# Who is to be identified?

## The importance of flexible identifiers in identity ecosystems.


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# Contents

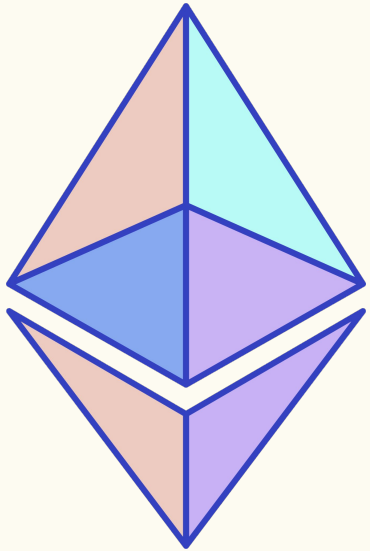
# Introduction

# Security and Sovereignty

- The use of sovereignty and security as characteristics of technical systems in the field of information and communication technology (ICT) is not self-explanatory. These terms are value-laden and deeply rooted in political theory. The reasons for thinking them together for ICT, thus, should be well defined and explained.

- Moreover, self-sovereign identity (SSI) claims to to provide individuals with secure and sovereign identities by using cryptographic algorithms and decentralised infrastructure (Preuschkat, A.; Reed, D., 2021).

# The driving forces behind SSI adoption



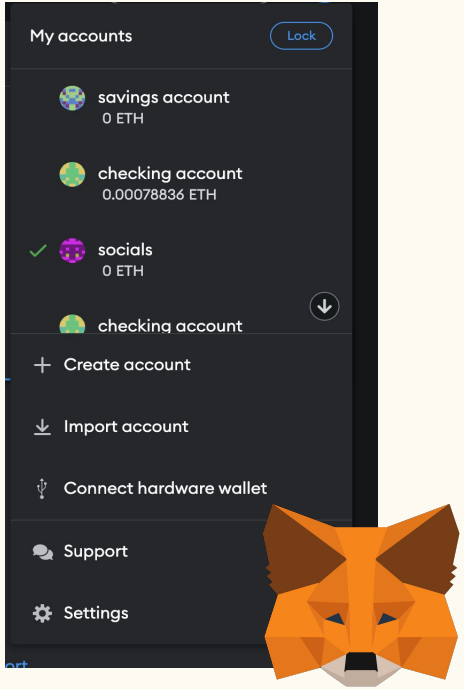
Web3

and

the state

# Origin Stories

# Web3 and where we came from



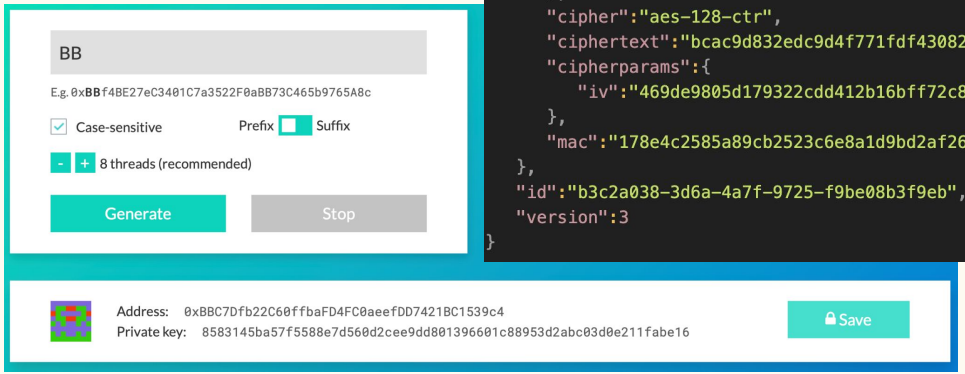

Metamask wallet application

- as Web3 or crypto wallet, Metamask is a predecessor of many SSI wallets
- EIP 4361: “Sign-In with Ethereum” introduces characteristics of identity wallets (Chang, 2021)
- modular key storage for many identifiers
- multiple accessible keys enable key rotation
- key deprecation is explicitly encouraged

# Persistent and transparent, but *modular* keys

*"A private key is made up of 64 hex characters and can be encrypted with a password. [...] The public key is generated from the private key using the Elliptic Curve Digital Signature Algorithm [1]. You get a public address for your account by taking the last 20 bytes of the Keccak-256 hash of the public key and adding 0x to the beginning". (Smith et al., 2023)*


```
{
  "address":"0xbbc7dfb22c60ffbafd4fc0aeefdd7421bc1539c4",
  "crypto":{
    "kdf":"pbkdf2",
    "kdfparams":{
      "c":262144,
      "dklen":32,
      "prf":"hmac-sha256",
      "salt":"ca3f1d3c3b2fc76dcf2f3c0c5007f570d3ba3ea34ad8778caa02600250cfeb22"
    },
    "cipher":"aes-128-ctr",
    "ciphertext":"bcac9d832edc9d4f771fdf430823b3cf3dc31b2bba1d38583a3c88014a21d64d",
    "cipherparams":{
      "iv":"469de9805d179322cdd412b16bff72c8"
    },
    "mac":"178e4c2585a89cb2523c6e8a1d9bd2af266693dfc3b1d1467bf203d2e7a50775"
  },
  "id":"b3c2a038-3d6a-4a7f-9725-f9be08b3f9eb",
  "version":3
}
```

# Wallets: a low-level means for device binding?

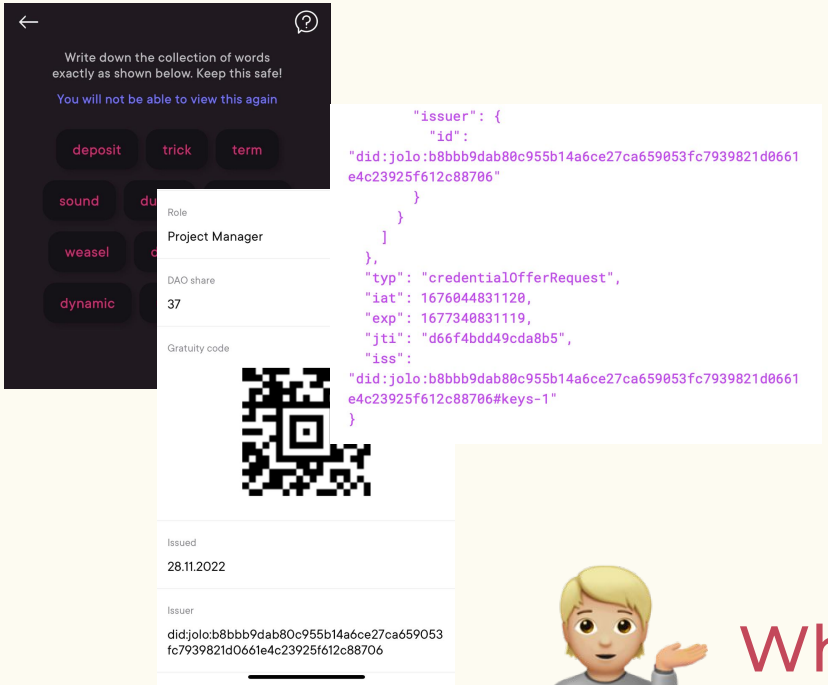
*"He who is subjected to a field of visibility, and who knows it, assumes responsibility for the constraints of power; he makes them play spontaneously upon himself; he inscribes in himself the power relation in which he simultaneously plays both roles; he becomes the principle of his own subjection"* (Foucault, 1995, pp.202).

## A NOTE ON WALLETS

An account is not a wallet. An account is the keypair for a user-owned Ethereum account. A wallet is an interface or application that lets you interact with your Ethereum account.

# Shaping Adoption

# Citizen wallets and where we are headed




- SSI wallets do not allow active and modular key management
- private or public keys are hidden
- Mnemonic backup is the closest one gets to see the key material
- public keys, or decentralised identifiers (DIDs) of issuers are still visible

## What about the user?

# Social technologies and governance

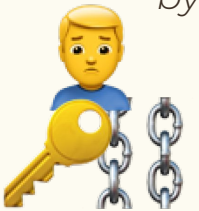
*Social technology transforms social expertise for a purpose, develops ideas for the solutions for social problems. Thus, it also establishes itself as a part of modern government[.]*

*[T]he switch to contemporary social technology [, however,] takes a step towards [...] the market [to] allow governing via networks and also for self-determination of the individual, who has to act as an active responsible citizen.* (Leibetseder, 2011 , pp. 14)

# DIDs, modularity and persistent identifiers

*"Our solution models subjects of identities as "Holders" in possession of trustable, claim-based digital identities. Holders are provided persistent virtual ownership over the "root" of their identity in the form of local private key generation and storage. Jolocom users maintain exclusive control of their private keys by default."* (Jolocom, 2019, p. 11)

*"The Jolocom framework [...] stores DIDs on the public permissionless Ethereum blockchain. DID documents (DDO) describe how to use a specifc [sic!] DID and may contain additional attributes. By default, DDOs are stored on the IPFS. Credentials are under the entire control of the user. Jolocom allows for the generation of child DIDs that can hide that credentials concern the same person."* (Kondova, 2020, p. 343)



Claims by the industry versus research findings

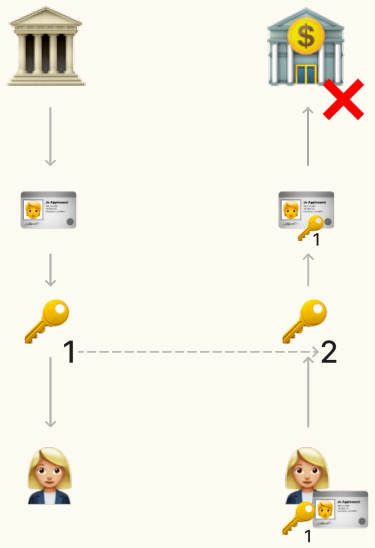
# Keeping Promises

# Privacy, anonymity, and the right to be forgotten

*"By privacy,* I understand the condition in which other people are deprived of access to either some information about you or some experience of you.

For the sake of economy, I will shorten this and say that *privacy is the condition in which others are deprived of access to you."* (Reiman, 1995, p.30)

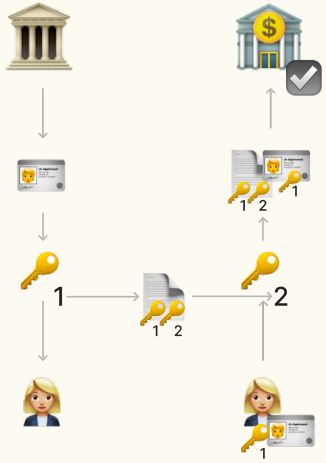
# Minimally modular did:key implementations




local only and pairwise identifiers

- This implementation has similarities to the wallet architecture of Metamask.
- It allows users to manage multiple identifiers.
- Identities for one identifier cannot be migrated to another key.
- Users have a high risk of being correlated by issuers and verifiers.

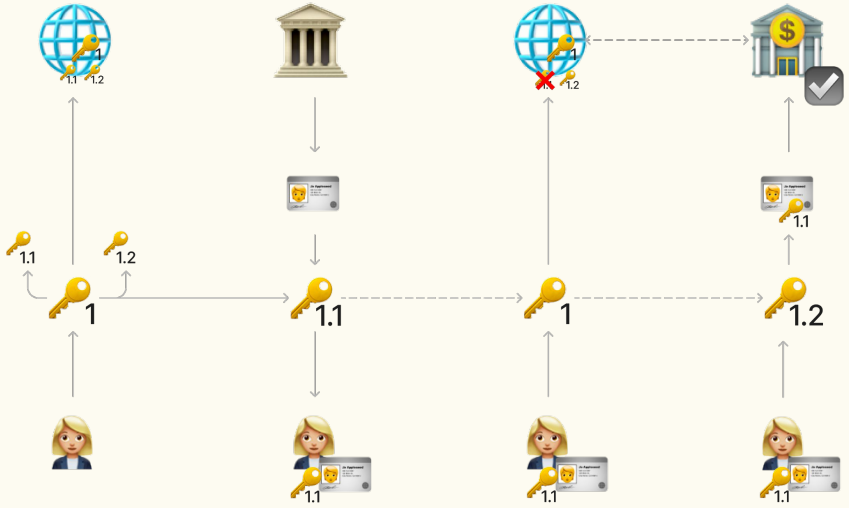
# KERI flavoured key rotation with did:key




local only and pairwise identifiers with key event log

- Loosely adheres to the principles of did:keri, and features a key event log (KEL) (Smith, 2019).
- The KELs comply out of the box with the verifiable credential data model v.1 (W3C, 2022)
- a lightweight implementation for key rotation
- correlation risks remain unaddressed
- allow salted hash claim-blinding

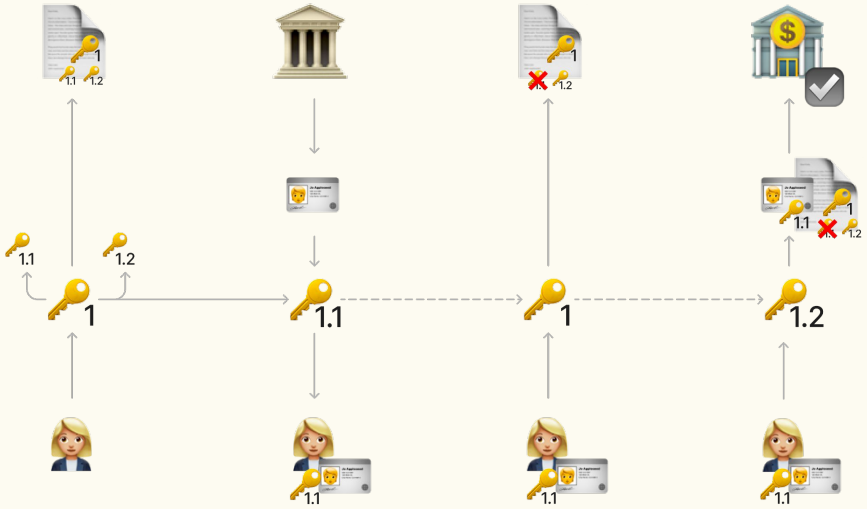
# DID:KERI with witnesses




globally resolvable and anywise identifiers with key event log

- did:keri uses witnesses as substitutes for known distributed ledgers
- Introduced by Smith (2019), KELs enable key rotation and function as self-addressing identifiers.
- This example uses a hash of the KEL as identifier (read DID) and requires a DDO.
- Derived keys can reduce the frequency of rotating keys.

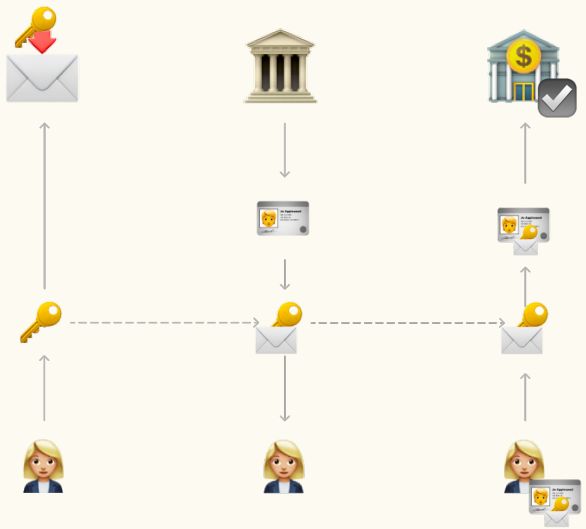
# DID:KERI without witnesses or VDRs for




locally resolvable and anywise identifiers with key event log

- KELs can be self-addressing DIDs without the need for DDOs.
- The infrastructure can neglect verifiable data registries (VDRs).
- Identifiers are any-wise and correlation risks remain.
- Derived keys can reduce the frequency of rotating keys.

# Anonymous Credentials (AnonCreds)



local only and pairwise identifiers with blinded key commitments

- AnonCreds use non-interactive zero-knowledge proofs (ZKPs)
- blinded Pedersen key commitments make identities non-correlatable (Zundel, 2021)
- BLS 12-318 curves could upgrade did:methods to compete (Looker et al., 2023)
- AnonCreds are not a did:method, but allow the DID to be a single use identifier
- Modular wallets with persistent identifiers then only appeal to non-human holders

# Conclusions

# General requirements for DID:Methods

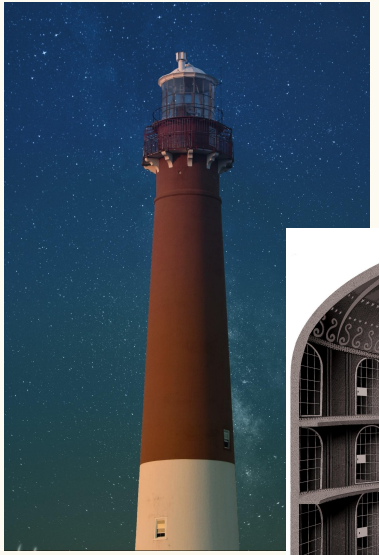
- We expect issuers and verifiers to require did:methods to be
  - globally resolvable,
  - are comprised of long-lived identifiers, which are,
  - updateable, with the possibility for key rotation, which are,
  - potentially anchored on use case-specific VDRs, e.g. distributed databases.

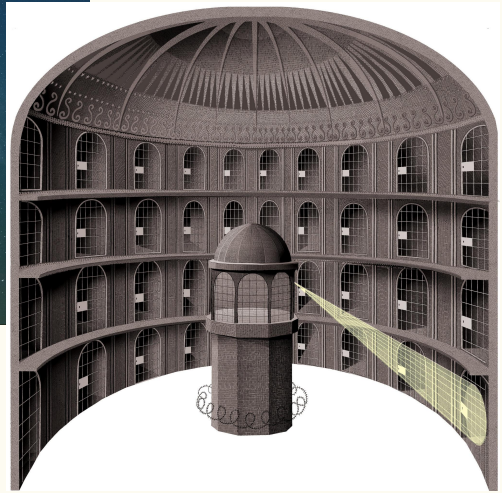
- We anticipate holders to require privacy preserving and pair-wise identifiers.
  - Such identifiers should be short-lived, as well as,
  - quick and cheap to create.

- Yet, requirements by credential-holding legal entities will differ from those by holders, who are natural persons.

- All did:methods used within the EU/ EEA must comply with GDPR.

# The contextuality of technology





The ethically acceptable use of technology is contextual of its societal framework. No did:method or credential standard is *a priori* harmful.

Yet, the direction of SSI risks subjecting individuals under insurmountable responsibility guised by sovereignty and security.

Projects like SDIKA then must built Lighthouses instead of Panoptica.

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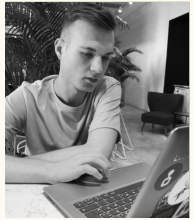

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