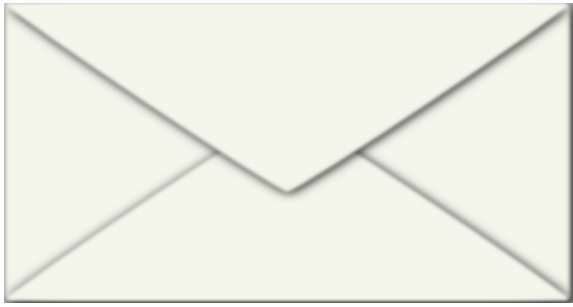
ONRC RESEARCH

How Did We Get Into This Mess? Automated Troubleshooting for SDN

Colin Scott, Andreas Wundsam, Sam Whitlock,
Andrew Or, Eugene Huang, Kyriakos Zarifis, Scott Shenker

How many events in a DC network?



- 20,000 servers * 4 VMs / server = 80,000 VMs

- (6 migrations / day / VM) + (2 power up | down / day / VM) * 80,000 VMs = 640,000 VM events / day ~= **450 VM changes / minute** [1]

- **8.5 network error events / minute** [2]

How many events in a DC network?

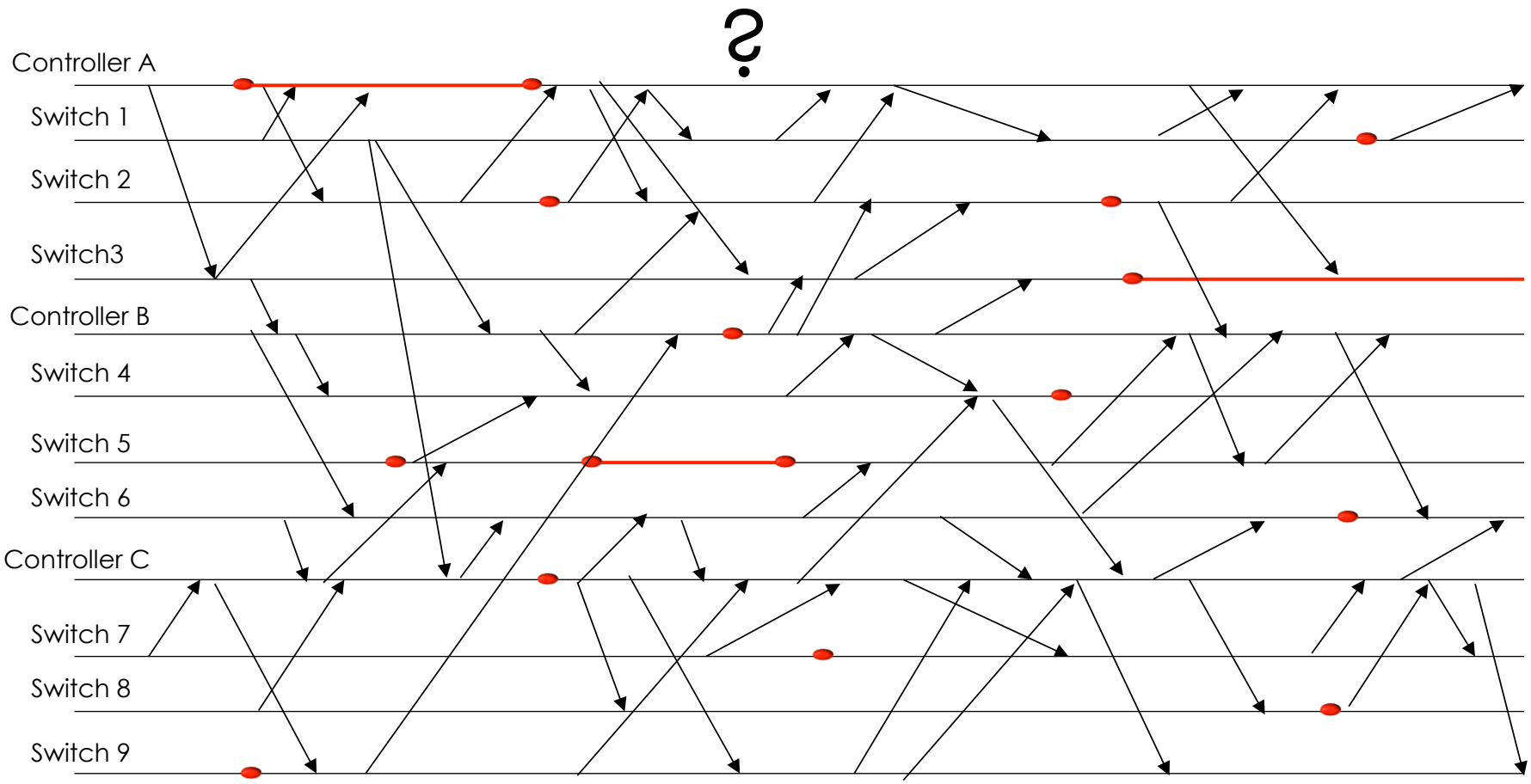
= ~500 events / minute

Something goes wrong!

Best practice: Logs

Manual analysis of log files

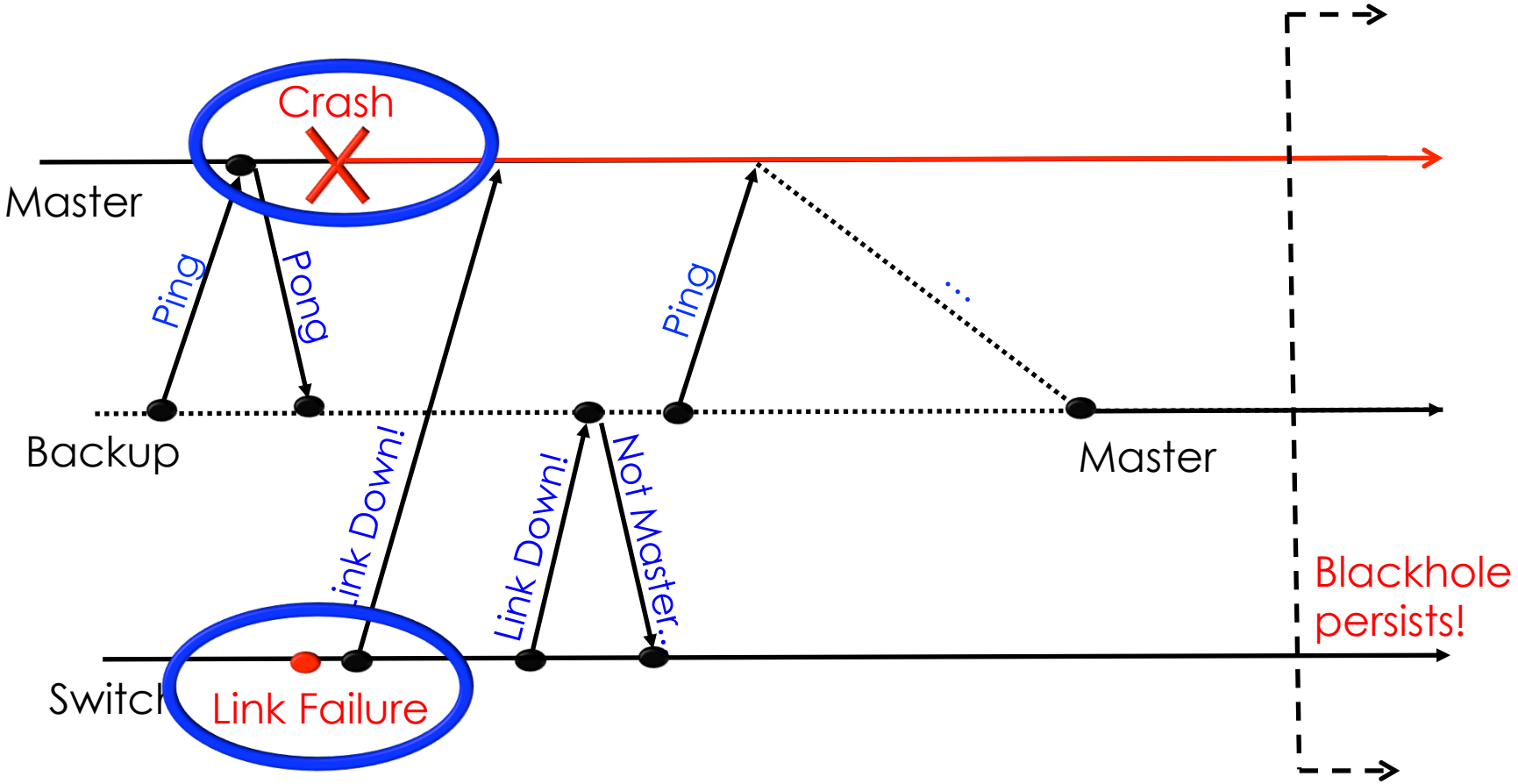
Best practice: Logs



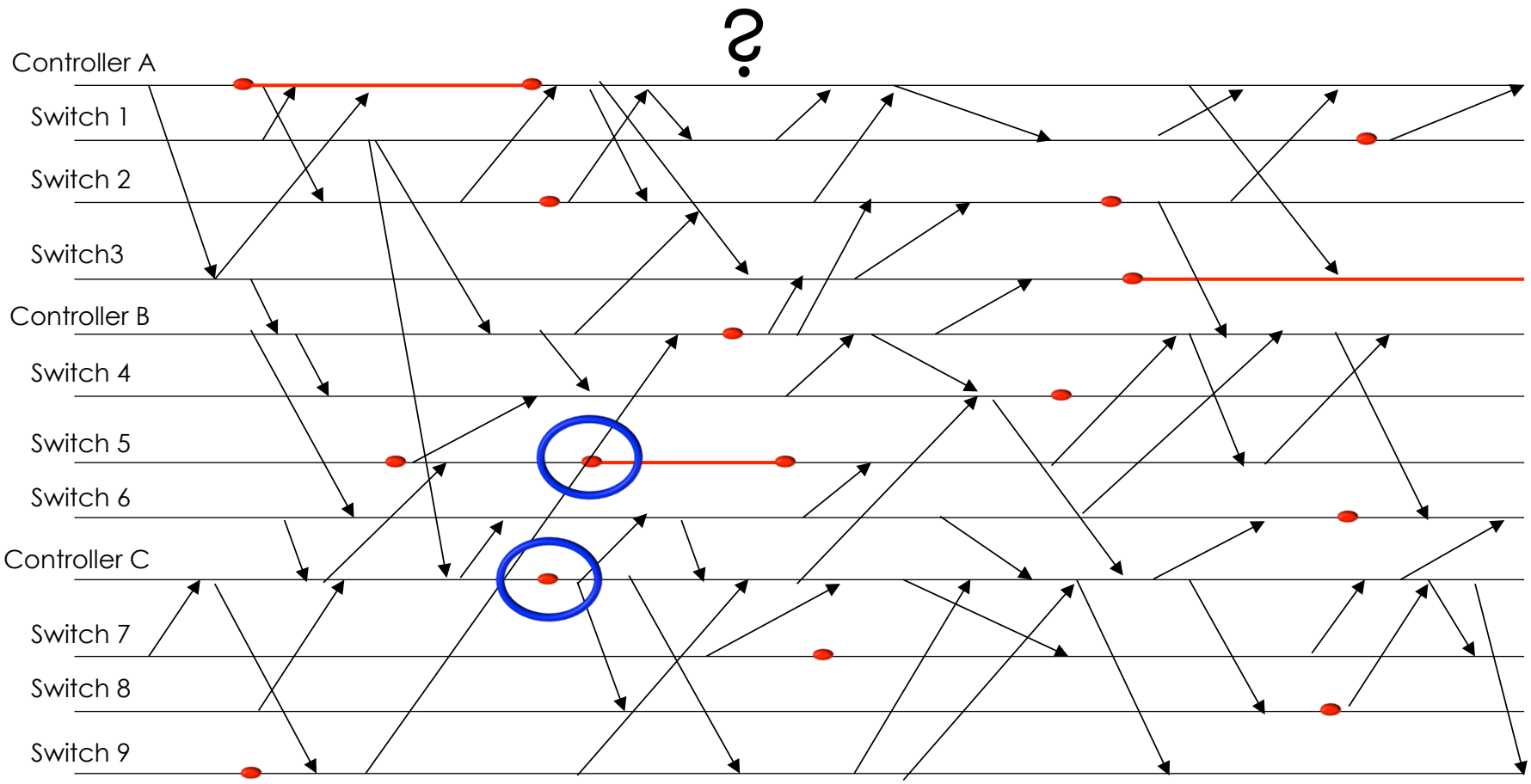
Goal

Identify the **minimal** set of inputs that trigger the bug

Minimal Causal Set



Minimal Causal Set



High-Level Approach

Modify history!

Possible failure causes

Set up first hypothesis

Test first hypothesis

Second hypothesis

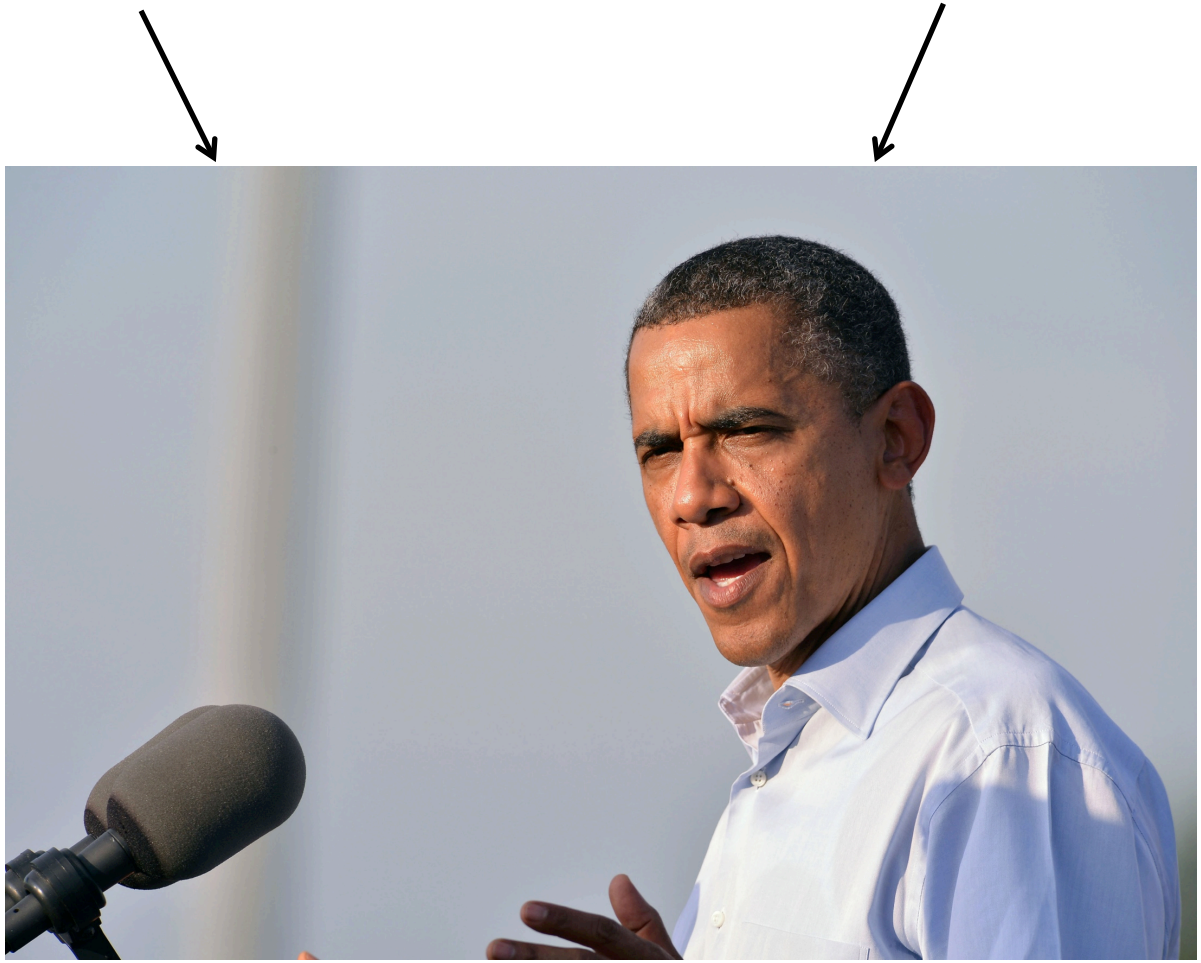
Third hypothesis

Fourth hypothesis...

Replaying Altered History is Hard

Pruning Causes Divergence

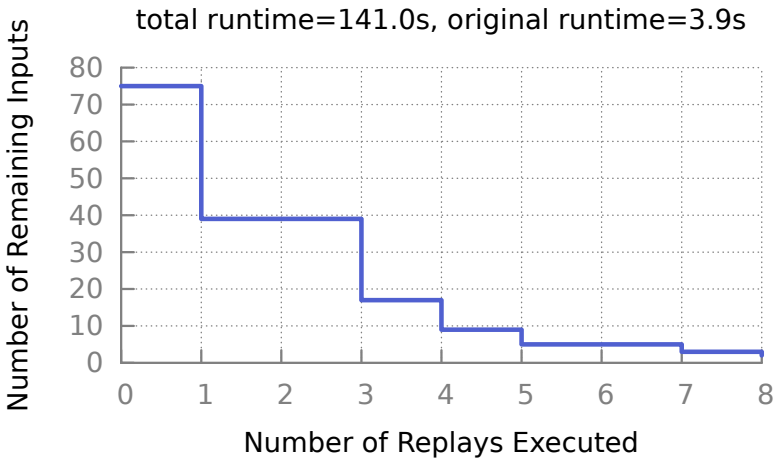
But usually it doesn't affect the result

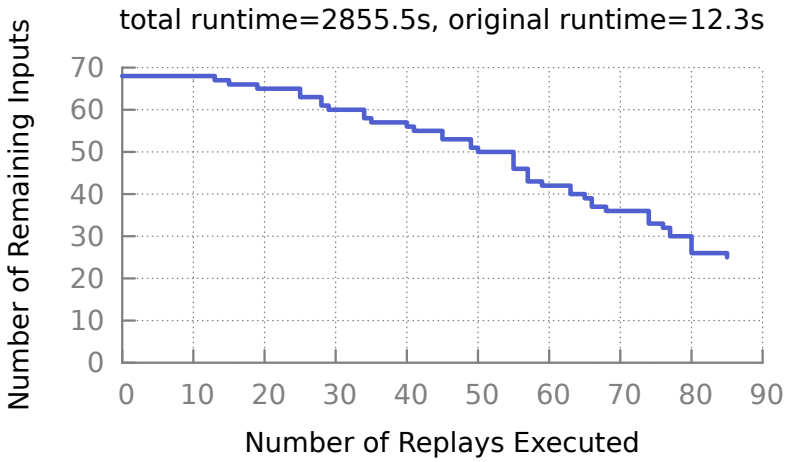


Need to Reason About Equivalence!

≈

It Works!


total runtime=141.0s, original runtime=3.9s
Number of Remaining Inputs
0
10
20
30
40
50
60
70
80
0
1
2
3
4
5
6
7
8
Number of Replays Executed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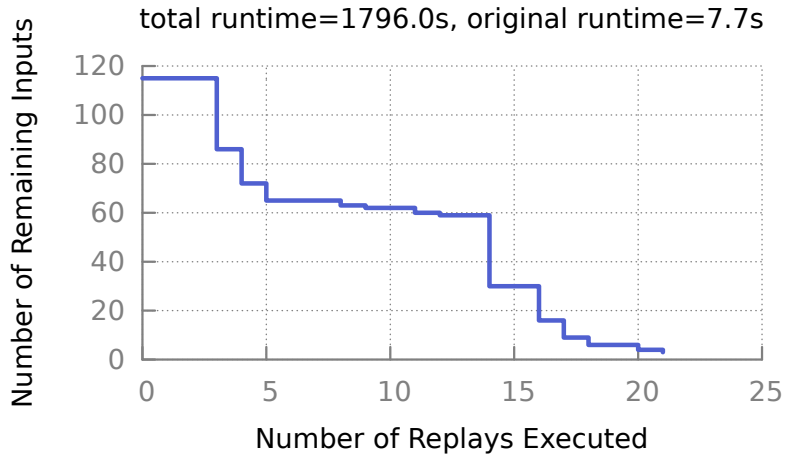
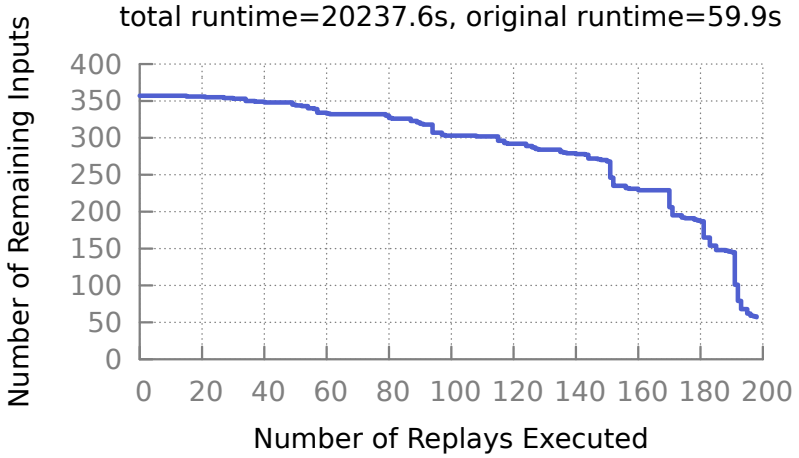
Number of Remaining Inputs
0
10
20
30
40
50
60
70
0
10
20
30
40
50
60
70
80
90
Number of Replays Executed


total runtime=1796.0s, original runtime=7.7s
Number of Remaining Inputs
0
20
40
60
80
100
120
0
5
10
15
20
25
Number of Replays Executed


total runtime=20237.6s, original runtime=59.9s
Number of Remaining Inputs
0
50
100
150
200
250
300
350
400
0
20
40
60
80
100
120
140
160
180
200
Number of Replays Executed

Summary

- Goal: automatically diagnose network problems
- Approach: iteratively alter history
- Check us out:

ucb-sts.github.com/sts/

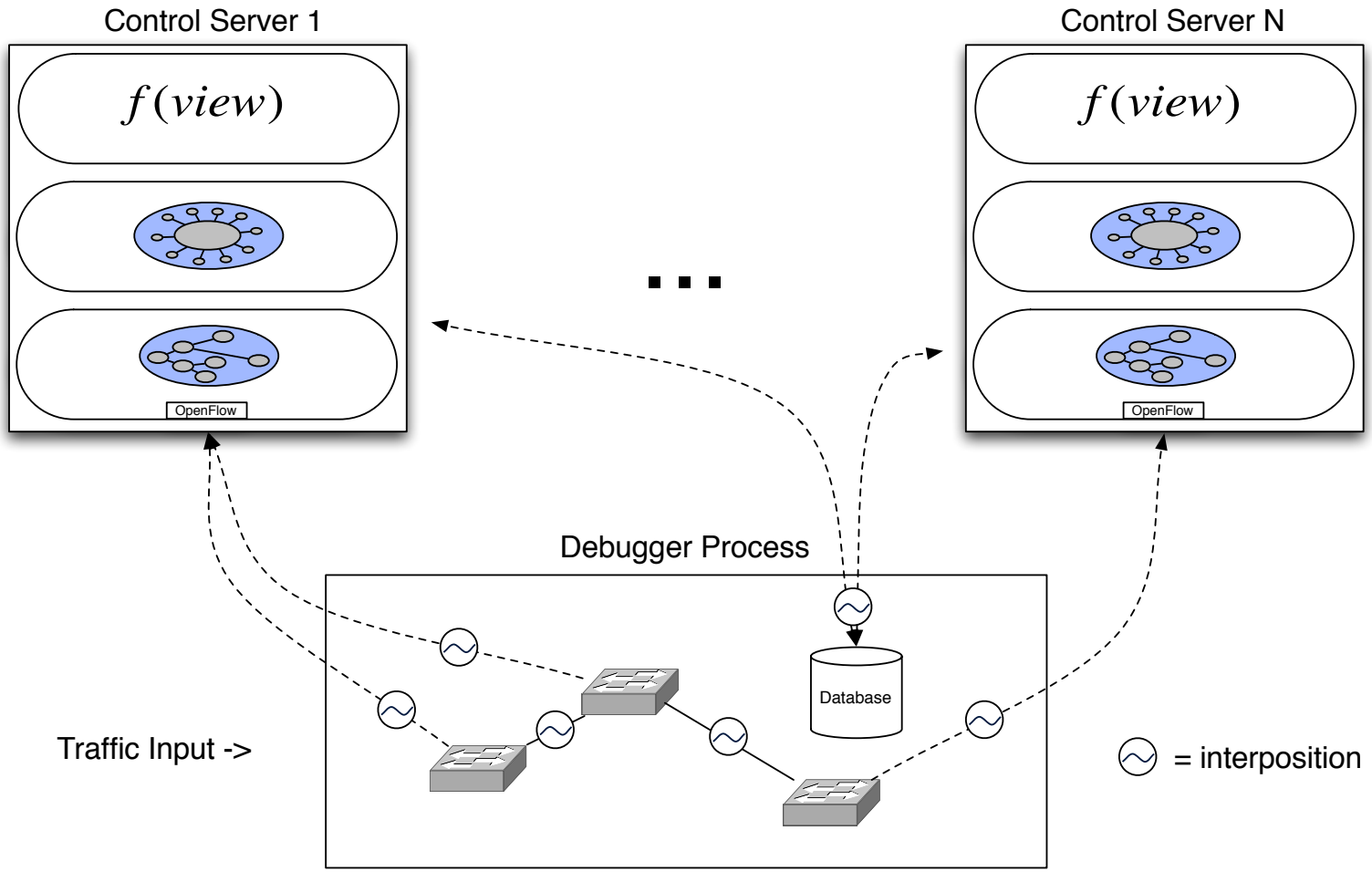
Backup

References

- [1] V. Soundararajan and K. Govil. Challenges in building scalable virtualized datacenter management. SIGOPS Operating Systems Review '10.

- [2] A. Greenberg, J. R. Hamilton, N. Jain, S. Kandula, C. Kim, P. Lahiri, D. A. Maltz, P. Patel, and S. Sengupta. VL2: a scalable and flexible data center network, Sec. 3.4. SIGCOMM '09.

Simulator


Control Server 1
f(view)
OpenFlow
Control Server N
f(view)
OpenFlow
Debugger Process
Database
Traffic Input ->
= interposition