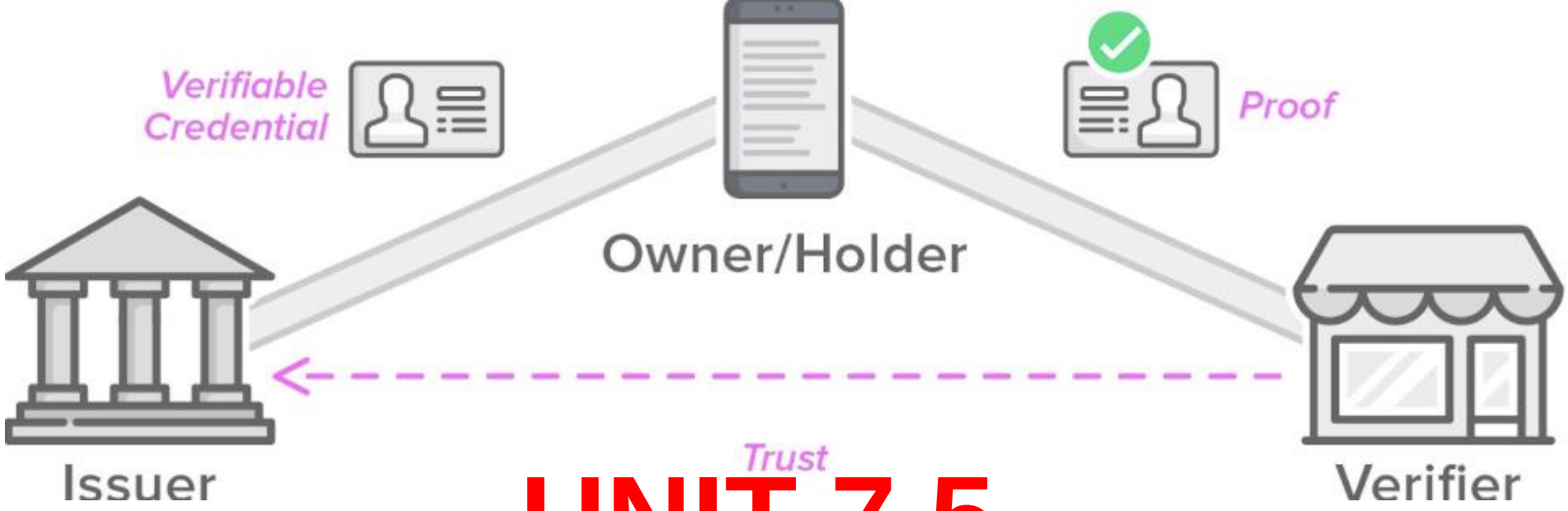


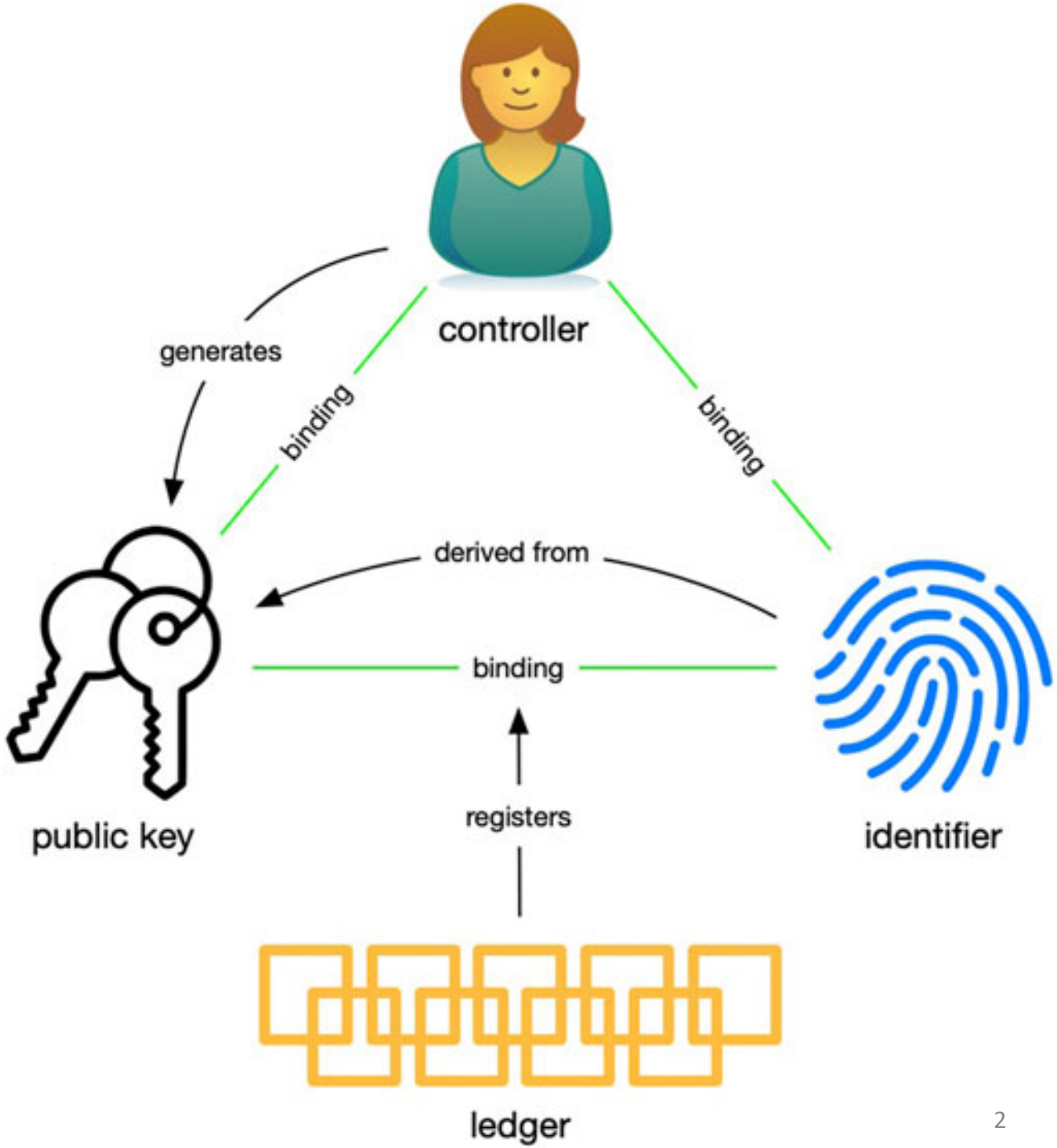
UNIT 7.5

BLOCKCHAIN APPLICATIONS

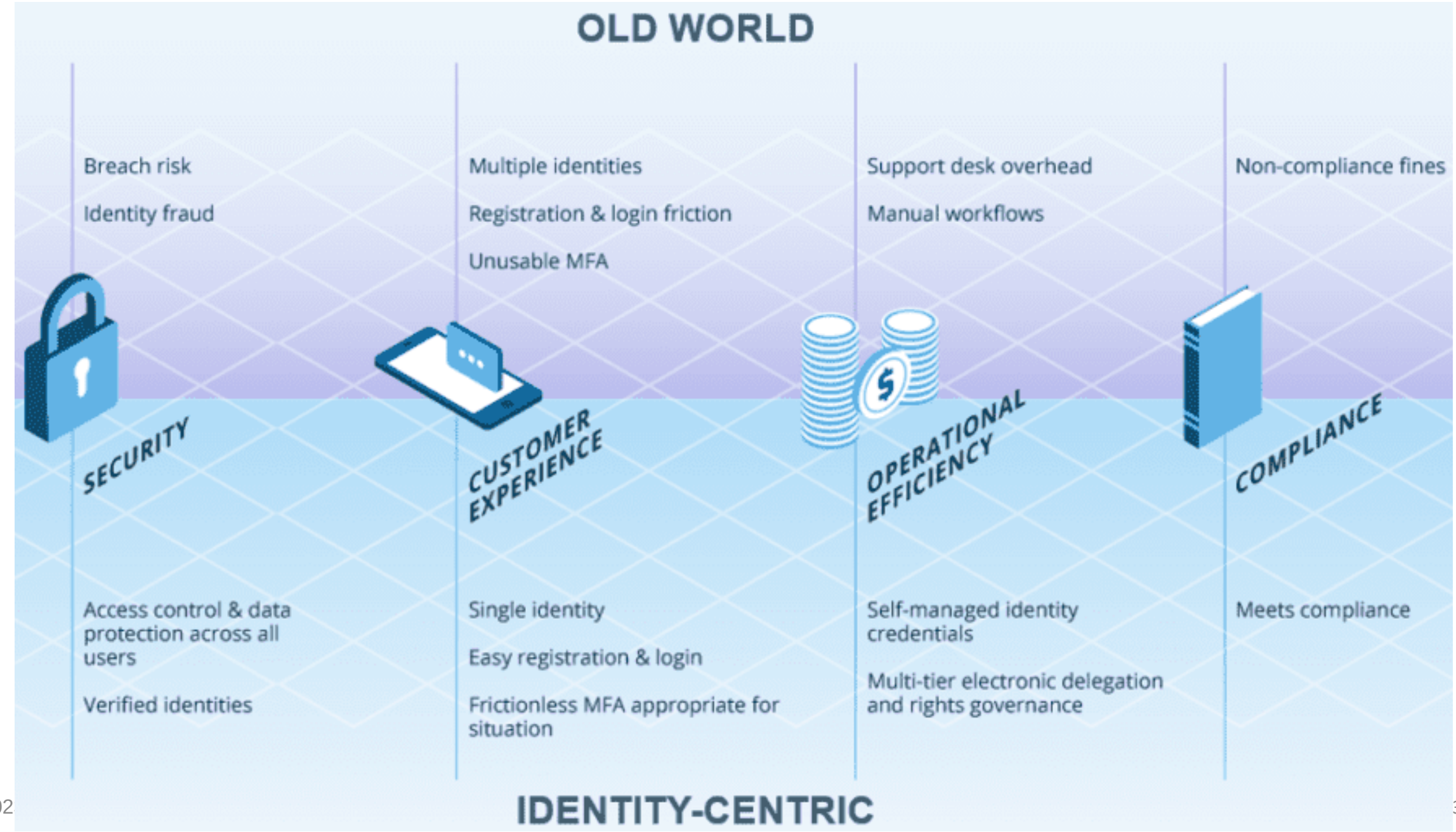
SELF-SOVEREIGN IDENTITY

Lecturer: Ph.D Lê Quang Huy

CONTENTS



1. INTRODUCTION



2. IDENTITY MANAGEMENT

2.1. INTRODUCTION

2.2. DIGITAL IDENTITY

2.3. IDENTITY MANAGEMENT

2.4. BENEFIT OF IDENTITY MANAGEMENT

2.5. IDENTITY MANAGEMENT MODELS

2.2. DIGITAL IDENTITY

Entity:

- thing with distinct independent existence.
- can have multiple identities

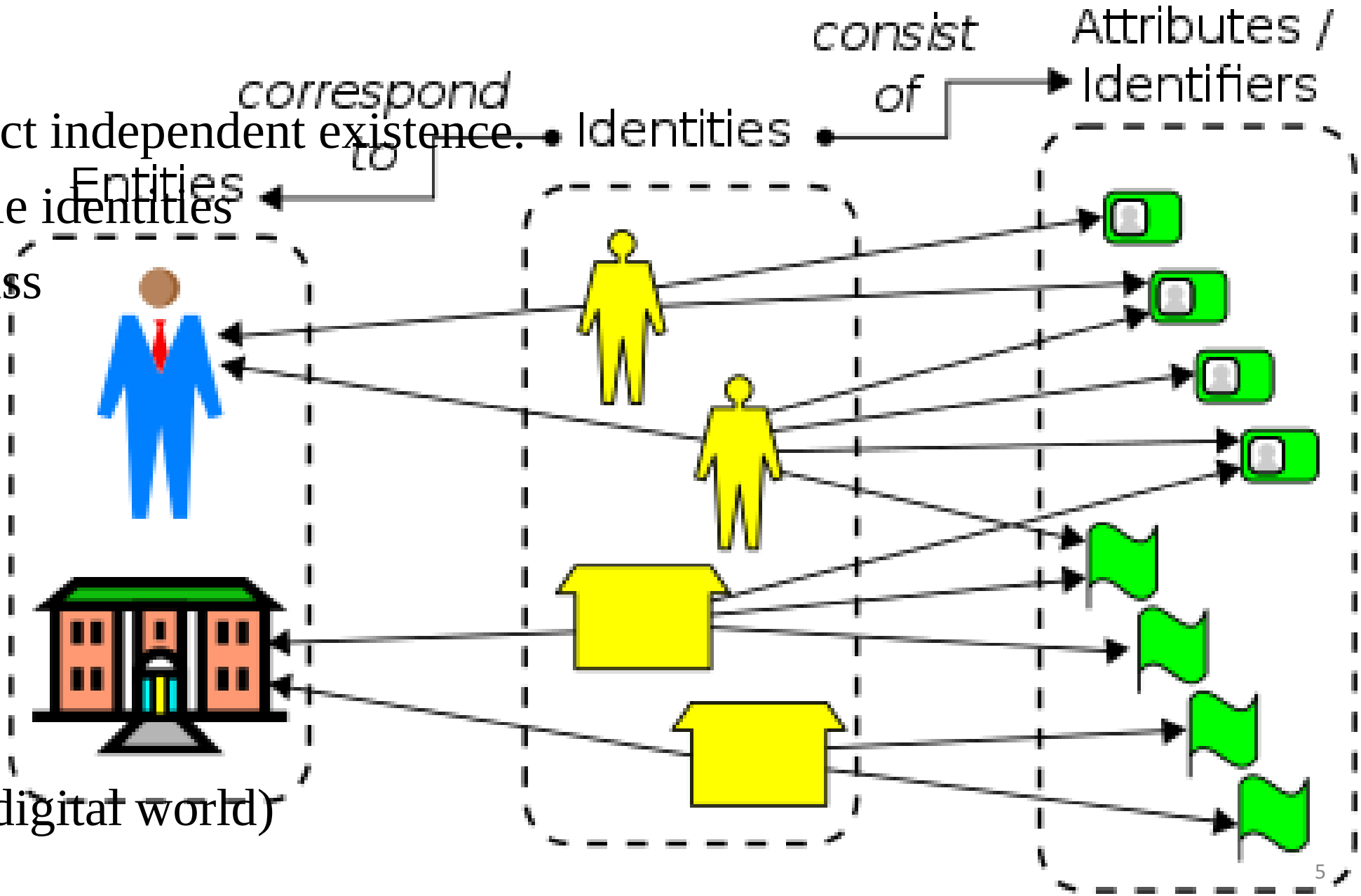
Identity: encompass

- an Identifier
- Attributes
- Activities

Physical Identity

- Intrinsic
- Extrinsic

Digital Identity: (digital world)



2.2. DIGITAL IDENTITY

Identity activities: create/destroy, use

Identification: create identity

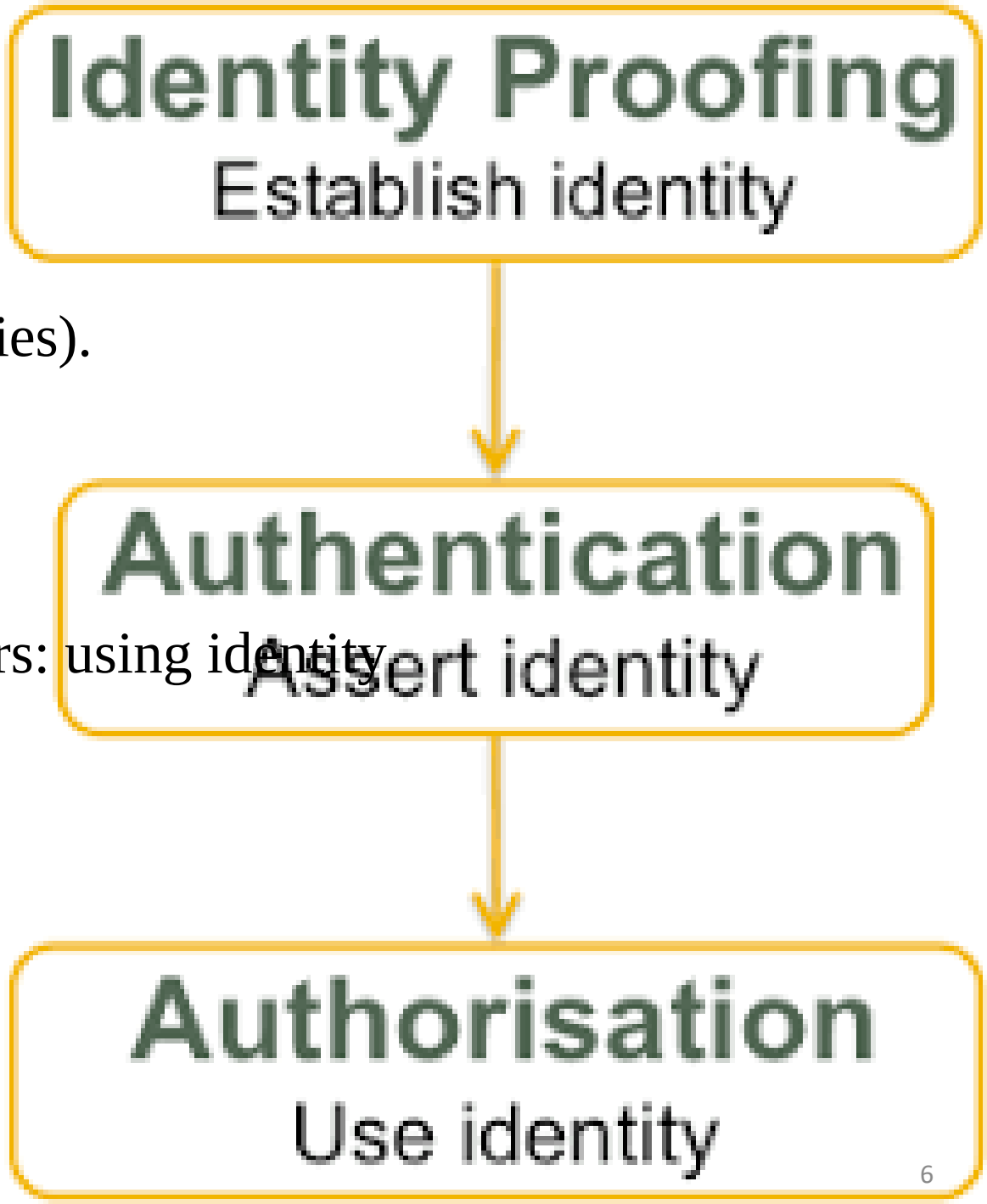
- Submit/gather identity claim (attribute, activities).
- Verification: check identity claim
- Deduplication
- Issue identity Artifact/Credential

Authentication: Check identity credential, factors: using identity

- Knowledge, Possession
- Inherence, Behavioral

Authorisation:

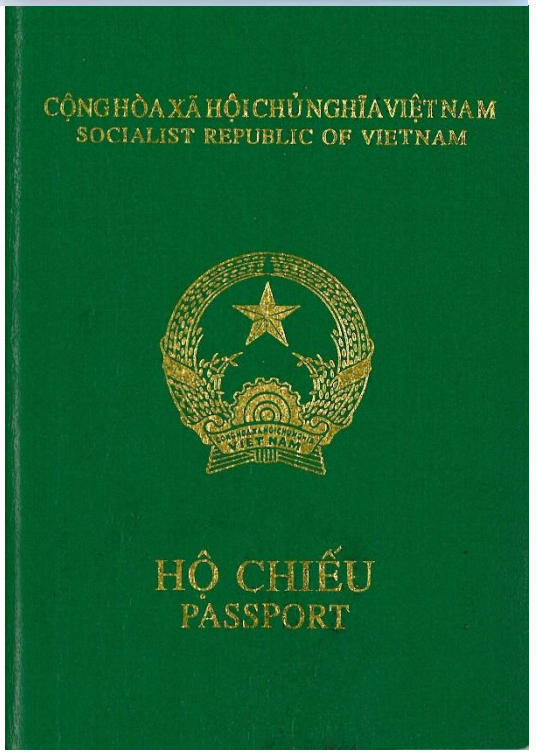
- Relying party
- Actions may be performed



2.2. DIGITAL IDENTITY

Credentials:

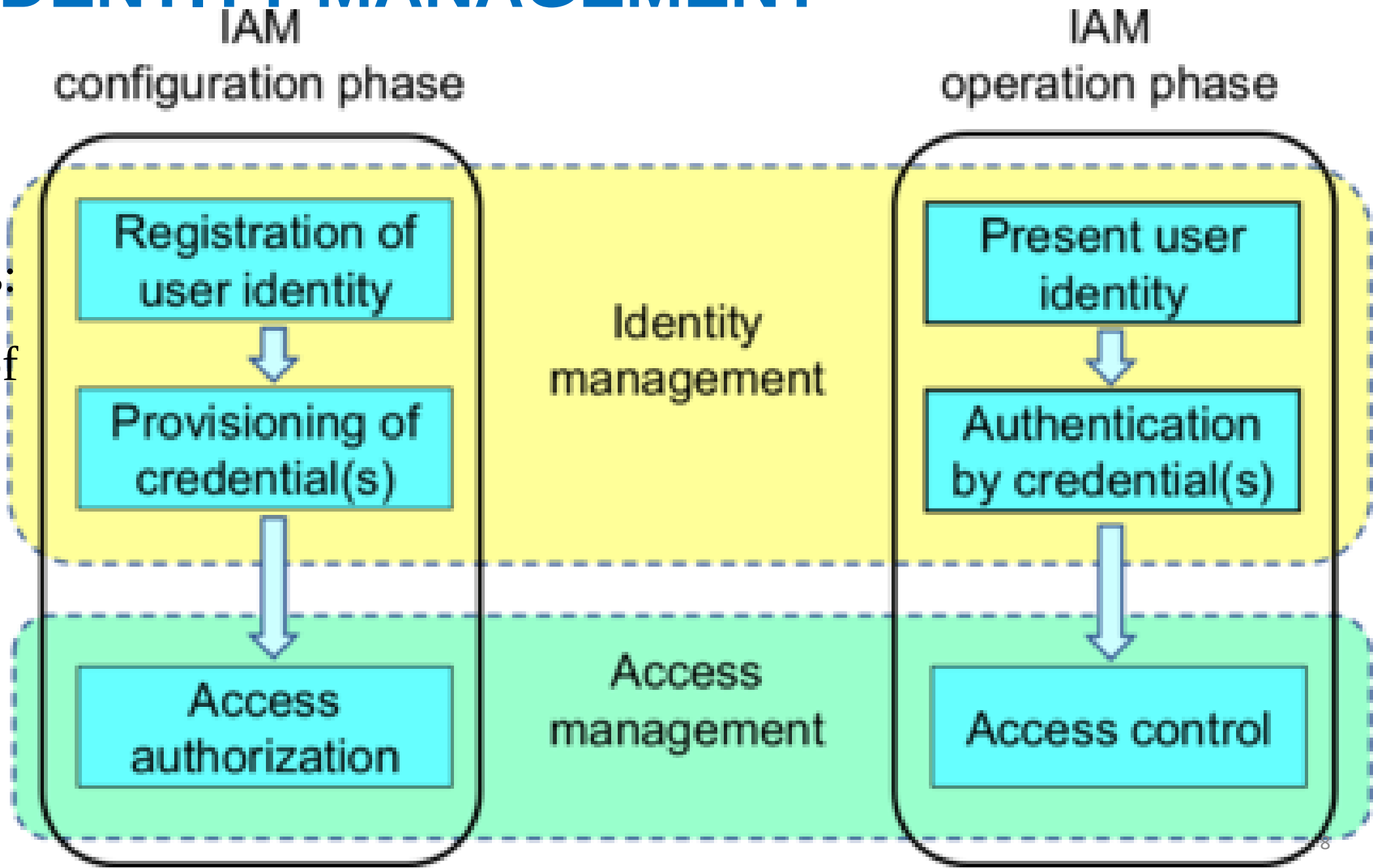
- part of our daily lives;
- driver's licenses, university certificate, passports



2.3. IDENTITY MANAGEMENT

Identity and Access Management (IAM) systems:

- Framework of policies and technologies
- Right users access to resources.

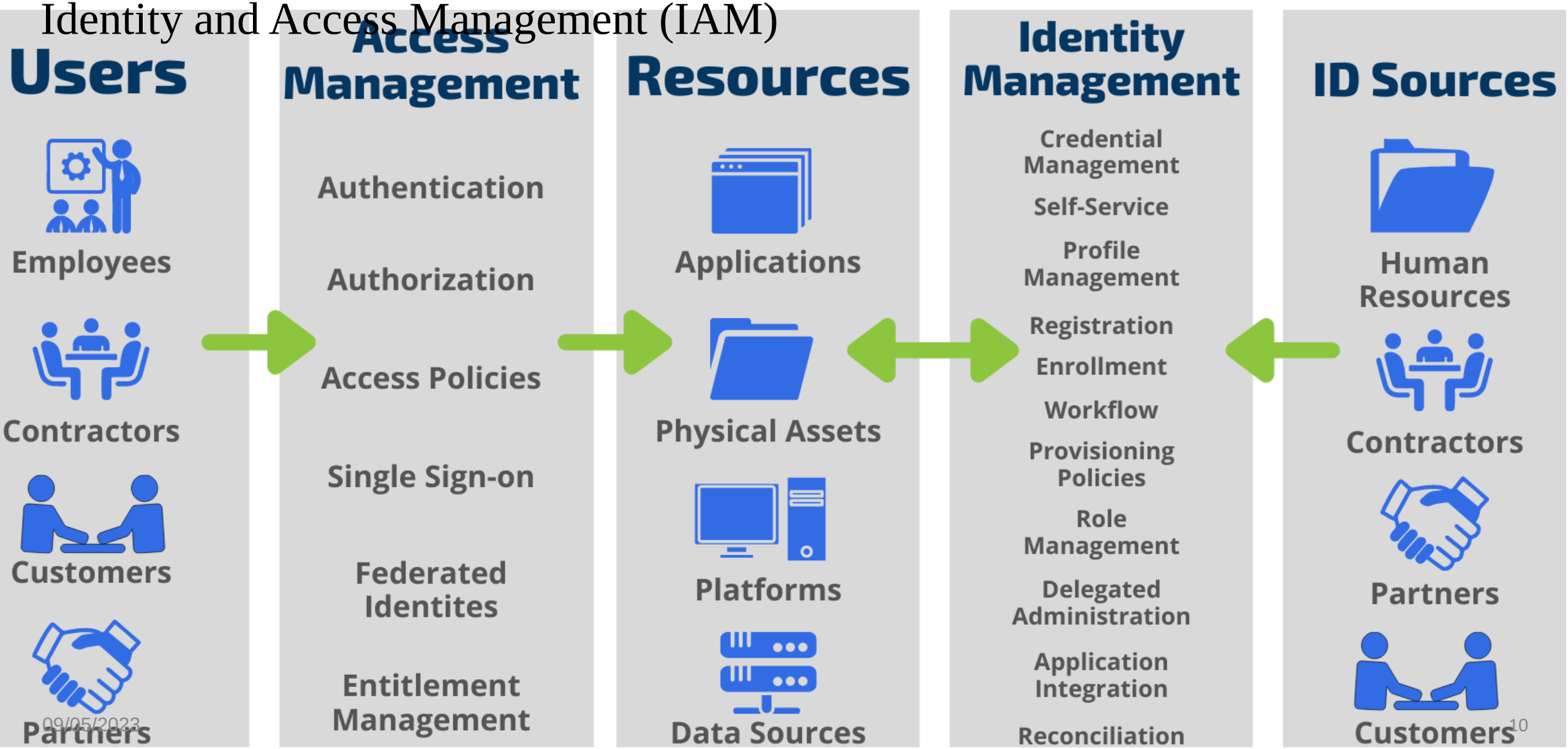


2.3. IDENTITY MANAGEMENT

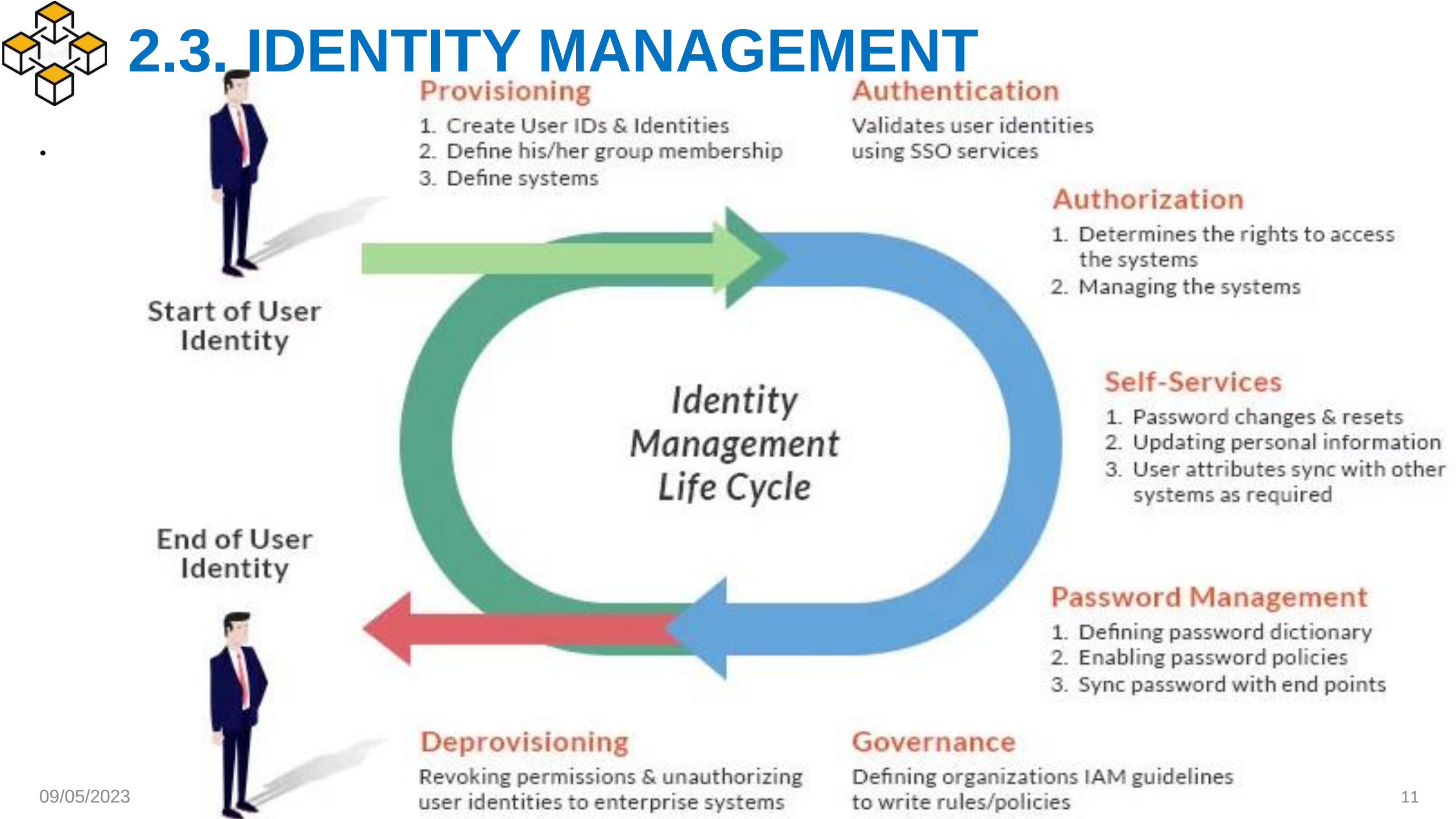
Identity and Access Management (IAM)

2.3. IDENTITY MANAGEMENT

Identity and Access Management (IAM)

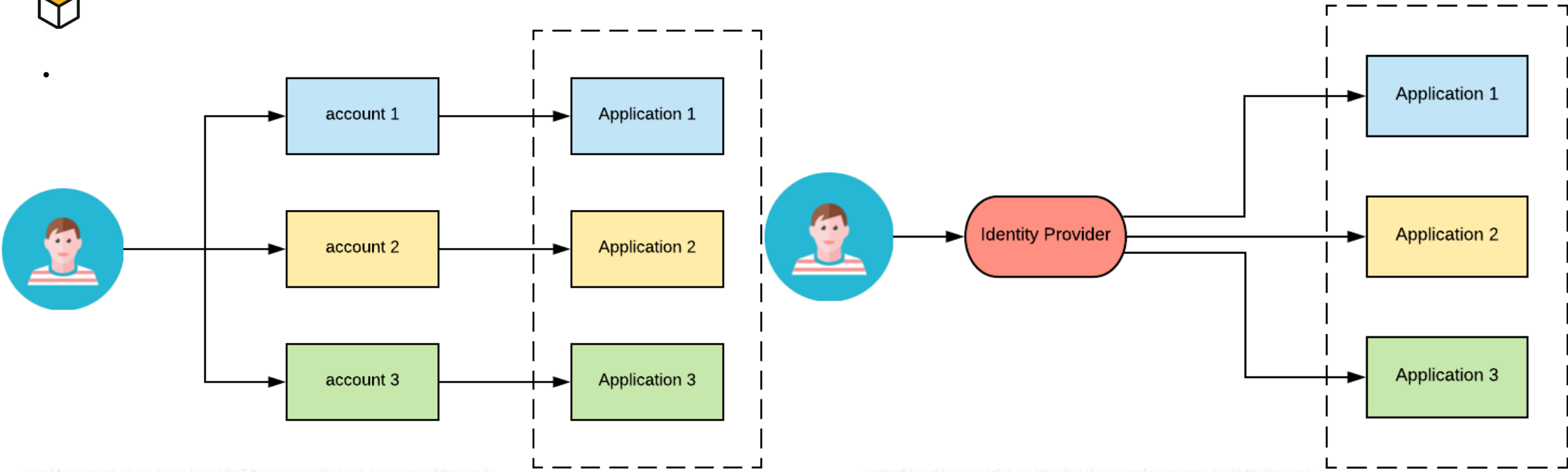


2.3. IDENTITY MANAGEMENT



2.4. BENEFIT OF IDENTITY MANAGEMENT

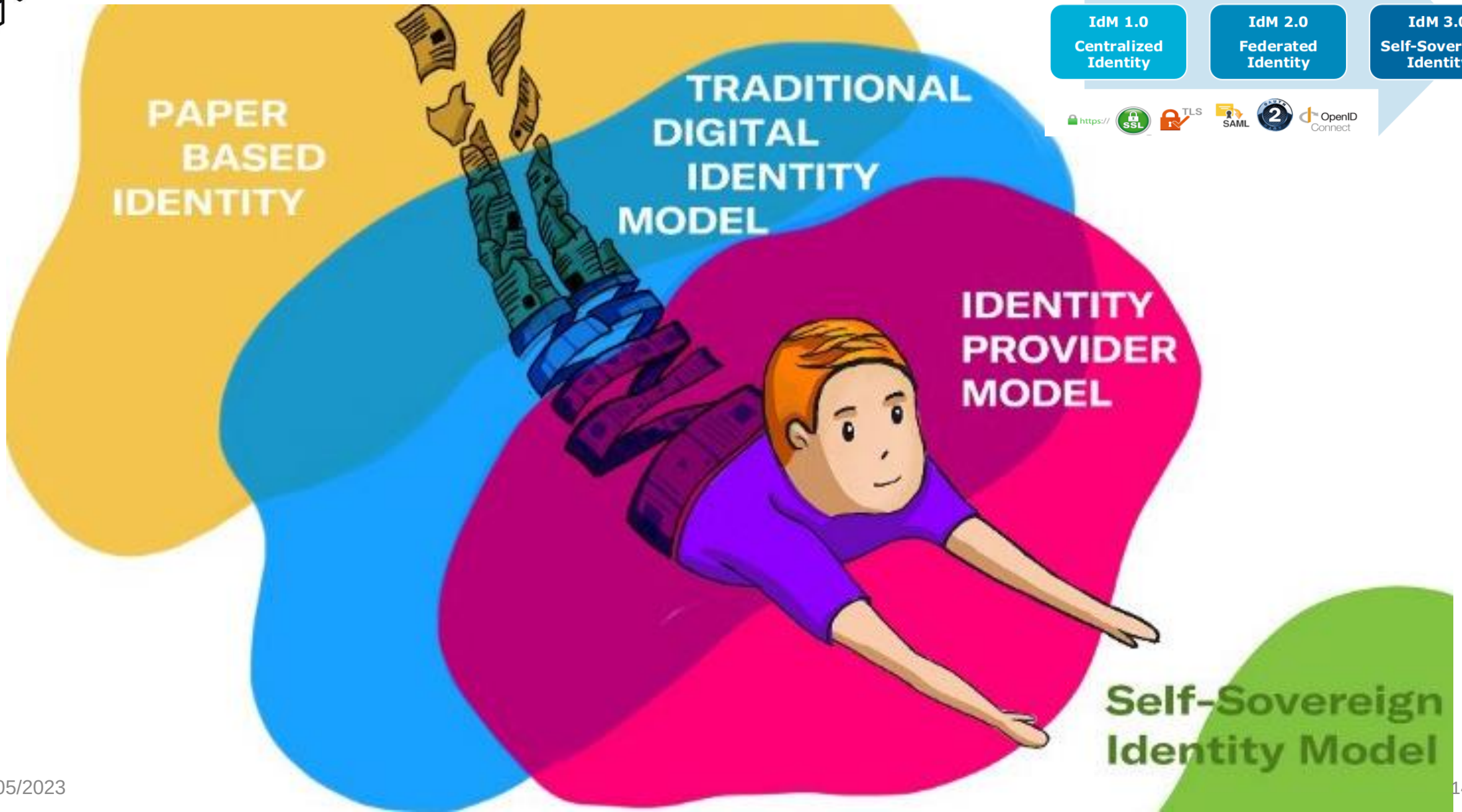
2.5. IDENTITY MANAGEMENT MODELS



#1: Centralized Identity

#2: Federated Identity

2.5. IDENTITY MANAGEMENT MODELS



3. SELF-SOVEREIGN IDENTITY

3.1. INTRODUCTION TO SSI

3.2. GUIDING PRINCIPALS

3.3. MODEL OF SSI

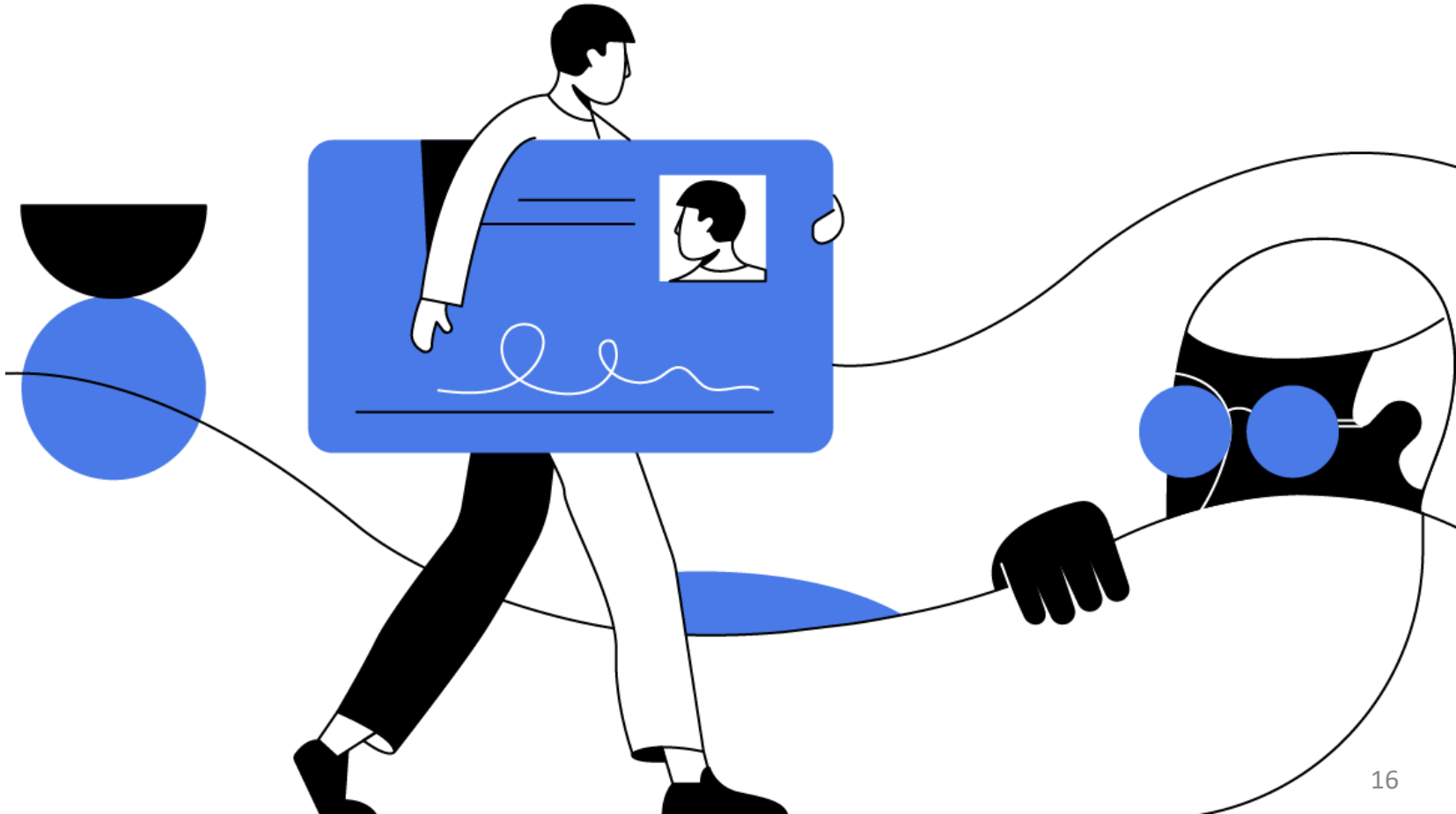
3.4. COMPONENTS OF SSI

3.5. USE CASES

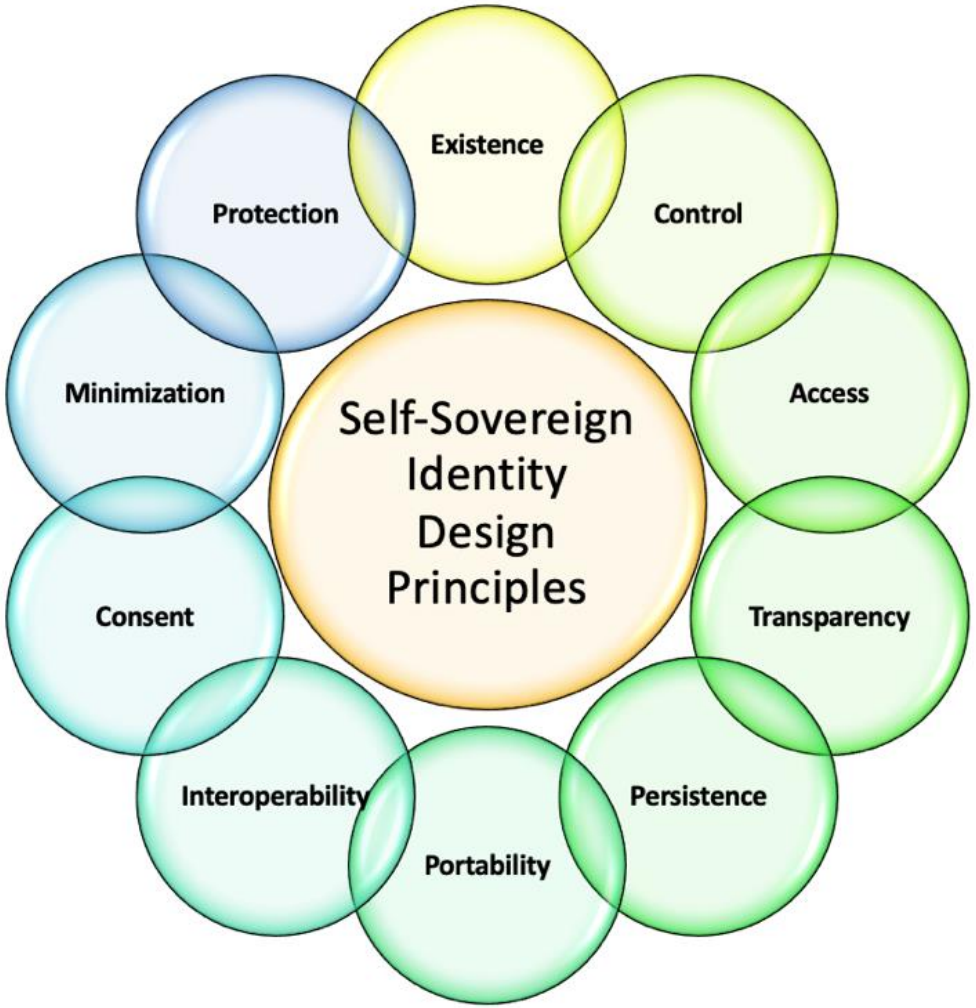
3.1. INTRODUCTION TO SSI

Self-sovereign identity (SSI):

- Is a digital identity.
- Individuals control identity data.



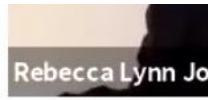
3.2. GUIDING PRINCIPALS



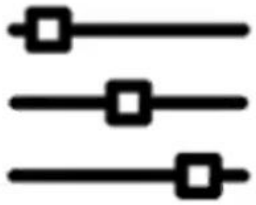
- **Existence**: Users must have an independent existence.
- **Control**: Users must control their identities.
- **Access**: Users must have access to their own data.
- **Transparency**: Systems and algorithms must be transparent.
- **Persistence**: Identities must be long-lived.
- **Portability**: Information and services about identity must be transportable.
- **Interoperability**: Identities should be as widely usable as possible.
- **Consent**: Users must agree to the use of their identity.
- **Minimization**: Disclosure of claims must be minimized.
- **Protection**: The rights of users must be protected.

3.2. GUIDING PRINCIPALS

10 Principles of Self-Sovereign Identity*



Existence
Users must have an independent existence.



Control
Users must control their identities.

Access
Users must have access to their own data.

Transparency
Systems and algorithms must be transparent.

Persistence
Identities must be long-lived.

Portability
Information and services about identity must be transportable.

Interoperability
Identities should be as widely usable as possible.

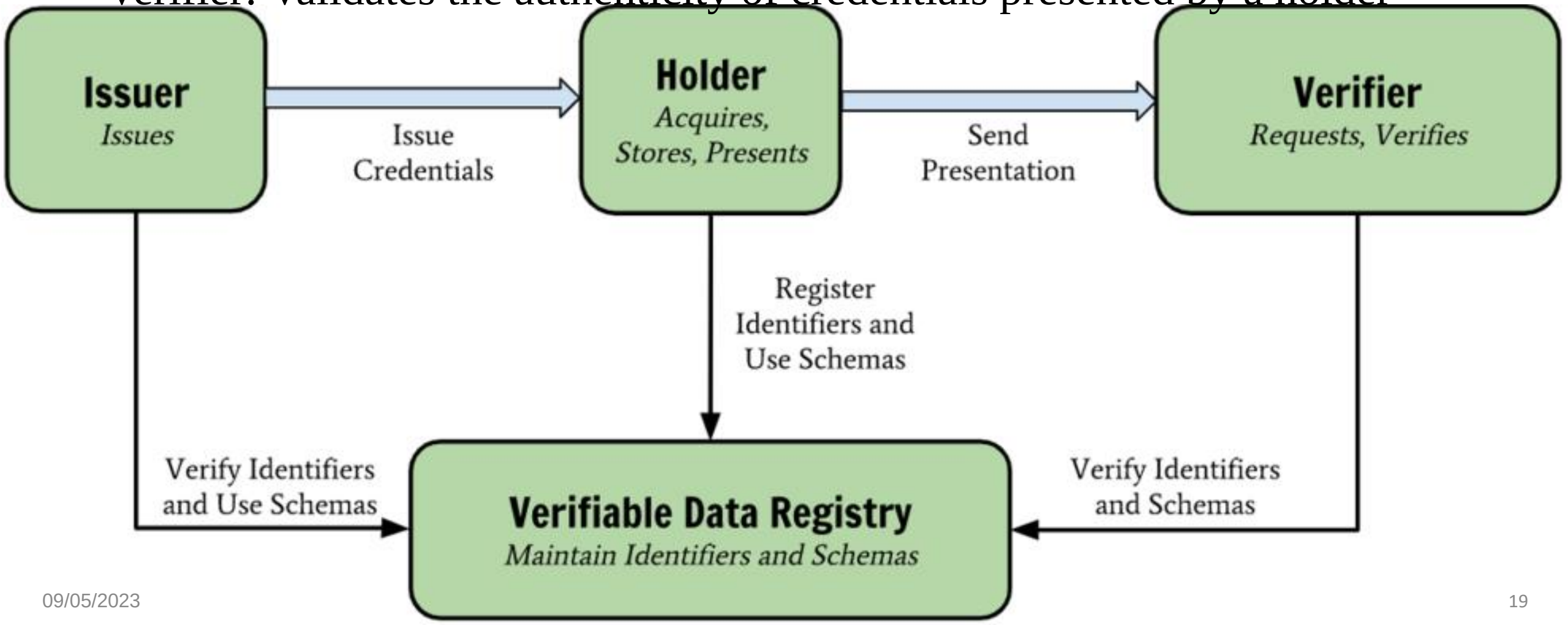
Consent
Users must agree to the use of their identity.

Minimization
Disclosure of claims must be minimized.

Protection
The rights of users must be protected.

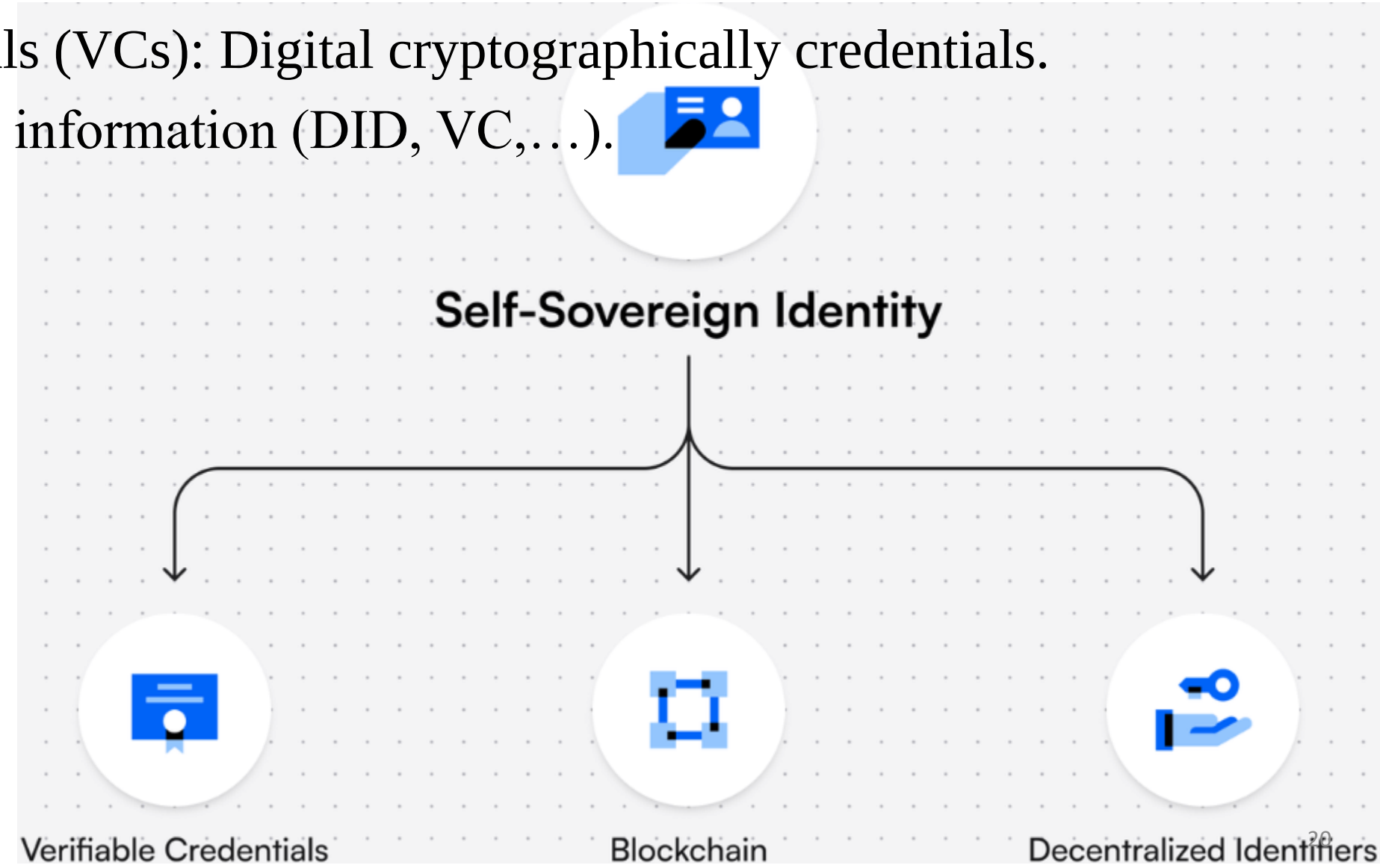
3.3. MODEL OF SSI

- Issuer: Generates credentials.
- Holder: individual/organization holds, present credential to proofs of identity
- Verifier: Validates the authenticity of credentials presented by a holder



3.4. COMPONENTS OF SSI

- Decentralized Identifiers (DIDs): created, owned by user.
- Verifiable Credentials (VCs): Digital cryptographically credentials.
- Blockchain: records information (DID, VC,…).



4. DECENTRALIZED IDENTIFIER - DID

4.1. INTRODUCTION TO DID

4.2. DID ARCHITECTURE

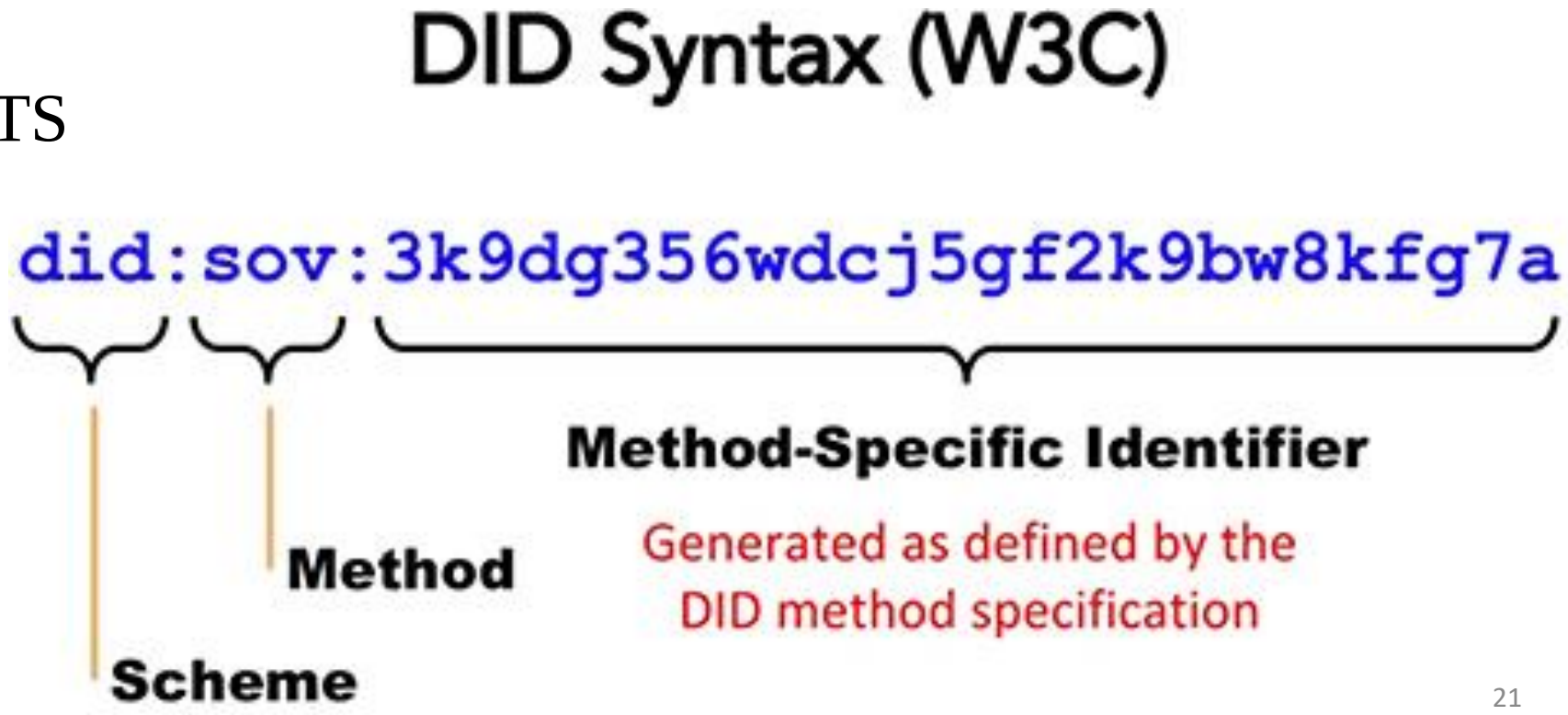
4.3. DID & DID URL SYNTAX

4.4. DID DOCUMENTS

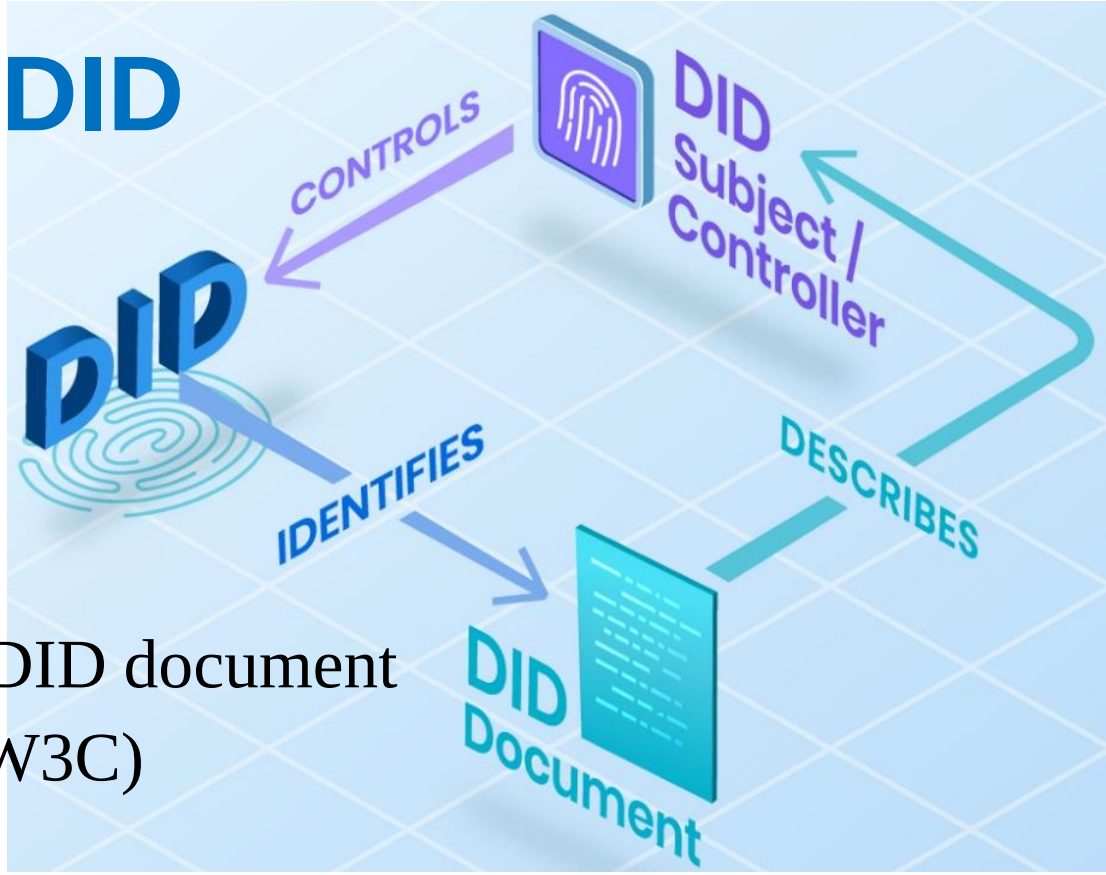
4.5. RESOLUTION

4.6. DID ACTIONS

4.7. DID USE CASES



4.1. INTRODUCTION TO DID



Decentralized Identifiers (DIDs):

- globally unique identifier
- enables verifiable, decentralized digital identity
- refers to subject (person, organization, thing,…) as controller of DID
- are URI (URN), associate a DID subject with a DID document
- standardized by World Wide Web Consortium (W3C)

Advantages of DID:

- Better privacy and control of data
- Higher security
- Protection against fraud
- No metadata collection

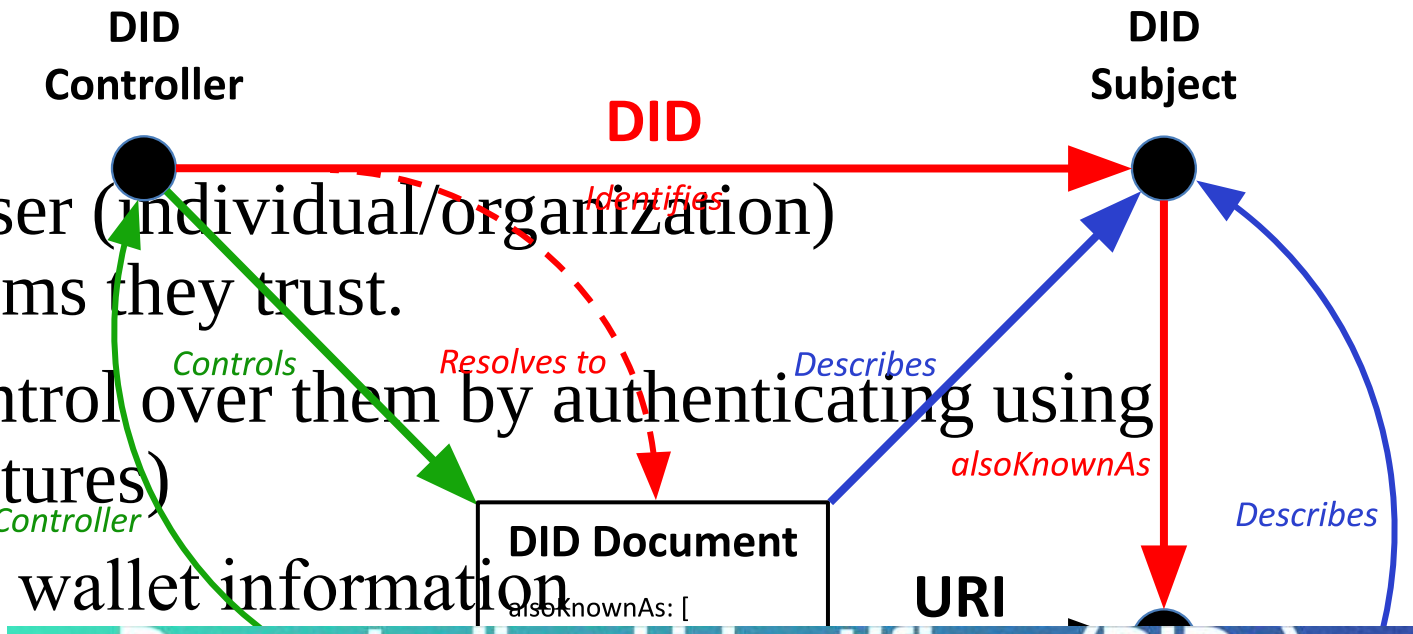
4.1. INTRODUCTION TO DID

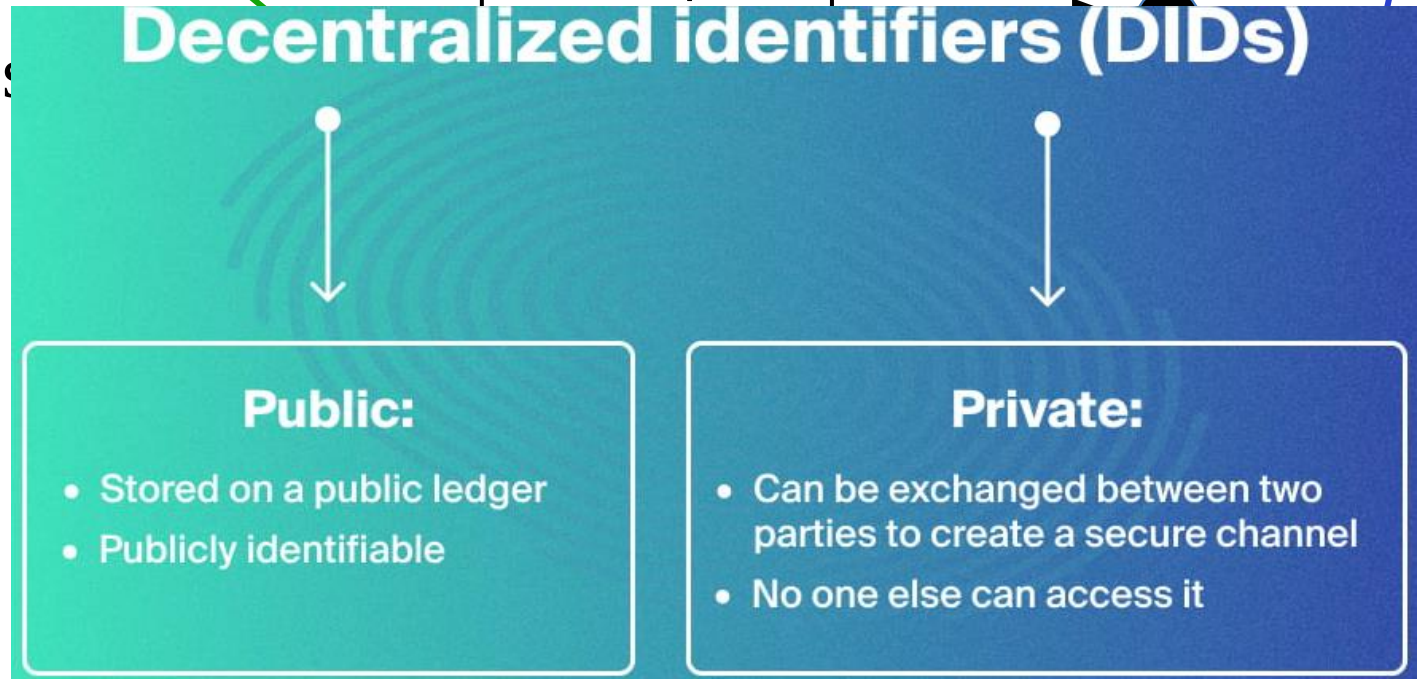
Key features of DIDs:

- Are created and managed by the user (individual/organization) without any third party using systems they trust.
- Allow owner to securely prove control over them by authenticating using cryptographic proofs (digital signatures)
- Don’t contain any personal data or wallet information
- Entity/subject can have many DIDs

Types of DID:

- public
- private

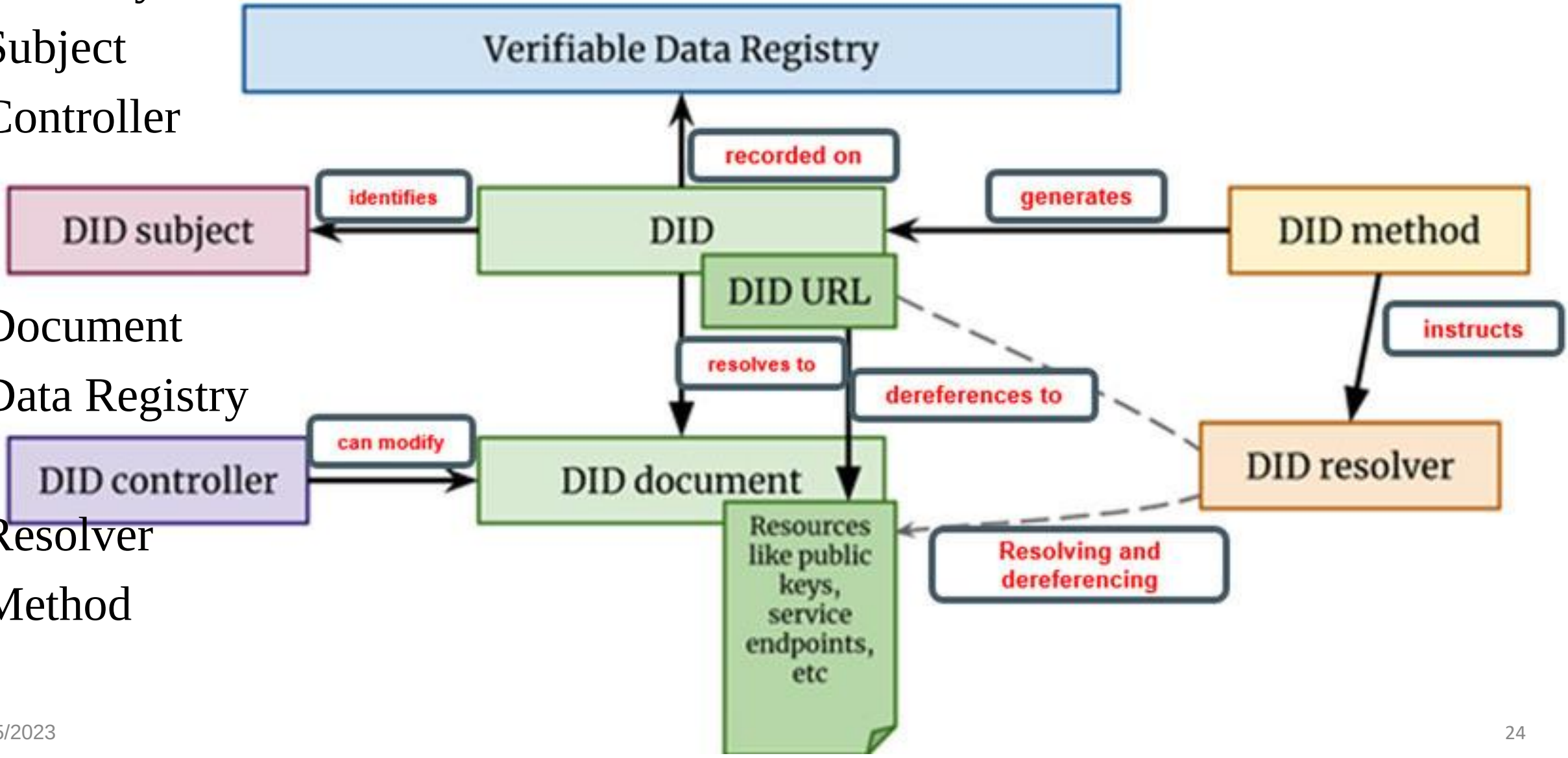




4.2. DID ARCHITECTURE

DID ecosystem:

- Subject
- Controller
- Document
- Data Registry
- Resolver
- Method

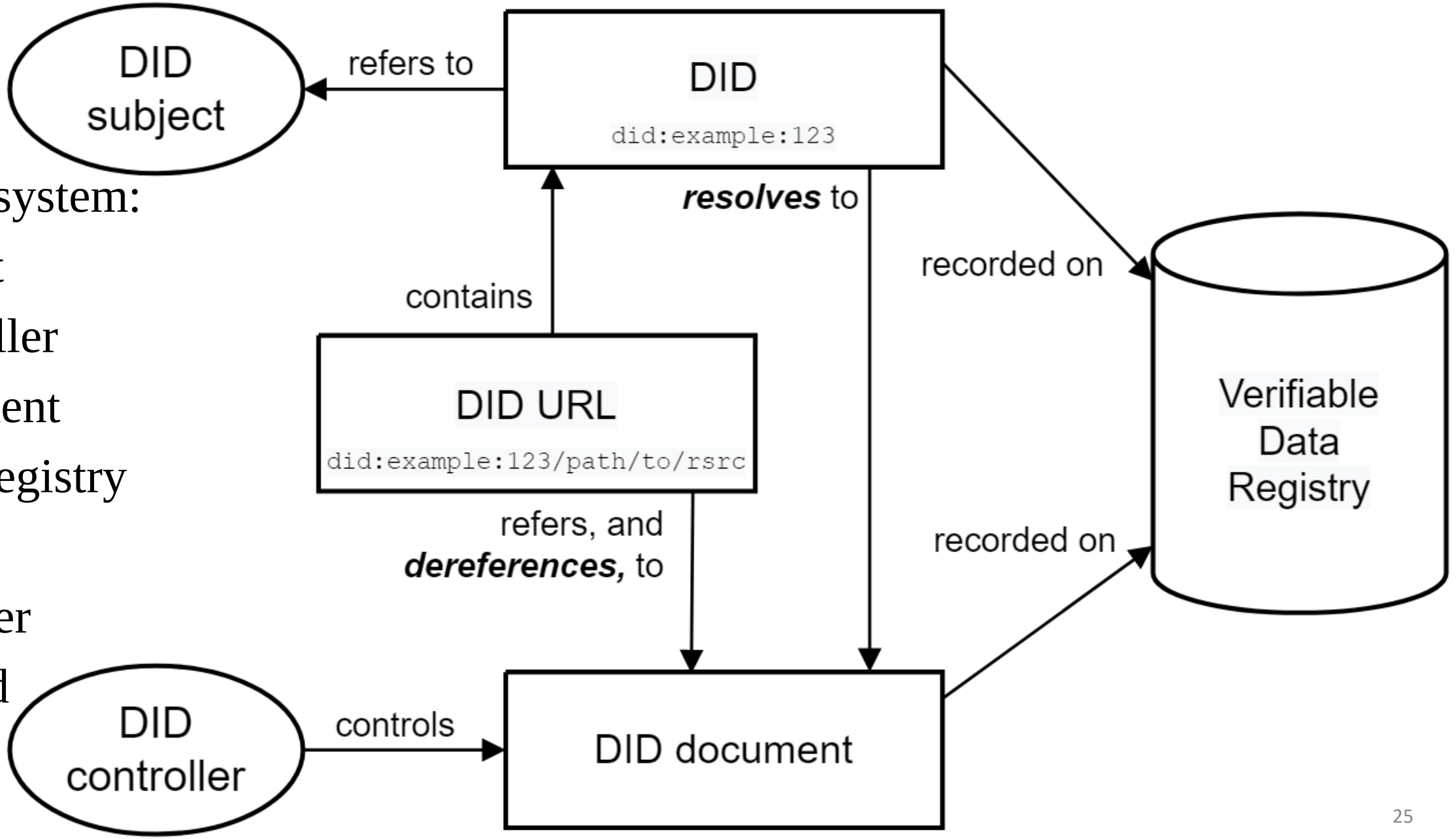


4.2. DID ARCHITECTURE

DID ecosystem:

- Subject
- Controller
- Document
- Data Registry

- Resolver
- Method



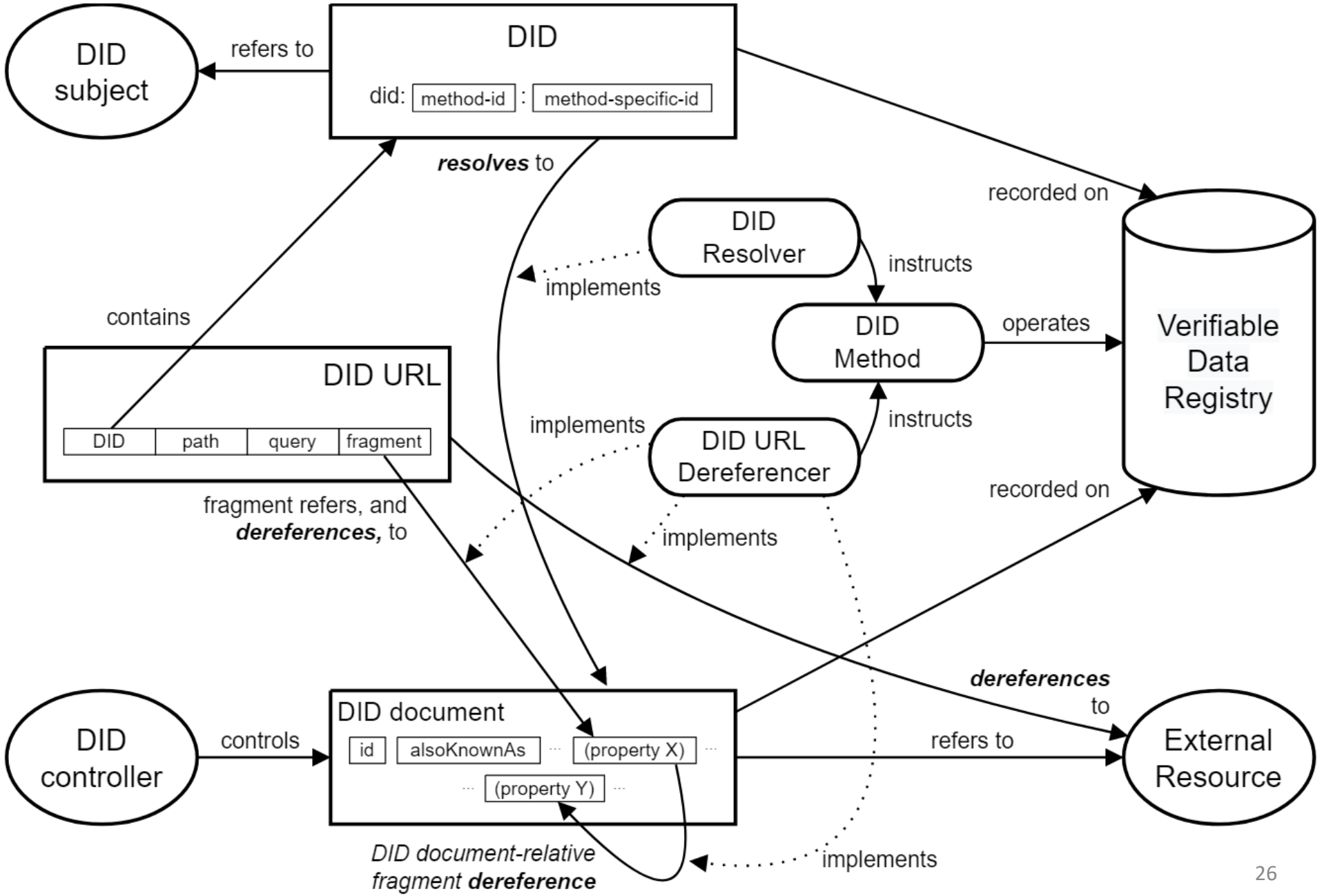
4.2. DID ARCHITECTURE

DID ecosystem:

- Subject
- Controller

- Document
- Data Registry

- Resolver
- Method



4.3. DID & DID URL SYNTAX

DID is a URI composed of :

1. scheme identifier
2. method identifier
3. unique, method-specific identifier

Method	DID Prefix
Sovrin	did:sov:
Bitcoin	did:btcr:
uPort	did:uport:
VeresOne	did:v1:
IPFS	did:ipid:
IPDB	did:ipdb:
Blockstack	did:stack

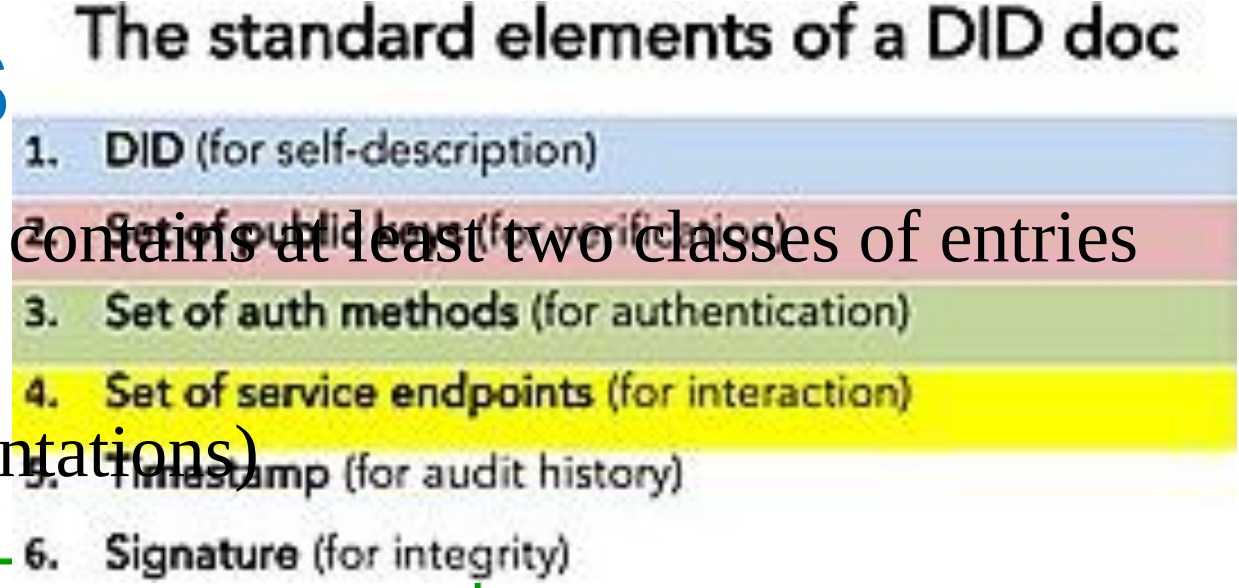
DID URL extends DID to incorporate other components: path, query, fragment
to locate a resource inside/outside DID document.

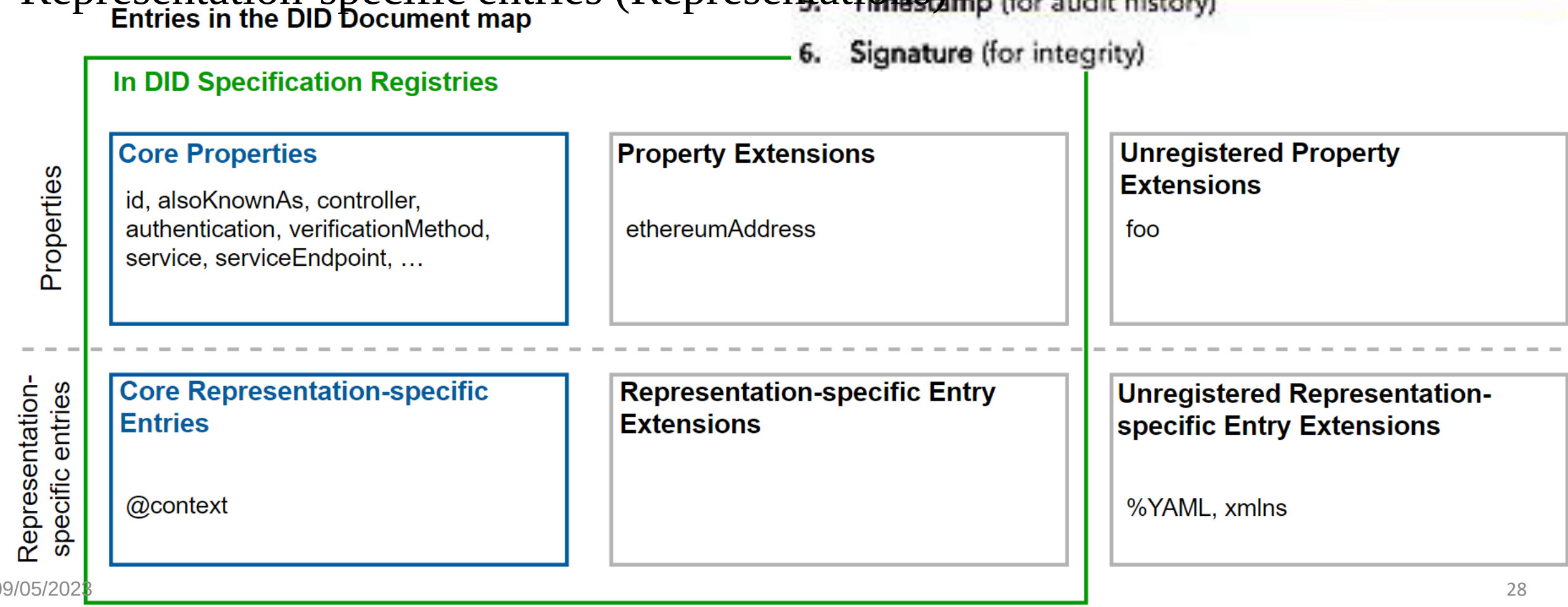
did-url = did path-abempty ["?" query] ["#" fragment]

4.4. DID DOCUMENTS

DID document consists of map of entries, contains at least two classes of entries

- Core Properties
- Representation-specific entries (Representations)





4.4. DID DOCUMENTS

Core Properties:

Property	Required?	Value constraints
id	yes	A string that conforms to the rules in 3.1 DID Syntax.
alsoKnownAs	no	A set of strings that conform to the rules of [RFC3986] for URIs.
controller	no	A string or a set of strings that conform to the rules in 3.1 DID Syntax.
verificationMethod	no	A set of Verification Method maps that conform to the rules in Verification Method properties.
authentication	no	A set of either Verification Method maps that conform to the rules in Verification Method properties) or strings that conform to the rules in 3.2 DID URL Syntax.
assertionMethod	no	
keyAgreement	no	
capabilityInvocation	no	
capabilityDelegation	no	
service	no	A set of Service Endpoint maps that conform to the rules in Service properties.

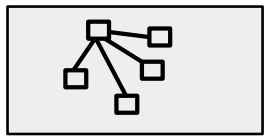
4.4. DID DOCUMENTS

Representations: serialization of DID document

- Production (serializing): data model to representation

resolve()

VERIFIABLE DATA REGISTRY



- Consumption: representation to data model

resolveRepresentation()

Core Properties

```
«[
  "id" → "example:123",
  "verificationMethod" → « «[
    "id": "did:example:123#keys-1",
    "controller": "did:example:123",
    "type": "Ed25519VerificationKey2018",
    "publicKeyBase58": "H3C2AVvLMv6gmMNam3uVA"
  ]» »,
  "authentication" → «
    "did:example:123#keys-1"
  »
]»
```

Core Representation-specific Entries (JSON-LD)

```
«[ "@context" → "https://www.w3.org/ns/did/v1" ]»
```

produce / consume / produce / consume / produce / consume

```
{
  "@context": ["https://www.w3..."],
  "id": "did:example:123",
  "verificationMethod": [{
    "id": "did:example:123#keys-1",
    "controller": "did:example:123",
    "type": "Ed25519Verificati...",
    "publicKeyBase58": "..."
  }],
  "authentication": [
    "did:example:123#keys-1"
  ]
}
```

application/did+ld+json

```
{
  "id": "did:example:123",
  "verificationMethod": [{
    "id": "did:example:123#keys-1",
    "controller": "did:example:123",
    "type": "Ed25519Verificati...",
    "publicKeyBase58": "..."
  }],
  "authentication": [
    "did:example:123#keys-1"
  ]
}
```

application/did+json

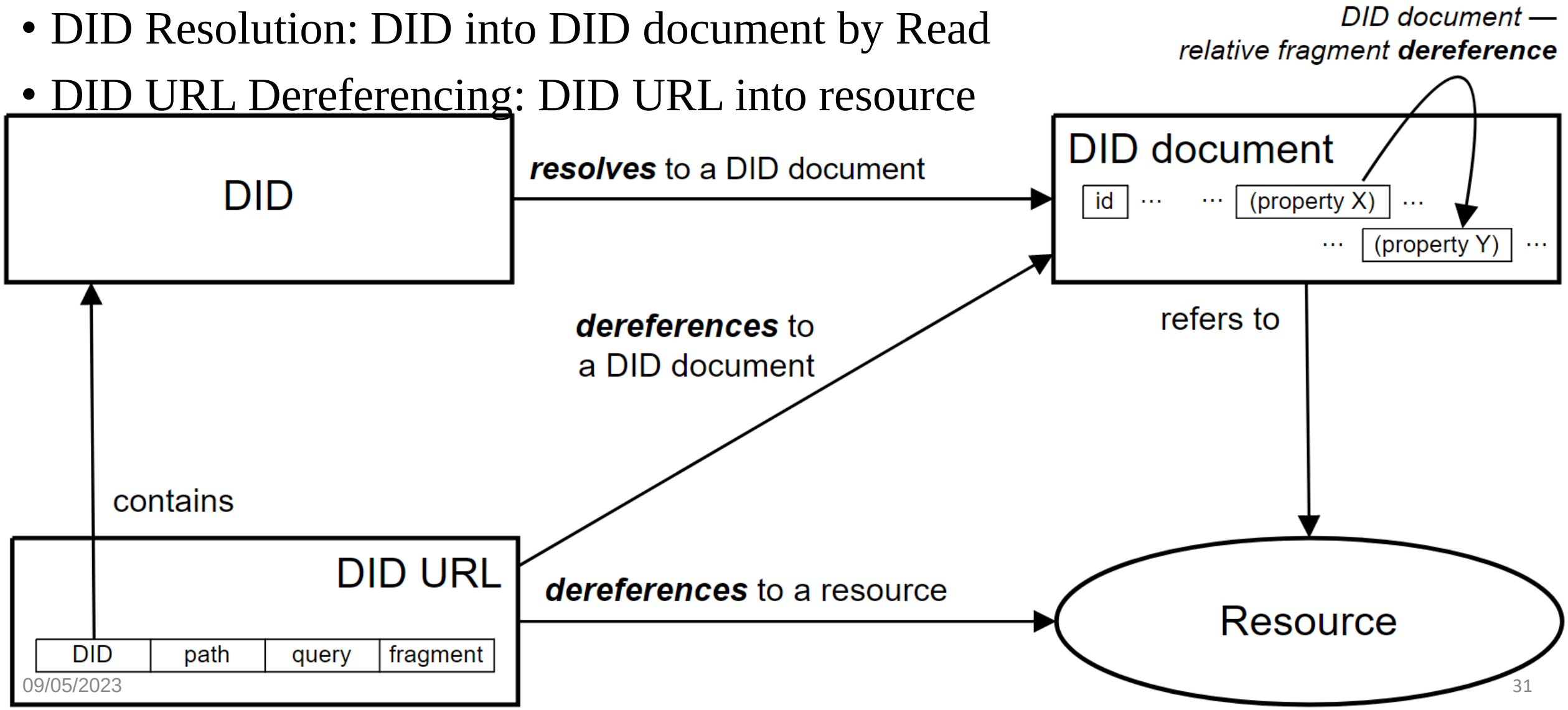
```
62a3 6469 646f 6469 653a 6178 706d
656c 313a 3332 7672 7265 6669 6369
7461 6f69 4d6e 7465 6f68 8164 62a4
6469 6476 6469 653a 6178 706d 656c
313a 3332 6b23 7965 2d73 6a31 6f63
746e 6f72 6c6c 7265 646f 6469 653a
...
```

application/did+cbor

4.5. RESOLUTION

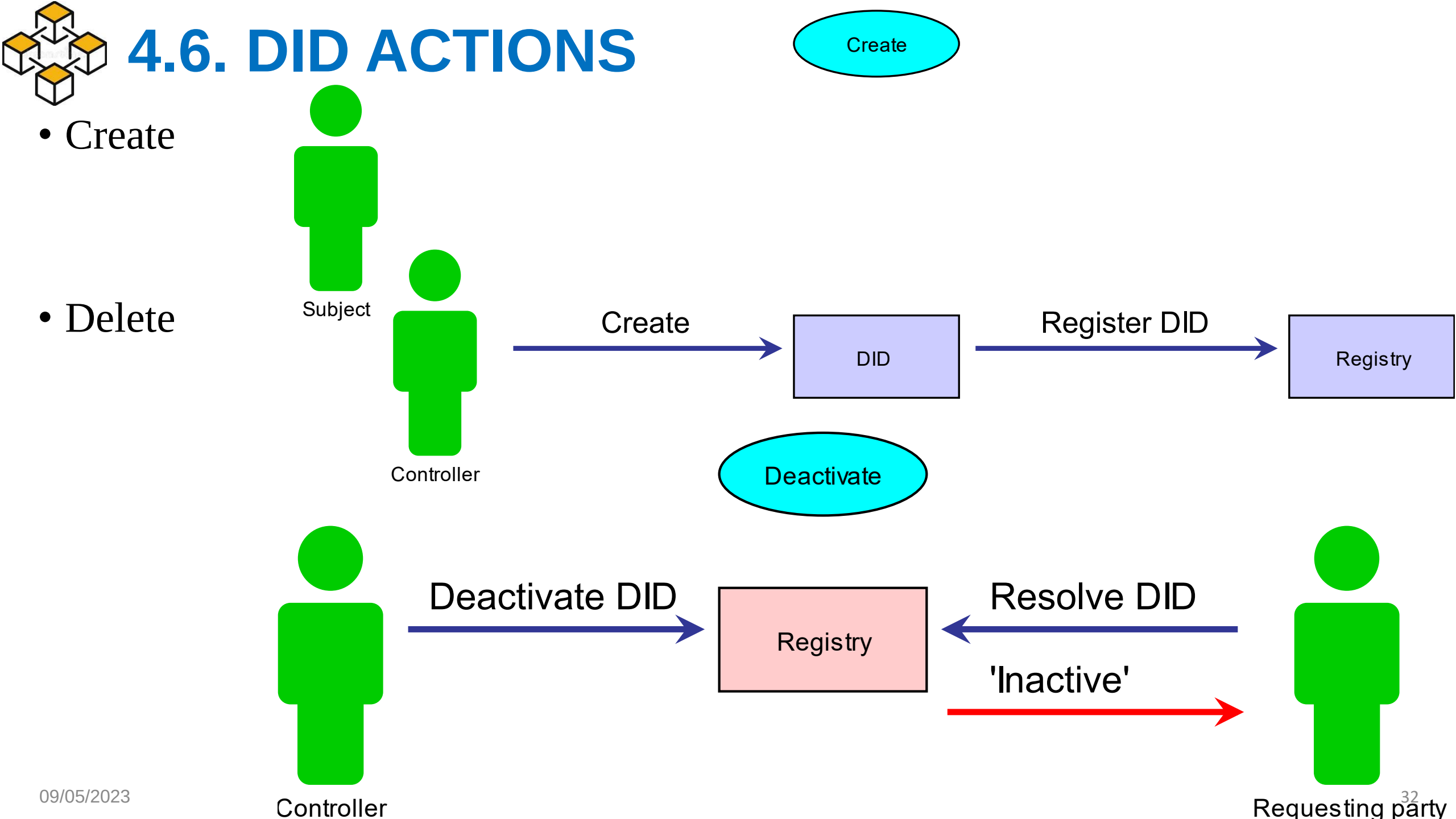
Resolution:

- DID Resolution: DID into DID document by Read
- DID URL Dereferencing: DID URL into resource



4.6. DID ACTIONS

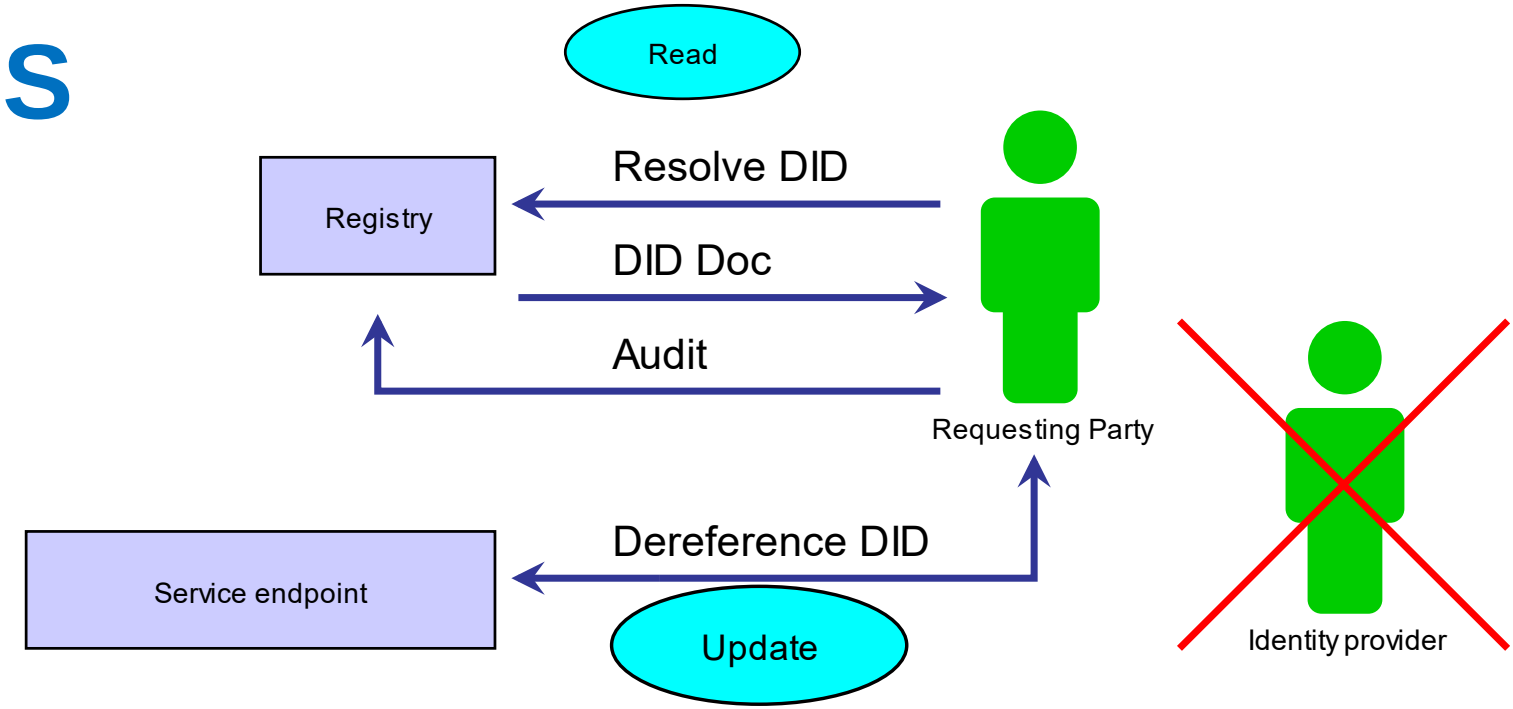
- Create
- Delete

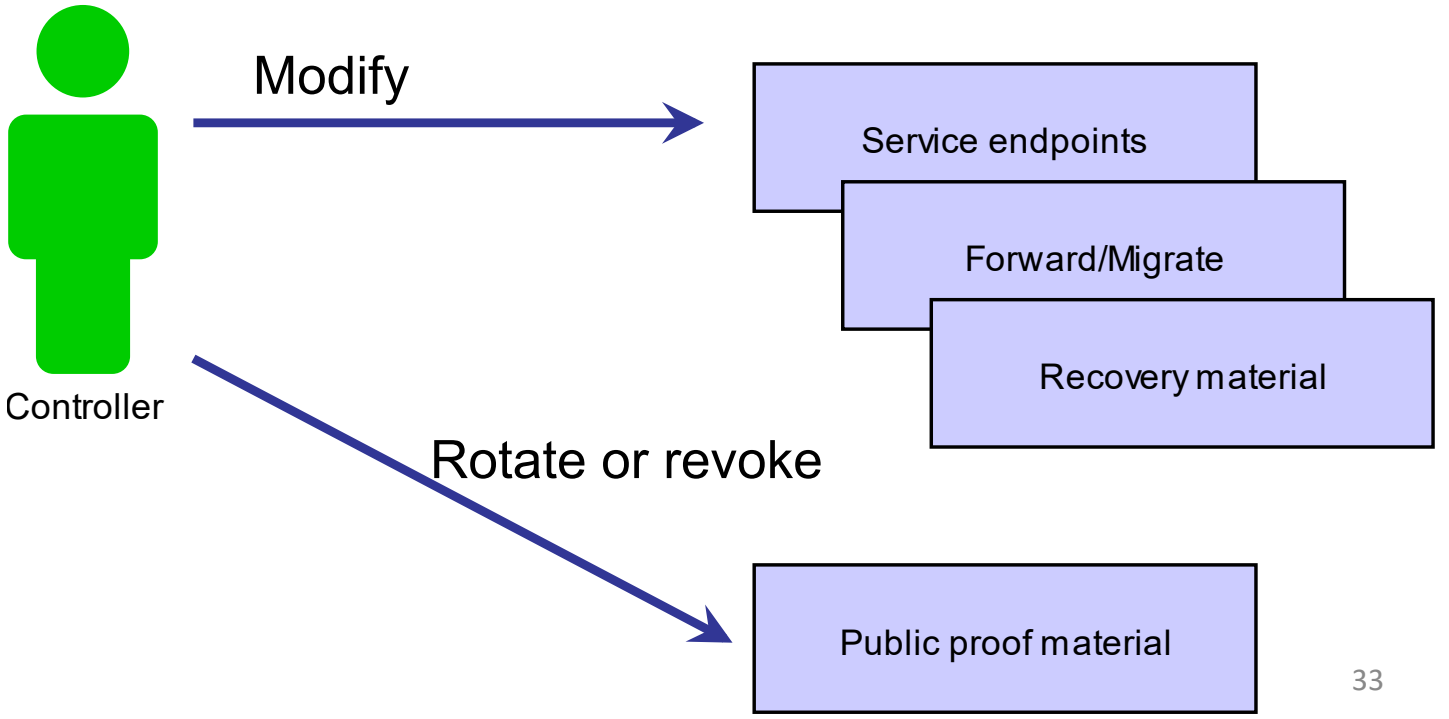


4.6. DID ACTIONS

- Read

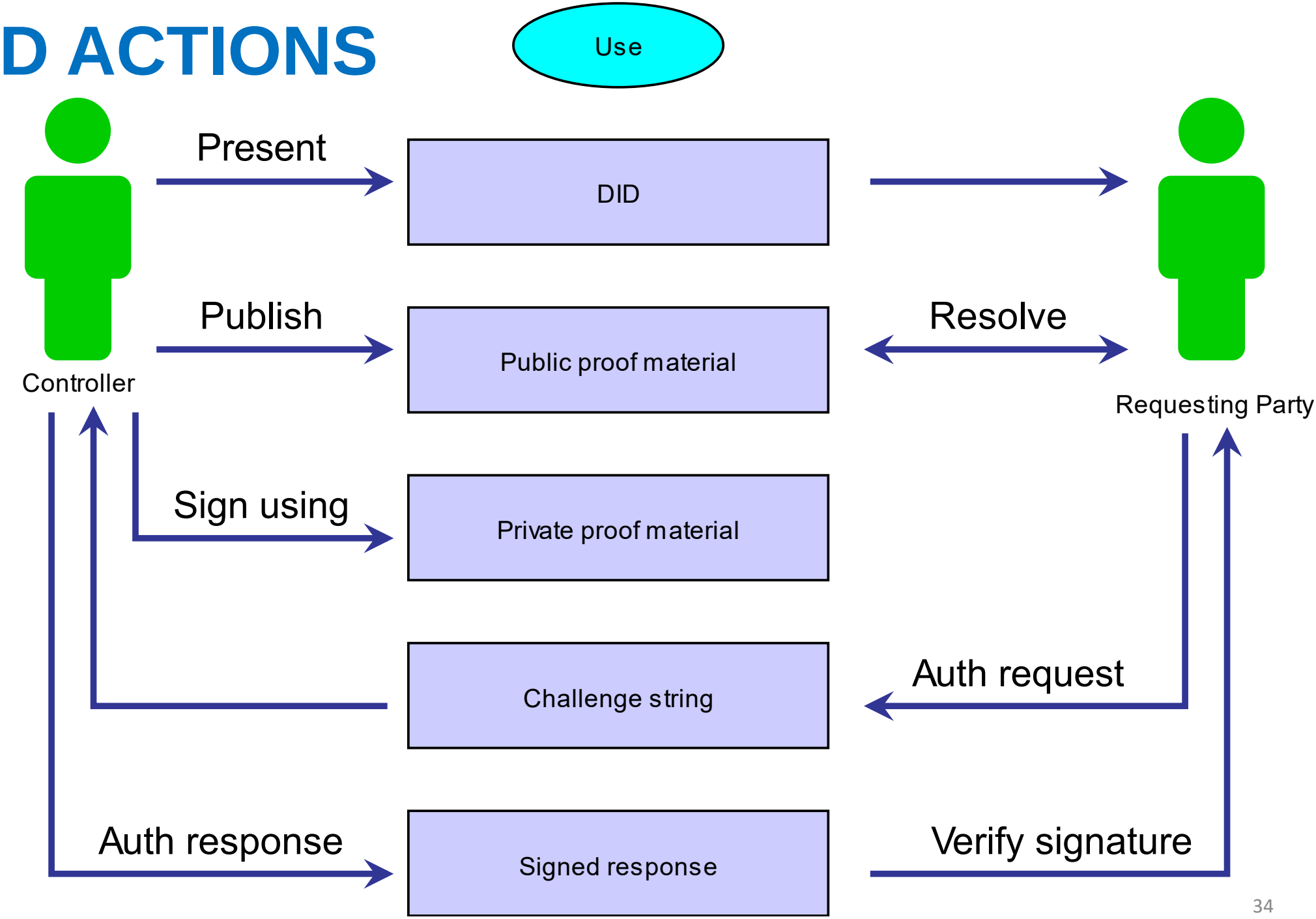
- Update





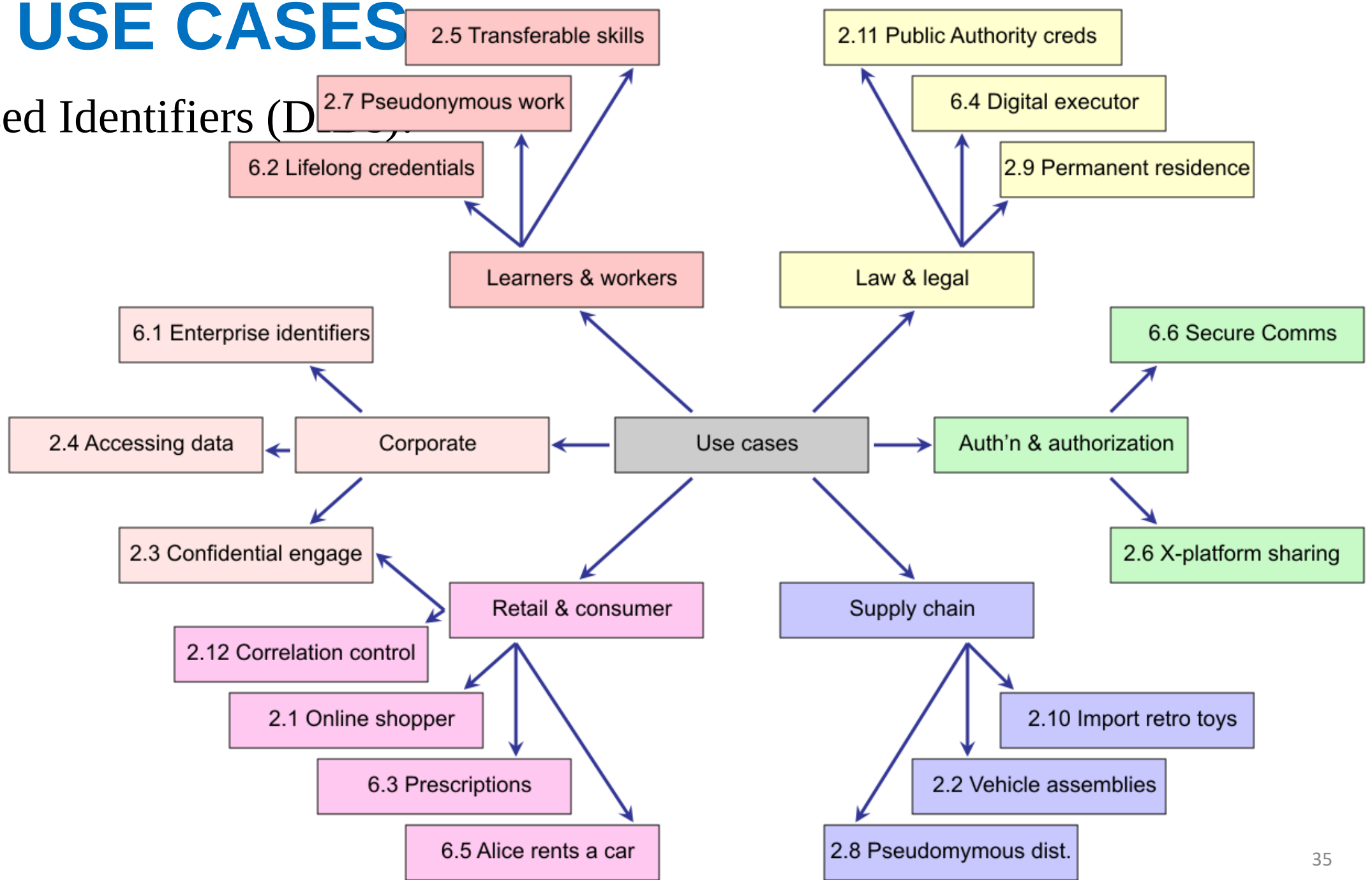
4.6. DID ACTIONS

- Use



4.7. USE CASES

Decentralized Identifiers (DIDs):



5. VERIFIABLE CREDENTIALS

5.1. INTRODUCTIONS

5.2. WORKFLOW OF VC

5.3. COMPONENTS OF VC

5.4. USER TASKS OF VC

5.5. VERIFIABLE PRESENTATION

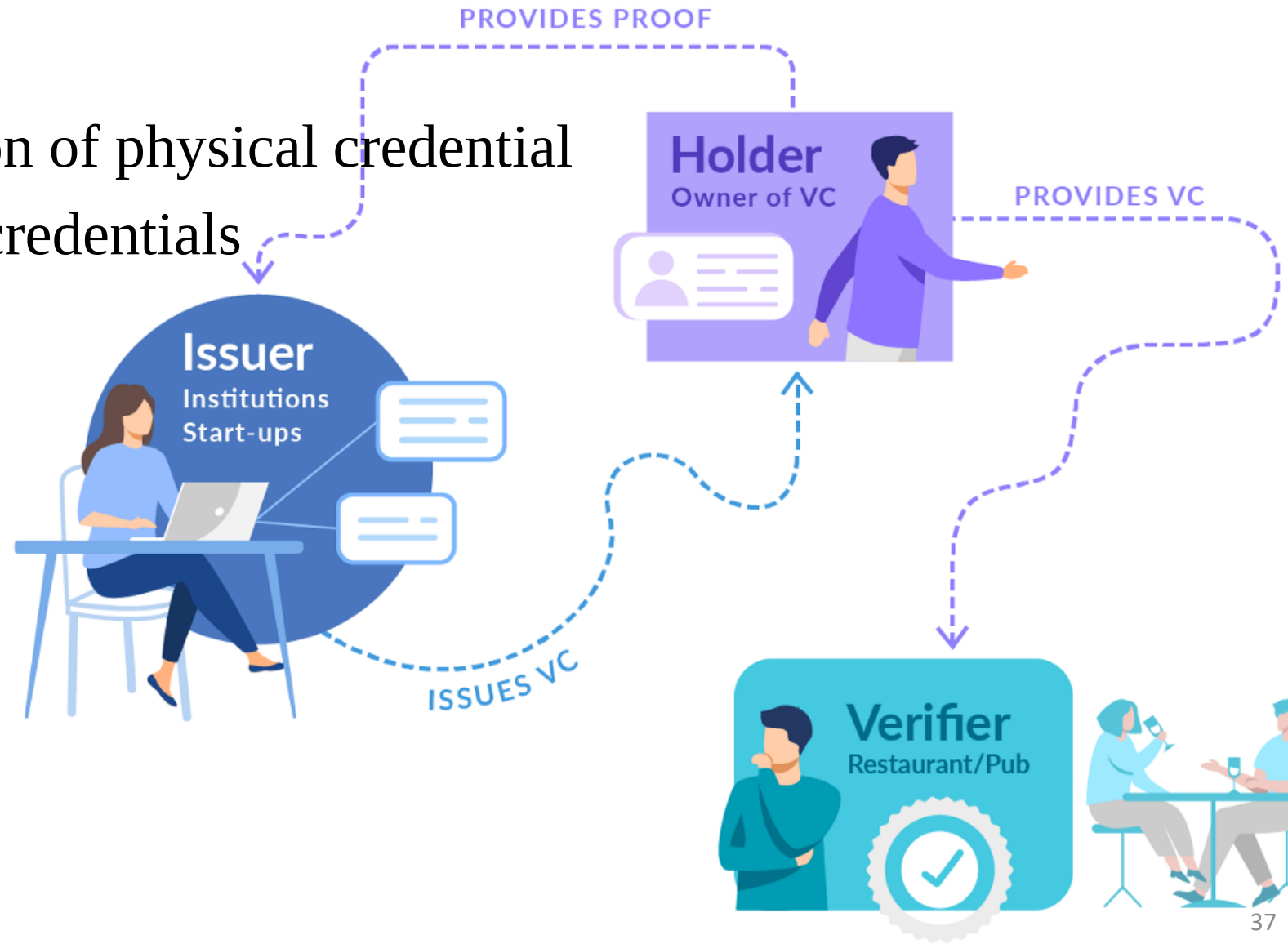
5.6. PRESENTATIONS USING DERIVED CREDENTIALS

5.7. USE CASES

5.1. INTRODUCTIONS

Verifiable Credentials (VC)

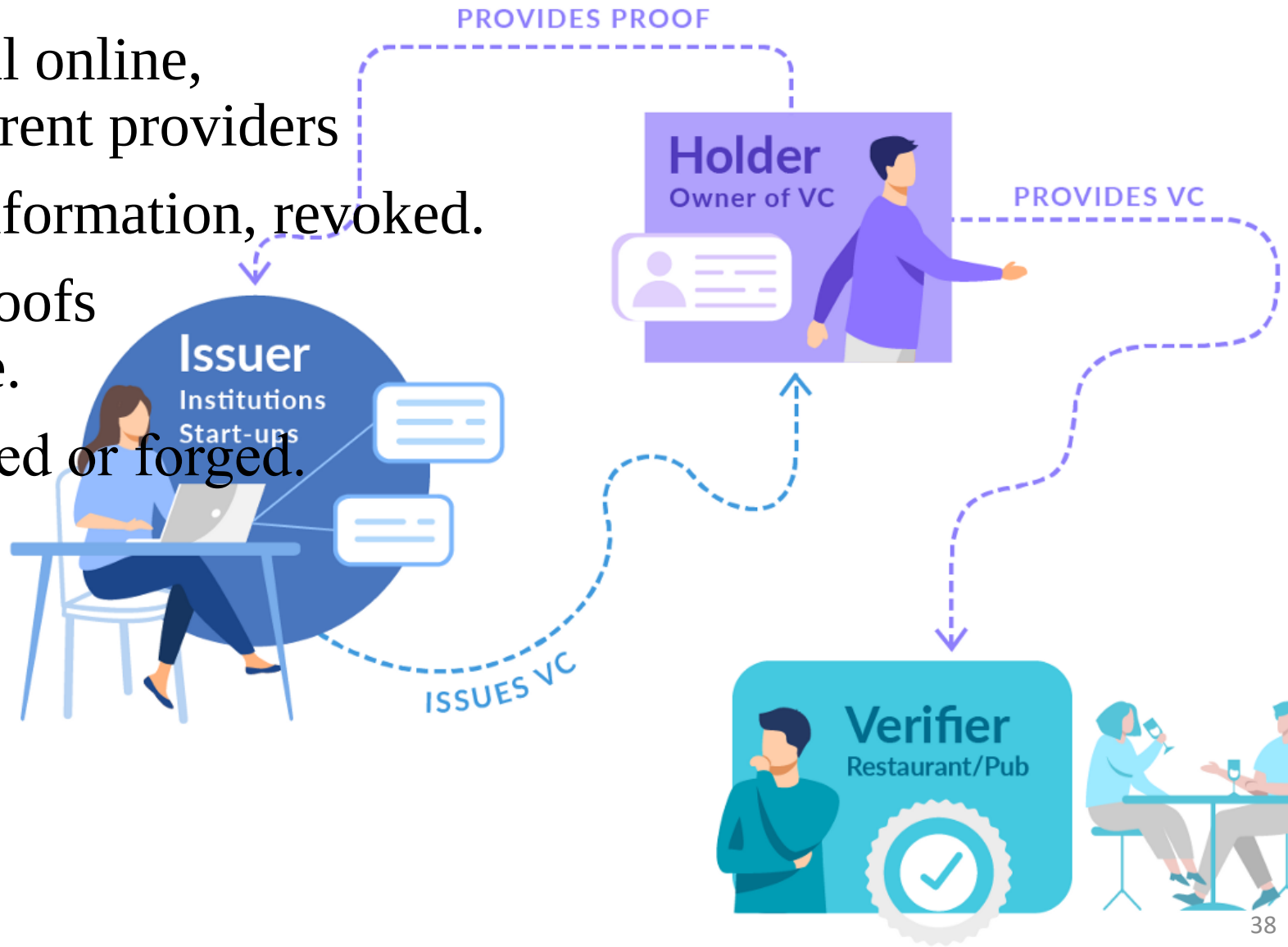
- are a digital credentials
- can represent all information of physical credential
- cryptographically secured credentials
- present for verification
- created by Holder



5.1. INTRODUCTIONS

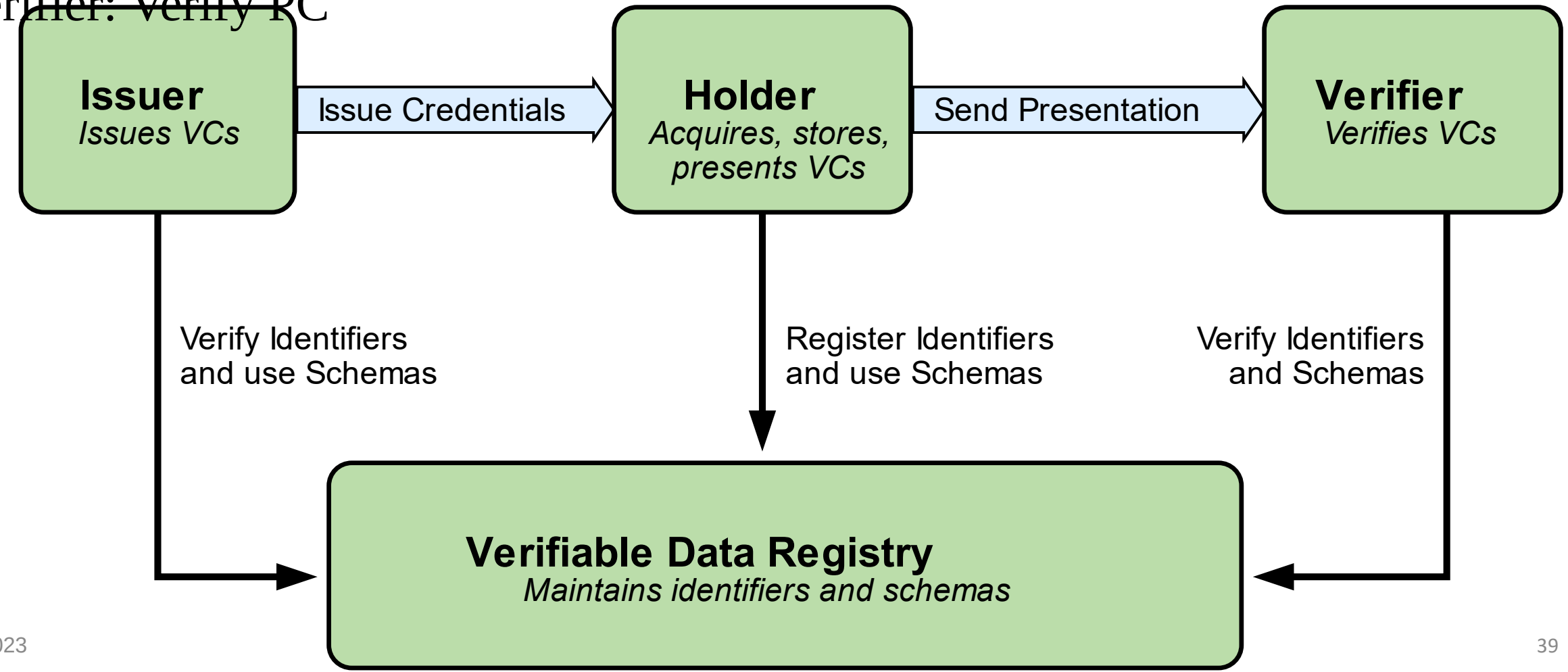
Verifiable Credentials properties:

- Portable: send the credential online, move wallets between different providers
- Verifiable: issuer, holder, information, revoked.
- Private: zero-knowledge proofs choose information to share.
- Tamperproof: can’t be altered or forged.



5.2. VERIFIABLE CREDENTIALS WORKFLOW

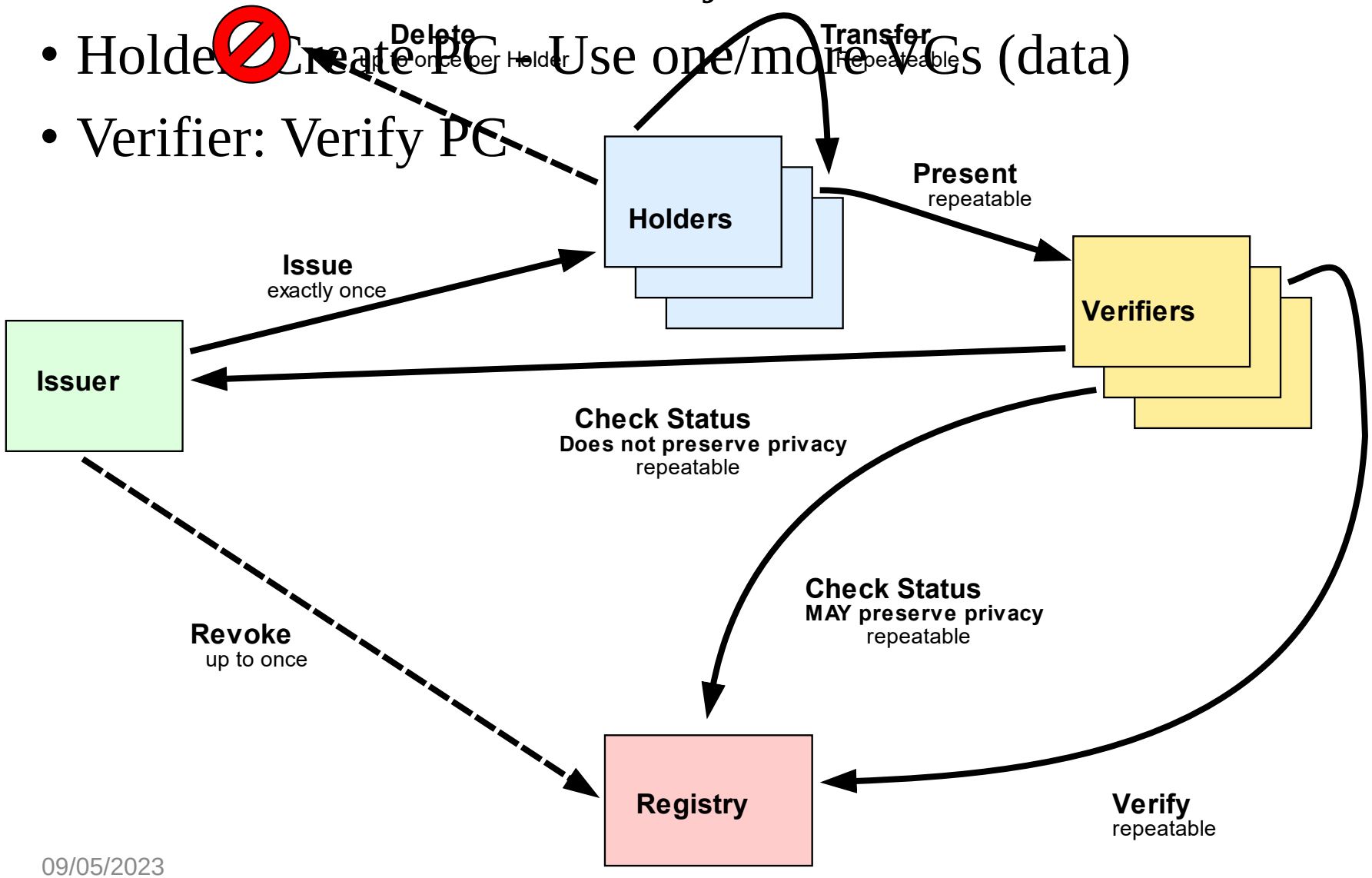
- Issuer: Create VC - Put subject's claims
- Holder: Create PC - Use one/more VCs (data)
- Verifier: Verify PC



5.2. VERIFIABLE CREDENTIALS WORKFLOW

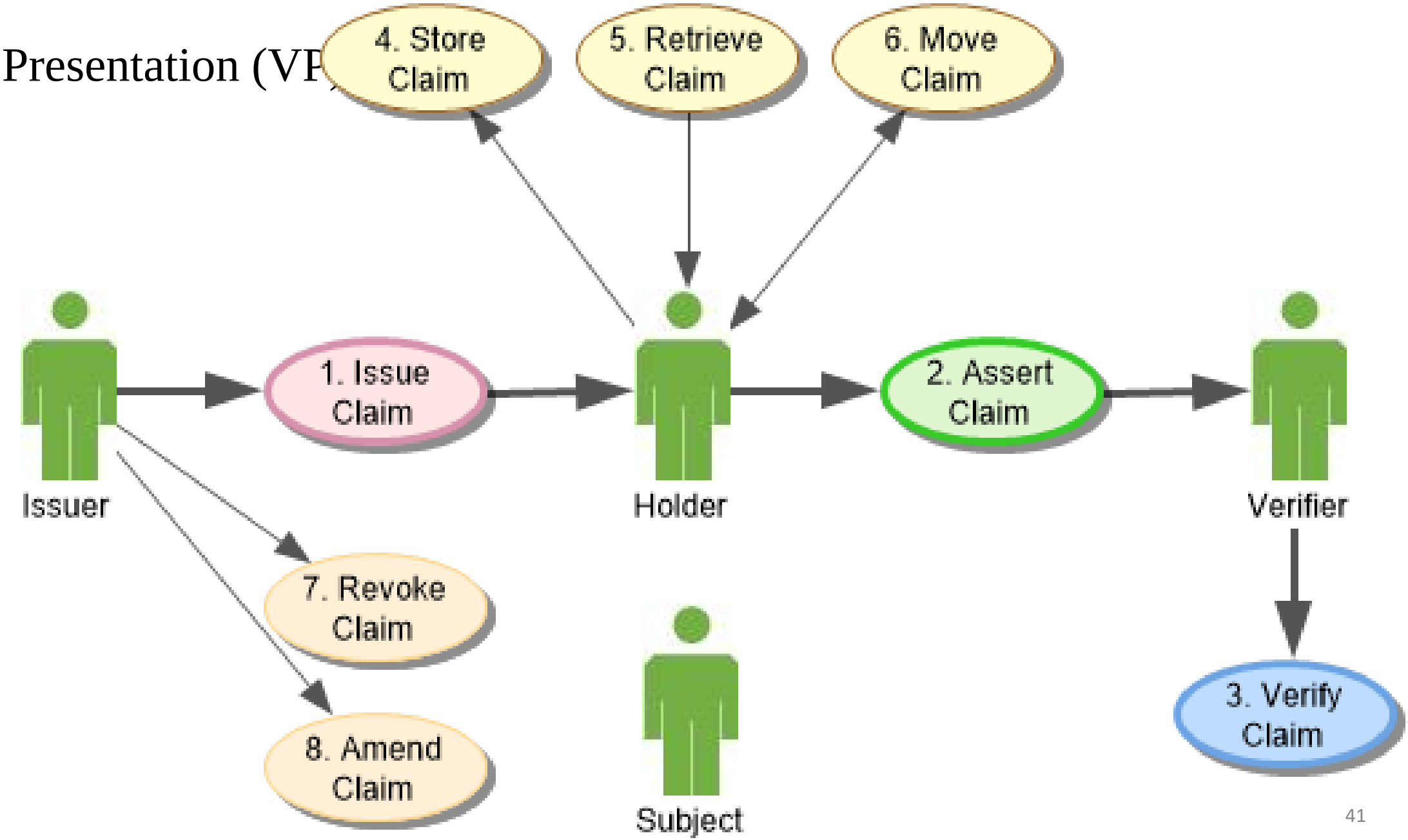
Life of a single Verifiable Credential

- Issuer: Create VC - Put subject's claims
- Holder: Create PC - Use one/more VCs (data)
- Verifier: Verify PC



5.2. VERIFIABLE CREDENTIALS WORKFLOW

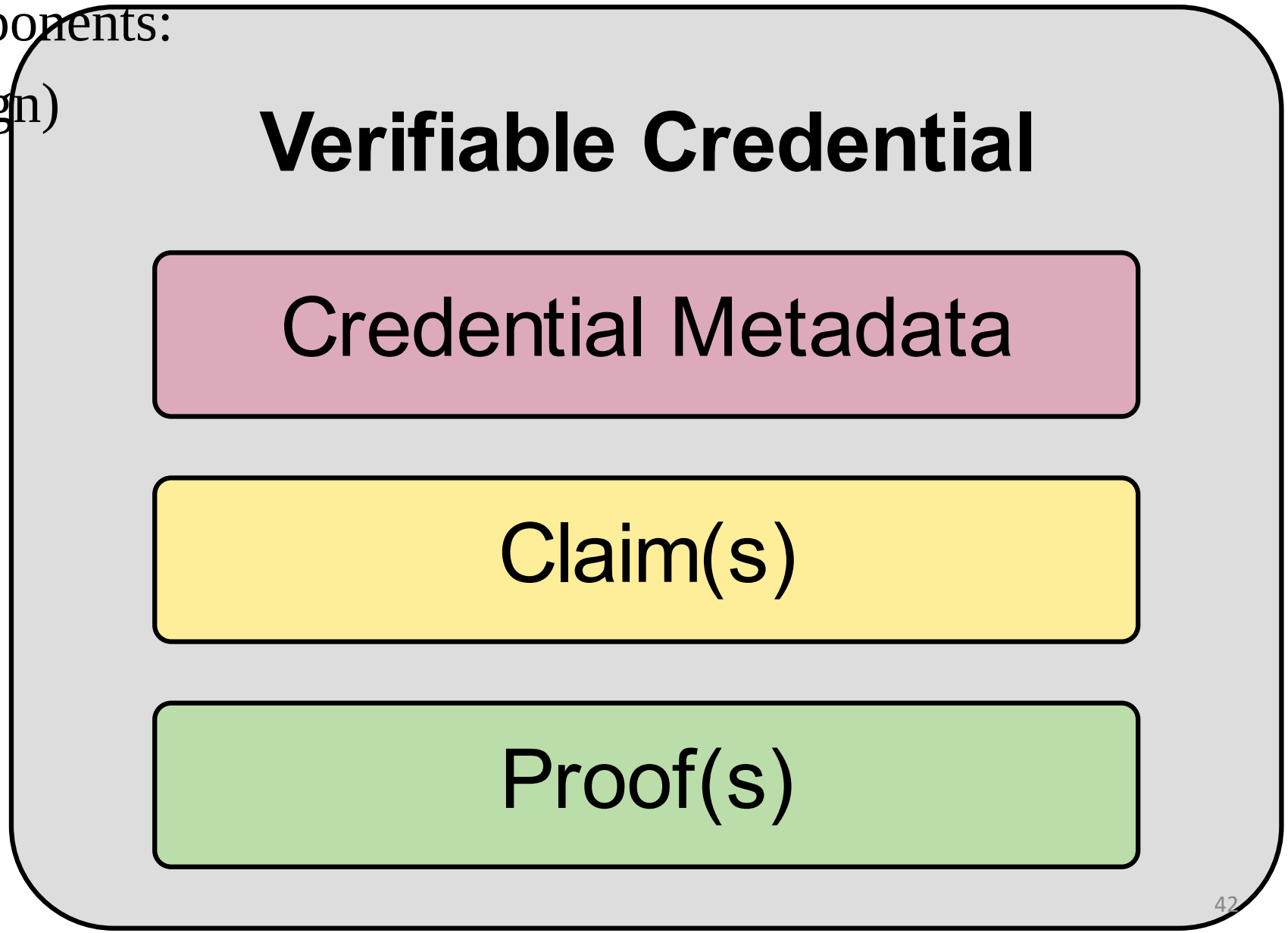
Verifiable Presentation (VP)



5.3. VERIFIABLE CREDENTIAL'S COMPONENTS

Verifiable Credential components:

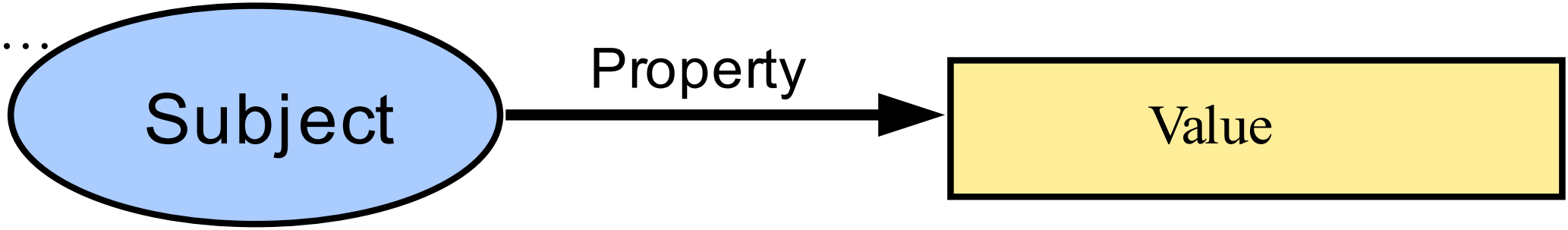
- set of tamper-evident (sign) claims and metadata.
- Proof: cryptographically prove who issued it.



5.3. VERIFIABLE CREDENTIAL'S COMPONENTS

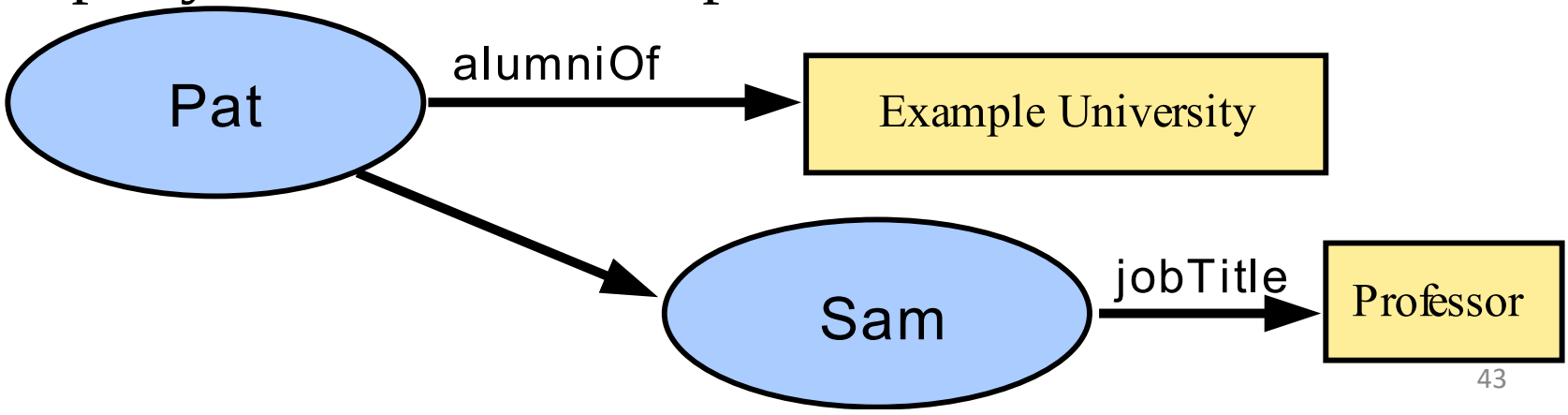
Metadata:

- describe properties of the credential
- issuer, expiry date and time, representative image, a public key, revocation mechanism, …



Claim:

- statement about a subject
- expressed using subject- property-value relationships



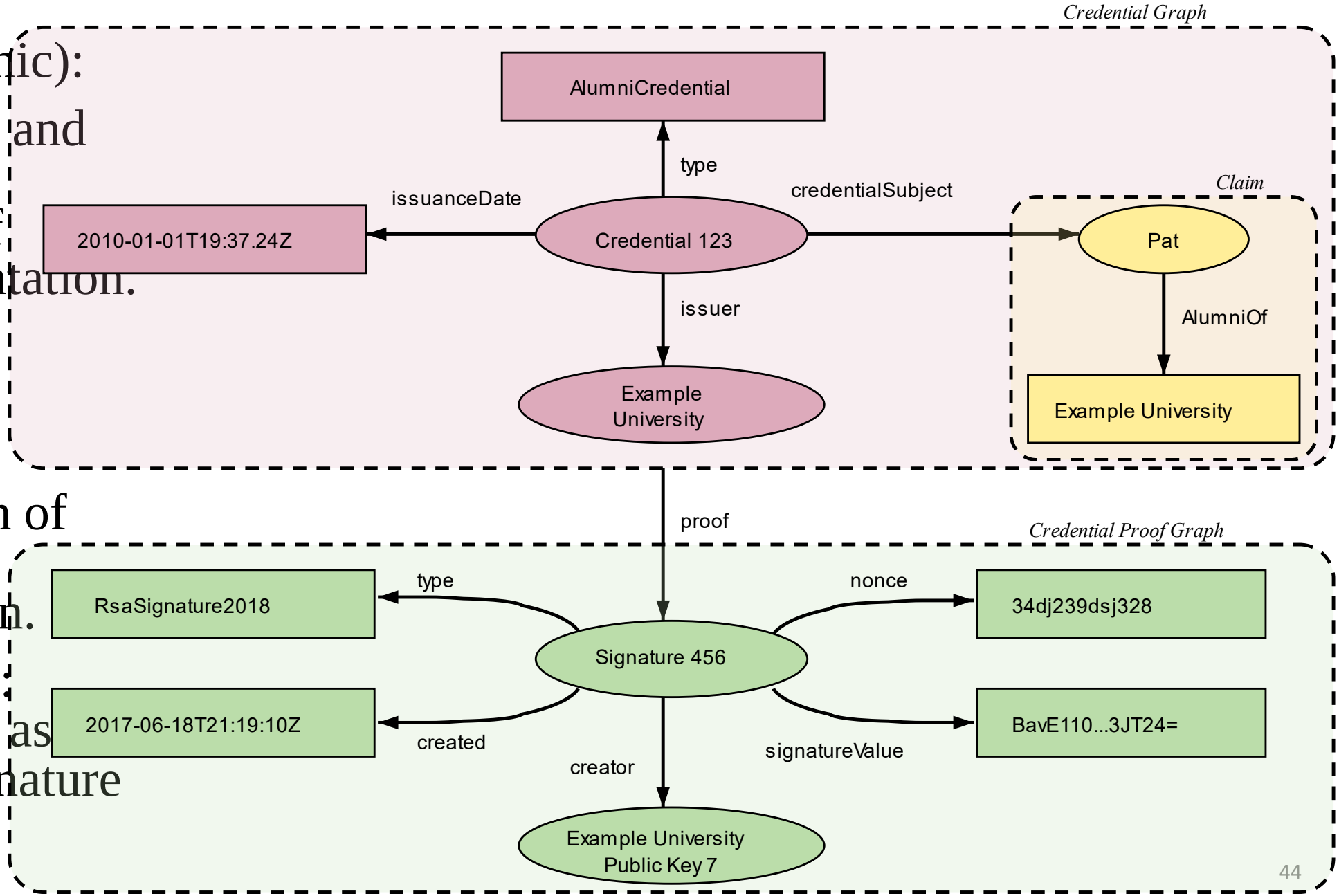
5.3. VERIFIABLE CREDENTIAL'S COMPONENTS

Proof (cryptographic):

- detect tampering and verify the authorship of credential/presentation.

Classes of proof mechanisms:

- External proof: wraps expression of data model as JSON Web Token.
- Embedded proof: included in data as Linked Data Signature



5.3. VERIFIABLE CREDENTIAL'S COMPONENTS

VC content:

- @context: URI,exchange data
- id: URI, refer to object
- type: URI/map to context
- credentialSubject: claims one/more subjects
- issuer: claim issuer, URI/id
- issuanceDate:
- expiration:
- status: information (id, type)
- proofs (Signatures): detect tampering, verify the authorship

```
"id": "0892f680-6aeb-11eb-9bcf-f10d8993fde7",
"type": [
   "VerifiableCredential",
   "UniversityDegreeCredential"
],
"issuer": {
   "id": "did:example:76e12ec712ebc6f1c221ebfeb1f",
   "name": "Acme University"
},
"issuanceDate": "2021-05-11T23:09:06.803Z",
"credentialSubject": {
   "id": "did:example:ebfeb1f712ebc6f1c276e12ec21",
   "degree": {
      "type": "BachelorDegree",
      "name": "Bachelor of Science"
   }
},
"proof": {
   "type": "Ed25519Signature2018",
   "created": "2021-05-17T15:25:26Z",
   "jws": "eyJhbGciOiJFZERTQYjY0ll19..nlcAA",
   "proofPurpose": "assertionMethod",
   "verificationMethod": "https://pathToIssuerPublicKey"
}
```

Context

Metadata

Claims

Proofs

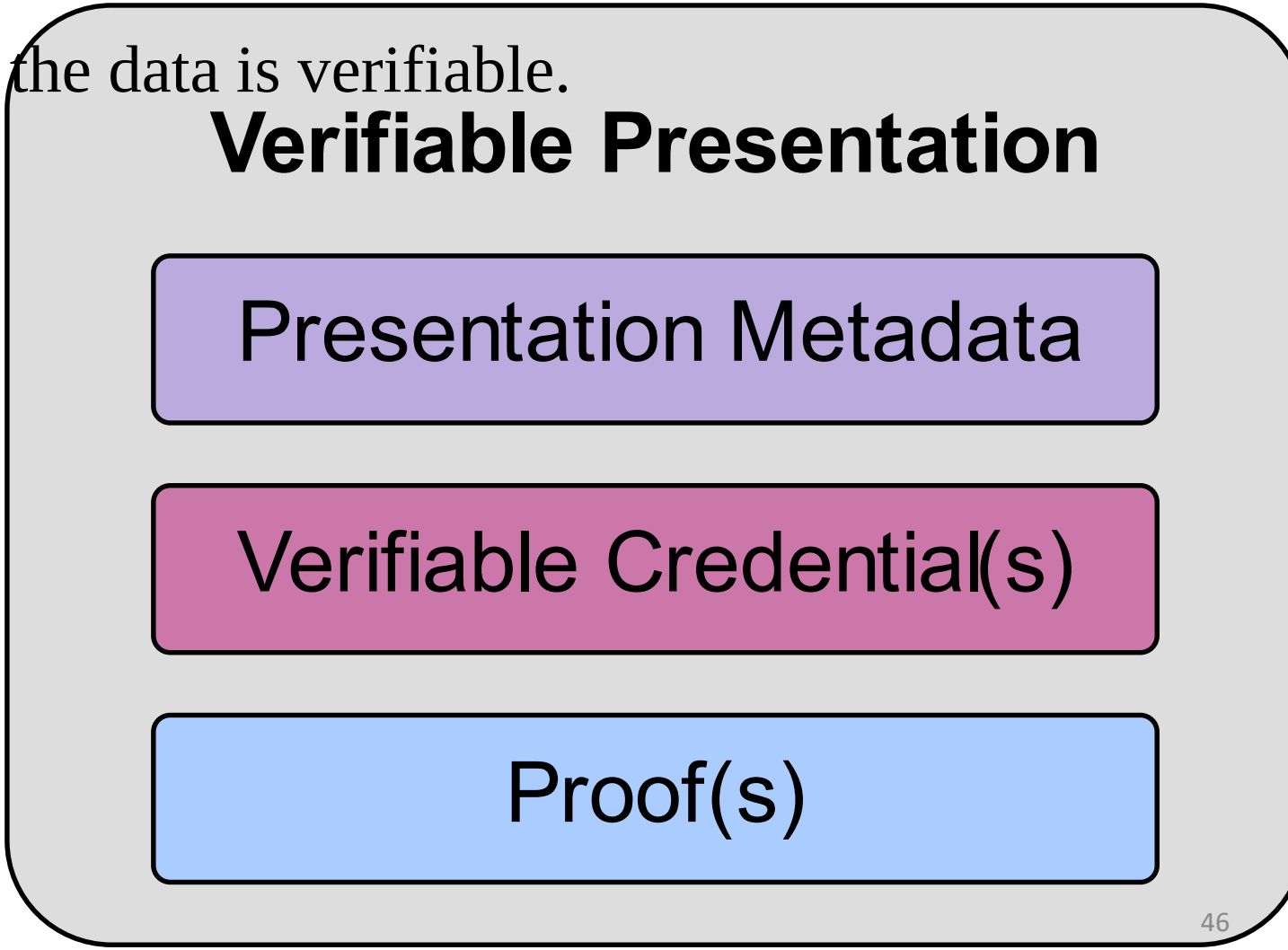
5.4. VERIFIABLE PRESENTATION

Verifiable Presentation (VP):

- expresses data from one/more verifiable credentials
- is packaged that the authorship of the data is verifiable.

Presentation's data:

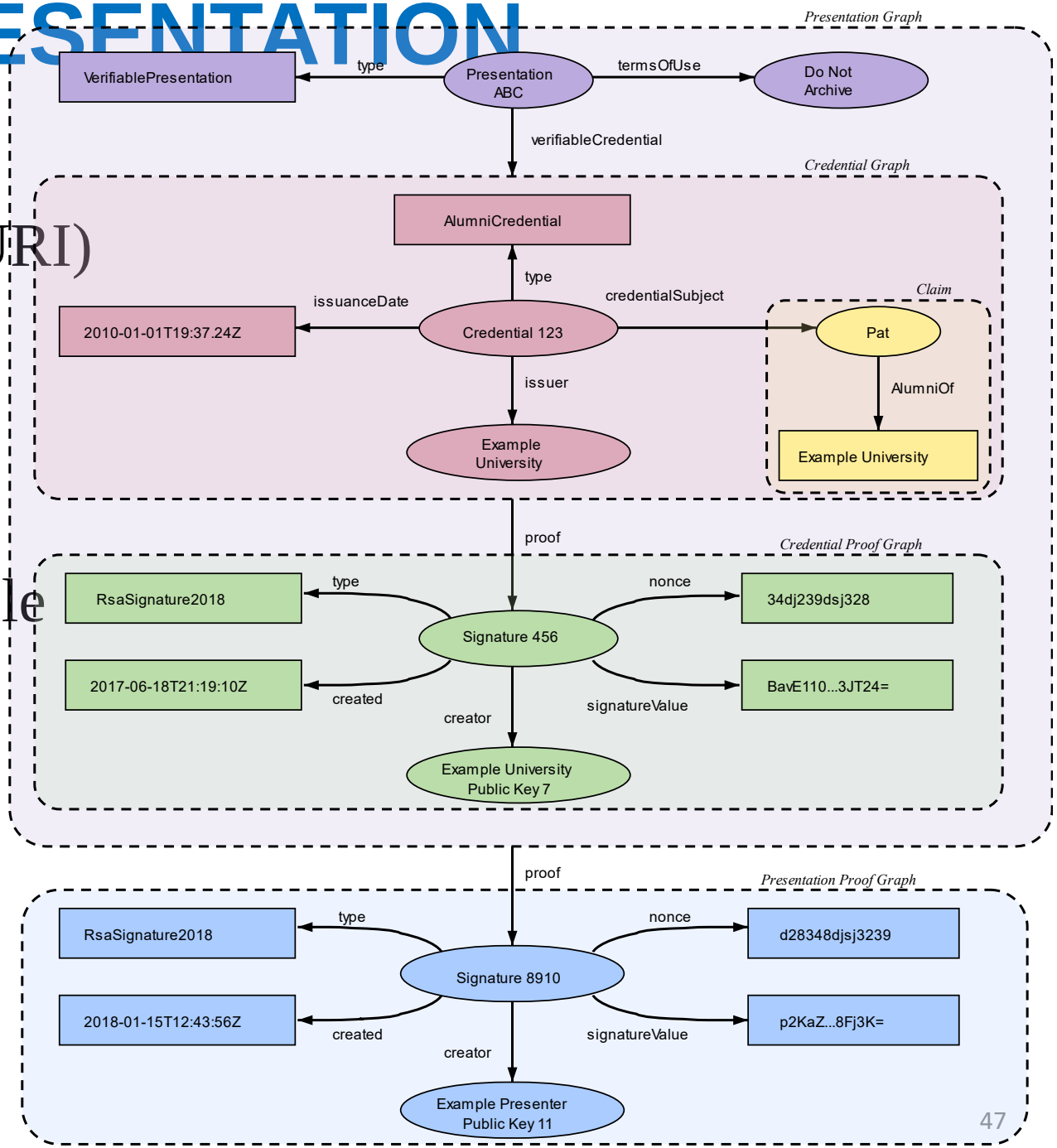
- is about the same subject
- be issued by multiple issuers information aggregation



5.4. VERIFIABLE PRESENTATION

Verifiable Presentation content:

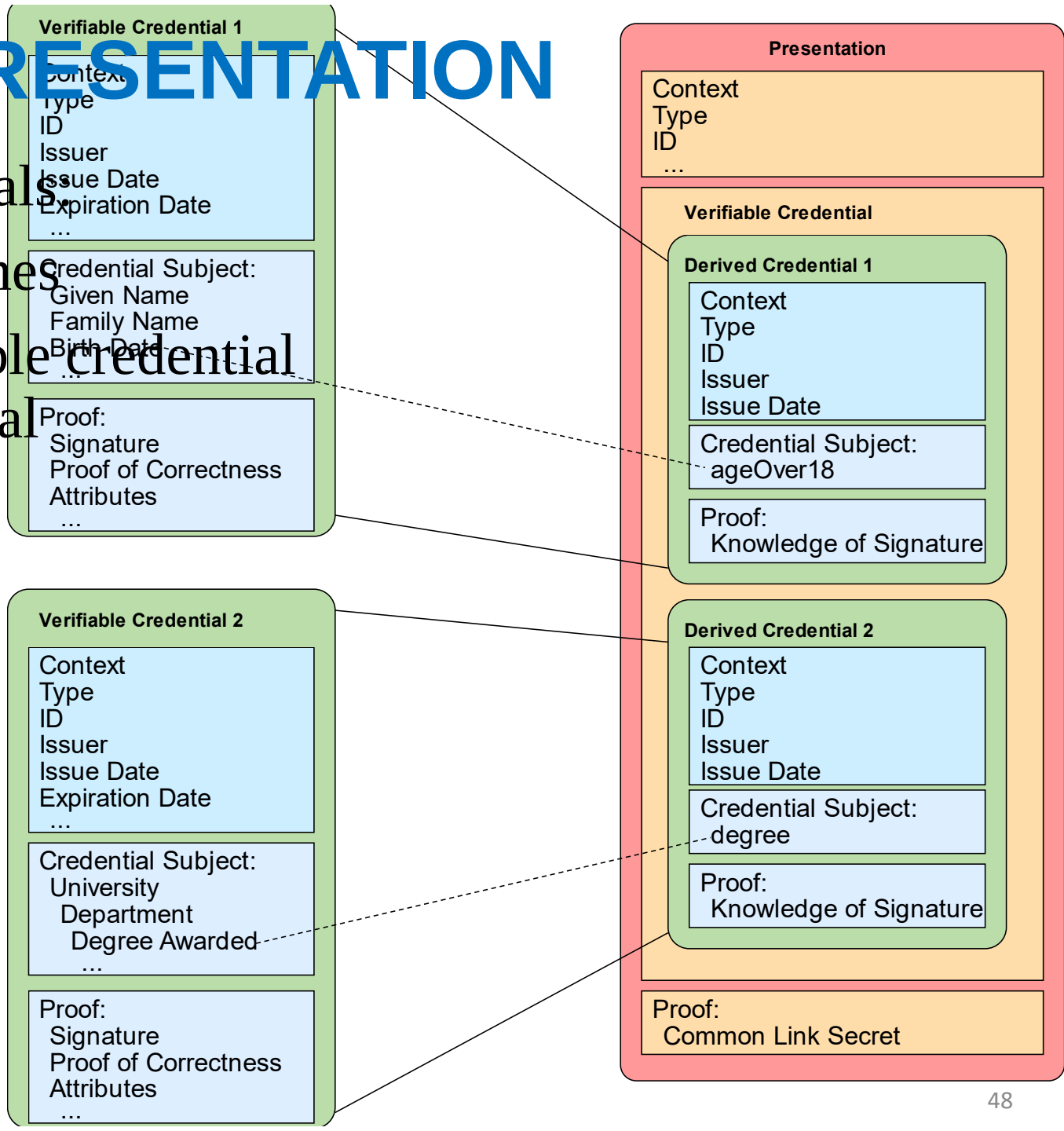
- id: unique identifier for presentation (URI)
- type: type of presentation, VP
- holder: URI for subject's presentation
- verifiableCredential: one/more verifiable credentials, or data derived from verifiable credentials
- proof: value of the proof



5.5. VERIFIABLE PRESENTATION

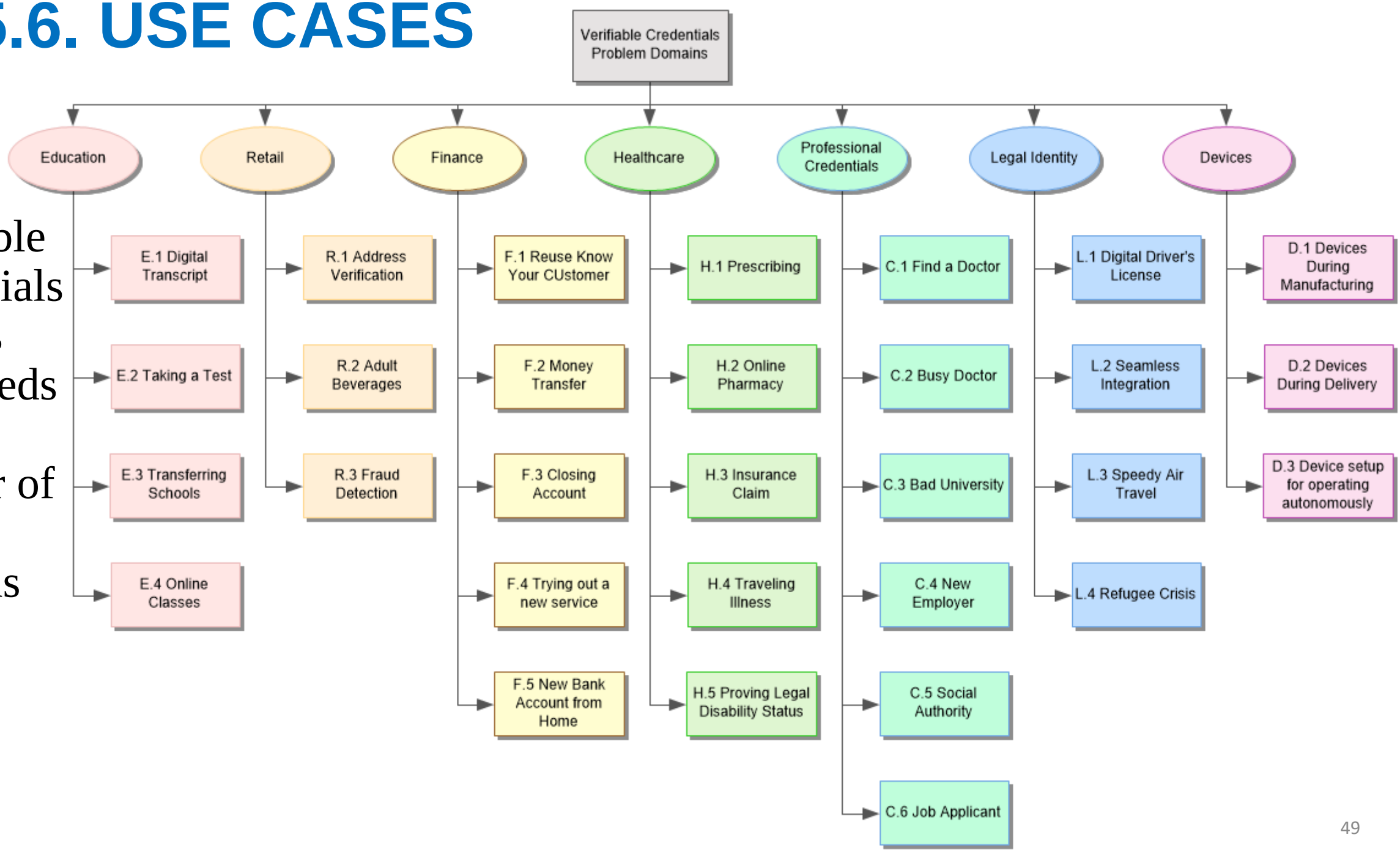
Presentations Using Derived Credentials

- zero-knowledge cryptography schemes
- indirectly prove claims from verifiable credential without revealing verifiable credential
- Selective disclosure schemes using zero-knowledge proofs



5.6. USE CASES

Verifiable credentials address user needs in a number of key domains



6. SSI BLOCKCHAIN PLATFORMS

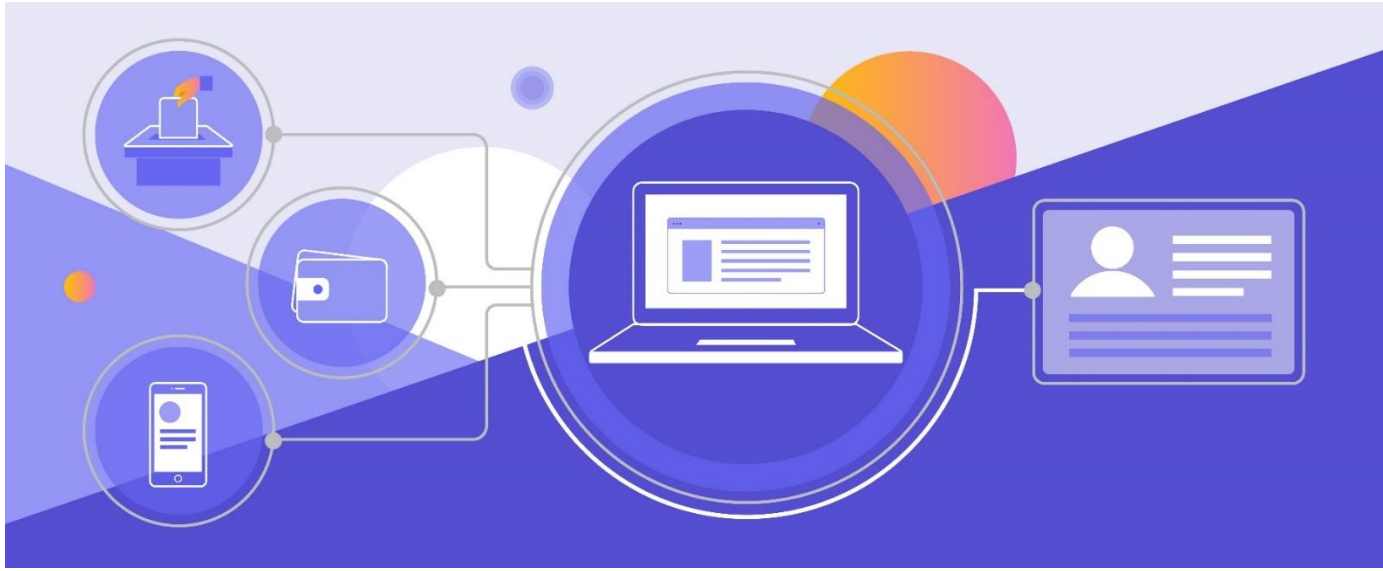
6.1. SSI BLOCKCHAIN PLATFORMS

6.2. SSI HYPERLEDGER

6.3. HYPERLEDGER URSA

6.4. HYPERLEDGER INDY

6.5. HYPERLEDGER ARIES



6.1. SSI BLOCKCHAIN PLATFORMS

Utilities with permissioned write access:

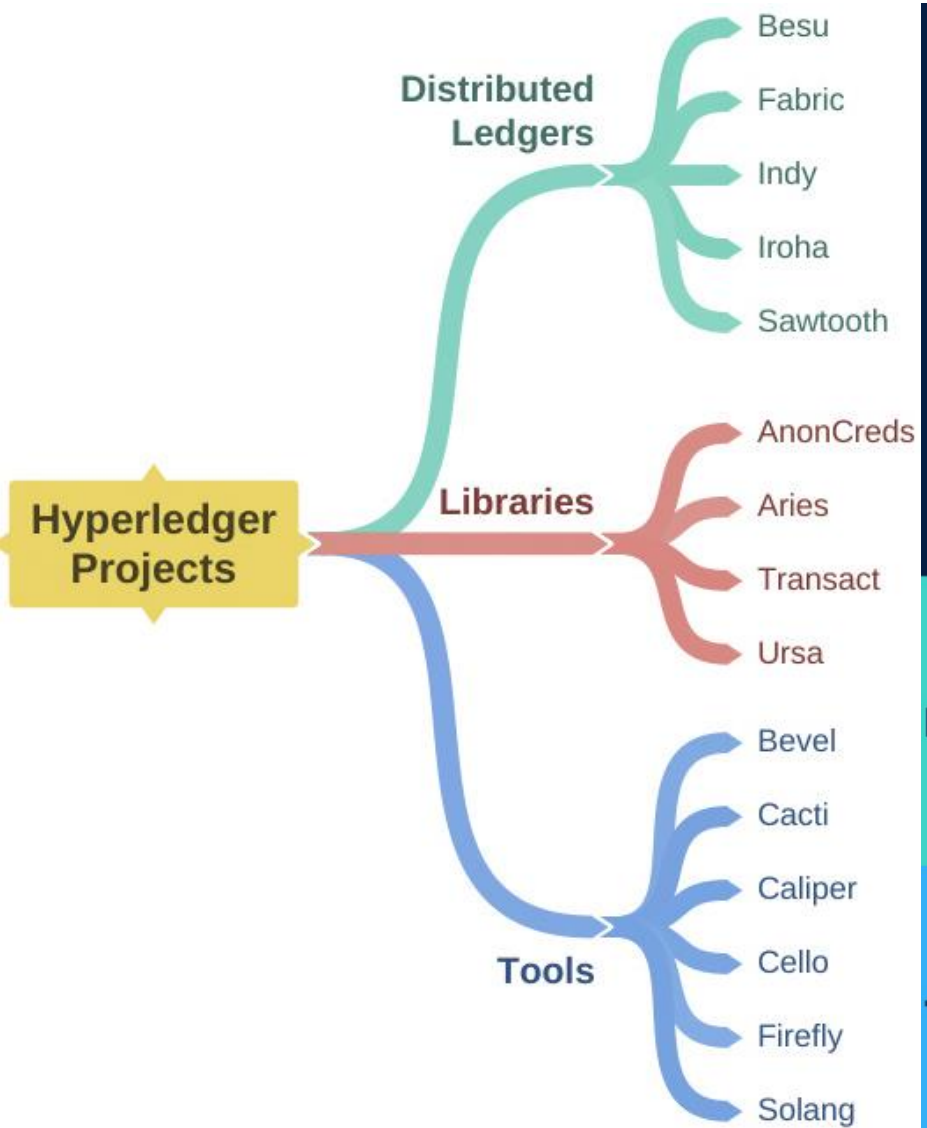
- Sovrin, Alastria
- in planning: SSI4DE (Lissi), Findy, eSSIF.

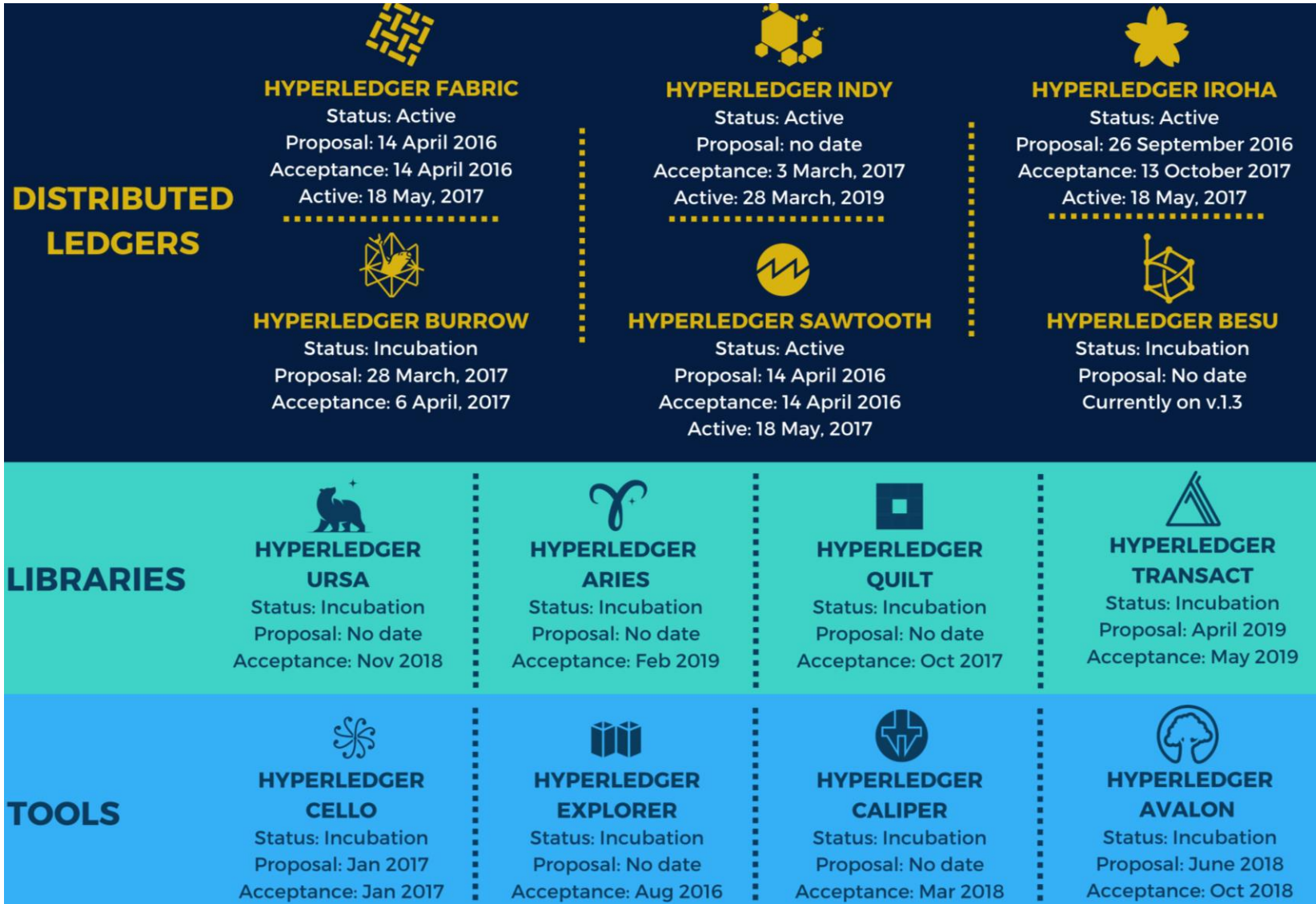
Utilities with permissionless write access:

- ION on Bitcoin, uPort, Jolocom, Selfkey,
- Elements, Digital Bazaar, more on Ethereum.

6.2. SSI HYPERLEDGER

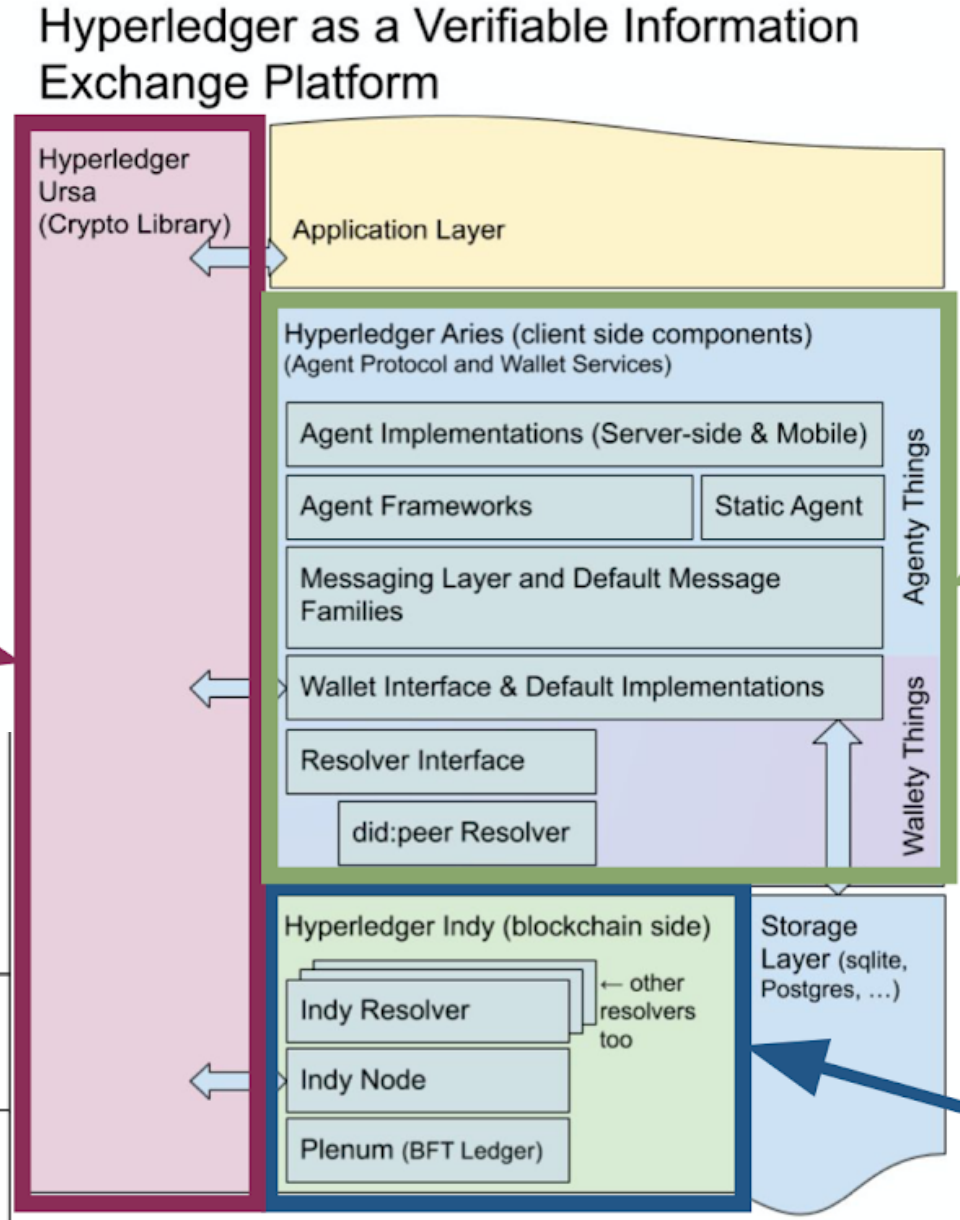
Hyperledger Projects:





6.2. SSI HYPERLEDGER

- Aries
- Indy
- Ursa



6.2. SSI HYPERLEDGER

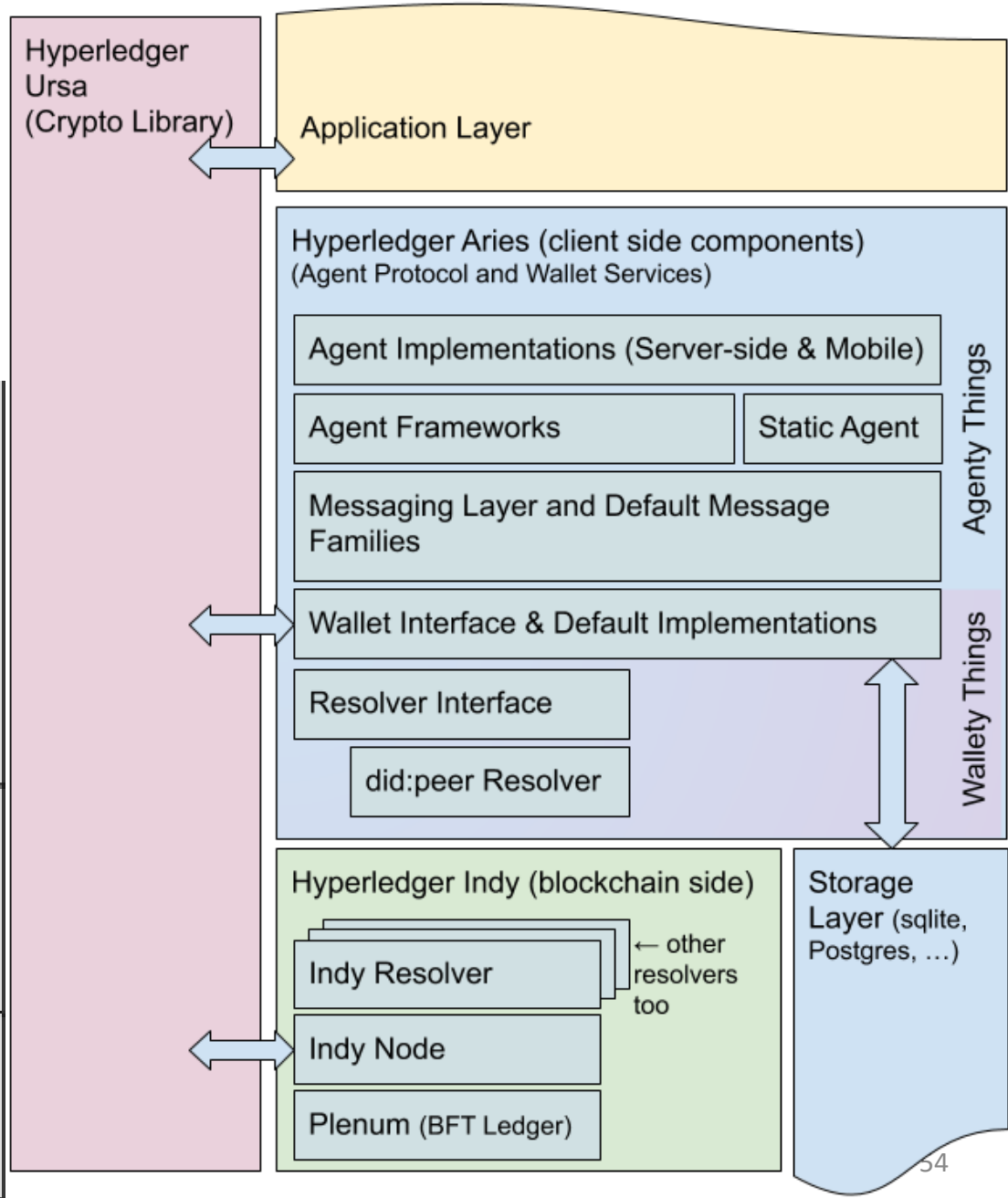
- Aries
- Indy
- Ursa

HYPERLEDGER ARIES

HYPERLEDGER INDY

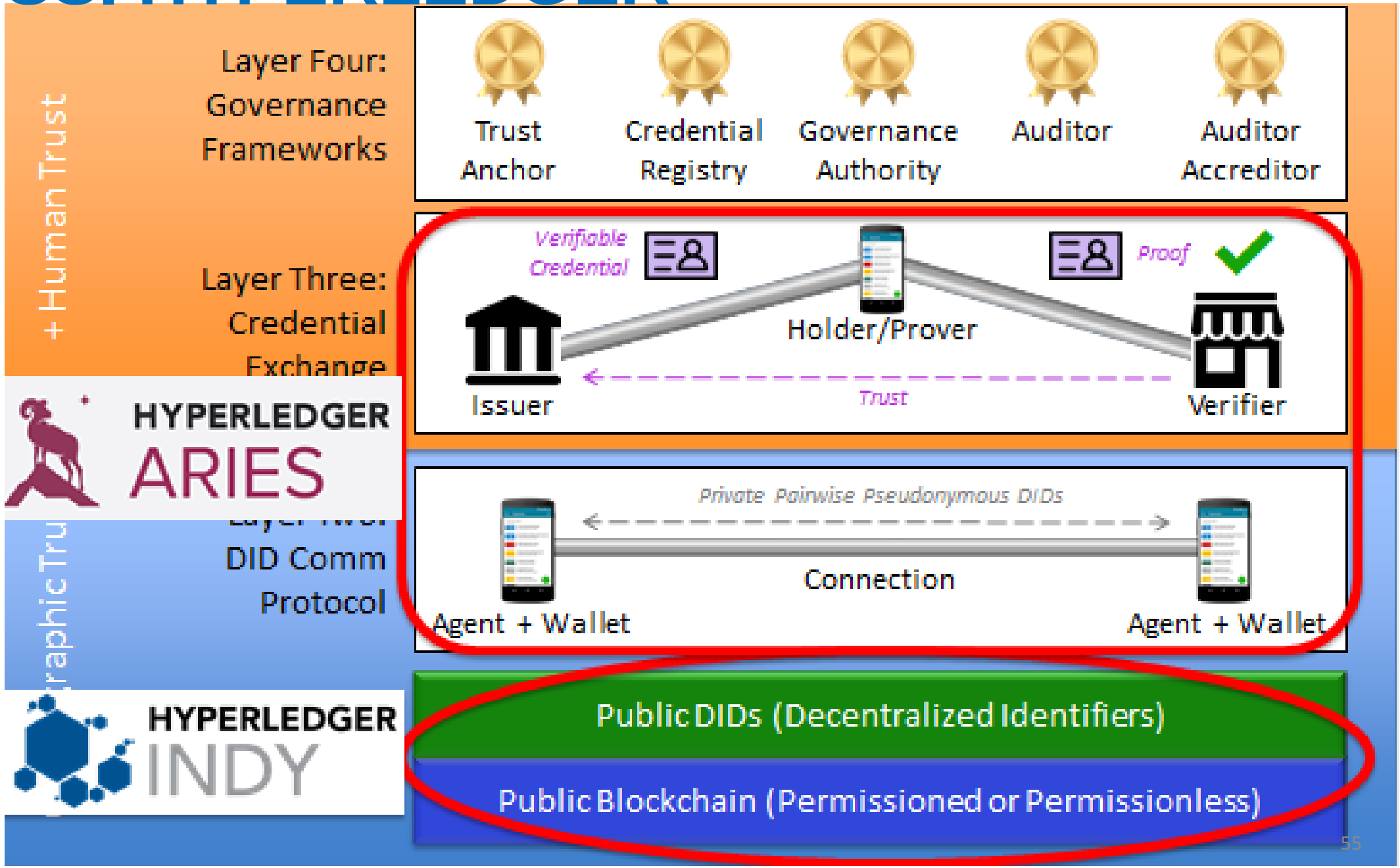
HYPERLEDGER URSA

Hyperledger as a Verifiable Information Exchange Platform



6.2. SSI HYPERLEDGER

- Layer 4: Aries Controller, Ursa
- Layer 3: Aries, Ursa
- Layer 2: Aries, Ursa
- Layer 1: Indy, Ursa



6.3. HYPERLEDGER URSA

Hyperledger Ursa:

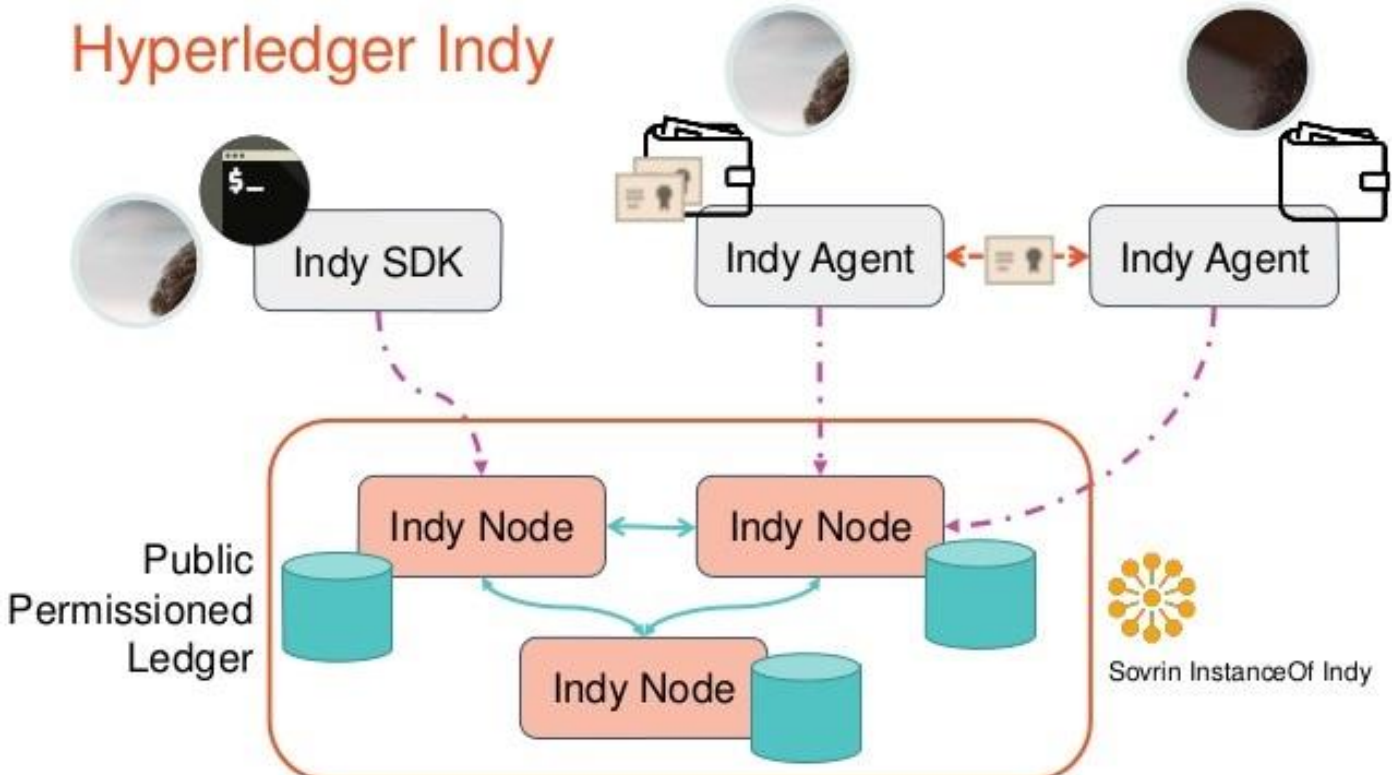
- shared cryptographic library (avoid duplicating code)
- opt-in repository (for Hyperledger and non Hyperledger projects).
- C-callable library interface
- Rust crate
- Libursa: cryptographic primitives:
  - digital signatures
  - encryption schemes
  - and key exchange.
- Libzmix:
  - create zero-knowledge proofs, proving statements about cryptographic building blocks, containing signatures, commitments, verifiable encryption.
  - uses blocks in Libursa.

HYPERLEDGER URSA

6.4. HYPERLEDGER INDY

Provides tools, libraries, reusable components for providing digital identities rooted on blockchains or other distributed ledgers

HYPERLEDGER INDY

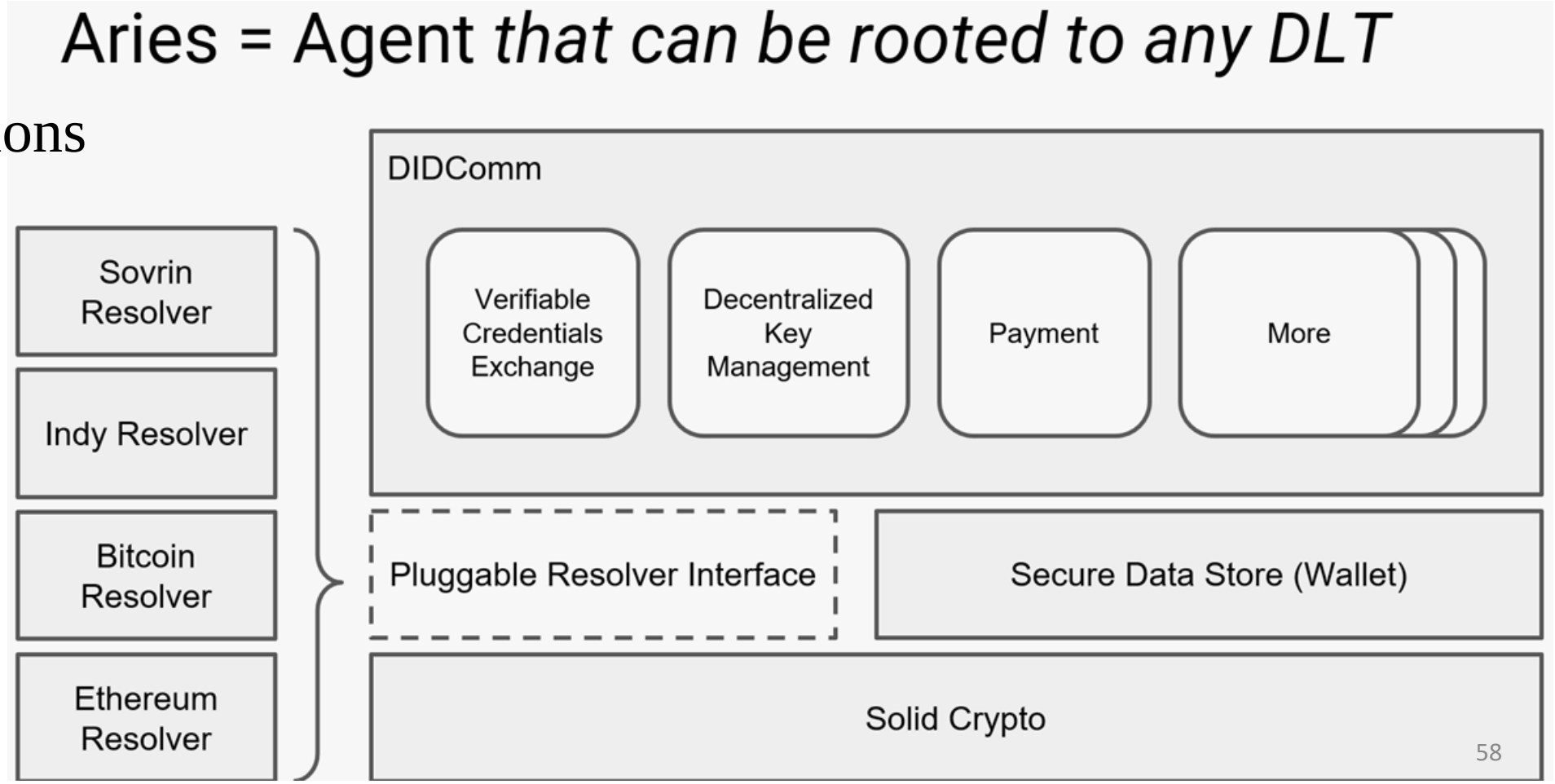


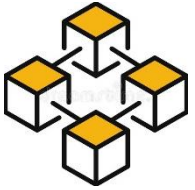
6.5. HYPERLEDGER ARIES

allows trusted online peer-to-peer interactions based on decentralized identities and verifiable credentials.

key components of Aries:

- agents
- DID communications
- Protocols
- key management.

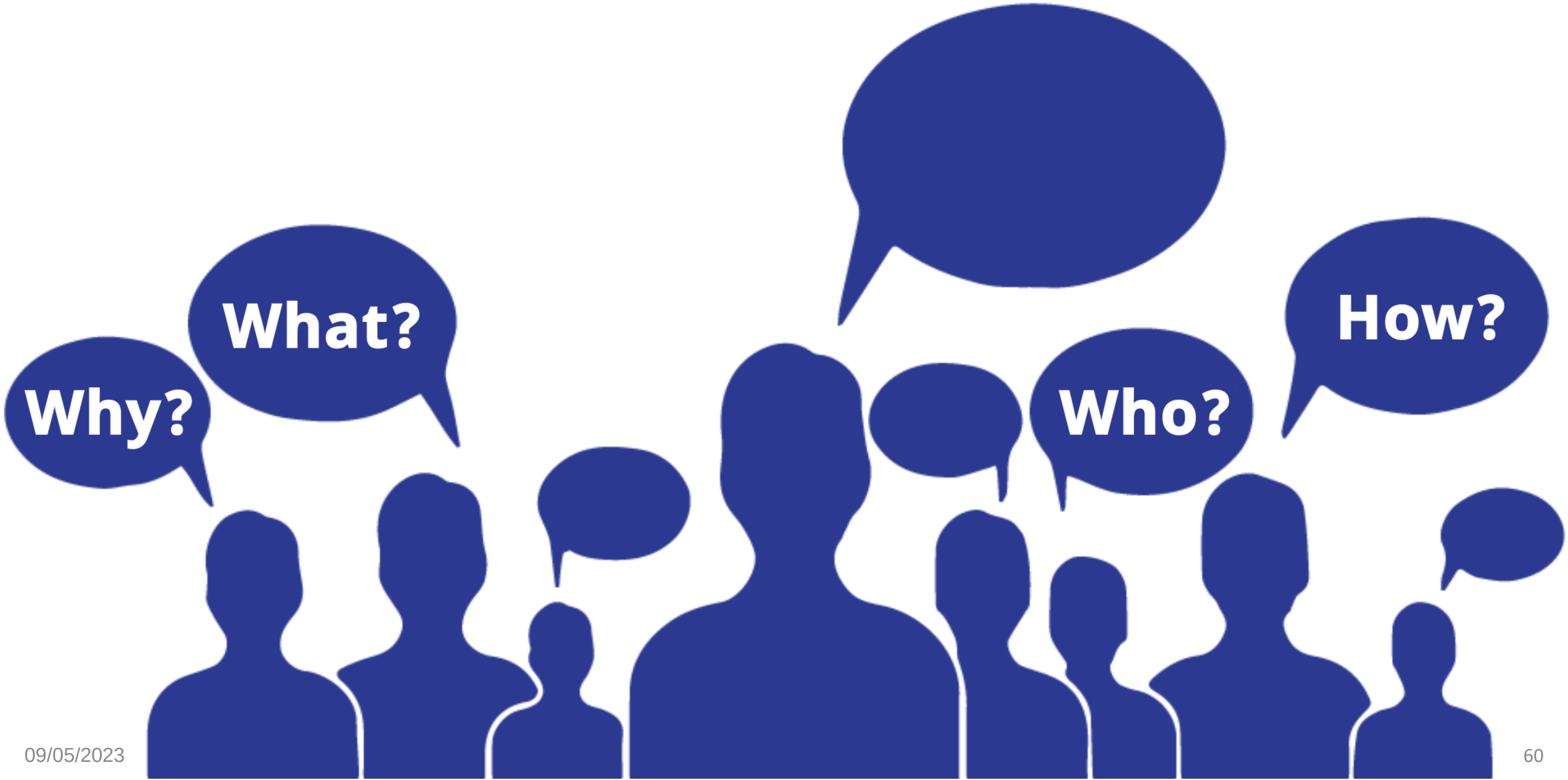




7. SUMMARY

- Digital Identity: Identity digital world
- Self-Sovereign Identity: Individuals control identity data
- Decentralized Identifier: globally unique identifierenables refers to subject, associate a DID subject with a DID document
- Verifiable Credential: are a digital credentials, cryptographically secured
- SSI Blockchain platforms: Hyperledger Projects (Indy, Aries, Ursa)

8. DISCUSSION



FINISH