IRMA and Blockchains

Architecting decentralized IRMA schemes

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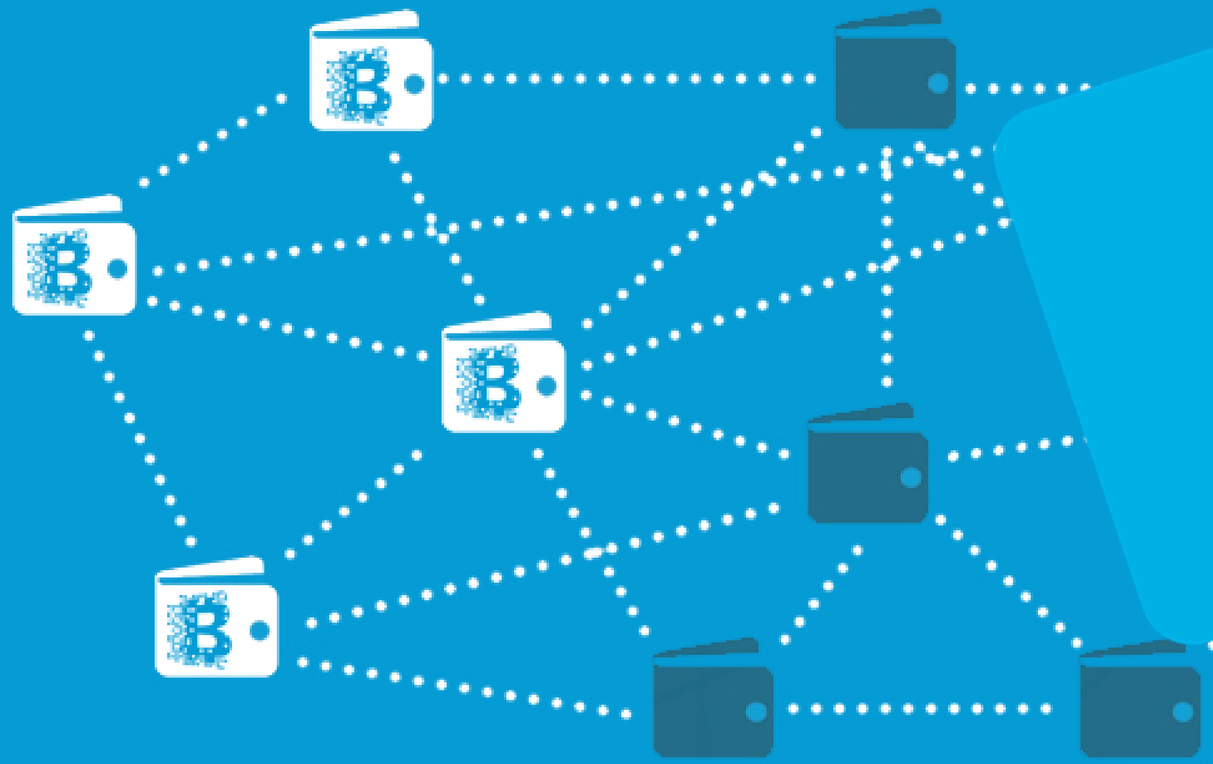
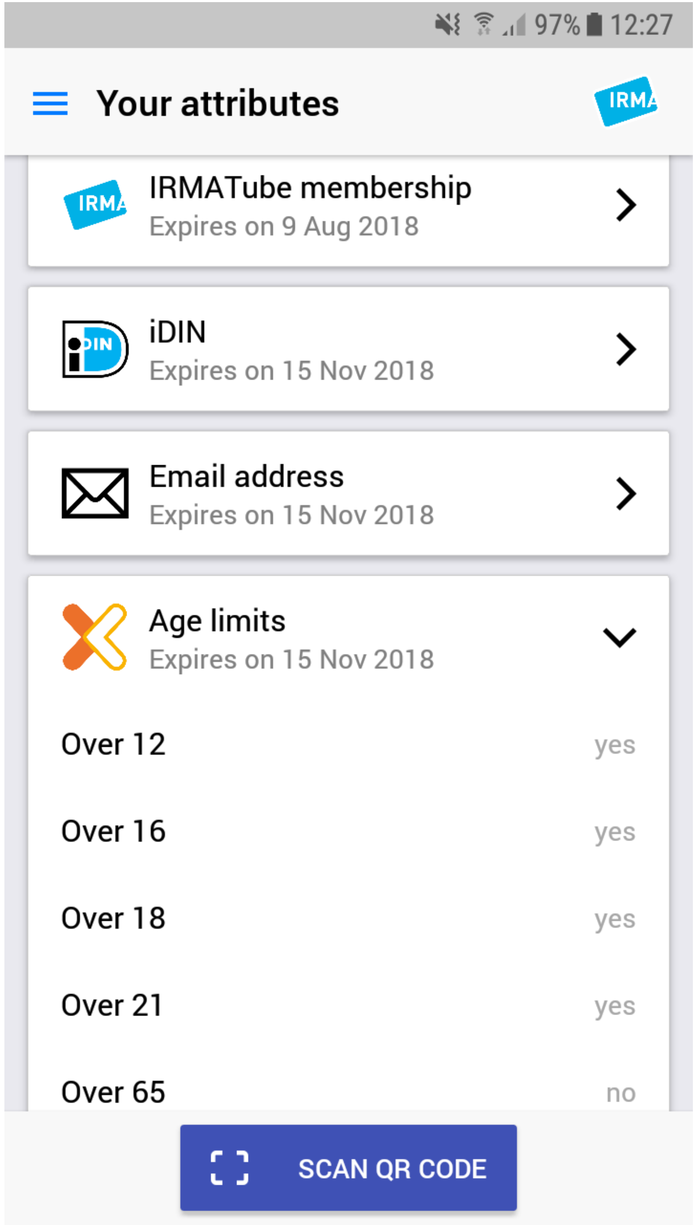
BLOCKCHAIN

Free. Secure. Easy to Use.



IRMA

IRMA background



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IRMA Attributes

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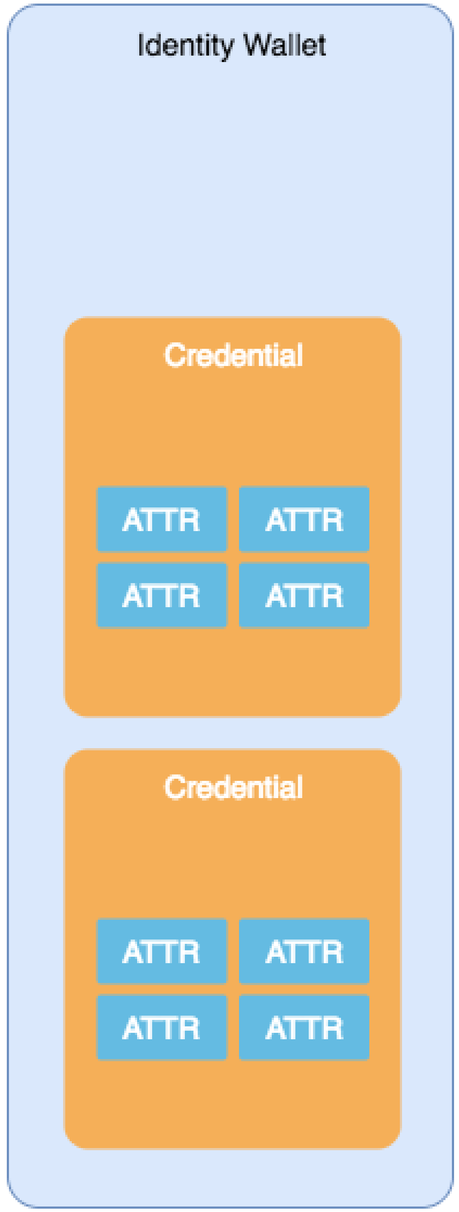
IRMA Credentials



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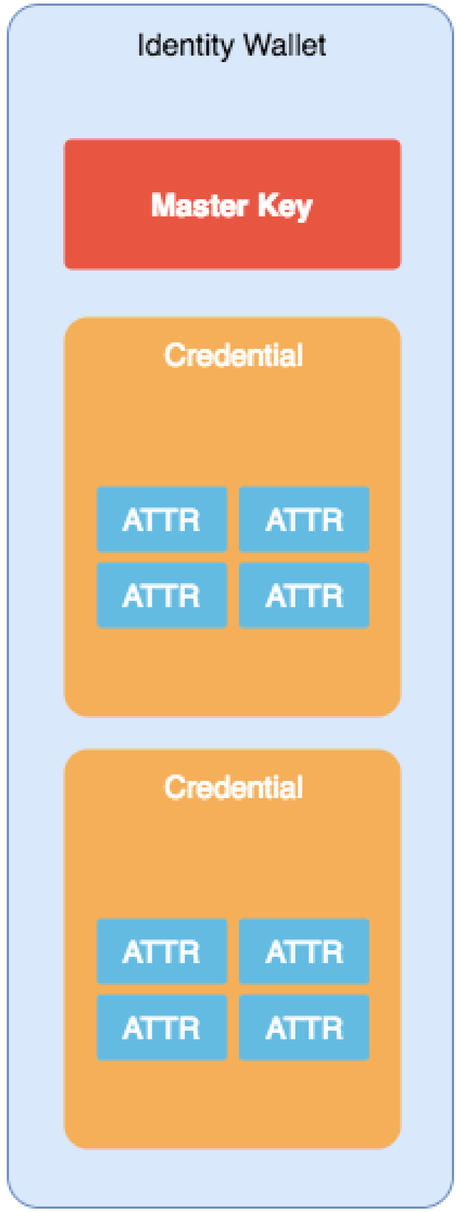
IRMA Master Key



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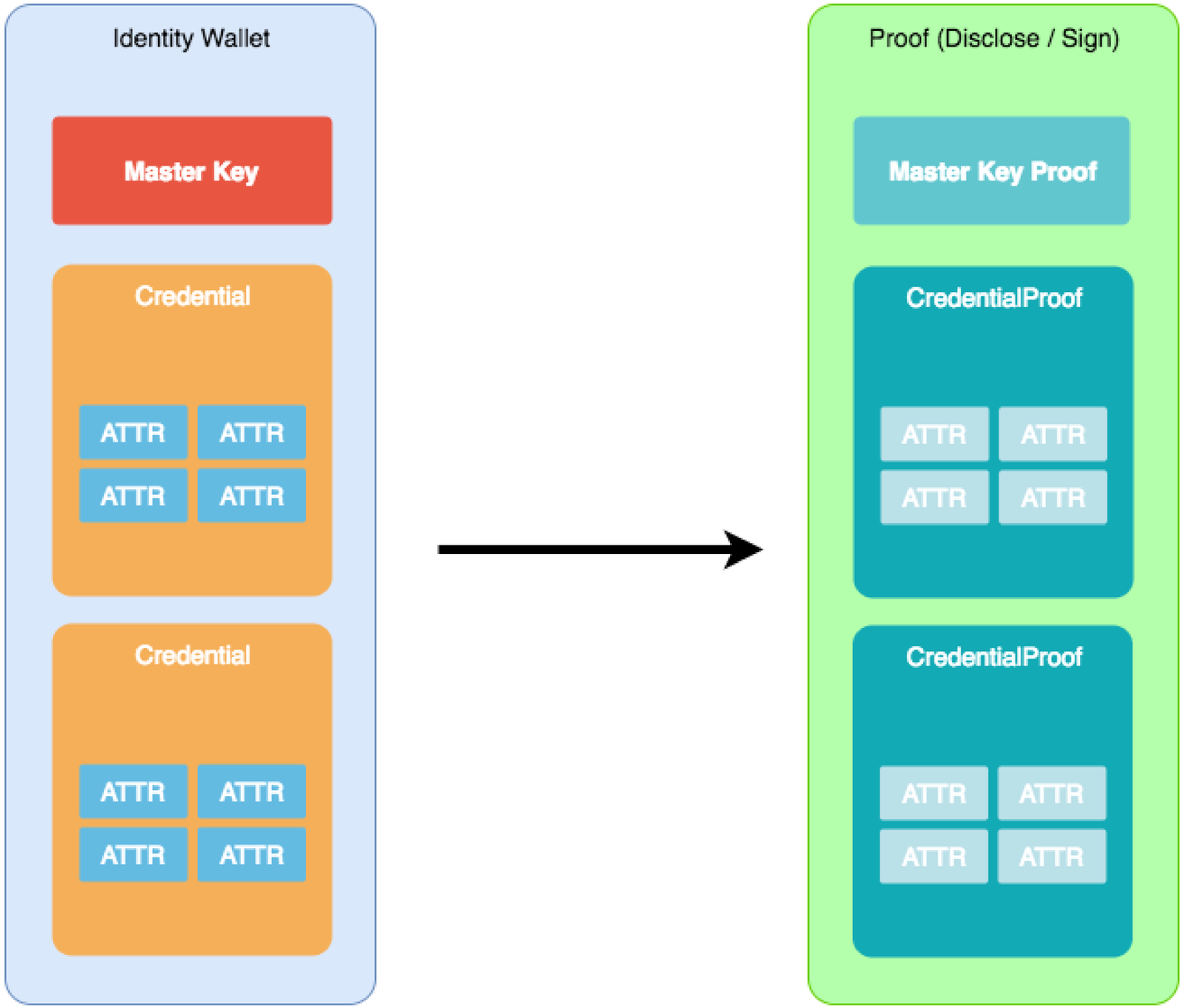
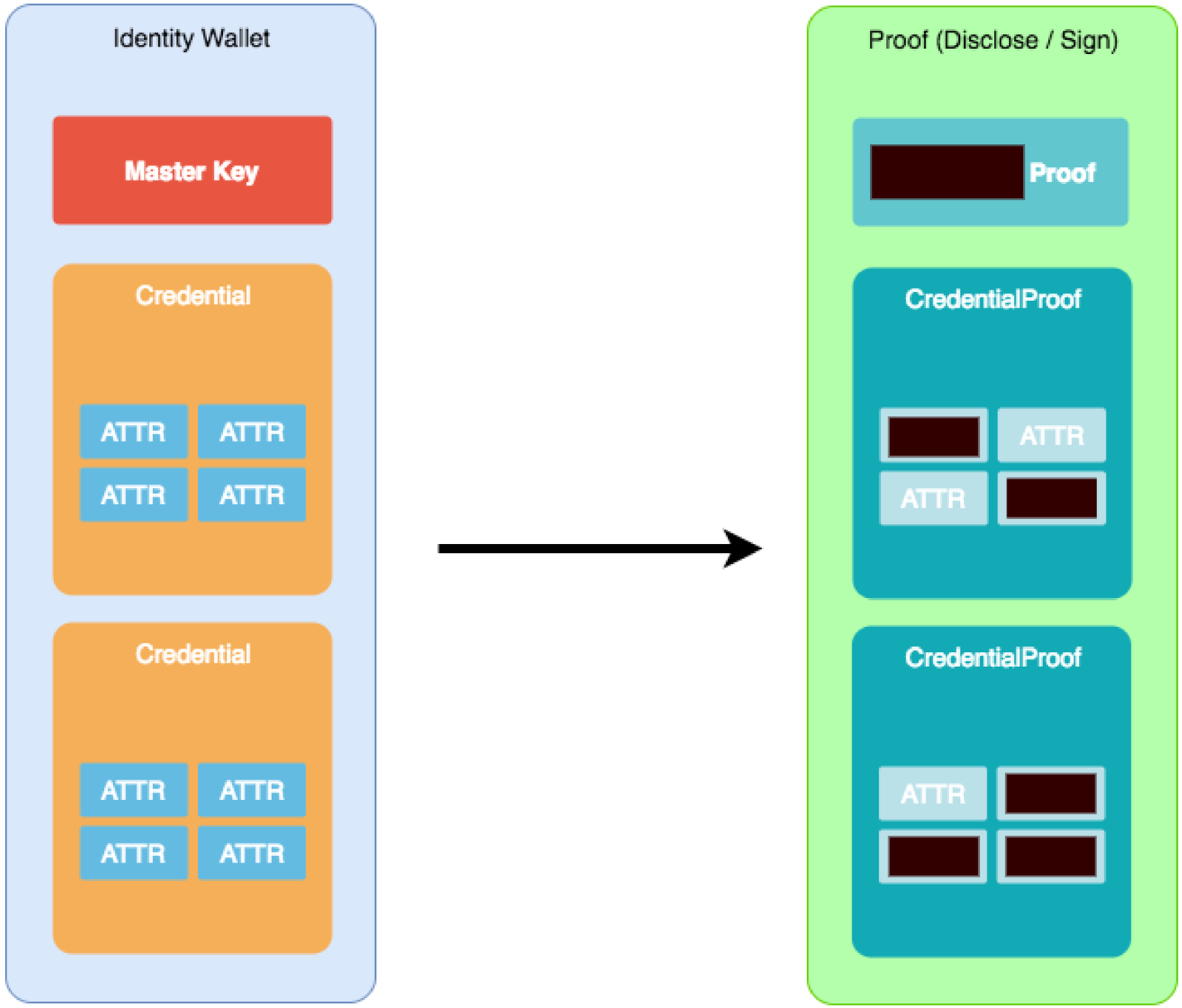
IRMA Proofs (naive)



IRMA Proofs (with selective disclosure)



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Why are IRMA proofs valuable?

- Short answer: Because the relying party decides that the proofs are valid.
- The RP has to trust all algorithms, tools and inputs that he uses to do this validation.

- The core element of this validation is trusting the issuers of the attributes.
- Verify cryptographically that the issuer(s) signed the attributes/credentials.
- Of course the IRMA software implementation does this for you :)

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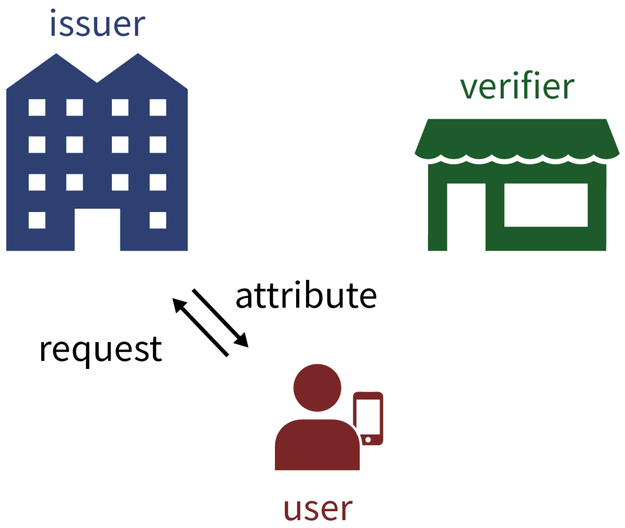
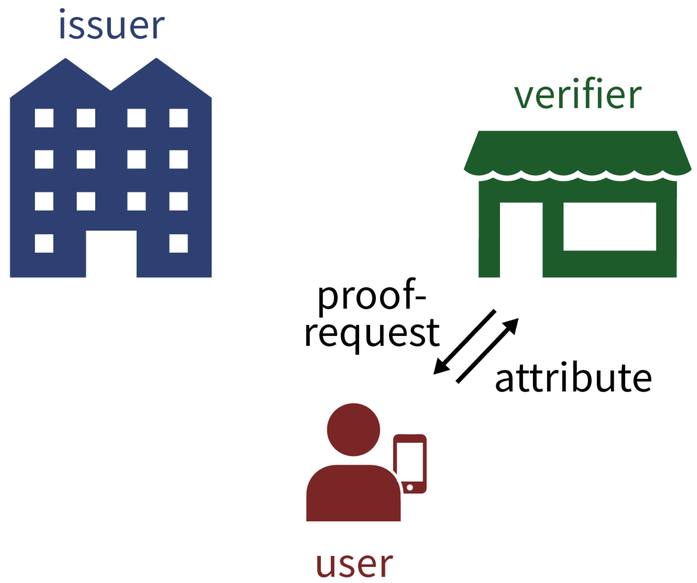
IRMA protocol

Issuance



Disclosure



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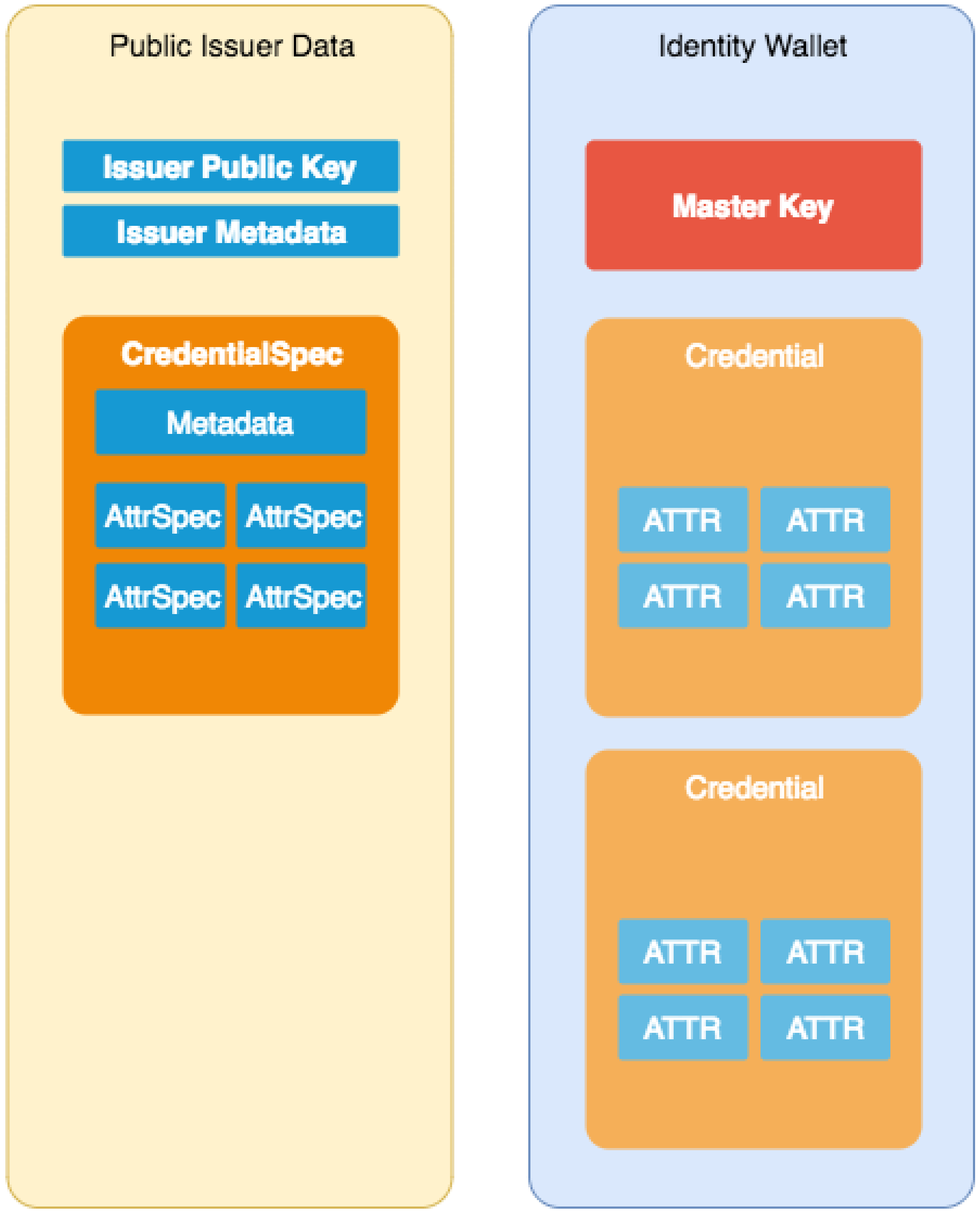
How to validate IRMA proofs?

- The RP has to know public keys of the issuers.
- The RP has to know that these keys do indeed belong to the parties that are trusted.
- For EVERY issuer that is relevant in the transaction/proof!

IRMA Issuer Data



IRMA Schemes

Schemes allow easier managing of IRMA issuer data.

- Instead of knowing about all issuers, we now just have to know about a few schemes.
- IRMA Schemes are open, anyone can start a scheme.
- Someone who starts a scheme, becomes the 'scheme manager' for that scheme.

IRMA Scheme XML (metadata)

```xml
<SchemeManager version="7">
  <Id>irma-demo</Id>
  <Url>https://privacybydesign.foundation/schememanager/irma-demo</Url>
  <Name>
    <en>Irma Demo</en>
    <nl>Irma Demo</nl>
  </Name>
  <Description>
    <en>Demo credentials within the IRMA domain</en>
    <nl>Demo IRMA-credentials</nl>
  </Description>
  <Contact>https://privacybydesign.foundation/</Contact>
</SchemeManager>
```

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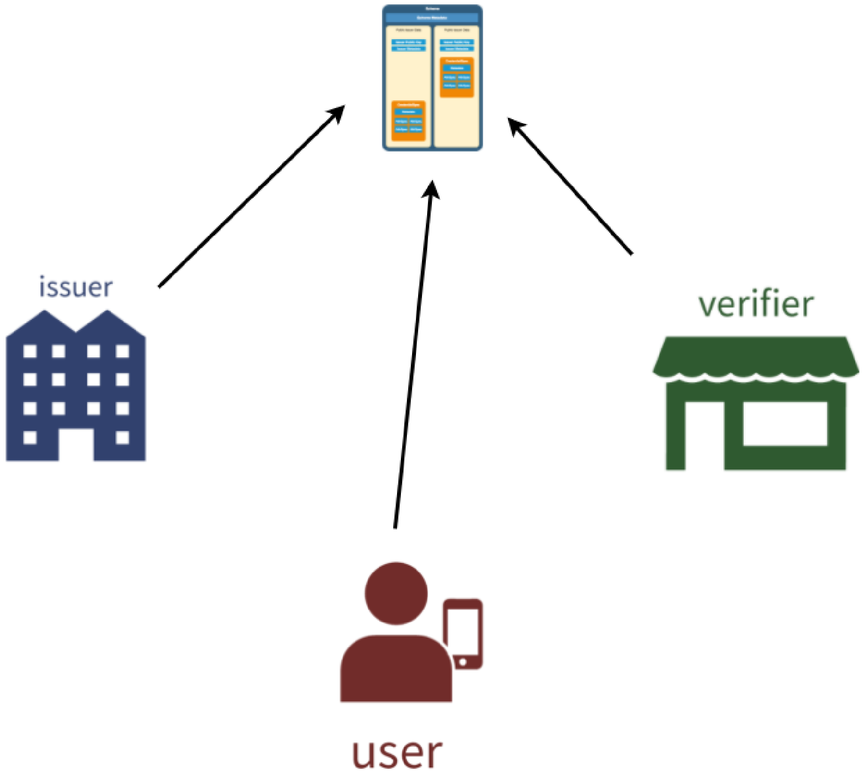
Scheme is context for all parties.



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Managing a scheme is a serious task!

- Current implementation as a signed file structure (on Github).
- Scheme manager manages all parts of the scheme.

- Good for standardization.
- Relatively inflexible.
- Are improvements possible?

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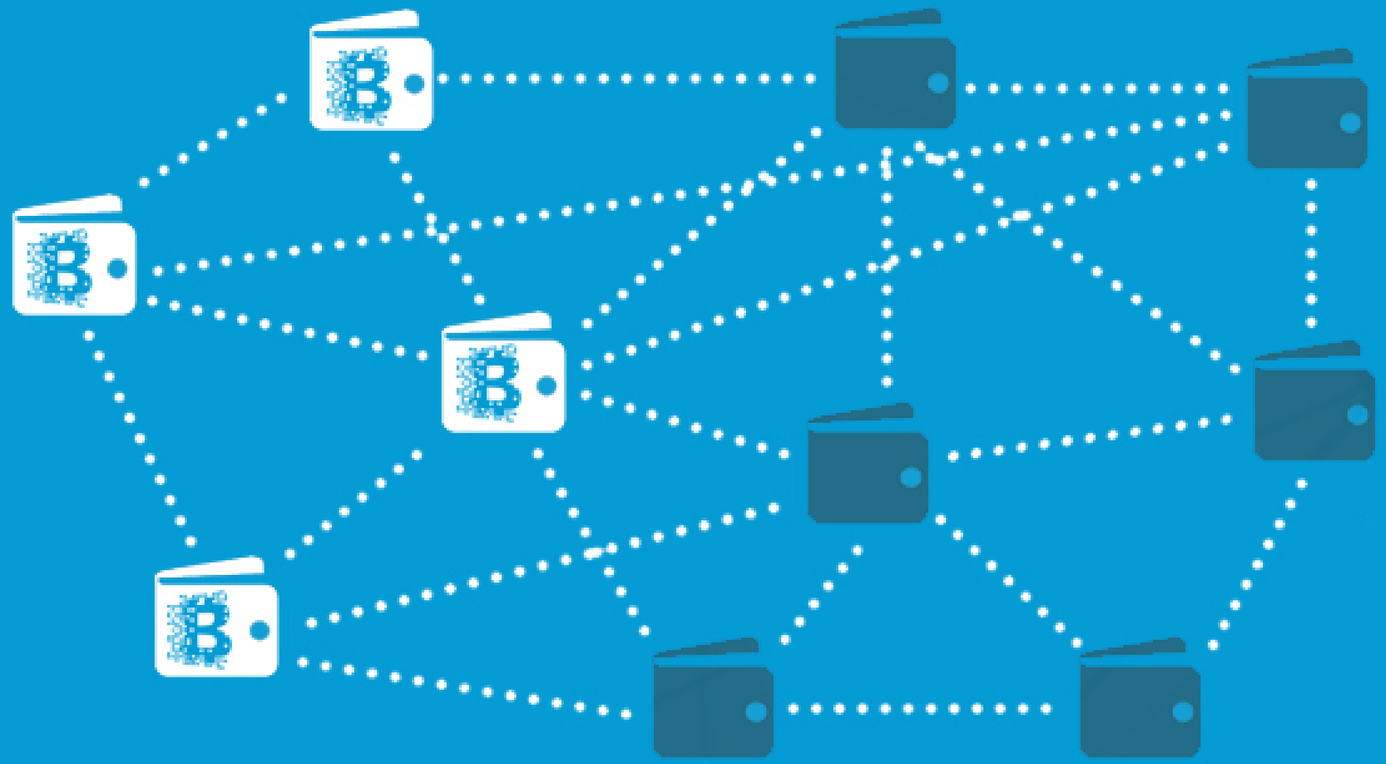
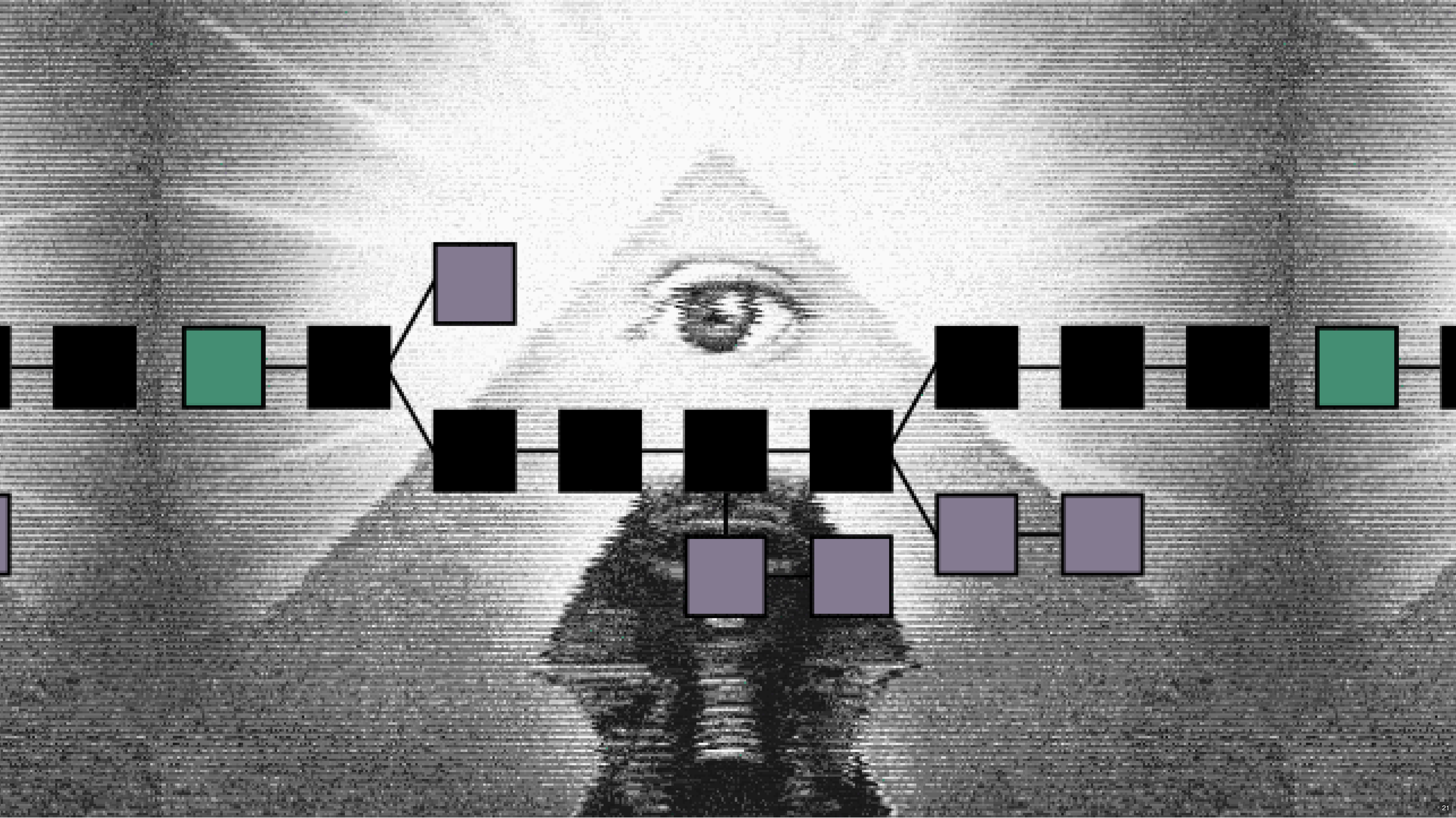



BLOCKCHAIN
VERIFIED
ADDRESS
WALLET
ICO
NETWORK
0010110101
11010110110
001110001101
TRUST
CRYPTOCURRENCY
MINING
%
TRANSACTION
SMART CONTRACTS


2
1
3



What is Blockchain?

- For the purpose of this talk:

- Smart Contracts
- Distributed Ledger Technology
- No single system administrator.

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Smart Contracts

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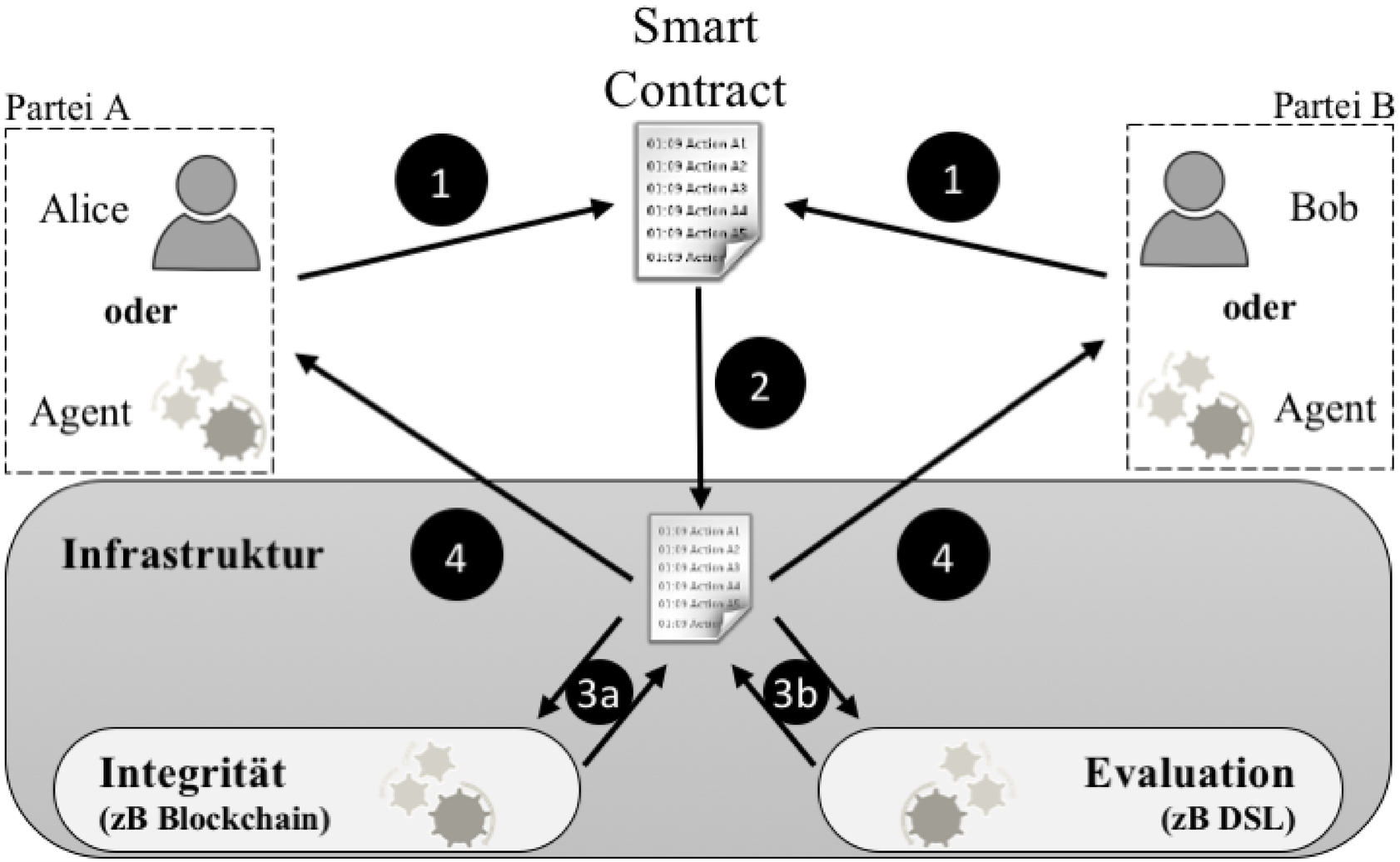
Distributed Ledger Technology



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How do other Identity Management systems use Blockchain?

- They started out really naive.
- Storing wallet (= personal data / attributes) on Blockchain?
- Store private (non-public) data on Blockchain?
- Gravest mistake: storing re-usable identifiers such as (a public version of) the master key on blockchain!

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Issues with Identity Management on Blockchain

- Linkability in case of repeated use of identifiers (which is generally the case).
- No dataminimalization (GDPR)
- No right to be forgotten (GDPR)
- Complexity / Rookie mistakes

- Developments are going fast.
- Soverin is implementing a kind of Attribute Based Credentials (AnonCreds)

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(Provisional) golden rule for Blockchain development

- Only store public data on (public) blockchains.
- Luckily the IRMA scheme IS public data!
- Not trying to do 'IRMA on Blockchain'.
- Better question: are these technologies useful to improve IRMA?

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IRMA Scheme implementation on Ethereum

- Experimental implementation on Ethereum.
- As close to original implementation as possible.
- IRMA Scheme represented as a smart contract.
- It works!
- Available on Github - https://github.com/timenolthof/irmaethereumscheme

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IRMA Scheme Smart Contract - Data Types

```
contract IRMAScheme {
    string public id;
    address public owner;
    bytes public metadata;
    mapping (string => Issuer) private issuers;
    string[] public issuerIds;

    struct Issuer {
        string id;
        string logoUrl;
        address owner;
        bytes metadata;
        mapping (uint => IssuerPublicKey) publicKeys;
        mapping (string => Credential) credentials;
    }

    struct IssuerPublicKey {
        uint id;
        bytes key;
    }

    struct Credential {
        string id;
        string logoUrl;
        bytes issueSpec;
    }
}
```

IRMA Schemes

Serialization using Protocol Buffers

```
1   syntax = "proto3";
2   package irmaproto;
3
4   // This mimicks IRMA issuer description.xml
5   message IRMAIssuerPublicKey {
6       int32 Counter = 1;
7       int64 ExpiryDate = 2;
8       bytes N = 3;
9       bytes Z = 4;
10      bytes S = 5;
11      repeated bytes Bases = 6;
12      int32 EpochLength = 7;
13  }
```

IRMA Scheme Smart Contract - Functions

```
contract IRMAScheme {
    function addIssuerCredential(string _issuerId,
                                 string _credentialId,
                                 string _logoUrl,
                                 bytes _issueSpec) public returns (bool) {
        Issuer storage issuer = issuers[_issuerId];
        if (!issuer.exists) { //issuer should exist
            return false;
        }
        if (issuer.owner != msg.sender) { //only owner can add credentials
            return false;
        }
        issuer.credentials[_credentialId] = Credential(true, _credentialId,
                                                       _logoUrl, _issueSpec);
        issuer.credentialIds.push(_credentialId);
        return true;
    }
}
```

Advantages of Ethereum implementation

- Issuers can manage their own metadata.
- Issuers can manage their own credential specifications.
- Issuers can manage their own keys (and key rotation).

- A lot less work for the scheme manager.
- Scheme data structure can become more dynamic when using multiple smart contracts.
- Schemes can support possible new features like
    - Users becoming issuers themselves 'on the fly'
    - 'web of trust'

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Problems with Ethereum implementation

- Ethereum VM and Solidity are slow, incomplete, and expensive.
- Transaction costs, although they are ok at about €5-10.
- There are tight limits on data size (gas limit).
- Adds a lot of complexity and dependencies to the codebase.
- Doesn't remove the need for a single 'root of trust'.

Next Steps / Future Work

- Ethereum is too limited, look for other suitable technologies
- IPFS (or variants) might be a candidate.
- Research other ways to decentralize schemes as well.
- Would love to hear your input!

Take Home

- Never store non-public data on a blockchain.
- Particularly not personal data.
- Using Blockchain for IRMA schemes can have some practical benefits.
- Better DLT needed to make IRMA scheme feasible in production.

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alliander

Thank you!

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Image/video sources / references

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