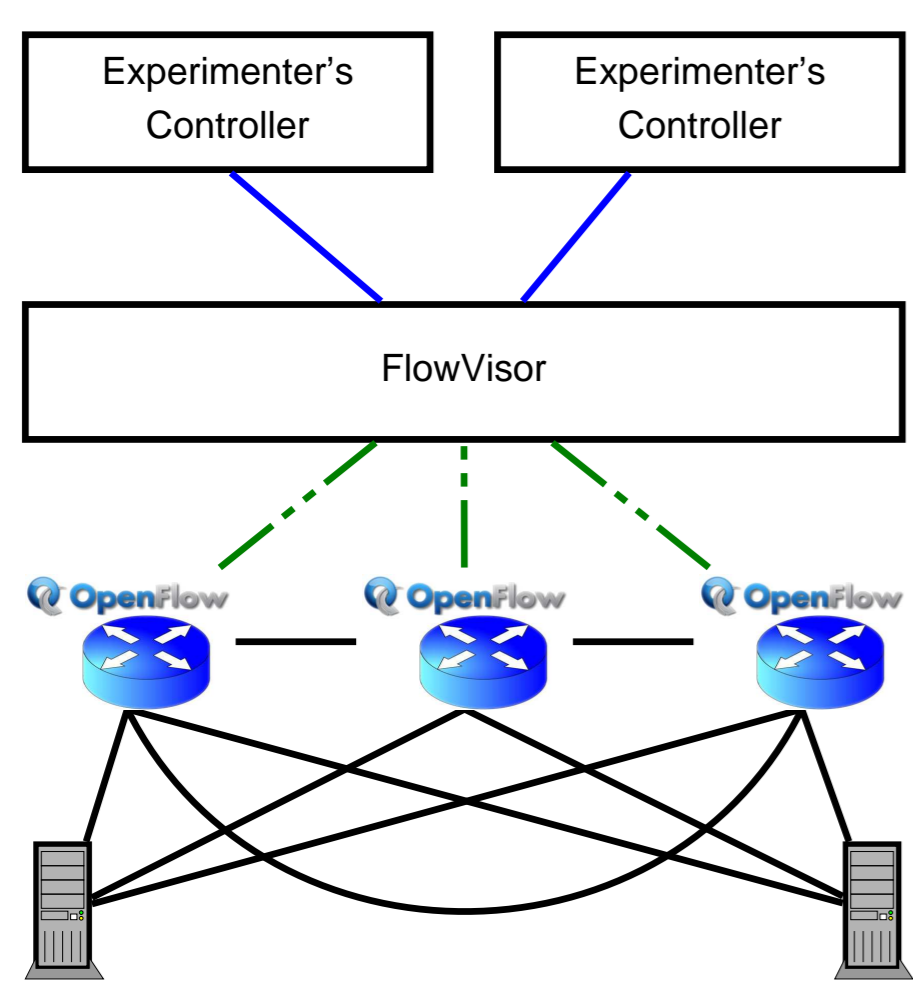


Bringing user traffic to the testbed



- SDN testbeds deployed everywhere
 - Stand-alone islands for safety and privacy
 - Experiments go wrong
 - User traffic is highly sensitive
 - But sometimes, user traffic is necessary!
- ⇒ **Covering the gap between model and reality**

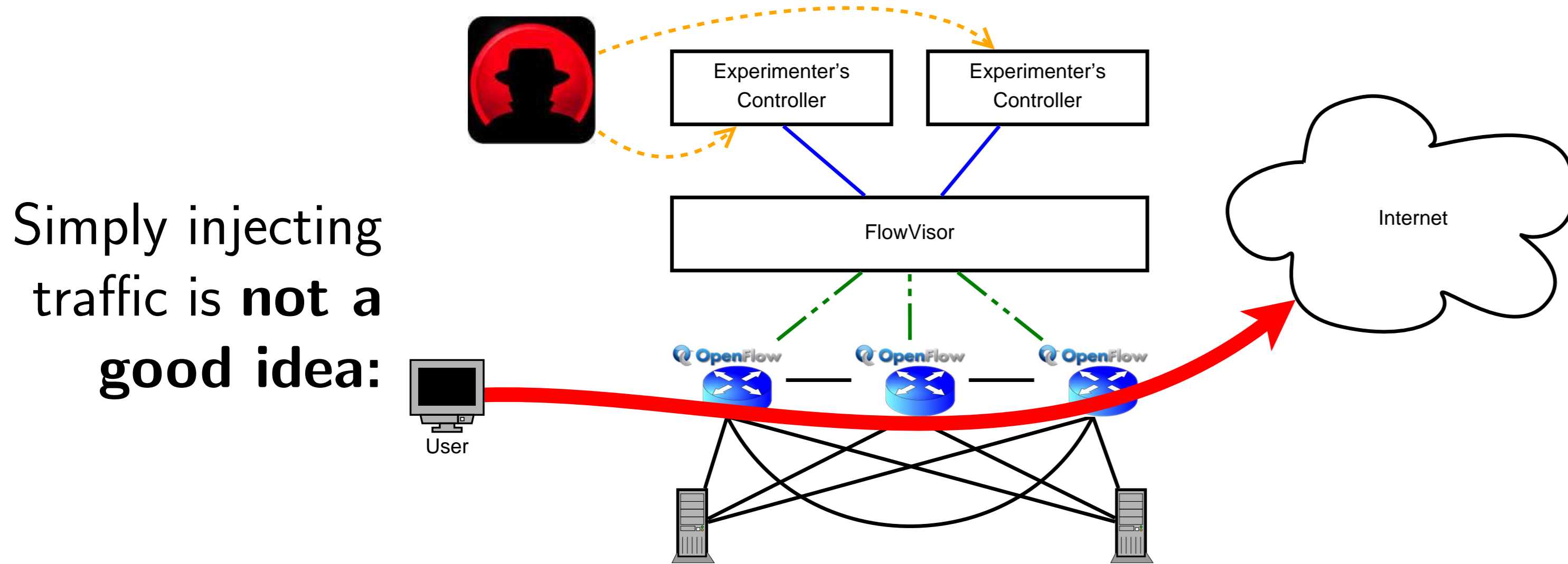
What is an SDN testbed?



Network slice:

- Virtual hosts
- Virtual topology

Risks when bringing traffic into a testbed



Simply injecting traffic is **not a good idea**:

Privacy threats

- Learn about traffic patterns
- Direct packets to controller
- Direct packets to hosts under attacker's control

Availability threats

- Drop packets
- Create forwarding loops
- Disable switch ports
- Inject packets in established communication

Attacker model

- OpenFlow 1.0
- Access to testbed hosts
- Possible control of multiple slices
- Access to external resources, e. g., hosts
- Assume: no software flaws, and OpenFlow switches are bug free

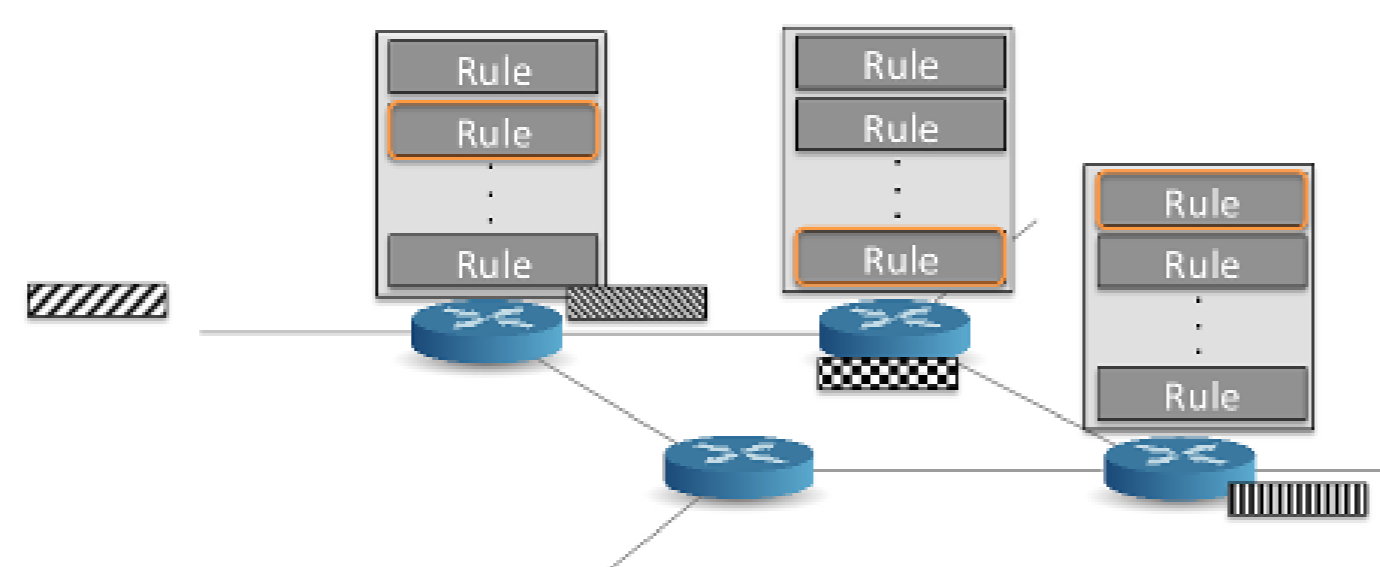


[Shamelessly plugged from the BlackHat conference]

How does it work?

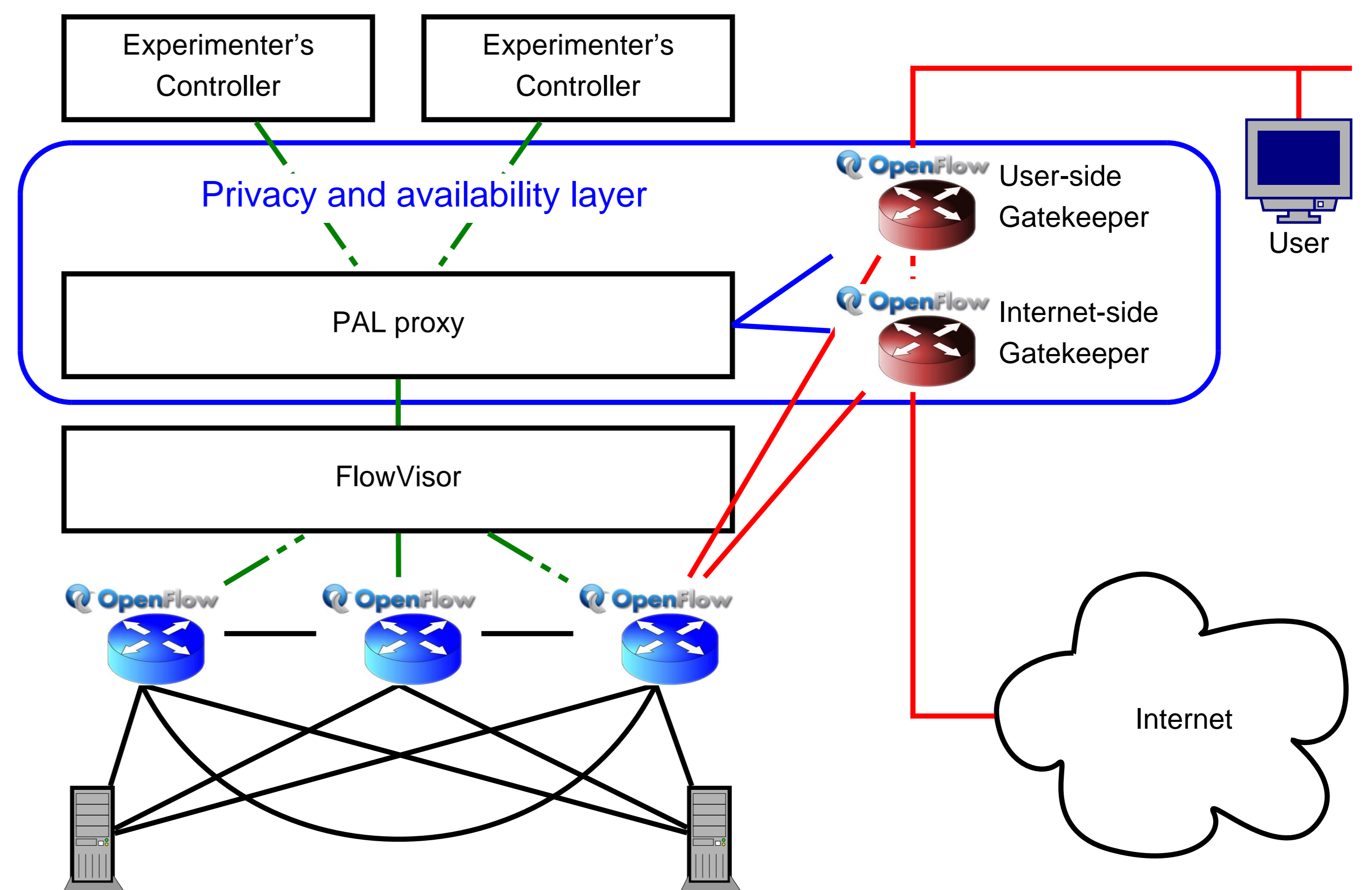
Utilize Header Space Analysis [1]

- Tracking how flows propagate
- Uses a header space algebra: Set-algebra on network flows
- Quite expensive!



[1] Kazemian et al. Real Time Network Policy Checking Using Header Space Analysis. NSDI'13.

Privacy and Availability Layer: PAL



- Proxy intercepts OpenFlow messages, can reject messages
- Gatekeepers perform selective traffic injection
- **Policy violation** ⇒ **short-circuit testbed**

Building a marketplace



Three roles

- User** specifies policies
- Experimenter** defines requirements for test traffic, provides incentives
- Operator** matches user traffic to experiments, enforces guarantees

Example policies

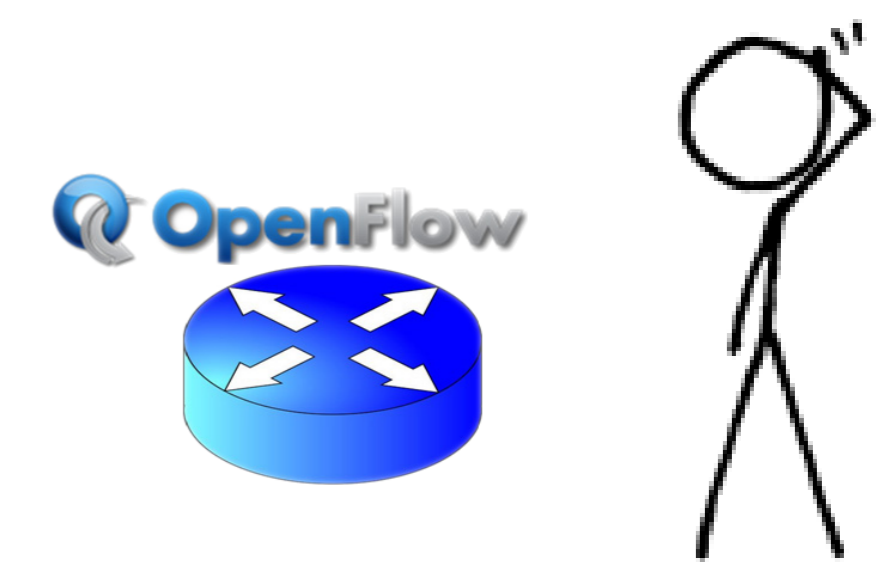
Part of traffic	Guarantees	Experiment
Facebook	no-sniff, copy-traffic	any
BitTorrent	none	transparent BT cache
E-Banking	direct-delivery	-

How to attract users

- Network services
 - IP address anonymization
 - Network usage statistics
 - On-demand network tunnels
- Games and competitions
- Money



Insights



- Worst case: HSA exponentially expensive
- OpenFlow quirks make things harder than necessary
 - **Flow timeouts triggered by switch**
 - Ambiguities introduced by OF specification further help attacker

⇒ Need to limit analysis effort and to pro-actively handle timeouts

Summary

- Marketplace enables users to voluntarily donate traffic
 - Experimenters may have to provide incentives, though
- Demonstrator running, final product to be deployed in OFELIA
- Approach is general: Outsourcing routing, "SDN app-store"