# ETSI GS PDL 012 V1.1.1 (2022-05)




## Permissioned Distributed Ledger (PDL); Reference Architecture



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# Foreword

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



# Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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# Executive summary

The present document defines a high level and abstract Reference Architecture (RA) for a Permissioned Distributed Ledger platform. The present document also describes the characteristics and behaviour of this platform, along with the services that it provides.

The following areas are discussed in detail:

1) PDL Platform Services.

2) PDL Abstraction Layers.

3) PDL Interfaces and Interface Reference Points.

The objectives of the present document are to:

- Maximize the choice of technology solutions available to entities using ETSI-ISG-PDL endorsed PDL platforms.
- Maximize ETSI-ISG-PDL endorsed PDL platforms' scalability in terms of the applications supported and the number of entities able to use them.

The ETSI-ISG-PDL RA is described in terms of abstract foundational (required minimum) and functional components that support specific sets of functionalities and reference points that describe the standardized interactions between different parts of the platform and with the external entities or platform. This enables technology vendors and developers to focus on their respective areas of expertise and platform users to choose a best-of-breed team of vendors/developers for their specific requirements.

# Preface

The present document defines a RA for a Permissioned Distributed Ledger platform. The present document also describes the characteristics and behaviour of this platform, along with the services that it provides and exemplary solutions that can be built using it.

A RA is a template for defining a solution to a particular problem domain (in this case, a PDL platform). It provides a set of common definitions of concepts, terminology, and common characteristics and behaviour of the system, including a set of external Reference Points that standardize communication. The present document uses a Functional Block architecture to define three key aspects of a PDL Platform:



- **Platform Services, which are services and functionality provided by the PDL platform.**
- **Abstraction layers, which are Data Model Brokers allowing different and diverse applications on one side and different DLT chain types on the other side to interface with the PDL platform.**
- **Modularity, which allows evolution and adaptation of PDL platforms to changing requirements.**

The objectives of using the RA are to:



- Maximize the choice of technology solutions available to entities using ETSI-ISG-PDL-endorsed technologies, Common Services, and applications.
- Maximize ETSI-ISG-PDL endorsed PDL platforms' scalability in terms of the applications supported and the number of entities able to use them.

The ETSI-ISG-PDL RA also provides standardized terminology to simplify the interaction between PDL Platforms Services and applications developed by technology vendors/developers.

# 1 Scope

The present document defines a RA for a Permissioned Distributed Ledger platform [i.1]. The present document also describes the characteristics and behaviour of this platform, along with the services that it provides and exemplary solutions that can be built using it.

The objectives of the present document are to:

- Maximize the choice of technology solutions available to entities using ETSI endorsed PDL platforms.
- Maximize ETSI endorsed PDL platforms' scalability in terms of the applications supported and the number of entities able to use them.

In scope:

- Definition of Functionalities, Interfaces, Reference points (e.g. Identity Services: PDL identity, Node identity, User identity).

Out of scope:

- Specific implementation details (e.g. Implementation of identity using a specific method). Such implementation details may be added at a later phase as separate documents or as corollaries/annexes to future releases of the present document.

The approach taken in the present document is to focus on defining *what* needs to happen, not *how* it is implemented.



# 2 References

## 2.1 Normative 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.



Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

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 necessary for the application of the present document.

Not applicable.

## 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] Framework for Permissioned Public Blockchain Networks, Inter American Development Bank (2021): "LACChain Framework for Permissioned Public Blockchain Networks".

NOTE: Available at https://publications.iadb.org/publications/english/document/LACChain-Framework-for-Permissioned-Public-Blockchain-Networks-From-Blockchain-Technology-to-Blockchain-Networks.pdf.

[i.2] MEF Sonata IRP MEF 55 Lifecycle Service Orchestration, 55.0.1 October 2017: "MEF 55 - LSO Reference Architecture".

NOTE: Available at https://www.mef.net/resources/mef-55-1.

[i.3] NIST Special Publication 800-162 (January 2014): "Guide to Attribute Based Access Control (ABAC) Definition and Considerations".

NOTE: Available at https://doi.org/10.6028/NIST.SP.800-162.

[i.4] Gamma, E., Helm, R. Johnson, R., Vlissides, J.: "Design Patterns:-Elements of Reusable Object-Oriented Software", Addison-Wesley, Nov, 1994.-ISBN 978-0201633610.

[i.5] Riehle, D.: "Composite Design Patterns", Proceedings of the 1997 Conference on Object-Oriented Programming Systems, Languages and Applications (OOPSLA '97), ACM Press, 1997, Page 218-228.



# 3 Definition of terms, symbols and abbreviations

## 3.1 Terms

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

**Abstraction Layer:** functionality that serves as an intermediator between subsystems that may be using different protocols, vocabulary, and methods that serves their respective purposes

**Access Control Policy:** privileges and permissions of a subject entity to perform operations on a set of target entities

**addressable atorage:** content/data that can be accessed through a web link (URL)

**API Broker:** software that mediates between two systems with different Data Models implemented as APIs

NOTE: Also referred to as API Gateway.

**API Gateway:** See API Broker.

**application (software):** program or group of programs designed to perform specific tasks for end users

**application abstraction layer:** APIs and interfaces, including API Brokers, enabling Applications to communicate with an ETSI-ISG-PDL Platform

**Application Programming Interface (API):** system of tools and resources in an operating system, enabling developers to create software applications

**asynchronized data:** data that does not require synchronization with other data

**Attribute Based Access Control (ABAC):** access control method where the subject requests for performing an operation on objects are granted/denied based on:

- Assigned attributes of the subject.
- Assigned attribute of the object.
- Environmental conditions.
- Set of policies.

NOTE: As defined by NIST [i.3].

**blockchain:** censorship and tamper-proof growing list of records, called blocks, that are linked using cryptography

NOTE: Each block contains a cryptographic hash of the previous block, a timestamp, and transaction data.

**business service:** service that is delivered to business customers by business units

**category alpha application:** application that is developed and delivered to all users of said application by a single vendor/developer using a Category Alpha Platform developed by that same vendor/developer

NOTE Can only use a single DLT type prescribed by the developer.

**category alpha platform:** PDL platform that is designed, developed, delivered, and integrated to all users of said platform by a single vendor using a single DLT technology

NOTE: Broken down to sub-categories "Alpha-1" and "Alpha-2".



**category bravo application:** application that is developed and delivered to all users of said application by a single vendor/developer using a Category Bravo Platform developed by that same vendor/developer

NOTE: Can only use DLT types prescribed by the developer.

**category bravo platform:** PDL platform that is designed, developed, delivered, and integrated to all users of said platform by a single vendor, but can operate using two or more underlying DLT technologies

NOTE: Broken down to sub-categories "Bravo-1" and "Bravo-2".



**category charlie application:** application that is developed towards a specification of an Application so that any user of an application supporting such specifications can fully interoperate with other users of other applications built towards the same Application specifications

**category charlie platform:** PDL platform that can operate using two or more underlying DLT technologies and is designed and developed towards a specification of an application abstraction layer so that any Application that supports such an abstraction layer can interface with said platform

NOTE: Broken down to sub-categories "Charlie-1", "Charlie-2", "Charlie-3" and "Charlie-4".

**category delta platform:** Category Charlie platform that only supports a single DLT type

NOTE: Broken down to sub-categories "Delta-1", "Delta-2", "Delta-3" and "Delta-4".

**Certificate Authority (CA):** entity that issues digital certificates. A digital certificate certifies the ownership of a public key by the named subject of the certificate

**composite application:** applications using the PDL platform that are made up of other applications that use the PDL platform

**composition:** act of creating a new object or a new functionality through combination of two or more existing objects or functionalities

**concurrency:** occurrence of and/or execution at the same time of different programmatic units

**consumer:** PDL Platform entity that consumes data produced by another entity

**data model:** concepts of interest to an environment in a form that is dependent on data repository, data definition language, query language, implementation language, and/or protocol

NOTE: Data Models are derived from the Information Model.

**data model broker:** software that mediates between two systems with different data models

NOTE: Also referred to as Data Model Gateway.

**data model gateway:** Same as Data Model Broker.

**directly connected storage:** storage that is local to the node and is either physically connected to the node or is external storage connected using a shared communication channel that is managed by the owner of that node

NOTE: Examples of physically connected storage: internal drive, external thunderbolt drive. Examples of external storage: NAS, Cloud.

**Discretionary Access Control (DAC):** access control policy where the owner of a resource/object defines the access control policy for the users

**distributed addressable storage:** addressable Storage that is distributed across multiple storage devices

**Distributed Ledger Ttechnology (DLT):** technology implementing a distributed ledger which is a consensus of replicated, shared, and synchronized digital data geographically spread across multiple sites, countries, or institutions

NOTE: Unlike with a distributed database, there is no central administrator.

**Domain Name System (DNS):** hierarchical and decentralized naming system for computers, services, or other resources connected to the Internet or a private network

NOTE: It associates various information with domain names assigned to each of the participating entities.

**external data:** data obtained from resources or systems external to the PDL platform

**external IRP:** IRP between a PDL platform and external entities

**Functional Block:** abstraction that defines the external structural representation of the capabilities and functionality of a component or module, and its relationships with other Functional Blocks

NOTE: Functionalities such as capabilities, behaviour, and relationships, as well as their inputs, outputs, and optionally, transfer functions. The internal structure of a Functional Block is **not** revealed.

**functional capability:** capabilities that a system has to manage resource in each functional area of operations

**Governance:** collection of rules and tools that control the behaviour and function of a PDL platform

**implementation agreement:** rules and agreements that describe how a Platform Service is implemented

**information model:** representation of concepts of interest to an environment in a form that is independent of data repository, data definition language, query language, implementation language, and protocol

**insignificant event:** event that does not affect any node other than the node where it occurred and does not affect the chain or consensus mechanism

**Interface Reference Point:** communication channels through which Functional Blocks communicate with each other

NOTE: IRPs are given names for reference purposes (e.g. "Debka").

**Internal Data:** data that is generated by a node either through computation or through a directly connected sensor that feeds data to that node

**Internal IRP:** IRP between Functional Blocks internal to a PDL platform

**Internet Corporation for Assigned Names and Numbers (ICANN):** American multi-stakeholder group and non-profit organization responsible for coordinating the maintenance and procedures of several databases related to the namespaces and numerical spaces of the Internet, ensuring the network's stable and secure operation

**Internet Engineering Task Force (IETF):** open standards organization, which develops and promotes voluntary Internet standards, in particular the standards that comprise the Internet protocol suite

**InterPlanetary File System (IPFS):** protocol and peer-to-peer network for storing and sharing data in a distributed file system that uses content-addressing to uniquely identify each file in a global namespace connecting all computing devices

NOTE: A global namespace connecting all computing devices such as the public internet.

**Loosely Coupled:** functionality that has little or no dependency on other functionalities

**Mandatory Access Control (MAC):** access control policy defined by system administrators

**Minimum Viable Product (MVP):** version of a product with just enough features to satisfy early customers and provide feedback for future product development

**Non-Addressable Storage:** content/data that cannot be addressed and accessed by any other entity except for the entity that directly manages this data

**orchestration:** automated (and/or manual) configuration and management of systems and their Functional Blocks

NOTE: Orchestrated objects may be Resources, Platform Services, Applications. Orchestration emphasizes coordinated actions; one form of this coordination is service function chaining.

**PDL Abstraction Layer:** APIs and interfaces, including API Brokers, enabling Platform services to communicate with ETSI-ISG-PDL endorsed PDL types

**PDL Hardware Interface:** point across which electrical, mechanical, and/or optical signals are conveyed from a sender to one or more receivers using one or more protocols

**PDL Data Model Broker/Gateway:** translates between data models allowing entities using different data models to communicate each using its own data model

NOTE: Details are for further study.

**PDL Platform Atomic Service:** PDL Platform Service that does not use any other PDL Platform Service to perform its functionality

NOTE: May use external applications or functions.

**PDL Platform Composite Service:** PDL Platform Service that uses one or more other PDL Platform Services to perform its functionality

**PDL Platform Mandatory Service:** PDL Platform Service that is mandated to be included in an ETSI-ISG-PDL compliant PDL platform

**PDL Platform Optional Service:** PDL Platform Service that does not need to be included in a PDL platform for it to be considered ETSI-ISG-PDL compliant

**PDL Platform Service:** services and functionality provided by the PDL platform that all applications may use

NOTE: Same as "Platform Service".

**PDL Software Interface:** point through which communication with a set of resources of a set of objects is performed

NOTE: Resources such as memory, CPU, Location, User roles or Smart Contracts.

**Platform Service:** services and functionality provided by the PDL platform that all applications may use

NOTE: E.g. Governance, Identity, Storage.

**policy:** set of rules that is used to manage and control the changing and/or maintaining of the state of one or more managed objects, defined by the Governance

**Policy Based Access Control:** Access Control method that uses Policies to determine the appropriate type of access control based on the needs of the PDL Platform

**principal:** highest authority or most important position in an organization, institution, group or system

**producer:** PDL Platform entity that generates data that other entities may consume

**RAM Swap Space:** portion of a computing device's hard drive that is used for virtual memory in the event that there is insufficient physical RAM installed on the device

**Random Access Memory (RAM):** hardware in a computing device where the operating system, application programs and data in current use are kept so they can be quickly reached by the device's processor

**Reference Architecture (RA):** template for defining a solution to a particular problem domain

**Remote Procedure Call (RPC):** in distributed computing, a remote procedure call is when a computer program causes a procedure to execute in a different address space, which is coded as if it were a normal procedure call, without the programmer explicitly coding the details for the remote interaction

**Role Based Access Control (RBAC):** access control approach based on the roles the user assumes in a system, rather than the user's identity

**Service:** instance of a technology product implemented using an ETSI-ISG-PDL compliant platform

NOTE: E.g. a communication circuit connection between two offices.

**Significant Event:** event that occurred on any node that may affect the behaviour of the node, the chain or the consensus mechanism

**Software Reference Model:** set of architectural patterns and other supporting artifacts that presents a set of unifying terminology, concepts, axioms, and Functional Blocks within a particular problem domain

**Synchronized Data:** data that requires sequencing and has dependency on timing or content of other data being collected

**Tightly Coupled:** functionality that has a high degree of dependency on other functionalities

**Trusted Third Parties:** in cryptography, a trusted third party is an entity which facilitates interactions between two parties who both trust the third party; the Third Party reviews all critical transaction communications between the parties, based on the ease of creating fraudulent digital content

**Universal Resource Locator (URL):** reference to a web resource that specifies its location on a computer network and a mechanism for retrieving it

NOTE: A URL is a specific type of Uniform Resource Identifier, although many people use the two terms interchangeably.

**Use Case:** specific situation in which a product or service could potentially be used

**Virtual Service:** service that uses one or more virtual objects

NOTE: Objects such as Resources, Services.



## 3.2 Symbols

Void.

## 3.3 Abbreviations

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

| | |
|---|---|
| ABAC | Attribute Based Access Control |
| API | Application Programming Interface |
| CA | Certificate Authority |
| CPU | Central Processing Unit |
| DAC | Discretionary Access Control |
| DLT | Distributed Ledger Technology |