

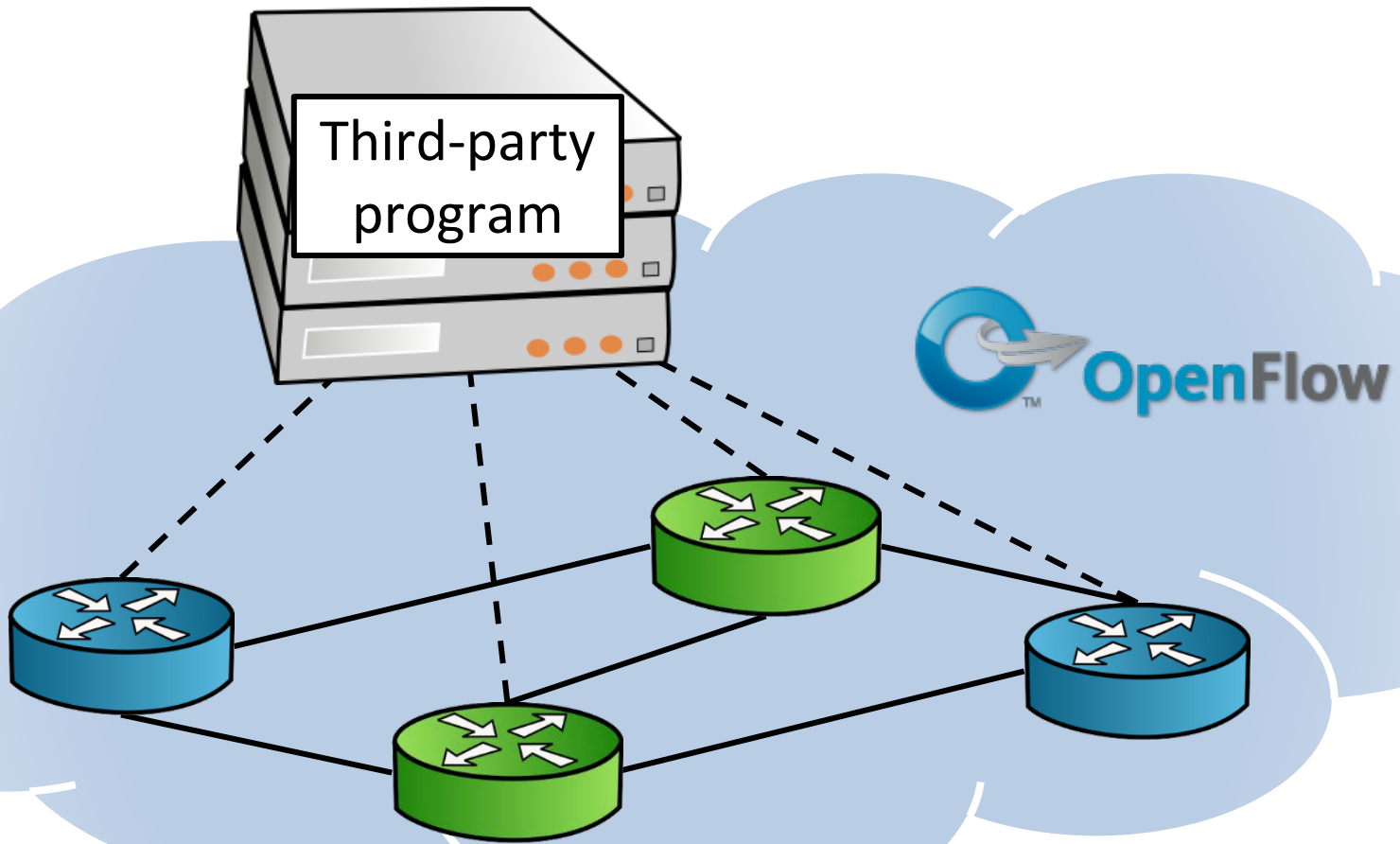
OFTEN Testing OpenFlow Networks

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Software-Defined Networking (SDN)



When Faults Happen



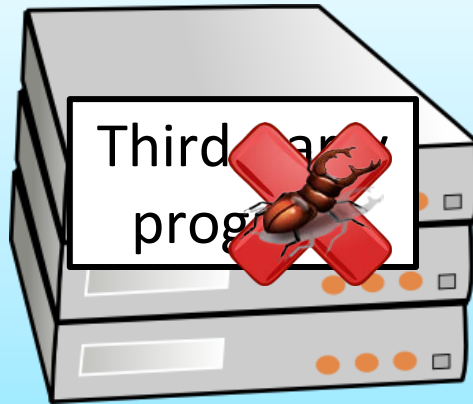
- Unreliable communication



- What is the rootcause?

Faults

NICE
[NSDI'12]

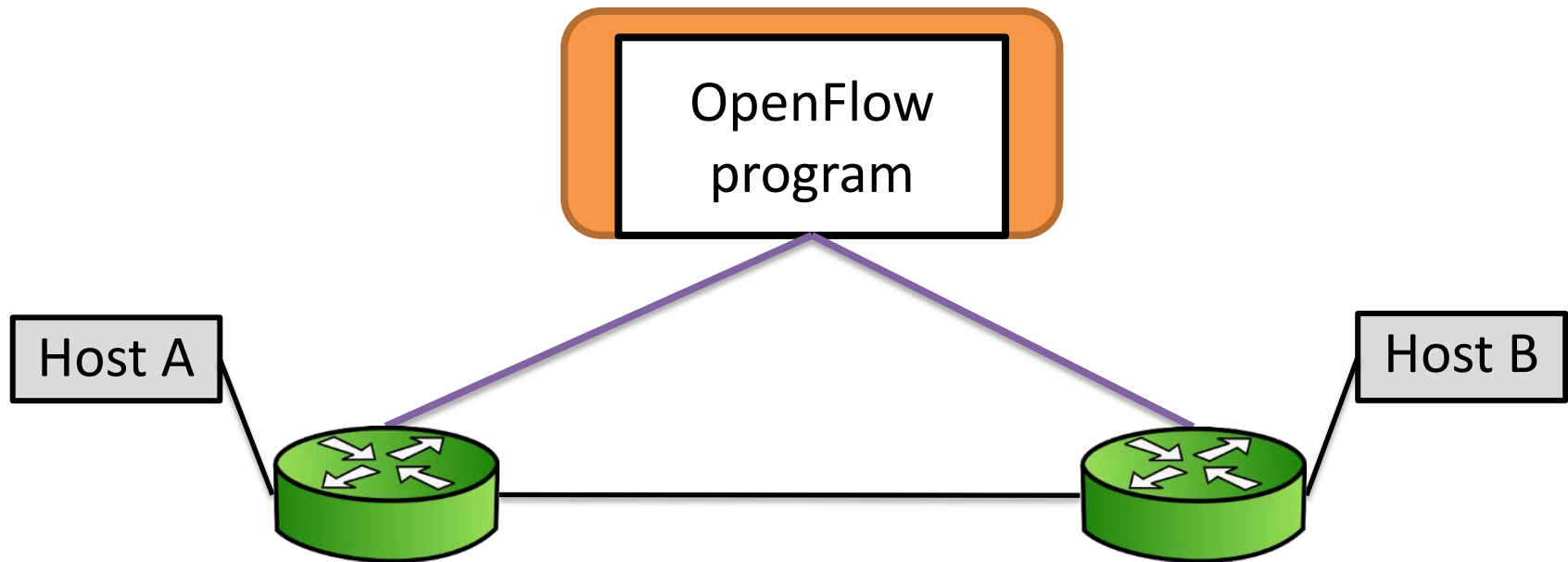


OFTest
SOFT

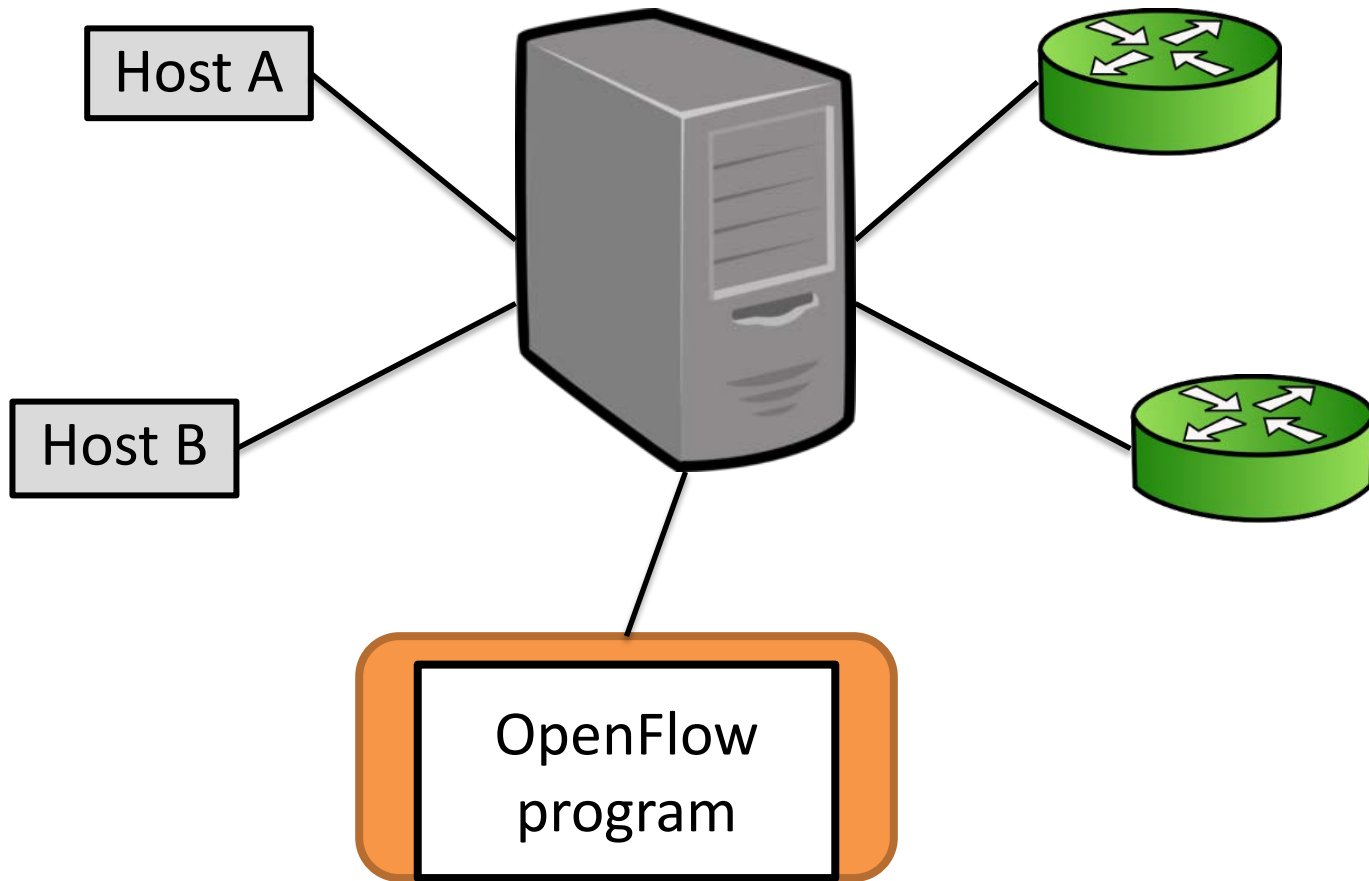
[CoNEXT'12]

We need to test an integrated SDN network

Testing Integrated Network



Testing Integrated Network

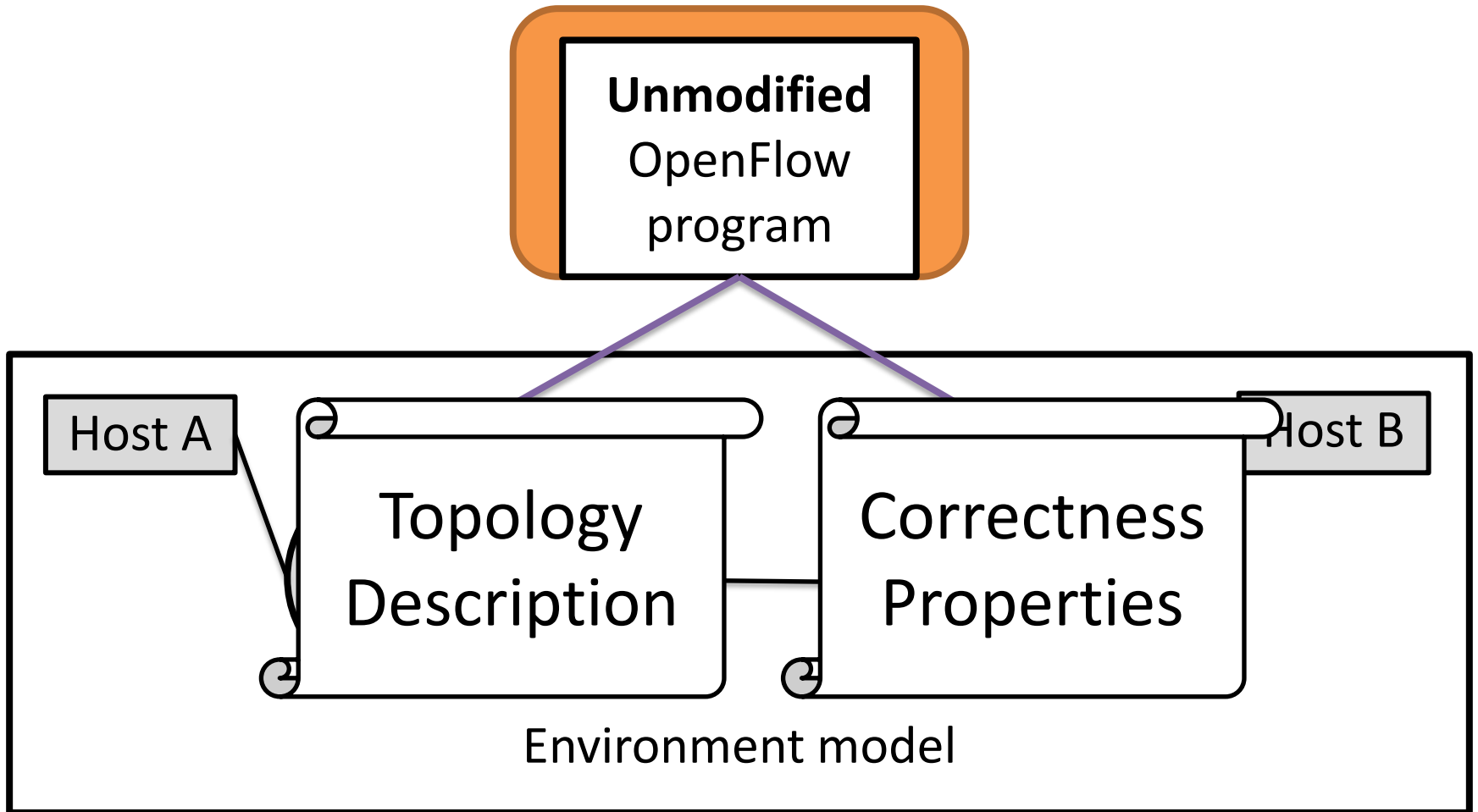


Challenges

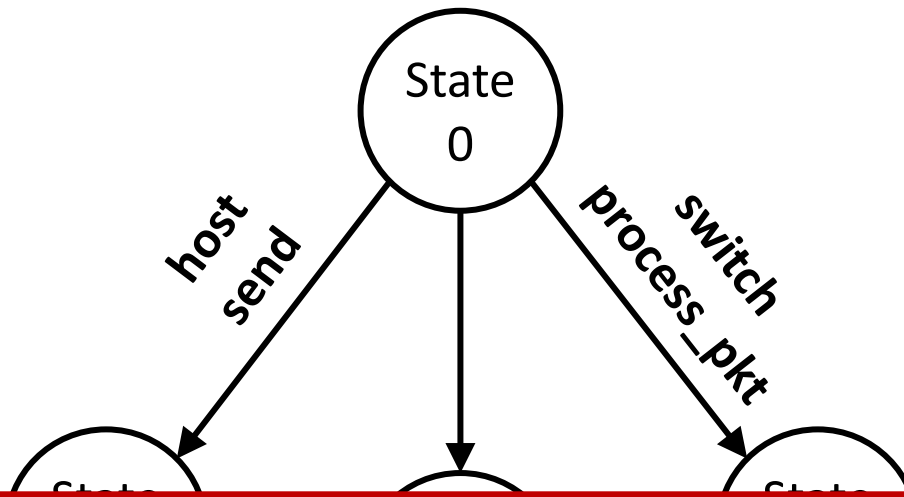
- Unmodified components
 - Switches as black boxes

- Correctness definition
 - Avoid false positives

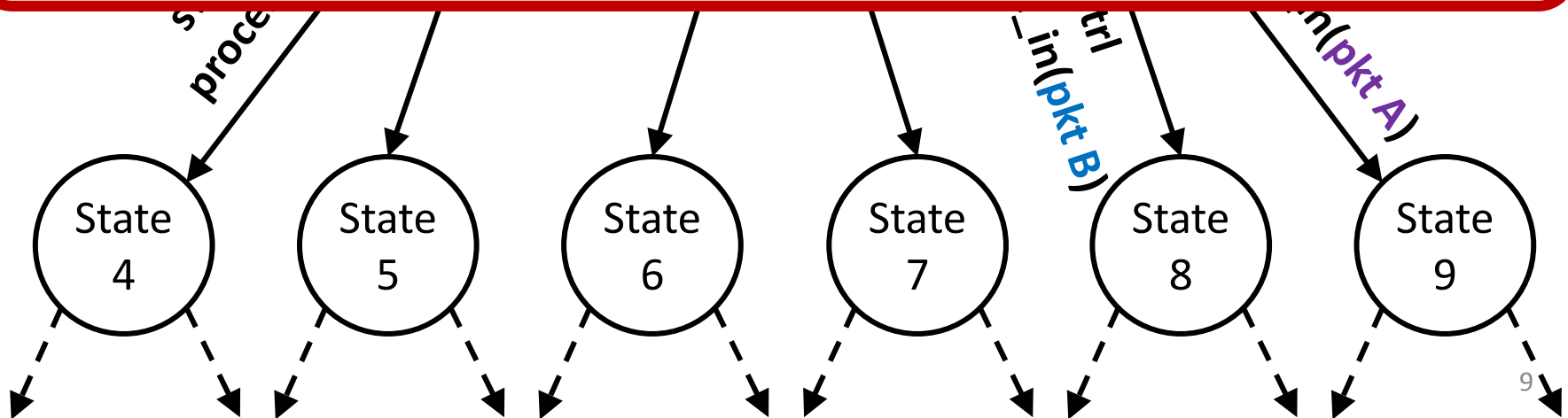
NICE



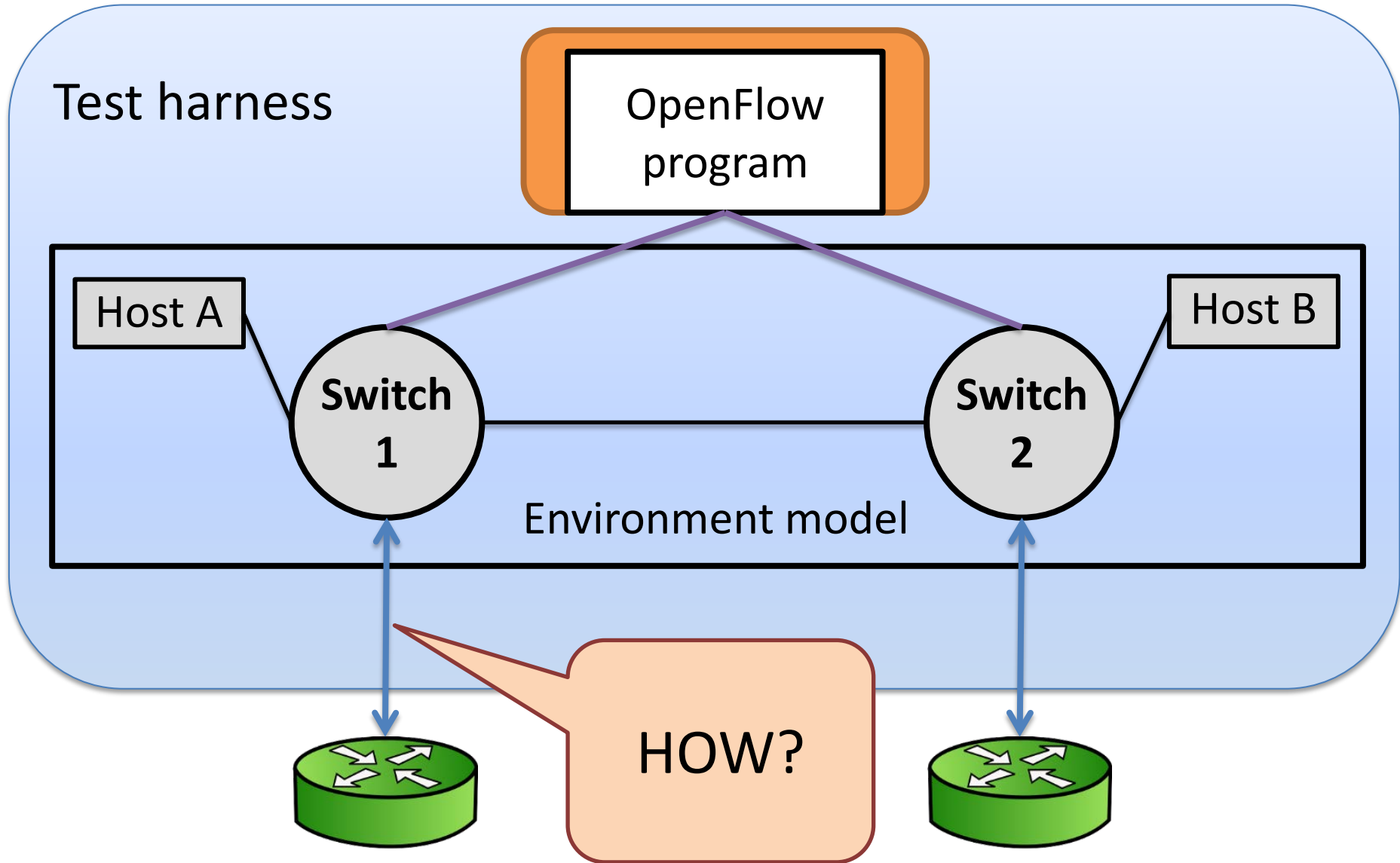
State-Space Exploration



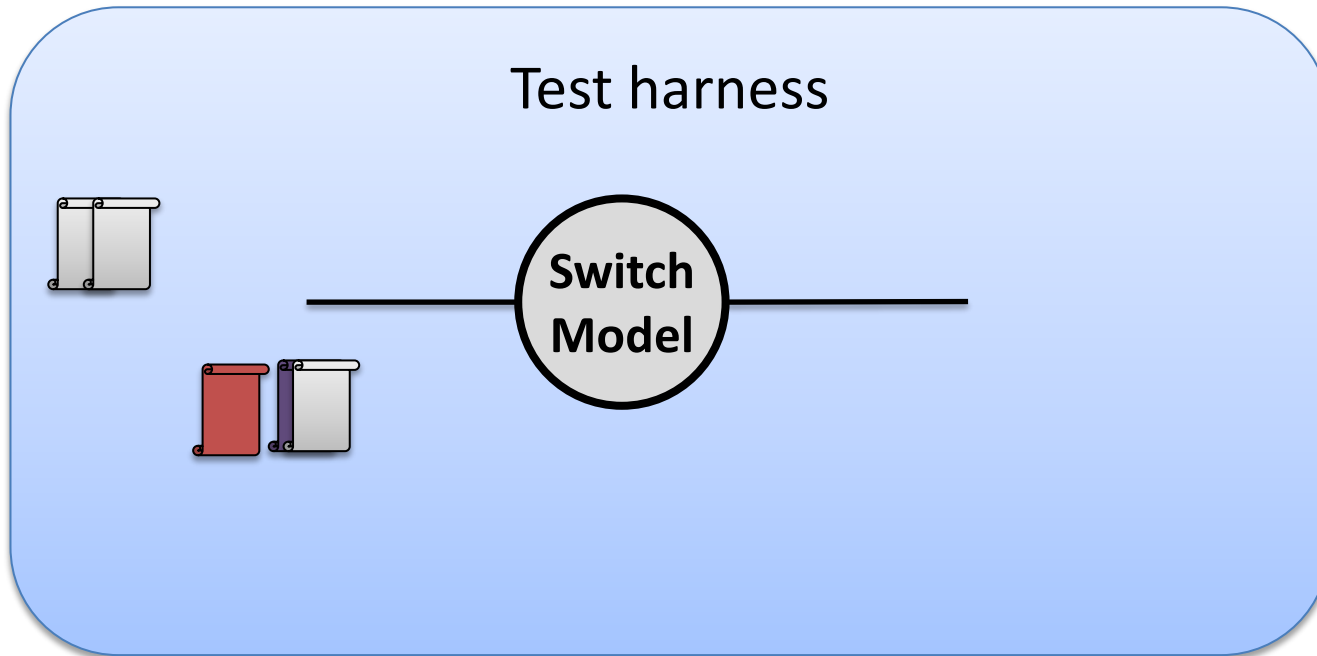
Define state and execute transitions



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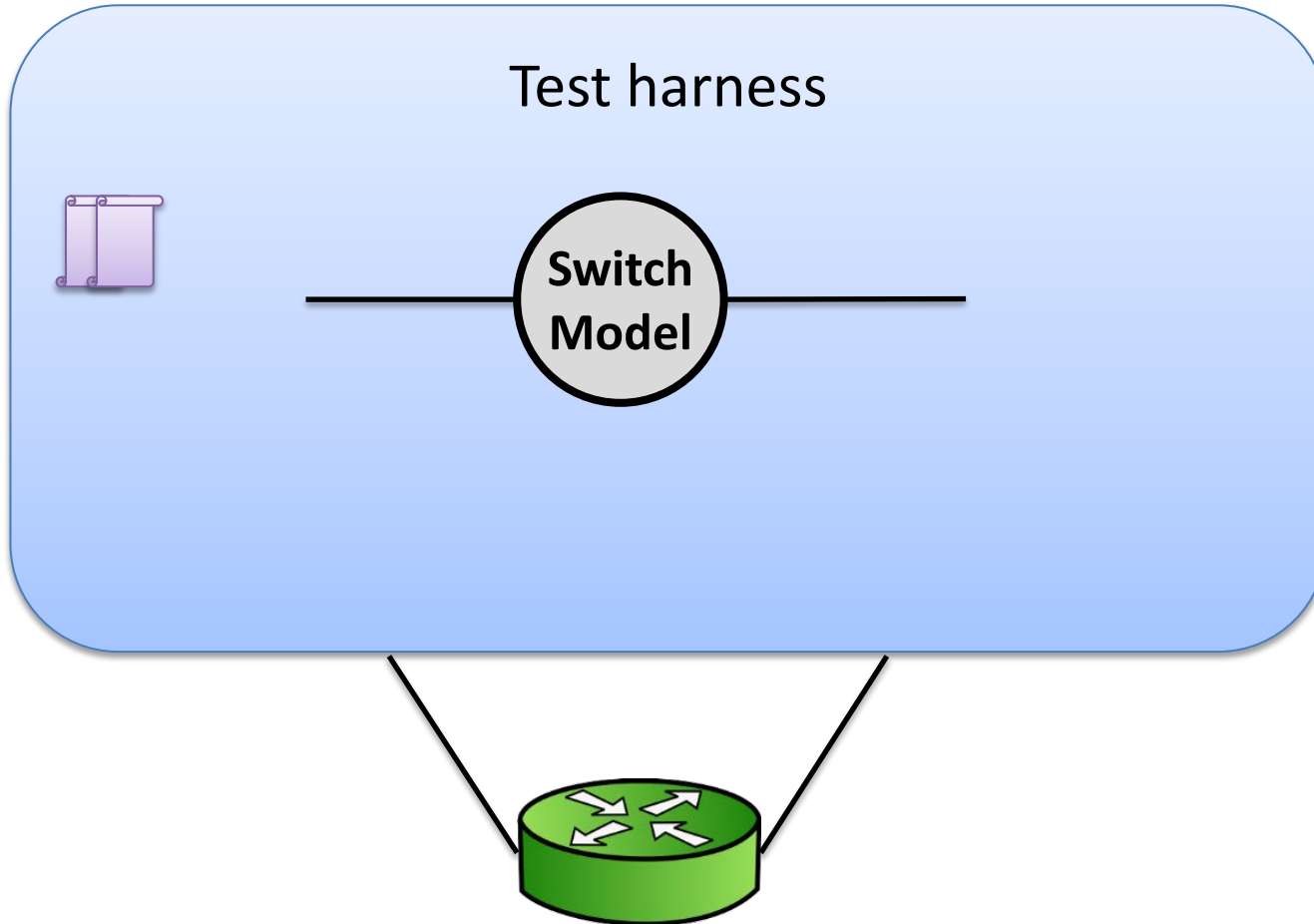


Problem I: Transitions - Packes



Flow	Table
MatchA	CTRL
MatchB	IN_PORT
...	...

Problem I: Transitions – Control Messages



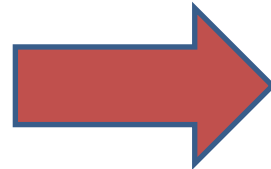
Problem II: Synchronizing states

Switch state

- Flow table
- Communication channels content

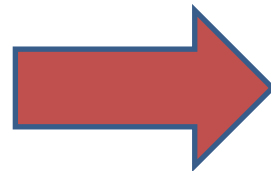
Problem III: Defining Correctness

- High-level correctness properties
 - Network-wide
 - User-defined



Faulty controller

- Switch-level



Faulty
switch or model

Results

- 3 applications
 - MAC-learning switch
 - Energy-aware traffic engineering
 - Web server load balancer
- 3 switches
 - Reference Stanford implementation
 - Open vSwitch
 - HP ProCurve E5406zl

Results

Load-balancer issue

- Send to the controller – 0 bytes

Incorrect PacketIn message fields

Conclusions

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- Testing of an integrated network
- Systematic state-space exploration
- Real unmodified switches

We need to test an integrated SDN network
that contains all real components

Future Work

Integrated network testing

- Required functionalities
- Interface extensions