

### Hyperledger Fabric

- Membership Service
  - X509 Certificate Authority, PKI
  - Mixer network for anonymity
- Dedicated orderer nodes
  - Agreement on order of transactions
  - Ex: Raft, Kafka
- Peers
  - Endorsers: Execute smart contracts
  - Committers: Add transactions to blockchain

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### Reference Architecture Reference Architecture APIs, Events, SDKs Multi-language native SDKs allow APIs, Events, SDKs developers to write DLT apps SMART IDENTITY LEDGER TRANSACTIONS CONTRACT Pluggable, membership, privacy, and auditability of transactions Membership Consensus Services Chain-code Services Services LEDGER | TRANSACTIONS Distributed Ordering Secure Enrollment Distributed transactional ledger Ledger Service Container whose state is updated by Attributes Secure consensus of stakeholders Endorsement Network Protocol Validation Registry SMART CONTRACT Security and Crypto Services "Programmable ledger," provides the ability to run business logic Distributed Ledger Technology Services against the blockchain

## **Blockchain Network Components**

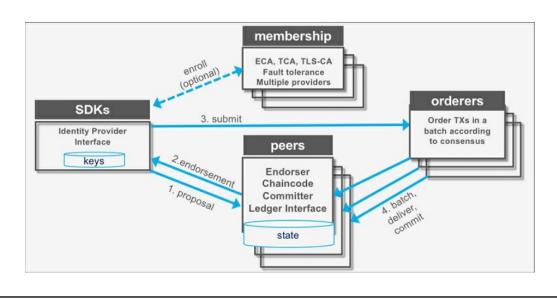


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### **Hyperledger Concepts**

- Transaction
  - Request to execute function on ledger
- Channel
  - Partition of ledger
- State database (world state)
- Contract service
  - Execute smart contract on world state
- Event
- Consensus

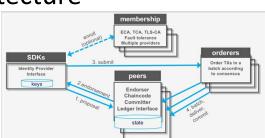
### Runtime Architecture



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### **Runtime Architecture**

- Transaction proposal (client SDK):
  - Sent to multiple endorsing peers
- Transaction endorsement:
  - Endorsing peers execute the txn
- Transaction submitted to the ordering service:
  - Client SDK submits endorsed transaction proposals
  - Ordering service orders them into blocks
- Transaction validation:
  - Validate before committing to the ledger
  - Endorsement policy and state DB



### **Transaction Flow**

- Endorsement of a transaction and checking its validity (validation step)
  - Gateway for correct transactions
- · Ordering through an ordering service
  - Consensus
- Validation and transaction commitment
  - Application-specific trust assumptions

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### Types of Nodes

- Endorsing peer
  - Grant or deny
  - Execute smart contract
  - Transaction proposal
- Ordering nodes (service)
  - Approve addition to ledger
- Committing peer
  - Maintains the ledger and state

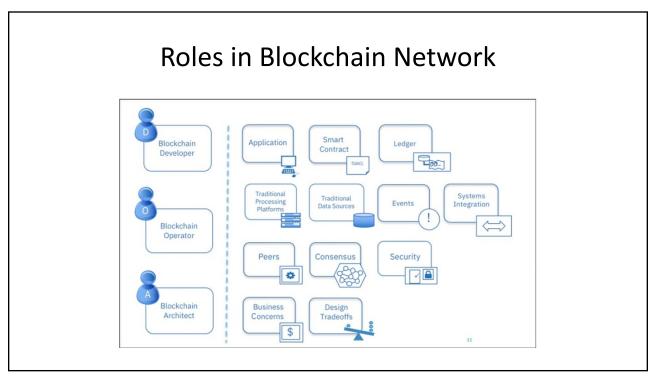
# Types of Validation

- Endorsement
  - Smart contract
- Ordering
  - Consistency
- Contract execution and block commit are separate!

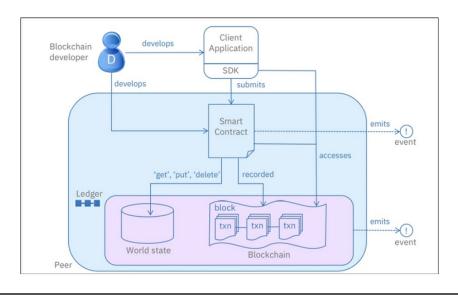
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# Flow of a Transaction Reg is most contact. Walkhrough Buy is most contact. Also and follow operations and have been by all members of the bounces of the bounces. Also and follow operations and have been been and of study, but to help might also to help mi

# Actors in Blockchain Network | Blockchain |



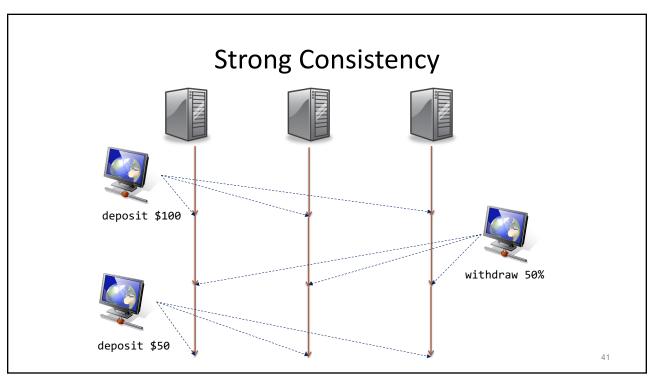
# **Developer Interaction**

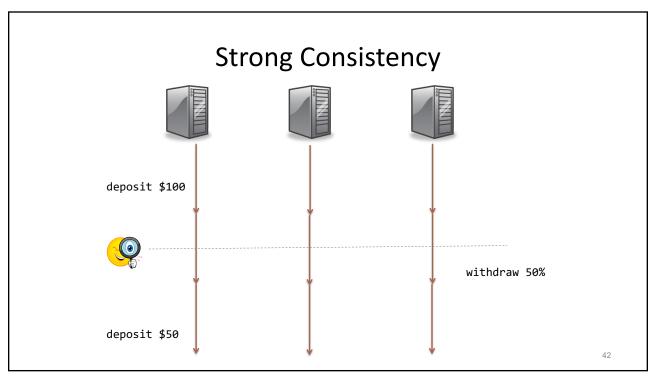


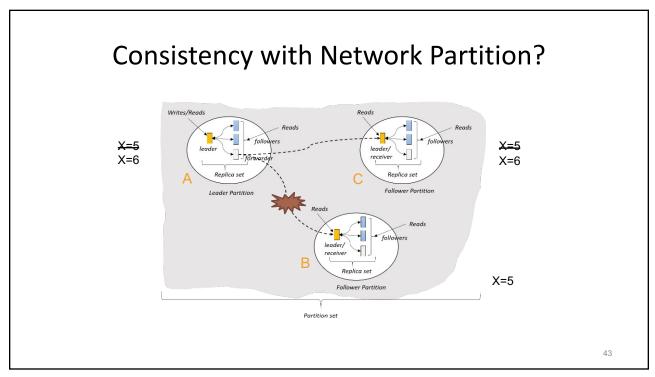
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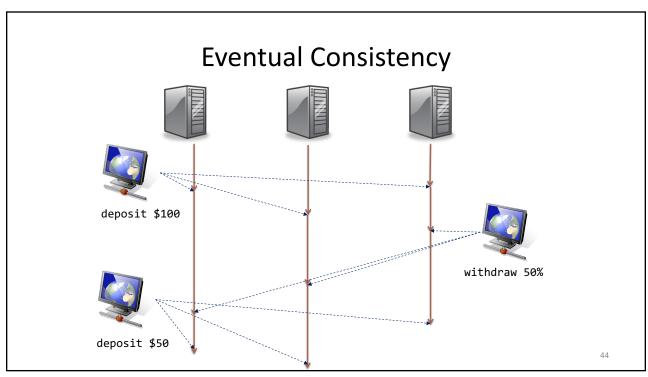
# Consistency and Availability

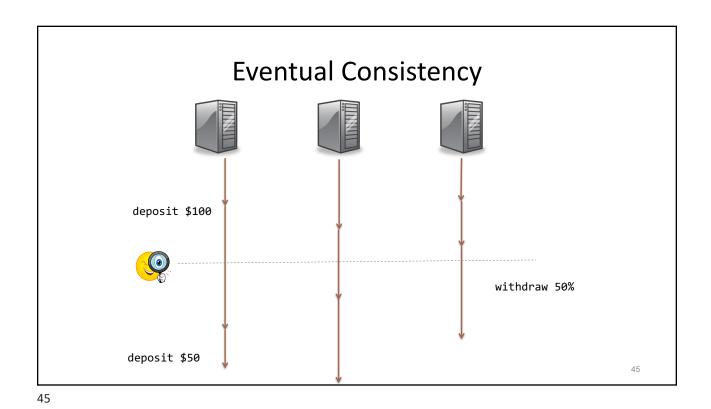
- Blockchain is distributed database
- Consistency
  - All copies are "the same"
- Availability:
  - Can perform queries and updates





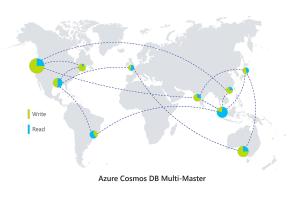






# Consistency and Availability

- CAP Theorem: With network failures, cannot achieve both consistency and availability
- Bigger issue is consistency vs latency



# Hyperledger Fabric Consistency

- Ordering nodes implement total broadcast
  - Agreement on global order
  - See Paxos protocol
- Transaction commit
  - Serializability part of final validation check
  - Multiversion concurrency control (MVCC)