Develop your First Smart Contract with Hyperledger Composer

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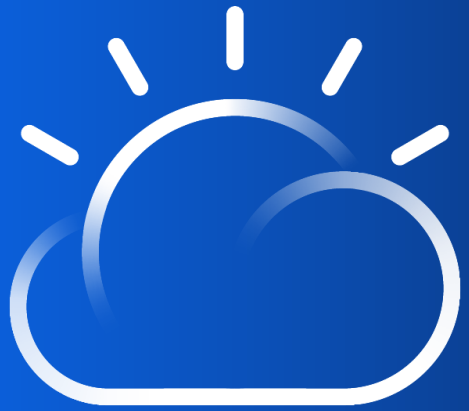


IBM Cloud

Hyperledger Fabric Architecture

Hyperledger Fabric Technical Deep Dive

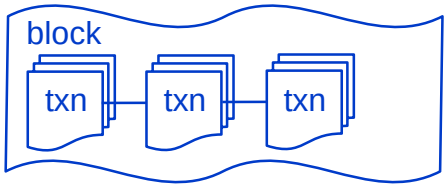
Hyperledger Fabric
Architecture

Hyperledger Fabric
Technical Deep Dive

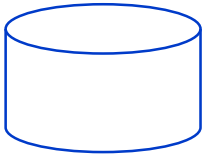
Components in a blockchain solution

Ledger	A ledger is a channel's chain and current state data which is maintained by each peer on the channel.
Smart Contract	Software running on a ledger, to encode assets and the transaction instructions (business logic) for modifying the assets.
Peer Network	A broader term overarching the entire transactional flow, which serves to generate an agreement on the order and to confirm the correctness of the set of transactions constituting a block.
Membership	Membership Services authenticates, authorizes, and manages identities on a permissioned blockchain network.
Events	Creates notifications of significant operations on the blockchain (e.g. a new block), as well as notifications related to smart contracts.
Systems Management	Provides the ability to create, change and monitor blockchain components
Wallet	Securely manages a user's security credentials
Systems Integration	Responsible for integrating Blockchain bi-directionally with external systems. Not part of blockchain, but used with it.

A ledger often consists of two data structures



Blockchain

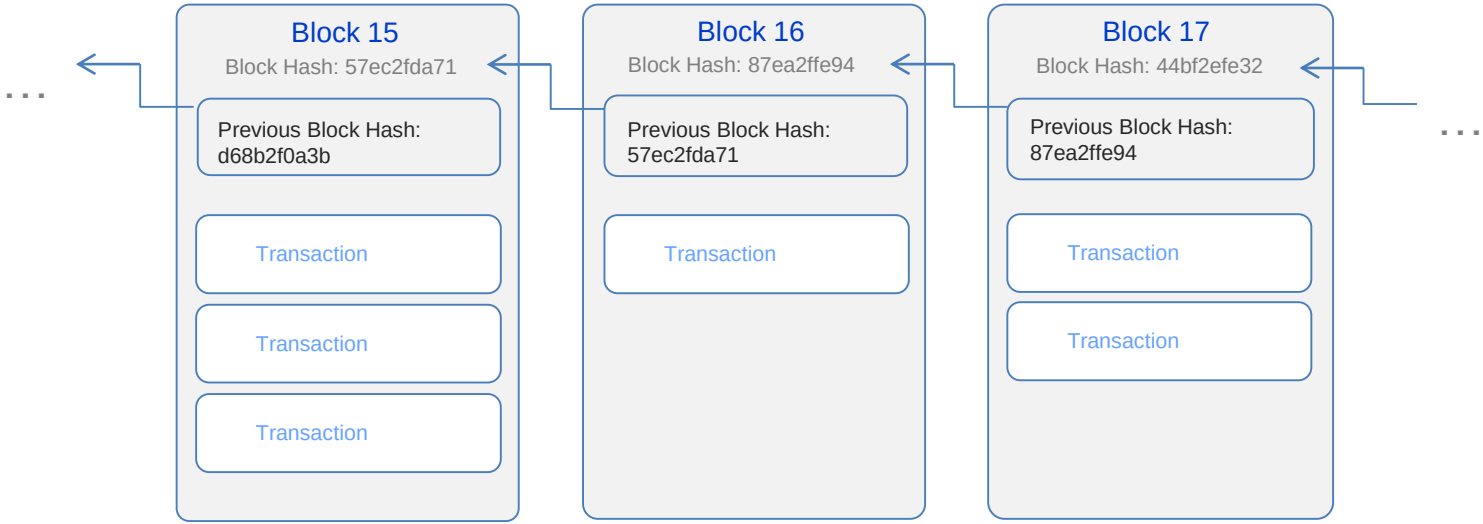


World state

- Blockchain
  - A linked list of blocks
  - Each block describes a set of transactions (e.g. the inputs to a smart contract invocation)
  - Immutable – blocks cannot be tampered

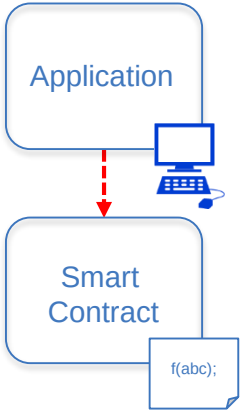
- World State
  - An ordinary database (e.g. key/value store)
  - Stores the combined outputs of all transactions
  - Not usually immutable

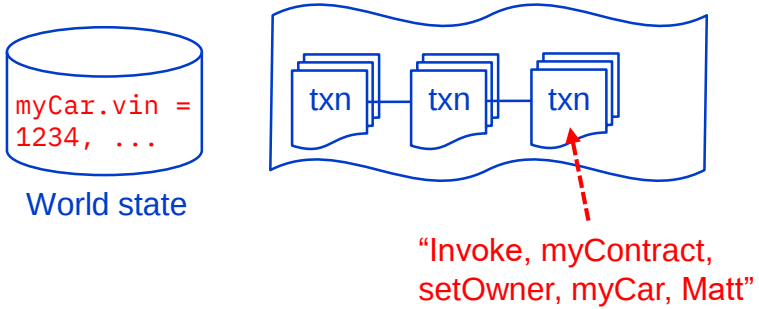
Block detail (simplified)



- A blockchain is made up of a series of blocks with new blocks always added to the end
- Each block contains zero or more transactions and some additional metadata
- Blocks achieve immutability by including the result of a hash function of the previous block
- The first block is known as the “genesis” block

Working with the ledger example: a change of ownership transaction





Transaction input - sent from application

```
invoke(myContract, setOwner,
        myCar, Matt)
…
```

Smart contract implementation

```
setOwner(Car, newOwner) {
   set Car.owner = newOwner
}
```

World state: new contents

```
myCar.vin = 1234
myCar.owner = Matt
myCar.make = Audi
…
```

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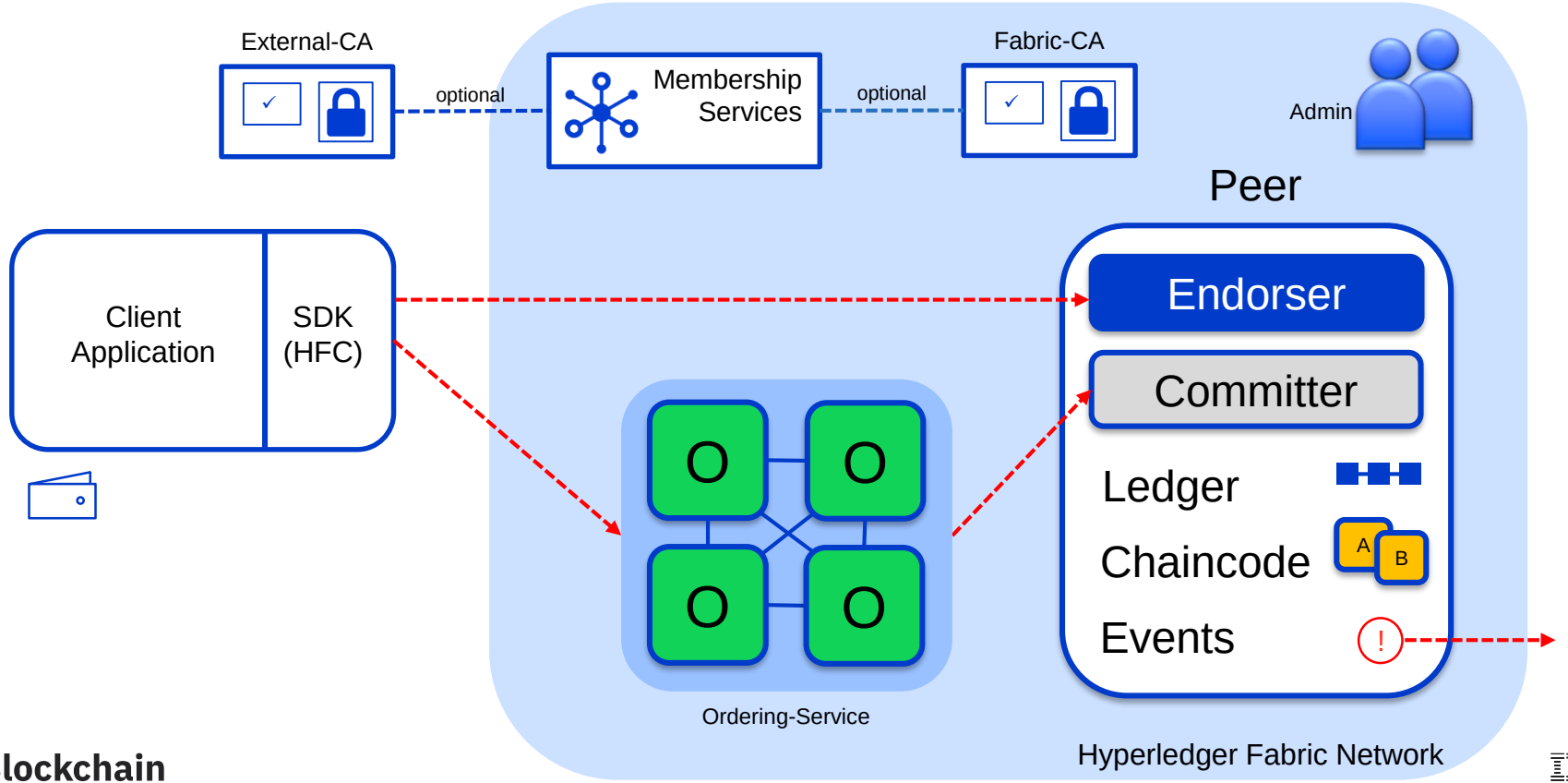
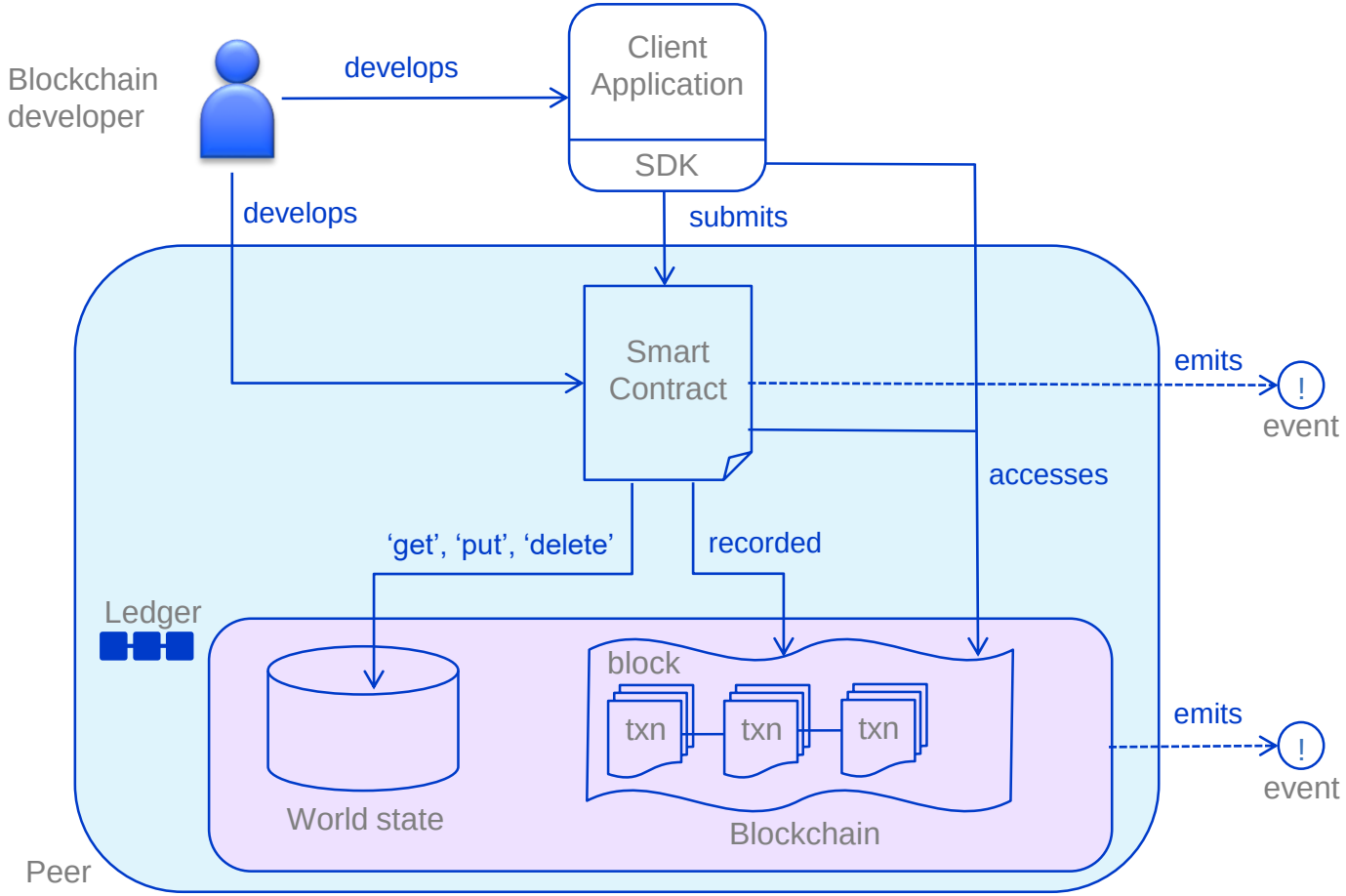
Hyperledger Fabric V1 Architecture

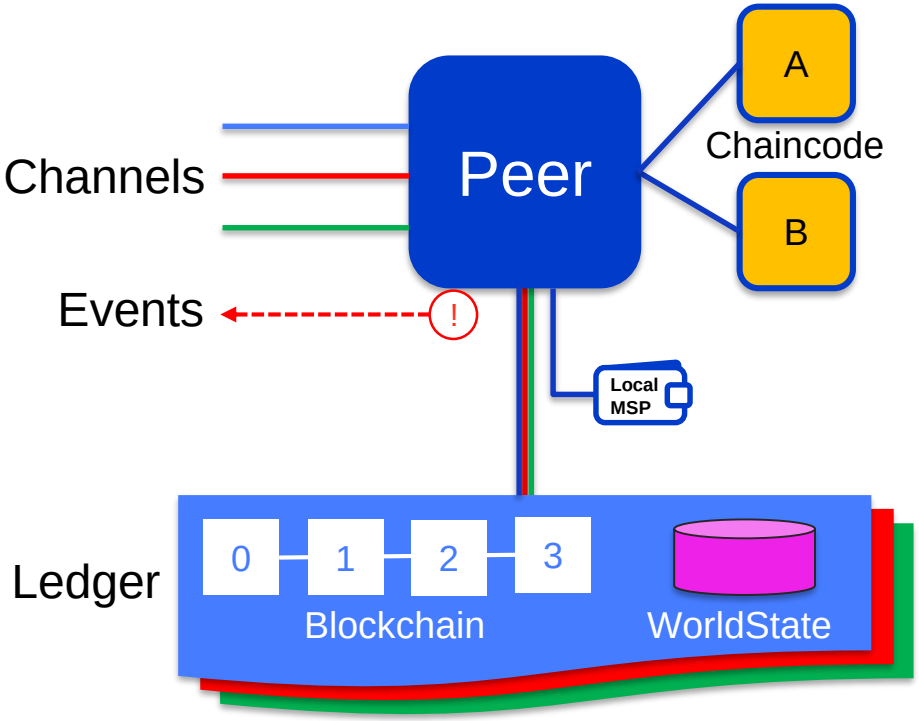


How applications interact with the ledger



Fabric Peer

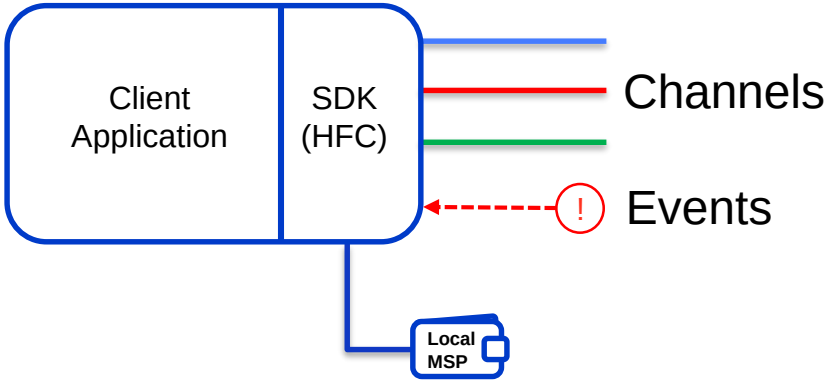
- Each peer:
  - Connects to one or more channels
  - Maintains one or more ledgers per channel
  - Maintains installed chaincode
  - Manages runtime docker containers for instantiated chaincode
    - Chaincode is instantiated on a channel
    - Runtime docker container shared by channels with same chaincode instantiated (no state stored in container)
  - Has a local MSP (Membership Services Provider) that provides crypto material
  - Emits events to the client application



Client Application

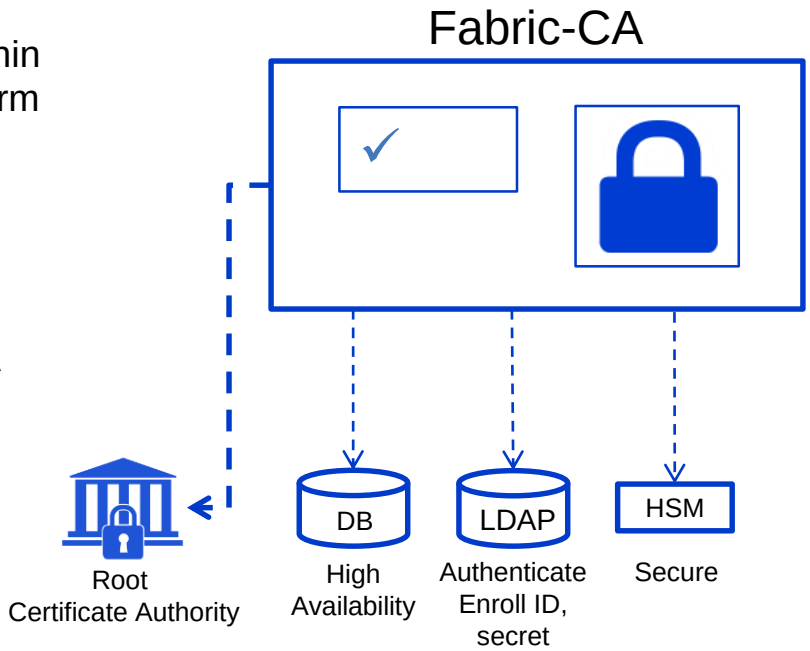
- Each client application uses Fabric SDK to:
  - Connects over channels to one or more peers
  - Connects over channels to one or more orderer nodes
  - Receives events from peers
  - Local MSP provides client crypto material

  - Client can be written in different languages (Node.js, Go, Java, Python?)

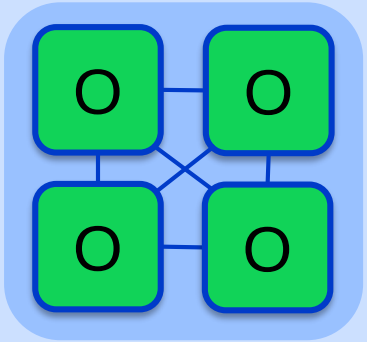


Fabric-CA

- Default (optional) Certificate Authority within Fabric network for issuing Ecerts (long-term identity)
- Supports clustering for HA characteristics
- Supports LDAP for user authentication
- Supports HSM for security
- Can be configured as an intermediate CA



Bootstrap Network (1/6) - Configure & Start Ordering Service



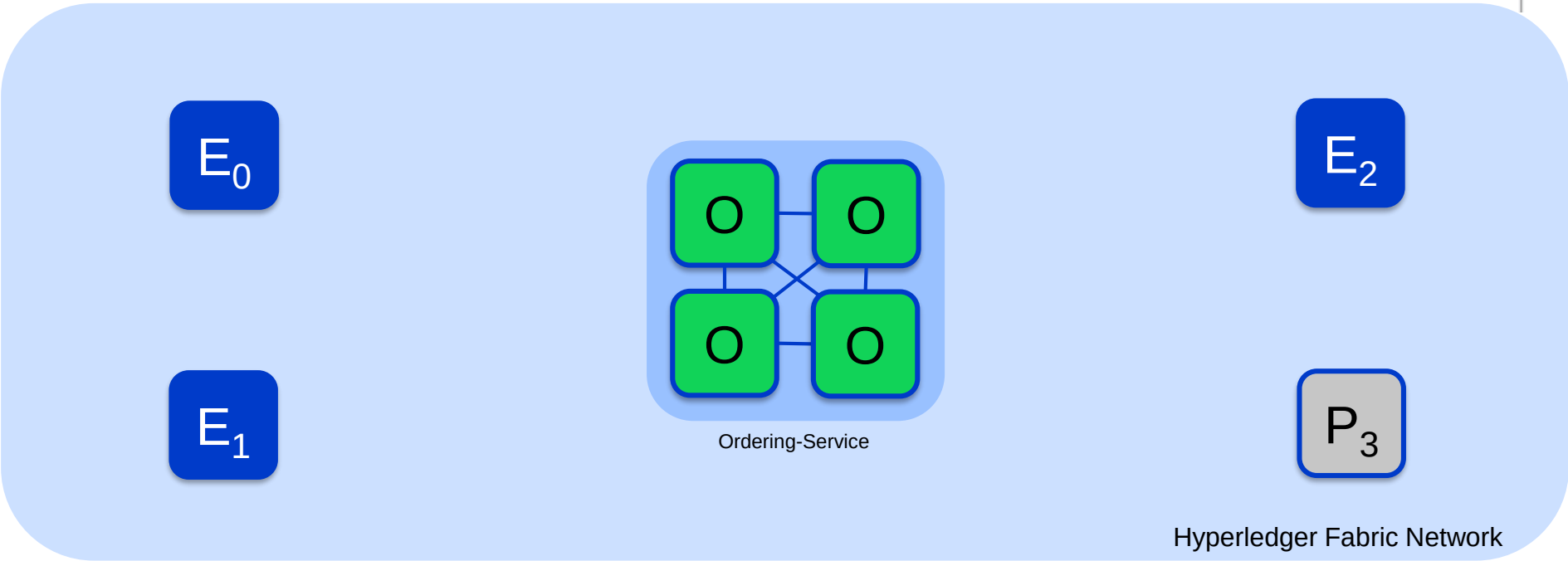
Ordering-Service

Hyperledger Fabric Network

An Ordering Service is configured and started for the network:

$ docker-compose [-f orderer.yml] ...

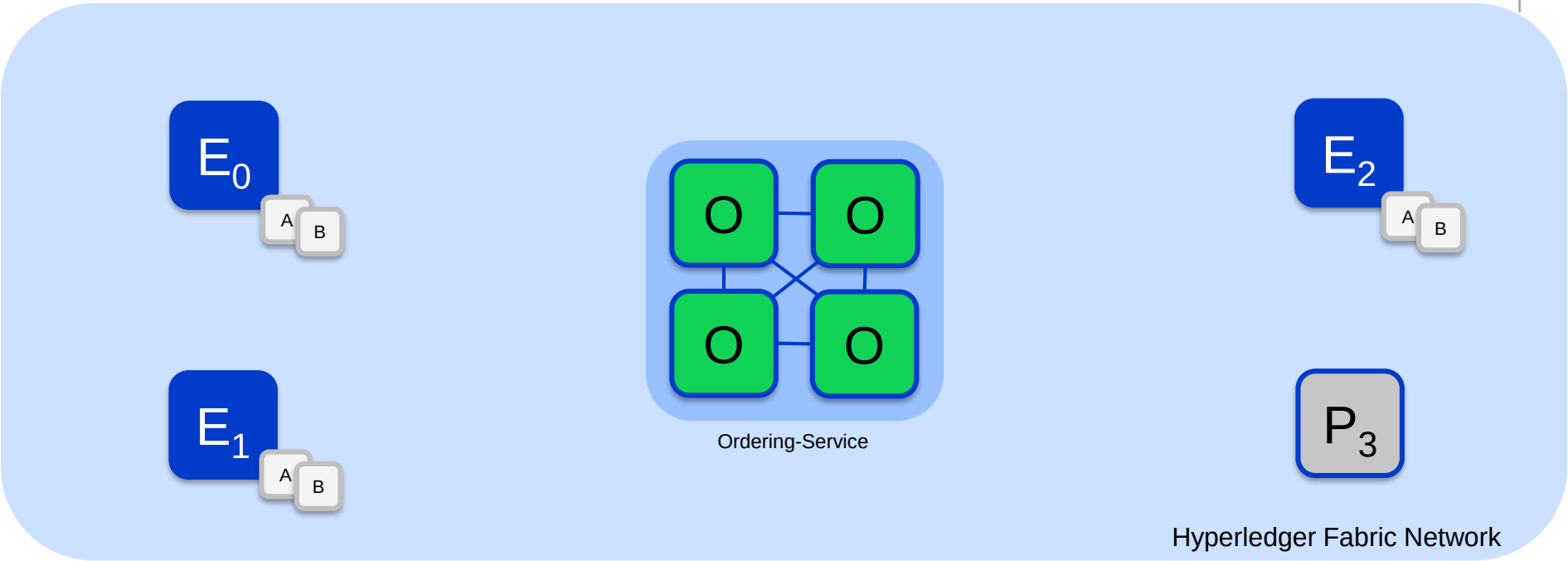
Bootstrap Network (2/6) - Configure and Start Peer Nodes



A peer is configured and started for each Endorser or Committer in the network:

$ peer node start ...

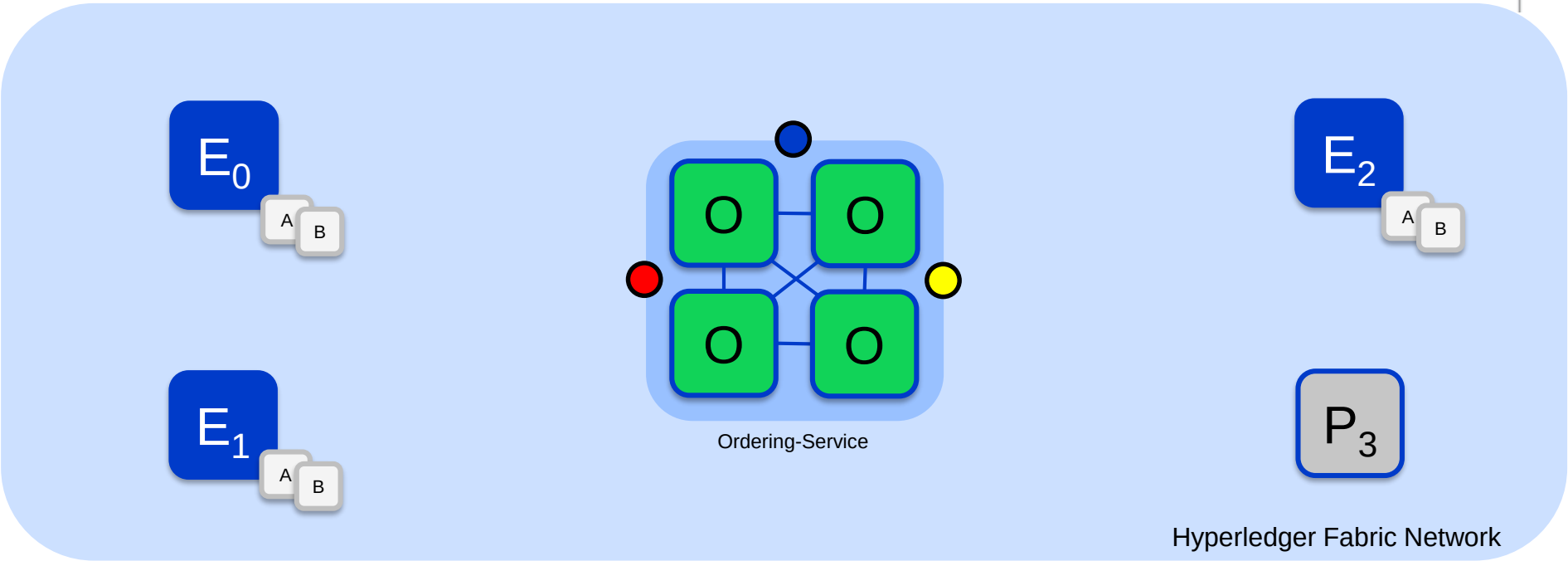
Bootstrap Network (3/6) - Install Chaincode



Chaincode is installed onto each Endorsing Peer that needs to execute it:

$ peer chaincode install ...

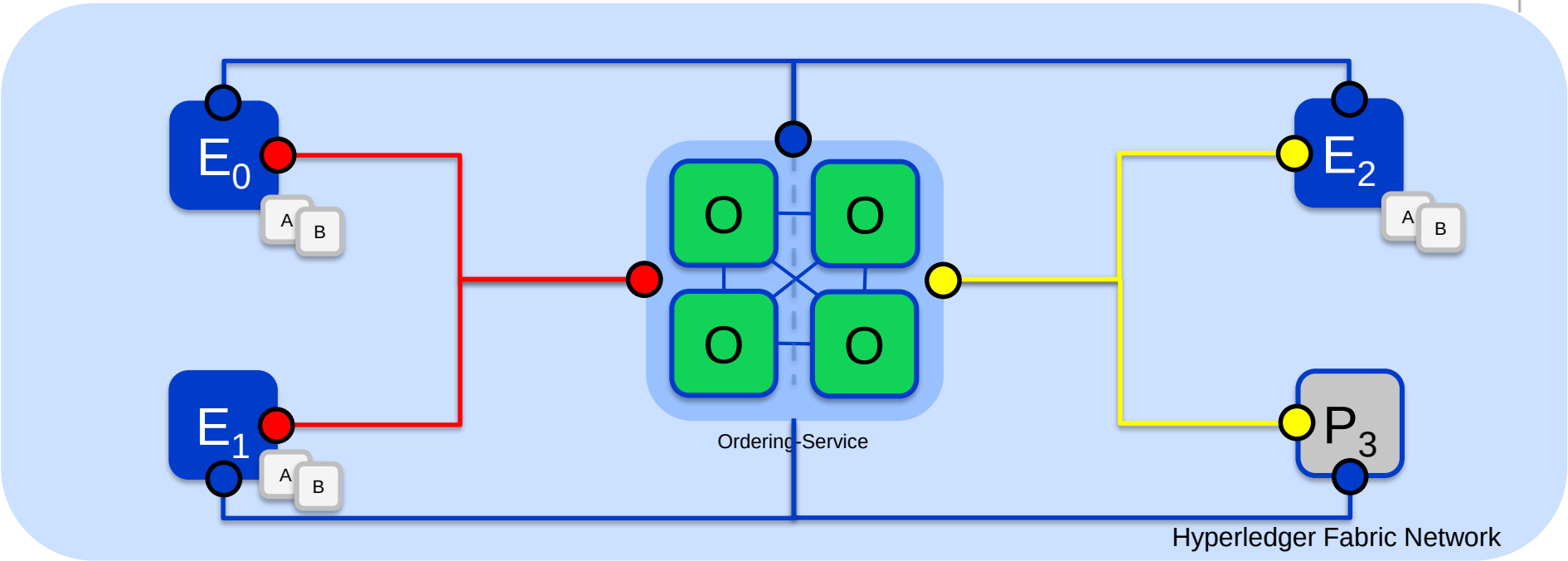
Bootstrap Network (4/6) – Create Channels



Channels are created on the ordering service:

$ peer channel create –o [orderer] ...

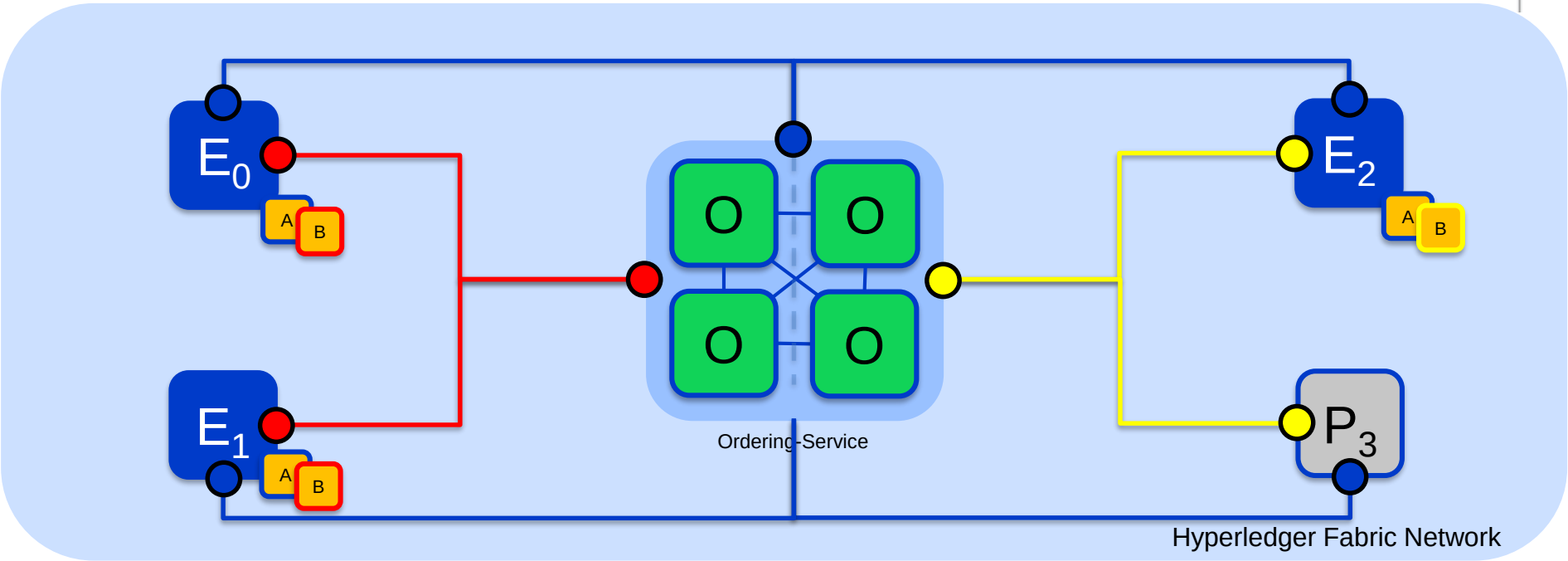
Bootstrap Network (5/6) – Join Channels



Peers that are permissioned can then join the channels they want to transact on:

$ peer channel join ...

Bootstrap Network (6/6) – Instantiate Chaincode



Peers finally instantiate the Chaincode on the channels they want to transact on:

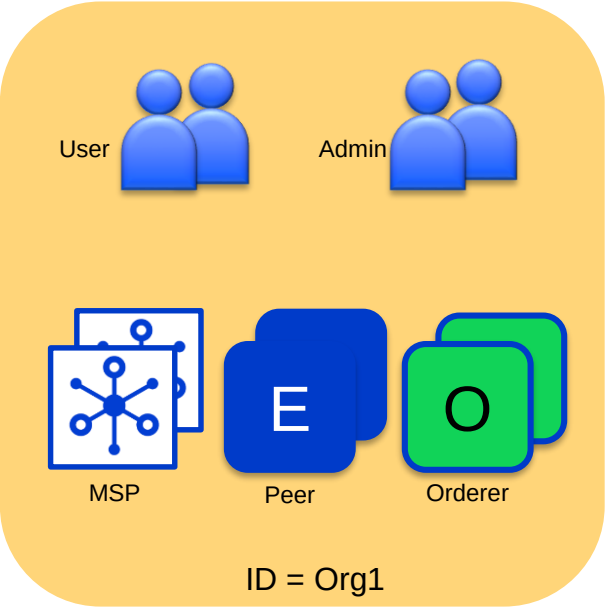
$ peer chaincode instantiate ... –P 'policy'

An Endorsement Policy is specified and once instantiated chaincode can process transactions.

Organizations

Organizations define boundaries within a Fabric Blockchain Network

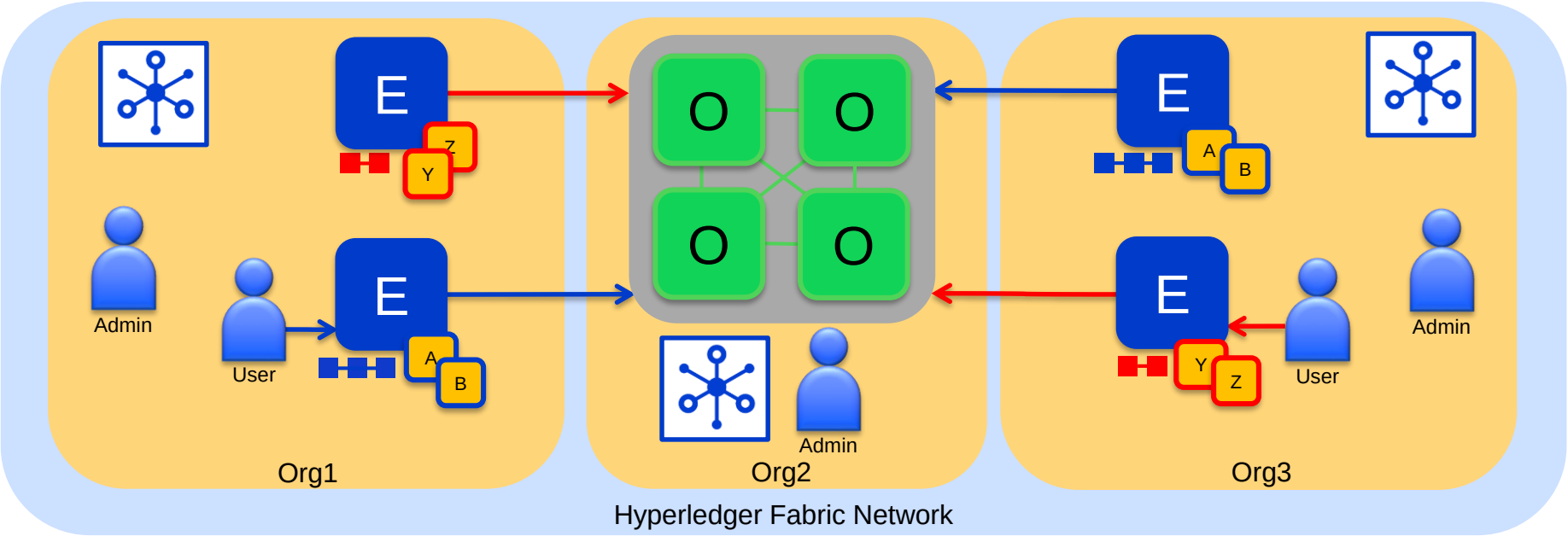
- Each organization defines:
  - Membership Services Provider (MSP) for identities
  - Administrator(s)
  - Users
  - Peers
  - Orderers (optional)
- A network can include many organisations representing a consortium
- Each organization has an ID



Consortium Network

An example consortium network of 3 organisations

- Orgs 1 and 3 run peers
- Org 2 provides the ordering service only



Thank you

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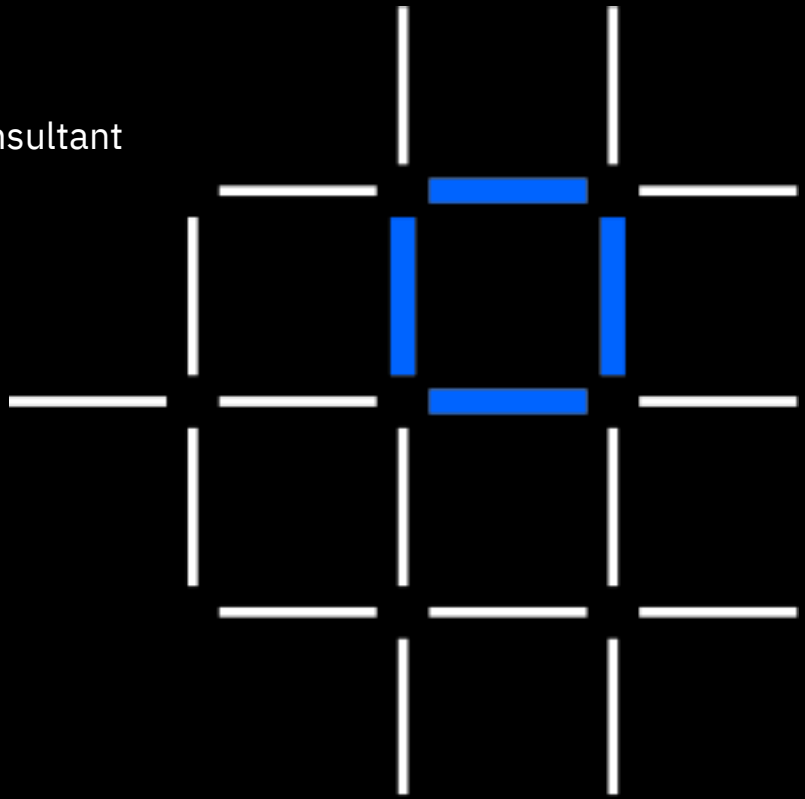

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