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Permissioned Distributed Ledger (PDL); Digital Autonomous Organization (DAO)

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Foreword

This Group Report (GR) has been produced by ETSI Industry Specification Group (ISG) Permissioned Distributed Ledger (PDL).

Modal verbs terminology

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Executive summary

The present document provides a comprehensive exploration of Digital Autonomous Organizations (DAOs) in the context of Permissioned Distributed Ledger (PDL) systems. It addresses the definition, implementation, and governance of DAOs, with a particular focus on the challenges and solutions in both single-ledger and hybrid multi-ledger environments.

The present document aims to provide a thorough understanding of DAO implementation and governance, offering insights and potential solutions to the unique challenges posed by decentralized autonomous systems, especially in complex multi-ledger environments. It serves as a guide for developers, policymakers, and organizations interested in implementing or participating in DAOs within PDL systems.

By addressing both the technical and governance aspects of DAOs, the present document provides a holistic view of their potential to revolutionize organizational structures in the digital age, particularly in the context of the telecommunications and ICT industries.

Introduction

Blockchain technology has introduced a new era of decentralized systems, with Digital Autonomous Organizations (DAOs) emerging as a revolutionary concept in organizational structure and governance. The present document explores the intricate world of DAOs within the context of Permissioned Distributed Ledger (PDL) systems, providing a comprehensive analysis of their definition, implementation, and governance.

DAOs represent a paradigm shift from traditional centralized organizations, offering a model where decision-making and management are distributed among participants. By leveraging smart contracts and distributed ledger technology, DAOs aim to create transparent, efficient, and autonomous systems that can operate with minimal human intervention.

The implementation of DAOs, particularly in complex environments involving multiple ledgers and codebases, presents unique challenges. The present document aims to address these challenges, offering insights and potential solutions for both single-ledger and hybrid multi-ledger DAO environments.

The present document seeks to provide a comprehensive resource for developers, policymakers, and organizations looking to understand, implement, or participate in DAOs within PDL systems. It aims to bridge the gap between theoretical concepts and practical implementation, offering a roadmap for navigating the complex landscape of decentralized autonomous organizations.

The present document pays particular attention to the challenges and opportunities presented by hybrid environments, where multiple ledgers, codebases, or governance models coexist. It provides insights into how DAOs can leverage these complex structures to create more robust, flexible, and inclusive governance systems.

Furthermore, the present document explores how DAOs can adapt to the specific needs of the telecommunications and ICT industries, potentially revolutionizing how partners in these spaces collaborate, innovate and deliver services globally.

As the field of distributed ledger technology continues to evolve, the insights provided in the present document will serve as a foundation for future developments in DAO implementation and governance. It paves the way for more efficient, transparent, and decentralized organizational structures that can adapt to the rapidly changing technological landscape while maintaining the principles of collective ownership and decision-making that are at the core of the DAO concept.

1 Scope

1.1 In Scope

The present document defines and specifies the implementation and governance of Digital Autonomous Organizations (DAOs) within Permissioned Distributed Ledger (PDL) systems. It encompasses:

1) A comprehensive definition of DAOs, including their key characteristics and differentiating factors from traditional organizations.

2) Detailed specifications of the recommendations to operate a DAO, covering implementation agreements, governing entities, smart contracts, data models, processes, ledgers, and codebases.

3) In-depth analysis of DAO operations in both single-ledger and hybrid multi-ledger environments, addressing the complexities and challenges unique to each scenario.

4) Extensive examination of governance structures and mechanisms in DAOs, including:

    a) Managerial and operational governance.

    b) Consensus-based governance models.

    c) Delegated and automated governance approaches.

    d) Hybrid governance structures.

5) Strategies and methodologies for achieving interoperability in multi-ledger DAO environments, specifically:

    a) Data alignment across different ledgers.

    b) Harmonisation of consensus protocols.

    c) Abstraction and alignment of smart contracts.

6) Comprehensive analysis of token economics in hybrid DAO environments, including:

    a) Multi-token ecosystems and their roles.

    b) Cross-ledger token compatibility and transfer mechanisms.

    c) Innovative voting mechanisms, including weighted and reputation-based voting.

    d) Tokenized reputation systems and their impact on governance.

7) Detailed exploration of automated governance, including:

    a) Recommendations for effective implementation.

    b) Strategies for codebase alignment in multi-vendor environments.

    c) Algorithmic governance mechanisms.

8) Guidelines for the evolution of DAO governance, from initiation to self-sustained operation, with a focus on adaptability and scalability.

9) Consideration of the specific applications and implications of DAOs in the telecommunications and ICT industries.

The present document is intended for use by developers, system architects, policymakers, and organizations involved in the design, implementation, or participation in DAOs within PDL systems. It aims to provide a standardized framework for understanding and implementing DAOs, with a particular focus on addressing the challenges posed by complex, multi-ledger environments and the unique needs of the telecommunications sector.

1.2 Out of Scope

The scope of the present document does not extend to:

1) Specific implementation details of underlying Blockchain or distributed ledger technologies.

2) Legal and regulatory considerations for DAO operations in different jurisdictions, although general compliance challenges are discussed.

3) Detailed economic models and tokenomics beyond their direct application to governance mechanisms.

4) Comprehensive security protocols for DAO operations, although security considerations are mentioned where relevant to governance and implementation.

5) Specific programming languages or development frameworks for implementing DAOs, focusing instead on abstract principles and requirements.

6) Detailed technical specifications for cross-ledger interoperability solutions, though the present document discusses the need for and challenges of such solutions.

While these aspects are crucial for the overall functioning of DAOs, they are beyond the scope of the present document and may be addressed in separate, specialized publications.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Bitcoin whitepaper: "Bitcoin: A Peer-to-Peer Electronic Cash System", Nakamoto, S., 2008.

[i.2] ETSI GR PDL 004 (V1.1.1) (2021-02): "Permissioned Distributed Ledgers (PDL); Smart Contracts; System Architecture and Functional Specification".

[i.3] DNB Working Paper 718: "Governance in systems based on distributed ledger technology (DLT): a comparative study", Ellen Naudts (DNB), Timothy Aerts (DNB), Leonard Franken (AFM), Aimo Pieterse (AFM), AFM -- Publiek, June 28, 2021.

[i.4] ETSI GS PDL 012 (V1.2.1) (2023-06): "Permissioned Distributed Ledger (PDL); Reference Architecture".

[i.5] ETSI GS PDL 015 (V1.1.1) (2023-01): "Permissioned Distributed Ledger (PDL); Reputation Management".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

algorithmic governance: governance approach that uses predefined rules and algorithms to automate decision-making processes within a DAO

automated governance: government approach that leverages technology to streamline decision-making processes, reduce human intervention, and increase efficiency within the DAO

autonomous: system/platform that operates independently of involvement from external entities or powers, while still potentially requiring certain external resources

codebase: code used to develop smart contracts, applications, user interfaces and machine interfaces in a DAO

cross-ledger compatibility: ability of tokens, smart contracts, or other Blockchain elements to function across different Blockchain networks

data models: models that organize elements of data and standardize how they relate to one another and to properties of real-world objects

decentralized: managed through decentralized governance using tools that allow it to function without a centralized authority

Decentralized Autonomous Organization (DAO): system that enables distributed decision making, management and ownership of assets, typically operated on a Blockchain or distributed ledger technology

delegated governance: governance model where token holders can delegate their voting power to trusted representatives

expert-driven governance: governance approach that relies on subject matter experts for decision-making in specialized areas

Governance Tokens (GTs): tokens used for voting on DAO proposals and decisions

governing entity: entity performing governance tasks by defining rules and Implementation Agreements, as well as ensuring compliance and resolving conflicts

hybrid DAO: DAO that uses more than one ledger type, codebase, data model or process

hybrid governance: governance approach that combines different governance models to create a flexible, robust and adaptable system

implementation agreements: collections of rules and agreements that define how the DAO is implemented

ledgers: blocks of data cryptographically linked to each other, forming the basis of Blockchain technology

liquidity pool: smart contract-based mechanism that holds reserves of two or more tokens, allowing for trading directly against these reserves

Membership Tokens (MTs): tokens used to grant access to DAO resources and services

multi-ledger consensus: process of achieving agreement across multiple PDLs within a DAO

non-validating nodes: nodes that do not participate in validation or consensus management but are required for proper Blockchain operation, such as aligning data across multiple ledgers

off-ledger consensus: decision-making processes that occur outside of the DAO ledgers but are still part of the DAO's governance structure

on-ledger consensus: process of reaching agreement through mechanisms implemented directly on the DAO ledgers

reputation-based voting: voting mechanism where a participant's voting power is influenced by their reputation score, which is based on their contributions and behaviour within the DAO

Reward Tokens (RTs): tokens used to incentivize contributions and participation in the DAO

smart contracts: executable code embedded into the Blockchain that operates on certain conditions

staking: process of locking up tokens as a form of commitment or collateral within a DAO, often in exchange for voting rights or rewards

tokenomics: study and analysis of the economic aspects of a cryptocurrency or Blockchain project

validating nodes: nodes that take an active part in consensus management, validating data format and ensuring hash integrity

weighted voting: voting system where votes are given different weights based on predefined criteria, such as token holdings or reputation scores

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

NOTE: While some of these abbreviations (like GPS, EU, EEA) are commonly known, they are included as they appear in the context of the present document.

AI Artificial Intelligence

API Application Programming Interface
BPMN Business Process Model and Notation
CI/CD Continuous Integration and Continuous Deployment
DAO Decentralized Autonomous Organization
DASH Digital cash
DLT Distributed Ledger Technology
EEA European Economic Area
ETSI European Telecommunications Standards Institute
EU European Union
GDPR General Data Protection Regulation
GPS Global Positioning System
GT Governance Token
GUI Graphical User Interface
IA Implementation Agreement
ICT Information & Communication Technology
IPR Intellectual Property Rights
IRP Interface Reference Point
ISG Industry Specification Group
MT Membership Token
PDL Permissioned Distributed Ledger
RT Reward Token
SLA Service Level Agreement
UI User Interface
UX User eXperience
VM Virtual Machine