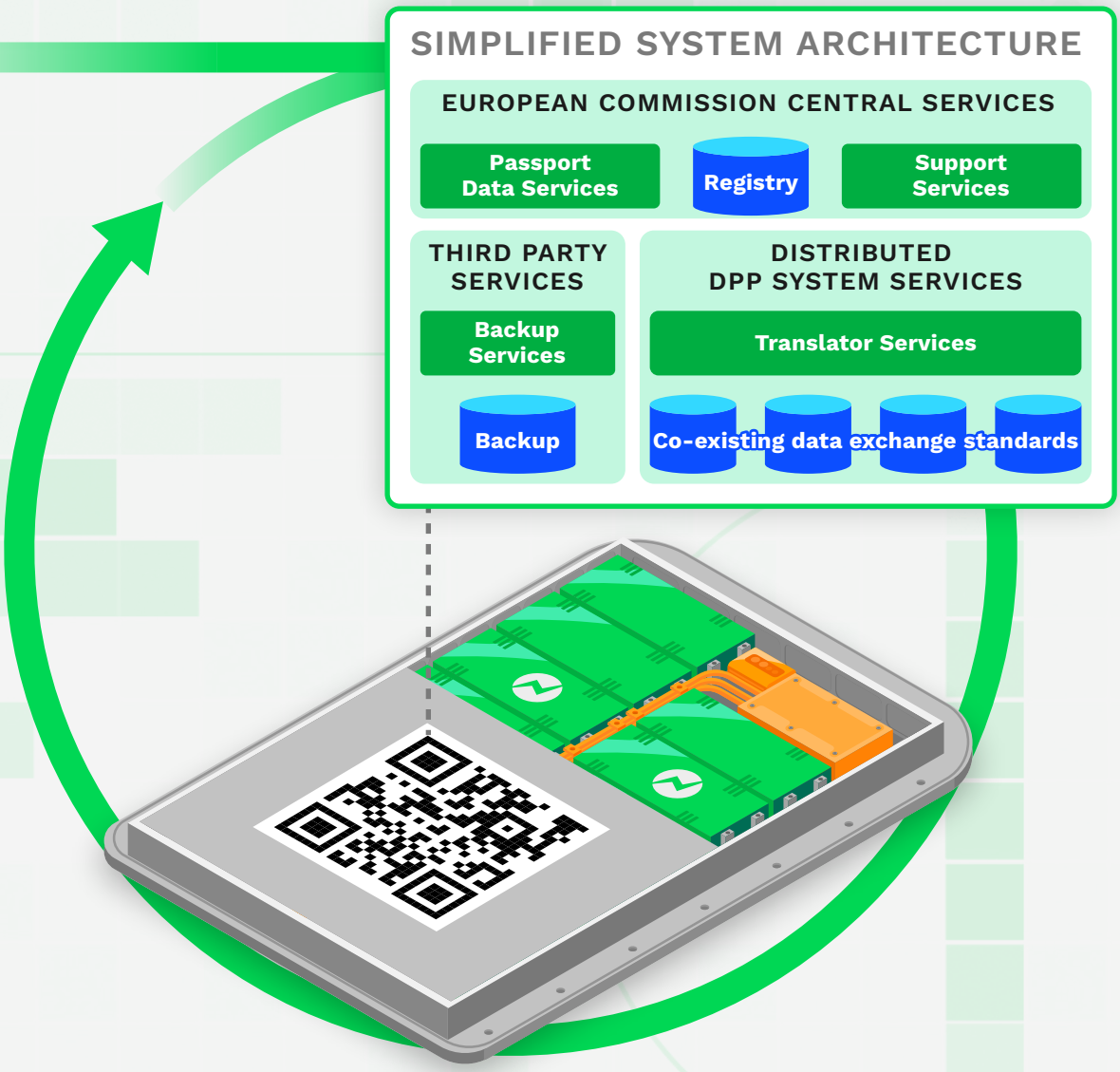
Battery Pass



Battery Passport Technical Guidance

Executive summary
of the main document

Version 1.0 / March 2024

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

The Battery Pass consortium

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Co-funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK), the Battery Pass consortium project aims to advance the implementation of the battery passport based on requirements of the EU Battery Regulation and beyond. Led by system change company Systemiq GmbH, the consortium comprises eleven partners and a broad network of associated and supporting organisations to draft content and technical standards for a digital battery passport, demonstrate them in a pilot application and assess its potential value.

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1 Introduction

The Technical Guidance, prepared by the Battery Pass consortium, presents a comprehensive technical overview intended for the development of a digital battery passport system. This initiative is in response to the European Green Deal, aiming to facilitate sustainable and circular management of batteries across their value chains, emphasizing transparency and data exchange through digital infrastructure. The document is structured into major sections including an introduction, technical challenges, system architecture, key challenges, and recommendations for a digital battery passport system. It details the collaboration, supported by the German Federal Ministry for Economic Affairs and Climate Action, and encompasses contributions from eleven partners.

The guidance aligns with the EU Battery Regulation as well as the Ecodesign for Sustainable Products Regulation requirements, proposing a framework that covers the entire battery life cycle, including production, use, and recycling phases. The technical guidance focuses on establishing interoperable, secure, and efficient data management practices to support the digital battery passport system. It outlines major technical components, interoperability frameworks, and a methodology for the proposed digital passport system, ensuring it supports sustainability goals while being adaptable across sectors.

A significant part of the guidance is the identification of technical challenges and the establishment of a Technical Standard Stack that encompasses data services, processes, system architecture, and interoperability among various stakeholders. Recommendations address the integration of data carriers, unique identifiers, secure data exchange, and the importance of cross-domain interoperability to facilitate seamless and secure access to battery data across the EU and potentially globally.

The document emphasizes the necessity for a collaborative approach in developing standards and frameworks that support the digitalization and sustainability objectives of the battery industry, underpinning the EU's ambition for a greener, more digital future. It lays down a foundation for the further development and implementation of the digital battery passport system, offering guidance for stakeholders across the value chain to prepare for the upcoming regulatory and operational changes.

1.1 Context – European regulations implementing the Green Deal

The European Green Deal, initiated in 2019, is a response to the well-known climate and environmental challenges. It outlines a new growth strategy that aims to transform the EU into a fair and prosperous society, characterised by a modern, resource-efficient, and competitive economy. The goal is to achieve net-zero emissions of greenhouse gases by 2050 and decouple economic growth from resource consumption[1].

In March 2022, the EU launched the Sustainable Products Initiative (SPI), which included the Proposal for the Ecodesign for Sustainable Products Regulation (ESPR). This regulation provides a comprehensive policy framework for the widespread introduction of digital product passports across various product categories as facilitators for the transition to a circular economy (CE). Additional regulations exist, which encompass elements of traceability, chain of custody, and

[1] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

data sharing requirements. These regulations are all part of the European Union's Digital Transition and Data Spaces plans, designed to harmonise and standardise access to data.

In addition to other sector-specific regulatory activities (e.g. the Construction Products Regulation), the new EU Battery Regulation 2023/1542 is ground-breaking as it is the first product legislation that covers the entire product life cycle. Its comprehensive requirements include transparency on carbon footprint, including performance classes and maximum threshold values, metal-specific recycling rates, recycled content quotas, corporate supply chain due diligence obligations, minimum requirements for durability and performance, as well as the introduction of a digital battery passport – the first digital product passport (DPP) at the European level.

With the introduction of a digital battery passport, the European Commission aims to support the sustainable and circular management of batteries by requesting comprehensive data along the entire battery value chain to be documented and exchanged through a digital infrastructure. As the first in a series of sector-specific DPPs due to be introduced in the coming years, the battery passport can be seen as the pilot implementation of the entire technical DPP system. Therefore, the implementation must consider the technological applicability for the whole DPP ecosystem, including areas such as construction, textiles, and furniture, in addition to batteries.

The digital battery passport is detailed in *Chapter IX* of the EU Battery Regulation and will be mandatory for batteries in light means of transport (LMT), industrial batteries with a capacity above 2 kWh, and electric vehicle batteries placed or put into service on the EU market. It will be required from 18 February 2027 onwards, which is 42 months after the regulation entered into force on 17 August 2023[2].

In parallel to the negotiation of the ESPR and Battery Regulation, the European Commission initiated the process to establish harmonised standards required for setting up, operating and, maintaining the DPP system from a technical perspective. Therefore, in May 2023, the first draft of a Standardisation Request (SReq) for the DPP system was sent to the European Standardisation Organisations CEN, CENELEC and ETSI as a basis for consultation and feedback. The SReq aims to underpin the regulatory specifications of the ESPR and the Battery Regulation.

In December 2023, the CEN-CENELEC Joint Technical Committee JTC 24 was established to develop the standards as required by the draft SReq, even though the proposal of the ESPR as well as the SReq have not been finalised. This decision was made because the timing requirements set forth in the Battery Regulation demand the availability of an operational DPP system for batteries by 18 February 2027. As a result, there is a strict deadline for the availability of technical standards on DPP by 31 December 2025. This would provide stakeholders in the battery industry just under 14 months for the implementation, testing and launch of their DPP system.

Due to the circumstances outlined above, the context of the technical standards is derived from the three sources of European regulation: the ESPR, the Battery Regulation and the current draft of the SReq on the DPP system. Furthermore, the very tight time constraints necessitate careful consideration when commencing operations of the DPP system for batteries, potentially with limited capabilities to meet the legal requirements.

[2] https://en.acatech.de/publication/resource-efficient-battery-life-cycles/

1.2 Aim, scope and targeted audience of this document

Aim

The primary objective of this document is to offer *a comprehensive overview of the technical standards that* should *be implemented in order to* support the development of a reliable and seamlessly interoperable battery passport system. It aims to assist *the key stakeholders of the battery passport* system, including economic operators, data providers across the value chain, regulatory authorities (especially market surveillance and customs), government agencies (for assessing the impact of policy decisions) and, last but not least, data consumers (e.g. recycling companies). Furthermore, this document is intended to *be valuable for the standardisation processes* related to DPP, both as required by European Regulations and within the global context.

What can readers expect to gain from this document?

Comprehensive overview of technical standards: The document will provide an overview of the scope of the technical passport system, encompassing value chains, necessary technical specifications to enable interoperability, data flows, and responsibilities. This includes the interface between the passport data as defined in the Content Guidance and the technical passport system. Employing a comprehensive framework, it will offer a complete set of technical standard categories to facilitate the assignment of existing and forthcoming standards. In conjunction with external work on DPP, suitable technical standards will be identified and presented. By defining the correct scope, the framework for technical standards and the standards themselves, the document will contribute to clarifying the procedural and organisational complexity.

Support of the main stakeholders: The document will address the key technical elements required for the implementation and utilisation of the battery passport and its data. Depending on their roles, stakeholders will be able to identify the necessary business processes, technical responsibilities, technical standard categories as well as potential candidates for standards. These are essential for participation in the battery ecosystem. Furthermore, the technical requirements will serve as a validation foundation to plan the technical passport infrastructure, services and processes, tailored to individual stakeholder groups.

Support of standardisation process: Given the complex situation, this document will contribute to the upcoming standardisation efforts in developing harmonised European Norms (hEN) for the DPP system in the JTC24. This will be achieved by providing a guideline with principles and criteria to assist the standardisation process. The document will identify gaps, overlaps, assess the maturity and readiness of the existing standard landscape, and identify ready-to-use standards and major interoperability issues. Based on this analysis, it will offer an in-depth understanding of the most critical interoperability challenges and propose approaches to address these contingencies while adhering to the principles of creating open standards, as mentioned earlier.

Scope

In this document, we address an interoperable system architecture for the DPP system, necessary to support the user stories of the battery passport operation and to enable the required management procedures around operations. Furthermore, the major architectural elements and their functions for executing the user stories are specified. An analysis of existing standards, reflecting their capabilities for reliable and future-oriented fulfilment of functional

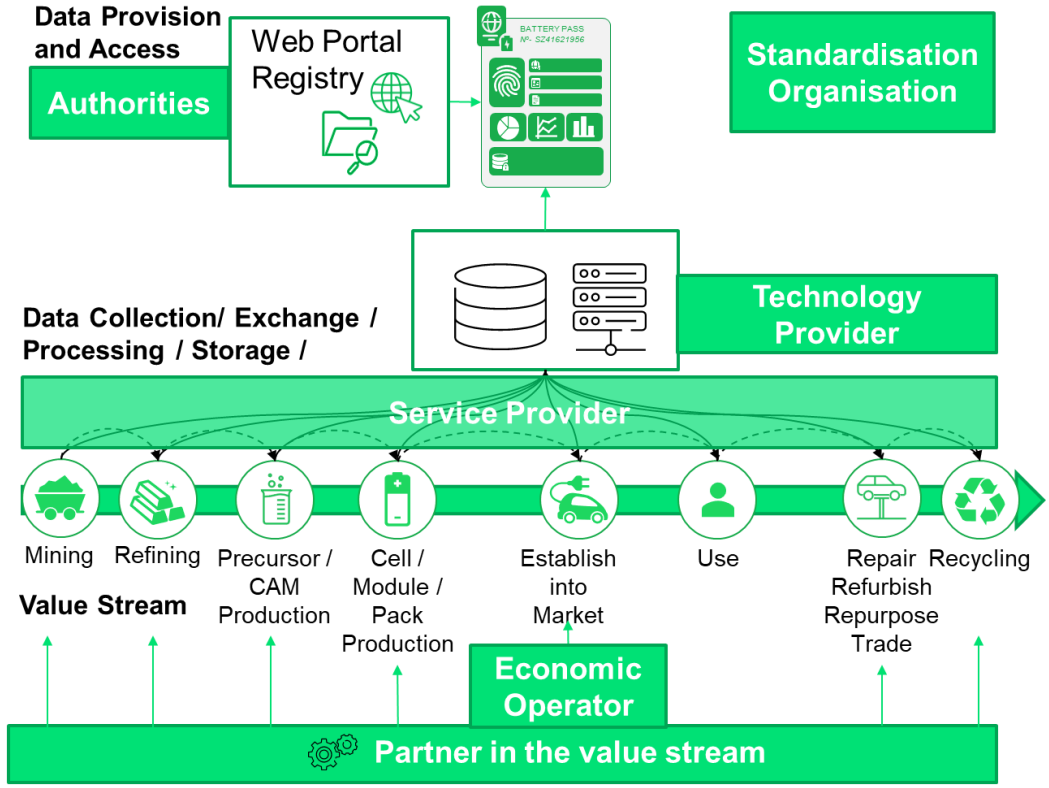
requirements will lead to a comprehensive map of existing and required technical standards for the entire DPP system. The basis for this reflection will be the actual SReq to elaborate harmonised European Norms (hEN) to specify the DPP system as demanded by the ESPR and the Battery Regulation.

Target audiences

The value chain of a battery defines the initial scope of the organisations affected by the battery passport (see Figure 1). Major upstream processes, such as mining and refining, as well as cell and module production, are carried out by dedicated supplier roles. Suppliers are required to provide data, such as greenhouse gas emissions of their parts and materials, or certificates. The economic operator placing a battery on the market is responsible for collecting and processing this battery passport information.

Other organisations are involved around the value stream. These include technology and service providers supporting the economic operator, as well as authorities that might need to use aggregated data, such as customs and market surveillance. Technology providers are responsible for reliable and functional technical components, such as data storage systems or application programming interfaces (APIs) for data exchange. DPP service providers are responsible for the operations of the DPP system, either overseeing an economic operator, setting up and maintaining the DPP system infrastructure, providing and updating DPP data and policies, or handling DPP system components that need to be managed by the European Commission, such as the web portal and the registry.

Figure 1: The EV battery value stream and the related targeted audience



Furthermore, *standardisation organisations and individuals* involved in standardisation activities are addressed by this document.

Table 1: Targeted audience

Targeted Audiences	What can be found in the document
Responsible Economic Operator (EO)	- User stories to be implemented - Specification of the DPP system architecture and its elements - Consideration of alternative technologies for implementation
Supplier and Partner in the value stream	- Interface specifications that may be useful for seamless interoperability
Technology Provider	- Same as economic operators - Interoperability challenges and specifications
Authorities	- User stories related to interactions with authorities to be implemented - Specification of the DPP system architecture and its elements, with a special focus on elements under the responsibility of authorities
Digital Product Passport Service Provider	- Same as economic operators - Interoperability challenges and specifications
Standardisation Organisation	- DPP system architecture - Interoperability challenges and recommendations

2 The technical battery passport system in a nutshell

The Digital Product Passport (DPP) will become a reality no later than February 18, 2027, when every new electric vehicle battery, light means of transport battery, and industrial battery above 2 kWh will require the operation of such a system. The digital battery passport will serve as a pilot for DPPs and will be relevant for most industrial sectors in the coming years. Unlike many other regulations, the technical infrastructure, procedures, and the business and economic environment must be established as prerequisites for the digital operation of DPPs.

2.1 Major business and technological challenges for the DPP system

Establishing standards is never easy, due to specific business interests, the need to consider and integrate existing applications, and anticipate future developments. In the case of DPP, the following major business and technological challenges make the development of standards for the setup of the DPP system an extraordinarily complex task.

- **Complete interoperability:** Various stakeholders, including consumers, business partners from different sectors and authorities must be able to access and maybe even exchange distributed and potentially highly sensitive data in a secure and reliable manner. This necessitates a full spectrum of interoperability aspects encompassing technical, organisational, and semantic interoperability, in compliance with various sector-specific regulations and conditions. Therefore, there is a need for a comprehensive and formal system specification for highly automated procedures, which should cover the necessary technical, organisational, and semantic elements. This specification should aim to be as

inclusive as possible, allowing for the integration of various existing technical systems to minimise changes and operational costs.

- **Complex legal and business environment:** From a legal perspective, fulfilling requirements stemming from various regulations across different sectors and legislative periods is a complex challenge. The battery passport system, in particular, is subject to compliance with two different regulations: the ESPR with its corresponding standardisation request for the DPP system, and the Battery Regulation, which share some conflicting requirements. Additionally, future regulations, such as the End-of-Life Vehicles (ELV) Regulation, and global regulations from regions like Asia and the US, may also impact the system design. Given the expected technological advancements in batteries, the emergence of new business models, and the significant market influence, the technical standards for the DPP system must be designed to accommodate future developments.
- **Tight timeline constraints for elaborating standards:** Harmonised European Norms (hEN) will be developed to fulfil the SRec, based on ESPR and the Battery Regulation. In the field of data access and exchange regarding products and organisations, there are numerous partially overlapping and even contradicting standards. However, some standards are still missing. The timeframe from the final standardisation request to the deadline of December 31, 2025, for providing the agreed-upon technical standards necessitates innovative approaches to the standardisation process. Additionally, the implementation of standards in government and industry also requires innovative approaches.

2.2 The fundamental parts of the technical guidance

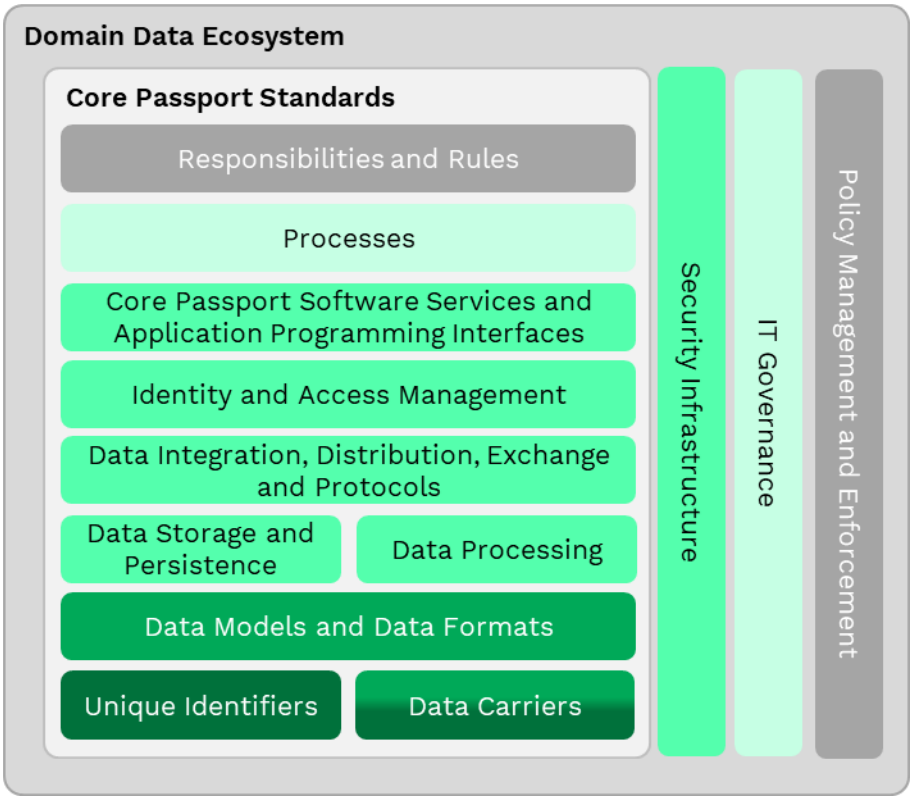
As background to the aforementioned challenges, the specification proposal for the technical standards of the DPP system comprises four fundamental parts:

1) The **Technical Standard Stack** for a comprehensive operational system based on existing frameworks to provide a complete and modular perspective on the standards that need to be established and harmonised.
2) **System architecture** with interconnected components fulfilling the standards derived from the Technical Standard Stack to enable automated data provisioning, exchange, and access processes.
3) **Interoperability challenge description** is a proposal aimed at facilitating the seamless integration of various technologies already in use in the market while ensuring that the DPP system remains as open as possible to accommodate global and future developments.
4) **Guideline to assist the industrial stakeholders** in preparing for their responsibilities within the specified time frame.

2.3 Introduction to the Technical Standard Stack

The Technical Standard Stack (see Figure 2) consists of essential technical standard building blocks that need to be integrated. These include IT infrastructure, (distributed) software functions, management systems, and governance systems. These components collectively lay the groundwork for achieving a range of critical objectives, with a primary focus on facilitating safe, secure, and cost-effective passport operations.

Figure 2: Technical Standard Stack

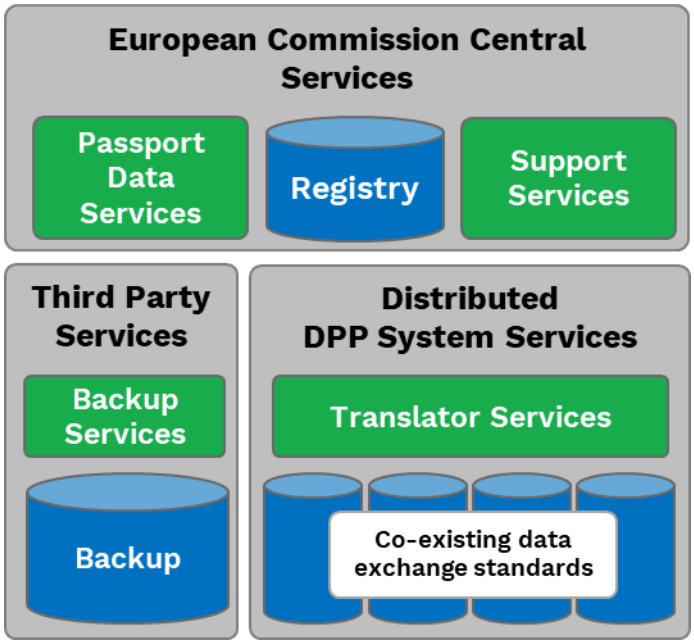


These technical components are divided into parts from the perspectives of data, services and processes as defined by the Enterprise Interoperability Framework in ISO 11354.

2.4 System Architecture

The recommended principal system architecture (Figure 2) is divided in the three major service-oriented components: the EC Central Services, the Distributed DPP System Services and the Third-Party Services. The EC Central Services are under the responsibility of the European Commission and the distributed DPP system services must be established and operated by the economic operator or by a service provider in charge. The Third-Party Services must be established, mandatorily by a certified independent third-party product passport service provider. This is a mandate according to the current ESPR Regulation, specifically for the data backup service. Additional Third-Party Services might be necessitated by other regulations. The distributed DPP system services require translator services providing functionalities that handle the conversion of data across various formats or standards in the distributed system ensuring the co-existence of different data exchange standards.

Figure 3 Principal System Architecture



2.5 Interoperability challenges

The following summarises the primary challenges in developing the Battery Passport System, emphasizing the need for attention and focus from all stakeholders. Key areas include:

1) **Application of different data carriers:** The choice between QR codes, as specified by the Battery Regulation, and alternative smart labels like RFID or NFC tags. The challenge lies in the QR code's static nature versus the evolving data of digital product passports. Solutions such as dynamic linking mechanisms need to be explored to ensure QR codes can direct users to up-to-date DPP information.
2) **Unique identifiers:** Establishing unique identifiers (UIDs) is essential for the battery ecosystem, requiring the accommodation of diverse identifiers used by economic operators. The goal is to avoid unnecessary duplication and potential ID collisions.
3) **Routing to different distributed DPP systems:** A flexible routing mechanism within a decentralized data system is crucial to ensure access to the correct and current Economic Operator data repository, especially when responsibilities shift or operators cease to exist.
4) **Application of different data management technologies:** Achieving full cross-sectoral interoperability poses a significant challenge. A federated approach to standardized data exchange is recommended, allowing for diversity in standards across different industries while maintaining interoperability.
5) **Secure and reliable supply chain data acquisition and exchange:** Supply chain transparency systems are vital for tracing the flow of products, materials, and information. Standardization in data, communication, and identifiers is necessary to integrate upstream value chain data with the battery passport effectively.
6) **Seamless and secure provision of access to different stakeholder groups with sector specific policies and rules:** Implementing secure and reliable access control mechanisms, integrated with sector-specific policies and rules, is imperative. This includes ensuring data protection and sovereignty to maintain trust in the decentralized data system.
7) **Cross-domain interoperability:** Interoperability across different data spaces requires harmonizing data formats, standards, and governance models. Collaboration among

stakeholders is essential to address the diverse challenges of data integration across domains.

8) **Connectivity for dynamic data acquisition:** Ensuring the battery passport's information remains accurate and up-to-date is challenging, especially with potential connectivity issues. Regulatory mandates for dynamic data provision need to be considered to mitigate risks associated with data gaps.
9) **Alignment global DPP initiatives:** The global importance of batteries necessitates common content and technical standards for DPPs. Initiating a joint work program under ISO Level for interoperability and collaborating with international standards institutions is suggested.

2.6 Guideline for supporting the industrial stakeholder

Below there are major guiding proposals provided for industrial companies affected by the DPP regulations and specifically by battery passport issues (this is not only related to economic operators but also to other companies involved in the physical and information value chain):

- **Decide on the business model and technical strategy for "make-or-buy".** A business and technical due diligence of existing data and infrastructure can serve as a solid foundation for this decision. The technical guidance can be used as a checklist for implementing technical specifications, requirements, and provides useful hints.
- **Decide whether to join or expand into one or more data spaces.** Data spaces enable efficient, secure, and standardised data sharing and transactions within an ecosystem by providing a technical infrastructure based on a governance framework. In the context of the digital product passport across different sectors, data sharing is one of the most crucial aspects. It impacts key business concerns such as your business models, protection of intellectual property, trade secrets, and even technical and business operational processes. Therefore, businesses must establish or maintain their business, organisational, and technological capabilities simultaneously.
- Even though the standardisation of technical aspects may take until the end of 2025, companies should **actively follow and contribute to the standardisation process**. This is especially important for economic operators since the adoption of already applied technologies and procedures should be implemented as simply and cost-effectively as possible.

In the full document, guidance is provided for organisations involved in standardisation, government entities, and IT service providers.

3 Outlook

The Technical Guidance Document for the Digital Product Passport (DPP) System is envisioned as a dynamic and evolving blueprint, designed to adapt to the changing landscape of digital product information management.

As indicated in the document, the design, development, and deployment of the entire DPP System must be conducted collaboratively by the responsible stakeholders: the European Commission, Economic Operators, and DPP System service providers. This necessitates coordination and the establishment of an organizational foundation. However, the formation of such an organization remains undecided. In this context, the document's update is also pending, underscoring the necessity for a dedicated entity or collaborative mechanism to maintain its relevance and effectiveness over time. This document aims to be a "living document" that undergoes regular updates and revisions, recognizing the importance of

staying current with technological advancements and regulatory changes. An opportunity for synchronization of efforts could be organized in conjunction with the creation of the JTC 24 under CEN CENELEC.

Critical to the document's utility is the need for its content to be rigorously challenged, validated and fed back into the standardization and regulatory working groups. This process is essential for ensuring that the guidance provided remains accurate, practical, and reflective of the latest industry standards and legislative requirements. To support this objective, the document calls for the development of methodologies and tools specifically designed to assess the implementation of the DPP system. These tools, whose specific identities are not yet known, will help identify gaps, challenges, and opportunities for enhancement. This will ensure that the system evolves effectively to meet the needs of all stakeholders.

As a technical specification blueprint, the document outlines the foundational requirements and standards for the DPP system, serving as a comprehensive guide for its development and implementation.

To ensure the DPP system's relevance and effectiveness across the entire value chain, the working group that created the Technical Guidance document advocates for extending its scope to more comprehensively cover both upstream and downstream activities. This holistic approach is crucial for capturing the full lifecycle of products and enhancing transparency and sustainability practices across industries.

Furthermore, the document highlights the importance of inclusive innovation, recommending the implementation of lighthouse demonstrations and testbeds that go beyond focusing on large companies. It stresses the need to involve small and medium-sized enterprises (SMEs) and to tailor the system also to their specific requirements, ensuring that the benefits of the DPP system are accessible to businesses of all sizes.

Finally, the document calls for the development of detailed roadmaps to guide the phased implementation of the DPP system. These roadmaps will provide clear milestones and objectives, facilitating coordinated efforts among stakeholders and ensuring that the system's rollout is both strategic and effective.

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