Packet Validation in the Network Environments

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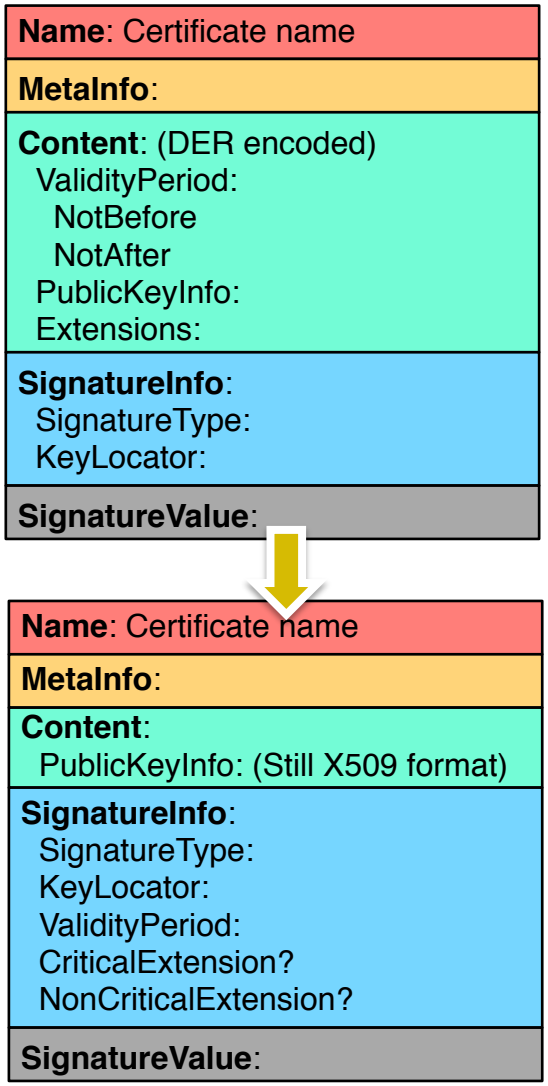
Packet Authentication

- How to authenticate a data packet containing the electricity usage of a room at certain time?

- Data is signed, but how to verify the signature?
  - How to get the signer's public key?
  - How to authenticate the signer?
  - Why the signer should be trusted?
  - Should the signer be trusted at this moment?

Data & Certificate

- Retrieved as data packets
  - public keys are just another type of content
- Data packets are similar to certificates
  - data is signed
- Data packets are incomplete certificates
  - no signature validity period
  - no signature revocation information
- Current solution:
  - put validity period & other extensions in content
- Ideal solution:
  - extend SignatureInfo



Naming

- Every data is named, what is the name of certificate?
- A certificate binds a key to a namespace (identity)
  - e.g., /<namespace>/[KeyId]
    - absolute KeyId: globally unqiue, e.g., key hash
    - relative KeyId: uniquely identify a key under the namespace, e.g, SeqNo
- Application interprets the namespace as some real world identity
  - in BMS, "/bms/boelter/4805/electrical" is interpreted as a sensor in the Room 4805 of Boelter Hall at UCLA
  - in openHealth, "/ucla/haitao/ndnex/dvu" is interpreted as a health data publisher of a user "/ucla/haitao"
- Certificate name may include version number
  - different signature versions (Key rollover)

Public Key Fetching/Provisioning

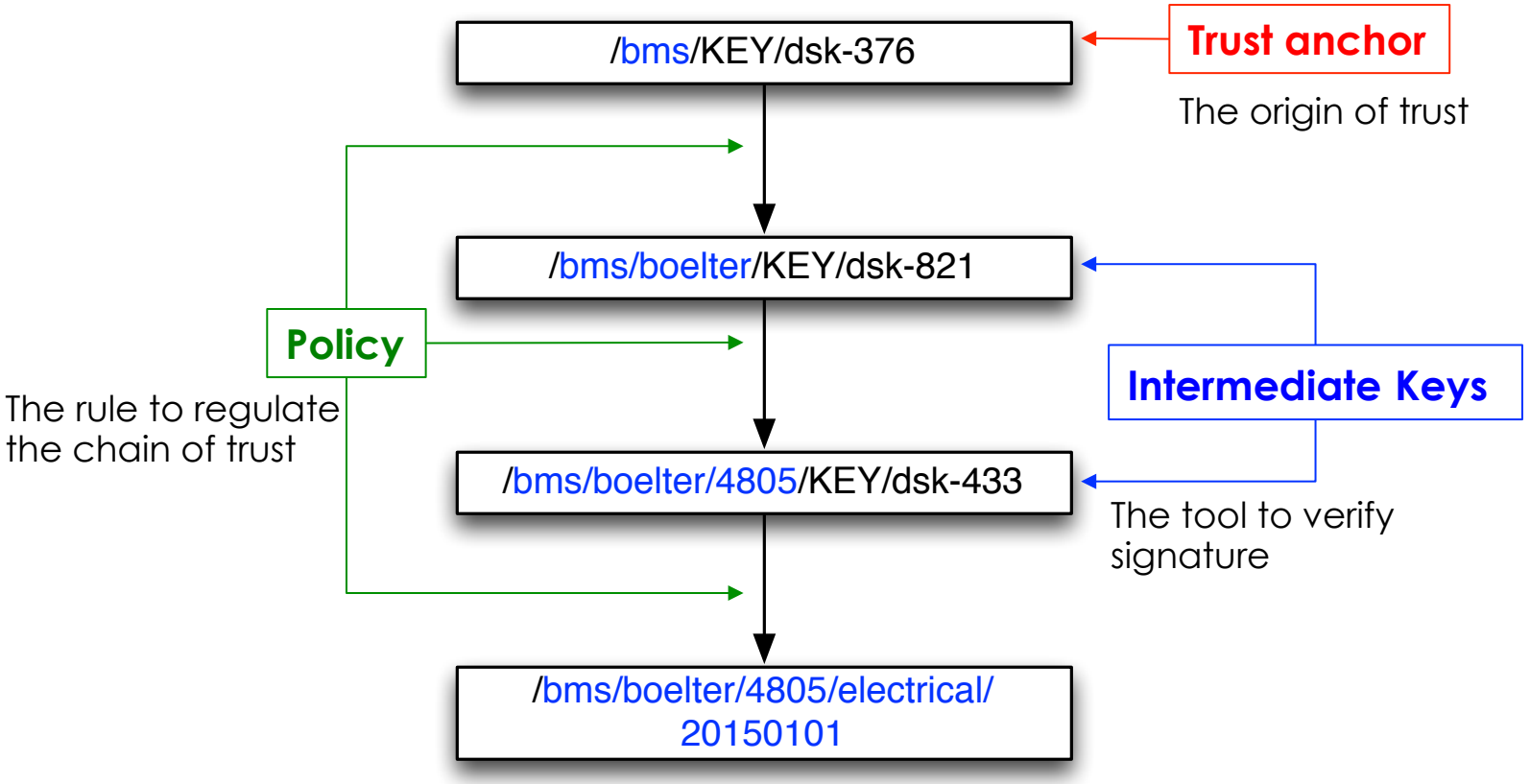
- Express an interest using the cert name in KeyLocator
  - certificate name of signer's public key (w/o version)

- Certificate is published somewhere
  - current solution:
    - published as NDN DNS record
      - /ndn/ucla/**KEY**/yingdi/ksk-123/**ID-CERT**/%01
    - published through repo
  - issue: prefix aggregation
    - demux interest for certificate introduces extra name components in cert name
      - /ndn/**KEY**/ucla/yingdi/ksk-123/**ID-CERT**/%01
      - /ndn/ucla/yingdi/**KEY**/ksk-123/**ID-CERT**/%01

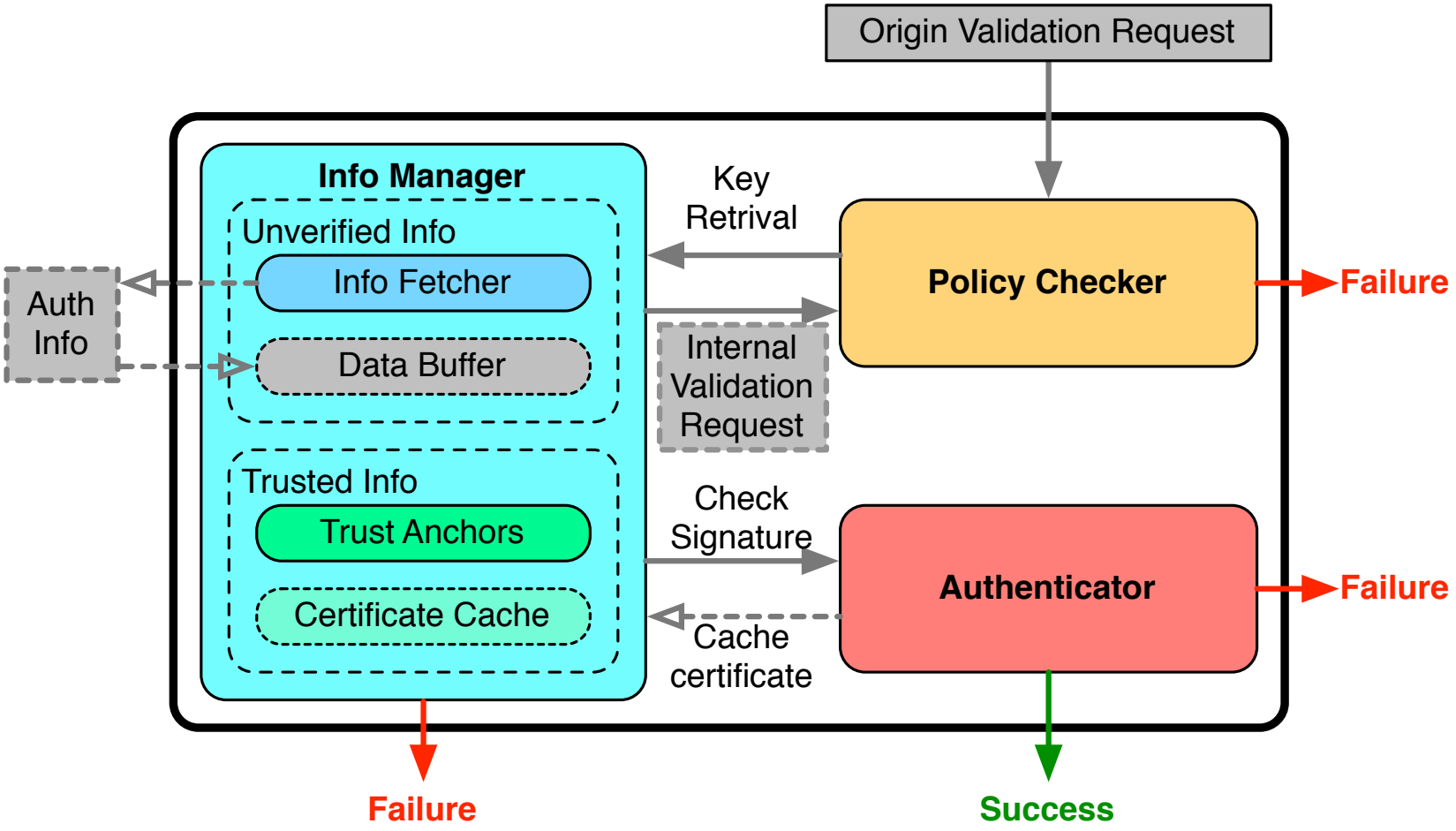
- General certificate infrastructure? or app-specific certificate infrastructure?

Signer Authentication

- Construct a chain of trust



Validation Framework



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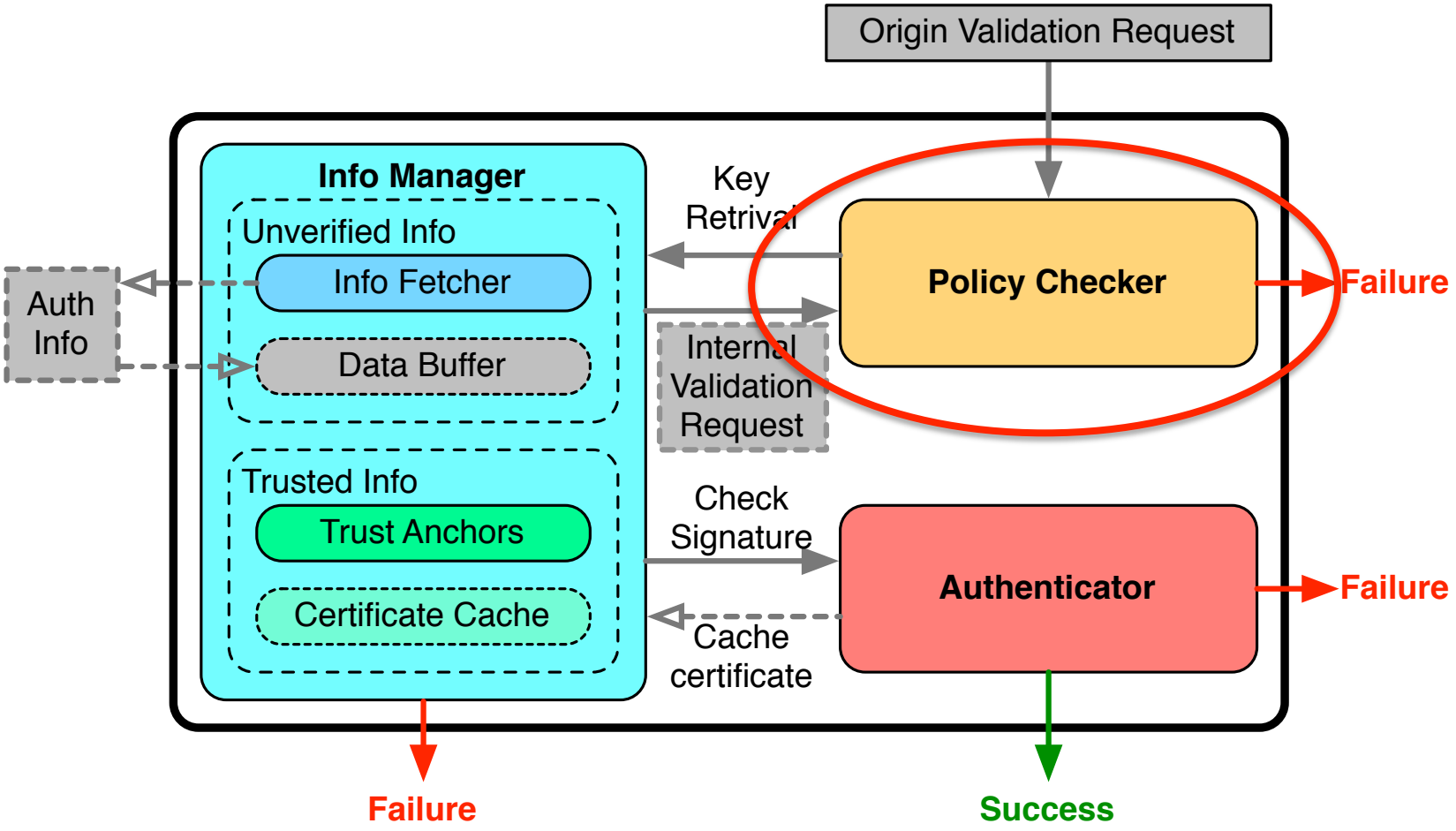
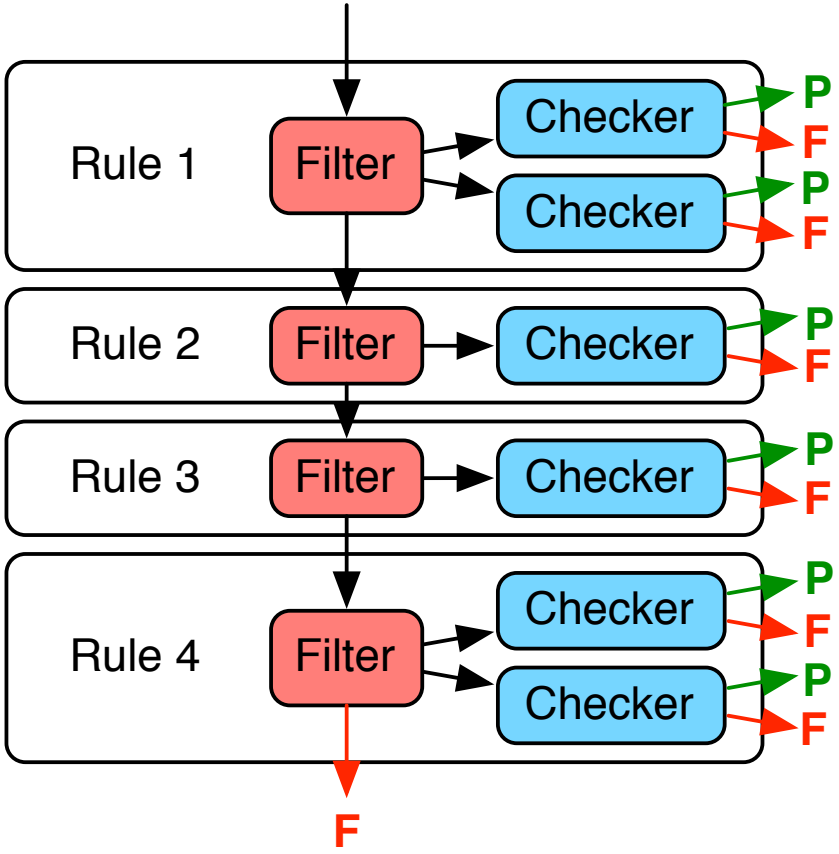


Policy

- Conditions on the SignatureInfo
- SignatureType
  - some data may require certain type of signature
    - algorithm
    - key size
- KeyLocator
  - some data must be signed by certain parties
- ValidityPeriod
  - signature must be valid at certain timestamp

Policy Rules

- A rule consists of
  - a filter
  - a set of checkers
- Filter
  - which packet should be checked by the rule
- Checker
  - the conditions that the packet's SigInfo must meet
  - could be more than one sets of valid conditions
  - pass one checker, pass the rule
  - fail all checkers, fail the policy checking
- Order of rules matters
  - packet will be checked by the first matched rule
  - rules with more specific filter should go first



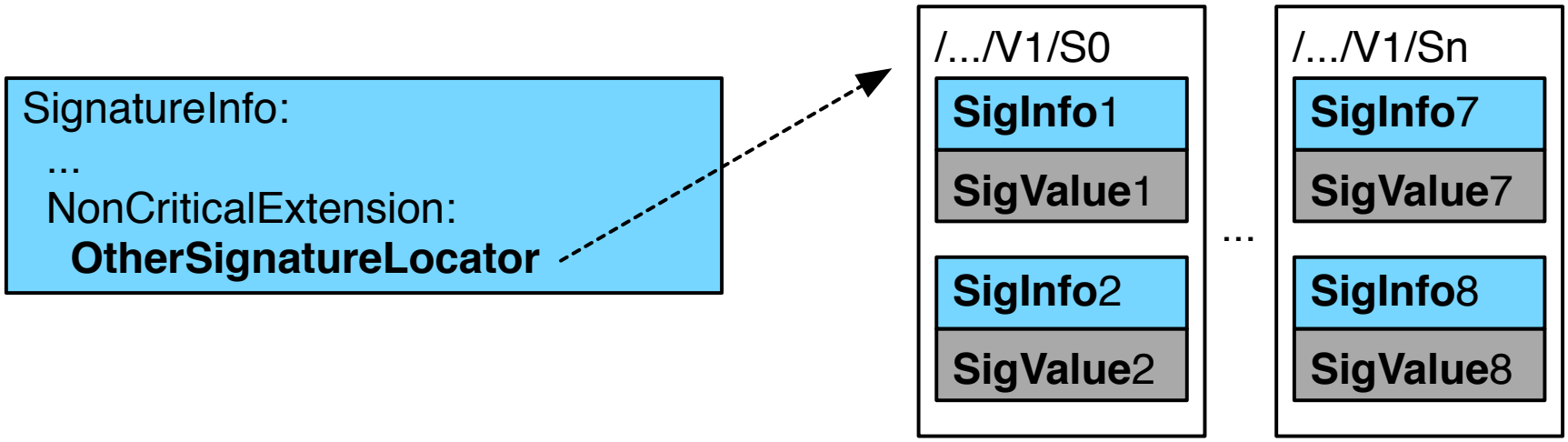
Policy Language

- Configurable
  - allow apps/users to specify its own trust models
- Interpretable
  - library can build the validator according to configuration
  - entities with the same configuration file share the same trust model
    - if router can fetch the policy, router knows how to validate data
- Easy to distribute
  - can be published as data packet
  - data name can be fixed with implicit digest

```
rule {
 filter {
  packet-type data
  packet-name <bms><>*
 }
 checker {
  signature-type ecdsa-sha256
  min-key-size 256
  key-locator {
   k-pattern (<>*)<KEY>(<>*)<><ID-CERT> \1\2
   h-relation is-prefix-of
   p-pattern (<>*) \1
  }
 }
 checker {
  signature-type ecdsa-sha256
  min-key-size 256
  key-locator {
   k-pattern (<>*)<KEY>(<>*)<><ID-CERT> \1\2
   h-relation is-prefix-of
   p-pattern <bms>(<>*) \1
  }
 }
}
```

Multiple signature

- The same content object may be signed by different keys
  - certificates: the same <name, key> pair may be certified by different parties
    - in openHealth, a doctor's key may be signed by both patient & medical board of California in order to access the patient's data
  - signature agility: different signing algorithms & key size
- Introduce a signature extension: OtherSignatureLocator



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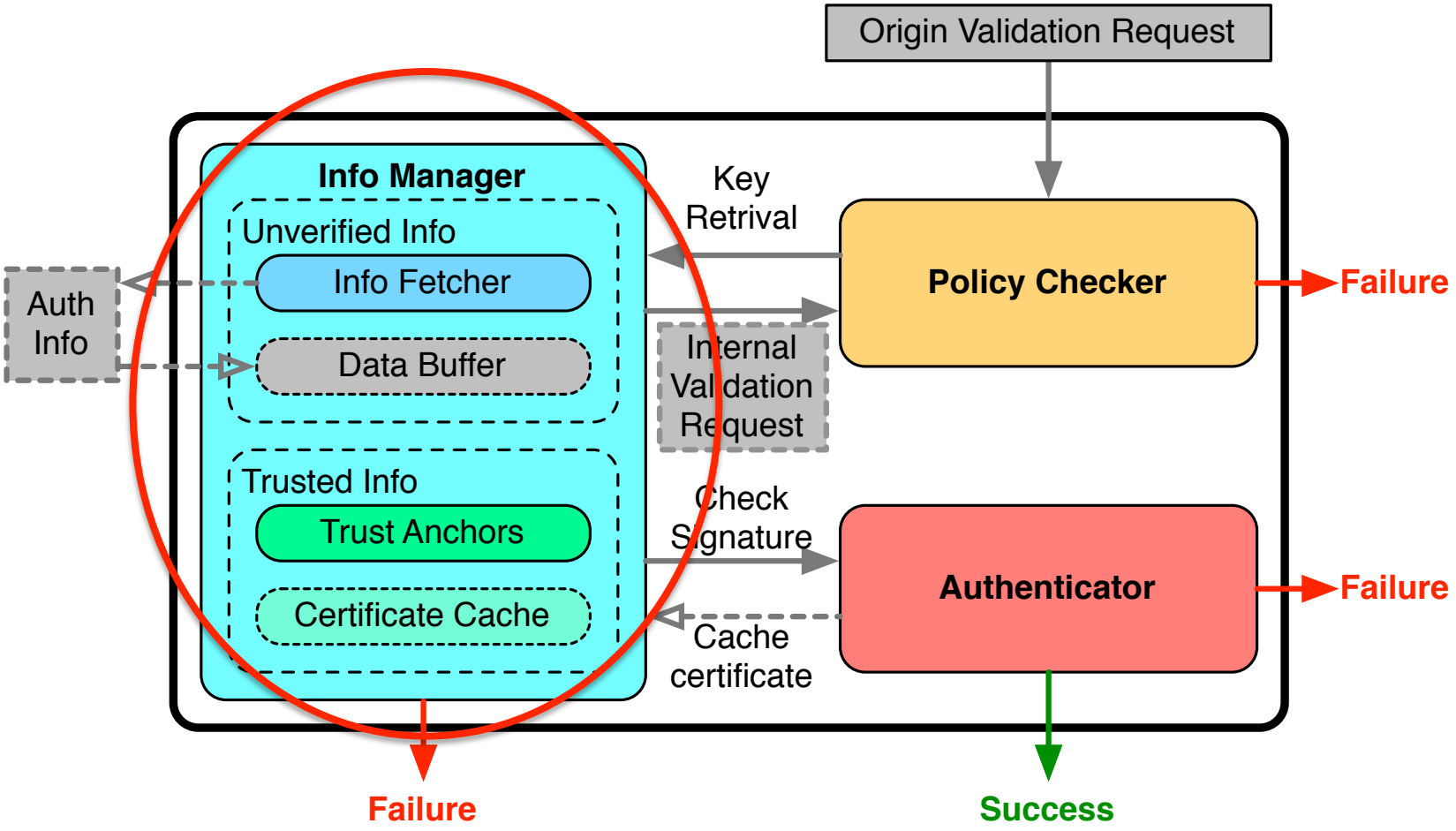


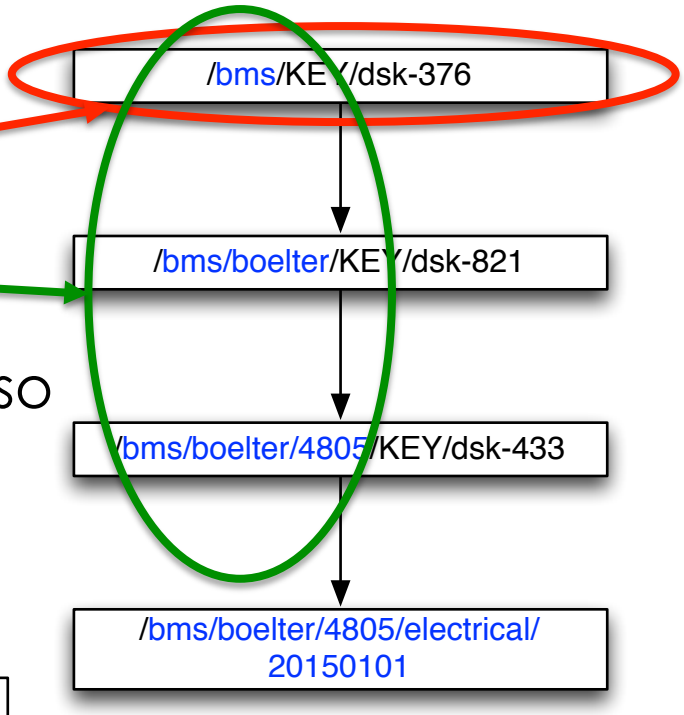
Public key retrieval issues

- Slow start
  - retrieve keys one-by-one, multiple RTTs
  - may involve more data
    - multiple signatures
- Single point failure
  - validation fail if one key is missing
    - limited internet access
    - key provision failure

- **Key Bundle**: why not ask data provider to collect keys and publish them along with the data?
  - fate sharing
    - if data can be fetched, so do the keys
  - efficiency
    - if producer collect the keys once, it can benefit many verifiers

Key Bundle Requirements

- Publisher & consumer agree on the trust policy and trust anchor
- In BMS
  - single trust anchor
  - hierarchical policy
- While expressing interest for data, also expressing interests for proofs

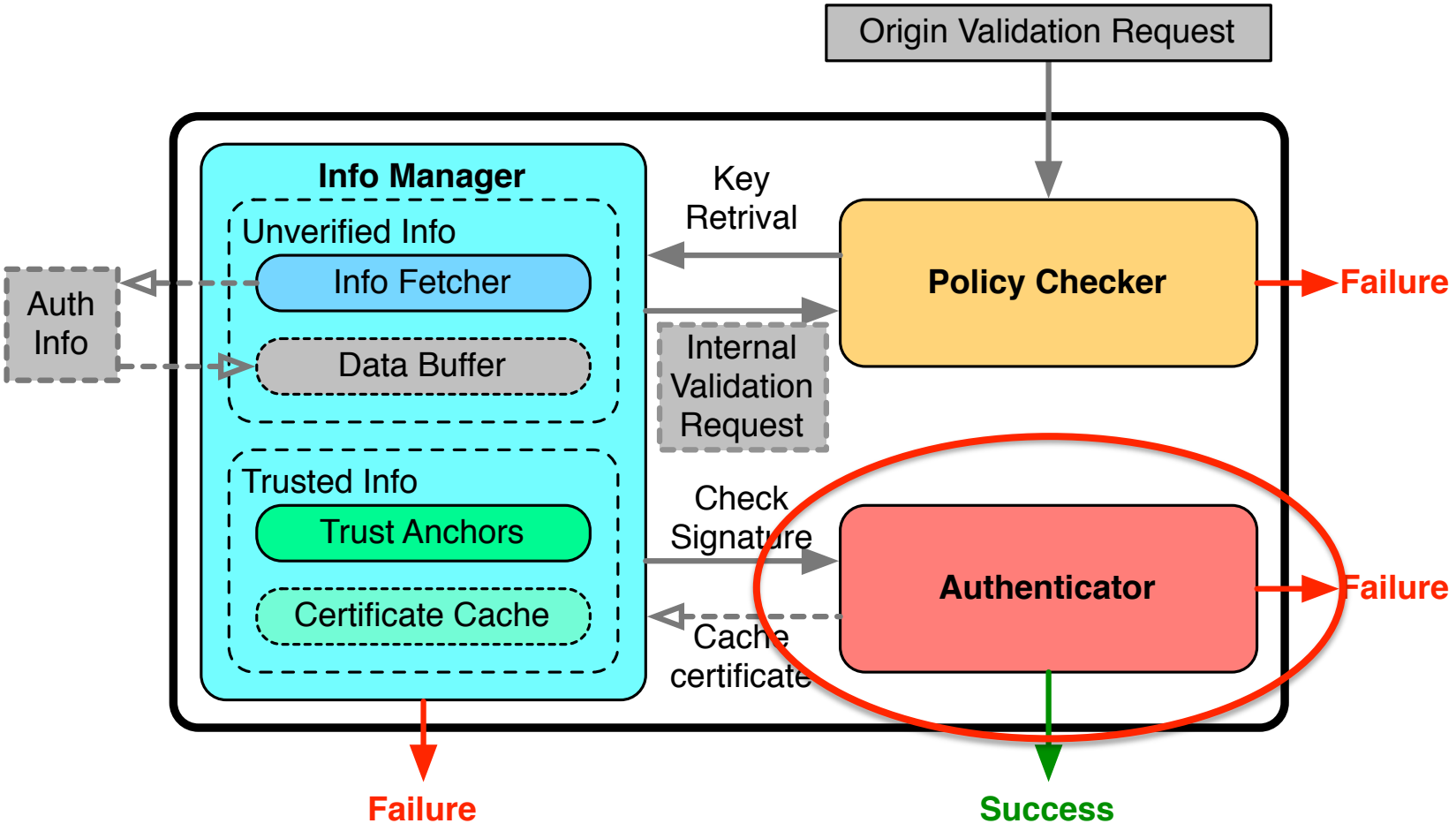


For data → /bms/boelter/4805/eletrical/20150201

For proof → /bms/boelter/4805/eletrical/20150201/AUTH_INFO/
hierarchy/3d4c89ef..

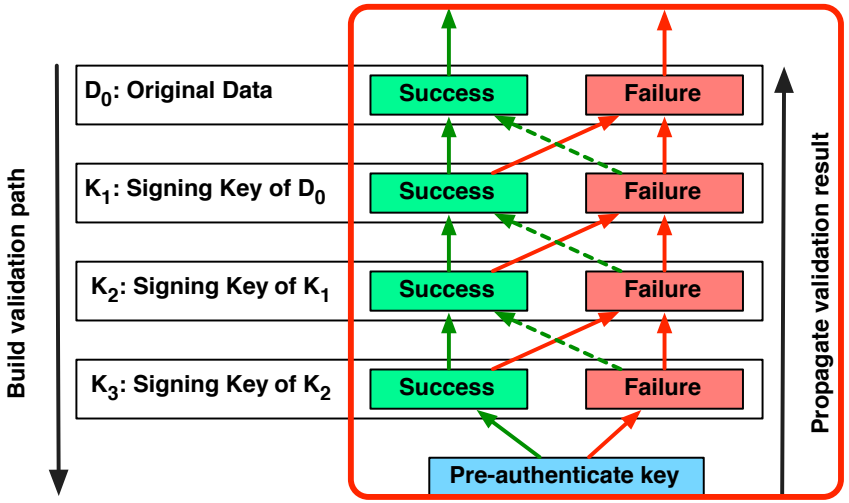
- /bms/boelter/KEY/dsk-821
- /bms/boelter/4805/KEY/dsk-433

Validation Framework



Signature Verification

- Start when reaching an pre-authenticated key
- Check signature status
  - should be done after the signature is verified
  - ensure the signature has not been revoked yet
- Once an intermediate signing key is validated
  - verify the signature of depending packets
  - recursively go back to the original data packet



Signature status checking

- Check if the signature has been revoked before expiration

- Verifier may retrieve signature status data
  - /<DataName>/[DataDigest]/[Timestamp]
  - content:
    - signature status: good, revoked
    - reasons (optional): revocation reasons

SignatureInfo:
...
(Non)CriticalExtension:
StatusChecking:
ForwardingHint
AuthorizedSigner

- Introduce a signature extension StatusChecking
  - ForwardingHint: where to forward the signature status interest
  - AuthorizedSigner: who can be trusted for signing signature status data

Thanks!