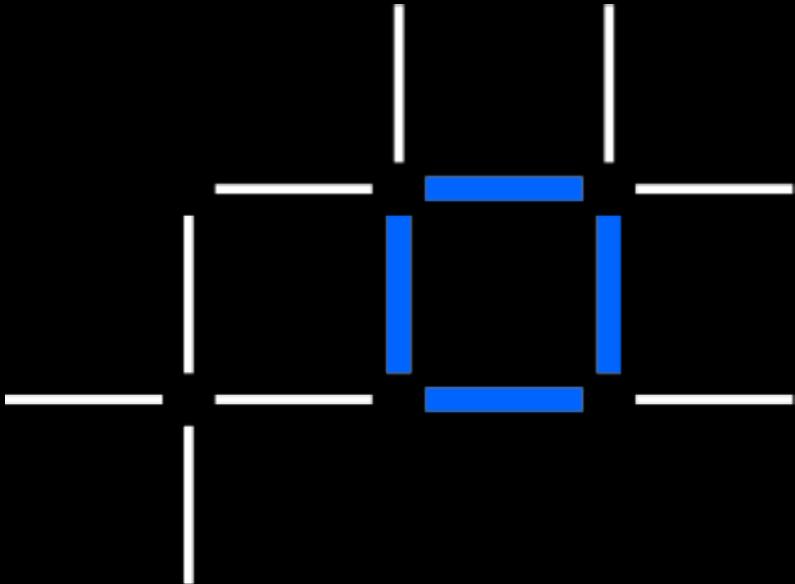


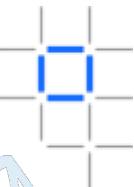
Blockchain Explored, Part 1

Basic components of a Hyperledger Fabric network

*Barry Silliman
IBM Washington Systems Center
silliman@us.ibm.com*



Hyperledger and Linux Foundation



- **Hyperledger is a blockchain for business project under the Linux Foundation organization**

<https://www.hyperledger.org>

A collaborative effort created to advance cross-industry blockchain technologies for business.

- Open source, open standards and open governance model.
- Currently more than 250 members, IBM is a premier member.
- Premier, General and Associate levels of membership

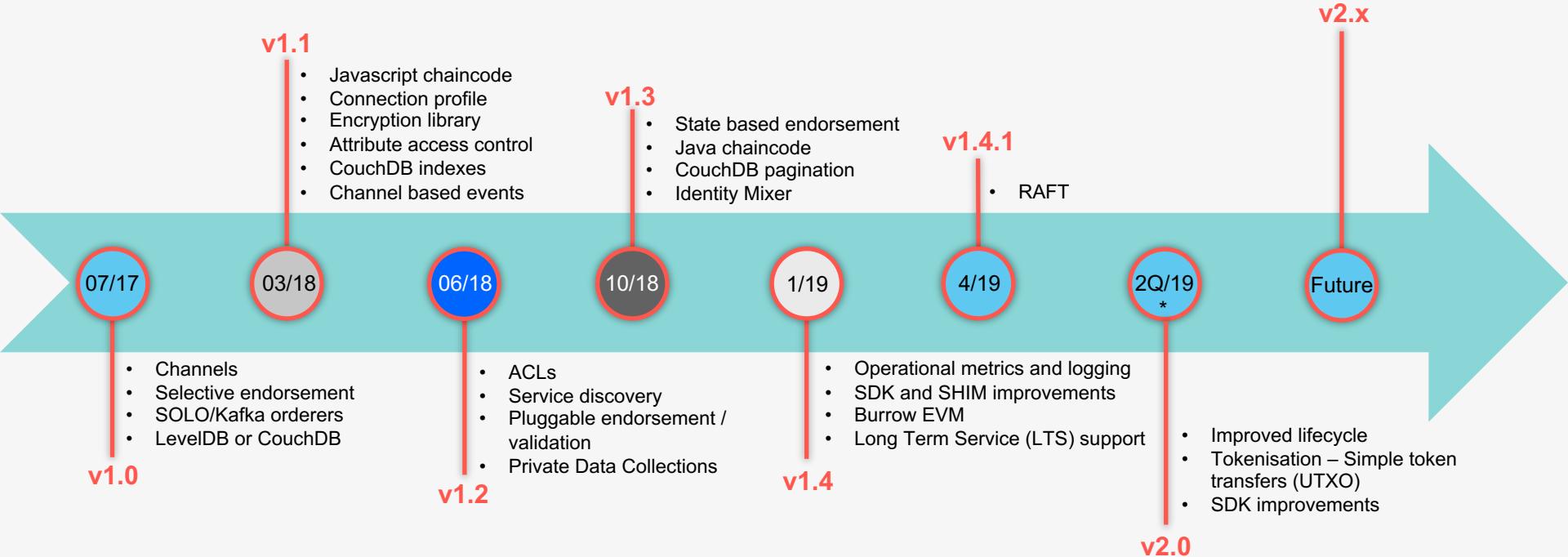
- **Hyperledger contains currently 6 frameworks and 6 tools.**

<https://www.hyperledger.org/projects>

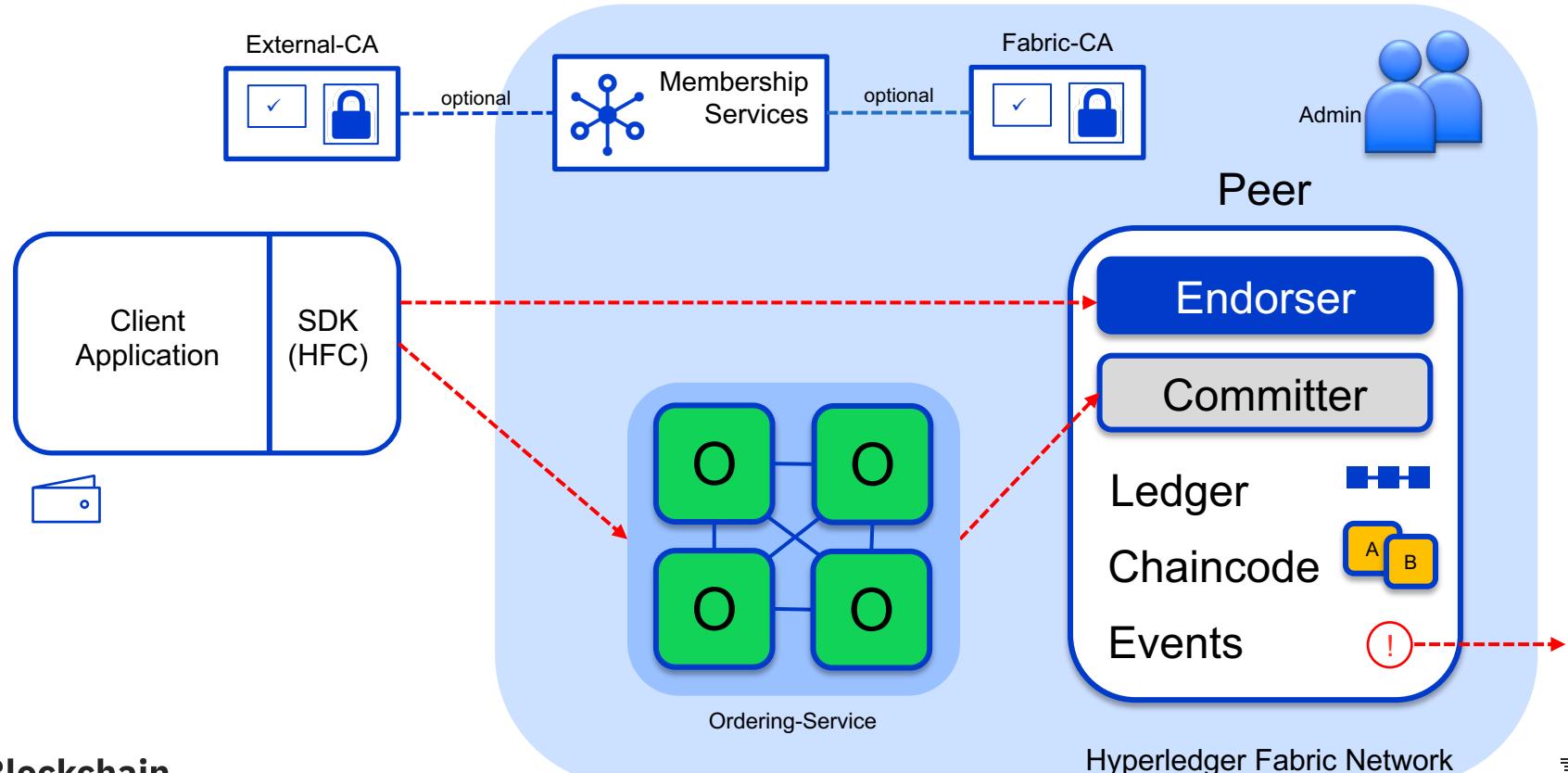
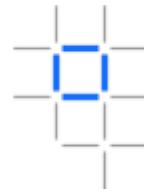
- IBM is supporting especially the development of the framework *Hyperledger Fabric*
- **Hyperledger Fabric**
- V1.x available since July 2017
- Currently over 250 active developers from different organizations.
- Focus is development of ledger, smart contracts, consensus, privacy, scalability and resilience.

<https://www.hyperledger.org/projects/fabric>

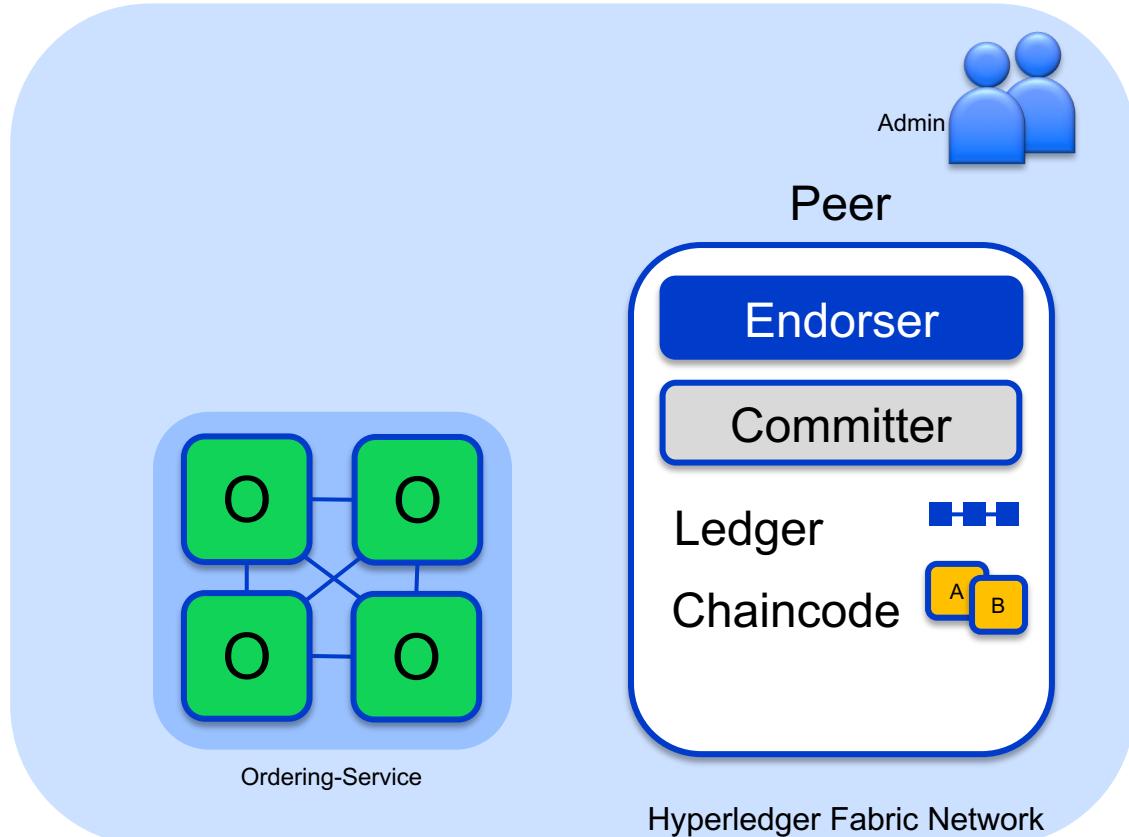
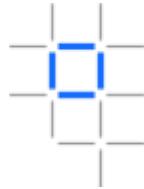
Roadmap



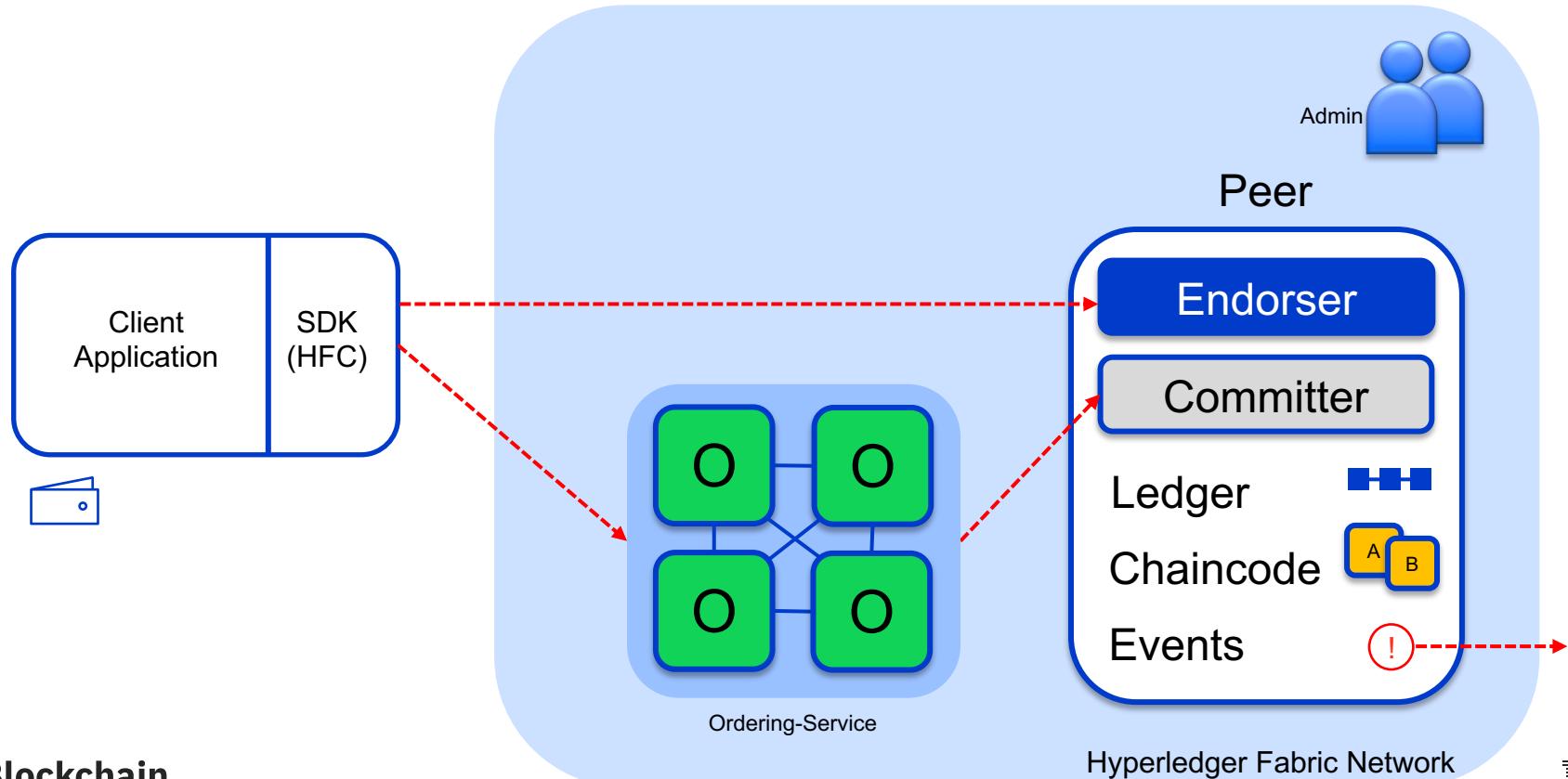
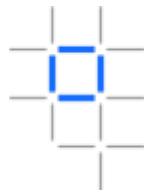
Hyperledger Fabric V1.x Architecture



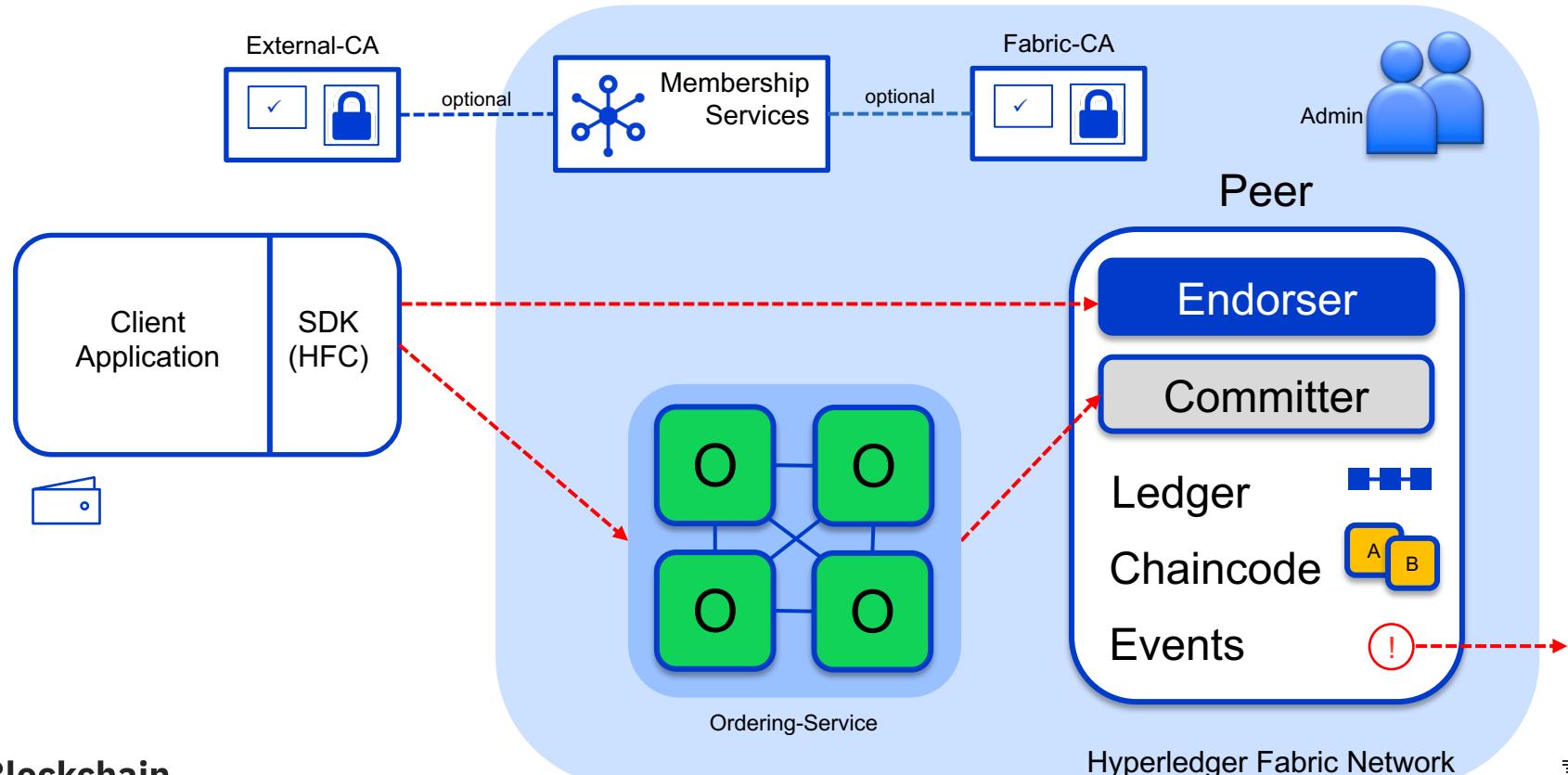
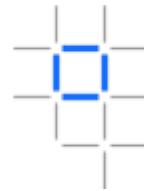
Hyperledger Fabric V1.x Architecture



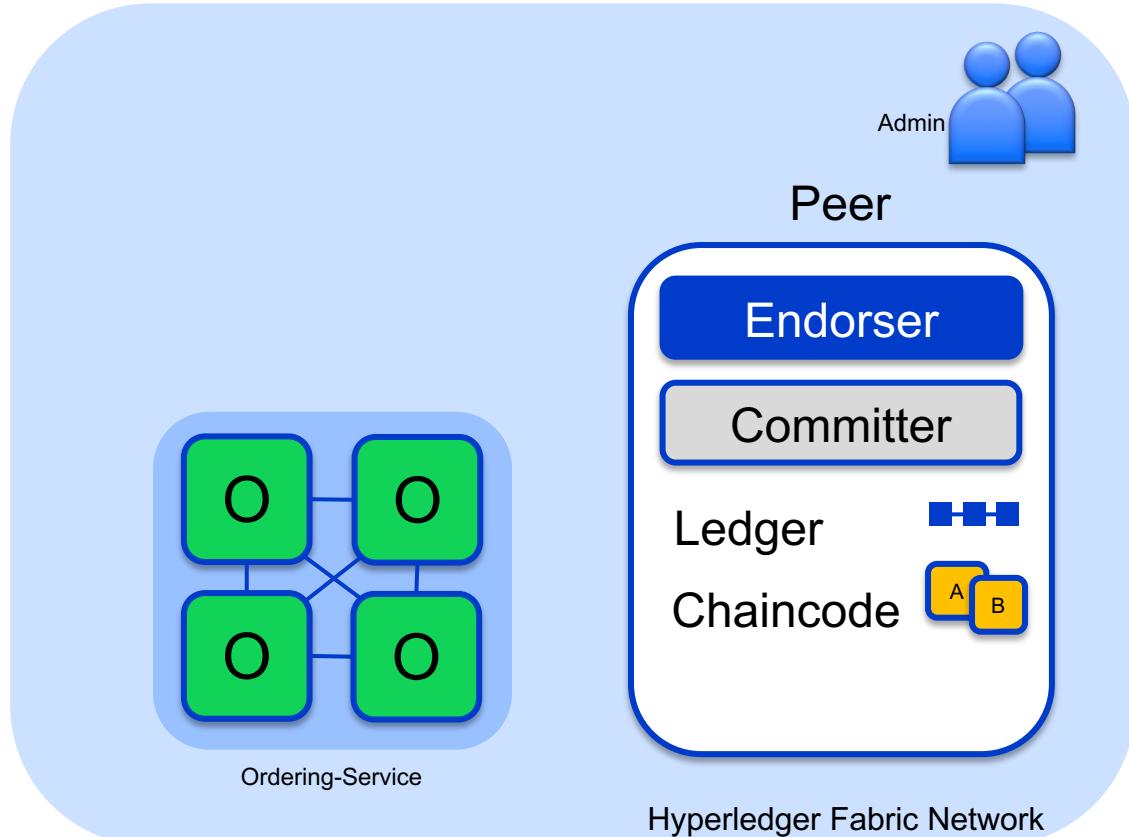
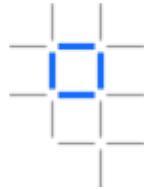
Hyperledger Fabric V1.x Architecture

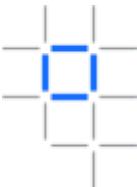


Hyperledger Fabric V1.x Architecture



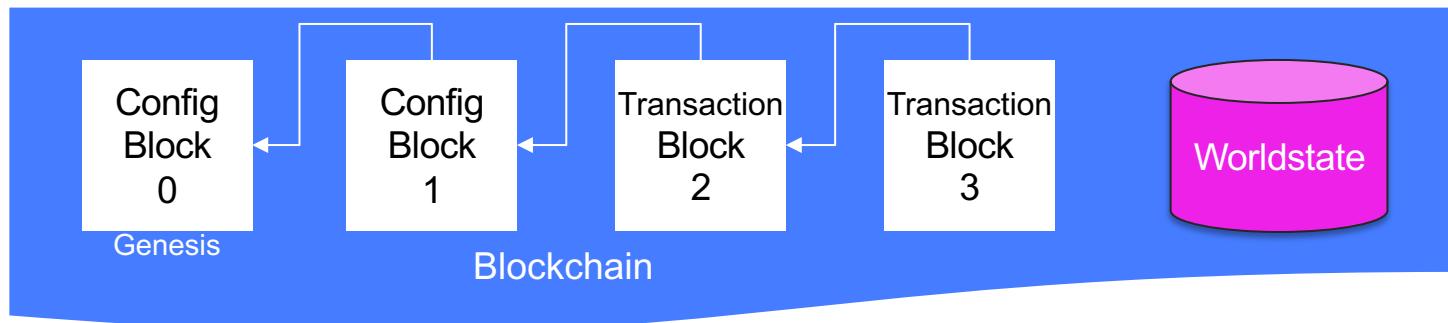
Hyperledger Fabric V1.x Architecture

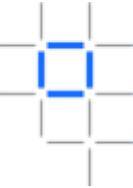




Fabric Ledger

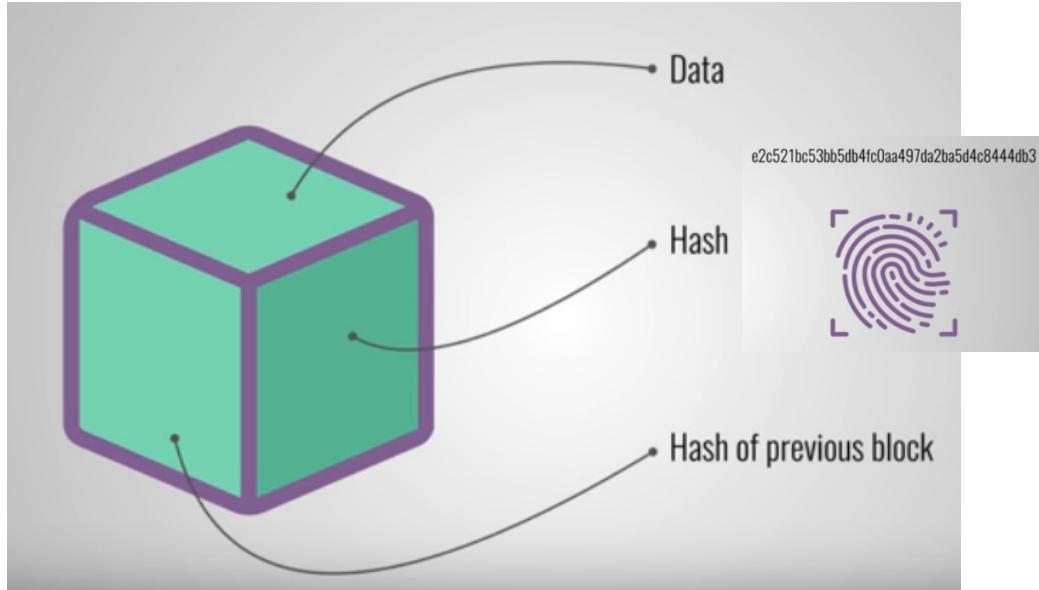
- The Fabric ledger is maintained by each peer and includes the blockchain and worldstate
- A separate ledger is maintained for each channel the peer joins
- Transaction read/write sets are written to the blockchain
- Channel configurations are also written to the blockchain
- The worldstate can be either LevelDB (default) or CouchDB
 - LevelDB is a simple key/value store
 - CouchDB is a document store that allows complex queries
- The Smart Contract decides what is written to the worldstate



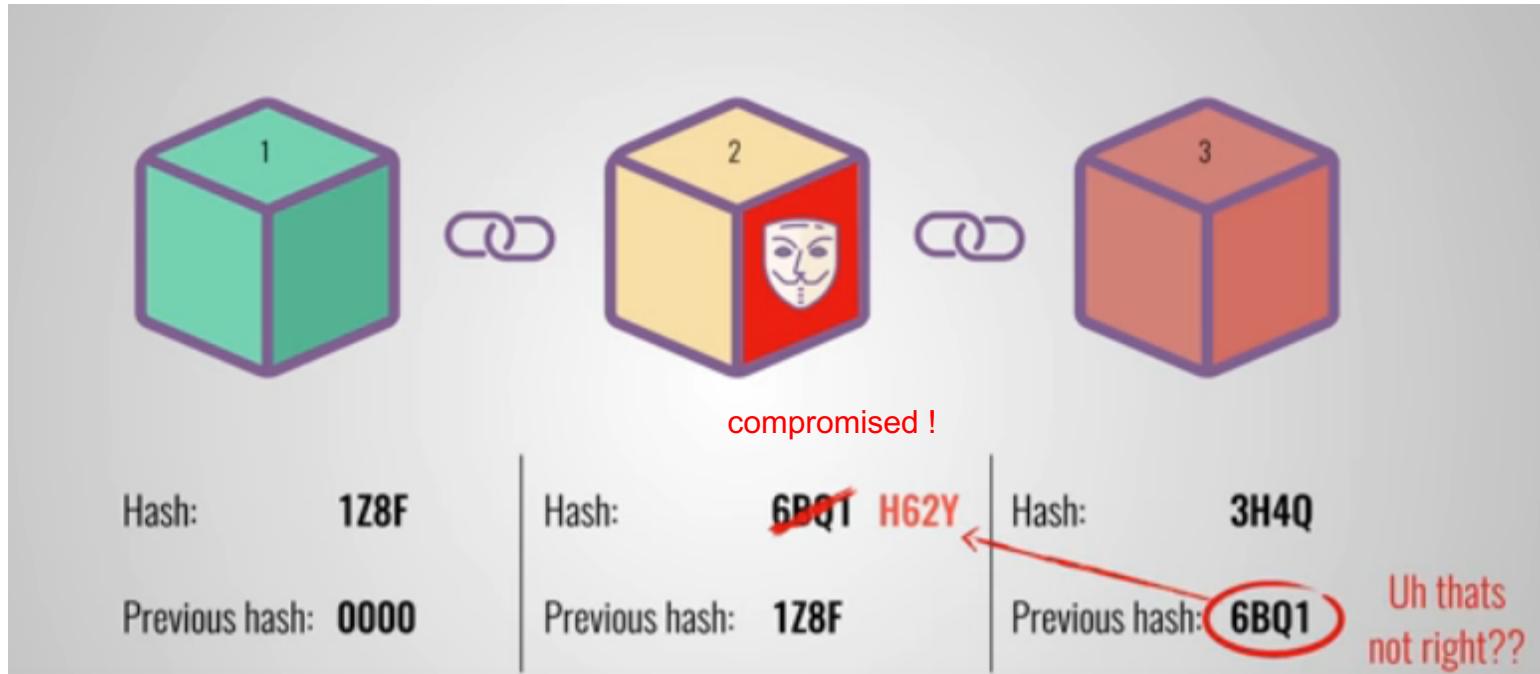
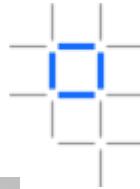


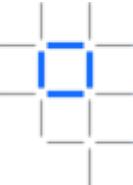
Blocks in the shared ledger

- contain the data to be stored in the blockchain
- the hash of the data
- hash of previous block

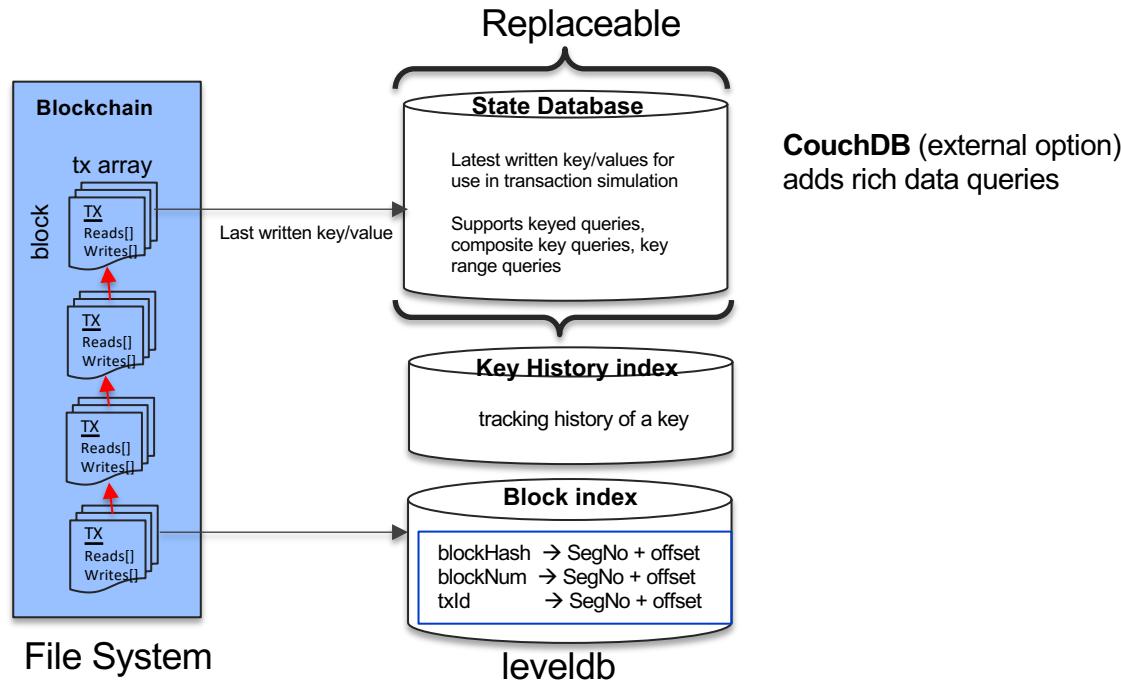


Immutability of blocks

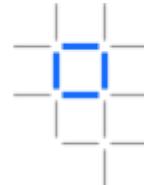




Fabric Ledger

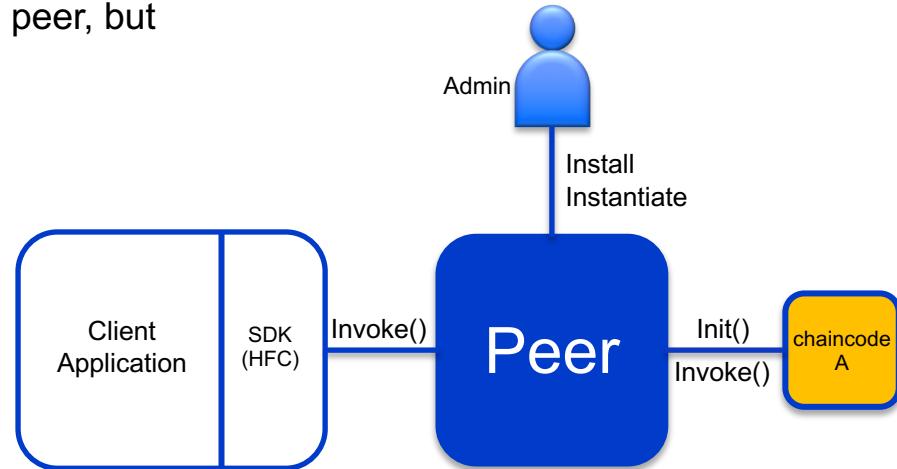


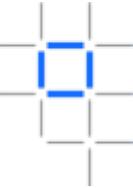
Chaincode



Chaincode (Smart Contract) contains business logic deployed to peers

- Installed on peers and instantiated on channels
- Run in secured docker images separate to the peer
- Interact with the world state through the Fabric shim interface
- Each chaincode has its own scoped world state
- Needs to be present to endorse a transaction from a peer, but does not need to be present to commit transactions
- Language support for:
 - Golang
 - Node.js
 - Java
- Implements:
 - Init() - Called on instantiate and upgrade
 - Invoke() – Called from client application

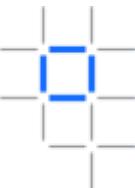




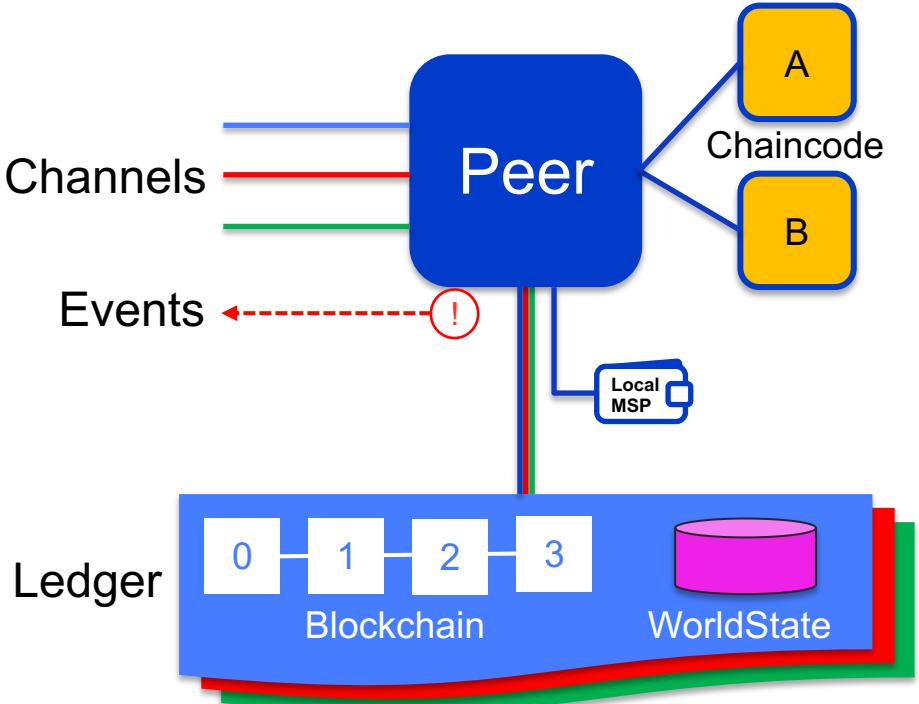
Transaction data flow



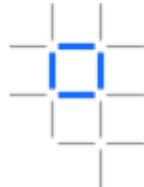
Fabric Peer



- 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

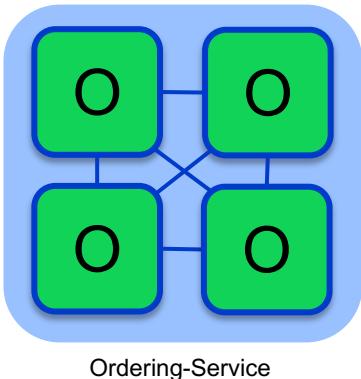


Ordering Service



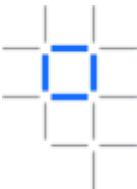
The ordering service packages transactions into blocks to be delivered to peers. Communication with the service is via channels.

Different configuration options for the ordering service include:



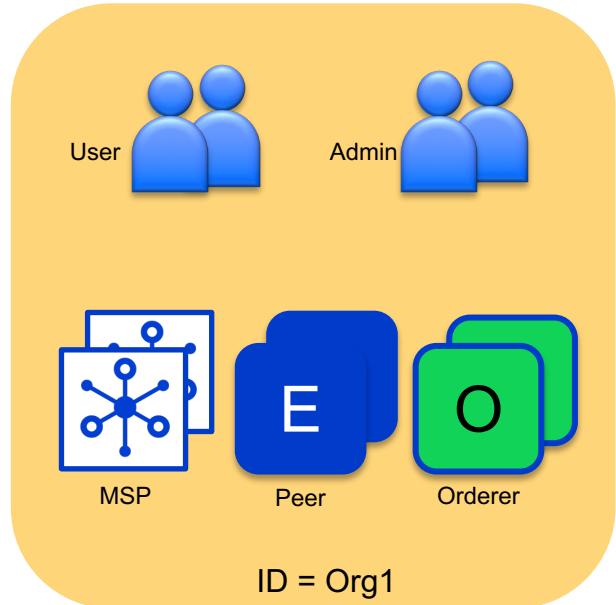
- **SOLO**
 - Single node for development
- **Kafka** : Crash fault tolerant consensus
 - Minimum recommendation: 3 Orderer nodes, 4 Kafka nodes, 3 Zookeeper nodes
- **Raft**: Crash fault tolerant consensus
 - New with Hyperledger Fabric 1.4.1
 - Recommended

Organizations

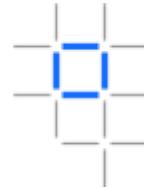


Organizations define boundaries within a Fabric Blockchain Network

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

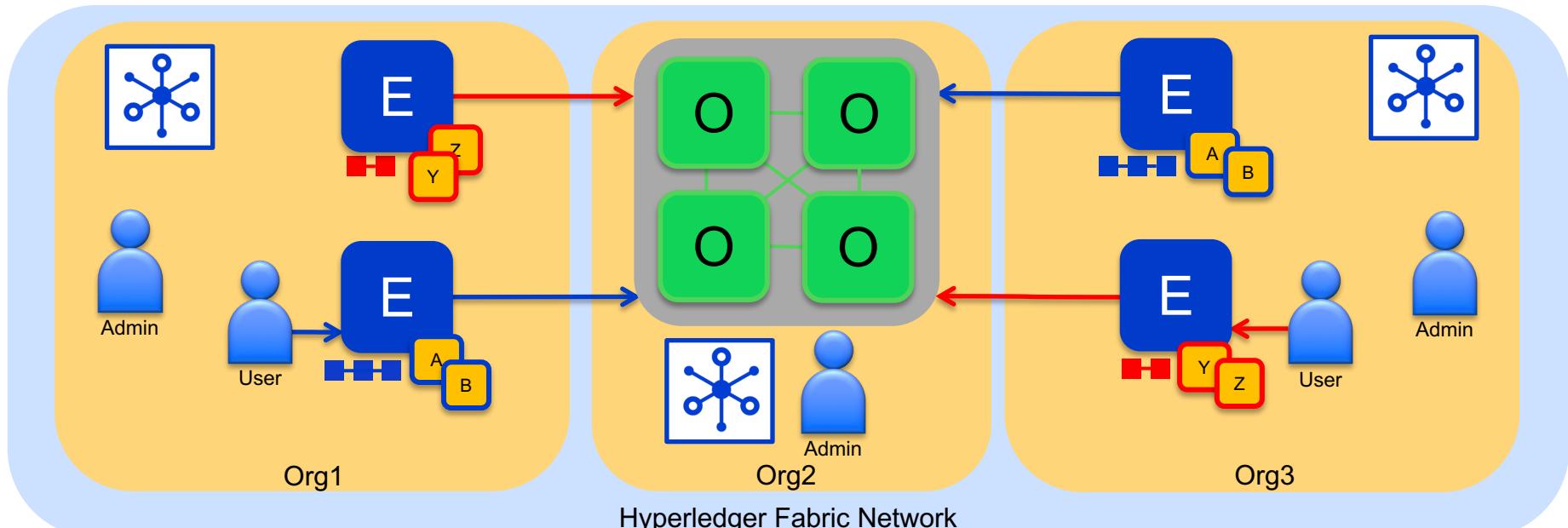


Consortium Network

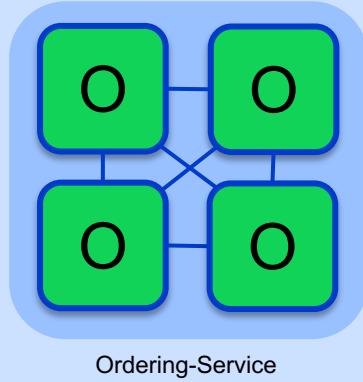
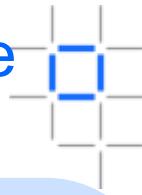


An example consortium network of 3 organizations

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



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

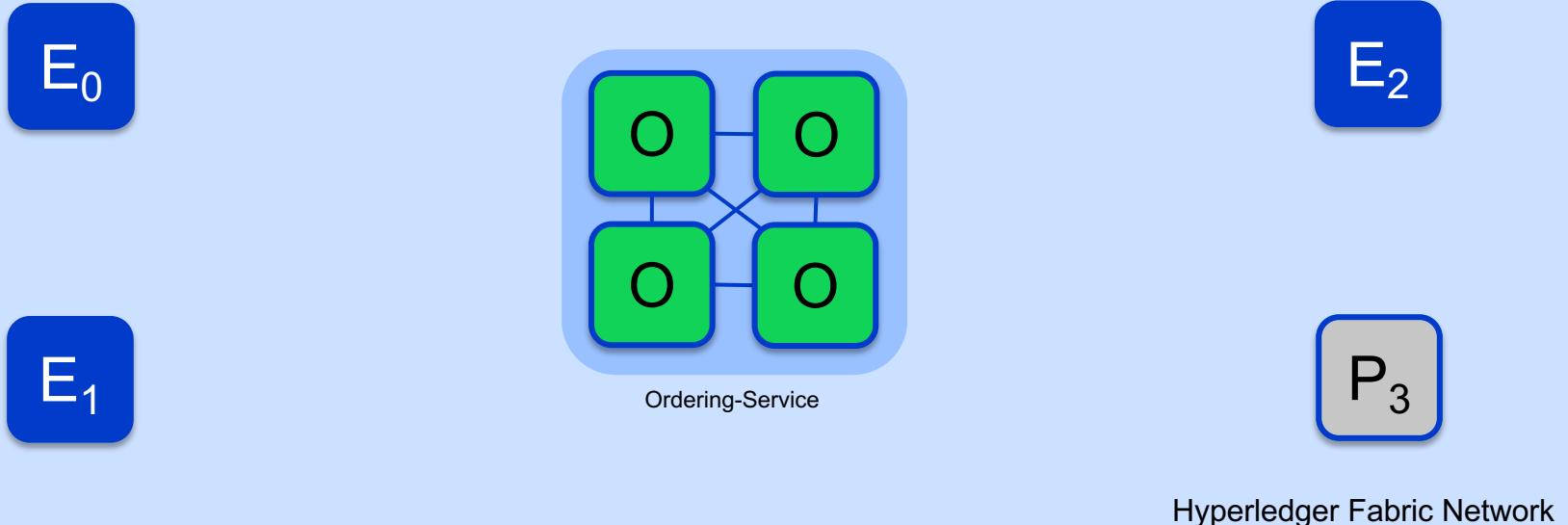
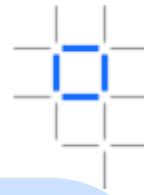


Hyperledger Fabric Network

An Ordering Service is configured and started for the network:

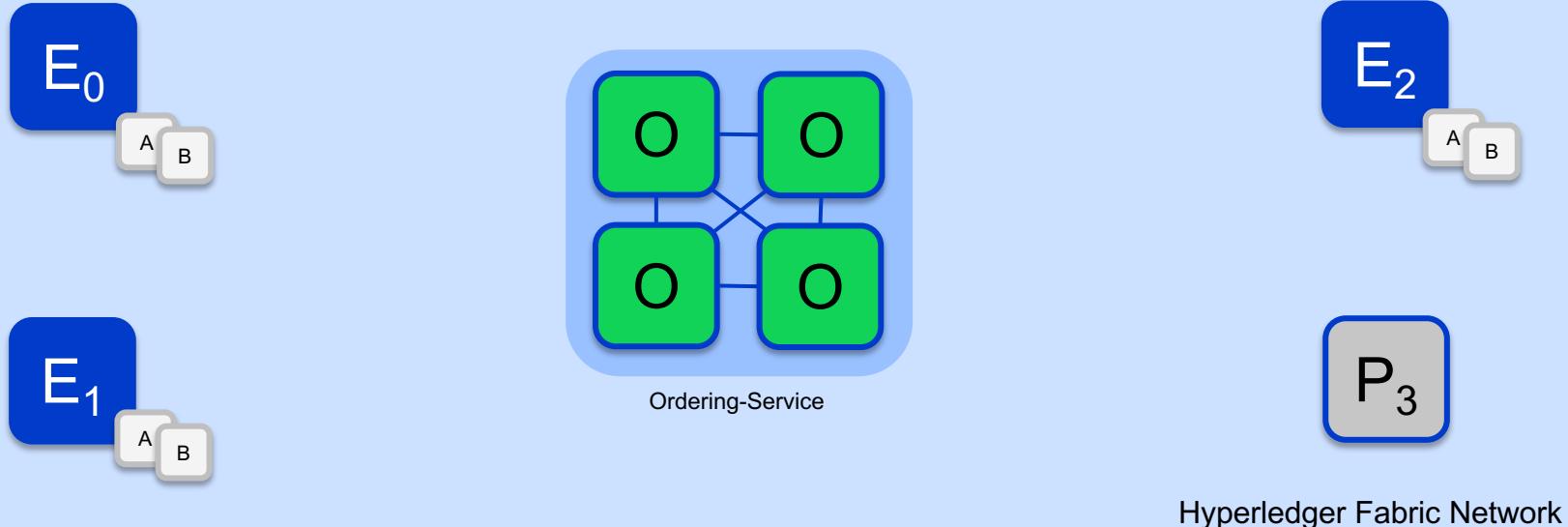
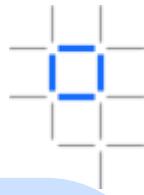
\$ docker-compose [-f orderer.yml] ...

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

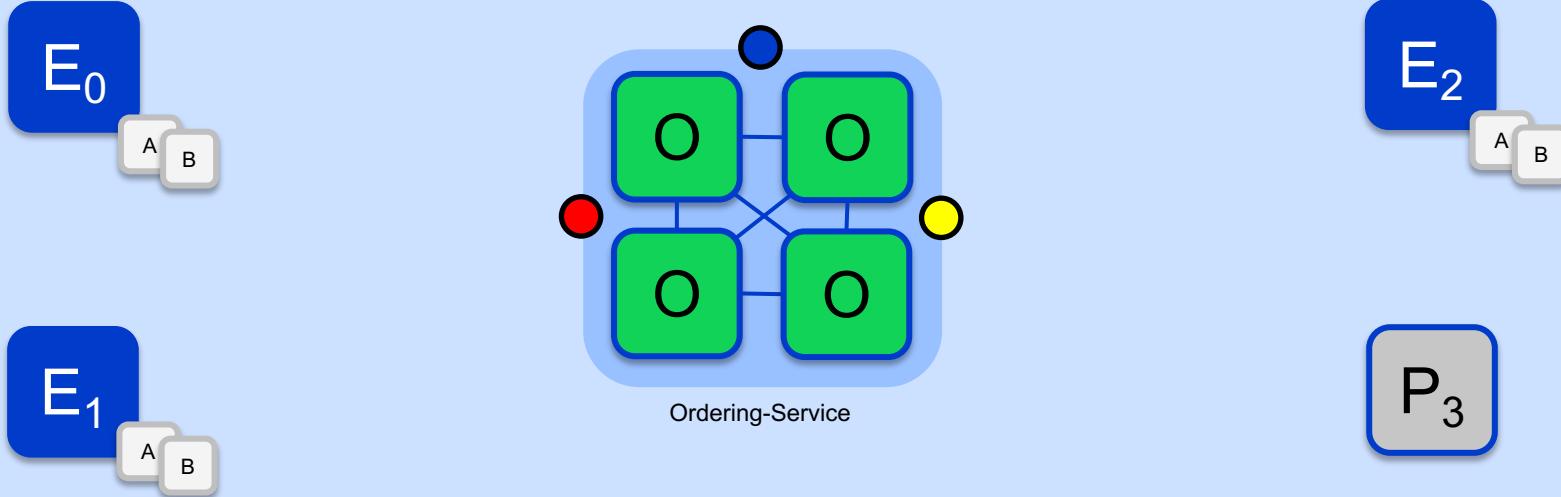
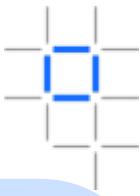


Chaincode is installed onto each Endorsing Peer that needs to execute it:

```
$ peer chaincode install ...
```

Hyperledger Fabric Network

Bootstrap Network (4/6) – Create Channels

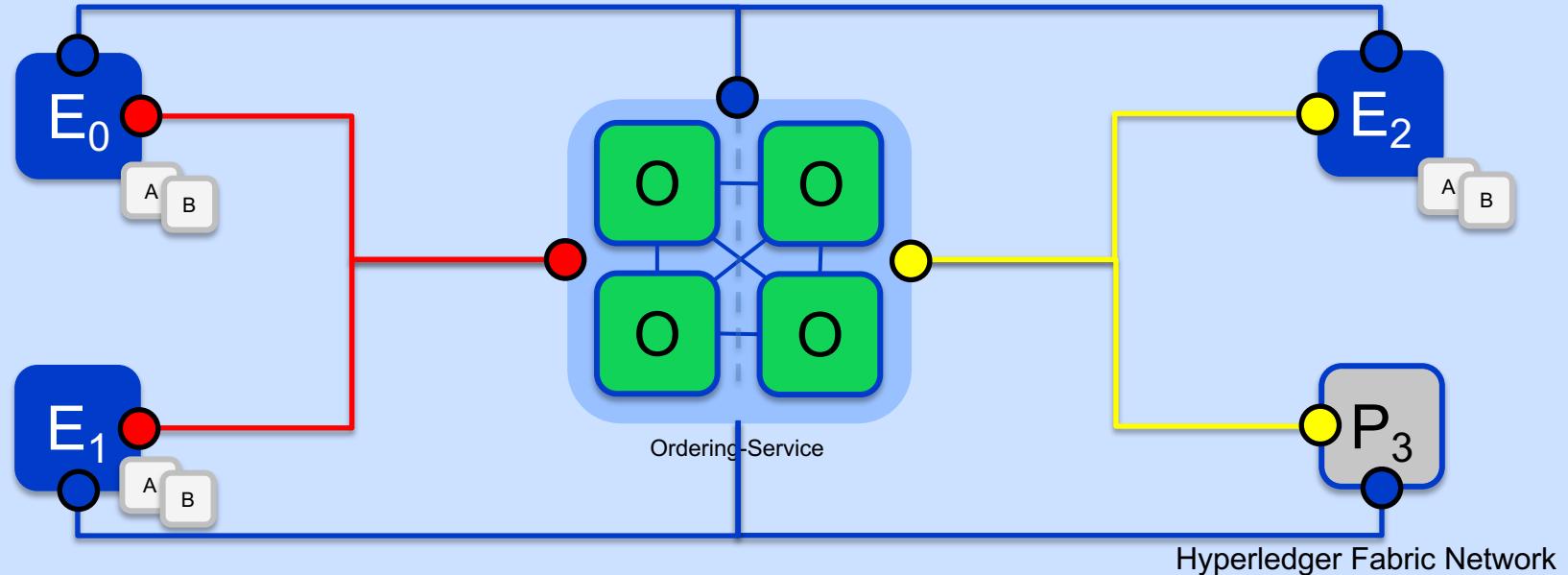
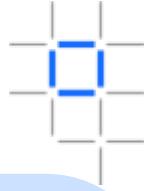


Hyperledger Fabric Network

Channels are created on the ordering service:

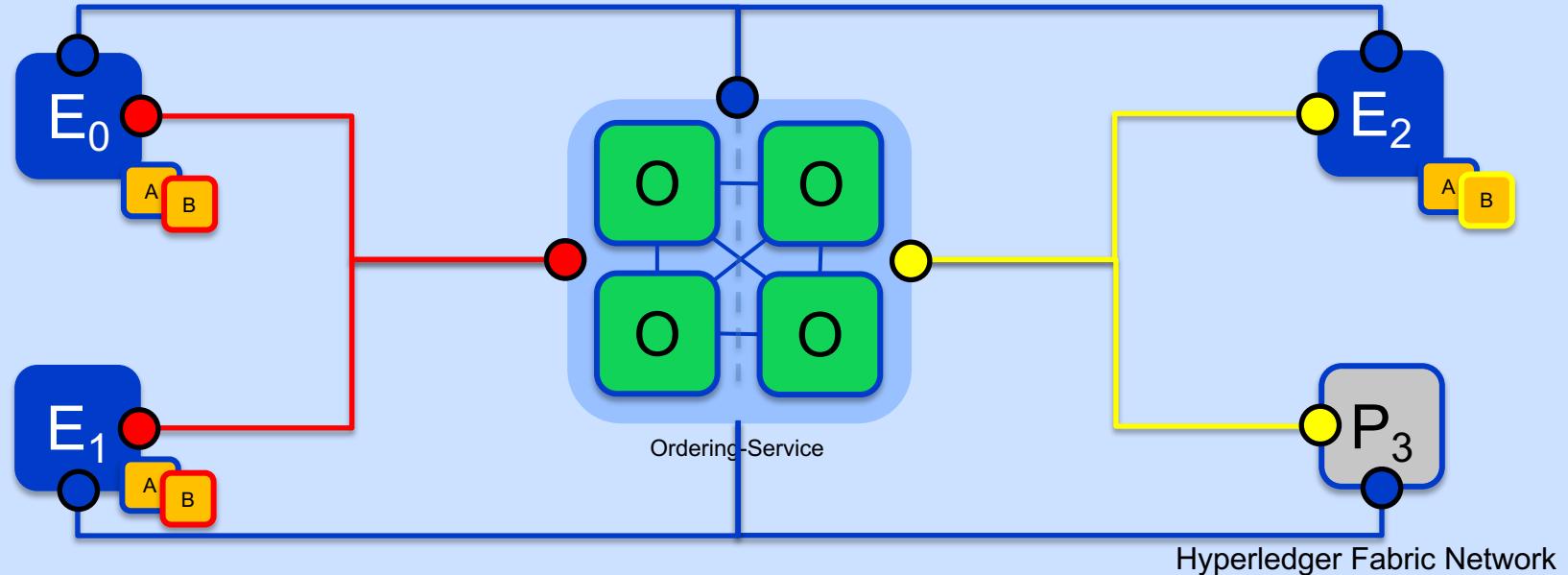
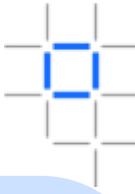
\$ peer channel create -o [orderer] ...

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'

Thank you

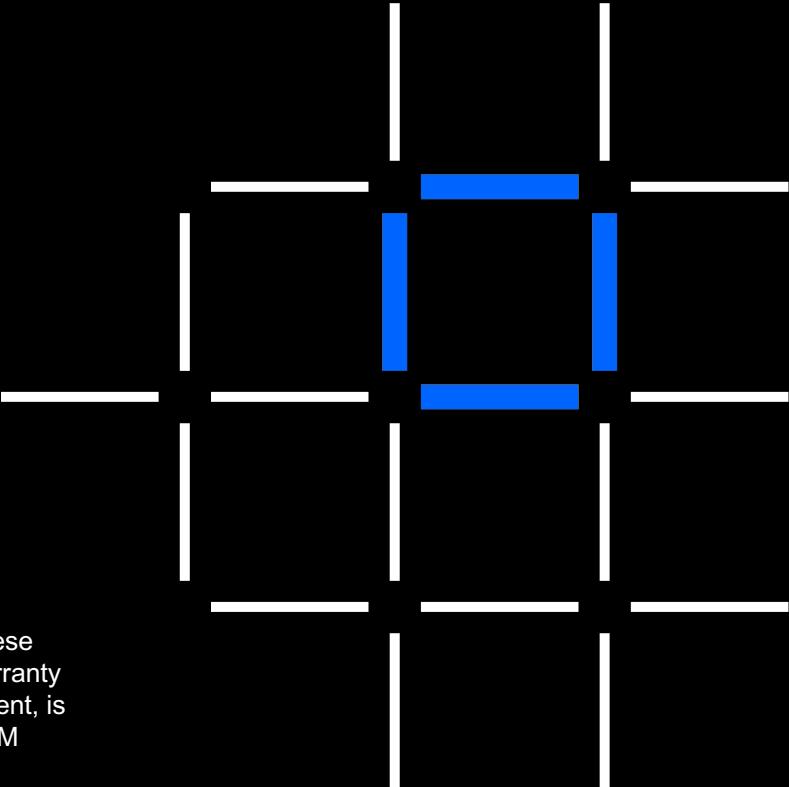
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IBM Blockchain

www.ibm.com/blockchain

developer.ibm.com/blockchain

www.hyperledger.org



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