Verification of Digital Credentials Supporting Self-Sovereign Identity for Higher Education Institutions

Pascal Herrmann, June 13th 2022 – Master's Thesis Kick-Off

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Outline

1. Motivation and Introduction
2. Problem Statement
3. Research Questions & Methodology
4. Timeline & Current Status

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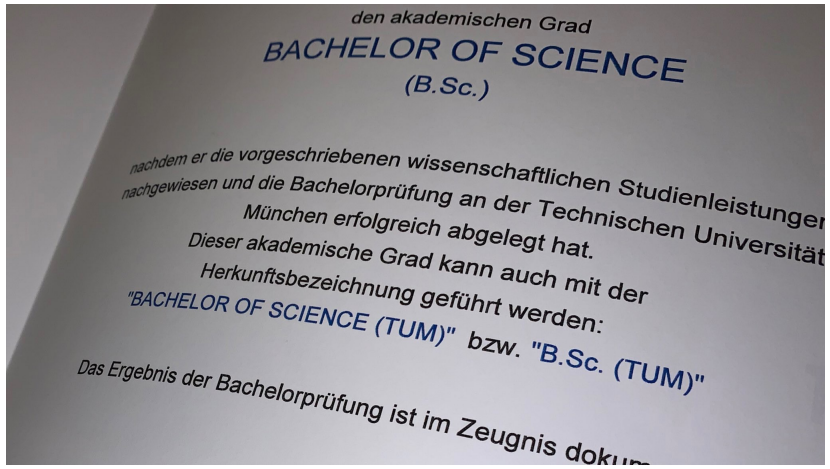
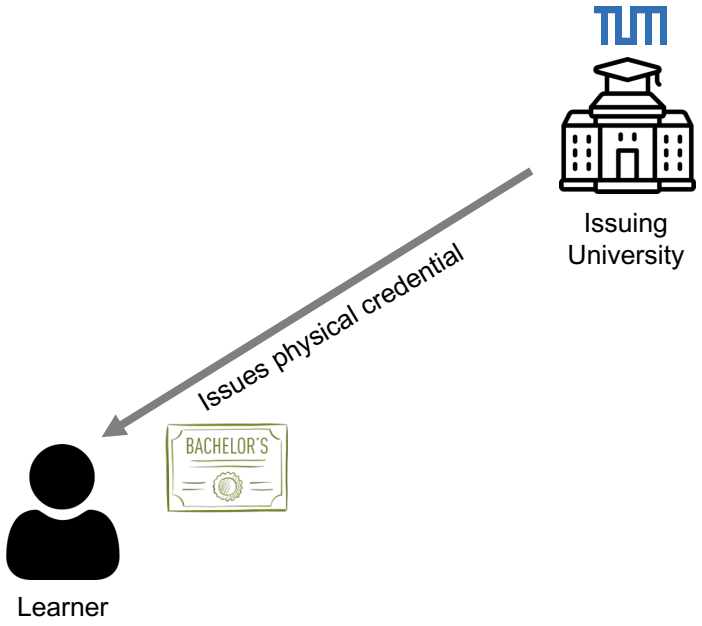
Motivation

Typically, Higher Education Credentials are issued to students as **physical paper documents**.





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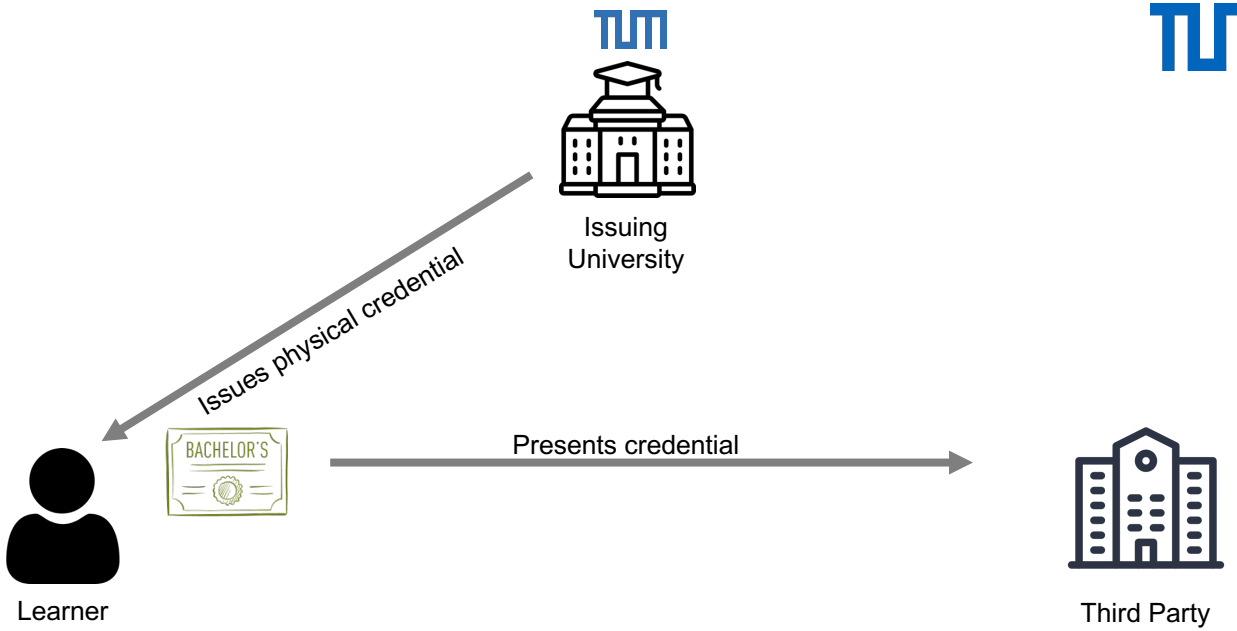
Motivation

Typically, Higher Education Credentials are issued to students as **physical paper documents**.

These documents are required for several important purposes.



Employment

Further Education

Immigration

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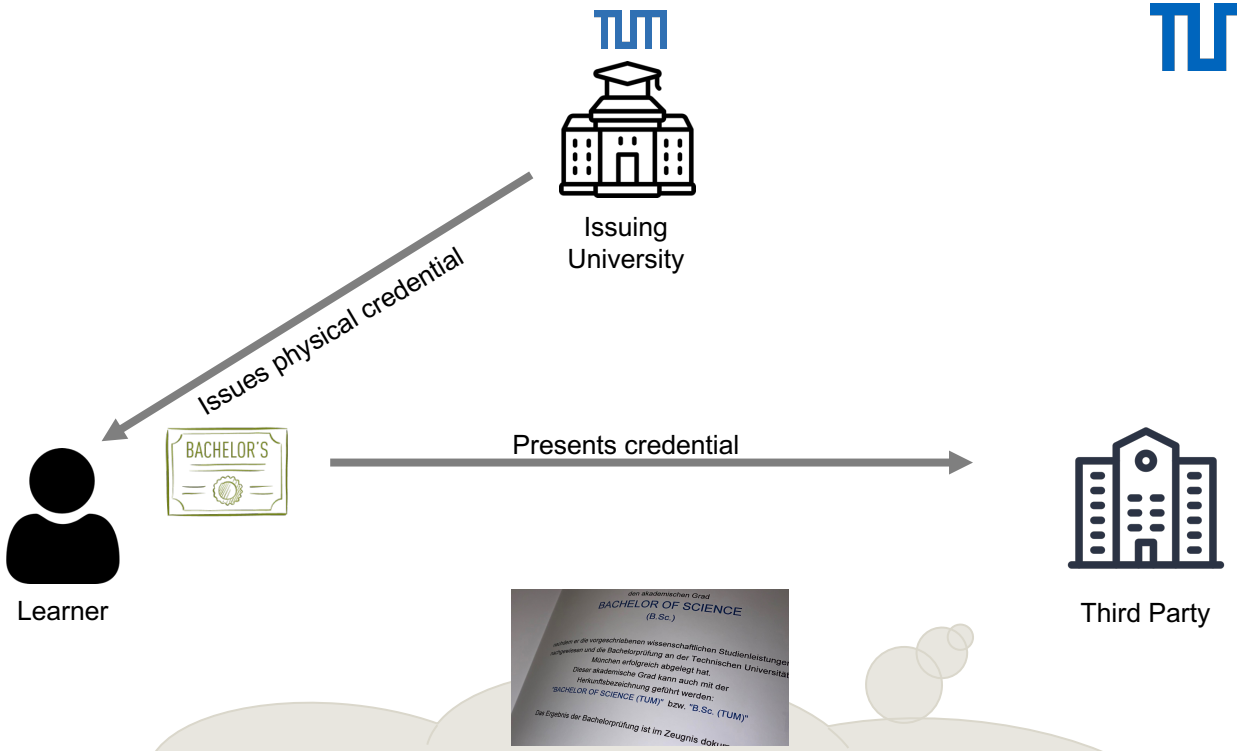
Motivation

Typically, Higher Education Credentials are issued to students as **physical paper documents**.

These documents are required for several important purposes.



The verification of these documents is challenging!

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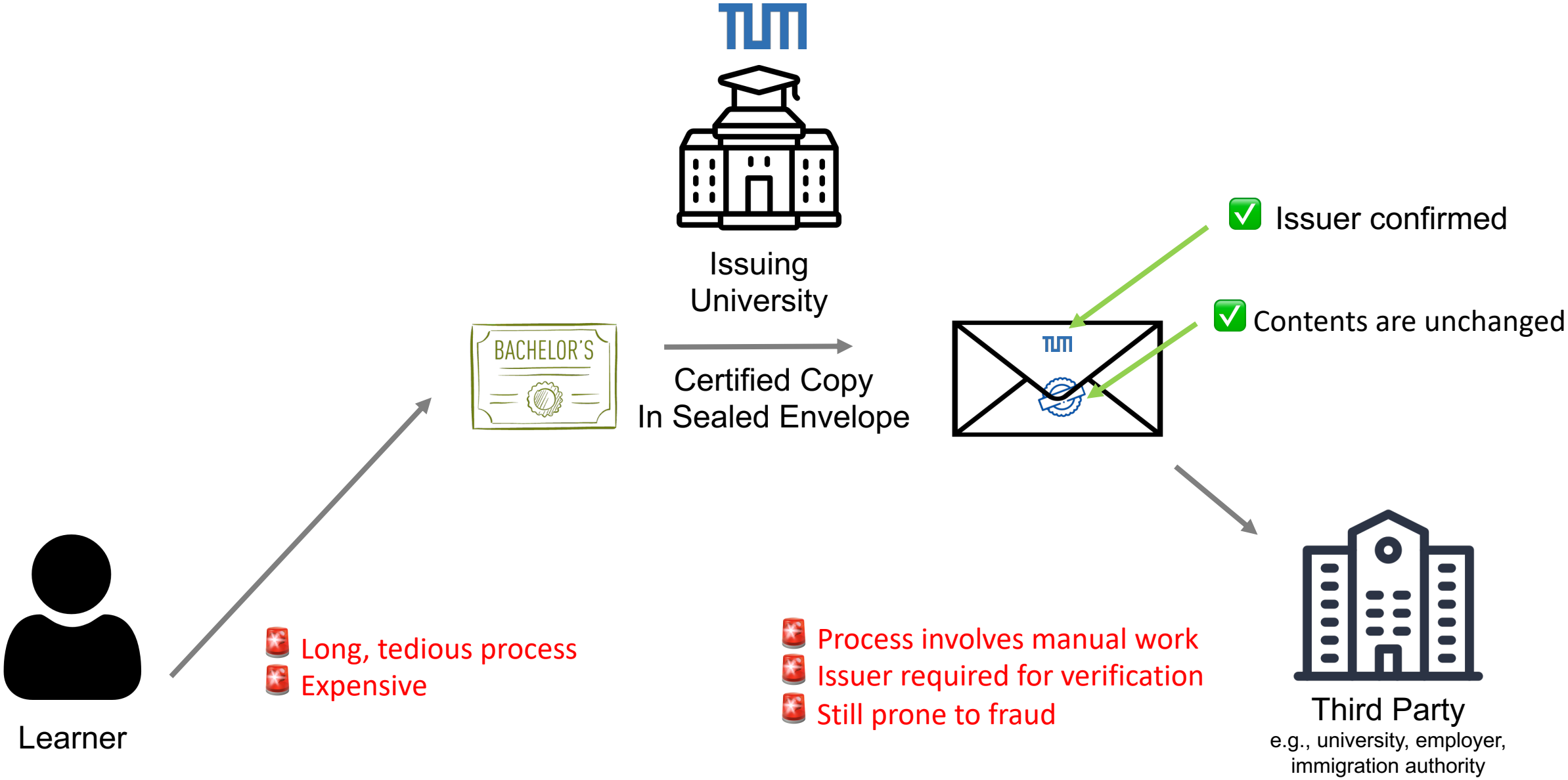
Example: Verification of Physical Education Credentials



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Vision: Verifiable Digital Credentials

Students obtain a **digital, verifiable credential** at graduation.

MyDegrees

Bachelor's Degree


```
{
  "issuer": "did:ipid:z6MkqVmUBC49F98kv ···  12zms",
  "credential": {
    "learner": "did:ethr:0x759871343297 ···  ffa5b",
    "degreeType": "Bachelor of Science",
    "major": "Informatics",
    "grade": "1.3"
     ⋮
  },
  "signature": "z2hMLrKN5x6m1i9DRctPNSL ···  X19bHn"
}
```


Self-Sovereign Identity:
✅ prove identity of issuer & learner

Cryptographic Signature:
✅ contents remain unchanged

The digital credential can be verified by relying parties
- ✅ Without involvement of the issuer
- ✅ In an efficient, automated way

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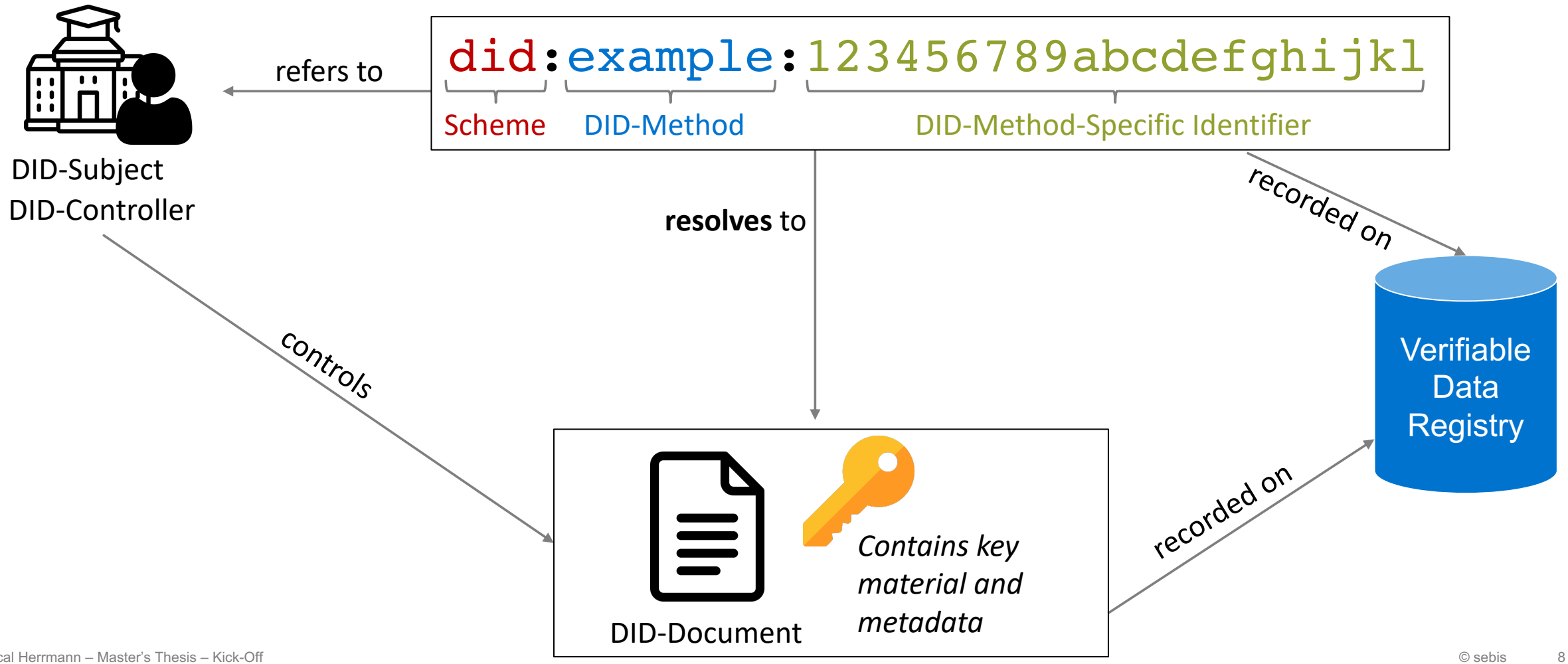
Self Sovereign Identities

Decentralized Identifiers (DIDs) resolve to DID-Documents that contain key material and metadata which can be used to authenticate DID subjects



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DiBiHo

- A collaboration of

Deutscher Akademischer Austauschdienst
German Academic Exchange Service

- In close cooperation with the

Goal: Proof of Concept for verifiable, digital credentials for higher education institutions

https://www.dibiho.de/

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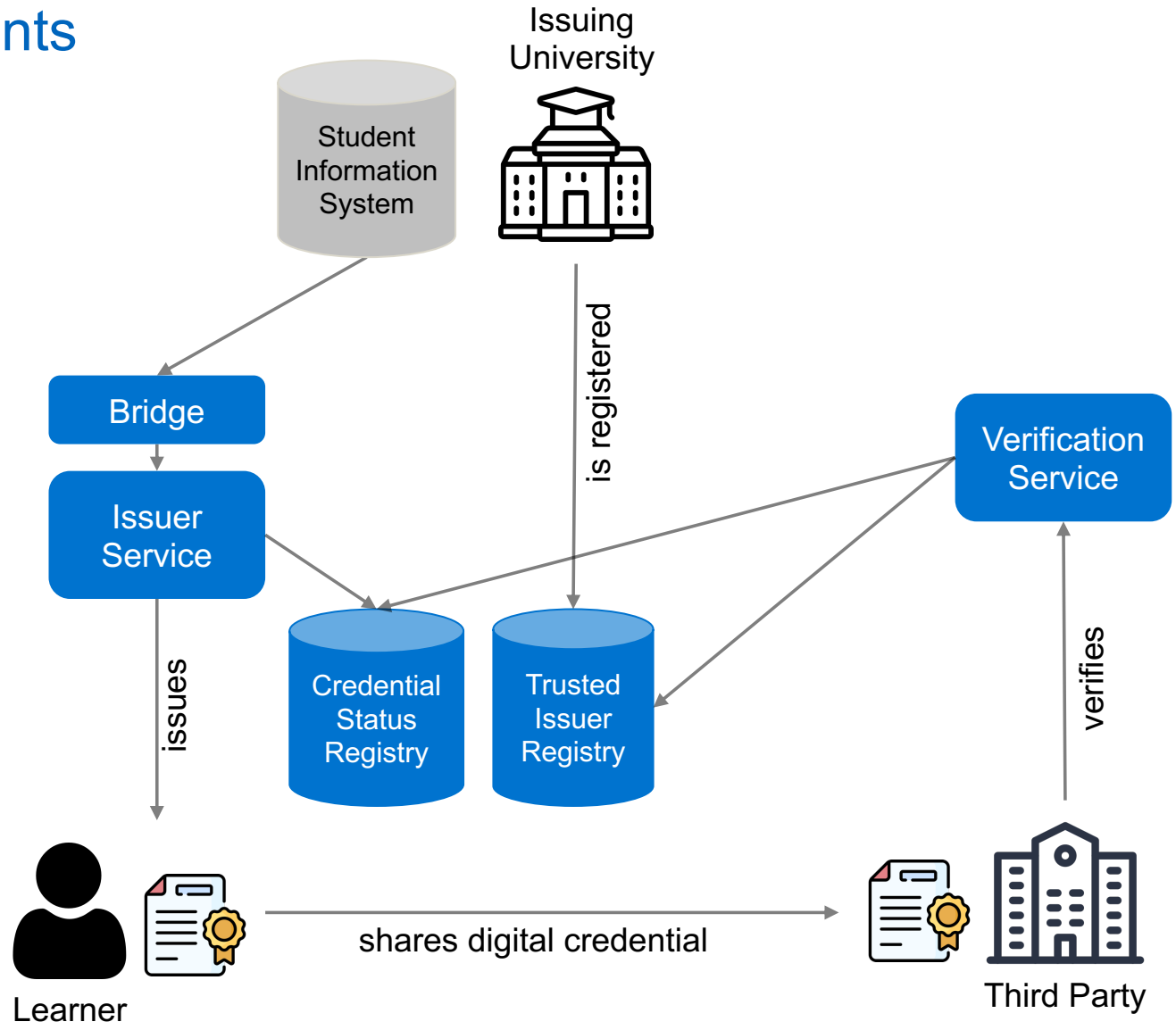
DiBiHo Components

Open-Source Reference Implementations

Consortium-Maintained Registries



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DiBiHo Components

Open-Source Reference Implementations

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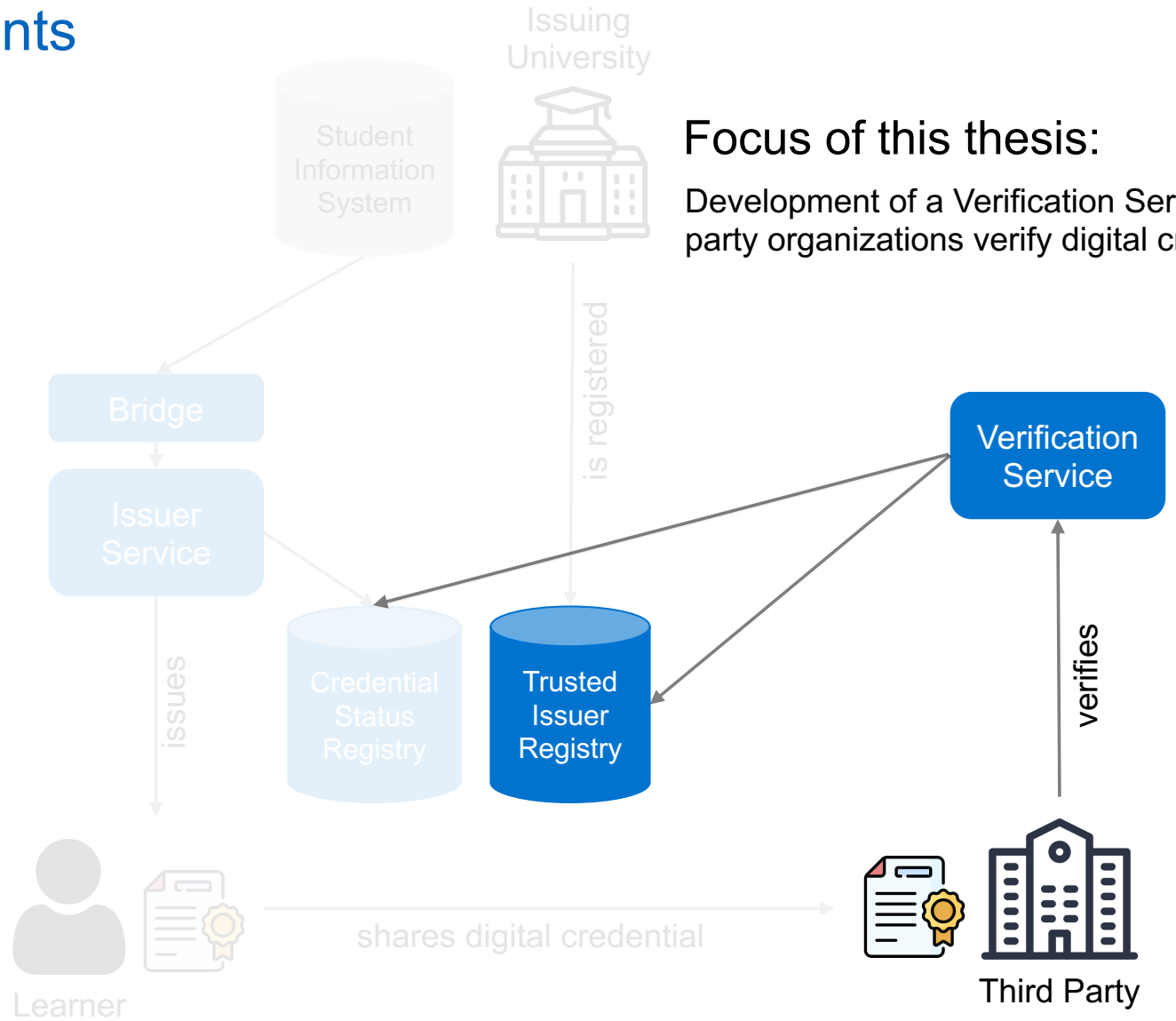

Focus of this thesis:

Development of a Verification Service component, which lets third-party organizations verify digital credentials.

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Research Question 1

RQ1: What is an effective validity check for verifiable credentials?

- What checks must be performed and in what order?
- What data must be fetched?
- What error states are possible? How should they be communicated?

Artifact:

Functioning implementation that can verify digital credentials created in accordance to the needs of higher education institutions

Methodology:

- Requirements Analysis
- Literature Research
- Scrum
- Test Driven Development

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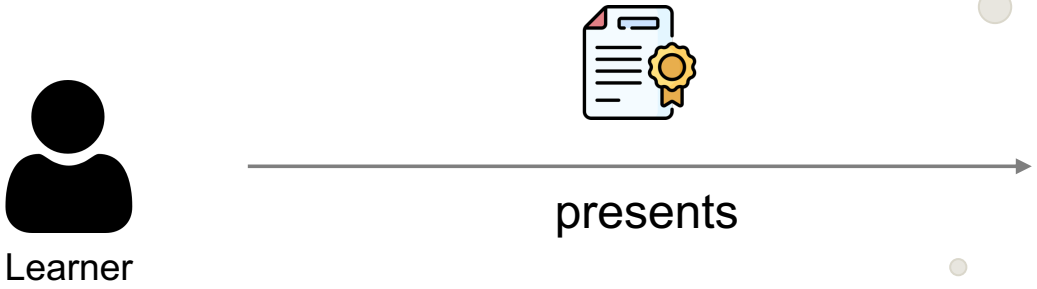
Is the **issuer** a **trusted university?**

Has the credential been **revoked**?

Is the content **unchanged**?



Is the credential **expired**?

… ?

Is the person who **presents** the credential the **owner** of the credential?

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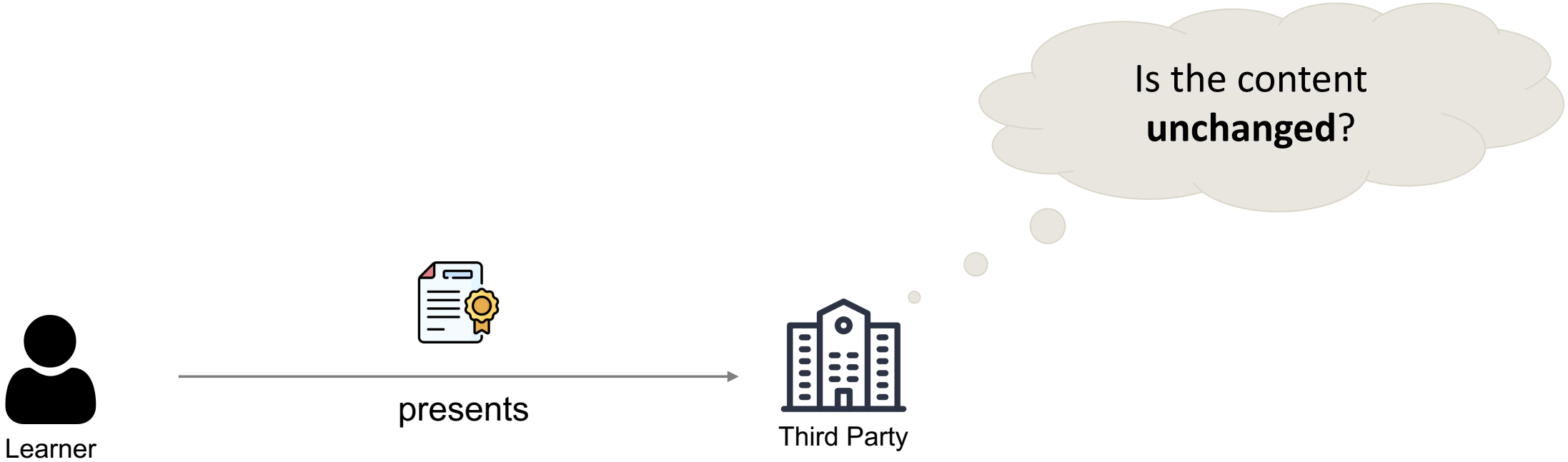

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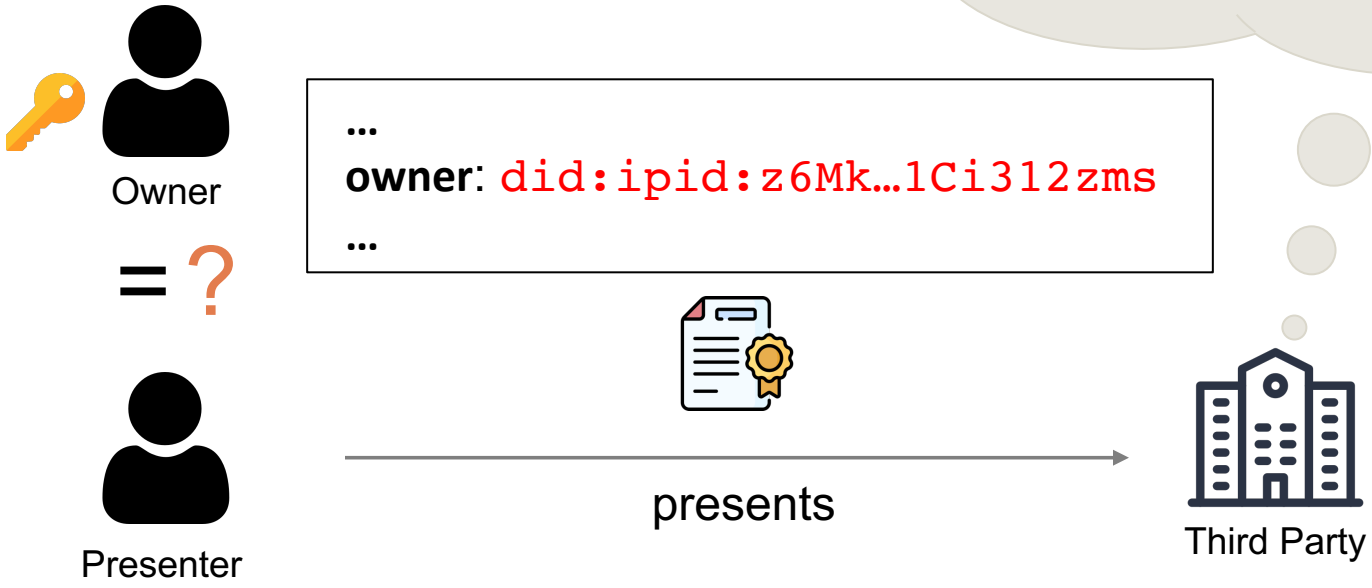
Is the person who **presents** the credential the **owner** of the credential?



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Research Question 2

RQ2: What SSI libraries shall be used in the implementation of the Verification Service?

- Which criteria must SSI libraries fulfill to be well-suited for this use case?
- What SSI libraries exist and how do they fulfill these criteria?

Artifact:

- Criteria Catalog
- Set of frameworks rated according to these criteria

Methodology:

- Requirements Analysis
- Literature Research

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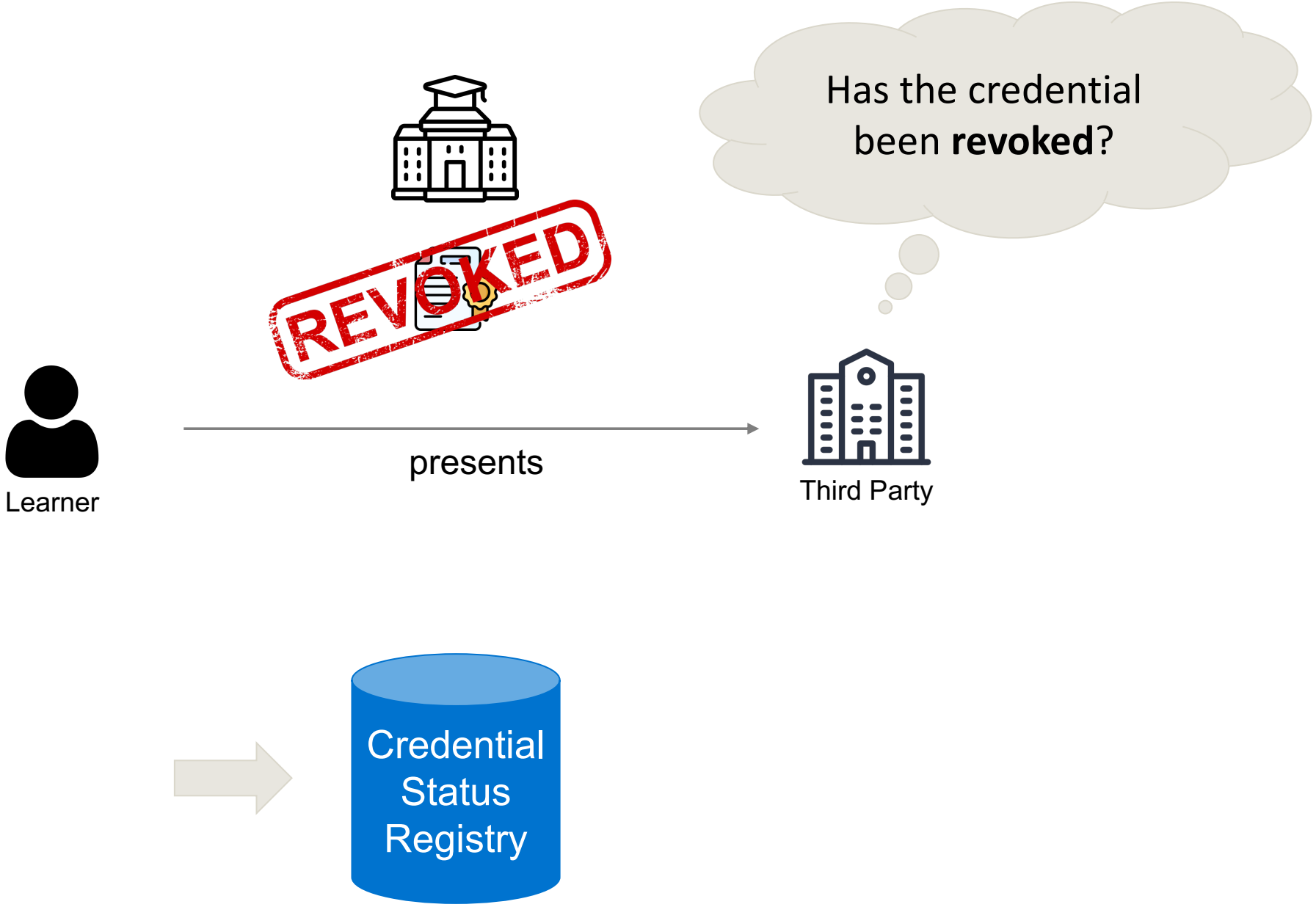
Has the credential been **revoked**?
REVOKED
Learner
presents
Third Party
Credential Status Registry

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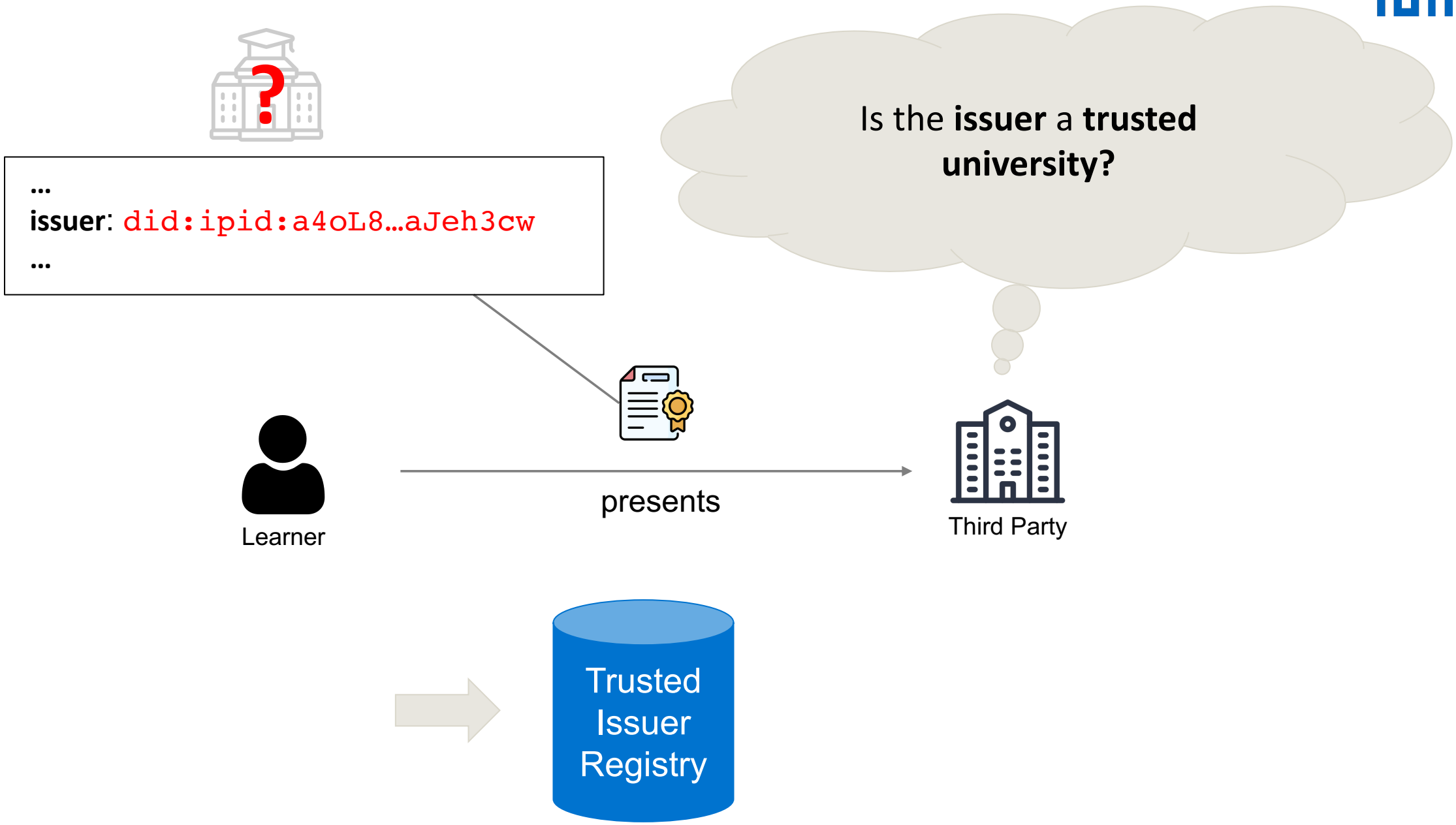
...
issuer: did:ipid:a4oL8…aJeh3cw
...
Is the issuer a trusted university?
Learner
presents
Third Party
Trusted Issuer Registry

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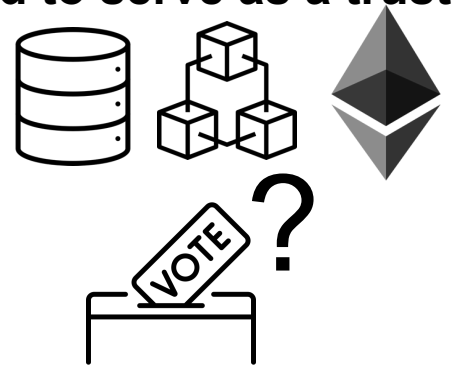
Research Question 3

RQ3: How can a Trusted Issuer Registry be designed and implemented to serve as a trust-anchor for verifying issuers of digital credentials?



- Which type of infrastructure is suited?
- What information must be stored?
- How can new issuers be added while maintaining high level of trust?
- How can the Trusted Issuer Registry be implemented?

Artifact:

- Architecture and Implementation of Trusted Issuer Registry

Methodology:

- Literature Research
- Proof of Concept Development

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Overview: Verification Checks

Verifiable Credential

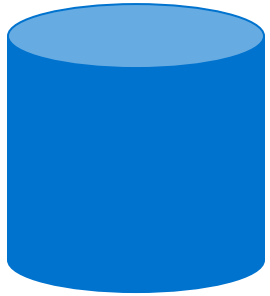
Credential to be verified
Shared/Uploaded by Learner

- Check whether the credential is **expired**
- Check whether **format/syntax** is correct
- …?

DID Registry/Registries

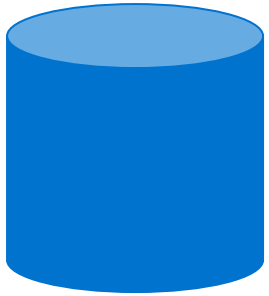
Depend on supported DID methods
Provide cryptographic keys/metadata
e.g. Ethereum, IPFS, Web Server

- Resolve Issuer DID/ **Resolver** Learner DID to obtain **Key Material**
- Verify whether issuer **signature** is valid
- Check if credential provider can **authenticate as credential subject**?
- …?



Credential Status Registry

- Check whether credential has been **issued**
- And **not revoked**
- …?



Trusted Issuer Registry

- Check whether the issuer is (still?) a **trusted organization**
- …?

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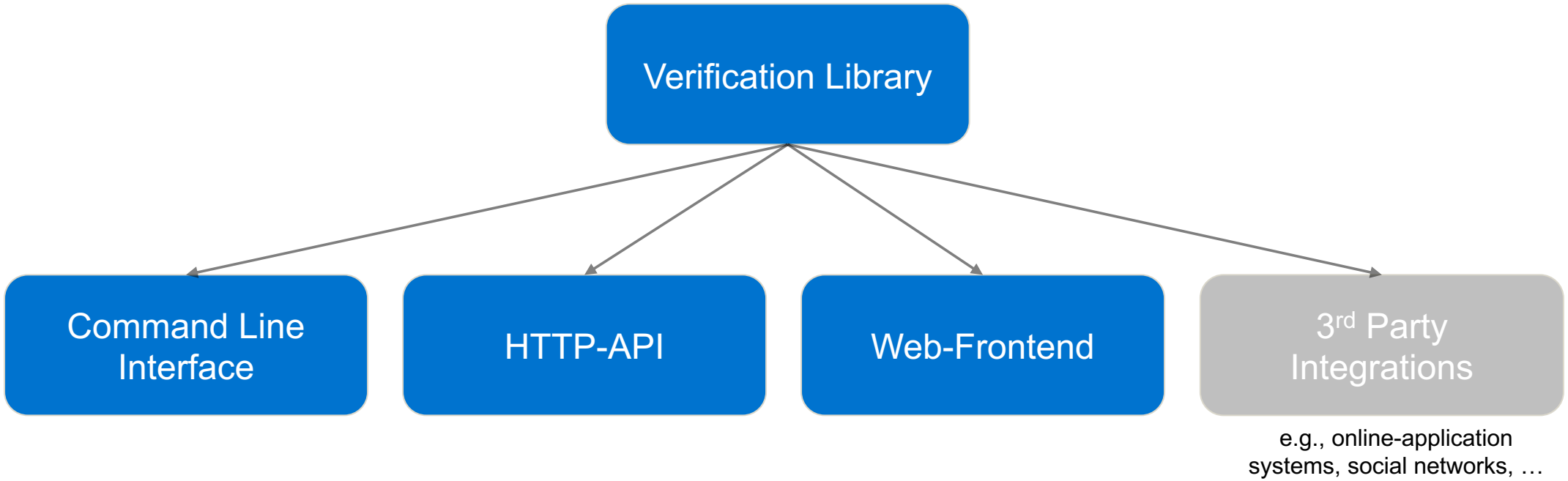
Goal: Implementation of Verification Library



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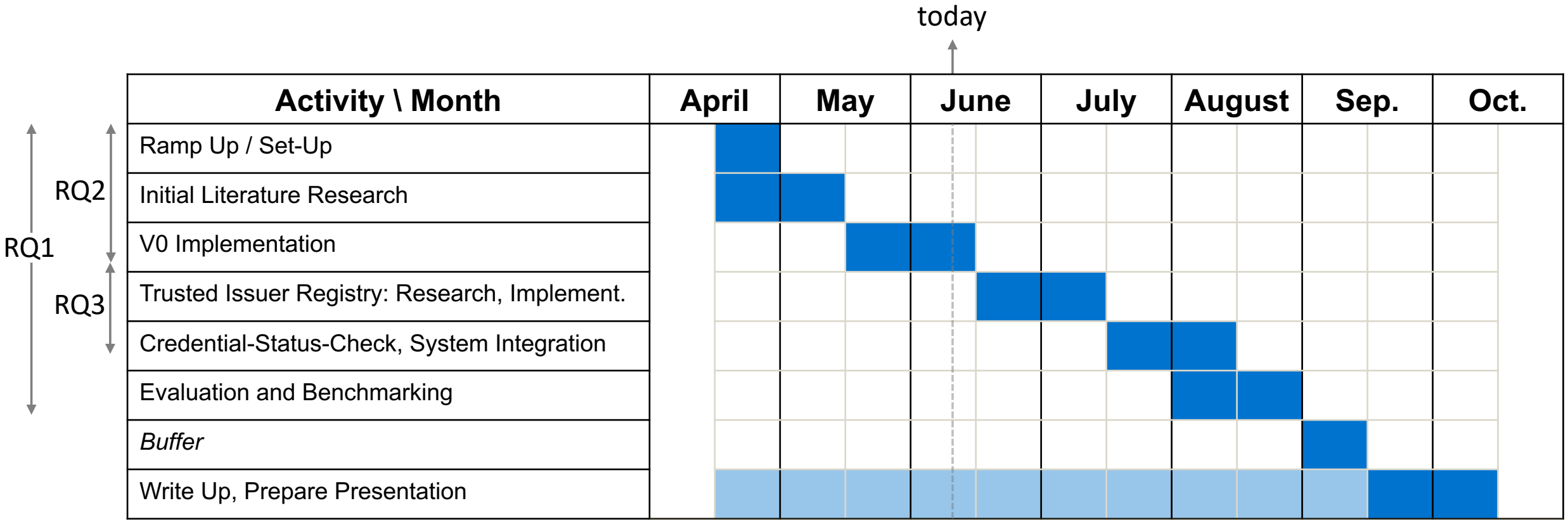

Current Status:

- Evaluated and assessed several SSI-Frameworks
- Set up DID-Resolving and Dereferencing for did:key, did:web, did:ethr, did:iota
- Set up Signature Verification, supporting EC and EdDSA verification methods
- Currently working on V0-Version of Verification Service (focus on DID-Resolving and Signature Verification)

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Icons: https://www.flaticon.com/

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