

理解和检测数据库系统中写特定序列化违背

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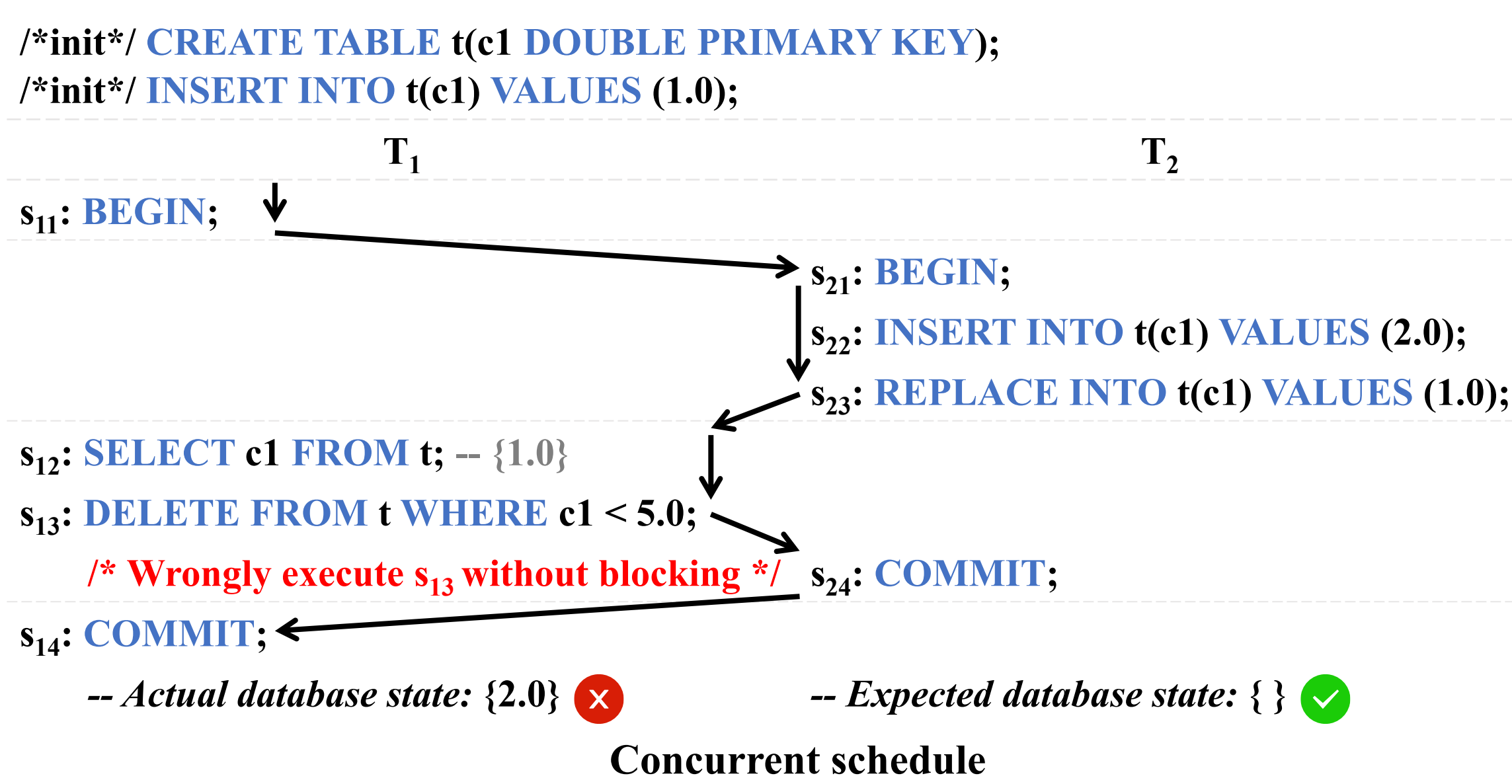
Simple Testing Can Expose Most Critical Transaction Bugs: Understanding and Detecting Write Specific Serializability Violations in Database Systems

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Critical Transaction Bug (txBug)

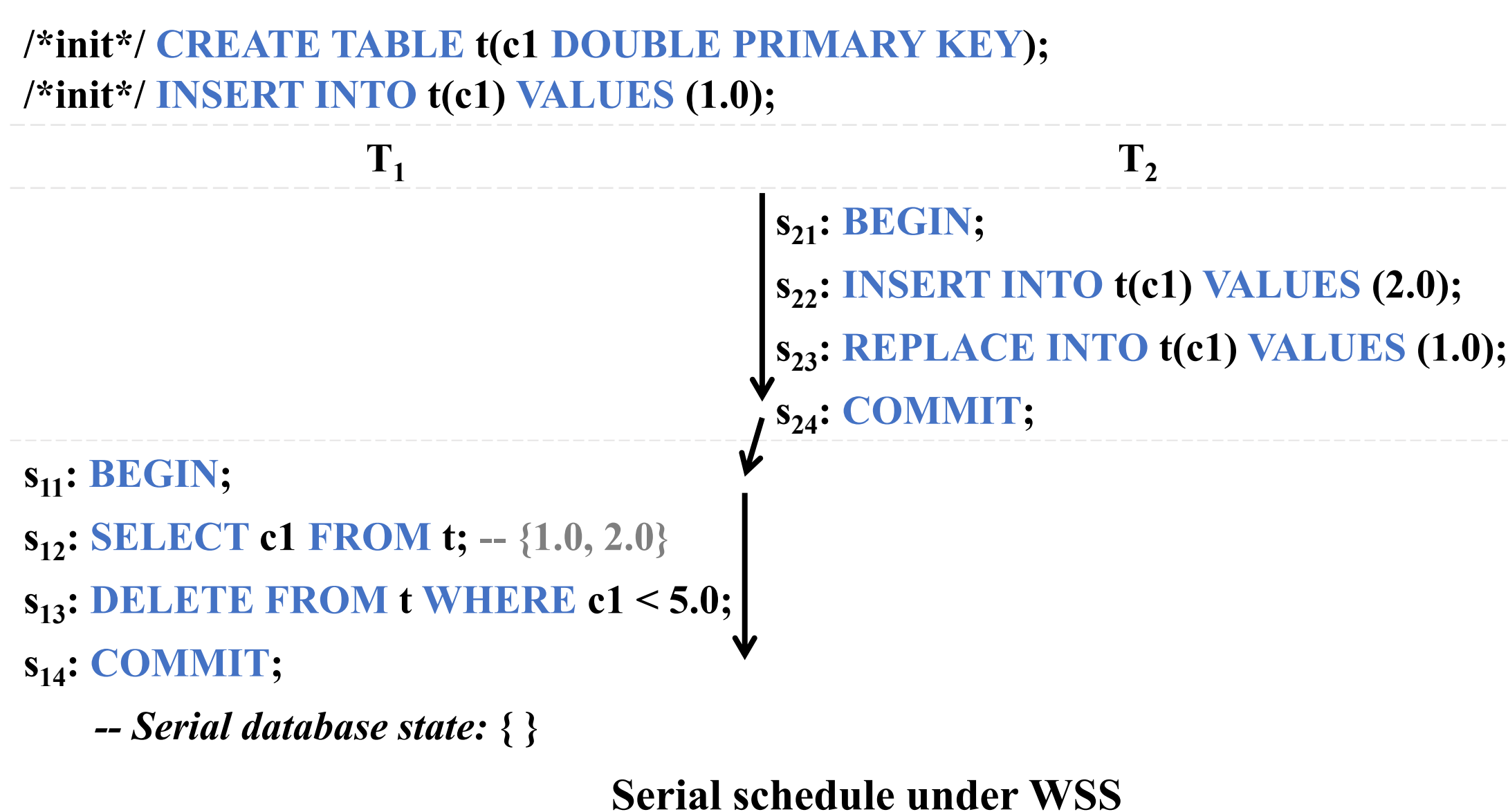
- Incorrect implementations of transaction can cause critical transaction bugs
 - Lead to incorrect database states



<https://github.com/pingcap/tidb/issues/42121>

Write-Specific Serializability (WSS)

- A schedule of concurrent transactions should produce the same final database state as that produced by a corresponding serial schedule of the same transactions



Empirical Study On WSS Violations

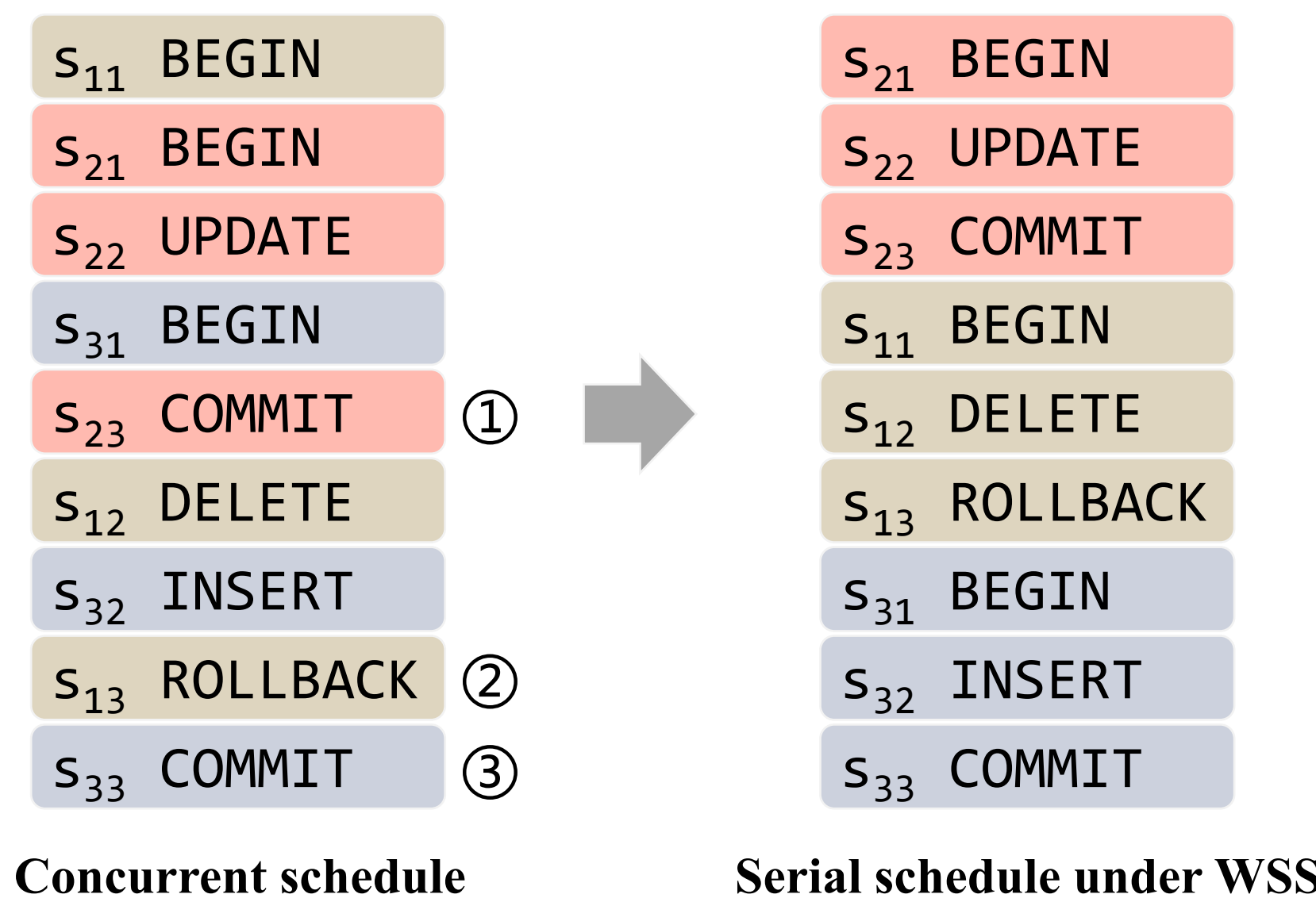
- Start study from transaction bug dataset^[1]
 - 25% of txBugs cause incorrect database states
 - 91% of critical txBugs' test cases violate WSS

DBMS	All txBugs	Critical txBugs	WSS Violations
MySQL	33	2	2
PostgreSQL	6	1	1
SQLite	6	2	2
MariaDB	24	5	3
CockroachDB	9	2	2
TiDB	62	23	22
Total	140	35	32

[1] Z. Cui et al., Understanding Transaction Bugs in Database Management Systems. (ICSE 2024).

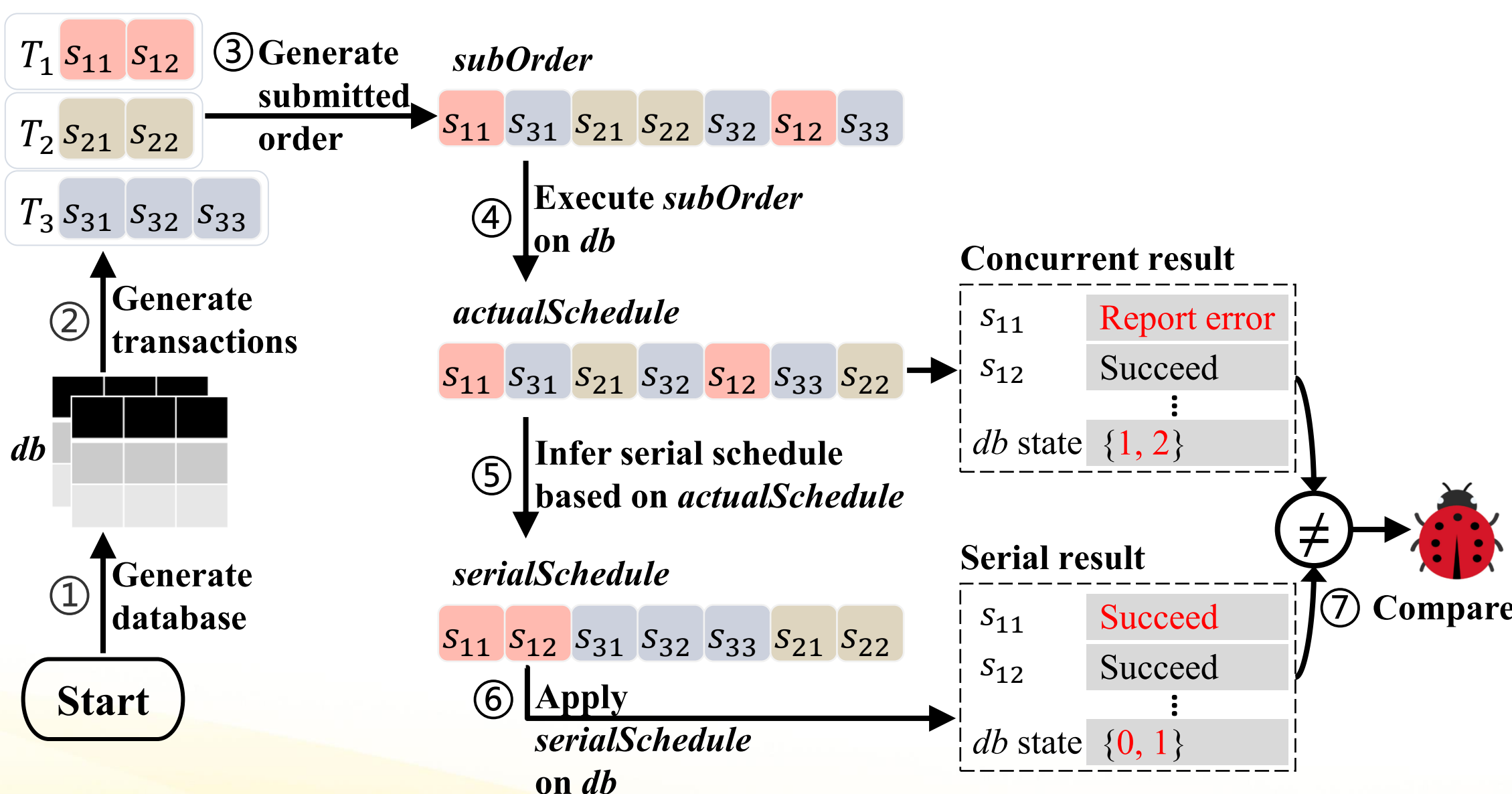
Empirical Study On WSS Violations

- Using First Commit/Rollback First Scheduled (FCRFS) serial pattern can detect all the 32 WSS violations



WriteCheck

- Use FCRFS serial pattern to infer serial schedules under WSS
- Identify inconsistencies in the final database states produced by the original schedule and its serial schedule to detect WSS violations



Overall WSS Violations

- WriteCheck has detected 22 unique WSS violations
 - 13 critical transaction bugs
 - 9 WSS violations stem from improper or inconsistent designs in the target DBMSs, which are permissible

DBMS	Total	txBug		False Positive
		New (Fixed)	Duplicate	
MySQL	3	1 (0)	0	2
PostgreSQL	3	0 (0)	0	3
MariaDB	5	3 (1)	0	2
TiDB	11	7 (1)	2	2
Total	22	11 (2)	2	9