

Verifying Transactional Consistency of MongoDB

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MongoDB 的三种经典部署架构

MongoDB 3.0	MongoDB 3.2	MongoDB 3.4	MongoDB 3.6	MongoDB 4.0	MongoDB 4.2
New Storage engine (WiredTiger)	Enhanced replication protocol: stricter consistency & durability	Shard membership awareness	Consistent secondary reads in sharded clusters	Replica Set Transactions	Distributed Transactions
	WiredTiger default storage engine		Logical sessions	Make catalog timestamp-aware	Oplog applier prepare support
	Config server manageability improvements		Retryable writes	Snapshot reads	Distributed commit protocol
	Read concern "majority"		Causal Consistency	Recoverable rollback via WT checkpoints	Global point-in-time reads
			Cluster-wide logical clock	Recover to a timestamp	More extensive WiredTiger repair
			Storage API to changes to use timestamps	Sharded catalog improvements	Transaction manager
			Read concern majority feature always available		
			Collection catalog versioning		
			UUIDs in sharding		
			Fast in-place updates to large documents in WT		

MongoDB 事务的三阶段发展过程

A Fundamental Question:

What transactional consistency guarantee do MongoDB transactions in each deployment provide?

挑战一：MongoDB 官方规约不清楚, SI 有多种变体

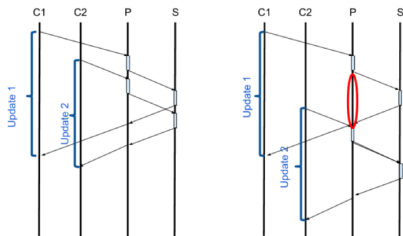
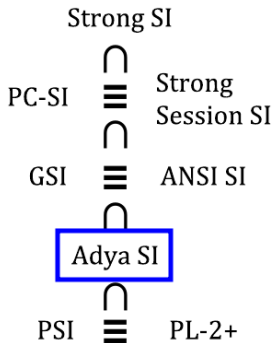


Figure 3: Back-to-Back Transactions with and without **Speculative Snapshot Isolation**



挑战二: MongoDB 缺少精简的事务协议描述, 更没有严格证明

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master specifications / source / transactions / transactions.rst

durran WRITING-6786: Load Balancer Spec (#939) ✓

11 contributors

1433 lines (1118 sloc) | 59.4 KB

Driver Transactions Specification

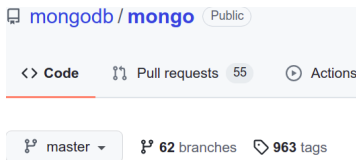
Spec Title:	Driver Transactions Specification
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挑战三: SI 检测问题是 NP-complete 问题, 复杂度高

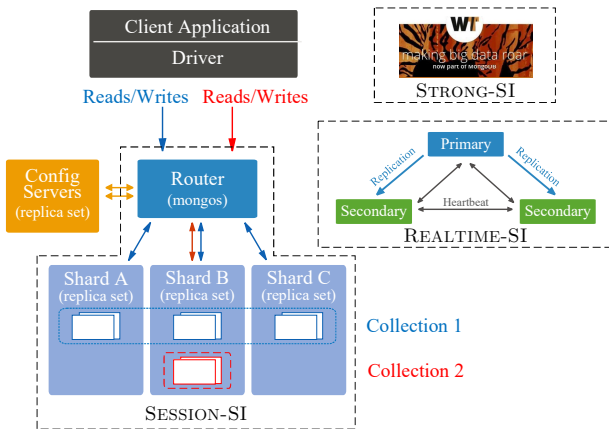
THEOREM 3.2. *For any criterion $C \in \{\text{PREFIX CONSISTENCY}, \text{SNAPSHOT ISOLATION}, \text{SERIALIZABILITY}\}$ the problem of checking whether a given history satisfies C is NP-complete.*

贡献一: 使用 (VIS, AR) 框架, 为多种 SI 变体提供形式化规约

贡献二: 为 MongoDB 事务一致性协议提供精简的伪代码描述



贡献三: 证明 WIREDTIGER、REPLICASET、SHARDEDCLUSTER 事务协议分别满足 STRONGSI、REALTIME-SI、SESSION-SI 变体



贡献四: 设计并评估了多项式时间 SI 变体白盒检测算法

JEPSEN

Conclusion



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