Exploring Decentralized Digital Identity Protocols

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Founding Partner

Identity Woman in Business

We provide consulting and advisory services to help governments, industries and organizations globally transition to the new generation of decentralized identity infrastructure.

Co-Founder
Co-Producer
Co-Facilitator

INTERNET IDENTITY WORKSHOP & REGIONAL EVENTS

OpenID and OAuth were founded at IIW

Rest of this talks what we have innovated in the last 10 years.

Exploring Decentralized Digital Identity Protocols

1. Decentralized Identifiers
2. Verifiable Credentials
3. Exchange Protocols
4. Decentralized Trust & Governance Frameworks
5. *Where work is happening*

Decentralized Identifiers

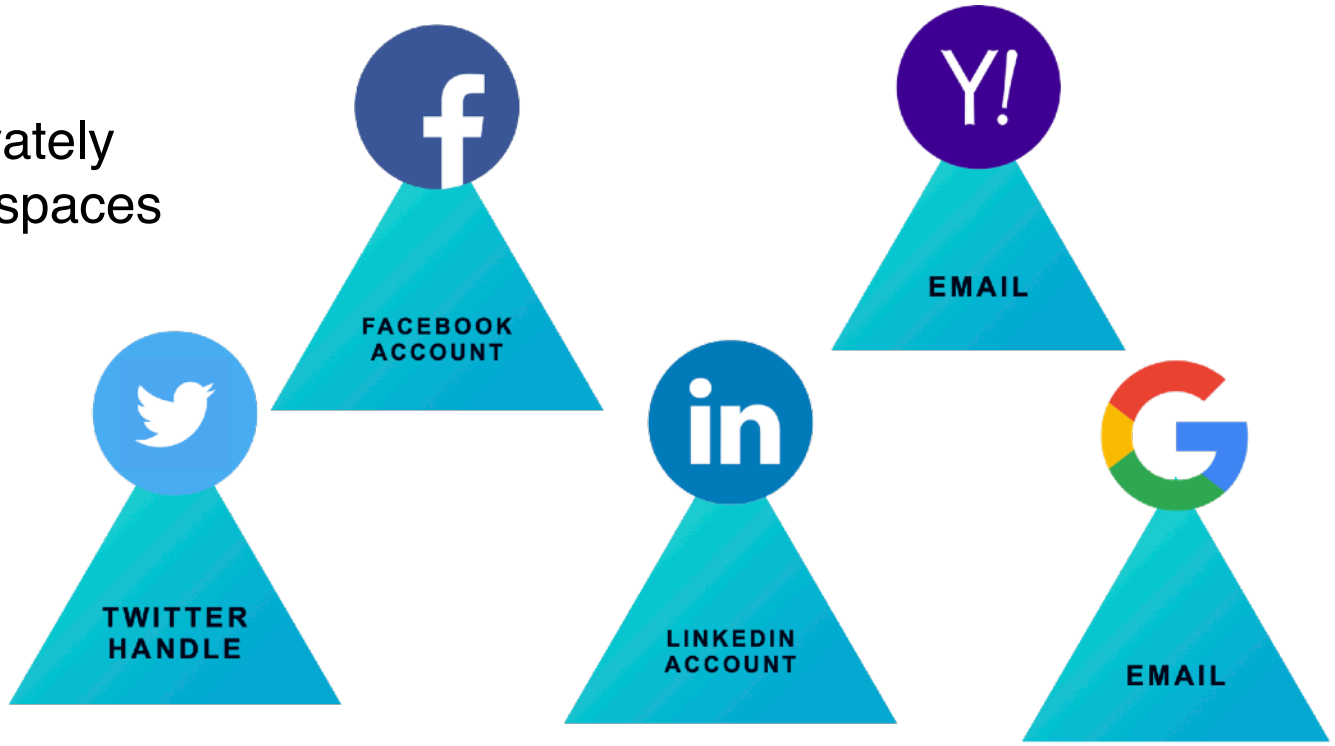
Approved by W3C v 1.1

New Maintenance Working Group
+ mandate to specify resolution

How are digital identifiers managed today?

Private Name Spaces

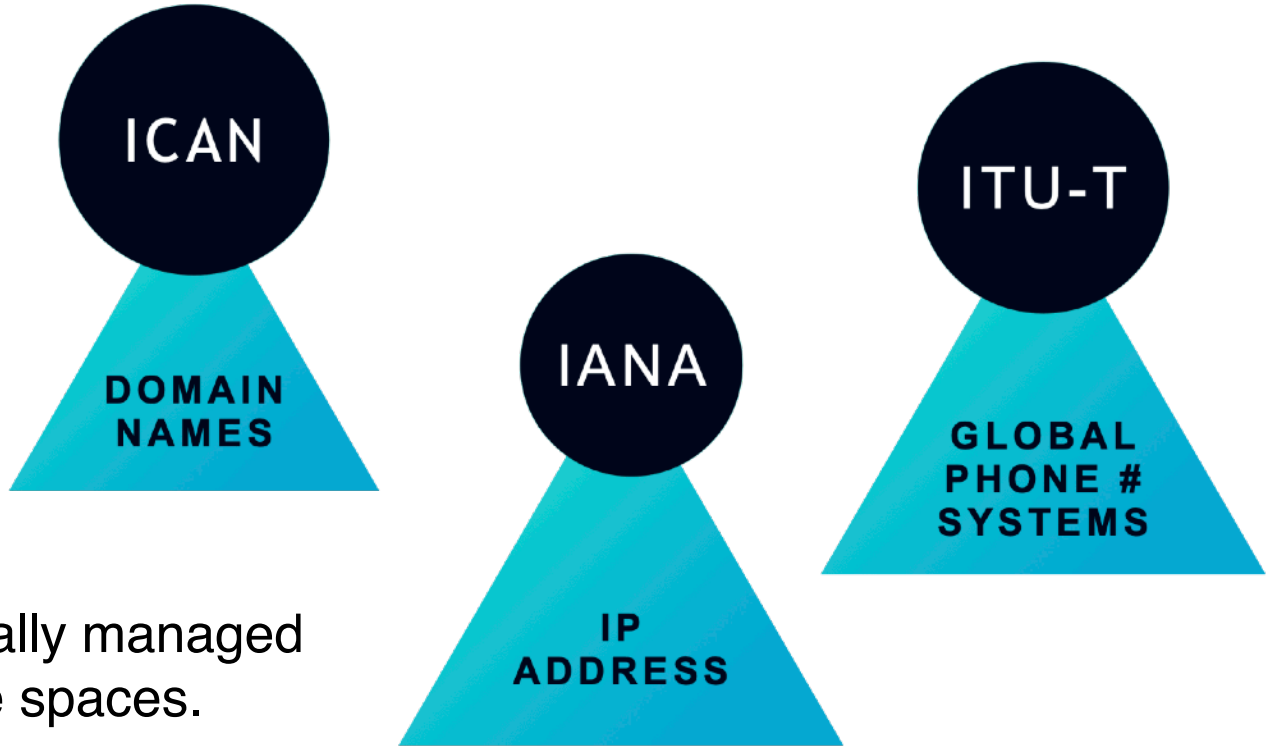
Identifiers in privately controlled namespaces



Private Name Spaces

- At the Affect of the owner of the namespace
- Often only communicate internal to namespace
  - With exception of e-mail (open standard) to communicate across domains

Globally Managed Registries



Identifiers in globally managed hierarchical name spaces.

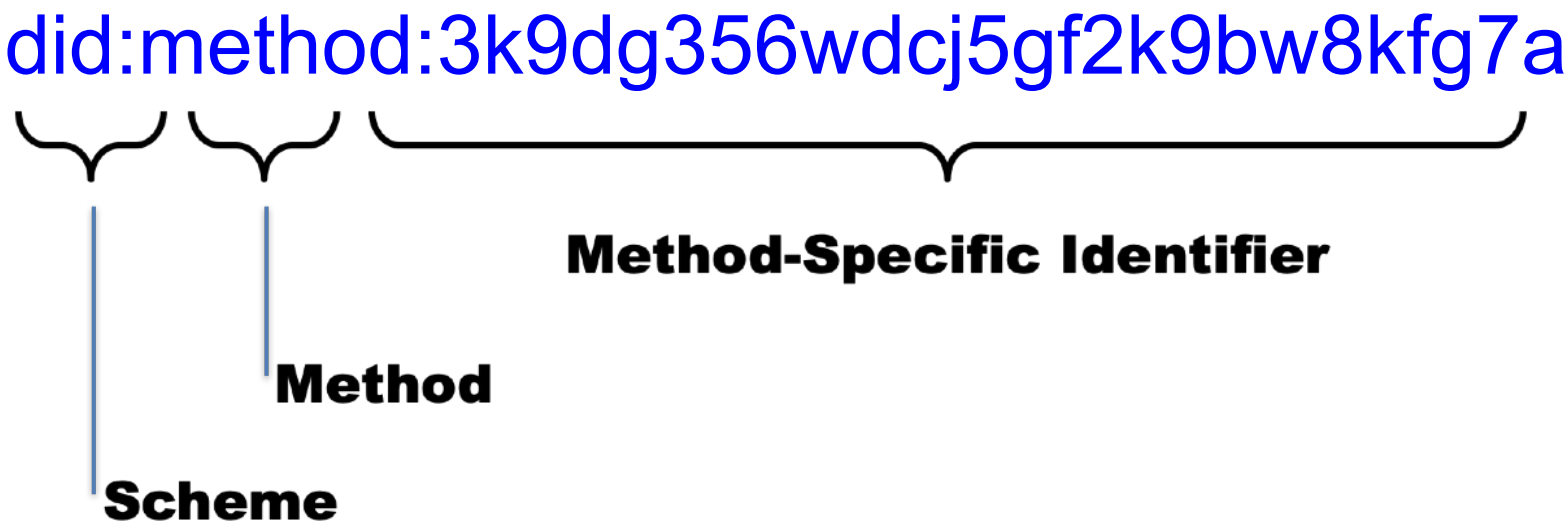
Globally Managed Registries

- Broadly Accessible
- Pay rent to keep your “identifier”
- At the affect of / governance of the names space
- Globally Resolvable
- Basis of global communications networks
- But have emerging security and fraud concerns

How are Decentralized Identifiers Different?

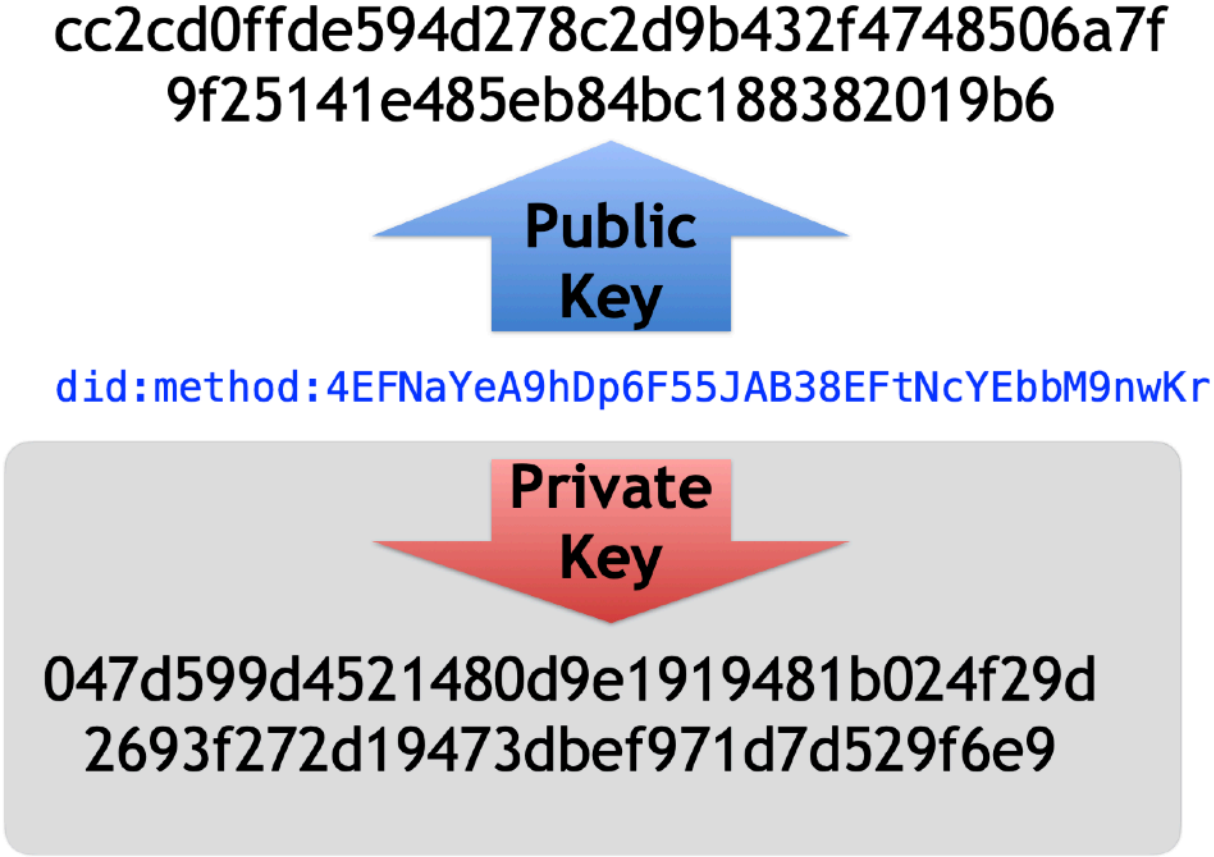
- Any Entity can create one
  - Using software they control
- Infinitely large namespace

Decentralized Identifier (DID)



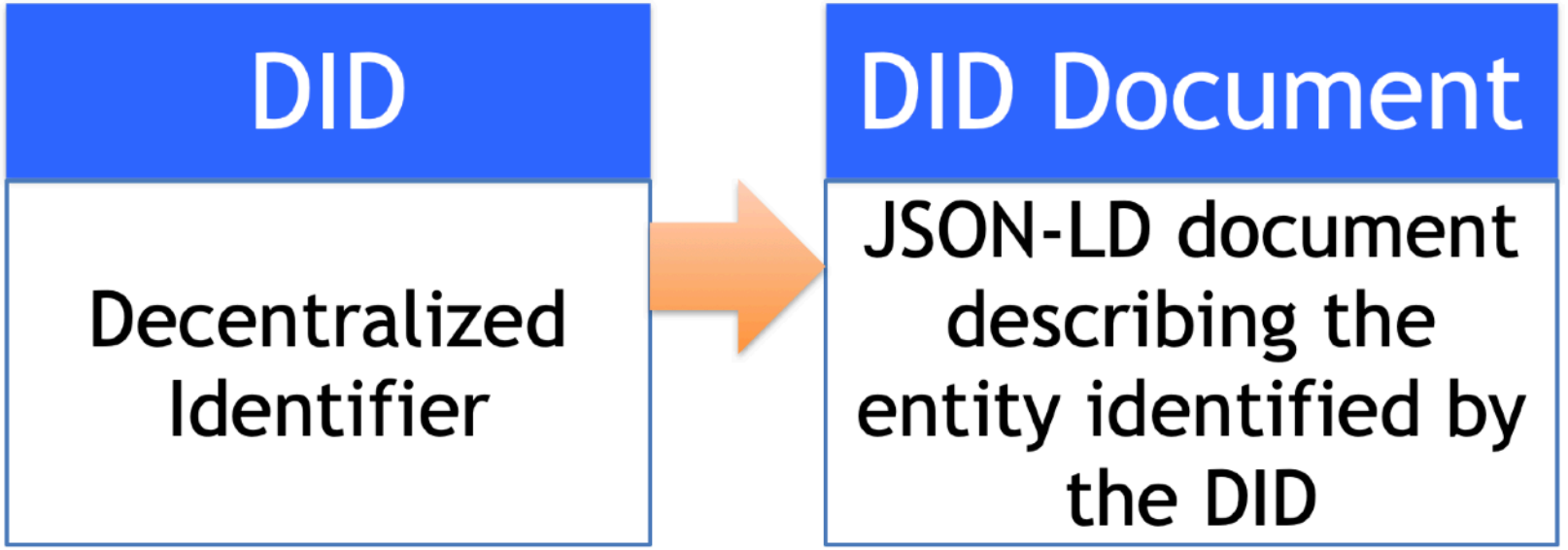
"Decentralized identifiers (DIDs) are a new type of identifier that enables verifiable, decentralized digital identity. A DID refers to any subject (e.g., a person, organization, thing, data model, abstract entity, etc.) as determined by the controller of the DID. In contrast to typical, federated identifiers, DIDs have been designed so that they may be decoupled from centralized registries, identity providers, and certificate authorities."
(Source: https://www.w3.org/TR/did-core/)

Decentralized Identifier (DID)



Decentralized Identifier (DID)

{ “Key”: “Value” }



Decentralized Identifier (DID)

The standard elements of a DID doc

1. **DID** (for self-description)
2. **Set of public keys** (for verification)
3. **Set of auth protocols** (for authentication)
4. **Set of service endpoints** (for interaction)
5. **Timestamp** (for audit history)
6. **Signature** (for integrity)

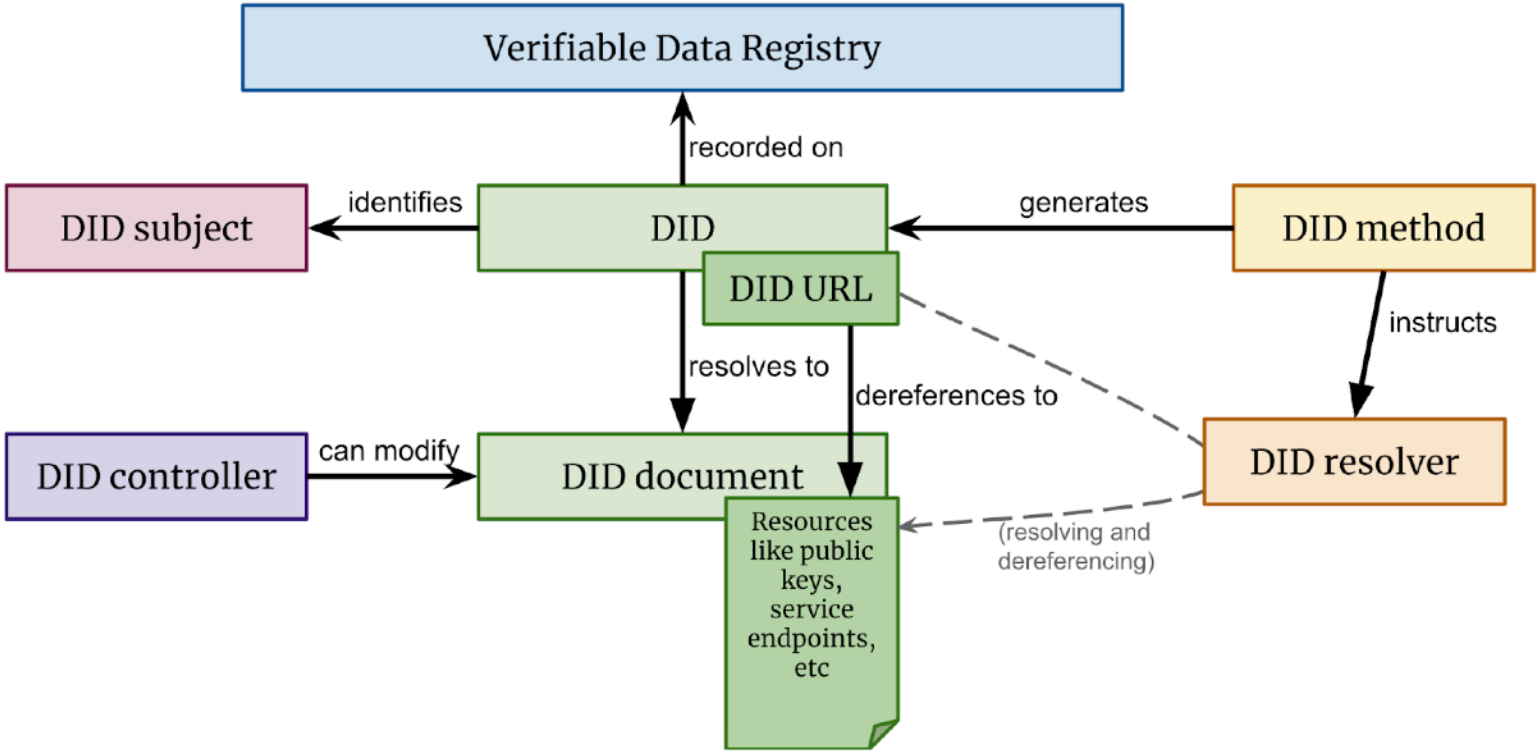
Example DID Document (Part 1)

```
{
  "@context": "https://w3id.org/did/v1",
  "id": "did:example:123456789abcdefghi",
  "publicKey": [{
    "id": "did:example:123456789abcdefghi#keys-1",
    "type": "RsaSigningKey2018",
    "owner": "did:example:123456789abcdefghi",
    "publicKeyPem": "-----BEGIN PUBLIC KEY...END PUBLIC
KEY-----\r\n"
  }],
  "authentication": [{
    "type": "RsaSignatureAuthentication2018",
    "publicKey": "did:example:123456789abcdefghi#keys-1"
  }],
  "service": [{
    "type": "ExampleService",
    "serviceEndpoint": "https://example.com/endpoint/8377464"
  }],
```

Example DID Document (Part 2)

```
    "created": "2002-10-10T17:00:00Z",
    "updated": "2016-10-17T02:41:00Z",
    "signature": {
        "type": "RsaSignature2016",
        "created": "2016-02-08T16:02:20Z",
        "creator": "did:sov:8uQhQMGzWxR8vw5P3UWH1j#key/1",
        "signatureValue": "IOmA4R7TfhkYTYW87z640O3GYFldw0
        yqie9Wl1kZ5OBYNAKOwG5uOsPRK8/2C4STOWF+83cMcbZ3CBMq2/
        gi25s="
    }
}
```

Decentralized **ID**entifier - **DID**



In the Reality and Spirit of Decentralization

The DID standard doesn’t define “A DID” method but a kind of MVP for a DID method

There is a Registry of DID methods

(Anyone can add to it)

There are over 180 methods!

A DID Method spec defines…

1. The syntax of the method-specific identifier
2. Any method-specific elements of a DID document
3. The CRUD (Create, Read, Update, Delete) operations on DIDs and DID documents for the target system

Slide credit: Drummond Reed, Sovrin Foundation

Many DIDs are Globally Resolvable

- Some DID methods anchor DIDs to public blockchains
- Some are on existing infrastructure like DID Web method into existing DNS

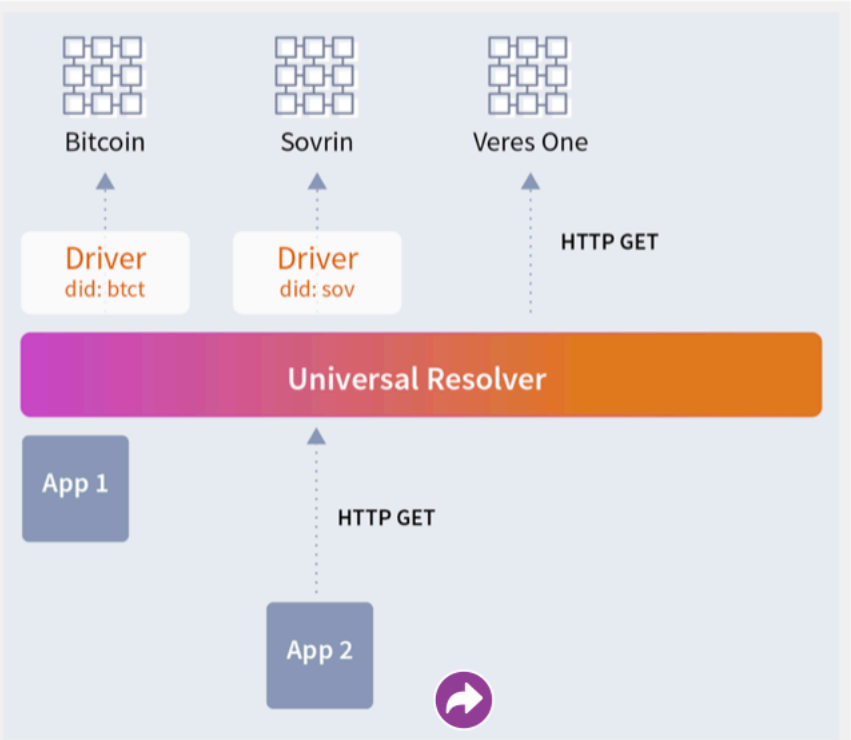
Many DIDs are Globally Resolvable

DID:Web (public) supports leveraging existing DNS architecture to anchor DIDs. This provides backwards compatibility into conventional Web1 and Web 2.0 infrastructure.

DID:PKH (public) leverages existing crypto addresses to create DIDs. It allows most if not all blockchain accounts to instantly leverage an existing identity/account and deploy a DID from it in a standards-conformant way. This provides forward compatibility into Web 3.0 infrastructure.

DID:TDW (public) Trust DID Web is an enhancement to the DID method. Including a self-certifying identifier (SCID) for the DID that is globally unique, embedded in the DID, and derived from the initial DIDDoc.

Maintains Code for a Universal Resolver in GitHub



There are companies like Danube Tech that have commercial services for this

godiddy

godiddy is a hosted platform that makes it easy for developers and solution providers to work with Decentralized Identity

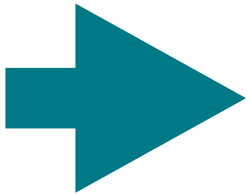
Some DIDs are Non-Public

- DID:PEER (non-public) is suitable for most private relationships between people, organizations, and things. They create the conditions for people, organizations and things to have full control of their end of the digital relationships they sustain.

- DID:KEY (non-public) is used to express public keys in a way that doesn't require a DID Registry of any kind. It is an offline-friendly, cryptographically self-certifying method that requires no trust of certificate authorities or blockchain and is ideal for ephemeral use.

DIDs are Identifiers that are

- Globally resolvable
- Decentralized
- Have Associated
  - Public Keys
  - End Points

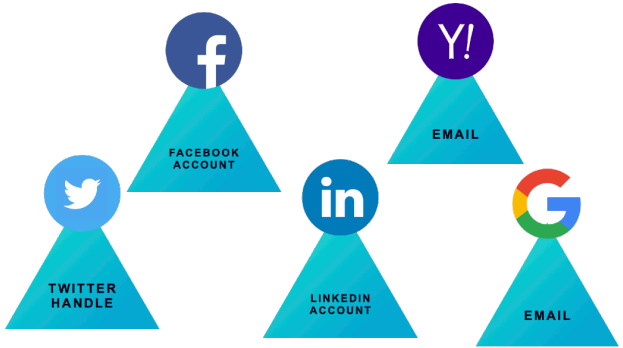


Resolvable
Decentralized
Public Key
Infrastructure

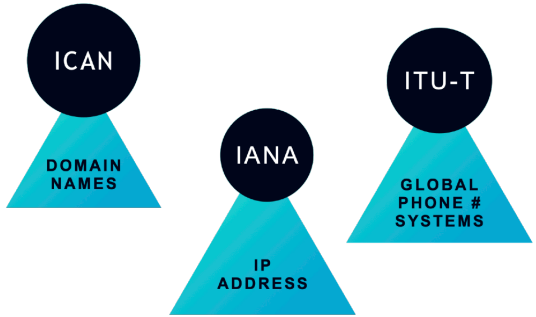
DIDs are Deep Infrastructure

Essential to reset the foundation to get beyond:

Private Name Spaces



Globally Managed Registries



did:method:3k9dg356wdcj5gf2k9bw8kfg7a

Slide credit: Drummond Reed, Sovrin Foundation

did:method:3k9[illegible]dcj5gf2k9bw8kfg7a

Who cares about really long numbers?

Slide credit: Drummond Reed, Sovrin Foundation

Verifiable Credentials

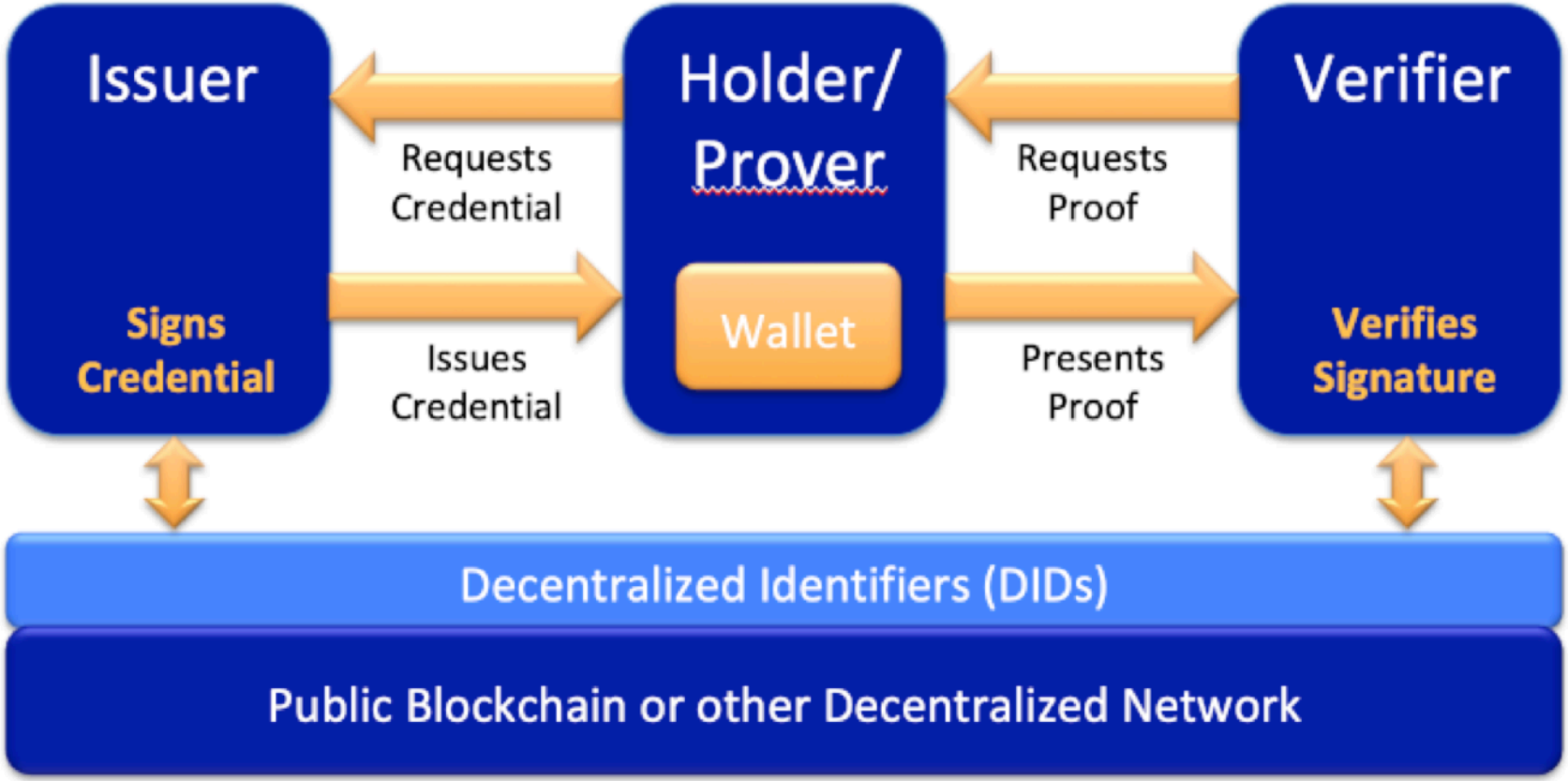
Originally incubated in the Credentials Community Group
then Standardized at the W3C

Version 1.1. [Implementors Guide]
Version 2 is nearing completion

**The SPICE working group was just spun up in IETF

I co-authored a report about the various flavors of digital credentials.

Verifiable Credential (VC)



Digital U.S. Permanent Resident Card

```
{
  "@context": [
    "https://www.w3.org/2018/credentials/v1",
    "https://w3id.org/vc-revocation-list-2020/v1",
    "https://w3id.org/citizenship/v1",
    "https://www.uscis.gov/prc/digital/v1"
  ],
  // specify the identifier for the credential
  "id": "https://vc-issuer.uscis.gov/credential/prc/83627465",
  // the credential type which declares what data to expect in the credential
  "type": ["VerifiableCredential", "PermanentResidentCard"],
  // the entity that issued the credential
  "issuer": "did:web:www.uscis.gov:green-card",
  // alternate identifier used by the Issuer of the credential
  "identifier": "83627465",
  // when the credential was issued
  "issuanceDate": "2019-12-03T12:19:52Z",
  // when the credential expires
  "expirationDate": "2028-02-26T00:00:00Z",
  // discover current status of the credential
  "credentialStatus": {
    "id": "https://vc-issuer.uscis.gov/credential/prc/status/3#94567",
    "type": "RevocationList2020Status",
    "revocationListIndex": "94567",
    "revocationListCredential": "https://vc-issuer.uscis.gov/credential/prc/status/3"
  },
  // claims about the subject of the credential
  "credentialSubject": {
    // identifier for the only subject of the credential
    "id": "did:approved-did-method:b34ca6cd37bbf23",
    // assertions about the only subject of the credential
    "type": ["PermanentResident","Person"],
    "givenName": "TEST",
    "familyName": "SPECIMEN",
    "gender": "M",
    "image": "...kJggg==",
    "residentSince": "2015-01-01",
    "lprCategory": "C09",
    "lprNumber": "000-000-204",
    "commuterClassification": "C1",
    "birthCountry": "Bahamas",
    "birthDate": "1958-08-17"
  },
  // digital proof to make the credential tamper-evident
  "proof": {
    // the cryptographic signature suite used to generate signature
    "type": "RsaSignature2018",
    // the date the signature was created
    "created": "2020-01-30T03:32:15Z",
    // purpose of the proof
    "proofPurpose": "assertionMethod",
    // the identifier of the public key that can verify the signature
    "verificationMethod": "did:web:www.uscis.gov:green-card#public-key-1",
    // the digital signature value
    "jws": "eyJhbGciOiJFZERTQSIsI...wRG2fNmAx60Vi4Ag"
  }
}
```

Who is the **Issuer** of this credential?
e.g. did:web:www.uscis.gov:green-card

What is the **current status** of this credential?
https://w3c-ccg.github.io/vc-status-list-2021/

Who is the **Subject** of the credential? BYO-W3C-DID

What does the Issuer **assert about** the Subject?
https://w3c-ccg.github.io/citizenship-vocab/

How can a Verifier find the Public Key of the Issuer to **Verify the Digital Signature** that ensures the integrity and provenance of the credential?

Verifiable Credential (VC)

Broad Expressive Capacity

Huge Range of Use-Cases

Exchange Protocols:

DIDComm

OpenID4VC

OpenIDIDComm

DIDComm Messaging

DIDComm Protocols for Human Communication allow for the interactions between two parties using human focused communication.

DIDComm uses DIDs (Decentralized Identifiers) to establish confidential, ongoing connections, without the need for usernames and passwords.

DIDComm protocols enable trusted interactions between parties. These support activities like secure chat, verifiable credential exchange, buying and selling, scheduling, escrow, bidding, ticketing, and so forth. If not already in use, protocols can be designed for any use case.

Decentralized Identity Foundation Specification on GitHub

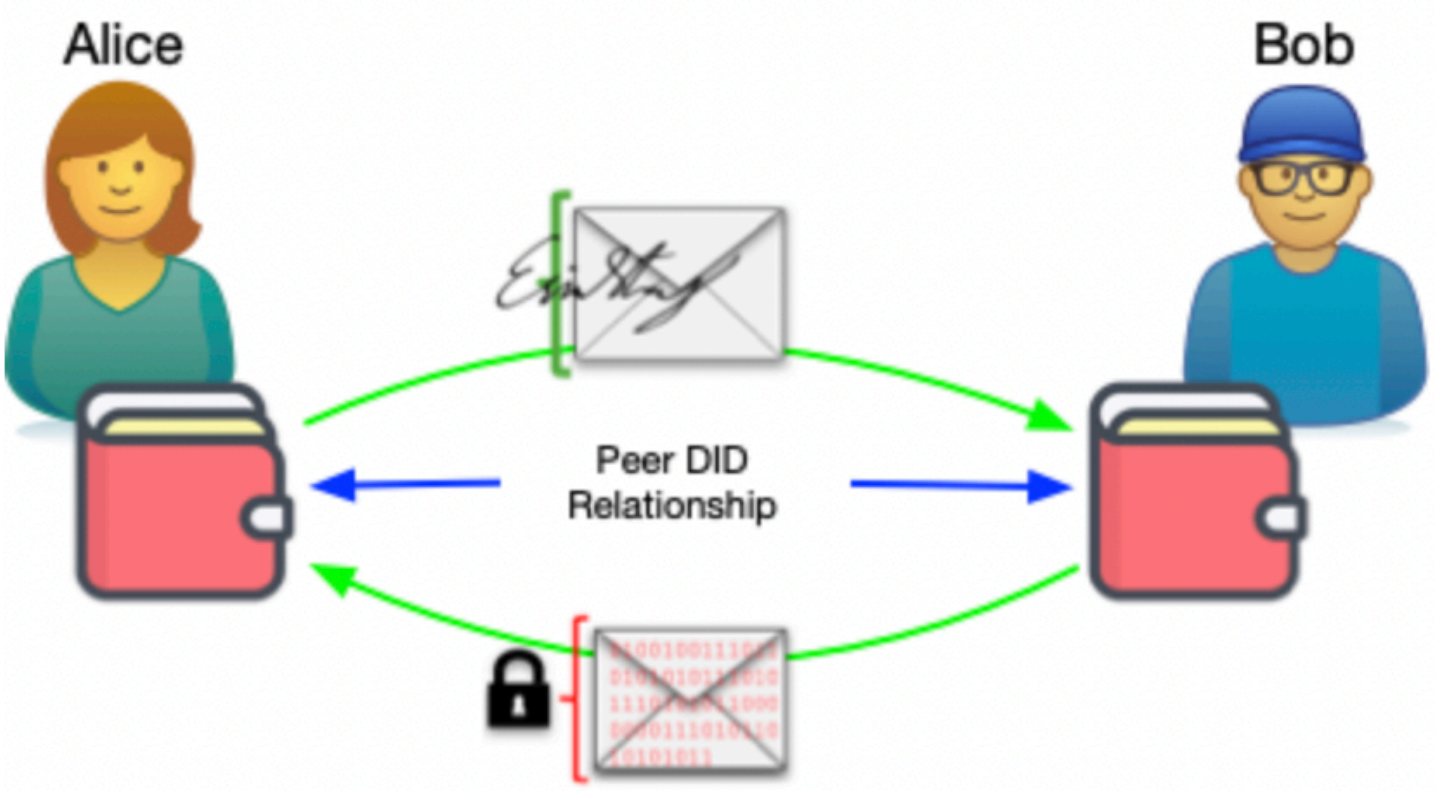
DIDComm Messaging

DID:PEER (non-public) is suitable for most private relationships between people, organizations, and things. They create the conditions for people, organizations and things to have full control of their end of the digital relationships they sustain.

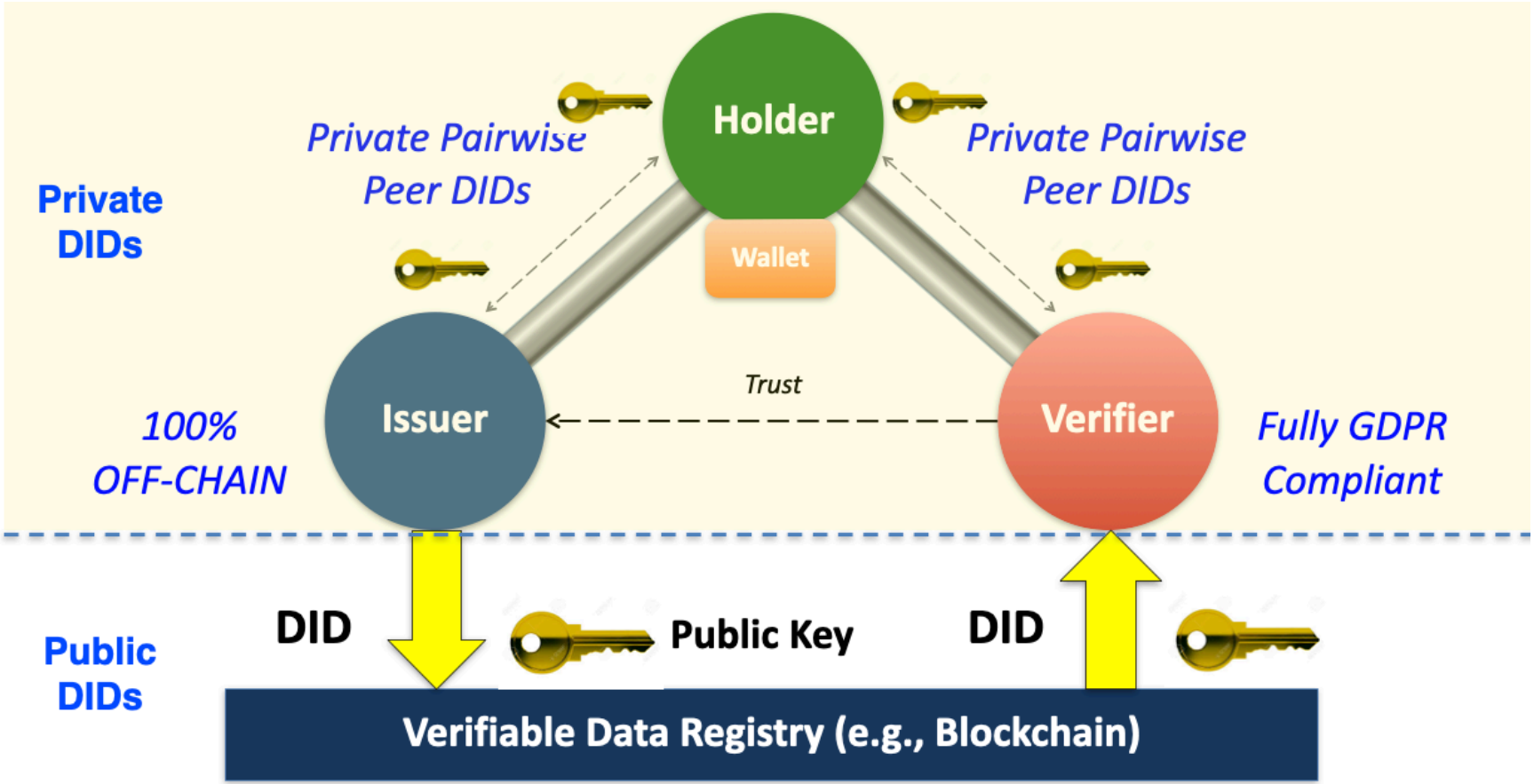
DIDComm Messaging

Alice and Bob exchange Peer DIDs to create a relationship

DIDComm Messaging



DIDComm & Verifiable Credentials



Source: https://trustoverip.github.io/WP0010-toip-foundation-whitepaper/trust/vcred_trust_triangle/

OpenID4VC

To understand OpenID4VC, it is helpful to first understand OAuth 2.0, which is the basis of our work, for a brief overview, just have a look at OAuth 2.0 simplified

OID4VCI is used for the issuance of Verifiable Credentials. It provides an API

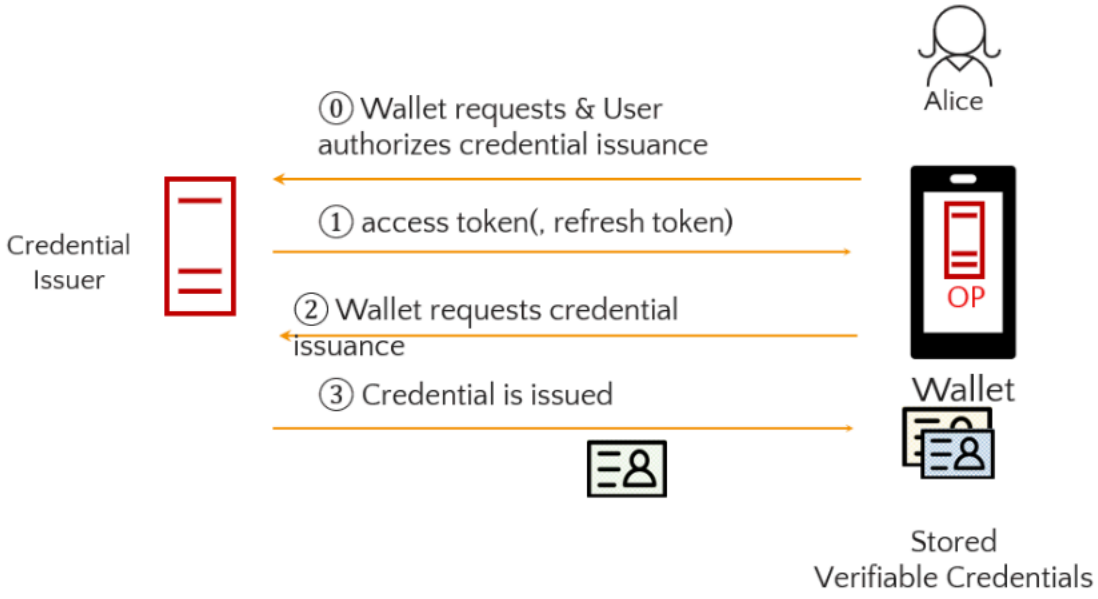
- Credential Endpoint
- Batch Credential Endpoint
- Deferred Credential Endpoint

OpenID4VP is used for the presentation of Verifiable Credentials. It extends the OAuth2.0 flow by introducing the so called VP Token as a container which allows users to present their presentations to verifiers via a wallet. One can distinguish different scenarios where the verifier and the user are using the same device (Same-Device-Flow) or using different devices (Cross-Device-Flow).

OpenID4VC

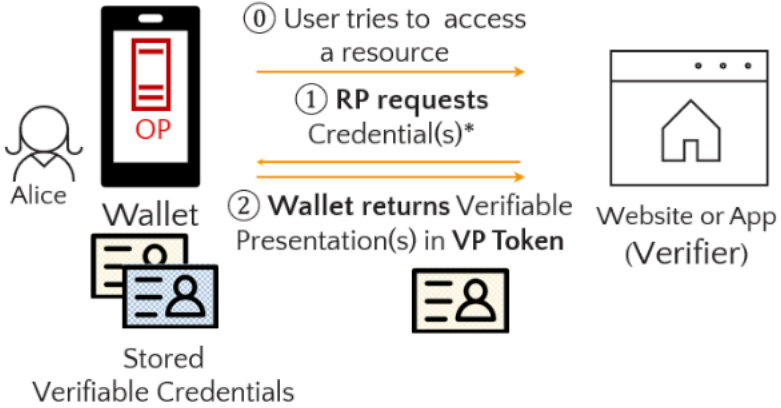
OpenID 4 Verifiable Credentials Issuance

Credential issuance via simple OAuth-authorized API



OpenID4VC

OpenID for Verifiable Presentations



- Query language to granularly specify what kind of credential Verifier wants. (utilizes DIF Presentation Exchange 2.0)
- Verifiable Presentations* are returned in a newly defined VP Token
- Simple overall architecture, e.g. device local communication when same device flow is used

OpenIDIDComm

In order to turn an OID4VC interaction into a DIDComm connection, the OID4VC exchange must include a DID that contains a DIDComm service endpoint, or can be updated to include a DIDComm Service Endpoint. Ideally, both parties share their DID in the exchange, allowing either to initiate a DIDComm relationship.

https://github.com/IDunion/OpenIDIDComm

https://book.didcomm.org/oid4vc/

Decentralized Trust & Governance Frameworks

What is Governance Framework or Trust Registry?

What types of entity are in the registry?
How do you know who owns Public Keys (DID/x509)?
What types of credentials do they issue?
How is the registry governed?
What do they agree to?

[Introduction to Trust Over IP Model]

[Trust over IP Deliverables Page - Lots of Document]

How the Trust Registry fits in with VC exchange

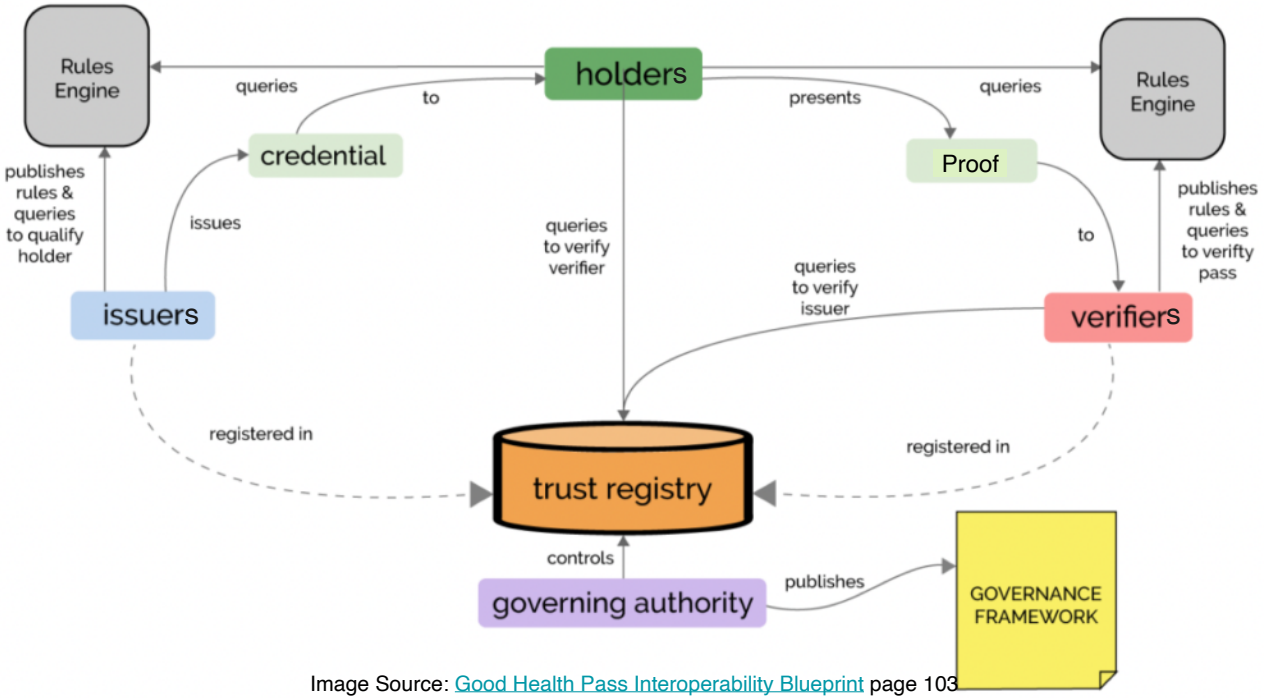


Image Source: Good Health Pass Interoperability Blueprint page 103

How do you figure out where the Registries Are?

TRAIN (TRust mAnagement INfrastructure)

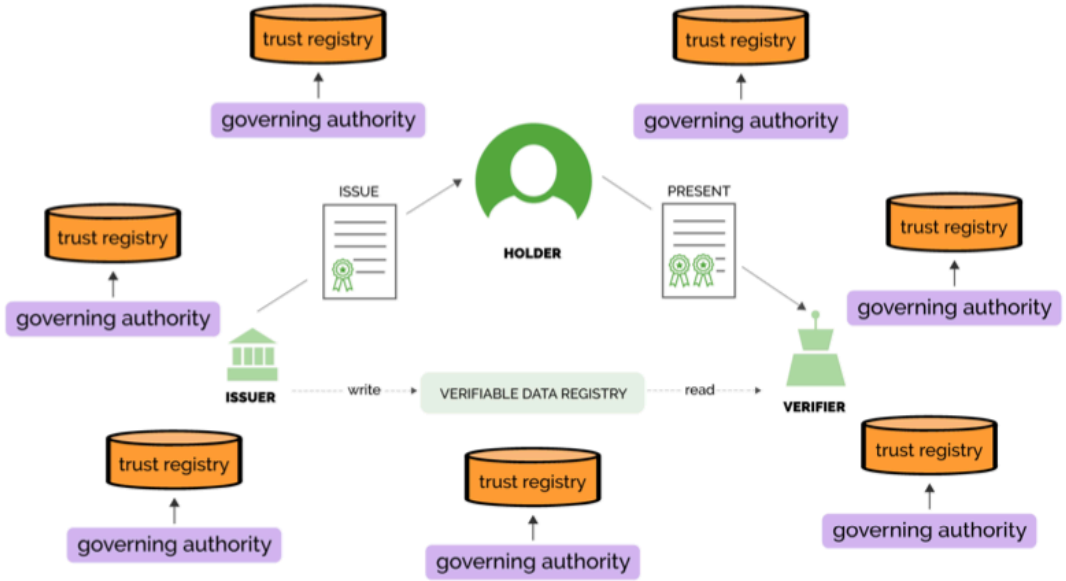


Image Source: Good Health Pass Interoperability Blueprint page 104

https://www.lfph.io/2022/04/19/lfph-completes-the-proof-of-concept-of-its-gccn-trust-registry-network/

https://essif-lab.eu/essif-train-by-fraunhofer-gesellschaft/

Regi-Trust is building a directory of trust Registries

Digital TRUST Infrastructure for Discovery and Validation (Regi-TRUST) is an infrastructure project sponsored and hosted at the United Nations Development Programme (UNDP). The project is intended to develop and provide a suite of tools to enable discovery and validation of trusted services by leveraging existing Internet infrastructures of the Domain Name System (DNS) and its security extensions.

Regi-TRUST can enable scalable 'network of networks' model that today's fully centralized model is not able to. decentralized, cloud-agnostic architecture it adopts, any participating service of an implemented network or ecosystem will be able to maintain the sovereignty and control of their own systems and data. Such an approach provides the necessary trust infrastructure that can help to thwart the ubiquitous phishing attempts mimicking online service organizations, such as government institutions, health providers and banks.

Git Hub Code

Three Centers of Gravity all doing key work on Decentralized ID Standards

Credentials Community Group

https://w3c-ccg.github.io/

Decentralized Identity Foundation

https://decentralized-id.com/

https://trustoverip.org/

Internet Identity Workshop #39
Mountain View, California
October 29-31, 2024

Internet Identity Workshop #40
Mountain View, California
April 6-8, 2025

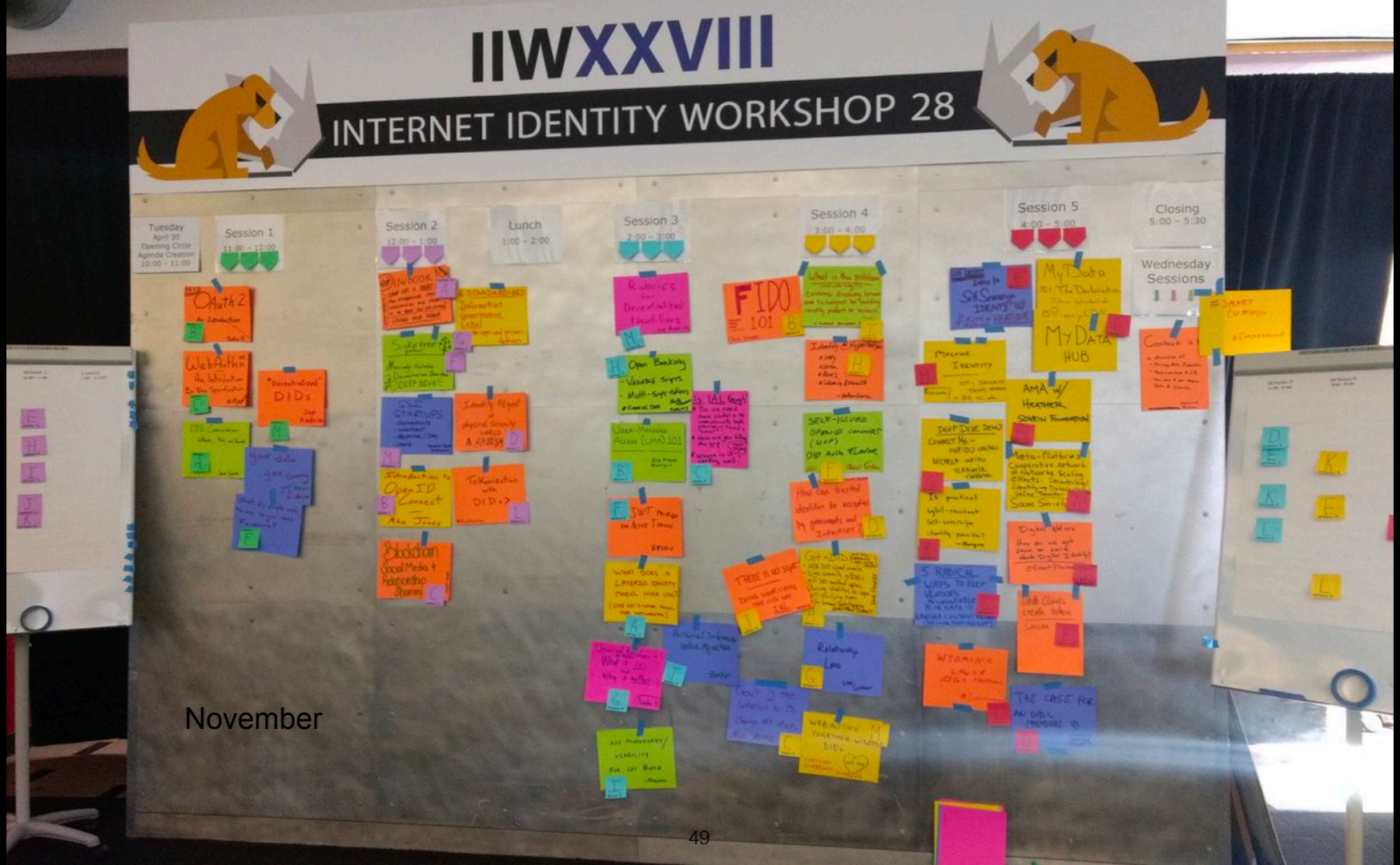
Regional Events:

DID UnConf Africa
Cape Town South Africa
September 25-27, 2024

APAC Digital Identity unConference
Bangkok, Thailand
January 22-24

Digital Identity unConference Europe
Hack/Write Event in Feb/March 2025
Main Conference: September 2025

https://internetidentityworkshop.com/


IIWXXVIII
INTERNET IDENTITY WORKSHOP 28
Tuesday
April 30
Opening Circle
Agenda Creation
10:00 – 11:00
Session 1
11:00 – 12:00
Session 2
12:00 – 1:00
Lunch
1:00 – 2:00
Session 3
2:00 – 3:00
Session 4
3:00 – 4:00
Session 5
4:00 – 5:00
Closing
5:00 – 5:30
Wednesday
Sessions
OAuth 2
WebAuthn
DIDs
FIDO 101
Open Banking
Blockchain
Social Media + Relationship Sharing
MyData HUB
AMA w/ Heather
November

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Identity Woman in Business