

SChain: A Scalable Consortium Blockchain Exploiting Intra- and Inter-Block Concurrency

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Introduction

- Blockchain provides data integrity, traceability and immutability to tackle trust problems among mutually distrusting parties
- **Consortium blockchain** is being widely applied to support large-scale businesses in enterprise collaborations



Introduction

- As users and applications of blockchain proliferate, the system has to **scale** to provide more transaction processing
 - exploit the parallelism of network, i.e **sharding**
 - enhance the capability of every **single participant**

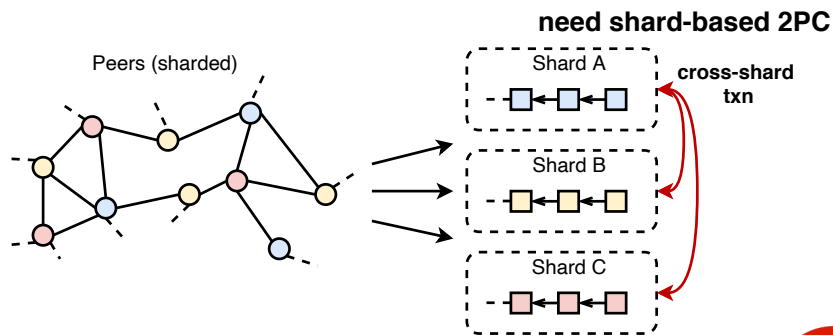


Fig.1: Sharding technique



Cross-shard txn incurs **a large number of** intra- and cross-shard communications

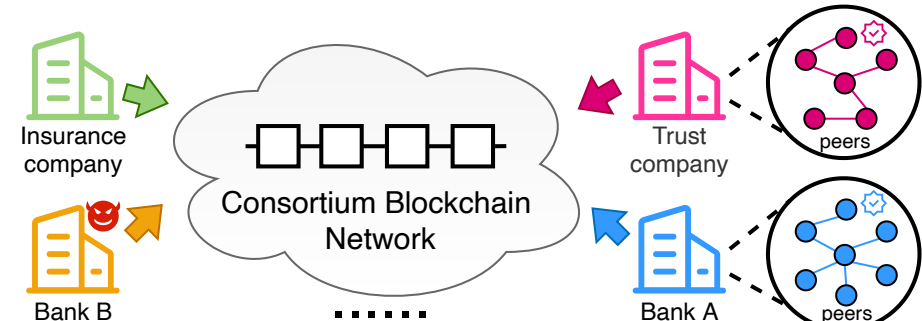


Fig.2: Enhance single participant



Scale the consortium blockchain in terms of each participant **based on trust domain**

Background

To empower the individual participant

- Fabric incorporate concurrency
 - **High abort rates** for hotspot workloads
 - Enhanced works still inherits the limitations of serial validation
- ParBlockchain and BlockchainDB parallelize the execution
 - Allow non-conflicting transactions to execute in parallel

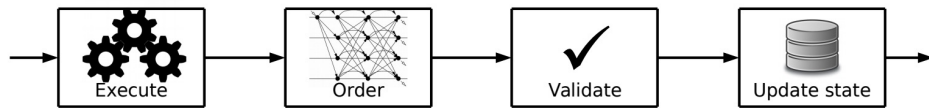


Fig.3: execute-order-validate paradigm

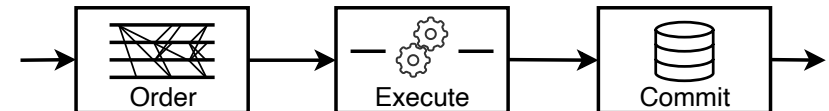


Fig.4: order-execute paradigm

1. **Limited** to single peer

2. **Overlook** transaction parallelism **across** multiple blocks

SChain Overview

- System Architecture
 - **Scalable** order-execute-finalize (SOEF) paradigm
 - Hybrid trust and fault assumptions
 - Exploit **Intra-** and **Inter-Block** concurrency

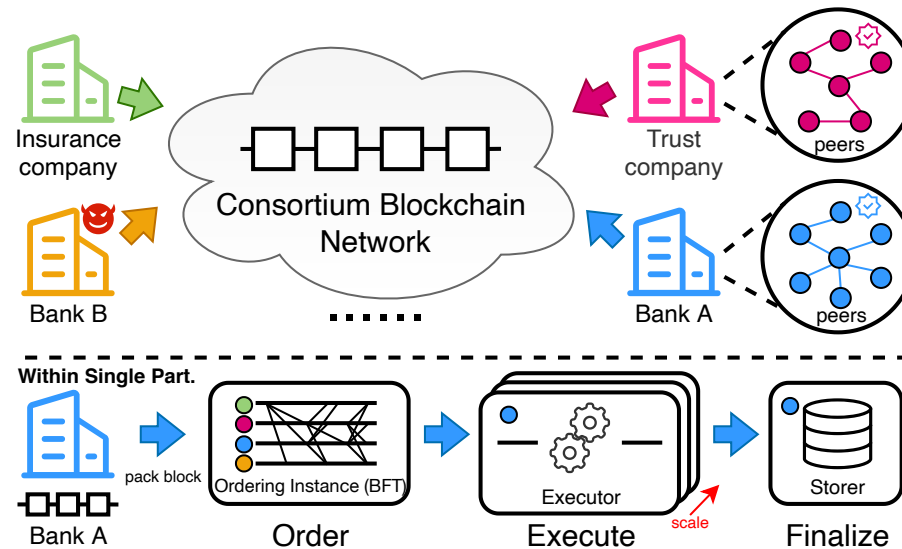


Fig.5: Scalable order-execute-finalize paradigm

SChain's Intra-Block Concurrency

- Multiple executors
 - **Deterministic** concurrency control
 - Early read/write **keys** acquisition for Turing-complete smart contract
 - Guarantee the **merge** of execution result is **equivalent** to the predetermined serial order

defined by
ordering phase

Transactions are executed **in parallel** among all executors
concurrently within a single executor

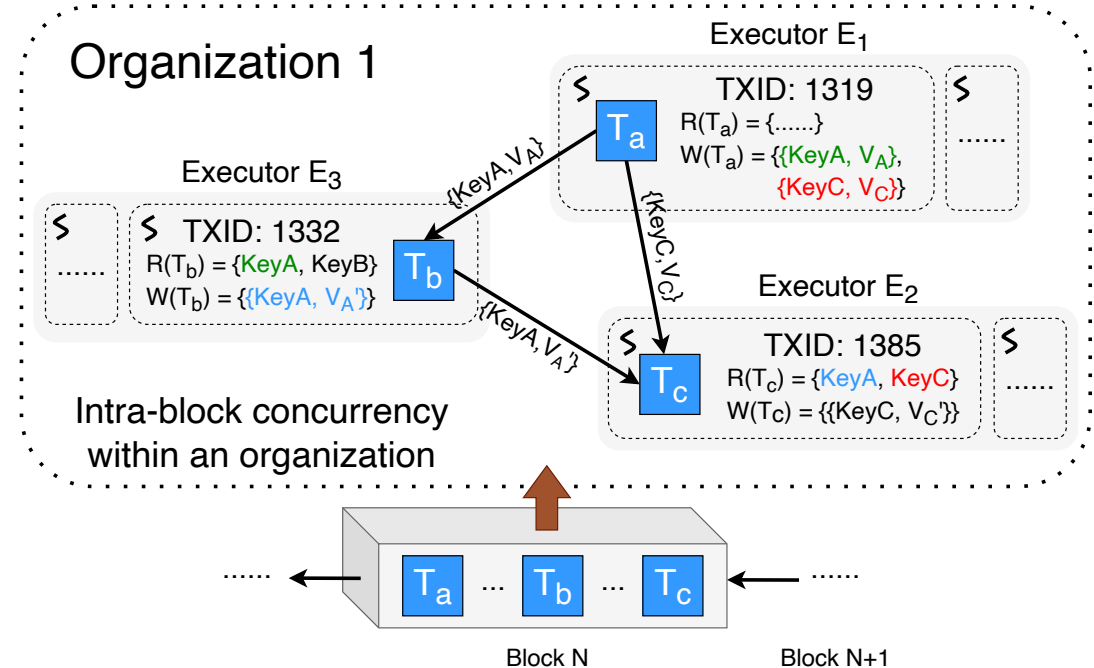


Fig.6: Intra-Block Concurrency

SChain's Inter-Block Concurrency

- Pipelined workflow
 - **Interleave** workflows for different blocks
 - > no longer block-by-block quiescently
 - Explore the **inter-block concurrency**
 - > allow txns in later blocks to be executed **earlier**

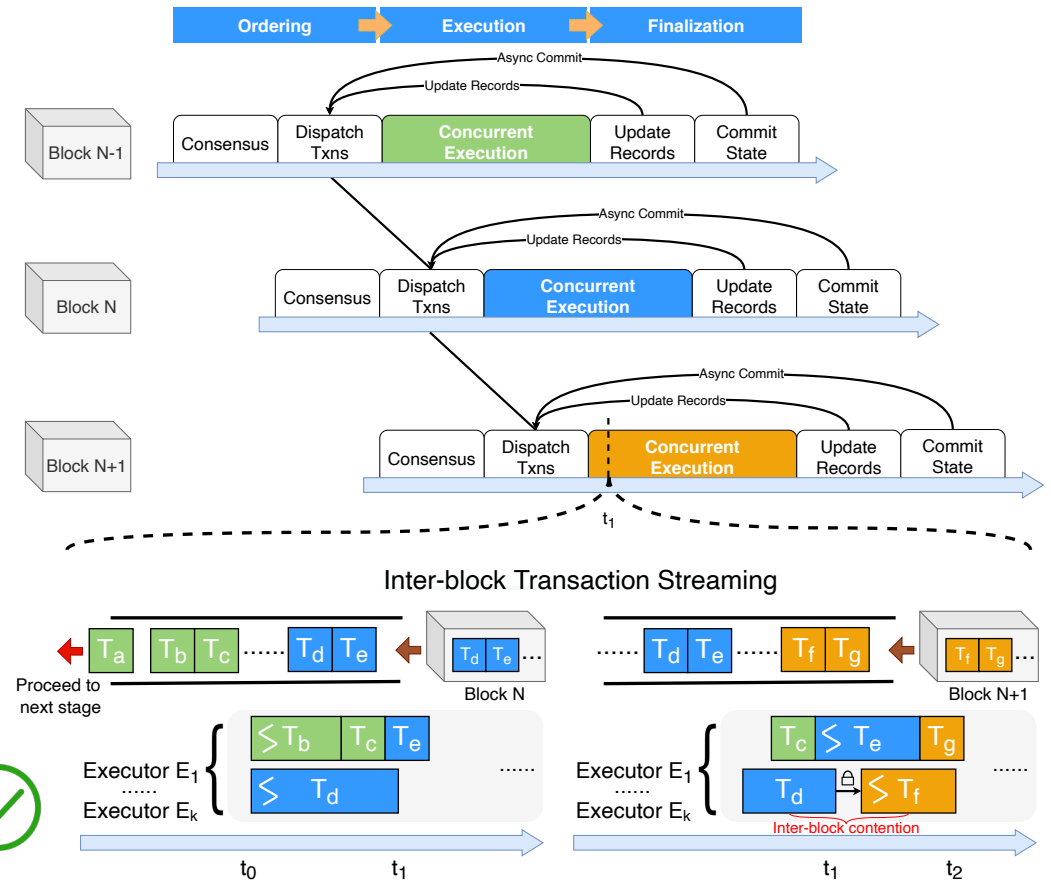


Fig.7: Inter-Block Concurrency

Non-quiescent workflow ✓ **Inter-Block** concurrency ✓

Fully-utilized resources ✓

SChain's Scalability

- Ordering ✓
 - **Merely order** the transactions
 - Concurrent instances (easily get a **global order** due to trust domain)

- Execution ✓
 - Devote more executors **on demand**

- Finalization ⊖
 - Complexity of state partition
 - Expect to design a scalable storage

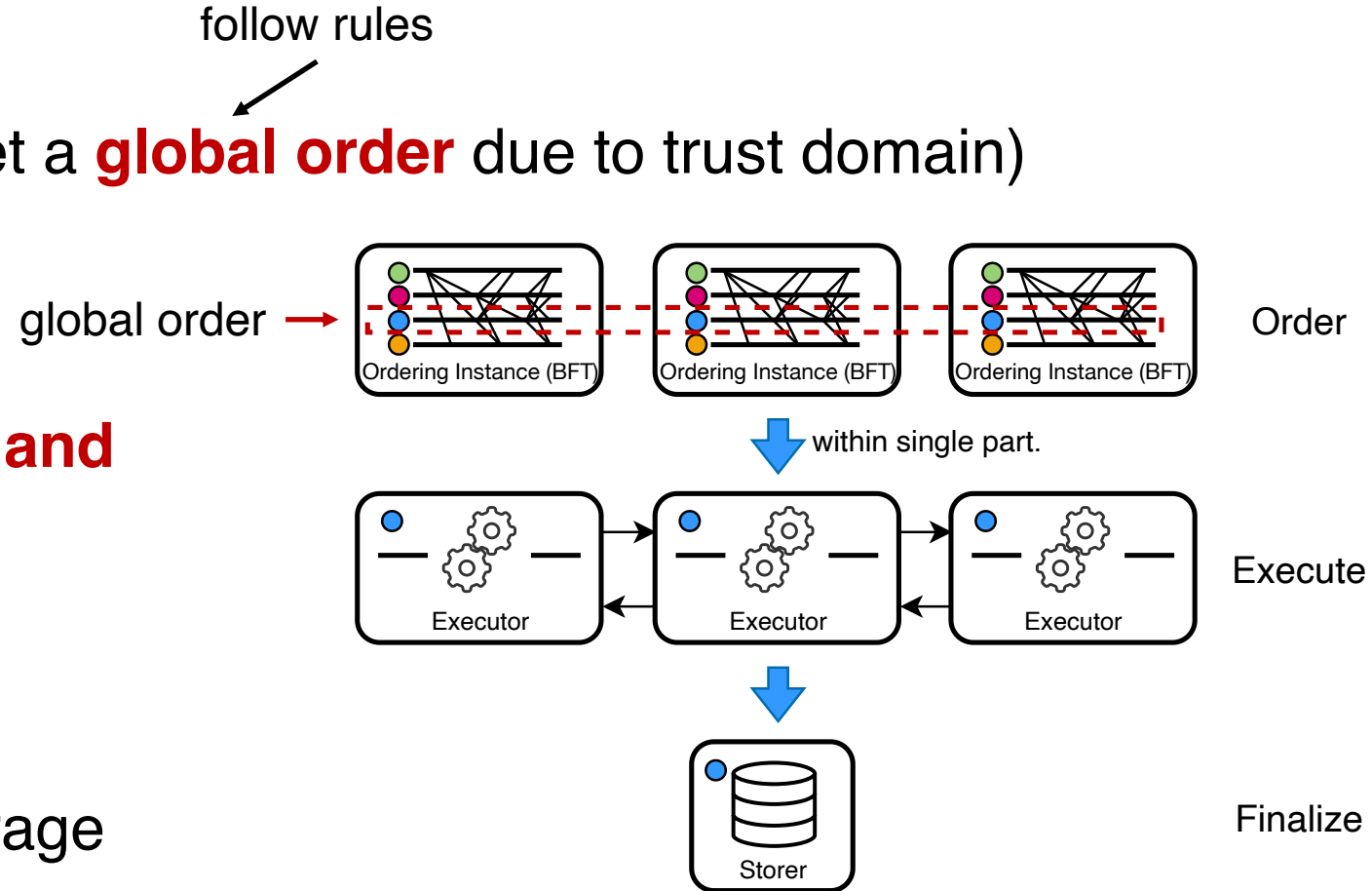
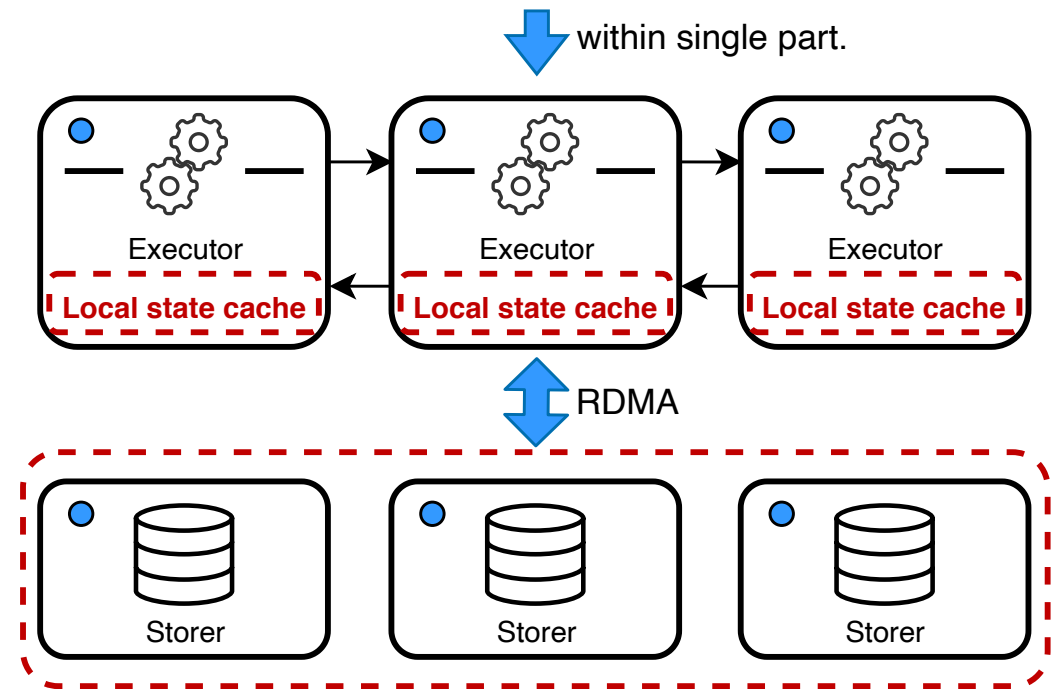


Fig.8: SOEF paradigm

Conclusion and discussion

- We introduce **SChain**, a scalable consortium blockchain that scales transaction processing by exploiting intra- and inter-block concurrency
- Future works
 - Design efficient cache maintenance to leverage data locality
 - Explore the scalable state storage



THANKS !