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**Group REPORT**

PDL INTER-LEDGER INTEROPERABILITY

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Reference

PDL-006 INTER-LEDGER INTEROPERABILITY

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# Foreword

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# Modal verbs terminology

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# Executive summary

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# Introduction

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Enabling communication between different DLT is a challenge that can be resolved in favour of scalability if interoperability is implemented with security, however the architecture, taxonomy and ontology of the DLT landscape is certainly very diverse and with a variety of technical issues and challenges that a lot of time and efforts are being invested in deploying approaches and solutions. This is in favour of the ecosystem as a whole. Priorities for multi-stakeholders are based on interoperability and cross-chain solutions for connecting the new era of internet.

The baseline for this document is aligned with the definition of ISO/IEC 17788:2014 “information Technology -Cloud Computing-Overview and vocabulary” whereby Interoperability is “the ability of two or more systems or applications to exchange information and to mutually use the information that has been exchanged.

The European Interoperability Framework (EIF) from the European Commission (EC) had first version adopted in 2010 between the new EU policies in the field of information technology with strong focus on openness and information management, data portability, interoperability governance, and integrated service delivery. Furthermore, NIFO (National Interoperability Framework Observatory) produce a variety of documents with recommendations for policy makers, researchers, and business stakeholders with the latest developments on digital government and interoperability across Europe. On the other hand, the European Blockchain Services Infrastructure (EBSI) is officially established with which inter-ledger interoperability will be a key ingredient for scalable business and connecting networks for cross-border communications. Actually, four use cases are applying on the top of EBSI and one of them is related to trusted data sharing which is a value for considering interoperability as a priority within the deployment of the European Digital Single Market.

# 1 Scope

This document will describe the key elements of interoperability to exchange information between different ledgers and to mutually use the information that has been exchanged.

# 2 References

## 2.1 Normative references

Normative references are not applicable in the present document.

## 2.2 Informative references

European Blockchain Services Infrastructure (EBSI)

<https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/EBSI>

European Interoperability Framework (EIF)

“Full Text: <https://ec.europa.eu/isa2/sites/isa/files/eif_brochure_final.pdf>

# 3 Definition of terms, symbols and abbreviations

## 3.1 Terms

## 3.2 Symbols

## 3.3 Abbreviations

API: Application Programming Interface

DLT. Distributed Ledger Technology

EBSI: European Blockchain Service Infrastructure

EIF: European Interoperability Framework

EC: European Commission

NIFO: National Interoperability Framework Observatory

PDL: Permissioned Distributed Ledger

# 4 Using multiple ledgers simultaneously

## 4.1. Brief review--DLT types and properties

* permissionless vs. permissioned, public vs. private and variations (open read, but permissioned write)
* support for scripts, smart contracts, or general computation
	+ availability, power and easy of programming languages and tools
* transaction costs (monetary)
* levels of trust, security, privacy (large-scale proof-of-work => more security)
* performance limits and trade-offs (transaction latency, throughput), scalability

## 4.2 Why interledger

* exploit different properties of each ledger, lowering cost and latency, better security and privacy (due to GDPR we can not store personal data in public ledgers), etc.
* Transferring and/or trading (or exchanging) value between chains
* Transferring information or generic messages between chains
* Allowing different tradeoffs between trust and cost
* Different levels of privacy
* Increasing the overall scalability and functionality

# 5 Introduction to inter-ledger scenarios:

This document will envision the scenarios for multiple ledgers and distinguishing from this document considerations intra-chain or inside the same PDL which allows interoperability between applications but do not communicate with other PDL. Although it is a very important dimension of the interoperability which is part of the intrinsic mechanism of the PDL, in this section it is an introduction for a cross-chain or inter-ledger interoperability scenario.

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Figure 1 EXAMPLE OF NON INTER-LEDGER INTEROPERABILITY

As per the Figure 1, there is just one ledger, in this scenario it is a type of interoperability out of the scope of this document. Serve as illustrative, that functional components, sometimes security functional components others minimal functional components or simply optional functional components, are able to provide intra-chain interoperability, inside the PDL for a completeness of the DLT.

#

Figure 2 EXAMPLE ONE OF INER-LEDGER INTEROPERABILITY

In this basic scenario there are two ledgers whereby interoperate between them, one PDL is exchanging information with other PDL to mutually use such information in a perfected interest. As per the figure 2, the two ledgers represent two different DLT which make via API an interoperability approach, but there are a variety of approaches as it is described in section 8 of this document.



Figure 3 EXAMPLE TWO OF INTER-LEDGER INTEROPERABILITY

In this scenario there are three ledgers that consolidate a common ledger as part of one PDL

Hence inter-ledger interoperability can occur between ledgers within a same DLT or between various DLT

# 6. Facets of Interoperability

# 7. Trust-Anchoring:

# 8.Security considerations and incident management responsiveness.

# 9. Interoperability Approaches

## 9.1 Overview

- “interledger” denotes a number of different approaches that attempt to establish interoperability among different distributed ledgers or blockchains

- interledger approaches vary widely in their purpose and structure:

- Atomic cross-chain transactions (or atomic swaps)

- Sidechains

- Bridging approaches

- Ledger-of-ledgers approaches (Polkadot, Cosmos)

- Transactions across a network: Lightning and Raiden

- Layered value transfer protocols (W3C ILP)

references to

- “Interledger Approaches,” IEEE Access, 2019

- other publications, research and practice

## 9.2 Examples of interledger

* SOFIE Interledger use cases
	+ food-supply-chain:
		- storing hashes of transactions (of a private ledger, even db) to a public DL
		- hierarchical DLT solutions
	+ context aware mobile gaming ecosystem
* SOFIE Interledger component implementation

# 10. Other issues

* the role of DIDs and VCs in interoperability
* requirement/enabler: semantic representation
* reliability, robustness, decentralized interledger mechanisms
* scalability

etc.