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SSIBAC: Self-Sovereign Identity Based Access Control

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DEFINING TECHNOLOGY

IEEE

QualiChain

Outline

- Introduction to SSIBAC
- Background on Access Control, DIDs and VCs, and
- SSIBAC Model
- SSIBAC + ABAC
- Use Case: Qualichain
- Evaluation
- Conclusions

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-Data breaches are usual, and its severity increasing

-Despite regulatory efforts, such as the General Data Protection Regulation (GDPR), data breaches still occur, causing great damage

https://resilientedigital.com/wp-content/uploads/2020/01/Qu%C3%A9-es-la-Auto-Identidad-Soberana-SSI-%E2%80%93-Self-Sovereign-Identity.jpg

SSI: Self Sovereign Identity

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-A DID represents an identity and allows trustable interactions, rooted on a verifiable registry (e.g., a blockchain), and public-key cryptography.

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-A verifiable credential (VC) provides a standard way to digitally express credentials in a way that is cryptographically secure, privacy-respecting, and machine-verifiable

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-This happens via verifiable presentations (VP), which contains metadata and proofs for a subset of the contained claims. Can use Zero Knowledge Proofs.

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-Access control models (ACM) provide selective access to a set of resources, under a specific set of conditions. Common ACMs include Attribute Based Access Control (ABAC)

-SSI allows services to store less data about users

Access Control

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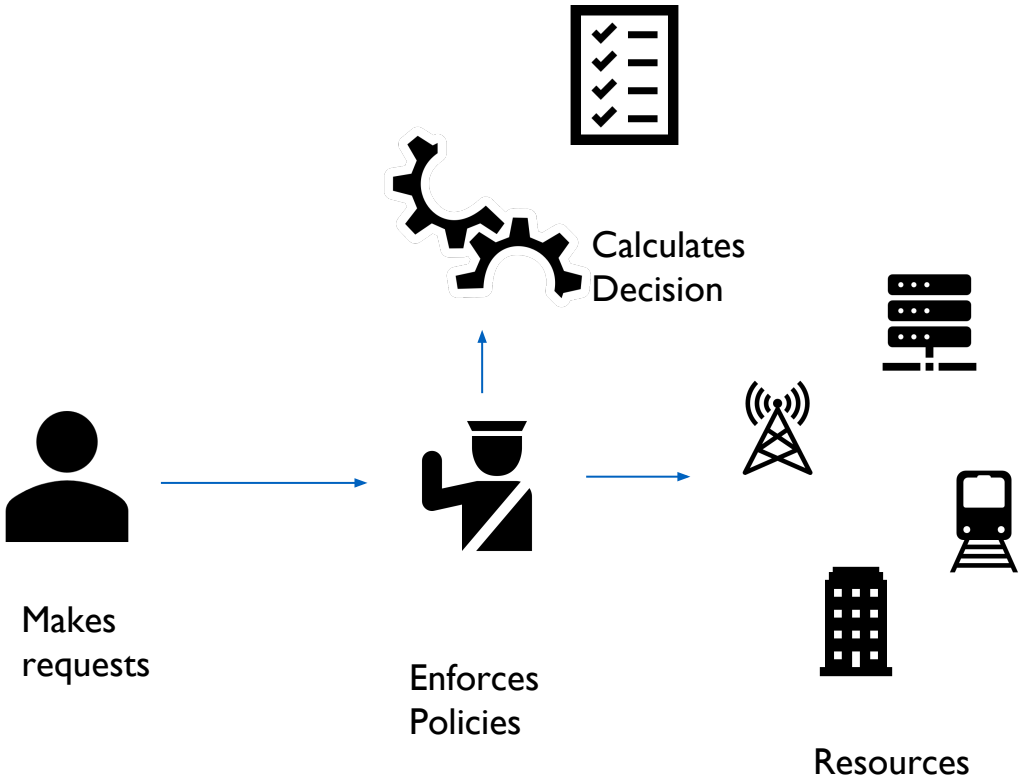

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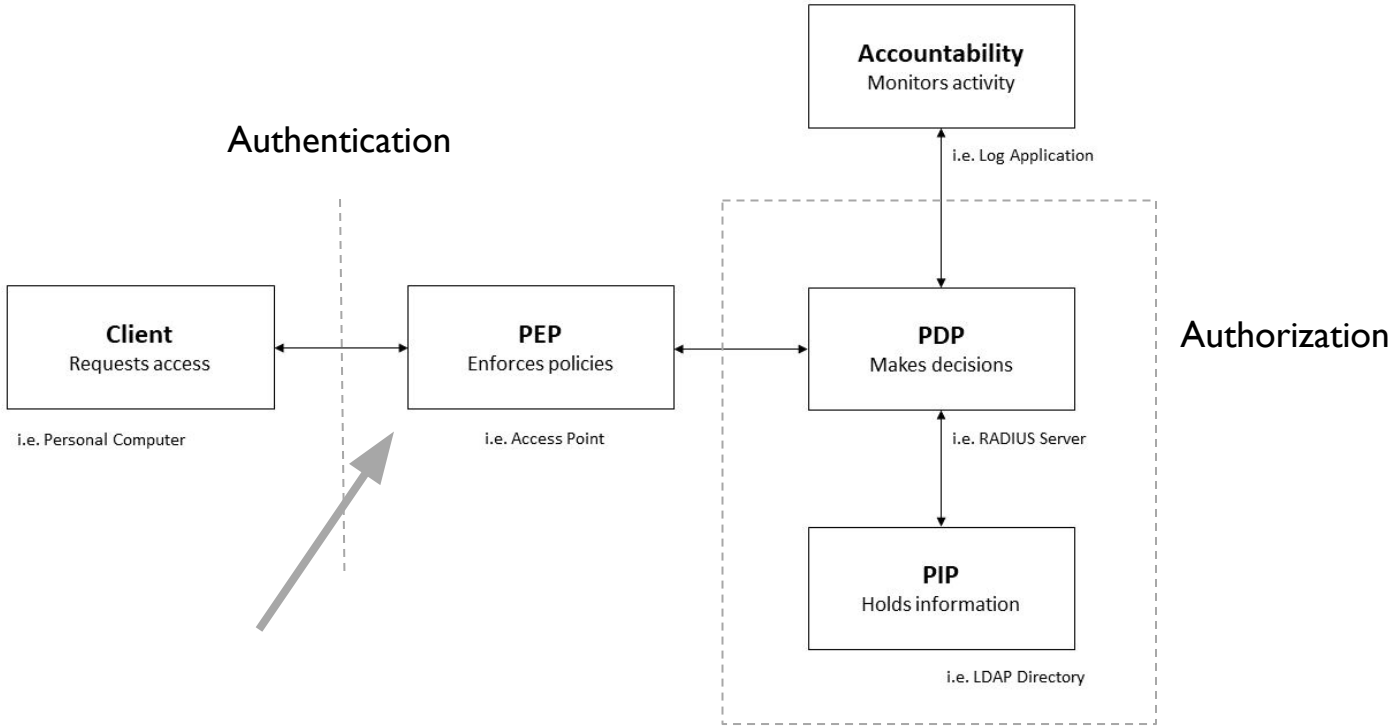

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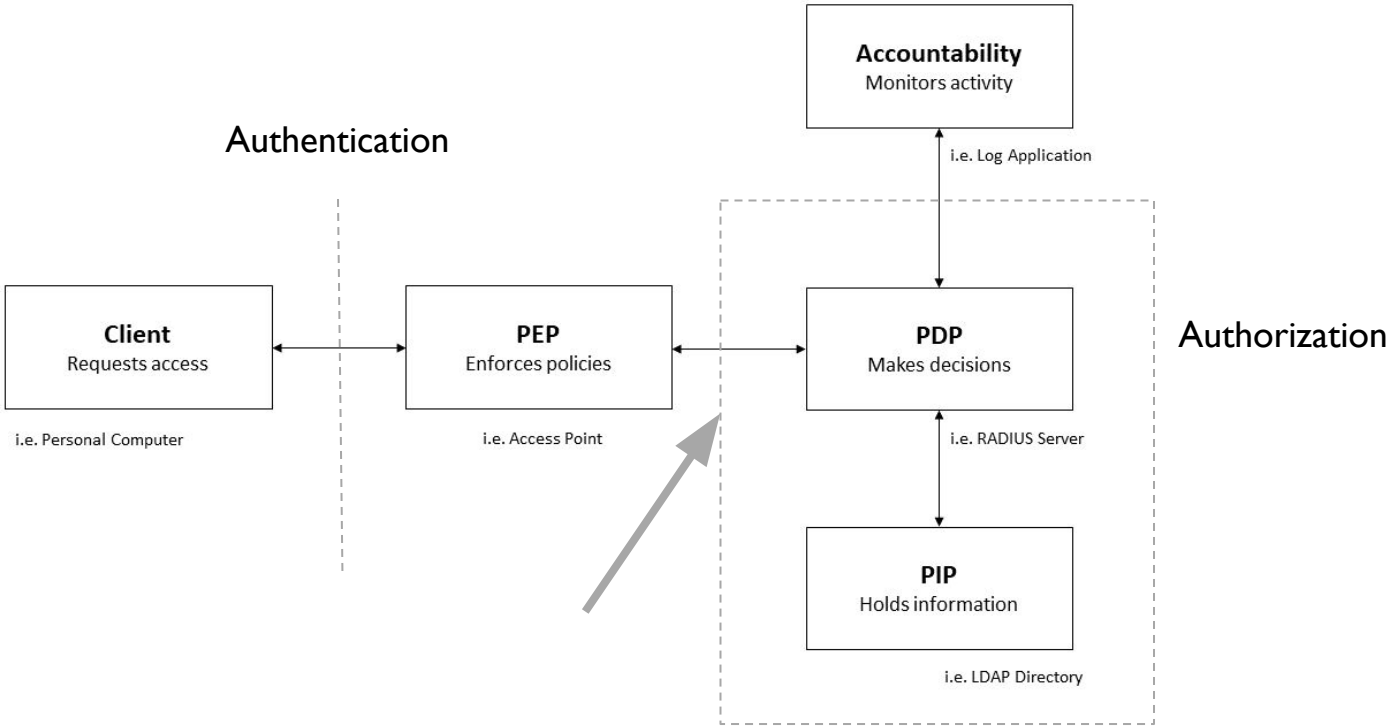

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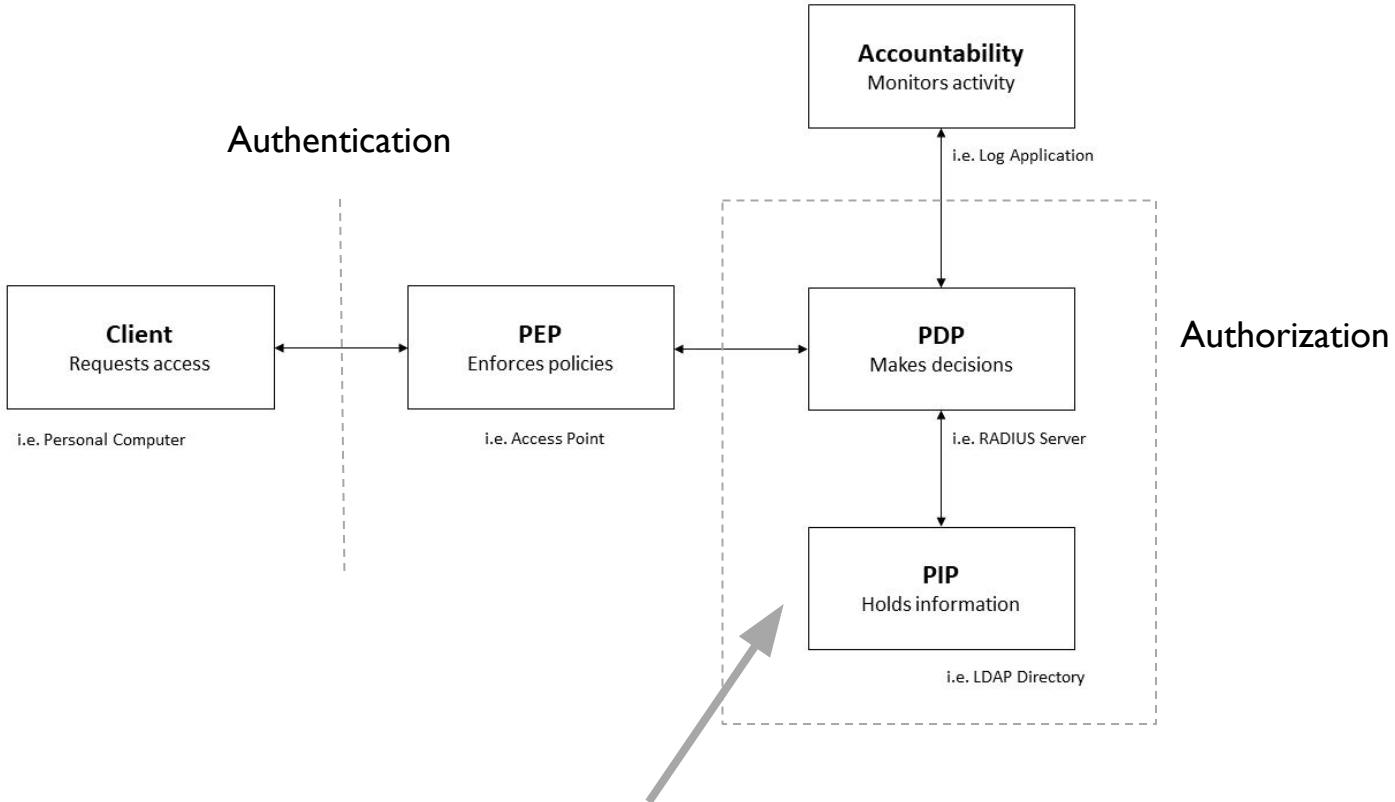

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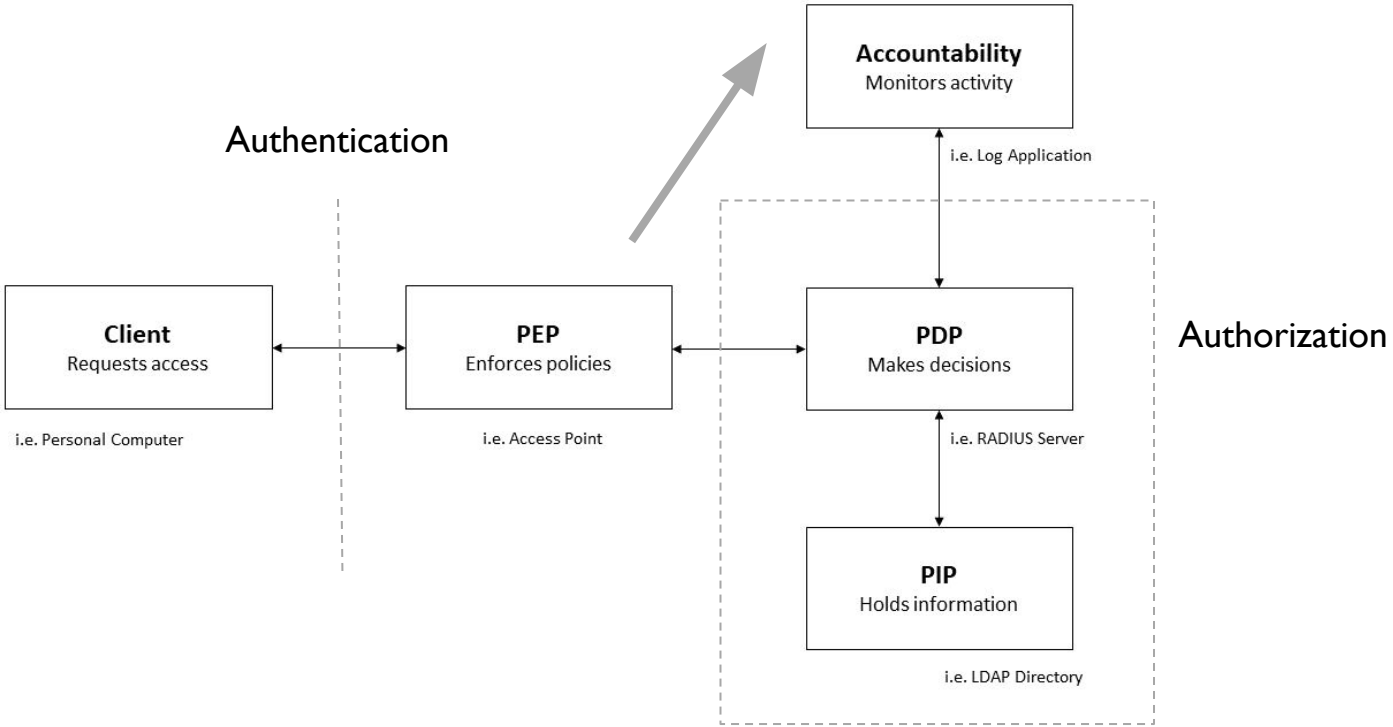

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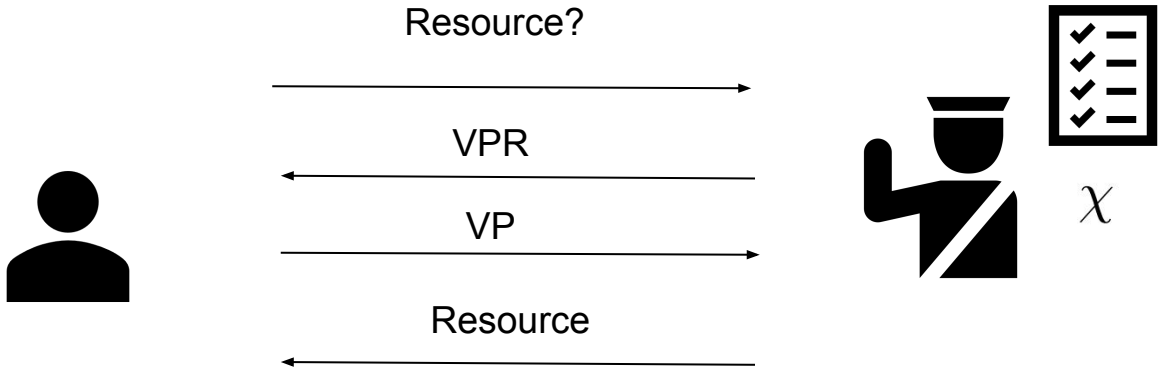
SSIBAC maps:

- VCs to attributes/roles/etc... on access control policies
- access control requests to verifiable presentation requests
- verifiable presentations to access control policies
- access control policies evaluated using conventional ACMs



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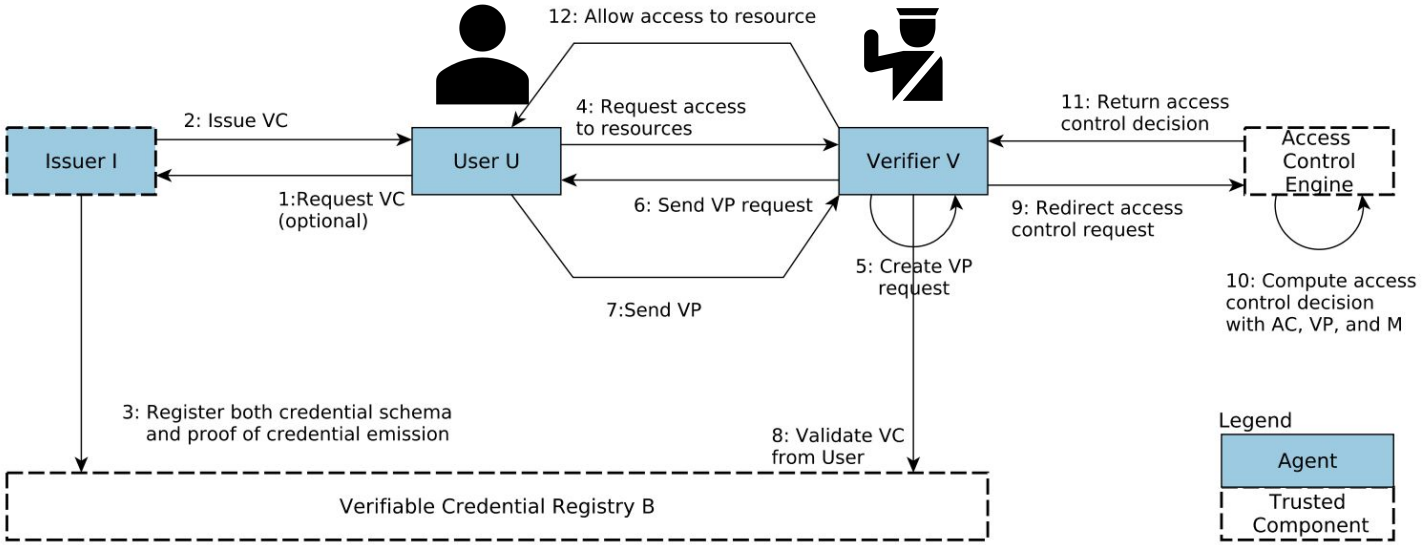

Fig. 1: Access control flow enforced by the SSIBAC model

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SSIBAC components

- a set of users $\mathcal{U} = \{u_1, u_2, ...\}$. Each $user_i$ is identified by a DID and holds a public/private key pair (K_p^i, K_s^i) associated to that DID and a set of VCs $\mathcal{L}_i = \{l_1^i, l_2^i, ...\}$;
- a set of resources $\mathcal{R} = \{r_1, r_2, ...\}$;
- a set of issuers $\mathcal{I} = \{i_1, i_2, ...\}$ that issue VCs for users;
- a set of verifiers $\mathcal{V} = \{v_1, v_2, ...\}$ who request VPs and mediate the access control flow. Typically, they are also resource providers;
- a set of permission validators $\mathcal{P} = \{p_1, p_2, ...\}$;

Attribute, Role, etc

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- a set of injective functions $\psi = \{\psi_1, \psi_2, ...\}$, such that $\psi_i : \mathcal{L}_i \rightarrow \mathcal{P}_k$, i.e., function ψ_i maps the VCs from $user_i$ to permission validator P_k;
- an injective function $\chi : \mathcal{AC} \rightarrow \mathcal{VP}_R$, mapping access control policies to VPRs.

χ () = VPR

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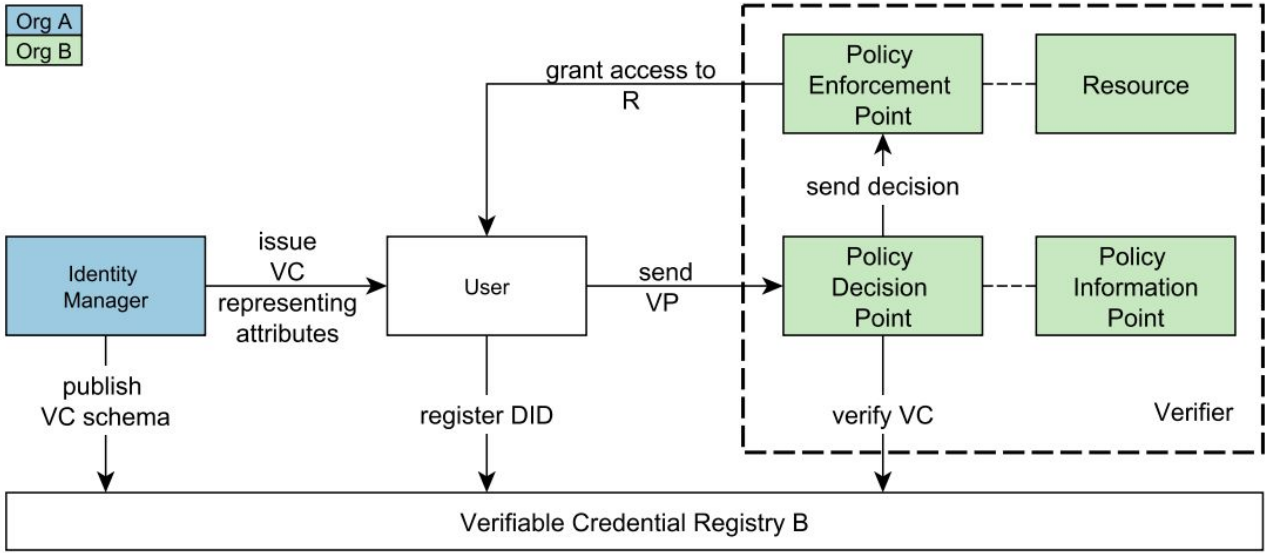

Fig. 2: SSIBAC in a multi-organizational setting, in light of the XACML standard perspective

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The QualiChain project aims to propose a blockchain based approach for disrupting the archiving, management, and verification of educational and employment qualifications

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Stakeholders:

- **certification seekers**, e.g., graduated students. Correspond to users (or subjects)
- **certification providers**, e.g., higher education institutes; correspond to issuers
- **certification validators**, e.g., potential employer, correspond to verifiers

Universities issue verifiable credentials for students for using the QualiChain platform.

It is desirable to use SSI-based access control in this scenario so that QualiChain does not need to store any personal data; authorization is conducted in a p2p way, using DIDs and VCs:

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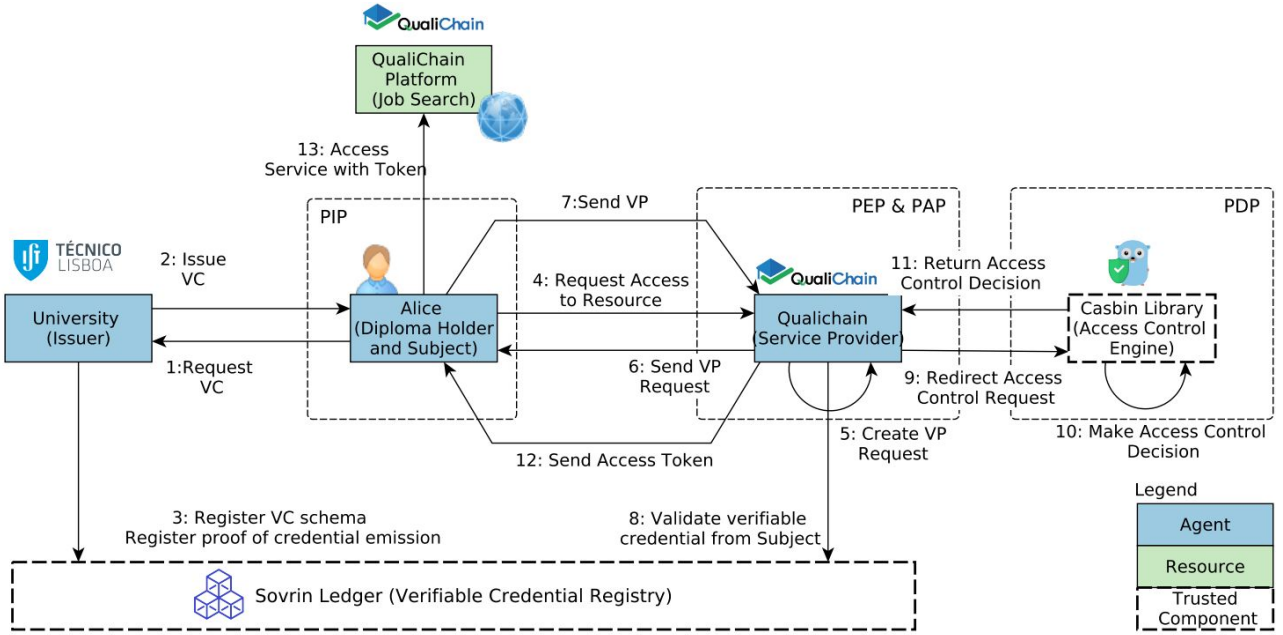

Fig. 3: SSI-based ACM applied to the QualiChain scenario

Implementation

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HYPERLEDGER INDY

GreenLight Dev Ledger Contributed by the Province of British Columbia - vonx.io

HYPERLEDGER ARIES

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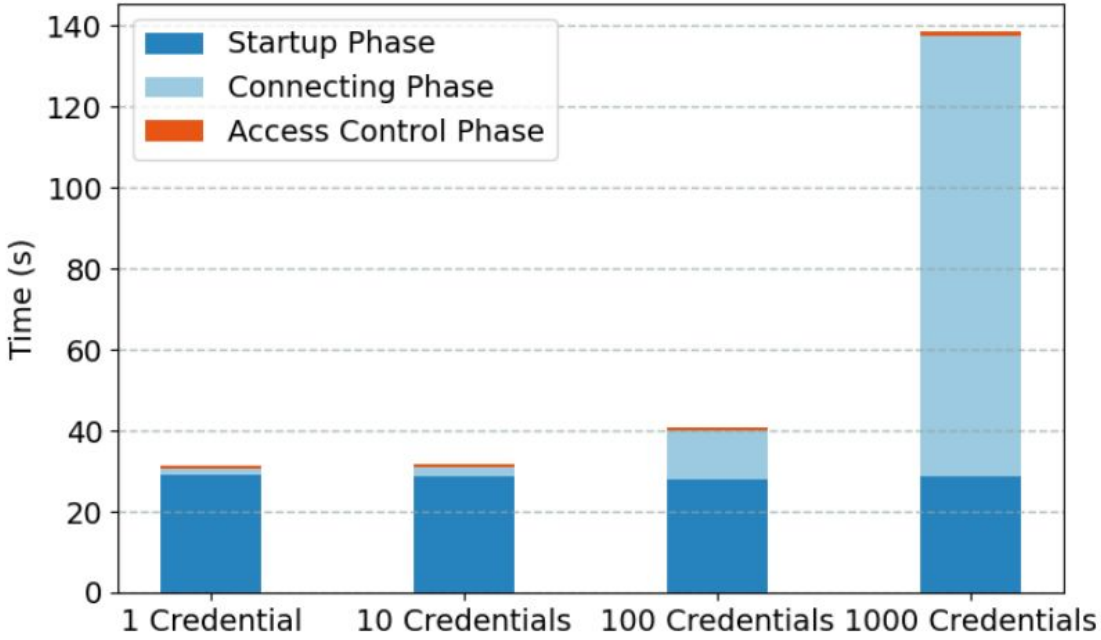

Fig. 4: Latency depending on the number of emitted credentials

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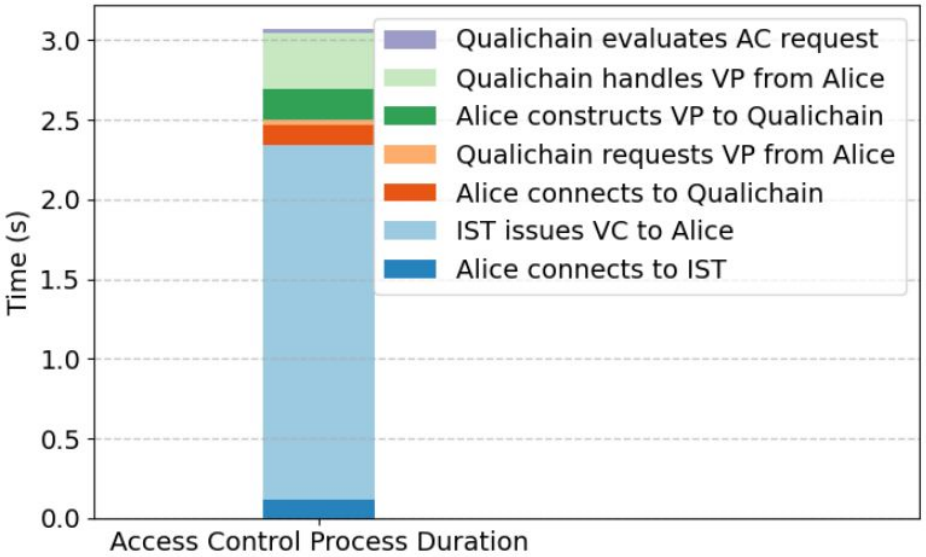

Fig. 5: Duration of the various steps in the *Connecting* and *access control* phases (startup phase omitted), with 10 issued credentials

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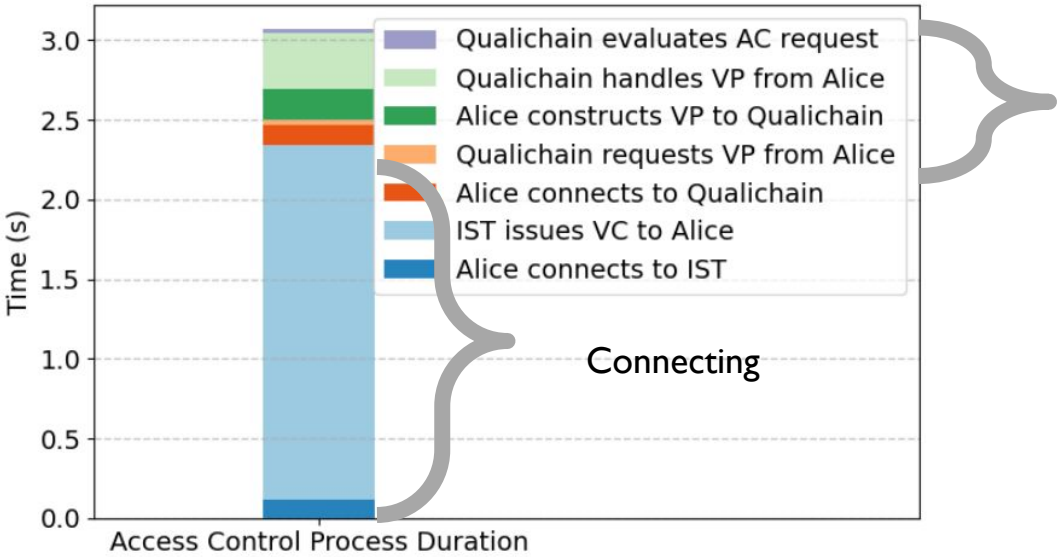

Fig. 5: Duration of the various steps in the *Connecting* and *access control* phases (startup phase omitted), with 10 issued credentials

E2E access control request and response takes ~1s

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- Self-Sovereign Identity Based Access Control (SSIBAC), the first approach to access control based on decentralized identity

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- Self-Sovereign Identity Based Access Control (SSIBAC), the first approach to access control based on decentralized identity

- We explore this topic by instantiating our SSIBAC model with attribute-based access control, which is applied to a real-world case, the EU QualiChain project.

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- Self-Sovereign Identity Based Access Control (SSIBAC), the first approach to access control based on decentralized identity
- We explore this topic by instantiating our SSIBAC model with attribute-based access control, which is applied to a real-world case, the EU QualiChain project.
- Our experimental evaluation shows that each access control request can be served in around 0.9 seconds.

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- Self-Sovereign Identity Based Access Control (SSIBAC), the first approach to access control based on decentralized identity
- We explore this topic by instantiating our SSIBAC model with attribute-based access control, which is applied to a real-world case, the EU QualiChain project.
- Our experimental evaluation shows that each access control request can be served in around 0.9 seconds.
- Although more timeconsuming than traditional centralized access control systems, access control based on self-sovereign identity can alleviate the data privacy problem

Future Work

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- Explore cross-chain (and cross-blockchain) authorization, leveraging recent blockchain interoperability techniques.
  (see “A Survey on Blockchain Interoperability: Past, Present, and Future Trends)

- Verifiers are single points of failure.
  Solution: decentralizing the access control engine e.g. using blockchain based access control
  (see Distributed Attribute-Based Access Control System Using a Permissioned Blockchain)

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Thank you for your attention

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