be required through the specific delegated acts. So, a standardisation roadmap would theoretically be necessary for each data point.

This report focuses on Data System standards this includes the ontology standards including information models. The following two figures illustrate the standards which data related aspects are in scope, which are aligned with categories of standards from the Standardization Request DPP, which are in this picture, the Unique identifier, the Data Carrier and the link product and data for Figure 2.
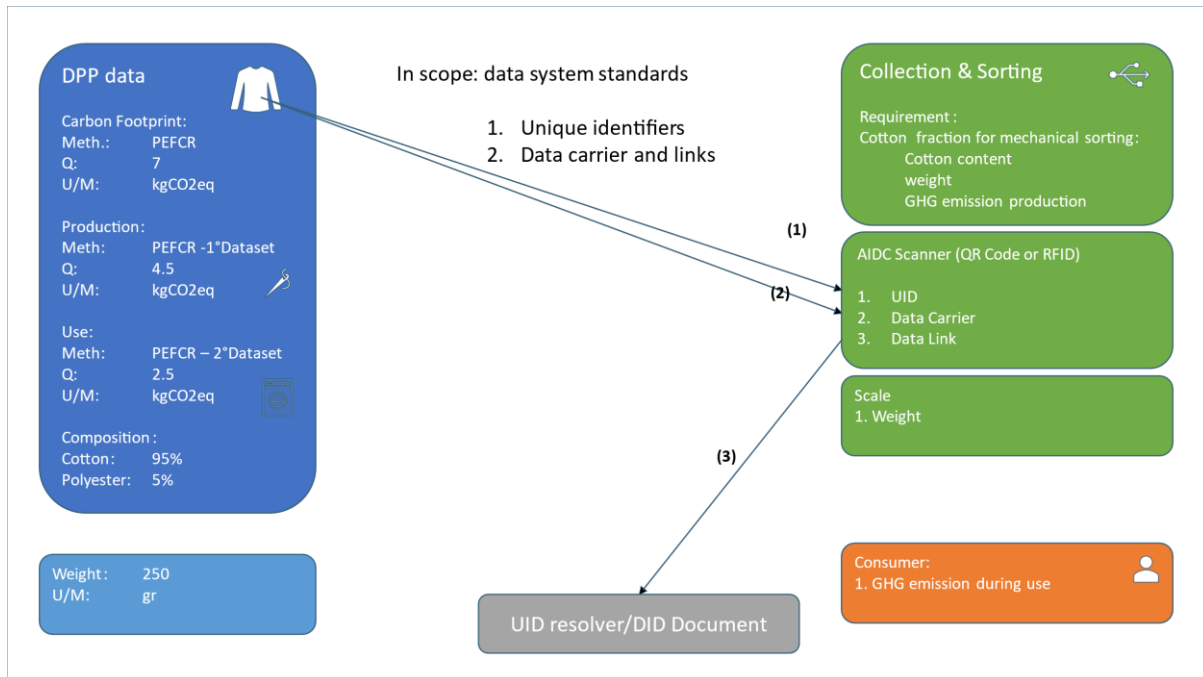
Figure 2: Data that needs to be included as per ESPR and in line with the CEN/CENELEC standardization mandate on the DPP.

Figure 3 shows the example categories of DPP-system standards for the scenario. Relevant categories would be Data storage, Interoperability, data formats and protocols, access rights management and data authentication, and API for life cycle management and searchability.
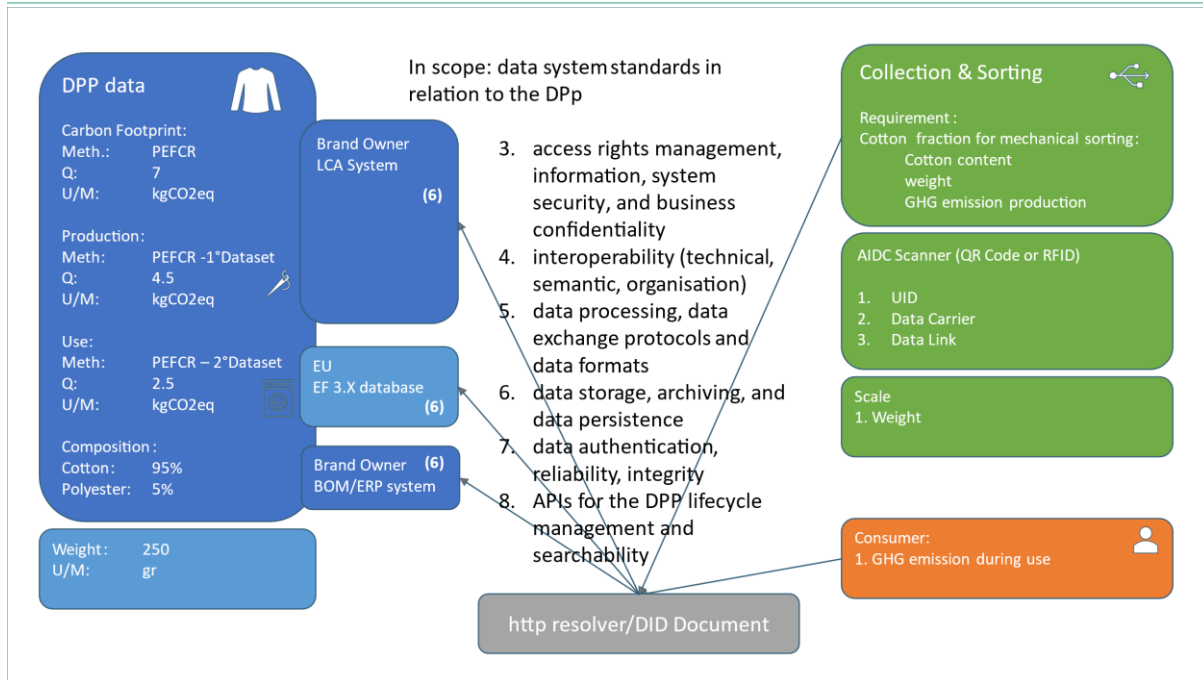
Figure 3: Information structures that need to be considered for in order for the exchange of data addressing the areas of standardization.

2 Methodology

This section describes the different methodologies that were followed by the CIRPASS standards work stream towards identifying gaps in the CIRPASS proposal for the DPP-System Architecture. In this work, it is assumed that the internet is being used, therefore the usage of internet standards is presumed.

2.1 General methodology

The ESPR specifies essential requirements for the DPP-System in Articles 9, 10, 11 and 12 and Annex III. In response to the EU Commission mandate to the European Standardisation Organisations (ESO's) to propose harmonized standards for the DPP-System based on appropriate standards corresponding to a number of areas of standardisation, the CEN-CENELEC Joined Technical Committee 24 Digital Product Passport – Framework and System (JTC24) was established. Its task is to develop the DPP-Standards requested by the Commission which should be made available by the end of 2025.

The aim of CIRPASS is to contribute to the standardisation effort of the JTC24 by sharing its results to support their work. To reach this goal, the methodology presented in the figure below was followed which shows how the activities performed by the CIRPASS consortium contribute to the DPP-System standardisation landscape. This report focuses on the steps identified in yellow, whereas those in orange were addressed by other CIRPASS results (listed in the introduction).
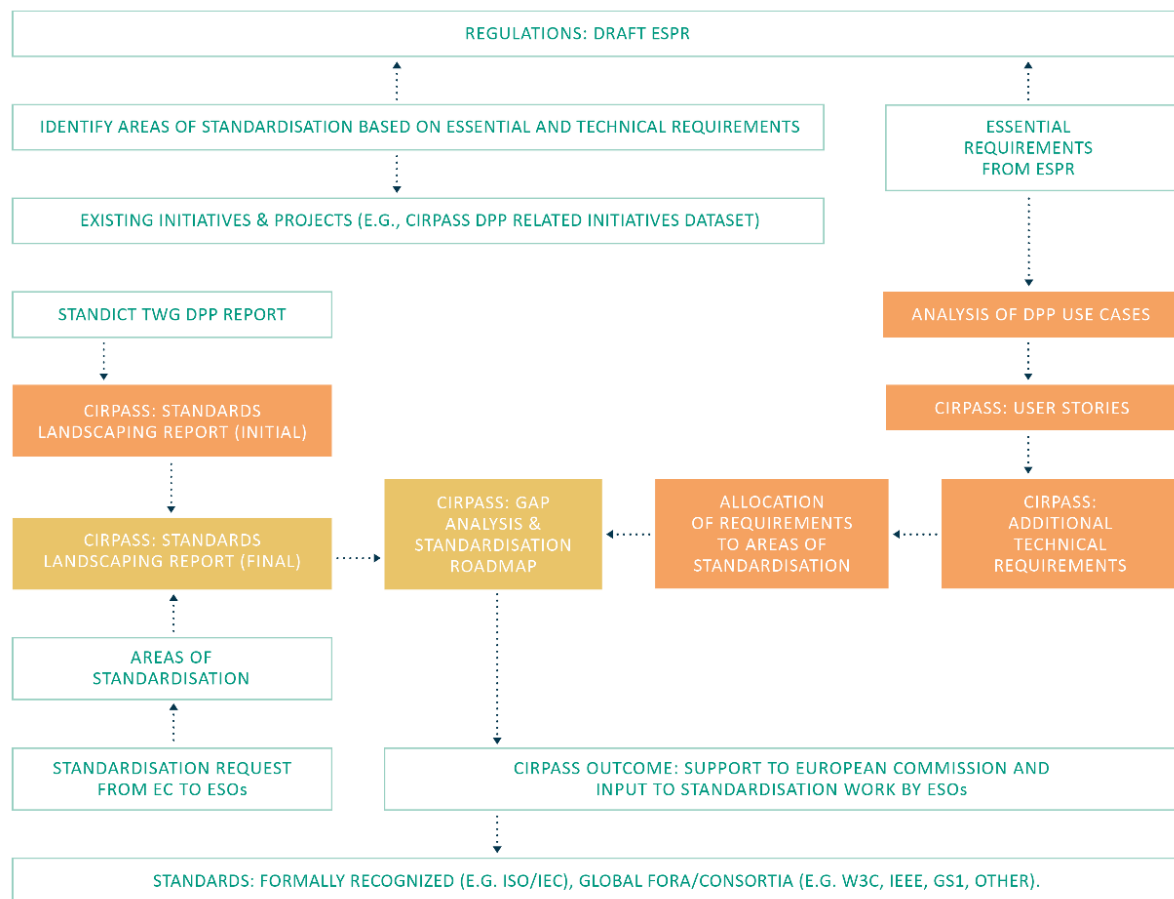
Figure 4: CIRPASS DPP-System standards work stream methodology (Orange: previous results. Yellow: present work)

To reach the work stream's objectives of mapping the standards landscape and performing a gap analysis to identify any missing standards on which a cross-sectoral DPP-System may be based, two inputs are required:

- The first input involves the creation of a full list of standards that might be relevant for the implementation and operation of a DPP-System. The aim is to provide a complete overview of all available standards and their relevance to key categories, based on the areas of standardisation stated in the latest version of the draft European Commission standardisation request DPP to CEN/CENELEC (made available to members of these standardisation bodies on 26th September 2023), referred to in this report as **SR**.

- The second input involves the definition of requirements based on the CIRPASS proposal for the DPP-System architecture (briefly summarized in Section 2.3.2) which itself is based on ESPR-specific user stories. To achieve this, several "user stories" have been identified which enable the definition of technical requirements for a DPP-System. These requirements are then mapped to the relevant areas of standardisation and, finally, mapped to specific standards.

2.2 Areas of standardisation

It should be noted that, at the time CIRPASS began, not only the ESPR was still in a draft state and under negotiation, but several initiatives such as the BatteryPass project and the StandICT TWG DPP initiative were actively working on defining the required areas of standardisation for DPP use cases.

Simultaneously, and differently from the common practice of regulation adoption before the start of any standardisation work, the preparation of the standardisation request for the DPP was also initiated by the European Commission. This situation resulted in the need to avoid double work and contradicting statements and therefore prompted extensive exchanges between the various initiatives and working groups. All this work resulted in the definition of the following 8 areas of standardisation in the SR:

(1) Unique identifiers
(2) Data carriers and links between physical product and digital representation. [3]
(3) Representation access rights management, information system security, and business confidentiality
(4) Interoperability (technical, semantic, organisation)
(5) Data processing, data exchange protocols and data formats
(6) Data storage, archiving, and data persistence
(7) Data authentication, reliability, integrity
(8) APIs for the DPP lifecycle management and searchability[4]

2.3 Methodologies for analysis of standards landscape

The details of the methodology for this assessment are described in more detail in CIRPASS D4.1 *Report on current standards landscape, including gap analysis and interoperability requirements* chapter 2.3.1 *Methodology: Mapping the current standards landscape*. The full list can be found in the Annex: List of Standards relevant a DPP-IT-Framework.

The categorization of standards is based on the structure of the SR. Each standard's relevance has been mapped against the 8 standard categories from *no relevance* to *high relevance.*

2.3.1 Assessment of standards by experts

The first primary objective of the CIRPASS standards workstream is to identify existing standards, standards in development and specifications, relevant for the establishment and operation of a cross-sectoral DPP-System. To this end, the following sources were exploited:

- In 2023 a landscaping report of digital product passport standards was released by the StandICT initiative [7]. The landscaping report provided by the StandICT is a general overview of a large number of DPP related standards to which a relevance grading is assigned for each area of standardisation in need for harmonization. The gradings are "No relevance", "Some relevance", "Significant relevance" and "High relevance". The full report can be found at the StandICT Website: standICT.eu.
- The expert knowledge of CIRPASS consortium members.
- The expert knowledge of a selected team of experts external to the consortium.
- Additional standards that may be identified as needed following the further analysis of requirements defined in both the draft ESPR and the SR.

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[3] Remark: In the draft ESPR this is also referred to as "web link" to the product passport (article 2 (31))
[4] Remark: a standardised DPP-System ontology may be necessary, both for cross-sectoral semantic interoperability and to enable data fusion for advanced market surveillance and customs queries

- Additional standards that may be identified as needed following the further analysis of requirements described in the DPP user stories formulated by CIRPASS consortium partners, based on a conceptual DPP-System.

The list of applicable standards was analysed by standardisation experts with different expertise and agreed by the CIRPASS consortium. After analysis, different workshops with the experts were set up to review their input. The analysis showed that standards are already available for the 8 areas of standardization.

The participating experts were asked for each identified standard to assess the relevance to the DPP and the eight different categories. After the assessment each standard was tagged with a colour code as presented in the following table.

Table 1: Identification of gaps and overlaps between standards

Colour code	Gap Analysis
Green	All agree that a standards is somewhat relevant for one of the areas of standardization
Orange	Contradicting or missing assessment of a standards by experts. This could be a gap or overlap between standards.

Figure 5: Example: Evaluation of standards with regards to the consensus between experts

Additionally, the standards have been rated with their relevance level for the areas of standardization. The requirements defined in the documents D3.2 for the system components and the data flows have been sorted with their relevance to the areas of standardization, following the gradings from the StandICT report: "No relevance", "Some relevance", "Significant relevance" and "High relevance".

This Document assumes that standards, which were marked with Green, have no disagreement with their relevance to the DPP. Orange marked standards, have been assessed differently by experts if they should be included in the list or the have not be assessed with their relevance in the 8 areas of standardization.

Categories - with indication of relevance						
Data carriers and links between physical product and digital	Representation access rights management, information system security, and business confidentiality	Data storage, archiving and data persistence	Data processing, data exchange protocols and data formats	Interoperability (technical, semantic, organisation), including data exchange protocols and formats and Data processing (introduction, modification, update)	Data authentication reliability, and integrity	APIs for the DPP lifecycle management and searchability
No relevance	Significant relevance	Significant relevance		Significant relevance	Significant relevance	
No relevance	Some relevance	High relevance		High relevance	Some relevance	
No relevance	High relevance	Some relevance		Significant relevance	High relevance	
No relevance	High relevance			High relevance		
No relevance	High relevance			High relevance		
No relevance				High relevance		
No relevance				High relevance		
No relevance				High relevance		

Figure 6: Grading of standards with their relevance for the 8 areas of standardization, from no relevance to high relevance.

The assessment has been made by the experts that has entered the standard to the list. It can be expected that in further works, different experts groups, such as the CEN CENELEC JTC24, may re-assessing the relevance of the listed standards with regards to relevant use cases and user stories.

2.3.2 Approach for the identification of standardisation gaps related to the CIRPASS Proposal for DPP-system architecture

The CIRPASS proposal for the DPP system is described in report "DPP system architecture (D3.2)". It proposes a product centric "one system, two ways to access" approach for accessing the distributed DPP data repositories from a unique product identifier (UID) (Table 2). The HTTP based approach is more matured set up whereas DID technologies are not as known to IT service providers compared to HTTP.

Table 2: One system, two ways to access reach product data via a unique identifier (extracted from CIRPASS report DPP System Architecture (D3.2))

	HTTP	DID
Product UID	• https://example.org/UID • URL (e.g., RFC3986, IEC61406-x)	did:method:UID
Finding the resolver	e.g. DNS, ISO/IEC DIS 18975	DID method (e.g. EBSI, web method etc.)
Finding the data	Resolver	DID Document
Accessing the data	**Decentralized Data Repositories (or dataspaces or maybe with Linked data API)**	

Figure 7 illustrates the structural view of the DPP system for the approach based on HTTP and Figure 8 shows using DIDs. The pictures do not distinguish between necessary and optional components. The two figures are component views for the DPP system, with the lines indicating that the components have a relationship between them. These relationships are described in detail in additional data flow diagrams available in Chapter 4 of D3.2.
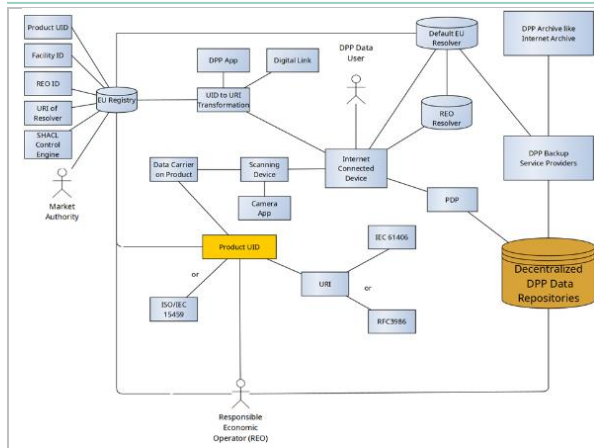
Figure 7: Structural view of the HTTP based DPP-System (extracted from D3.2)
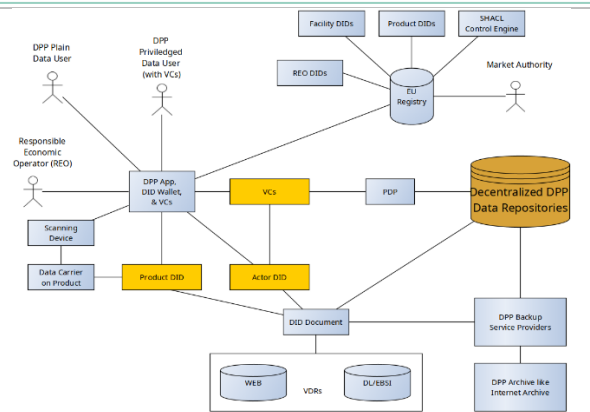
Figure 8: Structural view of the DPP-System showing the structure, actors and components of the DID architecture (extracted from D3.2)

The components and their interfaces listed in the Figure 7 and Figure 8 have been analyzed and sorted with regards to the 8 areas of standardization, based on their system requirements.
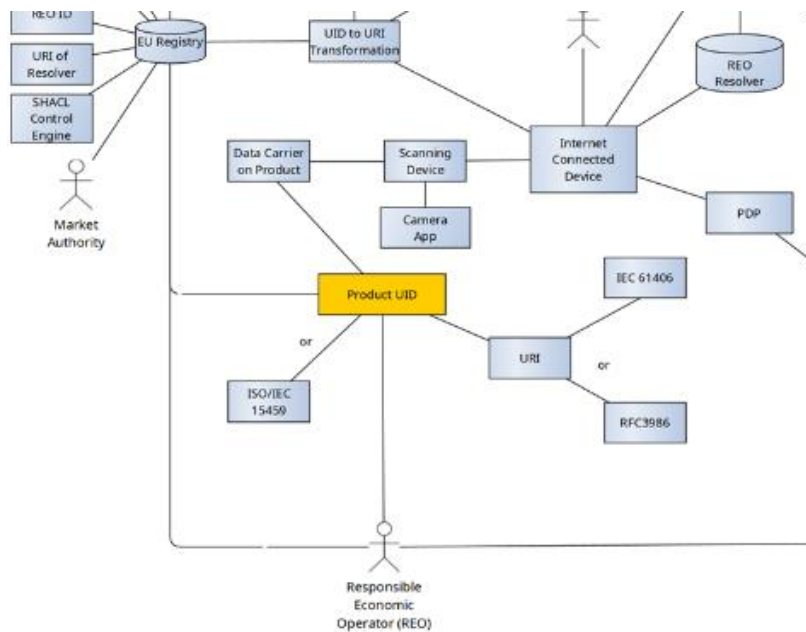
Figure 9: Snippet of the prototype system, displaying the various components and the relation between them.

Based on the snippet diagrams, components which need an interface with other components in order to enable an information and data flow are listed down and potential standardisation gaps are identified. Table 1 shows the assessment on the example of the Product UID.

Table 3: Example which components need an interface and which type standards describe these requirements.

Component/Function Structure of the DPP-System	Interface to other components needed	Category of Standards describing the requirements to the interface components	Remark on standards listed, potential gaps

Example: **Product UID**	Example, which components are connected to the component "**Product UID**" • REO • Data Carrier • EU-Registry	Category of standards describing the requirements to the interface: Identifiers	Potential gap in the standards The interoperability between ID schemes would require further clarification

A performance assessment of the standards, if the content of a standard describes sufficiently the system and the data, has not been conducted. A separate analysis has been conducted on the topic of the vocabularies with a particular focus on the ontologies. The operations and support functionalities for a DPP-System may be dependent of specific elements of vocabularies. This may include for example, the definition of specific link types and their corresponding registration or the definition of "mandatory" data property or class to indicate that a specific data point of a DPP is required by legislation.

2.4 Road mapping methodology

From the standardization viewpoint the CIRPASS work aimed to align with the work of the CEN/CLC, to avoid parallel development of architecture standards. This is to avoid double work and the development of a fractured ecosystem.

The CIRPASS project has produced numerous road mapping reports, each one with its own focus. To ease the reading exercise, all the roadmaps share a common methodology which is described here.

The methodology used for the process of developing the roadmaps is based on the Advanced Technology Roadmap Architecture (ATRA) by De Weck 2022[5]. The core process after collecting the relevant information from other CIRPASS tasks for producing the roadmaps consists of four steps. In these four steps we filter and assess the available information from different perspectives based on guiding questions and criteria sets.

Step 1: Where are we today?

In this step, we identify the current state of the standardisation effort with respect to the DPP system.

Step 2: Where we are going!

In this step, we will summarize the mostly predetermined pathways with regards to standardisation activities for the DPP system.

Step 3: Where could we go?

The regulation mandating the introduction of DPPs for different product groups leaves plenty of scope for different technological and organisational approaches in order to implement functioning DPPs in a compliant way. Do to this high variety, we explore the possible paths for standardisation.

Step 4: Where should we go?

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[5] Olivier L. De Weck (2022), Technology Roadmapping and Development, p. 216

Based on the exploratory work performed by CIRPASS regarding the standardisation gaps with respect to the CIRPASS proposal for the DPP system architecture, we will describe some recommended pathways.

2.4.1 Methodology: Roadmap DPP- Data model on the example of Textiles

Although the DPP-data are not in the focus of this document, they need to be addressed in the context of the information model. While various textile data standards exist or are in development, lack of harmonization is a major issue resulting in inconsistent terminology and categorizations making data exchange challenging. The industry acknowledges the need to harmonize the data models for textiles and the governance and incentive mechanisms around them and various multi-stakeholder initiatives emerged to work on the harmonization (e.g. CIRPASS, GIZ Textiles Transparency Governance Project, Apparel Alliance Data Working Group, UN workstreams). Further consolidation of these efforts is important to facilitate interoperability in the context of the Digital Product Passport.

An important part of the roadmap would be convening these initiatives and major players to work on the harmonization. While comprehensive harmonization is a long-term process, the roadmap should prioritize a small set of key terms first and then continuously expand its coverage.

3   DPP-system requirements from policy

This chapter focuses on policy sources for requirements for the DPP system.

3.1 Requirements from ESPR

This chapter describes the essential requirements derived from the ESPR which can then be addressed by the DPP standards, developed by JTC24. This report uses the finalized version published on the Official Journal of the European Union from June 13th, 2024 as the basis of analysis. Article 9 sets out the elements that the Commission needs to specify in relation to the digital product passport, for example the information to be included, the product granularity to which the DPP applies and who has access to what information. Articles 10 to 12 lay down the necessary provision to implement the product passport. Article 10 lays down the general requirements in relation to the product. Article 11 provides the essential requirements for the technical design and operation of the product passport. Article 12 lays down the rules related to unique operator and facility identifiers.

Table 4 lists the essential requirements as mentioned in the ESPR, organized according to each corresponding area of standardization. It should be mentioned that it is very unusual to mention specific standards within a regulation, since this is in contradiction of the new legislative framework, which states that regulations shall only cover essential requirements while technical requirements shall be covered by the technical specifications. Where exceptions have been made, the Commission is empowered to adopt delegated acts (in accordance with Article 10) to amend the articles containing these specific references. Such amendments may be made in light of technical and scientific progress by replacing the standard referred to, or by adding other European or international standards, for example, with which the data carrier and the unique identifiers shall comply for the purposes of meeting the conditions set out in that article.

Table 4: Essential requirements as mentioned in Articles 9 to 12 of the ESPR version 13 June 2024.

Areas of Standardisation	Essential Requirement Description(s) from the ESPR
Unique identifiers (1)	"the data carrier and the unique identifiers shall comply with one or more of the standards referred to in point (l) in Annex III or equivalent international or European standards until reference harmonized standards are listed in the OJEU" (art.10) Further specified by Annex III: "The data carrier, the unique product identifier referred to in point (b), the unique operator identifiers referred to in points (g), (h) and (k), and the unique facility identifiers referred to in point (i) shall, where relevant for the products concerned, comply with standards ISO/IEC 15459-1:2014, ISO/IEC 15459-2:2015, ISO/IEC 15459-3:2014, ISO/IEC 15459-4:2014, ISO/IEC 15459-5:2014 and ISO/IEC 15459-6:2014" "it shall be connected through a data carrier to a persistent unique product identifier" (art. 10) "the information included in the product passport shall refer to the product model, batch, or item as specified in the delegated act adopted pursuant to Article 4" (art. 10) "The unique **operator** identifiers referred to in Annex III, first paragraph, points (g) and (h), and the unique **facility** identifiers referred to in Annex III, first paragraph, point (i), shall comply with the standards referred to in Annex III, first paragraph, point (c), and second paragraph, or equivalent European or international standards, until the references of harmonised standards are published in the Official Journal of the European Union." (art. 12(1)) "Where a unique **operator** identifier referred to in Annex III, first paragraph, point (h), is not yet available, the economic operator that creates or updates the digital product passport shall request a unique operator identifier on behalf of the relevant actor and shall provide that actor with full details of the unique operator identifier once issued. Before issuing a request as referred to in the first subparagraph, the economic operator that creates or updates the digital product passport shall seek confirmation from that relevant actor that no unique operator identifier exists." (art. 12(2)) "Where a unique facility identifier referred to in Annex III, first paragraph, point (i), is not yet available, the economic operator that creates or updates the digital product passport shall request a unique facility identifier on behalf of the actor responsible for the relevant location or building and shall provide that actor with full details of the unique facility identifier once issued. Before issuing a request as referred to in the first subparagraph, the economic operator that creates or updates the digital product passport shall seek confirmation from the relevant actor that no unique facility identifier exists." (art. 12(3))

| | "The Commission is empowered to adopt delegated acts in accordance with Article 72 to supplement this Regulation by establishing rules and procedures related to the life cycle management of unique identifiers and of data carriers. In particular, those delegated acts shall:
| | (a) establish rules for organisations wishing to become an issuing agency for unique identifiers and data carriers; and
| | (b) establish rules for economic operators wishing to create their own unique identifiers and data carriers without relying on an issuing agency for unique identifiers and data carriers." (art. 12(4))
| | "The delegated acts adopted pursuant to paragraph 4 shall set out: (a) the criteria to become an issuing agency for unique identifiers and data carriers; (b) the role of an issuing agency for unique identifiers and data carriers; (c) the rules to ensure that unique identifiers and data carriers are reliable, verifiable and unique globally; (d) the rules on creating, maintaining, updating, and withdrawing unique identifiers and data carriers; (e) the rules related to data management." (art. 12(5))
| | "When establishing the rules and procedures as referred to in paragraph 4, the Commission shall: (a) seek to ensure interoperability between different approaches; (b) take into account relevant existing technical solutions and standards; (c) ensure that the rules and procedures established remain, to the largest extent possible, technologically neutral." (art. 12(6))
| **Data carriers and links between physical product and digital (2)** | "the data carrier and the unique identifiers shall comply with one or more of the standards referred to in point (l) in Annex III or equivalent international or European standards until reference harmonised standards are listed in the OJEU" (art. 10)
| | Further specified by Annex III:
| | "The data carrier, the unique product identifier referred to in point (b), the unique operator identifiers referred to in points (g), (h) and (k), and the unique facility identifiers referred to in point (i) shall, where relevant for the products concerned, comply with standards ISO/IEC 15459-1:2014, ISO/IEC 15459-2:2015, ISO/IEC 15459-3:2014, ISO/IEC 15459-4:2014, ISO/IEC 15459-5:2014 and ISO/IEC 15459-6:2014"
| | "it shall be connected through a data carrier to a persistent unique product identifier" (art.10)
| | "the data carrier shall be physically present on the product, its packaging or on documentation accompanying the product, as specified in the applicable delegated act adopted pursuant to Article 4" (art. 10)
| | "The economic operator placing the product on the market shall: (a) provide dealers and providers of online marketplaces with a digital copy of the data carrier or the unique product identifier, as relevant, to allow them to make the data carrier or the unique product identifier accessible to potential customers

	where they cannot physically access the product; (b) provide the digital copy referred to in point (a) or a webpage link free of charge promptly and in any event within five working days of receiving a request to do so." (art. 10)
Representation access rights management, information system security, and business confidentiality (3)	"the access to data included in the digital product passport shall be regulated in accordance with the essential requirements set out in this Article and Article 11 and with the specific access rights at product group level as specified in the applicable delegated act adopted pursuant to Article 4." (art. 10) "customers, manufacturers, importers and distributors, dealers, professional repairers, independent operators, refurbishes, remanufacturers, recyclers market surveillance authorities and customs authorities, civil society organizations, trade unions and other relevant actors shall have free of charge and easy access to the product passport based on their respective access rights set out in the applicable delegated act adopted pursuant to Article 4;" (art. 11) "the rights to access and to introduce, modify or update information in the product passport shall be restricted based on the access rights specified in delegated acts adopted pursuant to Article 4;" (art. 11) "product passports shall be designed and operated so that a high level of security and privacy is ensured and fraud is avoided." (art. 11) "The Commission may adopt implementing acts setting out procedures to issue and verify the digital credentials of economic operators and other relevant actors that shall have access rights to information included in the product passport. Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 73(3)" (art. 11))
Interoperability (technical, semantic, organisation) (4)	"The power to adopt acts in accordance with Article 290 TFEU should be delegated to the Commission to amend this Regulation by replacing or adding standards in accordance with which the **data carrier**, the unique **operator** identifier and the unique **facility** identifier can be issued, in light of technical or scientific progress. This should ensure that the data contained in the digital product passport can be recorded and transmitted by all the economic operators, as well as guarantee the compatibility of unique identifiers with external components such as scanning devices." (Considerando 36) "product passports shall be fully interoperable with other product passports required by delegated acts adopted pursuant to Article 4 in relation to the technical, semantic and organisational aspects of end-to-end communication and data transfer" (art. 11) "all data[6] included in the digital product passport shall be based on open standards, developed with an interoperable format,

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[6] Note that the word « data » is used in the final version in replacement of the word « information ».

and shall be, as appropriate, machine-readable, structured, searchable, and transferable through an open interoperable data exchange network without vender lock-in, in accordance with the essential requirements set out in this Article and Article 11" (art. 10)

"product passports shall be fully interoperable with other product passports required by delegated acts adopted pursuant to Article 4 in relation to the technical, semantic and organisational aspects of end-to-end communication and data transfer;" (art. 11)

Data processing, data exchange protocols and data formats (5)	"all data included in the digital product passport shall be based on open standards, developed with an interoperable format, and shall be, as appropriate, machine-readable, structured, searchable, and transferable through an open interoperable data exchange network without vender lock-in, in accordance with the essential requirements set out in this Article and Article 11" (art. 10)
Data storage, archiving, and data persistence (6)	"To ensure access to the digital product passport for the period specified in delegated acts, including after an insolvency, a liquidation or a cessation of activity in the Union, the economic operator placing the product on the market should make available a back-up copy of the digital product passport through a digital product passport service provider that is an independent third party." (Considerando 38)
	"the digital product passport shall be stored by the economic operator responsible for its creation or by digital product passport service providers;"[7] (art. 11)
	"If the digital product passport is stored pursuant to point (c) of the first subparagraph or otherwise processed by digital product passport service providers, those digital product passport service providers shall not sell, reuse or process such data, in whole or in part, beyond what is necessary for the provision of the relevant storing or processing services, unless specifically agreed with the economic operator placing the product on the market or putting it into service." (art. 11)
	"personal data related to the customer of the product shall not be stored in the product passport without the explicit consent of the end-user in compliance with article 6 of Regulation (EU) 2016/679" (art. 10)
	"the digital product passport shall remain available for the period specified in delegated acts adopted pursuant to Article 4, including after an insolvency, a liquidation or a cessation of activity in the Union of the economic operator responsible for the creation of the digital product passport;" (art. 11)

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[7] Note that the phrase « digital product passport service providers » is used in the final version in replacement of the phrase « certified independent third-party product passport service providers authorized to act on their behalf».

	"The economic operator, when placing the product on the market, shall make available a back-up copy of the digital product passport through a digital product passport service provider" (art. 10)
Data authentication, reliability, integrity (7)	"data authentication, reliability and integrity shall be ensured;" (art. 11) "product passports shall be designed and operated so that a high level of security and privacy is ensured and fraud is avoided." (art. 11)
APIs for the DPP lifecycle management and searchability (8)	"Moreover, the data should be transferable through an open interoperable data exchange network without vendor lock-in." (Considerando 36) "The economic operator, when placing the product on the market, shall make available a back-up copy of the digital product passport through a digital product passport service provider. " (art. 10) "the digital product passport shall remain available for the period specified in delegated acts adopted pursuant to Article 4, including after an insolvency, a liquidation or a cessation of activity in the Union of the economic operator responsible for the creation of the digital product passport;" (art. 11) "where a new digital product passport is created for a product that already has a digital product passport, the new digital product passport shall be linked to the original digital product passport or passports;" (art. 11)

The most challenging requirement is described by Article 11 a.: "Product passports shall be **_fully interoperable_** with other product passports in relation to the _technical, semantic and organizational_ aspects of end-to-end communication and data transfer." In addition, the ESPR also requires **_persistency_** of data as per Article 11 e.: "the digital product passport shall remain available for the period specified in delegated acts adopted pursuant to Article 4, including after an insolvency, a liquidation or a cessation of activity in the Union of the economic operator responsible for the creation of the digital product passport;" and Article 10(4) "The economic operator, when placing the product on the market, shall make available a back-up copy of the digital product passport through a digital product passport service provider."

3.2 Requirements from the Standardisation request – Digital Product Passport

Parallel to the work of the proposed ESPR and the StandICT initiative, the draft of the Standardisation Request for the Digital Product Passport (SR-DPP) was produced in June 2023 and revised over the fall of 2023. This chapter describes the technical requirements derived from the SR for the DPP.

The SR is issued to European Standardisation Organisations which are requested to draft eight European and harmonized standards in support of relevant Articles of the ESPR as well as Article 78 of EU Battery Regulation 2023/1542. The SR is not a standard, but rather provides recommendations

on areas of standardization that would need standards and which standards would need to be harmonized, based on the essential requirements from a regulation (e.g. ESPR). It may also occur that the need for additional requirements is identified. The SR proposes a list of technical standards which should be duly considered when drafting the new harmonised standards for the DPP-System. The harmonised standards should enable the DPP to be as interoperable as possible.

The SR-DPP shall support the legal requirements from the ESPR and the EU Battery Regulation. Additionally, the SR also advises that "Standards shall follow the principles laid down in the Union legal framework in the area of cybersecurity or processing of personal data or protection of privacy or networks".

The SR-DPP also states: "To reduce dependencies between elements in the eight standardisation areas (hereafter indicated as 'modules') included in this request, the standardisation work should be organised in a modular way to ensure interoperability, reduce lock-in effects, and enable parallel standardisation work. The standards shall be written as formalised avoiding different interpretations."

The SR requests that the interfaces between the eight modules shall be presented in a meta-structure, to ensure that different standards fulfilling the same function can be used and that a change to a standard within one module does not lead to the requirement of changes in other modules.

An important stated requirement is that the implementation of the DPP-System should be 'state of the art' and technology agnostic.

An excerpt of the technical and essential requirements and the area of standardization addressing them, are listed and detailed in the table below.

Table 5: Excerpt of the requirements where the areas of harmonized standards would be needed according to the Standardisation Request DPP.

Area of Standardisation	Requirement(s)
(1) Unique identifiers	The standard(s) shall define requirements related to the following areas: (a) Uniqueness of each identifier; (b) Syntax-related requirements; (c) Semantic-related requirements.
(2) Data carriers	Common rules on how to construct the Automatic Identification and Data Capture (AIDC) media used as data carrier linked to the product passport. The requirement should concern (if applicable): (a) Symbology characteristics; (b) Data character encoding method (c) Symbol formats; (d) Dimensional characteristics; (e) Error correction rules; (f) Reference decoding algorithm; (g) Printing quality requirements; (h) Production quality requirements; (i) User-selectable application parameters (if relevant); (j) Durability requirements. The data carrier should also include control data elements. These elements should enable the verification of:

	(a) the authenticity of the data carrier; (b) the product itself. The data carrier may also include cross-sectoral basic data elements, i.e. data that can be consulted offline: • the subject reading the data carrier is offline; • a link present in the data carrier is broken; • a link does not lead to a valid page on a website; • the server hosting the DPP is down for maintenance or is overloaded. The cross-sectoral basic data elements may include the following six information elements: (1) DPP owner (the economic operator who created the DPP); (2) Unique operator identifier (the main manufacturer, if different from the DPP owner); (3) The facility identifier (the location where the main manufacturing stage took place); (4) The unique product identifier (identifier of the product registered in the DPP registry); (5) An additional product identifier (additional identifier associated to the product; optional); (6) The product typology (information about the type of product)In case of visual data carriers, the possibility of setting a DPP visual identity should be duly considered. The link to the product passport should include the link to the public data as well as to restricted data. The link in the data carrier should lead to the public data as well as to restricted data. The control data elements could be a link to identify counterfeiting and a hash of the DPP registered in the DPP registry. Specify how the link between data carrier and DPP shall be established. Rules and requirements related to persistent web links (URL/URI) and universal resolvers should be considered.
(3) access rights management, information system security, and business confidentiality	Rules and requirements related to access control measures to regulate the access to restricted product passport information. Consideration of: (a) Access rights management shall be attribute-based; (b) It will be the economic operators placing the products on the EU market who will be responsible for managing the corresponding DPP access rights (or a service provider contracted by the economic operator); (c) The access rights for each piece of information included in the DPP will be product group specific. They will be included in the delegated acts adopted by the Commission pursuant to Article 4 of COM(2022).

	(d) The public data included in the DPP will not require any access right management.
	(e) The access rights should include any mandatory and necessary licensing rules governing items related to data models, data exchange protocols, data processing, and interoperability.
	The standard(s) shall also identify rules to guarantee IT-security, cybersecurity, and data protection. Transfer responsibilities, access-rights, and data from one economic operator to another,
(4) Interoperability (technical, semantic, organisation), including data	The standard(s) shall define, inter alia, rules related to:
	(a) semantic description of a product, including but not limited to unambiguous meaning and consistent naming and, where relevant, a value list, a specific format and defined units of measure for all quantitative values;
	(b) a common information model allowing for the implementation of dictionary systems;
	(c) metadata models and formats to be used in exchange and representation. The standard(s) shall include rules on how to systematically use such metadata models when developing product group specific data models.
(5) Data exchange protocols and formats and processing	(a) Data exchange protocols, including rules to exchange data between two or more Parties;
	(b) Processes to introduce, modify, and update information in the passport.
(6) Data storage, archiving and data persistence	Define rules for decentralised data storage, archiving and data persistence.
	Persistence is required to make sure that data included in the product passports would remain available even when the economic operator creating the passport is no longer active
(7) Data authentication, reliability, integrity	Open and interoperable method, between automated identification services and data carriers, to read data, verify data originality and data integrity in offline and online use cases.
	It/they shall establish a framework for ensuring trust, interoperability and interoperation via secure and reliable electronically signed encoded data set (ESEDS) schemes for multi-actor applications in multi-sector environment.
	The following issues should be addressed (non-exhaustive list):
	(a) Management and verification of identifiers;
	(b) Relationship between the unique identifiers and possible authentication elements related to them;
	(c) Questions that deal with the identification of the verifier and any authorised access to privileged product related information;

	(d) Verifier access history (logs);
	(e) Authentication solutions;
	(f) Artefact metrics, where relevant;
	(g) Information processing and communication that protects integrity along the supply chain of physical and related electronic documents, products, software and services life cycle to mitigate product fraud and counterfeit goods, by using object identification techniques;
	(h) Verifiable credentials
(8) Standards on APIs for the DPP lifecycle management and searchability	The standard(s) aim at harmonising the APIs Aspects that should be adequately specified: 1. Syntax and semantics of the API interfaces; 2. Security and access control to the APIs; 3. Performance and response time; 4. Considerations on versioning and backward compatibility of API interfaces; 5. Message exchange patterns, e.g. synchronous, asynchronous, request-response, fire-and-forget, publish and subscribe; 6. Availability and scalability; 7. Mechanisms to ensure the authenticity, integrity and reliability of the data.

3.3 DPP-System Requirements Gaps

The definition of requirements for the DPP-System is a difficult task which reflects the dynamicity required to create a complex system such as the DPP. The ESPR and the DPP standardization request have defined essential requirements, though their granularity varies. These requirements lack the requisite specificity to serve as direct inputs for the implementation of a DPP-System. This will require a deeper dive into different topics such as the EU registry, backup mechanisms, and application programming interfaces (APIs), all of which are subject to ongoing work.

Moreover, some topics must be clarified. DPP deactivation, authentication mechanisms, and transfer of responsibility highlights the need for precise political requirements that will pave the way for the implementation work. Bridging the gap between regulatory requirements and a technical implementation requires a comprehensive understanding of all the DPP concepts and their translation into usable technical requirements. Furthermore, the integration of digital credentials to manage access to restricted DPP information presents governance challenges: who generates the credentials, how are they attributed to economic actors, when are they revoked.

 In response to these gaps, existing requirements must be clarified and refined to be then used to implement the DPP-System. This exercise should be carried on by the EC, technical experts and industry representatives.

Requirement gap concerning the EU resolver:

Depending on the ID-Scheme used, additional requirements might be required. In case the unique product identifier (UID) stored in the data carrier is not a dereferenceable URI, a UID-to-URI transformation from that non-URI Product UID to a URI must be done in some way for the DPP-System to function properly. It can be assumed that a normative interpretation will make clear that the URI stored in the data carrier and UID are linked via a standardised and well-formed procedure. If only the UID is stored in the EU-Registry, the UID to URI transformation must be known to the EU-Registry. It is therefore recommended that the EU-Registry rather stores the full URI. This can be done at registration time by submitting a URI or within the EU-Registry by applying the known transformation to the number submitted. A special attention should be given to current works on ISO/IEC JTC1 [DIS 18975].

Because many product identification schemes are not in the form of an URI, work has already begun on a new ISO/IEC DIS 18975 (draft international) "Encoding and resolving identifiers over HTTP" standard which will define an approach for using HTTP URIs as identifiers in AIDC (Automatic Identification and Data Capture) systems to consolidate and to provide an overview of the accepted ID-schemes on which the UID can be built upon. This does not define a new identifier system or a new URI scheme. Three areas will be covered[8]:

1. One or more methods to structure AIDC data in an HTTP URI. Methods are described in ISO/IEC 15418 and 15459 standards, IEC 61406, and the concepts of Linked Data.

2. Different methods to ensure that the identifiers are (globally) unique

3. A mechanism to access specific types of information about identified items. Details of how related digital information is managed and any access control that may apply, are out of scope.[9]

4 Identification of gaps in the standards landscape based on the CIRPASS proposal of the DPP-system architecture

This chapter provides an analysis of the standards landscape with regards to the availability of standards for the component interfaces described in the CIRPASS proposal for the DPP system architecture. The analysis follows the methodology described in section 2.3.2. This has been conducted for the 2 methods describing the data flow to linking the product ID to the product data.

Global transport and logistics of physical goods has been highly standardized to ensure efficient movement of goods all over the planet. However, where different standardization systems exist, we still might run into a gap where systems come together. On the long trip from exporting country to target market for example, the transports need to stop at the border. All containers need to pass from one train to another due to the difference in the width of the train rails.

Like the exchange of goods, there were no major gaps identified in standard based architectures. All layers within an architecture are well covered enabling the implementation of coexisting DDP-system architectures. The major challenge is how interoperability will be ensured between existing standardization schemes and ensure compliance with art. 11(a) "product passports shall be fully interoperable with other product passports". Therefore, there is a need to update existing application standards. Through delegated acts the Commission will define more into detail how semantical,

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[8] https://www.iso.org/standard/85540.html

technical, and organizational interoperability will work between different approaches, on the one hand unique identifiers governed by issuing agencies, and on the other end unique identifiers issued by economic operators themselves.

4.1 DPP-System components and interfaces

As described in chapter 2.3.2 Table 6 links the required component interfaces from Figure 7 to the areas of standardization of the proposed system architecture. It lists down which components are connected to each other for the purpose of a data flow, which area of standardization may include the requirements to the interface, and the potential gaps in the areas of standardization. The data flow is based on HTTP system to link the Product to the product data.

Table 6: HTTP System components and their relation, and potential gap in the areas of standardization

Component/Function Structure of the DPP-System	Interface to the following components needed	Category of Standards relevant to the interface components	Remark on the requirements
Product UID Economic Operators ID (e.g. REO) Facility ID	• EU-Registry • (Data Carrier)	Identifiers Links between the physical product and the digital representation	The interoperability between ID schemes would require further clarification, for REO and facility IDs. D3.3. proposes a concept for interoperability for Product IDs, which require more investigation for the need of standards The requirements to the Economic Operators ID (e.g. REO) and Facility ID may need further specification Registry requirements and interfaces and the registry as a whole need to be defined. API is undefined and requires further clarification of its requirements, e.g. with regards of its operation in a decentralized and federated DPP-System Since the data traffic is associated with cost, the REO (e.g. the manufacturer) that holds the DPP would need to know the allocated cost he is responsible for. In order or the REO to calculate the cost, the requirements to a decentralized data traffic for resolving unique product IDs to DPP endpoints needs to be specified with regards to, e.g. data confidentiality, load balancing. Limiting factors to a UID should be avoided:
EU-Resolver, (e.g. for resolving, Encoding and resolving identifiers over HTTP)	• REO Resolver • EU-Registry • DPP Backup • Internet connected device		

			• Fixed length • Only numerical • Fixed structure • Limited options at ID creation, e.g. when only a few positions are under control of the REO For every type of identifier standards need to be selected or to be defined for the data flow from product UID to DDR-repository.
Scanning Device (& Data carrier)	• Camera App • Internet connected device • Data Carrier	Data Carriers & Links between physical and digital	Transfer of responsibility requires further clarification Technical Specification of Resolver need to be specified Depending on the ID-Scheme used, Standards from UID to URI Transformation are needed to enable a predictable transformation from number to a resolvable URI. An example can be found in digital link 1.4.1 (Jul 2023). Draft ISO/IEC DIS 18975 standard "automatic identification and data capture techniques"
UID to URL Transformation Optional depending on the ID Scheme being used Camera App, Digital Link, Other	• EU-Registry • DPP App • Digital Link		
Web link & ID-link			
EU Resolver, (for resolving, Encoding and resolving identifiers over HTTP)	• REO Resolver • EU-Registry • DPP Backup • Internet connected device		
Validation and Engine Control SHACL Control Engine (Integrity)	• EU-Registry	Data authentication, reliability, and integrity	Integrity validation requirements would require further clarification. The usage of commonly used browser infrastructures for digital signatures and encryptions are insufficient for the DPP Long term capability and scalability unclear Trustworthiness and trust level
The Policy Decision Point	NA	Data processing, data exchange protocols and data formats	DPP-System ontology which might contain the minimum necessary vocabularies and semantics and information models
SHACL Control Engine	EU-Registry		
Decentralized DPP Data Repositories	• Policy Decision Point (PDP) • DPP Backup • REO		
DPP Data- User: • Consumer • Circular Economy Operator • Public authorities • Regulators	• Internet connected device	Access rights management	DPP authentication mechanisms need further clarification. The usage of commonly used browser infrastructures for digital signatures

			and encryptions are insufficient for the DPP.
			Interface to the security infrastructure provided by the EC needs to be defined.
The Policy Decision Point	NA		Security architecture: Threat and risk analysis (TRA) and specification of security requirement
			How to address threats and risks
Verifiable Credentials (VCs)	NA		DPP authentication mechanisms need further clarification.
DPP Apps	NA		The usage of commonly used browser infrastructures for digital signatures and encryptions are insufficient for the DPP.
			Interface to the security infrastructure provided by the EC needs to be defined.
			Security architecture: Threat and risk analysis (TRA) and specification of security requirement
			How to address threats and risks
Decentralized DPP Data Repositories • An interoperability layer built using linked data • Knowledge Graphs – A very short introduction	• PDP • DPP Backup • REO	Interoperability	DPP-System ontology which might contain the minimum necessary vocabularies and semantics, and information models Upper ontologies (System), describing the data structure and information models, may need to be harmonized
The Need for Archives Archiving and Backup Long term archives Remark: there is no distinction on warm/cold archives	• DPP Backup	Data storage, archiving, and data persistence	The requirements the needed backup mechanisms require further clarification. Interfaces between different repositories Minimum data types. SHACL (new approach, co-regulation)
DPP Apps	NA	API	The requirements to the EU registry and the web portal require clarification.
EU-Registry	• IDs • the UID to URI Transformation • EU Resolver • REO		
Internet Connected Device	• DPP-Data User • EU-Resolver • REO Resolver	Internet standards	Type links are standardized.

	• the UID to URI Transformation • Scanning device		But their use in the DPP-Architecture is not defined and not standardized.

Similarly, Table 7 links the required component and their interfaces from Figure 8 this time using the DID method to link the product to the product data.

Table 7: DID System components and their relation, and potential gap in the areas of standardization

Component/Function Structure of the DPP-System	Interface to the following components needed	Category of Standards relevant to the interface components	Remark on the requirements
Decentralized IDs Actor DID Product DID	EU Registry	Identifiers	The interoperability between ID schemes require further clarification. Registry requirements and interfaces and the registry as a whole need to be defined. API is undefined. Limiting factors to a UID that should be avoided: • Fixed length • Only numerical • Fixed structure Limited options at ID creation, e.g. when only a few positions are under control of the REO For every type of identifier standards need to be selected or to be defined for the data flow from product UID to DDR-repository.
DID Document	Actor DID Product DID Web DPP Backup Data Repository		
DID App, DID & VC Issuer/Wallet	Data Users REO EU-Registry Scanning device Product DID		
DID Document (Links between physical and digital)	Actor DID Product DID Web DPP Backup Data Repository	Data Carriers & Links between physical and digital	transfer of responsibility requires further clarification Technical Specification of Resolver need to be specified
Verifiable Credentials (VCs)	PDP DPP App, DID & VC Issuer/Wallet Actor DID	Data authentication, reliability, and integrity	DPP authentication mechanisms need further clarification The usage of commonly used browser infrastructures for digital signatures and encryptions are insufficient for the DPP.
DID App, DID & VC Issuer/Wallet	REO EU-Registry Scanning device Product DID		

	Data Users		
DID App, DID & VC Issuer/Wallet	EU-Registry Scanning device Product DID Data Users REO	Access rights management	The usage of commonly used browser infrastructures for digital signatures and encryptions are insufficient for the DPP. Standards on policy decision point (management of role, private vs public) the use or type of PUID will determine the data flow from product to the data repository. This is necessary which data is accessible. How to organize identity management and access control (eIDAS). DPP authentication mechanisms need further clarification. The usage of commonly used browser infrastructures for digital signatures and encryptions are insufficient for the DPP. Interface to the security infrastructure provided by the EC needs to be defined. Security architecture: Threat and risk analysis (TRA) and specification of security requirement How to address threats and risks
DPP Apps	EU-Registry Scanning device Product DID Data Users REO	API	The requirements to the EU registry and the web portal require clarification e.g. the (technical) requirements needed which allow for the search and comparison of data, or who controls the product data, on the requirements to the API accessing a decentralized, federated DPP system. Registry requirements need to be defined. API requirements need to be defined. Standard for API to the EU-Resolver and EU-Registry: This may include, for example, the definition of specific link types and their corresponding registration. Specific link types may be useful for the extraction of stakeholder-specific information. API between several repositories need to be standards, currently specifications can be found in SIMPL, which need to be further developed,
EU-Registry	Market Authority Shacl Control Engine DID's DPP App, DID & VC Issuer/Wallet		

			AAS for interoperability between data formats.
Decentralized DPP Data Repositories • An interoperability layer built using linked data • Knowledge Graphs – A very short introduction	• PDP • DID Document • DPP Backup service providers	Interoperability	DPP-System ontology which might contain the minimum necessary vocabularies and semantics, and information models upper ontologies (System)
VDR	DID-Document	Data storage, archiving, and data persistence	The requirements the needed backup mechanisms require further clarification. Interfaces between different repositories Minimum data types. SHACL (new approach, co-regulation)

Based on the defined user stories, 2 product centric methods using one system to access DPP data are proposed by CIRPASS. The utilization of standards allows for the coexistence of the 2 methods. The challenge is, that the requirements to the component interfaces require further specification, since the requirements to the system have not been fully defined. This means that the Interoperability between systems in general will depend on the following aspects:

- Usage and harmonization of standards on formats (data formats, data protocols etc.)
- Semantic interoperability (including syntactical interoperability) to ensure that the meaning of the information in the DPP can be recorded and transmitted efficiently between economic operators.

While the CIRPASS system architecture outlines a general technical proposal, many details of the requirements for the components and their interfaces are still unspecified. The standards listed in the corresponding areas of standardization would need to be assessed with regards to the future functional requirements for certain components of the architecture, such as:

- Requirements to the EU registry, including the API
- EU-Web portal
- DPP-Apps
- Backup mechanisms
- DPP authentication mechanisms
- Access rights management, Including IT-security
- DPP transfer of responsibility, and the "linking of DPPs", etc.
- The use of digital credentials for economic operators and other relevant actors that shall have access rights to information included in the product passport must also be elucidated with regards to their use in the architecture.
- A key component of the DPP-System that is currently underspecified is the DPP-System ontology which might contain the minimum necessary vocabularies and semantics applicable across sectors.

As of now the list of standards offers an extensive selection to choose from to look into the requirements for the component interfaces. Potential gaps in the standards and standardization landscape will be identified when the requirements to the interfaces can be further specified. One of the main component which needs further specification is the EU-Registry. As seen in Figure 7 and Figure 8, the EU – Registry does not only need an interface to the various IDs , but also to the Market authorities, the DPP app and the internet connected devices.

This means, the requirements to the interfaces may be found in several areas of standardization (Interoperability, Data authentication, reliability, and integrity, Identifier and data carriers, and access rights management, API).

A major gap that has been identified in the architecture is related to the decentralized data repositories. Requirements for the DPP-System ontology which might contain the necessary vocabularies and semantics as well as the information models applicable across sectors are currently underspecified.

4.2 DPP-System and regulatory ontologies

The results of the prototype described in D3.2 point to an additional gap in the standards landscape in DPP-System with regards the vocabularies, in particular the information models where data models have been put into consideration. To facilitate certain operations and support functionalities for the DPP-System, the standardisation of specific elements of vocabularies may be useful. This may include, for example, the definition of "mandatory" data property or class to indicate that a specific data point of a DPP is required by legislation. For further future proofing, the need to identify the corresponding legislation should be ensured. The structure of the data model is applicable to all sectors.

We list below potential elements of an upper-level ontology for the DPP based on ESPR. Unlike the upper-level ontology, the lower-level, i.e. regulatory, ontologies will differ between sectors. However, like the upper-level, they will all relate-back to the ESPR. That document points to the following areas where data shall be collected and used to grade products on the European market:

- Declaration of economic operators
- Means of identifying product
- Quantities of supplied products
- Reusability, upgradability, possibility of remanufacturing and recycling
- Recycled content
- Possibility of recovery of materials
- Presence of substances of concern
- Energy use or energy efficiency
- Environmental impacts, including carbon and environmental footprint
- Durability, reliability
- Reparability, possibility of maintenance and refurbishment
- Resource use or resource efficiency
- Expected generation of waste materials

Within each sector, the coverage of standards for the above topics varies in both maturity and granularity. Therefore, it will fall to the Delegated Acts to synthesize the standards by sector, and mandate which data points should be required. Similarly, based on the standards, the data formats for those data points must be set in the Delegated Acts.

If we take as an example the European Product Registry for Energy Labelling, we can see how the regulatory ontologies, data point and formats might be applied to ESPR. An example of an upper-level data model from the EPREL database (https://eprel.ec.europa.eu/), which applies to all products regulated under the Energy Labelling Regulation includes the following 4 mandatory types of information:

- General information
- Product information sheet
- Product availability
- Supplier contact

Within each of those for upper-level categories, the data points differ widely between products. However, the data points and formats are the same within each product type. For example, the data required for Tyres differs from the data required for Ovens. However, all Tyres must contain the same data points and formats, as seen in the images below.

Whatever regulatory ontologies emerge in the Delegated Acts, like EPREL, the DPP will have a consistent and simple way to describe, compare and combine the metrics for driving circularity as outlined in the ESPR.

Essential to the successful implementation is a means for semantically aligning the vocabularies used within each of the target industries, Textiles, Electronics and Batteries. While many terms and definitions are well-defined, widely accepted and used, others, especially those dealing with circularity or novel raw materials and processes lack harmonization and are inconsistently applied. There are numerous multi-stakeholder initiatives that could be leveraged to align on standards and definitions. This is further discussed in the following section.

4.3 Gaps in the data model: Insights from the Textile Sector

Information requirements were analysed from CIRPASS report D2.1 "*Mapping of legal and voluntary requirements and screening of emerging DPP-related pilots".* Based on D2.1, information are categorized as follows (cf. *Table 3 DPP information categories):*

Table 8: Categorization of information types identified by D2.1.

Information category	Examples on data from D2.1
Identification	• Material and composition information • Product design and service-related information • Product identification, company identification • Functional and technical specifications
History	• End-of-Life (EoL) history • Product usage history • Product repair history
Compliance and circularity information	• Mandatory compliance (certification norms), pictograms and markings • Non-mandatory compliance (standards) & associated labels • Indicators (e.g. circularity indicator, environmental impact)

Although the focus of this report is on the system architecture, the topic of DPP-data models must be addressed in the context of interoperability. To date, the most comprehensive overview of data standards and classifications used within the textile industry is the Reference Guide on Code Lists and Identifiers in the Textile and Leather Value Chains published by UNECE in October 2022. Its purpose "is to identify and describe code lists and identification schemes supporting the business processes and transactions for traceability and transparency in the textile and leather value chains." While various textile data standards exist or are in development, **lack of interoperability is a major issue** resulting in inconsistent terminology and categorizations making data exchange challenging.

Across the industry there are classifications and standards to describe products, materials and processes. Many of those are sector-specific and we noticed a proliferation in textiles. There are also non-sector-specific vocabularies, such as ones for sustainability, circularity, safety, facility, location, party, logistics/warehousing, and traceability, that are also used. The UNECE Reference Guide shows that there is considerable coverage and overlap, but, given the publication date and the speed of change in the industry, standards focusing on circularity (e.g., driven by solution providers like EON and Circular Fashion, but also driven by Governmental initiatives like Luxemburg's Product Circularity Data Sheet) and other recently popularized subjects are missing. Furthermore, several sustainability-focused standard and certification systems which have means of identifying and storing data of certified products, facilities or processes, are not publicly available and are therefore not included.

In general, data standards for dynamic areas such as sustainability, products, processes, and materials, are especially not well classified and it is often not clear how best classify them (closest replacement, process to create, etc.). For these, transparent, user-friendly, frequent, and aligned updates are required to avoid the use of inconsistent approaches as interim solutions.

Most of the standards that are publicly available have either machine-readable code list (short code with term) or are organized in formal data structures (e.g., XML, HTML, spreadsheet). Many have both.

ESPR Terminology	D2.1 Terminology
Good Coverage • Declaration of economic operators • Means of identifying product • Quantities of supplied products Some Coverage	Product and location master data • Product identification, company identification – good coverage • Functional and technical specifications – good coverage

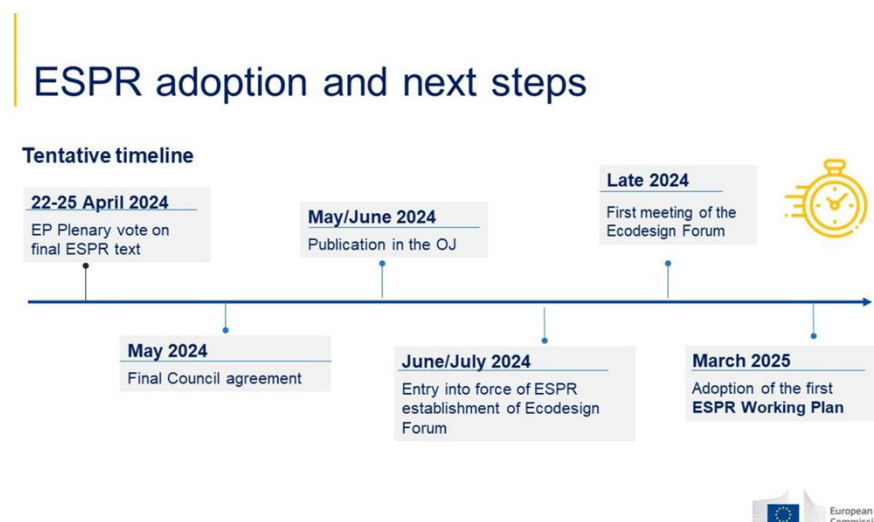|	
• Reusability, upgradability, possibility of remanufacturing and recycling • Recycled content • Possibility of recovery of materials • Presence of substances of concern Gap • Durability, reliability • Reparability, possibility of maintenance and refurbishment • Energy use or energy efficiency • Resource use or resource efficiency • Environmental impacts, including carbon and environmental footprint • Expected generation of waste materials	• Material and composition information – good coverage • Product design and service-related information – GAP Dynamic data • Product usage history – GAP • Product repair history – GAP • End-of-Life (EoL) history – GAP Methods related to sustainability/circularity • Mandatory compliance (certification norms), pictograms and markings – some coverage • Non-mandatory compliance (standards) & associated labels – some coverage • Indicators (e.g. circularity indicator, environmental impact) – some coverage

Important to note is that the information requirements for the battery passport are defined by the Battery Regulation (see annex XIII). And it is the work of the Joint Research Committee to define the information requirements for the DPP for textiles and electronics.

5   Standardization Roadmap

The following chapter describes the standardization roadmap for the DPP-System. It highlights the Status quo and potential developments and recommended actions with regards to the development of the standards.

5.1   Where are we today?

For the DPP to work as requested by the EC, a number of areas for standardization have to be considered. The CIRPASS standardization roadmap is oriented on the implementation timeline of the ESPR shown in Figure 10. The timeline shows the final vote on the current ESPR in March 2024, with the adoption of ESPR in June 2024.

ESPR adoption and next steps

Tentative timeline

22-25 April 2024 — EP Plenary vote on final ESPR text

May 2024 — Final Council agreement

May/June 2024 — Publication in the OJ

June/July 2024 — Entry into force of ESPR establishment of Ecodesign Forum

Late 2024 — First meeting of the Ecodesign Forum

March 2025 — Adoption of the first **ESPR Working Plan**

European Commission

Figure 10: Timeline for the implementation of the DPP

For the EU-DPP to comply to Europeans technical standards, the CEN/CENELEC joint technical committee 24 (JTC24) has been formed. Preceding the JTC24, the SReq-DPP AdHoc group proposed and formulated in the standardization request (version 2, 2023-10-4) to the ESOs, the following 8 areas of standardization.

For each of these areas, there already exist a number of standards from official recognized international and national standardization organizations (IEC/ISO, CEN/CENELEC, DIN/DKE etc.) as well as standards from Fora and Consortia as well as from industry and service providers. The full list of standards in provided in Annex. Workshops and discussions with internal and external experts lead to the conclusion, that based on these standards DPPs can be set up/ implemented. What is missing is a large-scale field test, implementing the DPP, to identify gaps in the standardization landscape, when different IT-Architecture need to exchange data.

Concerning the achievability of interoperability with regards to the data models on the example of textiles, there are still many open questions: Do the information standards used in the textile industry cover the items required by the upcoming ESPR delegated act for textiles?

The results of the analysis presented in section 4.3 show that, the availability of in-use standards for each of the eight categories is plenty. There is no gap identified at category level, rather the need for further specification of the requirements. With this respect, ESPR Article 8: Content of the Delegated Acts states:

"The delegated acts adopted pursuant to Article 4 shall specify at least the following elements:

(a) the definition of the product group or groups covered, including the list of commodity codes as set out in Annex I to Council Regulation (EEC) No 2658/8759 and product descriptions;

(b) the ecodesign requirements for the product groups covered;

(c) where relevant, the product parameters referred to in Annex I for which the Commission states that no ecodesign requirements are necessary, pursuant to Article 4;

(d) the test, measurement or calculation standards or methods to be used pursuant to Article 39(1);

(e) where relevant, requirements for the use of digital tools pursuant to Article 39(2);

(f) where relevant, the transitional methods, the harmonised standards or parts thereof the references of which have been published in the Official Journal of the European Union, or the common specifications to be used;

(g) the format, manner and order in which the information necessary for the verification of compliance is to be made available;

(h) the conformity assessment module to be used pursuant to Article 4(5); where the module to be applied is different from the module set out in Annex IV, the factors leading to the choice of that module;

(i) the requirements concerning information to be provided by manufacturers, including on the elements of the technical documentation that are necessary to enable the verification of compliance of the product with the ecodesign requirements;

(j) where relevant, any additional information requirements under Articles 36 and 37;

(k) the duration of the transitional period during which Member States are to permit the placing on the market or putting into service of products which comply with the national measures in force in their territory on the date of entry into force of the delegated act adopted pursuant to Article 4;

(I) the date for the review of the delegated act adopted pursuant to Article 4, taking into consideration, among other aspects: (i) the characteristics of the product group and its market; (ii) the need to adapt the requirements to make products more sustainable; (iii) Union policy objectives; (iv) technical progress; and (v) availability of methods."

CIRPASS, D3.2 proposes a DPP-System architecture which is based on the defined user stories. As of the time of writing an assessment has been conducted on the availability of standards that would support the implementation of such an architecture. The validity and feasibility of the standards I order to build the proposed system architecture was not part of this present work.

The following chapters summarize the status of the standardization landscape. It also provided an assessment where the standardization works could go and a proposal where it should go. It serves as a suggestion for relevant stakeholders involved in in the development and participation in standardization work.

5.2 Where we are going!

As of time of writing CEN/CLC started the development of the DPP standard in the Joined Technical Committee 24 (JTC24). The work on product and sector specific acts will come and independent of the finalization of a European Standards for the DPP architecture will be requirements of the ESPR will be implemented. As of now CEN/CLC is has formed a JTC to develop standards for a DPP-System. At the same time the formally recognized national and international standardization organizations, and various consortia and associations are also working on standards with relevance to the DPP, which are close to release. Examples from the technical committee on industrial-process measurement, the IEC TC65 and its subcommittees, covers a wide range of aspects relevant for systems and elements used process measurement, control and automation, for the industry. The principles work on can be utilized on for a DPP such as but not restricted to the requirements of the component interfaces such as data formats, interfaces and Interoperability (worked on in IEC/TC 65 WG24 - IEC 63278-X Asset administration shell), standardization of life cycle events and ID Links (worked on in IEC SC65E devices and integration in enterprise systems), and digital nameplates (worked on in IEC SC65E WG2). Additionally, to the continued works of officially recognized Standardization organizations, there are the works of ECLASS, working among others on interoperability of data, the IDTA, working on the asset administration shell and W3C working on internet standards such as decentralized identifiers.

5.3 Where could we go?

According to the EU the implementation of DPP for the adoption of the ESPR will not be delayed. This means, a DPP-System will be implemented, even in absence of a harmonized EU-Standard. Since the CEN/CENELEC JTC24 has less than 2 years to develop these standards, there are a few scenarios that may lead to different possible directions. Here is a non-exhaustive list of scenarios and the consequence of each one:

Plan: CEN/CENELEC JTC24 can finish the development on time

CEN/CENELEC JTC24 delivers a standard on time. In this case adopters of the DPP will have sufficient time for an implementation and the basis for the delegated acts is given. This scenario will be the basis for a new digital ecosystem enabling a seeming data exchange based on open standards and technology neutral systems and components. This will also reduce the risk of the implementation of different system architectures that are unable to exchange data.

Risk management: CEN/CENELEC JTC24 cannot finish the development on time or the standard is rejected

If the work of JTC24 cannot be completed on time or the proposal is rejected by the EC, thus no harmonized DPP system standards are available before January 2026, the commission will have to rely on existing standards, standards in development or common specifications on which a DPP-System can be developed. In this case there may be unclarities whether these specifications will be replaced by CEN/CENELEC outputs later.

The plan and risk management consider the existence of already available systems or systems in development that can already been used to creating a DPP, which may not in line with the principles established by CIRPASS. This may lead to the evolution of a digital ecosystem of several infrastructures, based on different standards that my coexist but not be interoperable with each other.

This uncertainty is further enhanced since certain aspects of a DPP architecture require further specification by the EC. This uncertainty might delay the willingness for REOs (Responsible Economic Operators) and potential providers of DPP services to invest in the infrastructure needed to roll out DPP. The parallel development and setup of DPP-Systems, at one point will require standards describing the requirements to the component interfaces, to enable a data exchange between these systems, after the official rollout of the EU-DPP.

The various official standardization organizations, fora and consortia, should take this risk into consideration. The detailed technical specifications for the implementation of the DPP-System, the standardisation work, will ensure a greater chance for interoperability of currently co-existing systems.

5.4 Where should we go?

Standardization is all about consensus among all affected stakeholders. DPP architecture should not be dominantly defined by the solution providers, but should include a broad spectrum of affected stakeholders. In particular, the REOs (e.g. the manufacturer, Certifiers, etc.) needs to be included in the discussion, as they will be responsible to fulfil the regulatory requirements. As it has been stated, the currently available technologies and standards allow for several methods to link a product to the product data with new scalable concepts close to release, but at this point there is no guarantee that the reliance on existing standards will ensure interoperability between systems.

Independent of the current status of the work of CEN/CENELEC, the affected stakeholders should follow the practical approach to start implementing the DPP with the technologies they already have while leaving room for newer concepts. It is most imperative that the interoperability between systems should be kept in mind when setting up new system or upgrading legacy systems to enable the data flow between the components of different systems, for existing and future architectures. This means that the principles and requirements of the ESPR as a base line with coexistence of standards and interoperability should be kept in mind. Keeping in mind that with existing technologies and standards the implementation of a DPP is already possible, the principle of coexistence systems should then be compared and assessed with regards to their performance. As a reference CIRPASS identified the following principles:

1. The essential requirements, from the ESPR can then be formulated into technical requirements of sufficient detail to match standards, when available. Based on the component interfaces, the compatibility of standards must be assessed due to the likelihood

of partial overlaps or technical incompatibilities with regards to the requirements for the interfaces

2. Avoid single technology and service provided dependencies, and any development that would lead to duplication and parallel incompatible ecosystems and infrastructures.

3. When setting up the DPP, backwards/reverse compatibility or non-disruption, build upon existing systems. This can be used to identify the requirements for interoperability.

4. DPP-Systems should be set up with technologies and standards, which can also be at least be from consortia, which are widely supported. This will allow for legacy systems to adapt without mandating specific solutions and technologies allowing for a smoother integration into the DPP-ecosystem.

The proposed CIRPASS architecture recommendations rely on widely used and/or modern technologies and consortia standards. Some technologies are described in established consortia standards and these consortia standards are currently transferred into standards at formally recognised standardisation bodies. If common specifications are required, they should build upon on these established technologies. Here a dialogue with recently established CEN/CLC JTC 24 DPP is essential. Therefore, it is recommended to identify the requirements to the key component interfaces to smooth the transition and implementation of the various DPPs into a system of open and interoperable federated DPP ecosystems. One such technology, among others, enabling such an open ecosystem without vendor lock-in is described in the IEC 63278-series for Asset Administration Shell. The Asset Administration Shell structure described in IEC 63278-1 (published in 2023), defines an information model and link mechanisms to access standardized machine-readable information about an asset via a unique identifier.

6   References

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1   ANNEX: List of standards with relevance to a DPP IT framework

This list is available for download at: https://cirpassproject.eu/dpp-related-standards-dataset/