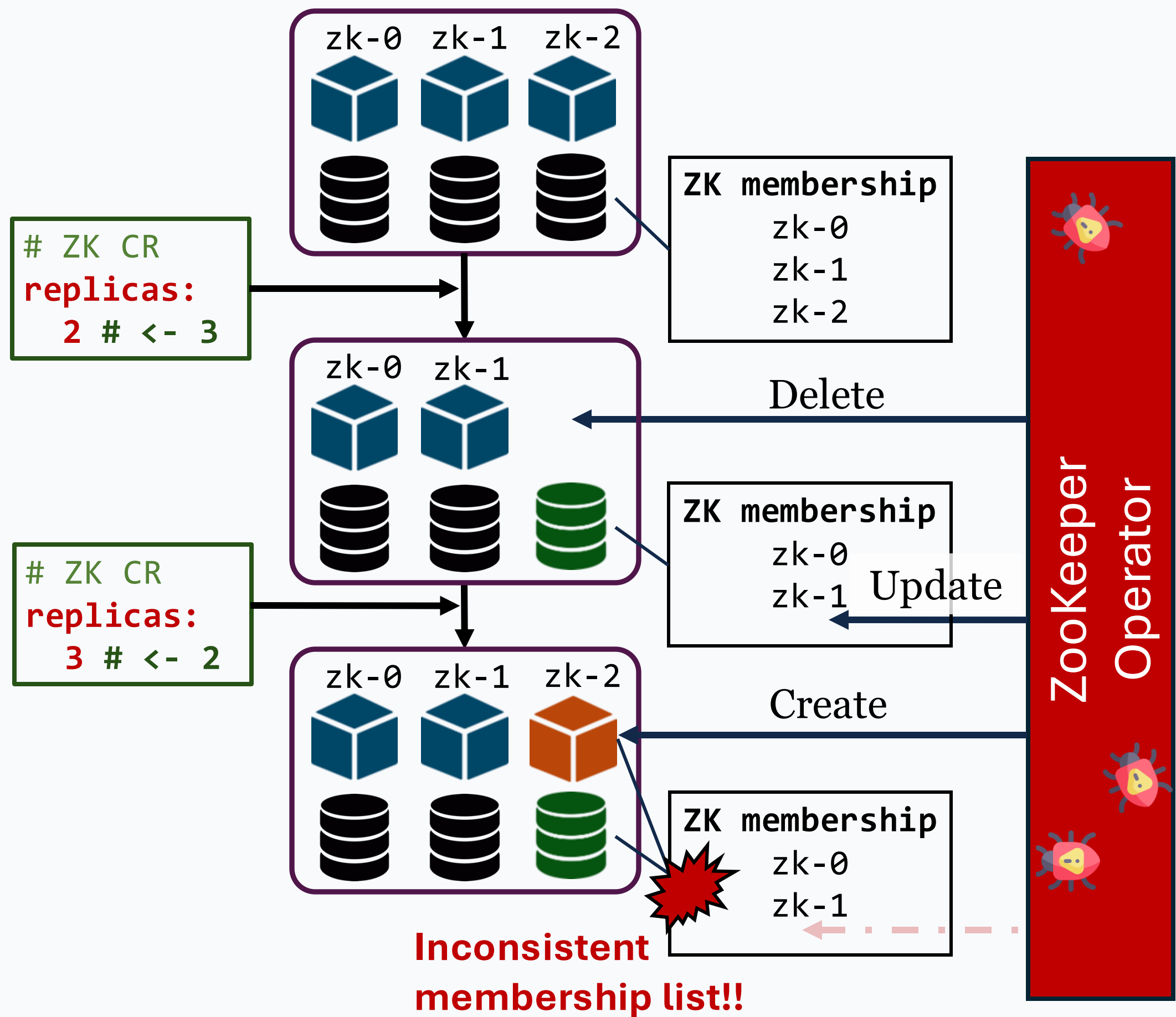


## Background

- Modern cloud systems are managed by “**operators**”
  - Implementing **declarative interface**
- Operator correctness is critical to system reliability

A real-world Kubernetes operator bug:

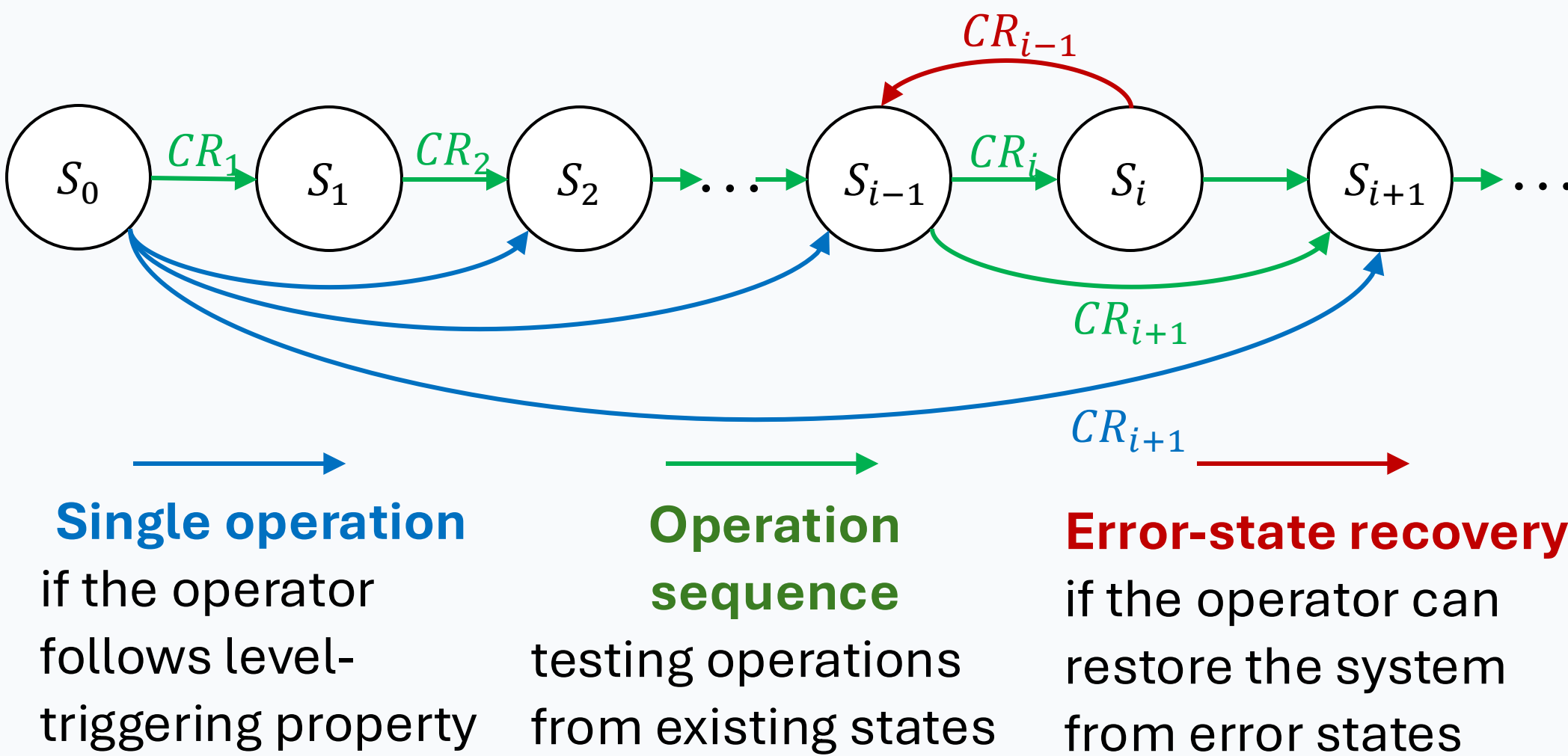


## Research Contributions

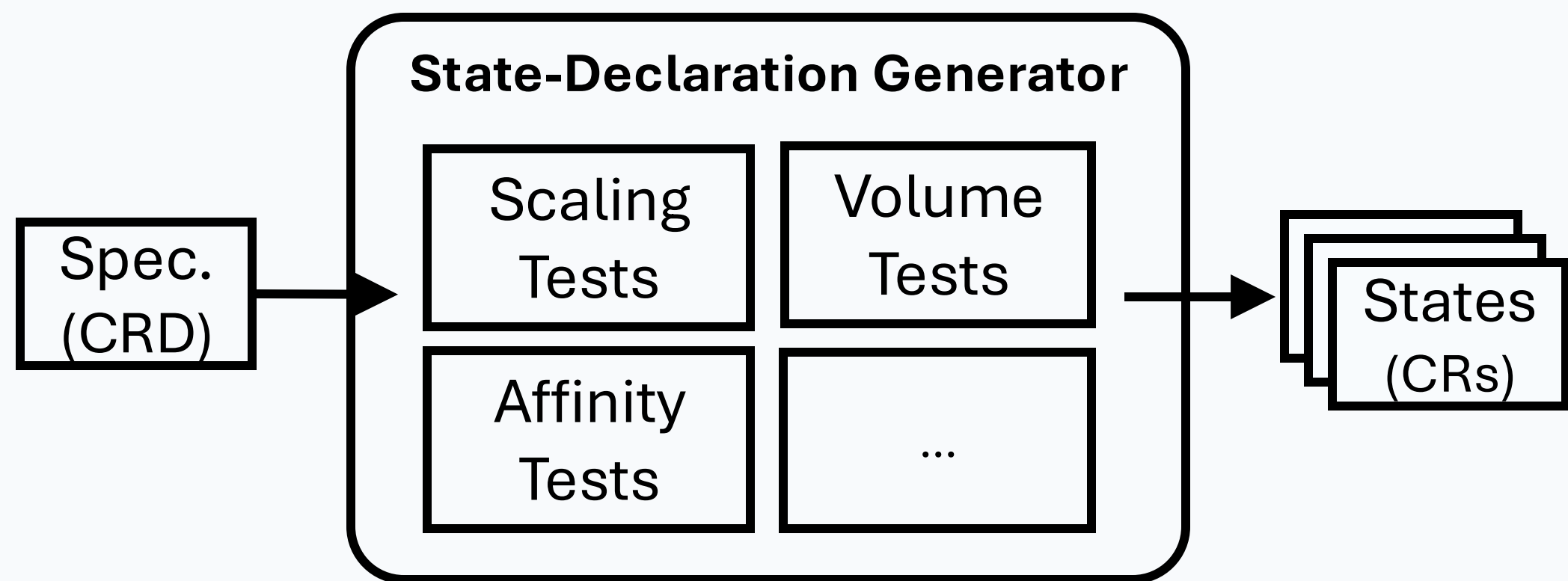
- Enabling **push-button E2E testing** to automatically find **critical bugs** in Kubernetes operators
- Validating three **operation correctness** properties
  - Always reconciling the system to the desired state
  - Always recovering the system from bad states
  - Always being resilient to operation errors
- Detected 150+ critical bugs in widely used operators

## Key Ideas [1]

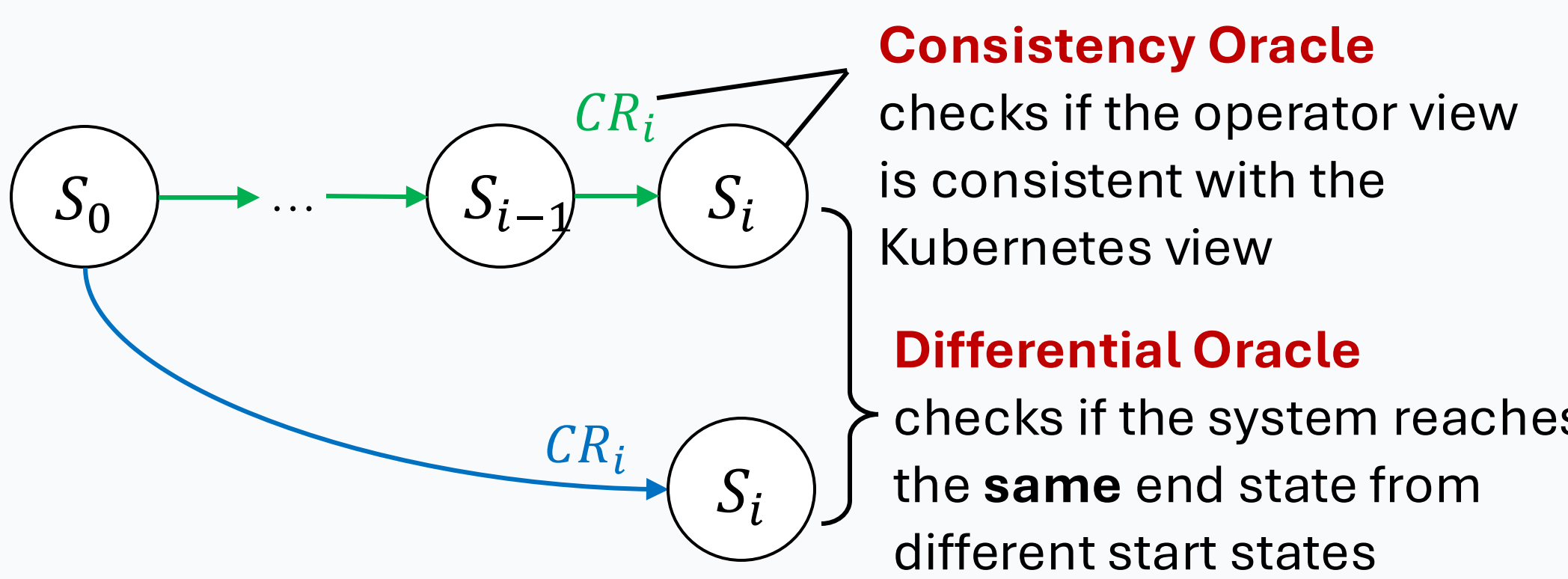
### ① How Acto Explores State Transitions



### ② Automatic State-Declaration Generation



### ③ Automatic Test Oracles



[1] “Acto: Automatic End-to-End Testing for Operation Correctness of Cloud System Management”, SOSP, 2023.

## Main Results

- Acto is applied to **39** open-source operators
- Acto tested each operator with a **nightly** run



Acto has found 150+ bugs in these popular Kubernetes operators so far!

## Practical Impacts

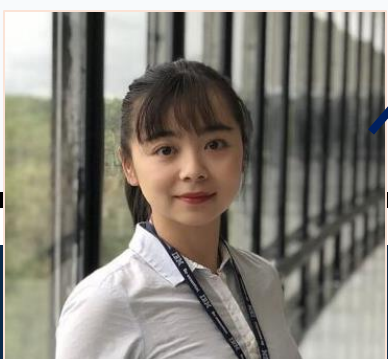
- Open-source project: <https://github.com/xlab-uiuc/acto>
- Used by multiple follow-up research projects
- Used as **course materials** at CS 523
- Solution showcase at **KubeCon+CloudNativeCon EU**
- Invited talk at **USENIX SREcon**
- Invited article at **USENIX ;login: magazine**
- Covered by CDS news and IIDAI newsletter
- Engaged 10+ undergrad students via IIDAI URE, UIUC SRP, etc

## Anticipated Benefits to IBM

- Acto as a part-and-parcel for **OpenShift**



“Operators are required for every workload we deploy in production on OpenShift.”  
 “LLMs/GPT is used to generate operator code.”



**Protect production ops with Acto!**