Design and Implementation of a Decentralized Trusted Issuer Registry for Self-Sovereign Identity

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16.10.2023, Kick-off Presentation

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Outline

1. Motivation
2. Problem Statement
3. Research Questions
4. Methodology
5. Timeline

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Are you in control of your digital identity?

- We all have only one real identity -> but many online accounts
- Identity providers have full control over your online identity
- You have limited control over your identity
- Today: low interoperability & portability, limited data protection, …

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Self-Sovereign Identity (SSI)

A rather new approach on digital identity where users have full control over their identity without relying on a third party [1]

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Gaia-X [2]

- A large European project, currently 377 members [3]
- Goal: a federated, self-sovereign and secure data infrastructure built on common standards and interfaces
- Gaia-X won't run the infrastructure, but build its standards

- Source of requirements for my thesis

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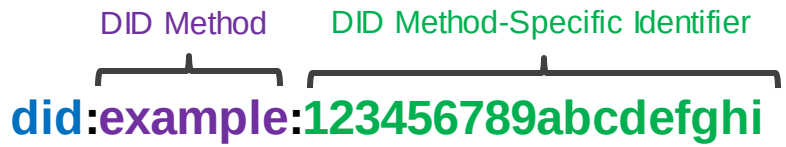
Decentralized Identifiers [4]

- A W3C standard for identifying subjects without relying on a central organization
- Today: Username, email address, phone number, etc...



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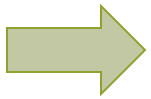
did:web:tum.de

…



```
// DID-Document
{
  "@context": [
    "https://www.w3.org/ns/did/v1",
    "https://w3id.org/security
/suites/ed25519-2020/v1"
  ],
  "id":
"did:example:123456789abcdefghi",
  authentication": [{
    "id":
"did:example:123456789abcdefghi#key
s-1",
    "type":
"Ed25519VerificationKey2020",
    "controller":
"did:example:123456789abcdefghi",
    "publicKeyMultibase":
"zH3C2AVvLMv6gmMNam3uVAjZpfkcJCwDwn
Zn6z3wXmqPV"
  }]
}
```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Verifiable Credentials [5]

- A W3C standard for subjects making claims about subjects that can be cryptographically verified
- Example: Company A claims that person B is an employee at A

…


```
{
  "@context": [
    "https://www.w3.org/2018/credentials/v1",
    "https://www.w3.org/2018/credentials
/examples/v1"
  ],
  "id": "http://example.edu/credentials/1872",
  "type": ["VerifiableCredential",
"AlumniCredential"],
  "issuer": "https://example.edu/issuers/565049",
  "issuanceDate": "2023-01-01T19:23:24Z",
  "credentialSubject": {
    "id": "did:example:ebfeb1f712ebc6f1c276e12ec21",
    "alumniOf": {
      "id":
"did:example:c276e12ec21ebfeb1f712ebc6f1",
      "name": [{
        "value": "Example University",
        "lang": "en"
      }]
    }
  },
  "proof": {
    "type": "RsaSignature2018",
    "created": "2023-06-18T21:19:10Z",
    "proofPurpose": "assertionMethod",
    "verificationMethod": "https://example.edu
/issuers/565049#key-1",
    "jws": "eyJhbGci...dBBPM"
  }
}
```


Verifiable Credential

- Metadata (e.g., Issuer DID)
- Claim(s)
- Proof(s)

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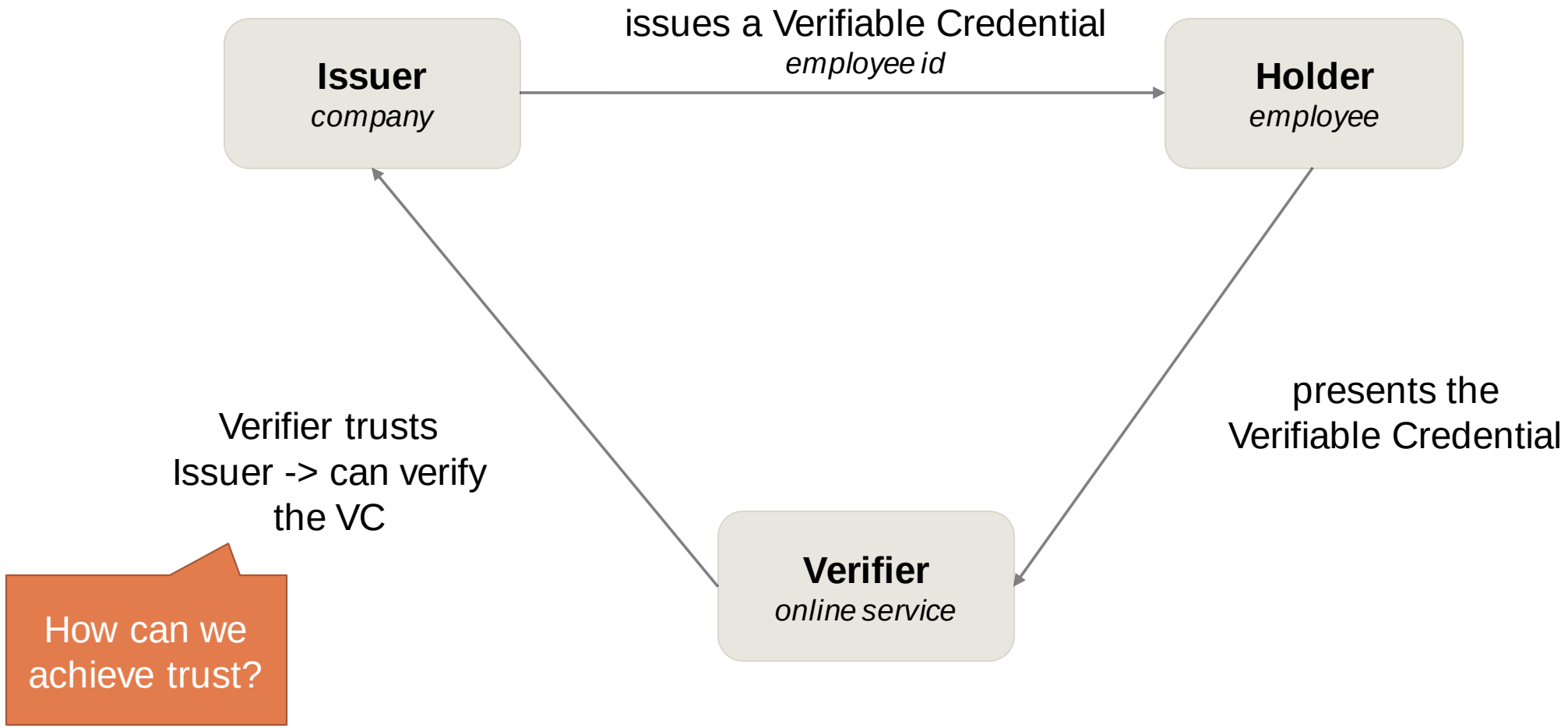
Problem Statement [5]

example



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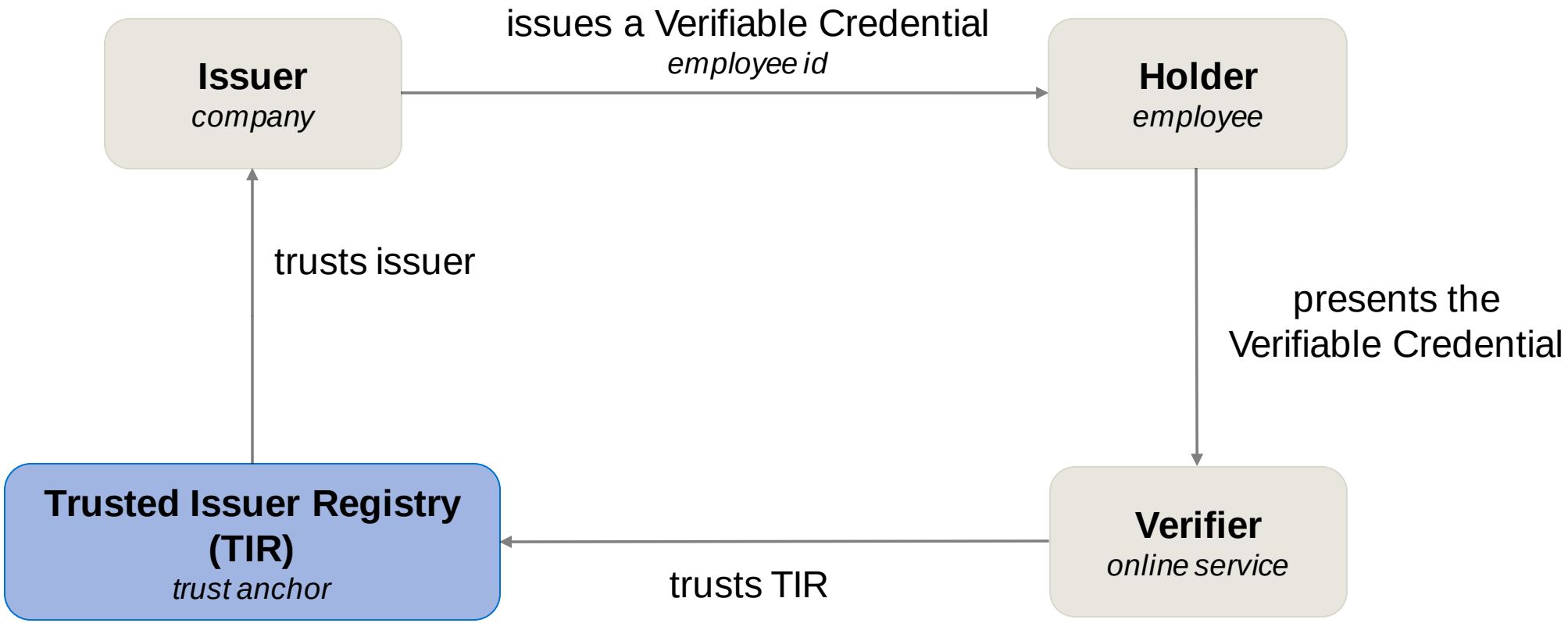
Problem Statement [5]

example



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Problem Statement

Trusted Issuer Registry (TIR)

- There exist already some Trusted Issuer Registry designs
- But: they all have several drawbacks

- Centralization vs Decentralization
- Authentication and/or Authorization?
- Scalability
- Security

[6]

```
// DCC Issuer Registry MVP
{
  "meta": {
    "created":
"2020-12-02T02:32:16+0000",
    "updated": "2022-05-25T12:40:00+0000"
  },
  "registry": {
     "did:example:1234": {
        "name": "Example University",
        "location": "San Diego, CA, USA",
        "url": "https://www.example.edu"
     },
     "did:web:tum.de": {
        "name": "Technical University
Munich",
        "location": "Munich, Germany",
        "url": "https:/www.tum.de"
     }
  }
}
```

TRAIN
Jeyakumar,
Chadwick, Kubach [7]

ebsi European Blockchain [8]

...

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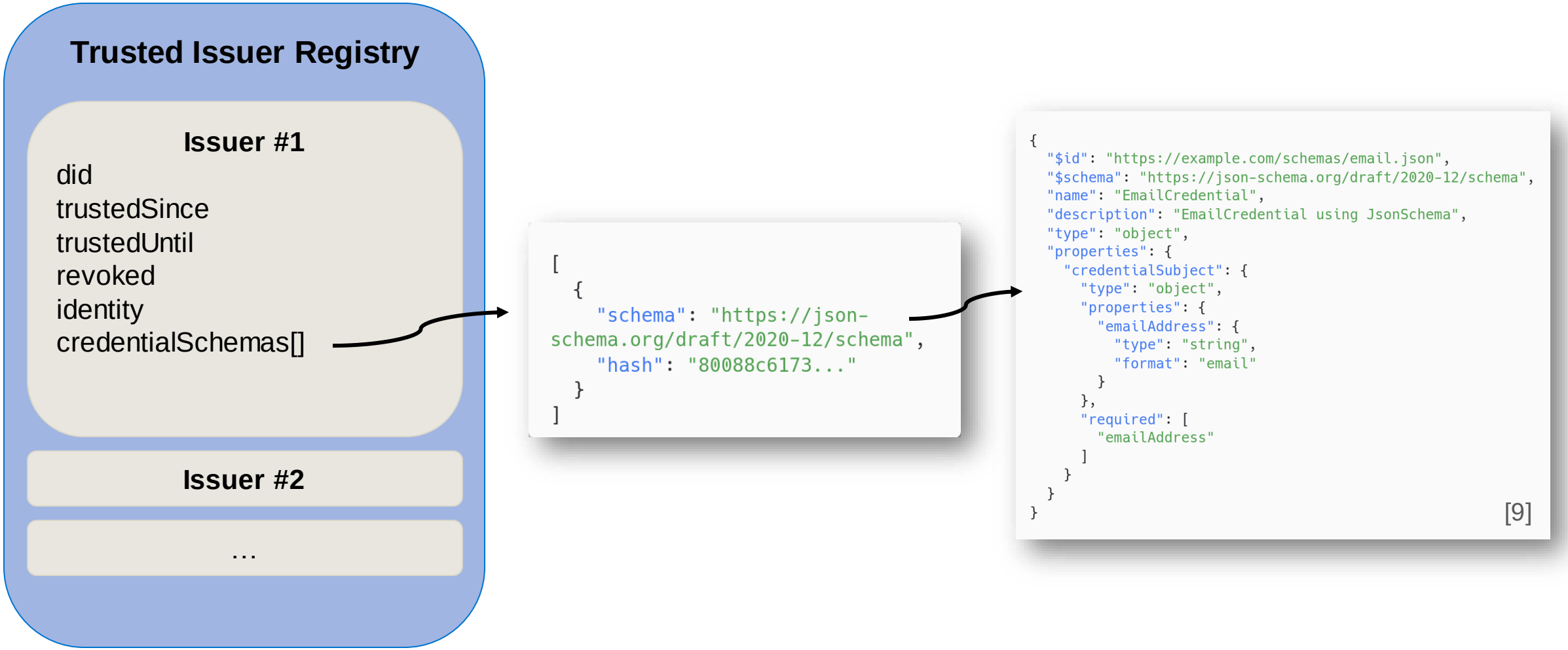
Potential Solutions - Authorization



[9]

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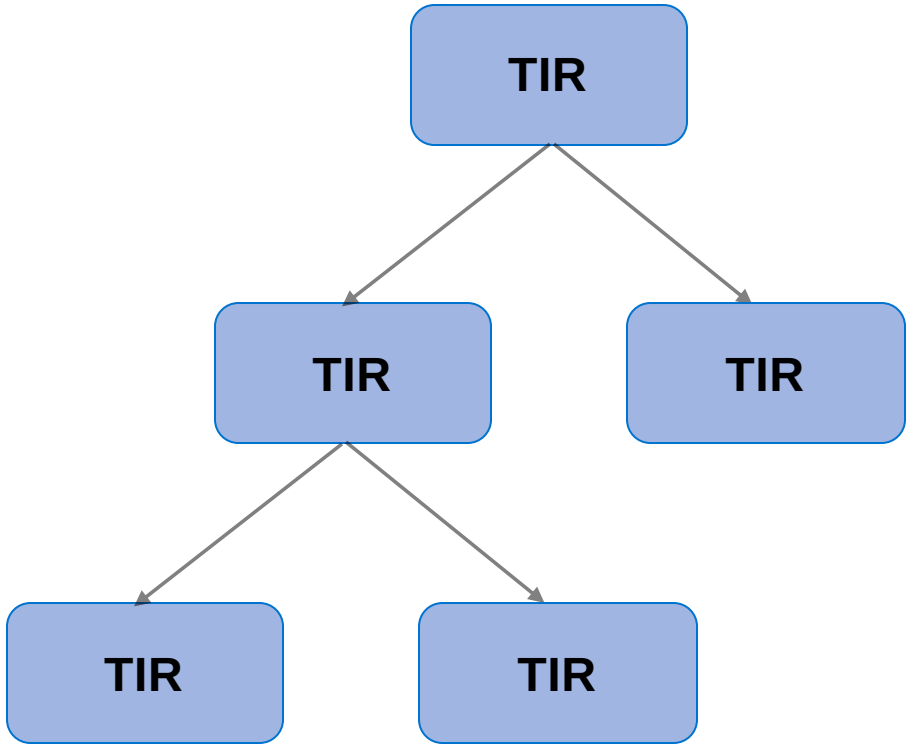
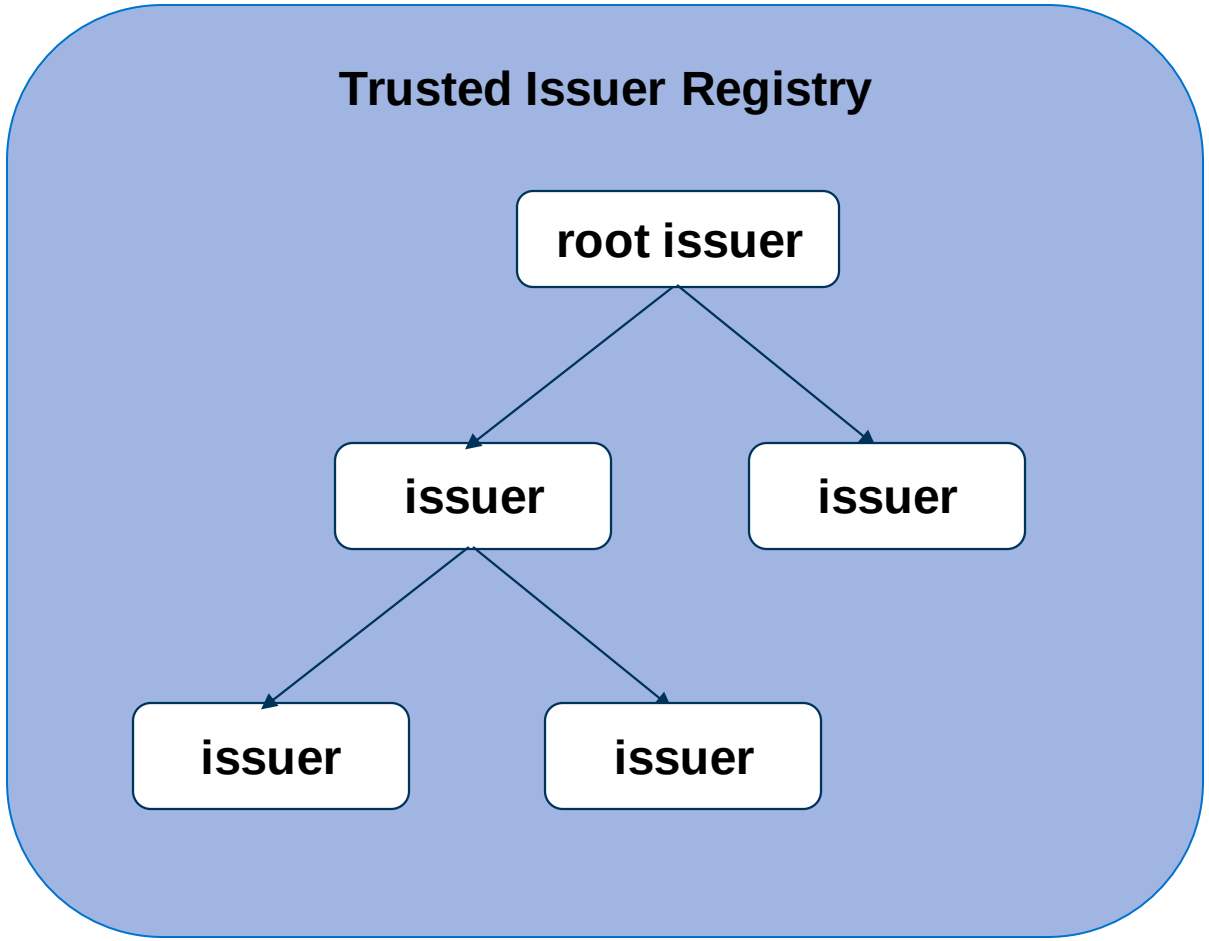
Potential Solutions - Scalability

- Hierarchy of registries
- Hierarchy of issuers
- ...





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Research Questions

RQ1: What are the advantages and disadvantages of existing centralized and decentralized Trusted Issuer Registry designs?

RQ2: How can a general-purpose Trusted Issuer Registry be designed to meet the needs of Self-Sovereign Identity in Gaia-X ecosystems and address the drawbacks of existing solutions?

- **RQ2.1:** What are the requirements for a Trusted Issuer Registry in Gaia-X ecosystems?
- **RQ2.2:** What specific functionalities should a Trusted Issuer Registry provide in Gaia-X ecosystems?
- **RQ2.3:** What is a suitable technical infrastructure for a Trusted Issuer Registry?
- **RQ2.4:** How can scalable governance be achieved?

RQ3: How can the design be implemented using a concrete technology?

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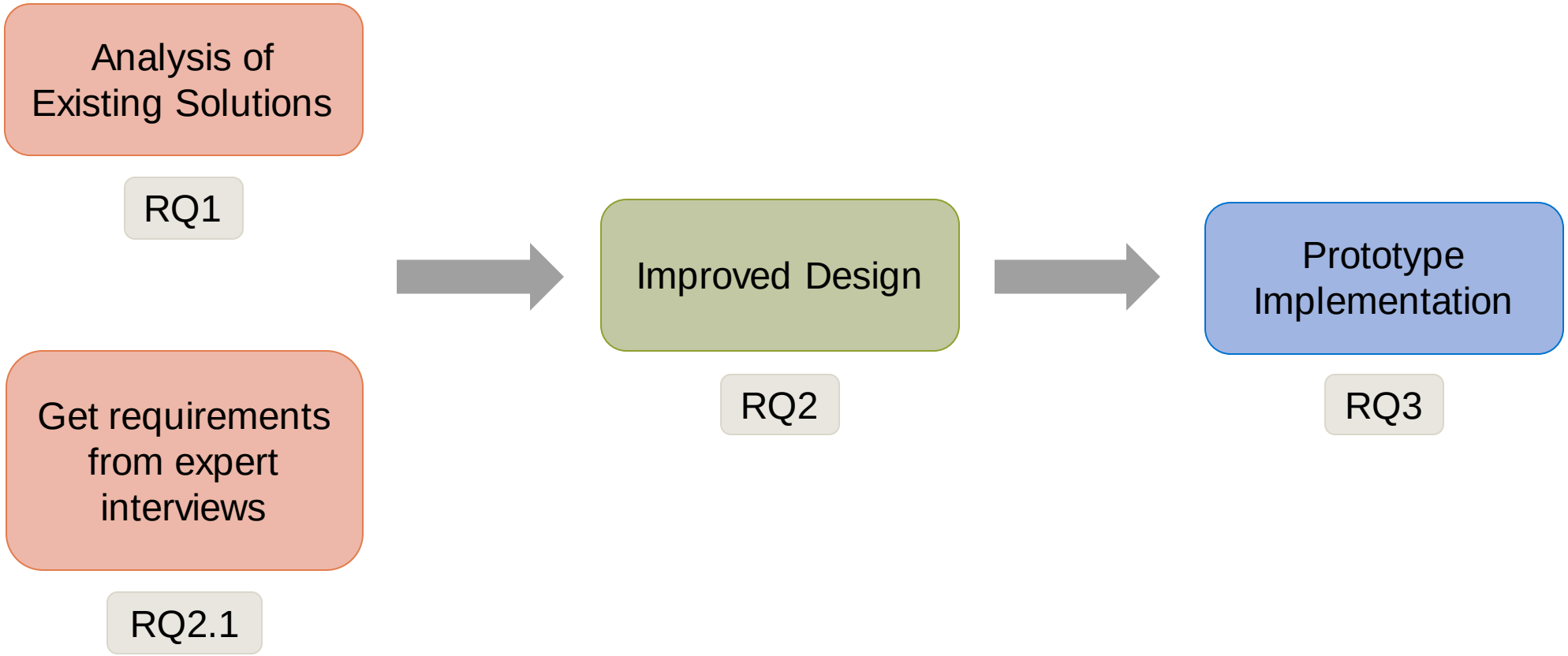
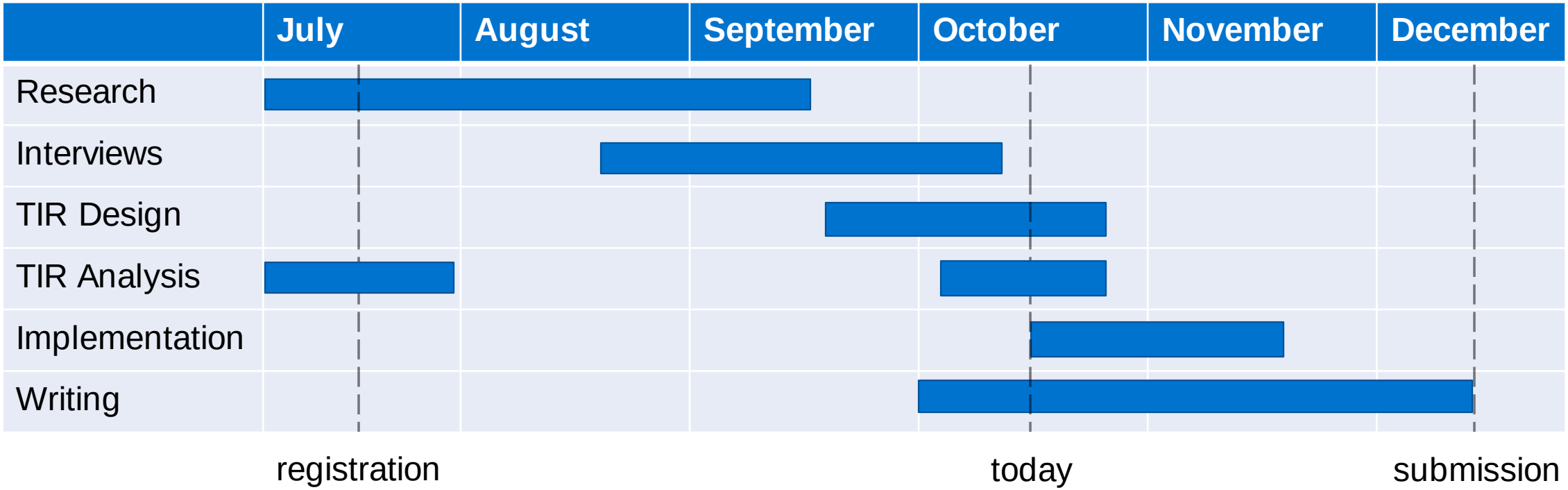
Methodology



Timeline



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