

模型检查导向的分布式系统增量测试方法

Model Checking Guided Incremental Testing for Distributed Systems

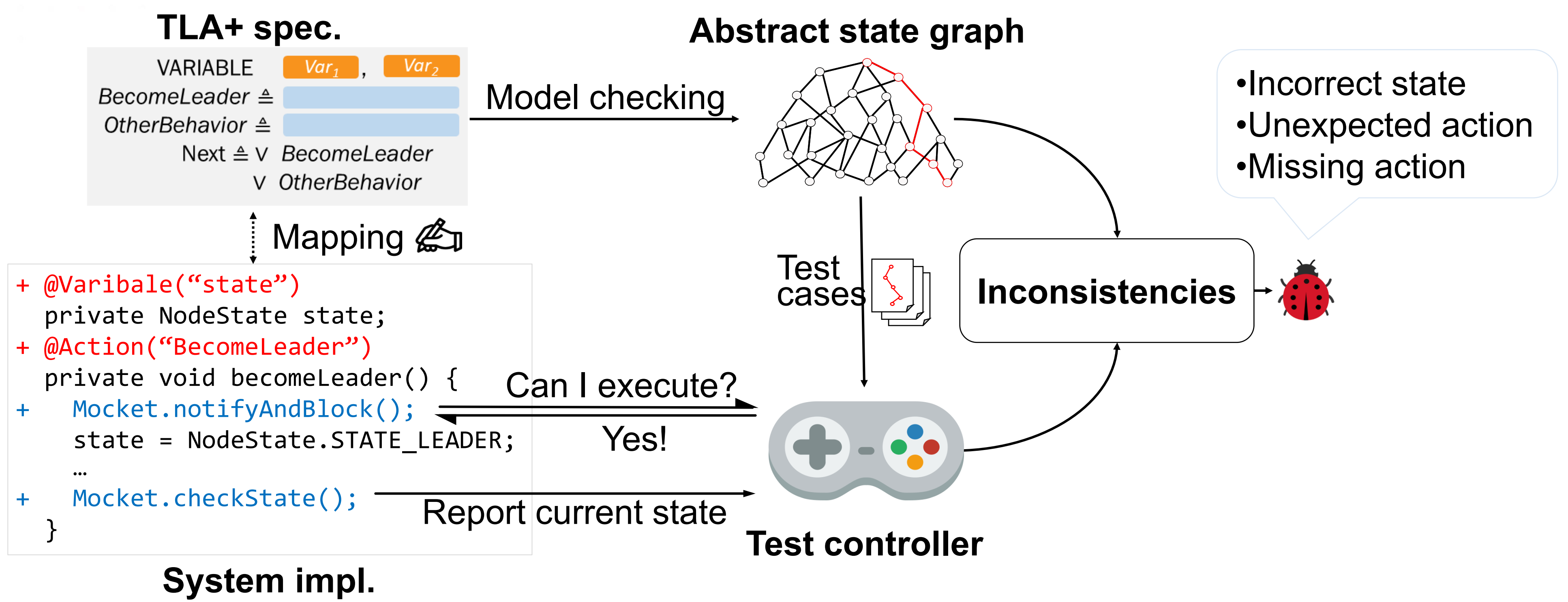
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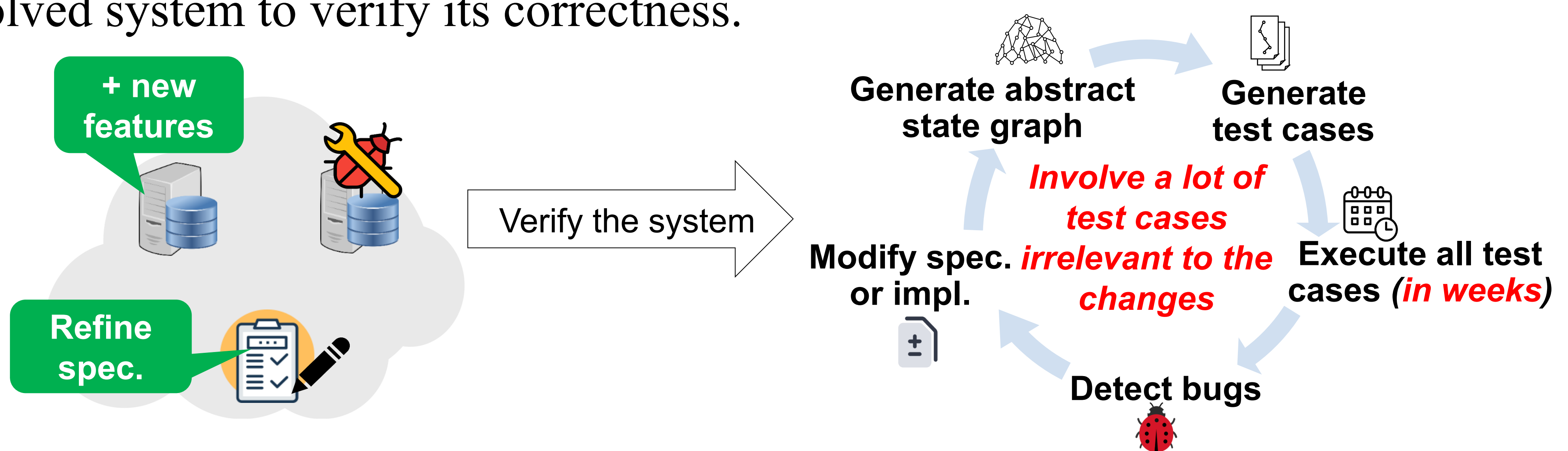
MCGT is Proposed to Test Distributed Systems Systematically

- Model Checking Guided Testing (MCGT) automatically generate test cases by traversing the abstract state space derived from model checking.



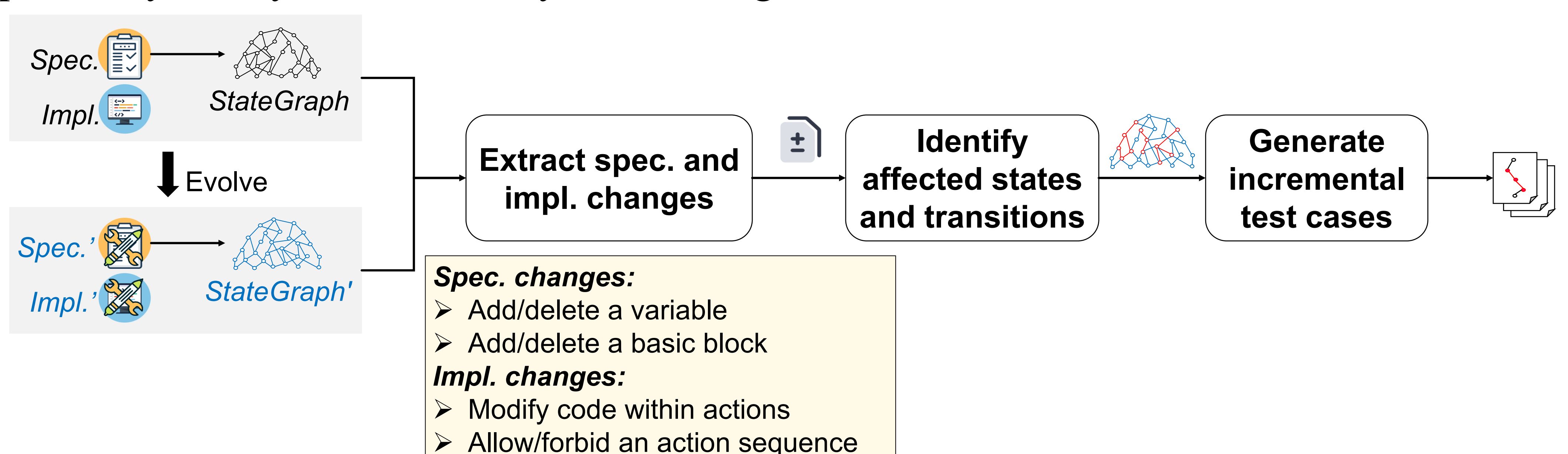
MCGT is Inefficient During System Evolution

- When system changes, MCGT needs to re-run the entire testing process for the evolved system to verify its correctness.



iMocket: Precisely Evaluate Distributed System Changes

- We propose a novel model checking guided incremental testing approach *iMocket* to precisely verify distributed system changes.



- ◆ We extract four types of specification changes and code changes within actions by comparing the syntax trees of the specification and code before and after modification. Testers are required to explicitly document changes in action concurrency within the code.
- ◆ We adopt a growth-based test case generation algorithm to generate incremental test cases to cover the affected states and transitions.

Evaluation

- iMocket* can effectively reduce the testing time by 22% to 99% for various distributed system change scenarios.
- Test cases generated by *iMocket* can accurately guarantee comprehensive coverage of system changes and the triggering of implementation bugs.

Scenario ID	#Test cases			Test time			Scenario ID	Can cover related code?	Can trigger fixed bugs?	Triggered ratio
	Full Traversal	iMocket	Reduction	Full Traversal	iMocket	Reduction				
Raft-java#1	145,222	359	99.75%	8 days	29 min	99.14%	Raft-java#1	√	-	-
Raft-java#2	215,336	120,357	44.11%	12 days	7 days	47.64%	Raft-java#2	√	-	-
Raft-java#3	85,976	42,331	50.76%	5 days	2 days	50.29%	Raft-java#3	√	√	98.47%
Raft-java#4	85,976	956	98.89%	5 days	79 min	98.90%	Raft-java#4	√	√	97.89%
ZooKeeper#1	342,770	179,331	47.68%	>3 weeks	15 days	>51.77%	ZooKeeper#1	√	√	95.11%
ZooKeeper#2	519,609	3,580	99.31%	>3 weeks	10 hours	>99.91%	ZooKeeper#2	√	√	83.03%
ZooKeeper#3	7,212,493	785	99.99%	>3 weeks	2 hours	>99.99%	ZooKeeper#3	√	√	68.91%
Xraft#1	296,154	19,259	93.50%	>3 weeks	37 hours	>99.08%	Xraft#1	√	√	100%
Xraft#2	296,154	24,306	91.79%	>3 weeks	2 days	>93.42%	Xraft#2	√	√	95.39%
Xraft#3	296,154	1,534	99.48%	>3 weeks	3 hours	>99.71%	Xraft#3	√	√	90.74%
Raft-spec#1	85,976	64,732	24.71%	5 days	3 days	22.54%				
Raft-spec#2	85,976	44,711	48.00%	5 days	2 days	44.30%				