Controller-agnostic SDN Debugging

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Motivation

- Debugging SDN applications is hard
- "Runs as designed" may be insufficient
- Deployments must cope with wide range of operating conditions
- How can we answer the following question:

Will my SDN app run as designed when deployed in a live setting?

Our solution: OFf!

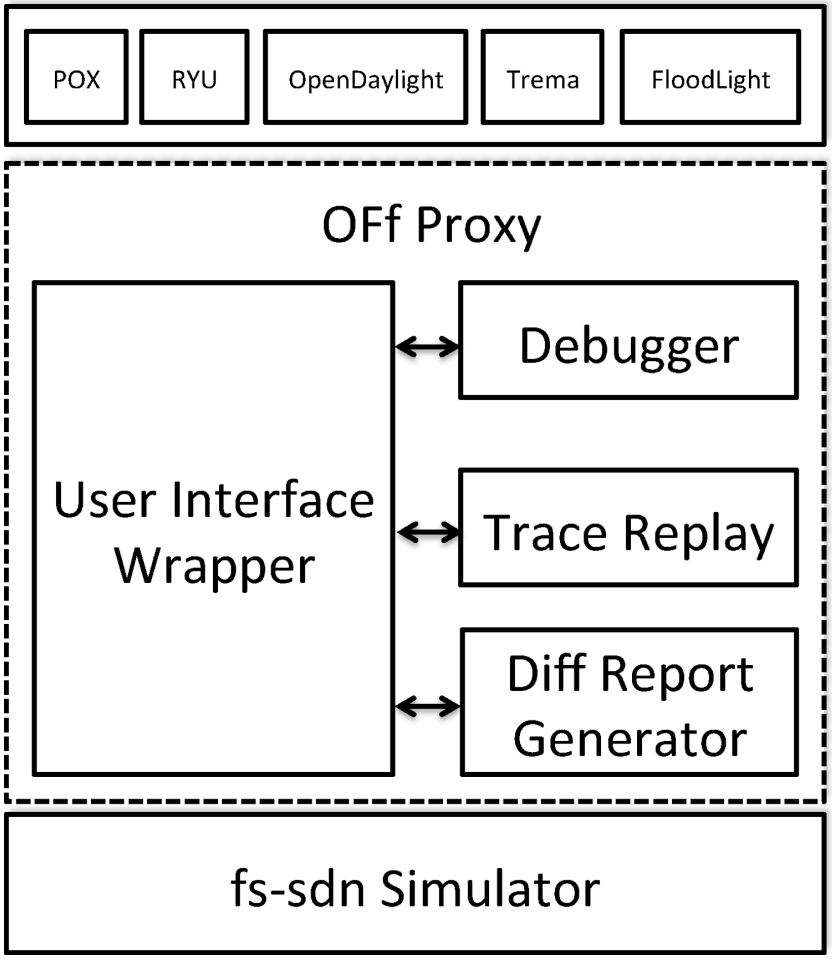
Design goals of OFf

- Controller-agnostic debugging and test environment for SDN developers
- Default debugging options
  - Stepping, breakpoints, watch variables, etc.
- Comprehensive testing for SDN applications
  - Packet replay, packet tracing, visualization, alerts, etc.
- Tie unwanted network behavior to faulty controller logic in source code
- Simple, light-weight and no hardware support
- Facilitate transition to live environments

fs-sdn simulation engine

- Fast and Accurate SDN prototyping (Gupta *et al.*, HotSDN 2013)
- Seamless transition of controllers to real deployments
- Based on fs simulator (Sommers *et al.*, IEEE Infocom 2011)
  - Discrete event simulation techniques
  - Core abstraction is flowlets; high performance
  - Transparently incorporates POX components
- Significant extensions to support OFf

OFf architecture



OFf commands

- longlist and shortlist source code
- pretty print expressions
- hide and unhide frames
- interactive interpreter with all variables in scope
- track, watch, or unwatch variables
- edit source files during debugging
- enable or disable break points on the fly
- sticky mode to visualize code

OFf additional features

- Trace packet through the network
  - *Holistic* view of flows, controller and switches
  - No additional hardware
- Replay packets later
  - No OFP modification
- Detect configuration changes
  - Topology changes
  - Rule/action changes
  - Performance variations

OFf in action

- We demonstrate OFf in three scenarios
  - Bad multi-app interaction
  - Incorrect ordering of updates
  - Unexpected rule expiration
- Goal: Identify logical bugs in the source code that lead to transient outages and losses

OFf in action

- We demonstrate OFf in three scenarios
  - Bad multi-app interaction
  - Incorrect ordering of updates
  - Unexpected rule expiration
- Goal: Identify logical bugs in the source code that lead to transient outages and losses

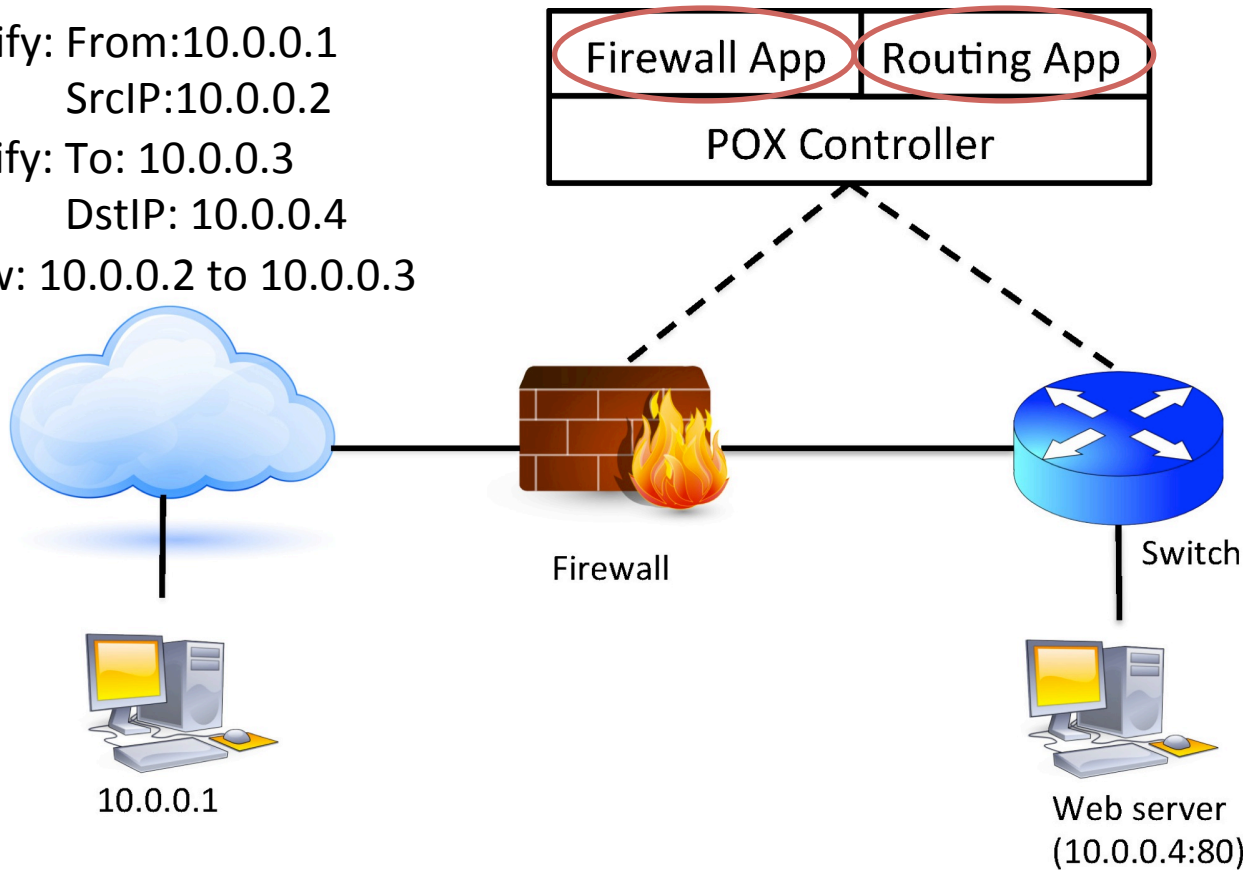
Bad multi-app interaction

~~Block: 10.0.0.1 to 10.0.0.4~~

Modify: From:10.0.0.1
SrcIP:10.0.0.2

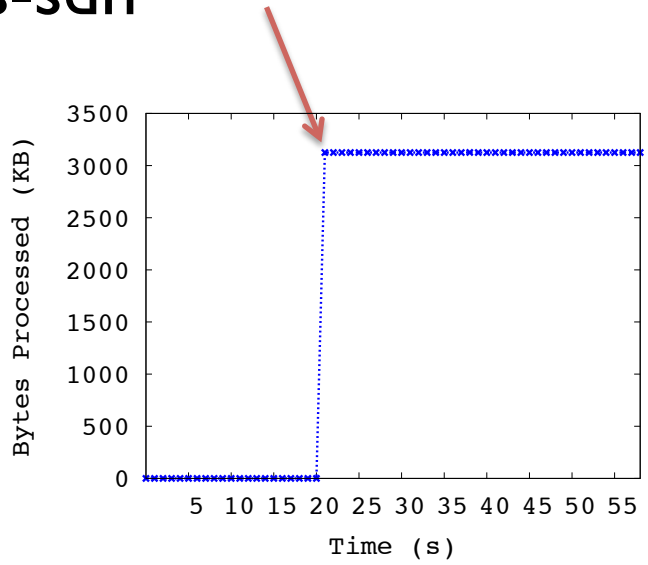
Modify: To: 10.0.0.3
DstIP: 10.0.0.4

Allow: 10.0.0.2 to 10.0.0.3



Solution: Bad multi-app interaction

- Using OFf developer 2 can
  - collect network traces (T1)
  - prototype routing app using fs-sdn
  - collect traces again (T2)
  - runs diff reports (T1 and T2)
    - Rule set conflicts are found
  - Change and iterate
  - Verify firewall invariants



Conclusion

- OFf – a controller-agnostic debugging and test environment for SDN developers
- OFf is simple, flexible, and light-weight
- We demonstrate OFf using three scenarios
- Future work
  - Generation of regression tests, fuzz testing, etc.

Thank you!

Source Code
https://github.com/52-41-4d/fs-master

Questions?