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**Group Specification**

PDL service enablers for Decentralized

Identification and Trust Management

Reference

DGS/PDL-023\_Decentralized Identification Framework

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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](https://portal.etsi.org/Services/editHelp%21/Howtostart/ETSIDraftingRules.aspx) (Verbal forms for the expression of provisions).

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# Executive summary

# Introduction

# 1 Scope

The present document defines Permissioned Distributed Ledger (PDL) Platform services to enable a decentralized identification and trust management framework. The present document also describes the characteristics and behaviour of this framework, along with the services that it offers and ideal solutions that can be built using it.

The objective of the present document includes:

* To define PDL platform services to handle registration management of different type of entities/participants to operate over the PDL platform to accomplish their specific tasks and purpose to realize the overall decentralized identification and trust management process.
* To define PDL platform services to handle decentralized identifier(s), related documents, and verifiable credentials.
* To define PDL platform services to verify the decentralized identifier and related information to enable a specific service provision (e.g., public, and private services).

In scope:

* Definition of Functionalities, Interface Reference points, and Procedures.

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

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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.

[1] ETSI GS PDL 012 (05-2022): "Permissioned Distributed Ledger (PDL); Reference Architecture".

[2]

## 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] W3C, Decentralized Identifiers (DIDs) v1.0, August 03, 2021, "Core architecture, data model, and representations".

[i.2] ETSI GR PDL 019 (02-2023): " PDL Services for Decentralized Identity and Trust Management".

# 3 Definition of terms, symbols and abbreviations

## 3.1 Terms

For the purposes of the present document which describes the decentralized identification and trust management process, the following terms, and definitions apply:

* Decentralized IDentifier (DID): a digital identifier managed through decentralized platform where the subject (e.g., end-user/device/any entity) possess the full control over its generation and associated data exposure, independent from any centralized registry, identity provider, or certificate authority.

NOTE: DIDs can be URLs/URIs that relate a DID subject which enables trustable interactions with that subject. DID can refer to any subject (e.g., a person, organization, thing, data model, abstract entity, etc.) as determined by the controller of the DID. A DID is considered as a form of pseudonym as used in eIDAS and it is not directly linked to a formal identifier of the natural or legal person.

* Applications at end-device:Application (e.g., a client application or wallet) used by the DID holder or Controller to generate, manage, store, or use private and public key pairs for related security (e.g., confidentiality and/or integrity protection).

NOTE: The sensitive information (such as cryptographic materials) may need to be protected by the "secure element" within the device or wallet. In such as case, the use of the cryptographic key(s) is restricted to the DID holder or controller respectively.

* DID Holder: The subject which is referred by the DID is called as the DID holder.

NOTE: A DID holder in some cases can generate the DID and, in such cases, the DID holder is also referred as a DID controller.

* DID Controller:The controller of a DID is the entity (person, organization, or autonomous software) that has the capability as defined by a DID method and indicated in the DID document to make any changes to a DID document.

NOTE: A DID holder can be the DID controller in some cases (or) a DID controller can be a different entity as authorized by the DID holder. DID controller holds the proof of possession or control of the holder's private key and will be responsible for issuance of a unique and anonymous DID to the holder.

* DID Document: DIDs resolve to the DID Documents, i.e., a set of simple documents that contains information associated to a DID (e.g., to verify the DID) and describes how to use a specific DID.

NOTE: Each DID Document may contain at least three information such as proof purposes, verification methods (such as cryptographic public keys), and service endpoints (can also indicate services relevant to interactions with the DID holder). Proof purposes are combined with verification methods to enable mechanisms for proving various aspects related to DID holder’s identification, authentication and authorization.

* Verifiable Credentials (VC):are tamper-evident credentialsthat has authorship which can be cryptographically verified, and it includes one or more claims asserted by the VC issuer for the DID holder (i.e., subject).

NOTE: In practice, DIDs are used in combination with VCs to enable trusted digital interactions, where the required information about the subject is shared with third parties, by proving to those third parties that the DID subject has ownership of certain attestations or attributes. This proof is based on the cryptographic link between the VC, the DID subject the VC is about, and the issuer of the VC, which can be the DID subject itself (self-asserted claims), or another trusted entity.

* VC Issuer is an entity (e.g., a trusted entity or a trust service provider) that performs claims assertation about one or more subjects, creates a VC from the claims, and transmits the VC to the holder.

NOTE: Trust on the VC is established either by trusting the issuer's DID (e.g., by out-of-band mechanisms, bilateral relationship, trusted lists etc,) or by any other means. The third party (e.g., service provider) can then use the presented cryptographically protected proof (i.e., the VC) to verify the ownership and trustworthiness of the claims about the subject.

* Distributed Ledgers: Record of data stored by consensus with cryptographic audit trail maintained and validated by nodes in a decentralized platform based on governance.

NOTE: Distributed ledger can be of two types such as permissioned distributed ledger and permission less distributed ledger. As the Permissioned Distributed Ledger (PDL) is further used in this document, PDL service is further clarified below.

* PDL services: it can facilitate the storage of DID related data such as DID documents, VC, etc.

NOTE: The ledgers which store the DID related data should be considered as a form of secure area (e.g., secure element or trusted platform). For example., the storage of DID can be supported through use of an agent service (such as PDL platform service if a distributed ledger is implemented for the storage) to remotely access the data from the end device and controlled through multiple authentication and authorization factors.

* Off-chain Storage: The privacy sensitive data associated to the DID can be stored and managed in isolation using off-chain methods or using any local/external authorized storage space as required.
* DID Verifier: It is a role that any third party service provider or application server would perform to identify and authenticate the DID holder using the trust management framework.
* DID Resolver function**:** DIDs can be resolvable to their corresponding DID documents, where a DID Resolver function supports storage of DIDs and returns necessary data to access DID documents.
* VC Storage: To enable usage of VCs, the system that implements VC storage performs mediation service for the creation and verification of the identifiers, keys, and other relevant data, such as VC schemas, revocation of VC data, issuer public keys, and so on. e.g., some configurations may require correlation of identifiers for subjects.
* DID Verification: Allows authentication of the subject identified by the DID.

NOTE: The DID holder presents the data derived from one or more VCs, issued by one or more VC issuers, with a specific verifier (i.e., a service provider) to request and receive specific service of interest to the DID holder. A verifiable presentation is a tamper resistant/evident presentation encoded (with cryptographic methods) in such a way that authorship of the data can be trusted after a process of cryptographic verification. The DID holder authentication is facilitated with protocol exchanges between the DID holder, DID verifier and the trust management framework to verify the DID and validate the VCs (as part of authentication) to check if that can be sufficient to provide a requested service (i.e., resource access) for the DID holder.

## 3.2 Abbreviations

For the purposes of the present document, the [following] abbreviations [given in ... and the following] apply:

# 4 Introduction [Informative]

With the evolution of technologies, businesses, and advanced services, a more seamless, user friendly, user controlled, and privacy preserved identity management system is most essential for the quick roll-out and success of any business and services. Meanwhile, the trust in the identity of the subject or object (i.e., a natural or legal person, entity etc.,) has become the cornerstone of all digital services and activities. Here comes the decentralized identification and a decentralized identifier is considered as the most suitable candidate which can link various essential and limited set of attributes (specific to the end-user(s) or device) as required for any specific service that can be shared with the service provider(s) or verifier(s) in order to enable authentication of the end-user/device to offer a specific set of service(s). This document defines various PDL platform services such as role-based registration management, DID operation participants registry service, DID registry service, DID Resolver service, DID document registry service, Verifiable credentials data registry service, and DID verification management service, to enable the overall decentralized identification and trust management process. All forms of decentralized identification methodologies can utilize the PDL platform services defined in this document to handle related data and trust management over the PDL platform. Specific implementation details (e.g. Implementation of identity using a specific method) are out of scope of this document.

# 5 ETSI-ISG-PDL Decentralized Identification and Trust management Framework

## 5.1 Definition of terminologies

A decentralized identification and trust management process enables authentication of the end-user(s)/device(s) (i.e., to set up the initial trust between the end-user/device being the service consumer and the service provider). The key enablers to realize a fully functional decentralized identification and trust management involves various operational aspects such as DID generation (i.e., by a DID holder or DID controller), VC issuance (by a VC Issuer), DID storage and management, VC storage and management, Verification of the DID (by a DID verifier) for identification and authentication as listed and described in detail below.

## 5.2 Reference Framework Overview

### 5.2.1 Introduction

The present document uses a functional block architecture to define various services required to enable a decentralized identification and trust management framework. A decentralized platform has the capability to facilitate a globally unique digital identifier (i.e. DID with no possibility of duplication) related data management and control of associated cryptographic verification data, service information, etc. as needed for decentralized identification and authentication of a DID holder (i.e. user/device) to setup trusted interactions between the DID holder and a service provider for any related digital service provisions. The procedural aspects of PDL based decentralized identification and trust management ranges from different participants registration along with access control over the decentralized identification system, related data storage and management operations (e.g., throughout the data lifecycle), the decentralized identifier verification, and selective data exposure to service provider(s) for end-user/device authentication respectively.

A Decentralized Identification and Trust management framework can utilize the PDL services described in the PDL reference architecture [1] for the governance related aspects and the decentralized identification management and operation specific PDL services as shown in Figure 5.2-1. The core PDL service functionalities (i.e., capabilities, behaviour, and relationships) which forms the building block of decentralized identification and trust management process includes the following as shown in Figure 5.2.1-1 and it is described in detail in Clause 5.2.2:

* Role-based registration management service;
* DID Operational participants Registry service;
* DID Resolver service;
* DID Document Registry service;
* VC Data Registry service; and
* DID Verification management service.

[R1] An ETIS-ISG-PDL compliant PDL platform SHALL include Mandatory Services required by the applications using a decentralized Identification and trust management framework.

[O1] An ETSI-ISG-PDL compliant PDL platform MAY include one or more of Optional Services required by the applications using such platform.

 

Figure 5.2.1-1: PDL based Decentralized Identification and Trust management framework

### 5.2.2 Decentralized identification management and operation specific PDL services

#### 5.2.2.1 Role-based registration management service

The role-based registration management service considers the following different roles for the participants who are the integral users of the decentralized identification and trust management framework. It provides registration service (along with authorization for fine grained access control) specific to the corresponding roles of the participants and their allowed operations in the PDL platform. The role-based registration management service offers registration and de-registration (e.g. revocation of registration) related services for different participants.

* Identity Holder;
* Identity Controller;
* VC Issuer; and
* ID Verifier.

[O2] An ETSI-ISG-PDL compliant PDL platform MAY include Decentralized Identification and Trust management framework related functionalities.

If the PDL platform supports decentralized identification and trust management framework (DTMF) related functionalities and operations, then further requirement(s) described in this clause are applicable.

[R2] An ETSI-ISG-PDL compliant PDL platform SHALL include Role-based registration management service to manage the registration and operation of different participants (entities) utilizing such a framework.

#### 5.2.2.2 DID Operational participants Registry service

The DID Operational participants registry service records and keeps track of the registered and de-registered participants from the PDL platform based DTMF by considering the instructions from the Role based registration management service.

[R3] An ETSI-ISG-PDL compliant PDL platform SHALL include a registry service to record the registration and operational details of different participants (entities) utilizing such a framework.

#### 5.2.2.3 DID Resolver service

The DID Resolver service stores the DIDs in a DID registry, keeps track of the DID(s) and its associated DID document location information (e.g. address) to enable DID document fetching and verification by the authorized services and entities (i.e. DID Verifiers e.g. service providers).

#### 5.2.2.4 DID Document Registry service

The DID Document Registry service allows to store and manage the DID documents associated to the DID to facilitate DID verification. Whereas each DID Document can contain at least three things: proof purposes, service specific information for which the DID document can be used, verification methods, and service endpoints. Proof purposes are combined with verification methods to provide mechanisms for proving things. For example, a DID Document can specify that a particular verification method, such as a cryptographic public key or pseudonymous biometric protocol, can be used to verify a proof that was created for the purpose of authentication. Service endpoints enable trusted interactions with the DID holder as well as authorized verifier. The DID Document Registry service offers Create (i.e. to store), Update, Revoke DID documents (i.e. deletion) related service operations.

#### 5.2.2.5 VC Data Registry service

The VC Registry service allows to store and manage the VCs associated to the DID to facilitate VC based DID verification and validation related to service request. The VC Data Registry service offers Create, Update, and Revoke VCs related service operations.

#### 5.2.2.6 DID Verification management service

The DID verification service can be a composite service [1] that uses DID resolver service, DID document registry service, DID operation(al) participant registry service and VC Data Registry service to fetch necessary data related to verification of DID (i.e. authentication of the subject identified by the DID), and performs exposure of selective data to the verifier to enable authorization verification of subject to respective service(s).

## 5.3 PDL Framework Operations and Services

### 5.3.1 Registration Management

#### 5.3.1.1 Introduction

Registration Management procedure describes how any participant mentioned in clause 5.2.2.1 can register to the DTMF shown in Figure 5.2.1-1 to perform any of decentralized identification and trust management related operations using the PDL based DTMF.

#### 5.3.1.2 Role based registration

The detailed registration management procedure for different participants (taking different roles) is described in this section as shown in Figure 5.3.1.2-1. The role based registration procedure primarily involves two services such as Role-based registration management service and DID Operational participants Registry service described in clause 5.2.2. An entity (i.e., a related to DID holder device, VC issuer and the DID Verifier) which requires to participate in the Decentralized identification and trust management process can use the registration procedure described in this section to initially register to the DTMF to allow any further any operations over the DTMF.



Figure 5.3.1.2-1: Role based registration Procedure

If the DID holder wants to register to the DTMF, it performs the following steps.

1. The DID holder sends a registration request to the PDL platform’s ledger role-based registration management service (L-RMS), which includes a source identity, service type information set as ‘DID service’ (i.e. to indicate that the registration is related to the DID related entity which need to act as the DID holder in the DTMF), required access role (indicates that DID holder access role is requested) and the actual DID (i.e. an identity such as decentralized identity or digital identity or self-sovereign identity (SSI) generated either by the subject or by the subject controller e.g., DID Controller in case of internet of things) in a privacy protected form to uniquely identify an entity).

NOTE: The entity may have registered to the PDL platform as a general user (e.g. using ETSI GS PDL 012 [i.10]) of the PDL platform, in which case the entity may have a source identity). In certain case of implementation if the entity has a client application or wallet installed to use the PDL platform, the access to the PDL platform can be authenticated using the identity and credentials (e.g., public-private key) associated to the client applications or the wallet.

[Conditional – applicable for DID Controller] In case, if a DID controller is involved in the registration procedure instead of DID holder, then in step 1 the DID controller sends to the L-RMS, a registration request with the required access role set as, ‘DID Controller’, Source Identity of the DID controller along with the other information described for step 1 above.

[Conditional – applicable for VC Issuer] In case, if a VC Issuer is involved in the registration procedure, then in step 1 the VC Issuer sends to the L-RMS, a registration request where the required access role is set as, ‘VC Issuer’, and Source Identity of the VC Issuer is also included with the other information as described for step 1 above.

[Conditional – applicable for DID Verifier] In case, if a DID Verifier is involved in the registration procedure, then in step 1 the DID Verifier sends to the L-RMS a registration request where the required access role is set as, ‘DID Verifier’, and Source Identity of the DID Verifier is also included with the other information as described for step 1 above.

1. The L-RMS can initiate and perform mutual authentication (e.g. based on local policy) with the DID holder based on any preconfigured credentials (e.g. public-private key pair or any secret key associated to the client application or wallet).
2. On a successful mutual authentication, the L-RMS process the registration request.
3. The L-RMS determines to register the DID holder and it sets a registration ID for the DID holder. Further it creates a Registry transaction notification message which includes the L-RMS ID, target Registry service information (i.e. such as registry service name, and ID (e.g., address) related to the DID Operation(al) participant registry, Source Identity, Service type information (DID service), Registration ID, DID, Authorized access role (set as DID holder), Authorization code, and Lifetime (for the validity of the registration). Further the message can be transformed into a transaction (i.e. DID Operation(al) participant registry transaction) to add the new participant related registration information to the DID Operation(al) participant registry.

[Conditional – applicable for DID Controller] In case, if a DID controller is involved in the registration procedure instead of DID holder, then in step 4, the L-RMS determines to register the DID controller and it sets a registration ID for the DID controller. Further it creates Registry transaction notification message which includes the L-RMS ID, target Registry service information (i.e. such as registry service name, and ID (e.g., address) related to the DID Operation(al) participant registry), Source Identity, Service type information (DID service), Registration ID, DID, Authorized access role (set as DID controller), Authorization code, and Lifetime (for the validity of the registration). Further the message can be transformed into a transaction (i.e. DID Operation(al) participant registry transaction) to add the new participant to the DID Operation(al) participant registry).

[Conditional – applicable for VC Issuer] In case, if a VC Issuer is involved in the registration procedure, then in step 4, the L-RMS determines to register the VC Issuer and it sets a registration ID for the VC Issuer. Further it creates Registry transaction notification message which includes the L-RMS ID, target Registry service information (i.e. such as registry service name, and ID (e.g., address) related to the DID Operation(al) participant registry), Source Identity of the VC Issuer, Service type information (DID service), Registration ID, DID, Authorized access role (set as VC Issuer), Authorization code, and Lifetime (for the validity of the registration). Further the message can be transformed into a transaction (i.e. DID Operation(al) participant registry transaction) to add the new participant to the DID Operation(al) participant registry).

[Conditional – applicable for DID Verifier] In case, if a DID Verifier is involved in the registration procedure, then in step 4, the L-RMS determines to register the DID Verifier and so it sets a registration ID for the DID Verifier. Further it creates Registry transaction notification message which includes the L-RMS ID, target Registry service information (i.e. such as registry service name and ID (e.g., address) related to the DID Operation(al) participant registry), Source Identity of the DID Verifier, Service type information (DID service), Registration ID, DID, Authorized access role (set as DID Verifier), Authorization code, and Lifetime (for the validity of the registration). Further the message can be transformed into a transaction (i.e. DID Operation(al) participant registry transaction) to add the new participant to the DID Operation(al) participant registry).

1. The L-RMS sends to the configured PDL node a DID Operation(al) participant registry transaction (which includes the Registry transaction notification message).

NOTE: The message to transaction conversion is upto the PDL platform service provider implementation.

1. PDL Node-1 propagates the received transaction through the target PDL network.
2. PDL Node-X (e.g. any PDL Node-2) receives the transaction from the target PDL network as the result of transaction propagation.
3. After the transaction is validated and it is successfully stored to the ledger (e.g. as a result of PDL consensus process in a ledger related to the registry service associated to the DID Operation(al) participant registry). Also, the PDL Node-X forwards the transaction to the registry service based on the target Registry service information. The registry service transforms the transaction into message to recover the message (i.e. DID Operation(al) participant registry transaction notification message).
4. The registry service can store the DID Operation(al) participant registry transaction received as part of the Registry transaction notification message based on local policies, e.g. in a local storage/off-chain/ledger.
5. The registry service can send to L-RMS, an acknowledgement message with the L-RMS ID, Source ID, Registration ID, Registry service type ID, and the result as ‘Success’ indication.
6. The L-RMS sends to the end device, a Registration Response with L-RMS ID, Service type information (DID service), Registration ID, Authorized access role, Authorization information (e.g. code/token), and Lifetime.

Based on step 1-2, if the L-RMS determines not to register the end device or application, it sends a Registration Response with ‘failure’ indication.

NOTE: The L-RMS can accept the required access role provided by the end-device/client/applicant (in step 1) based on the authentication results (e.g. based on end-user's information in the certificate or any SLA agreement which is outside the scope of the present document). So, based on the local policies, authentication credentials evaluation and authentication result the L-RMS can determine to agree or deny a required access role requested by the end-device/application.

NOTE: A smart contracts can be used by the registry services to keep track of lifetime related expirations, linking of all DID related entries, etc.

#### 5.3.1.3 De-registration

### 5.3.2 Data Management

#### 5.3.2.1 Introduction

#### 5.3.2.2 DID and DID Documents management

#### 5.3.2.3 Verifiable Credentials management

## 5.4 ETSI-ISG-PDL Platform Services

This section presents the PDL Platform Services required to realize the PDL based DTMF and the associated decentralized identification and trust management operations described in clause 5.2 and 5.3.

Ledger Role-based Registration management Service:

[RRMS-R1] The ETSI-ISG-PDL DTMF Ledger role-based registration management service SHALL support registration of participants to a specific requested and allowed access role.

[RRMS-R2] The ETSI-ISG-PDL DTMF Ledger role-based registration management service SHALL support registration of participants for DID service.

[RRMS-O1] The ETSI-ISG-PDL DTMF Ledger role-based registration management service MAY initiate and perform mutual authentication with the entity requesting registration for DID service.

[RRMS-R3] The ETSI-ISG-PDL DTMF Ledger role-based registration management service SHALL support authentication of the entity requesting registration for DID service.

[RRMS-R5] The ETSI-ISG-PDL DTMF Role-based registration management service SHALL assign participant registry information with a unique Registration Identifier, Registration Lifetime and authorization Code for each participant allowed to register for the DID service.

[RRMS-R6] The ETSI-ISG-PDL DTMF Role-based registration management service SHALL initiate propagation of the participant registry information as a transaction to add the data to the DID Operational Participant Registry service.

[RRMS-O2] The ETSI-ISG-PDL DTMF Role-based registration management service MAY support propagation of the participant registry information as transaction over the PDL network for validation.

[RRMS-O3] The ETSI-ISG-PDL DTMF Role-based registration management service MAY support propagation of the participant registry information as transaction over the PDL network (via a specific PDL node) for validation.

[RRMS-R7] The ETSI-ISG-PDL DTMF Role-based registration management service SHALL inform the entity about the participant registry information if the registration is considered successful.

[RRMS-O4] The ETSI-ISG-PDL DTMF Role-based registration management service MAY inform the entity about the registration failure based on local policy or if the authentication fails.

## 5.5 Summary

Annex (informative):
Change History

| Date | Version | Information about changes |
| --- | --- | --- |
| June 2023 | V0.0.1 | PDL(23)015\_009 |
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# History

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| **Document history** |
| <Version> | <Date> | <Milestone> |
| V0.0.1 | 13 June 2023 | PDL(23)015\_009 |
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*Latest changes made on 2022-03-14*