Distributed Authenticated Mappings

DINRG IETF-101

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I. Authenticated Mappings

What's broken?

Problem

Private conversations over encrypted email

Secure internet service for small websites

Domain lookups

Verifying identity

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Problem	Point Solution
Private conversations over encrypted email	Trusted keyservers
Secure internet service for small websites	HSTS preload lists
Domain lookups	DNS (+ DNSSEC)
Verifying identity	CA trust chains + CT

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Verifying identity	CA trust chains + CT // Single point of failure	Certificate mappings

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Authenticated mappings!

Generalized Mappings

Can we derive a scalable solution that will work for any mapping?

Idea: infrastructure for a global state database

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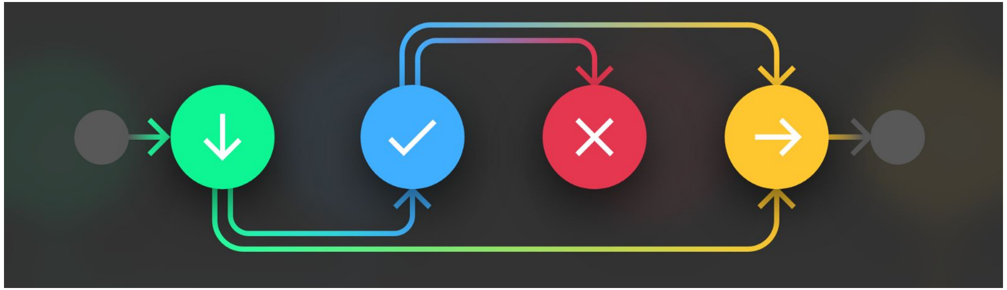

Generalized Mappings

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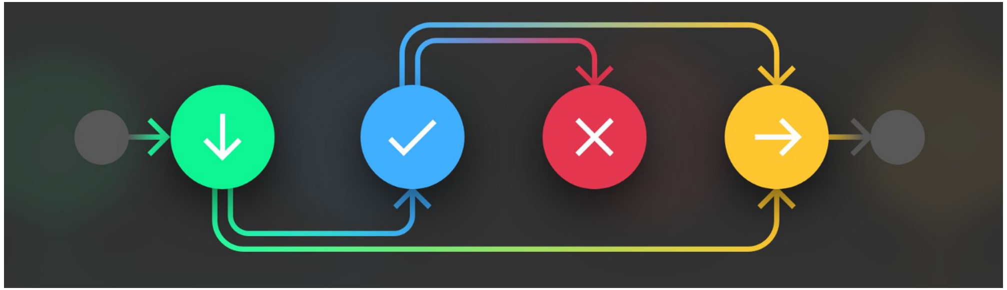
Idea: infrastructure for a global state database

- Append-only
- Well-formed transitions **(more on this later)**
- Transparent



Global State Database

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KeyNet (interim meeting)
Distributed OpenPGP key store for encrypted email

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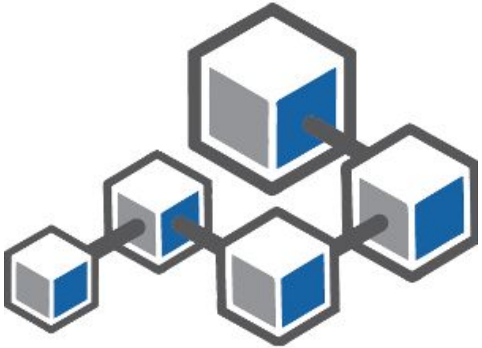
Open membership w/out accountability.
Trust is tied to hashing power or available resources.



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(4) Federated Byzantine Agreement

Variety of well-known stakeholders.
Trust in network is tied to real-world trust relationships.

II. Well-formed Transitions

Example 1: PGP Keys

We might want to securely map aliases to public keys.

On creation of an entry, we can check that a domain authority verifies their identity.

Every time an entry is updated, we should verify

1. the previous public key has signed the update.

   OR

2. *n* of *m* trusted parties have signed the update.

Example 2: Binary Hashes

We might want to securely map download URLs to binary hashes.

On creation of an entry, we should check that the domain hosting the URL has signed the entry.

Every time an entry is updated, we should maintain

1. the same domain has signed the update.

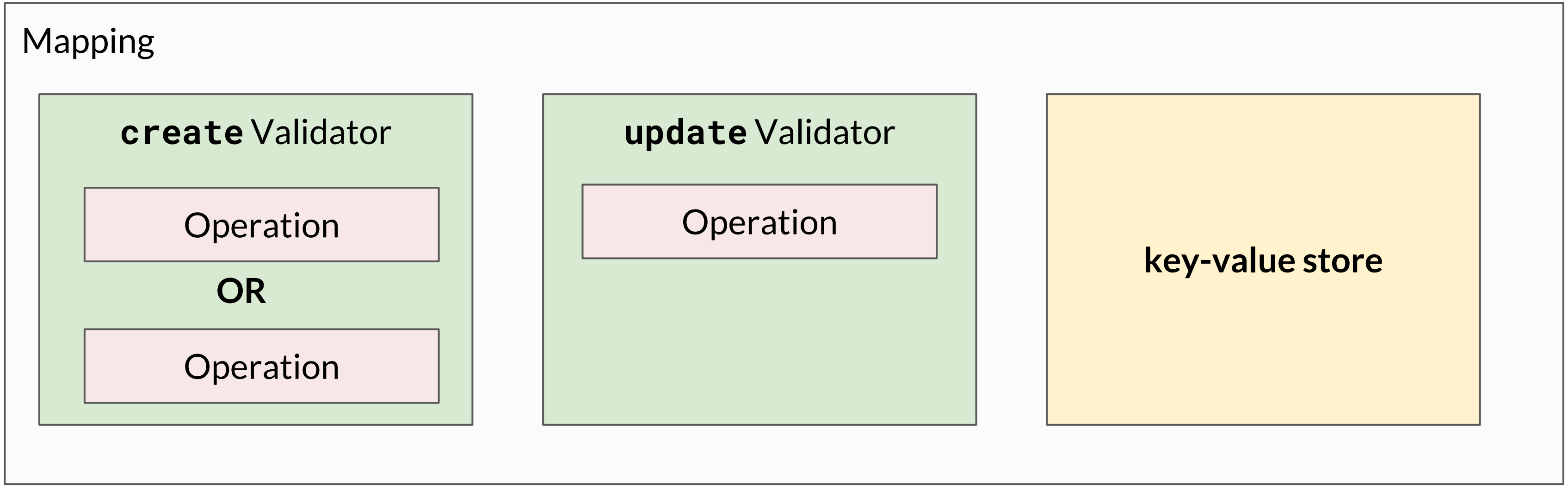
Observations

A mapping abstraction allows for shared components

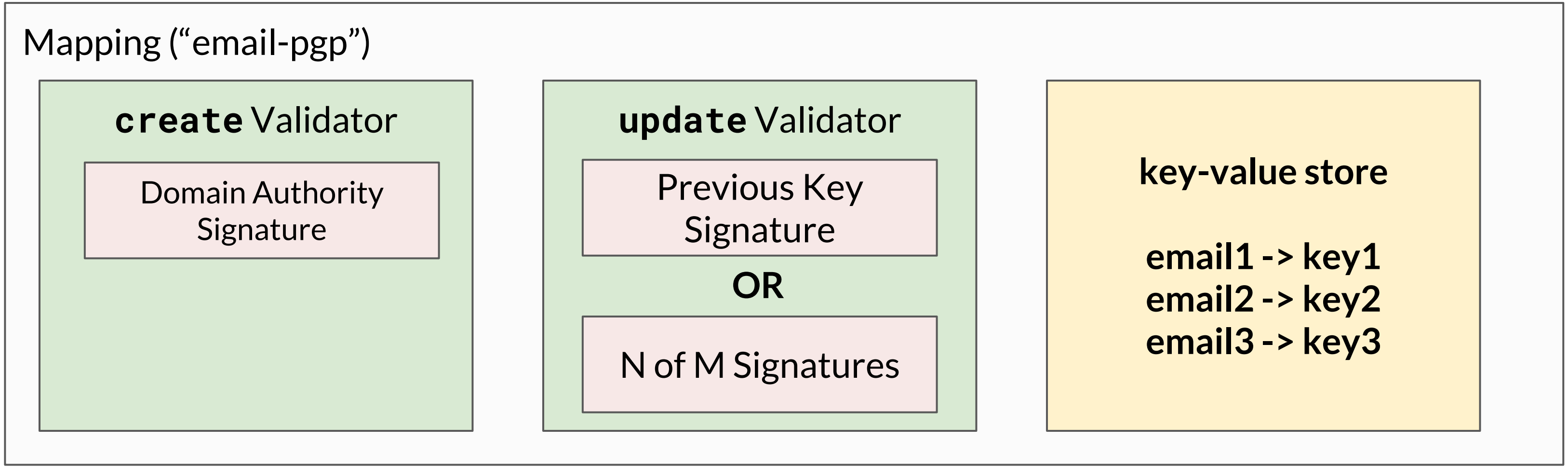
- Entry `create` and `update` validation based on local state
- External authentication
- Ownership
- Recovery/threshold cryptography

Mapping: specification for key-value mapping with `validators` to ensure well-formed, secure entry `creation` and `updates`.

- All creation validators must succeed to allow a new entry
- All update validators must succeed to allow a transition/change



Mapping Example: PGP Keys




```
mapping = Mapping {
    create_validator = [ "bootstrap_validator": Validator {...} ],
    update_validator = [ "identity_validator": Validator {...} ],
    key_type = ALIAS,
    value_type = PUBLIC_KEY
}
```

`Validators`: collections of **`operations`** enforced on entry creation/update

- At least one must succeed for validation to pass
- **`create`** and **`update`** validators defined at the mapping level

Validator Example: PGP Keys

```
"identity_validator": Validator {
    operation = [
        // require existing signature for updates
        "owner": ...,
        // allow threshold encryption for recovery
        "multisig": ...
    ]
}
```

`Operations`: validation rules enforced on each entry in a mapping

- Allowed operations in **`Validators`** are specified at **`mapping`** level
- Individual entries can customize operation parameters
- Example Operations
  - `OpCASignature, OpOwnerSignature, OpNofMSignatures`

Operation Example: PGP Keys

```
Validator { operations = [
    "owner": OpOwnerSignature { }
    "multisig": OpNOfMSignatures {
        alias = ["eff.org", "mozilla.org", "ietf.org"]
        required_number = 2
    }
]}
```

`EntryUpdates`: changes to a mapping entry

- All **`validators`** are evaluated and must pass for update to succeed

Entry Update Example: PGP Keys

```
EntryUpdate {
    mapping_id = "keynet",
    key = Alias { Email {
            address = "colinman@stanford.edu"
            domain = "stanford.edu"
        } }
    value = "{new public key here}"
    update_operations = {optional parameters}
}
```

Mapping Abstraction vs Smart Contracts

- Easy to implement on top of consensus layer
- Easy to use (operations already defined)
- Less error-prone (Parity, Dao, etc.)
- Designed to be bootstrapped off existing trust infrastructure
    - Exploring options to use Stellar Consensus Protocol

Questions?

https://github.com/colinman/keynet