did:orb

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https://trustbloc.github.io/did-method-orb

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Background

Orb’s design originates from prior experiences with Sidetree and Hyperledger Fabric.

Sidetree:

- Self certifying – DID suffix cryptographically bound to initial state.
- Self controlled – Ordered updates to a DID document form their own verifiable chain from inception to the current state of the DID document.
- VDR based on content-addressed storage and immutable files.
- Batch-based structures assist with performance and storage.

Hyperledger Fabric:

- Endorsement model and batch-based propagation model.

Motivation – Enable Open Federation

- Not be coupled to a particular blockchain or DLT.
  - Decouple propagation coordination into a ledger agnostic protocol.
  - Decouple transaction graph into a ledger agnostic CAS-based structure.
  - Remove the need to choose a common public blockchain and DLT lock-ins.
  - Still allow for ledger usage as a monitorable log.

- Allow for an open federation and replication model.
  - Enable protocols that allow VDRs to interconnect and replicate.
  - Allow a DID to use different servers (and backing ledgers) across updates.
  - Minimize trust in the network and servers.

Motivation – Enable both Web and DHTs

- Content-addressed objects need a mechanism to discover hosts.
  - DHTs are beneficial but a particular network isn't always acceptable.
  - Allow for both Web and DHT models within the same method.
- Enable Web-based discovery:
  - did:orb:webcas:example.com:bafkr…:EiDy…
  - Based on WebFinger + REST API.
- Enable DHT-based discovery:
  - did:orb:ipfs:…:bafkr…:EiDy…
  - Pluggable model for DHT networks.

Motivation – Enable portability

- VDR objects are replicated across Orb Servers.
  - Can be included in new transactions across servers.
  - Form a graph based on immutable CAS CIDs.
  - Graph can be discovered using CID in the DID string.

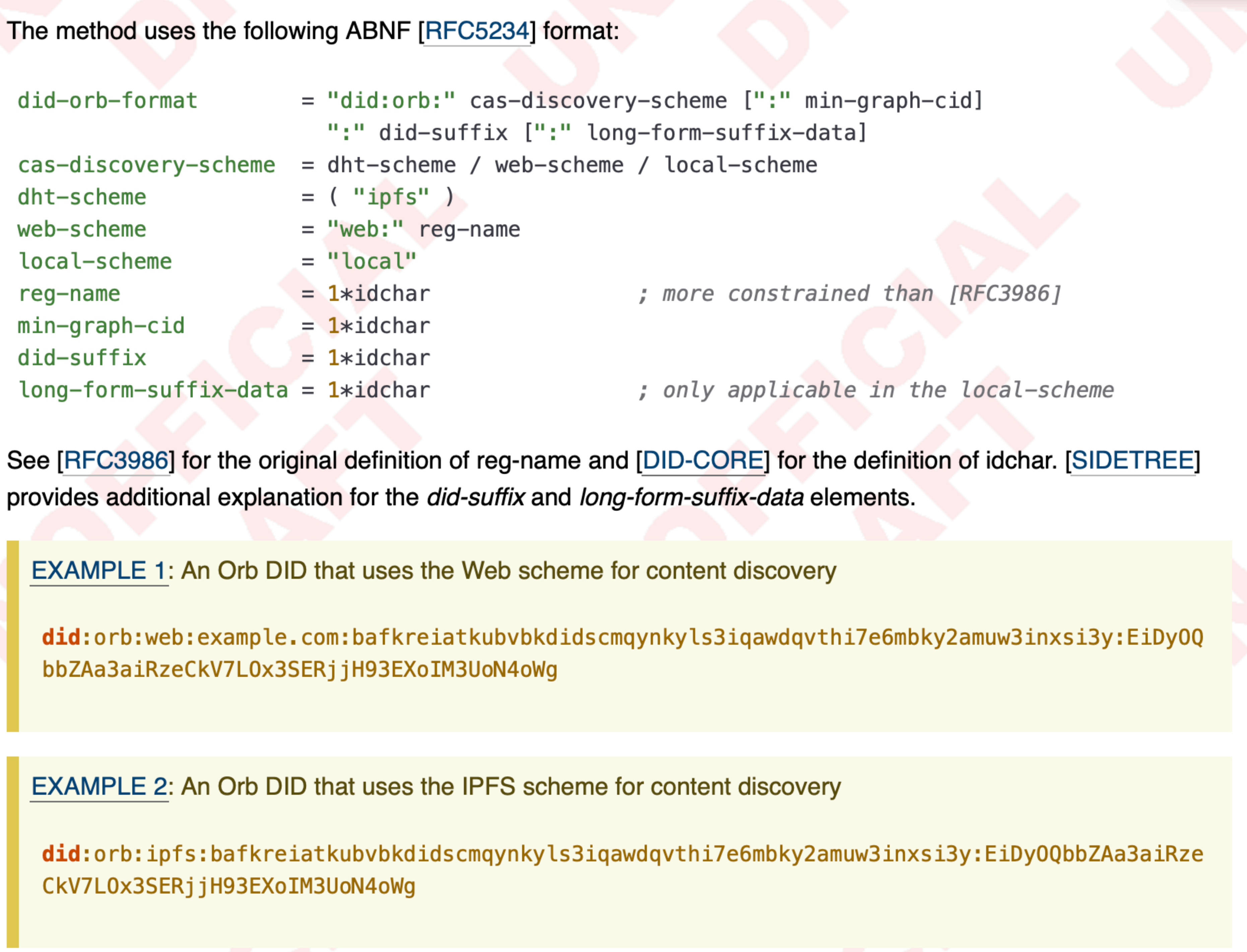
- DID controllers can write operations across Orb Servers.
  - Specify the origin that has knowledge of their latest DID operations.
  - Enabled to change origin over time.
  - Canonical DID updated when origin changes (graph CID is updated).

Motivation – Enable monitorable ledgers

- Decouple witness ledgers from the critical path.
    - Allow for Trust but Verify model.
- Leverage the Certificate Transparency model
    - Witnesses observe VDR objects and promise to include in their ledgers.
    - Provide a signed timestamp and a maximum merge delay.
    - Enable monitoring to ensure witnesses follow their promises.
- Use trusted Witness (and origin) timings to resolve late publishing.
- Use origin to enable observers to know if they have the latest operations.

Motivation - Leverage specifications

- DID core compliant.
- Sidetree Protocol to encode DID operations and batches.
- Verifiable Credential format to encode anchors - AnchorCredential.
- JSON-LD Proofs from witnesses form a VC proof chain.
- Certificate Transparency extended for VCs – VCT.
- ActivityPub for propagation.
- WebFinger for Web-based discovery.
- IPFS CIDs and encodings.



The method uses the following ABNF [RFC5234] format:

```
did-orb-format        = "did:orb:" cas-discovery-scheme [":" min-graph-cid]
                        ":" did-suffix [":" long-form-suffix-data]
cas-discovery-scheme  = dht-scheme / web-scheme / local-scheme
dht-scheme            = ( "ipfs" )
web-scheme            = "web:" reg-name
local-scheme          = "local"
reg-name              = 1*idchar                ; more constrained than [RFC3986]
min-graph-cid         = 1*idchar
did-suffix            = 1*idchar
long-form-suffix-data = 1*idchar                ; only applicable in the local-scheme
```

See [RFC3986] for the original definition of reg-name and [DID-CORE] for the definition of idchar. [SIDETREE] provides additional explanation for the *did-suffix* and *long-form-suffix-data* elements.

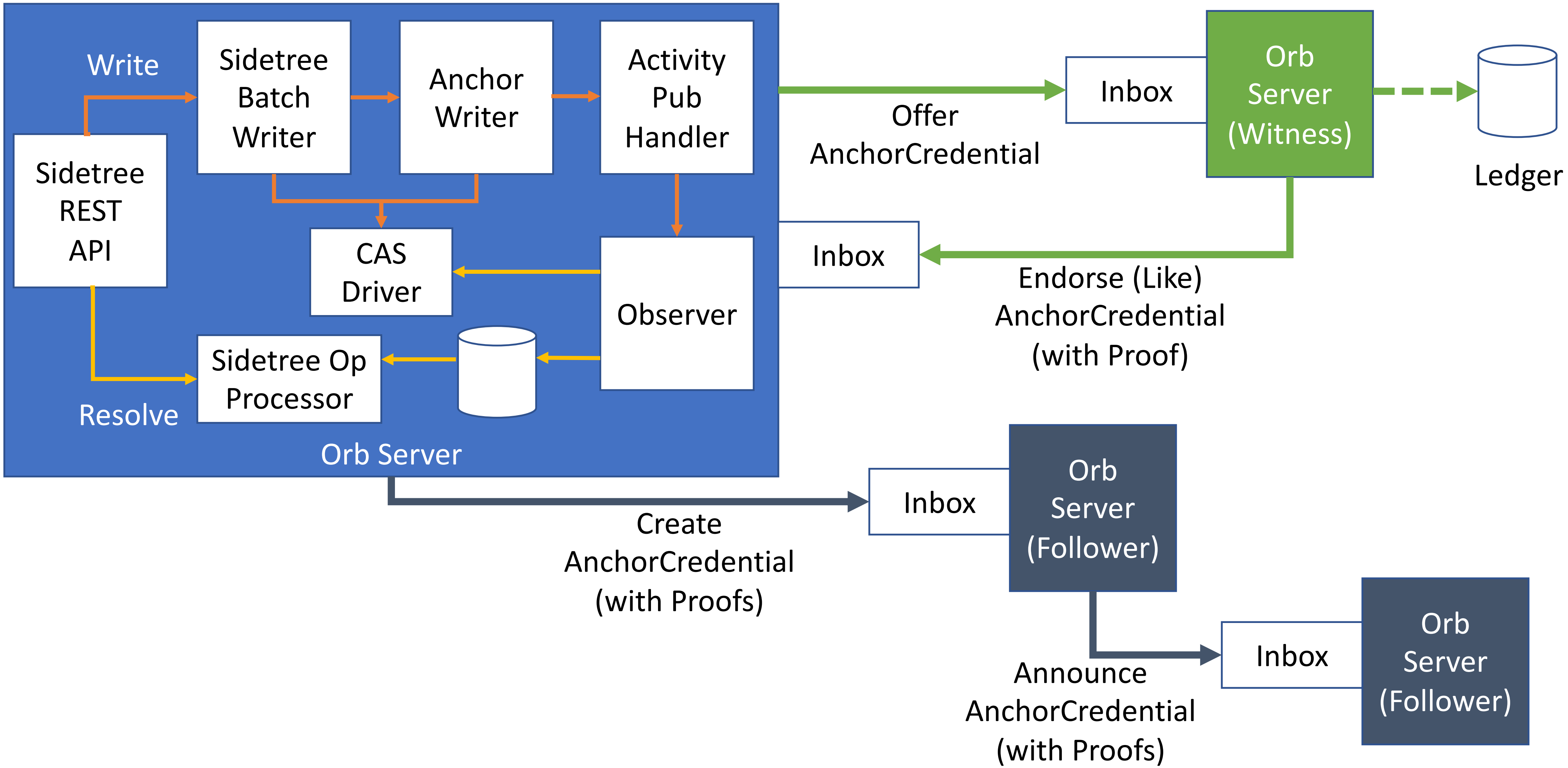
EXAMPLE 1: An Orb DID that uses the Web scheme for content discovery

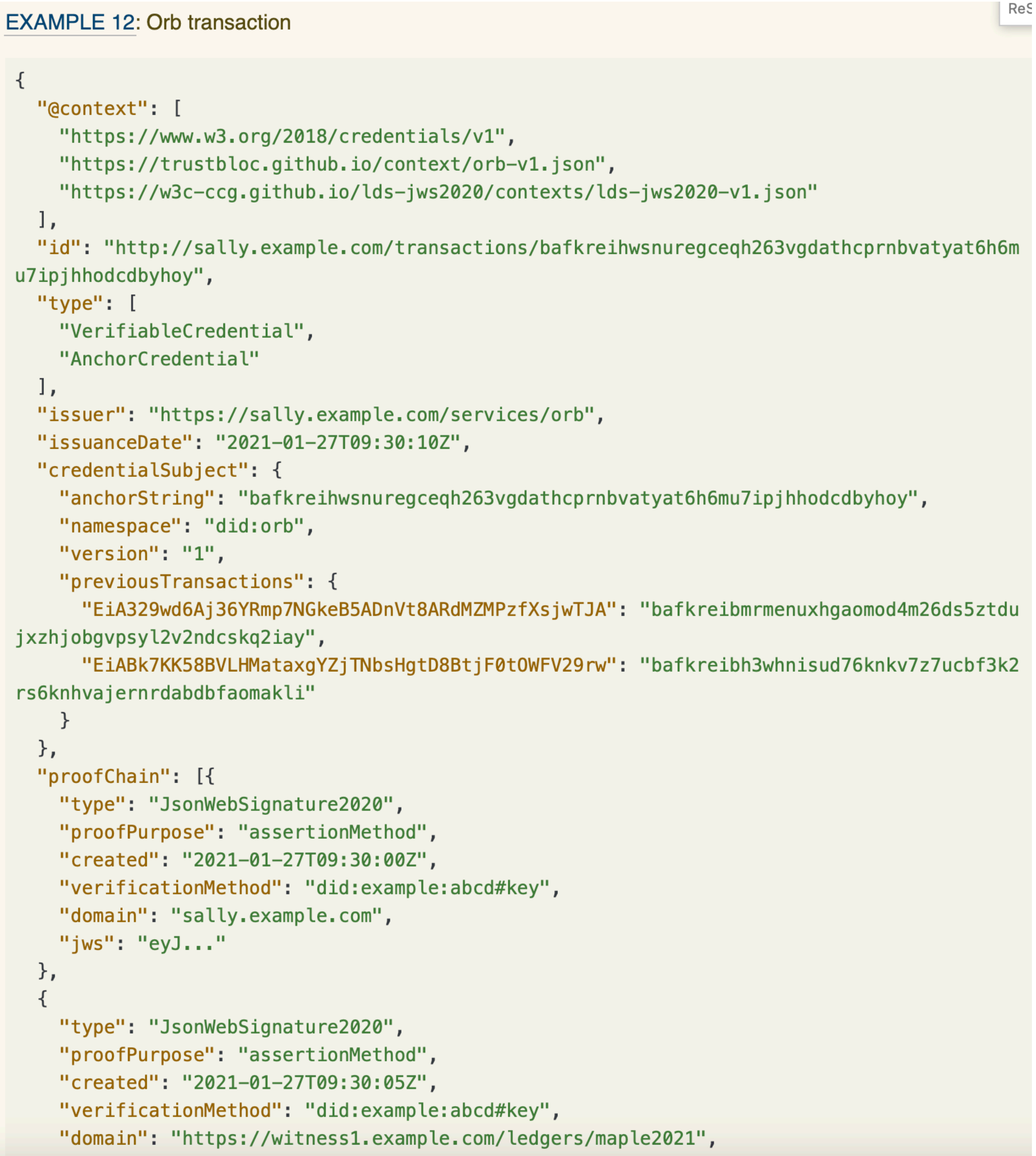
```
did:orb:web:example.com:bafkreiatkubvbkdidscmqynkyls3iqawdqvthi7e6mbky2amuw3inxsi3y:EiDyOQ
bbZAa3aiRzeCkV7LOx3SERjjH93EXoIM3UoN4oWg
```

EXAMPLE 2: An Orb DID that uses the IPFS scheme for content discovery

```
did:orb:ipfs:bafkreiatkubvbkdidscmqynkyls3iqawdqvthi7e6mbky2amuw3inxsi3y:EiDyOQbbZAa3aiRze
CkV7LOx3SERjjH93EXoIM3UoN4oWg
```

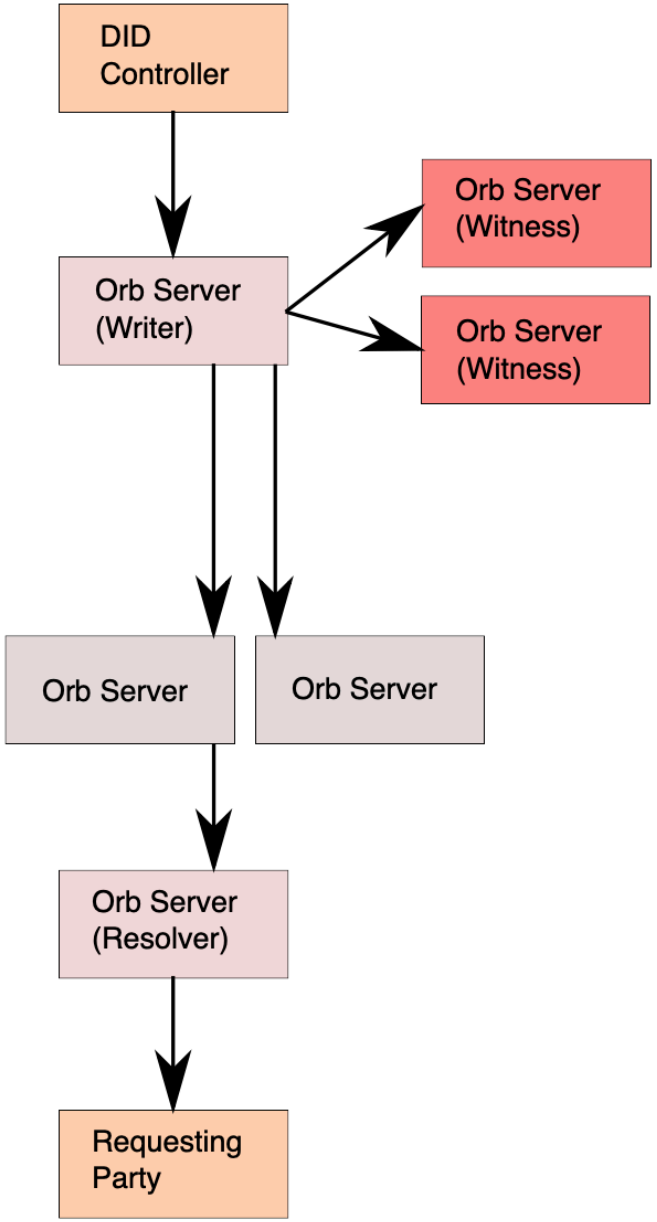
Orb Network Topology





EXAMPLE 12: Orb transaction

```
{
  "@context": [
    "https://www.w3.org/2018/credentials/v1",
    "https://trustbloc.github.io/context/orb-v1.json",
    "https://w3c-ccg.github.io/lds-jws2020/contexts/lds-jws2020-v1.json"
  ],
  "id": "http://sally.example.com/transactions/bafkreihwsnuregceqh263vgdathcprnbvatyat6h6mu7ipjhhodcdbyhoy",
  "type": [
    "VerifiableCredential",
    "AnchorCredential"
  ],
  "issuer": "https://sally.example.com/services/orb",
  "issuanceDate": "2021-01-27T09:30:10Z",
  "credentialSubject": {
    "anchorString": "bafkreihwsnuregceqh263vgdathcprnbvatyat6h6mu7ipjhhodcdbyhoy",
    "namespace": "did:orb",
    "version": "1",
    "previousTransactions": {
      "EiA329wd6Aj36YRmp7NGkeB5ADnVt8ARdMZMPzfXsjwTJA": "bafkreibmrmenuxhgaomod4m26ds5ztdujxzhjobgvpsyl2v2ndcskq2iay",
      "EiABk7KK58BVLHMataxgYZjTNbsHgtD8BtjF0tOWFV29rw": "bafkreibh3whnisud76knkv7z7ucbf3k2rs6knhvajernrdabdbfaomakli"
    }
  },
  "proofChain": [{
    "type": "JsonWebSignature2020",
    "proofPurpose": "assertionMethod",
    "created": "2021-01-27T09:30:00Z",
    "verificationMethod": "did:example:abcd#key",
    "domain": "sally.example.com",
    "jws": "eyJ..."
  },
  {
    "type": "JsonWebSignature2020",
    "proofPurpose": "assertionMethod",
    "created": "2021-01-27T09:30:05Z",
    "verificationMethod": "did:example:abcd#key",
    "domain": "https://witness1.example.com/ledgers/maple2021",
```



1. Submit Operation

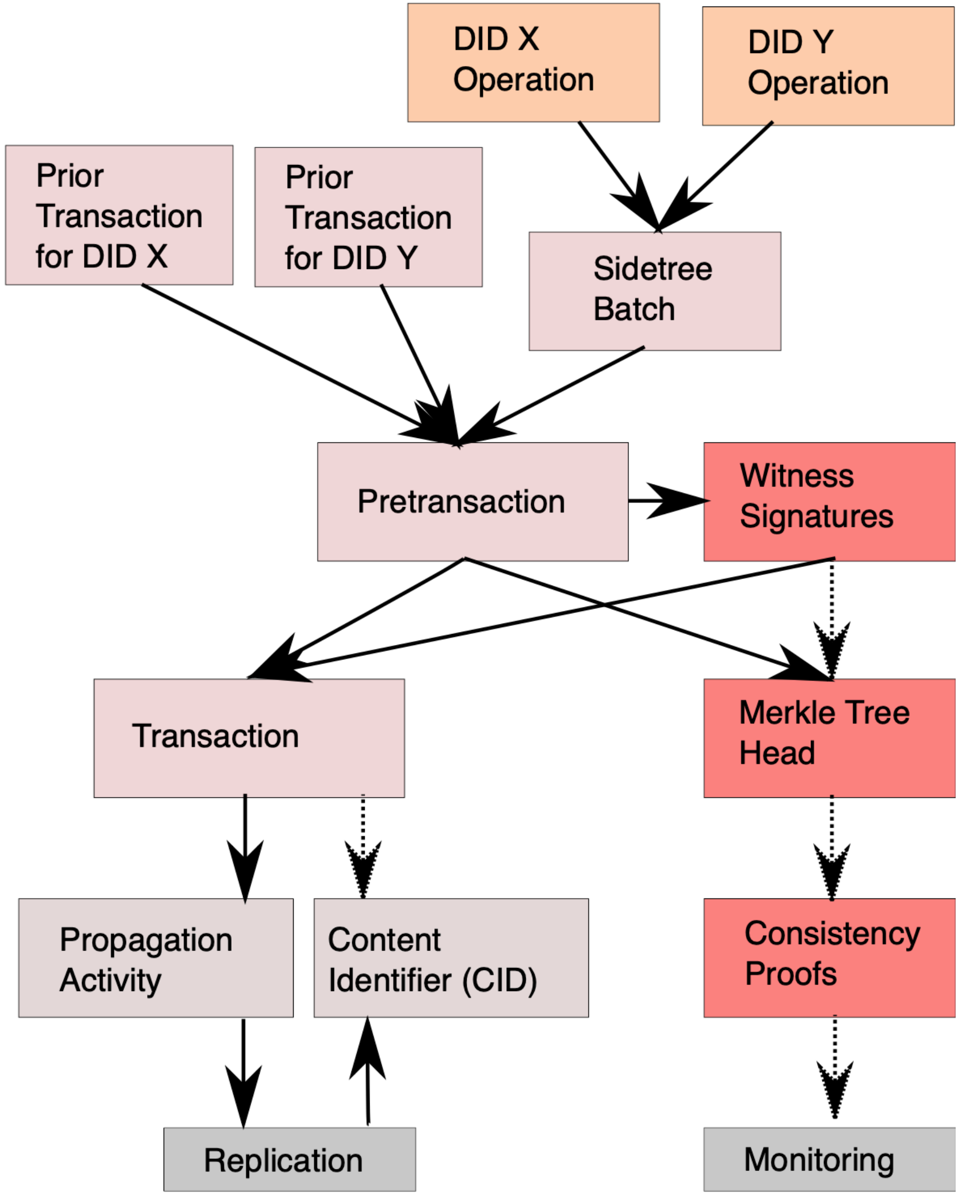
2. Batch operations

3. Preannounce Transaction to Witnesses

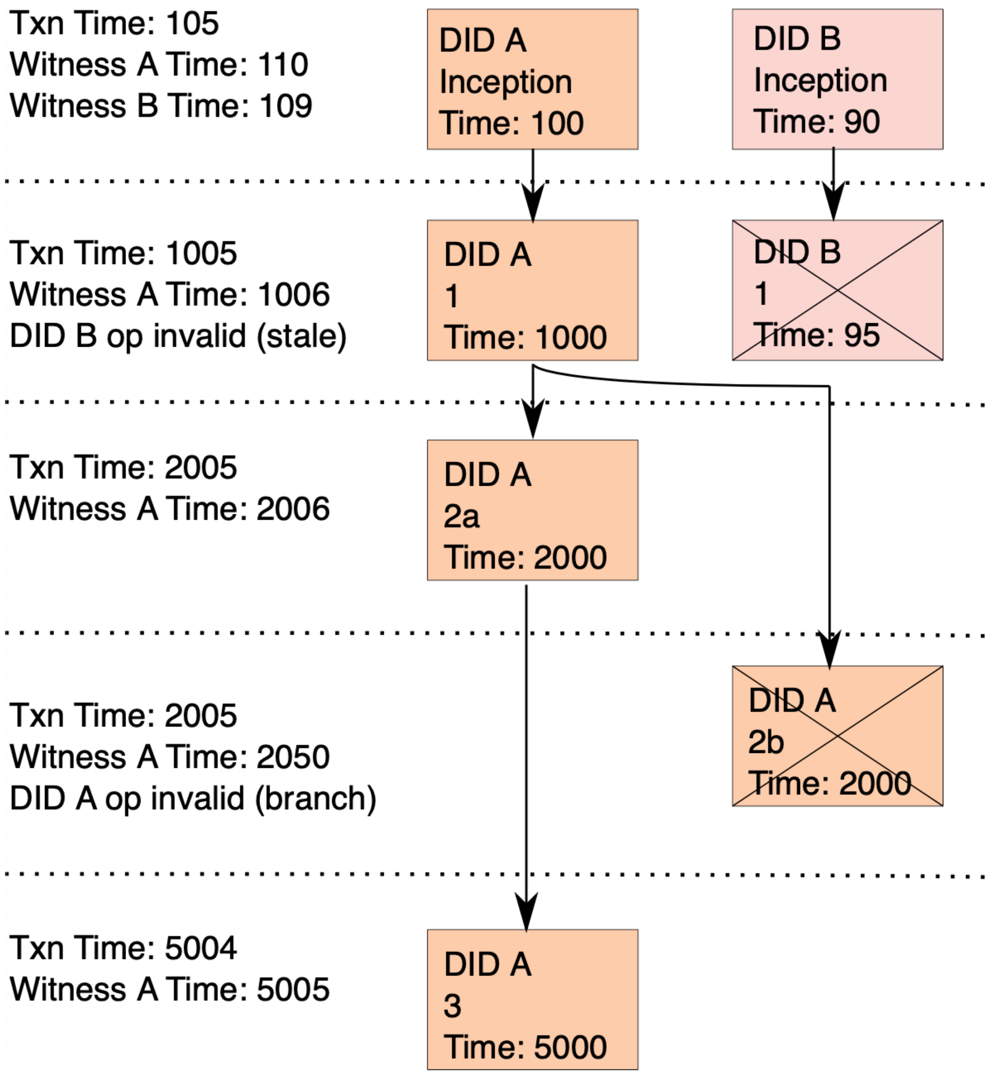
4. Propagate Transaction to Followers

5. Propagate Transaction to Followers

6. Resolve DID


DID X Operation
DID Y Operation
Prior Transaction for DID X
Prior Transaction for DID Y
Sidetree Batch
Pretransaction
Witness Signatures
Transaction
Merkle Tree Head
Propagation Activity
Content Identifier (CID)
Consistency Proofs
Replication
Monitoring

Late Publishing



Txn Time: 105
Witness A Time: 110
Witness B Time: 109

DID A
Inception
Time: 100

DID B
Inception
Time: 90

Txn Time: 1005
Witness A Time: 1006
DID B op invalid (stale)

DID A
1
Time: 1000

DID B
1
Time: 95

Txn Time: 2005
Witness A Time: 2006

DID A
2a
Time: 2000

Txn Time: 2005
Witness A Time: 2050
DID A op invalid (branch)

DID A
2b
Time: 2000

Txn Time: 5004
Witness A Time: 5005

DID A
3
Time: 5000