Stateful Connection Tracking & Stateful NAT

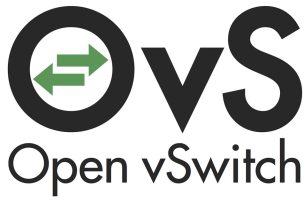
Justin Pettit
VMware

Thomas Graf
Noiro Networks, Cisco

Open vSwitch

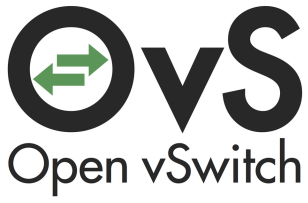
Agenda

- Connection Tracking
- NAT
- Integration of other stateful services



We had a performance problem

- With some traffic patterns, performance of OVS could be quite bad
- Last week, we added a post to Network Heresy describing the changes we made to improve performance and the results
- Focus of past two years was on performance. Now that we feel good about the performance, we're back to looking at features
- Any addition to OVS must consider its implication on performance



Implementing a Firewall

- OVS has traditionally only supported stateless matches
- As an example, currently, two ways to implement a firewall in OVS
  - Match on TCP flags (Enforce policy on SYN, allow ACK|RST)
    - Pro: Fast
    - Con: Allows non-established flow through with ACK or RST set, only TCP
  - Use “learn” action to setup new flow in reverse direction
    - Pro: More “correct”
    - Con: Forces every new flow to OVS userspace, reducing flow setup by orders of magnitude
  - Neither approach supports “related” flows or TCP window enforcement

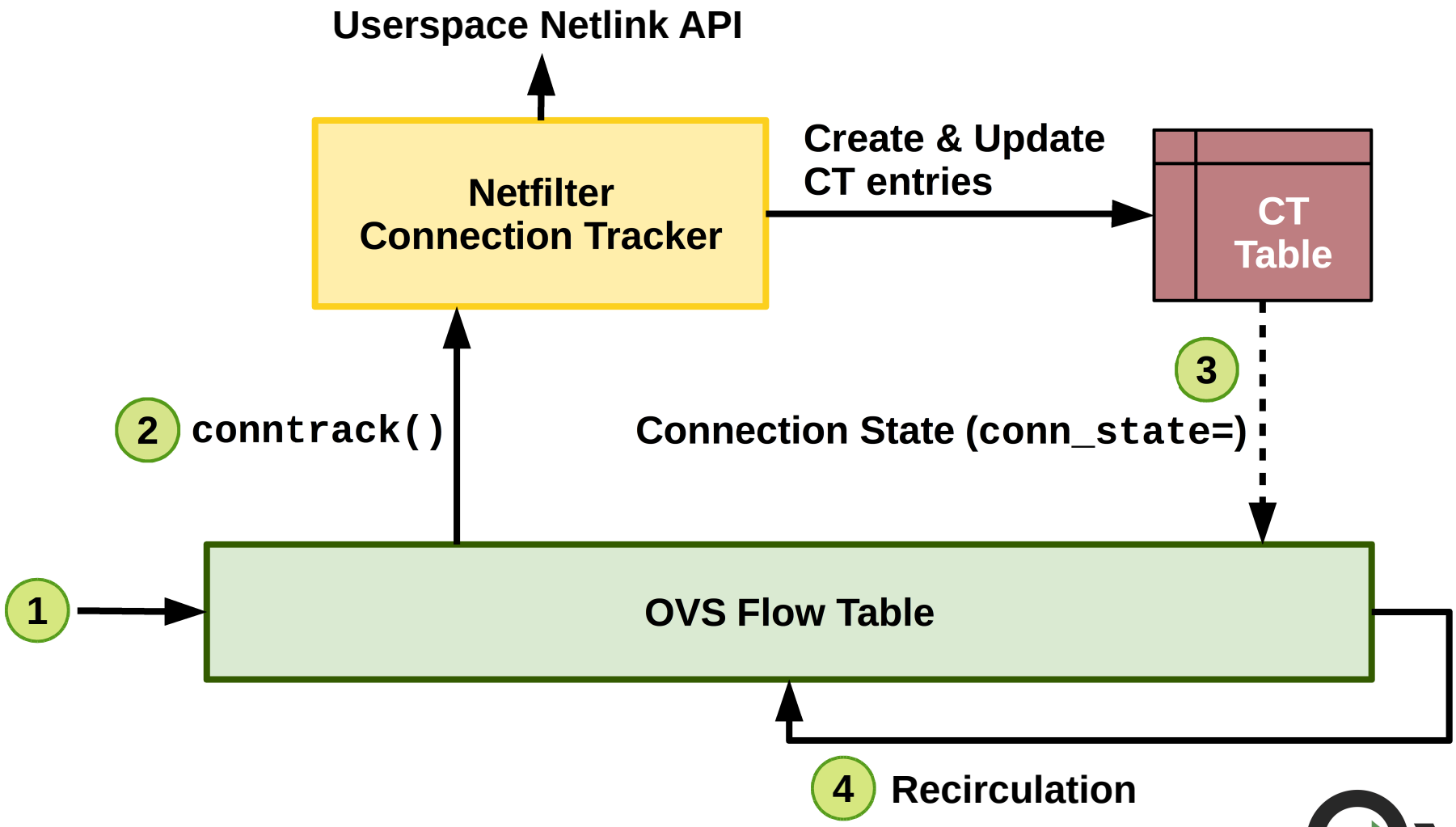
Open vSwitch

Connection Tracking

- We are adding the ability to use the conntrack module from Linux
  - Stateful tracking of flows
  - Supports ALGs to punch holes for related “data” channels
    - FTP, TFTP, SIP
- Implement a distributed firewall with enforcement at the edge
  - Better performance
  - Better visibility
- Introduce new OpenFlow extensions:
  - Action to send to conntrack
  - Match fields on state of connection

Open vSwitch

Netfilter Conntrack Integration



Open vSwitch

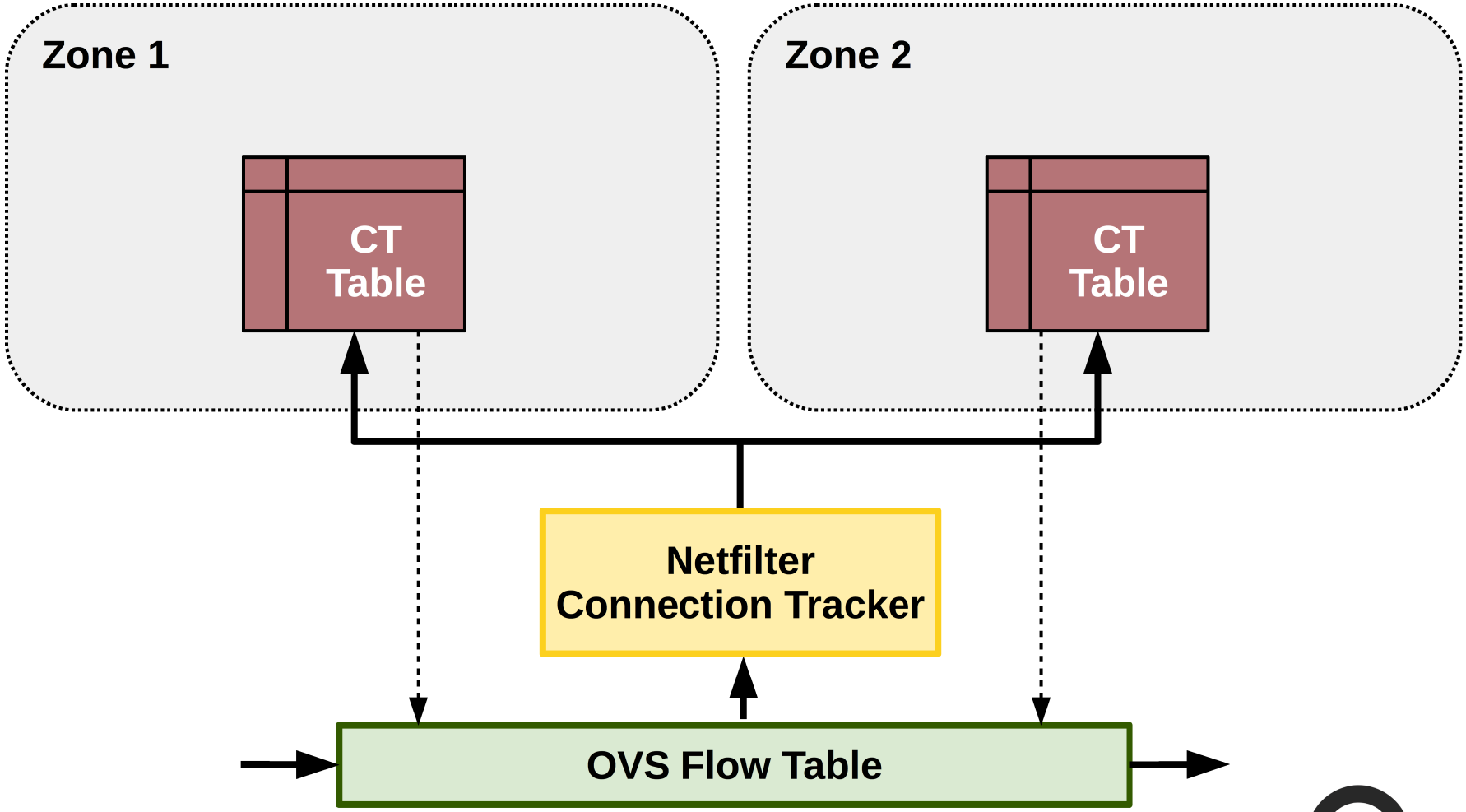
Conntrack Example

Conntrack example that only allows port 2 to respond to TCP traffic initiated from port 1:

Match	Action
`in_port(1),tcp,conn_state=-tracked`	`conntrack(zone=10),normal`
`in_port(2),tcp,conn_state=-tracked`	`conntrack(zone=10,flags=recirc)`
`in_port(2),tcp,conn_state=+established`	`output:1`
`in_port(2),tcp,conn_state=+new`	`drop`

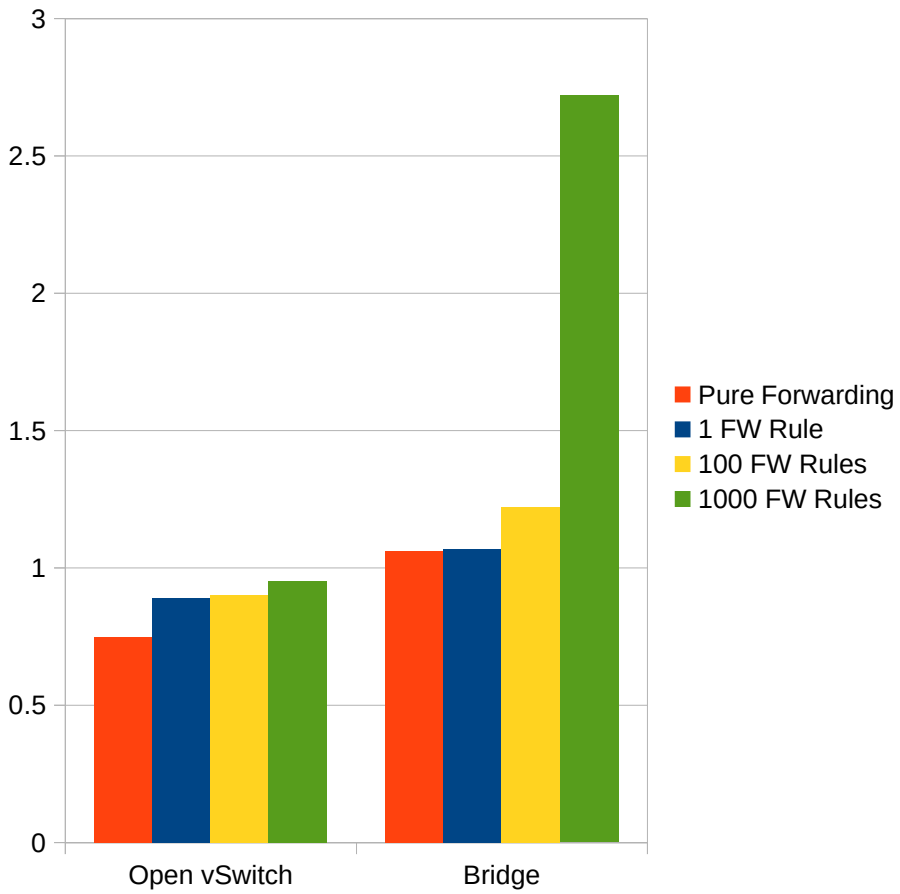
Open vSwitch

Connection Tracking Zones



Open vSwitch

Flow Caching Works



Number of gigacycles per second required to saturate a 10Gbps link with netperf TCP_STREAM. (Lower is better)

- Preliminary results are quite promising
  - OVS+conntrack uses a nearly consistent rate regardless of number of rules
  - Bridge+iptables uses more CPU as rule count increases

Open vSwitch

Design Goals

- Performance implications must be thought through
- Thought needs to be put into API, since OVS and OpenFlow have traditionally been flow-based and stateless
- While this will only be supported on Linux initially, the API shouldn’t be Linux-specific
- New stateful features being discussed and leveraging kernel:
  - NAT
  - Load-balancing through IPVS
  - DPI

Open vSwitch

Release Plan

- Will ship with OVS 2.4
- Will include:
  - connmark
  - IP fragment reassembly
  - Hide break in pipeline from userspace
- Available to try now:
  - https://github.com/justinpettit/ovs/tree/conntrack

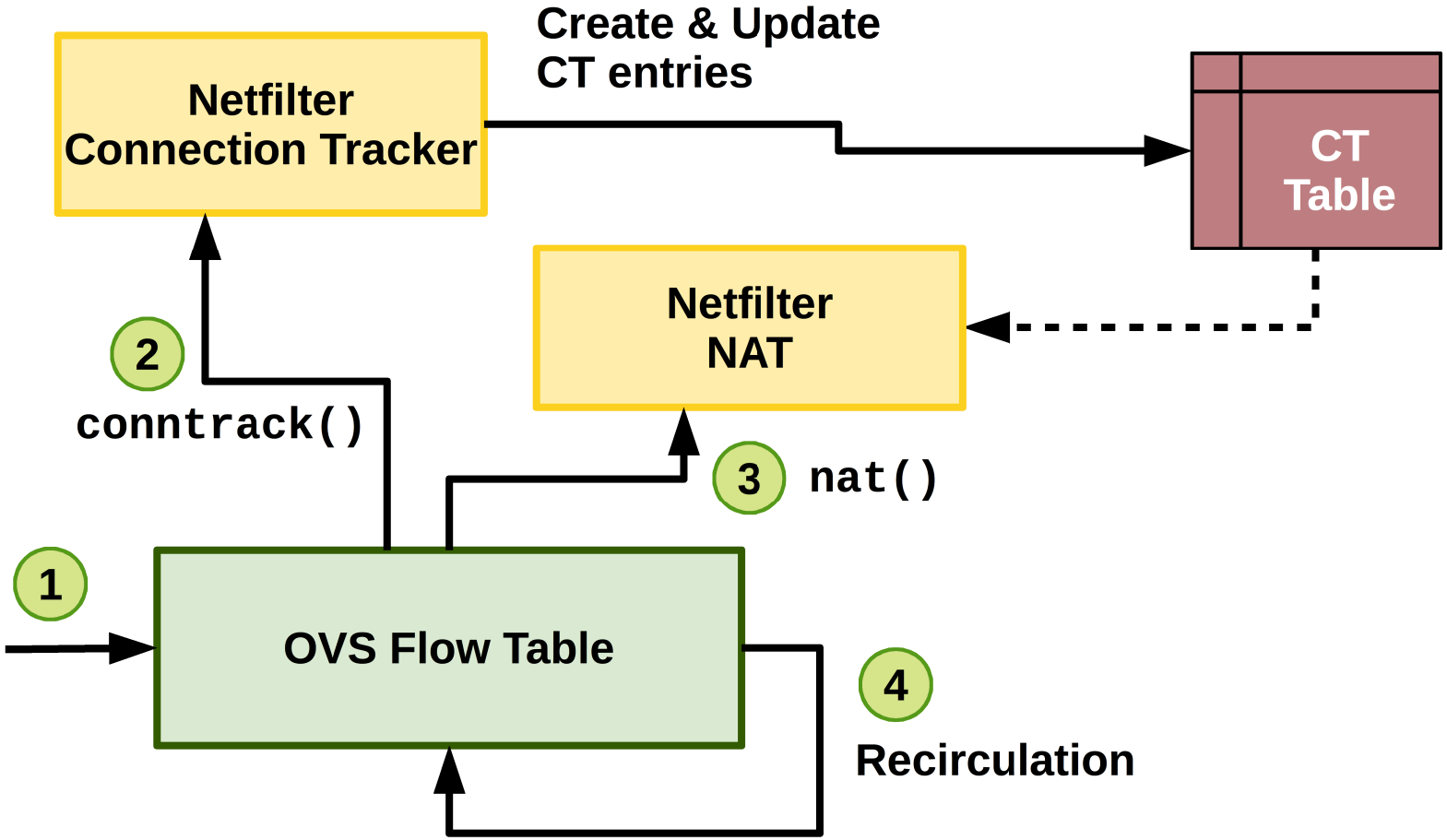
Open vSwitch

Stateful NAT Overview

- SNAT and DNAT
- Based on connection tracking work
- Leverages stateful NAT mechanism of Netfilter
- Able to do port range and address range mappings to masquerade multiple IPs
- Mapping Modes
  - Persistent (across reboots)
  - Hash based
  - Fully random

Open vSwitch

Stateful NAT Flow



Open vSwitch

NAT Example

SNAT all TCP packets on port 1 to the IP range 10.0.0.1/24 with reverse SNAT on port 2:

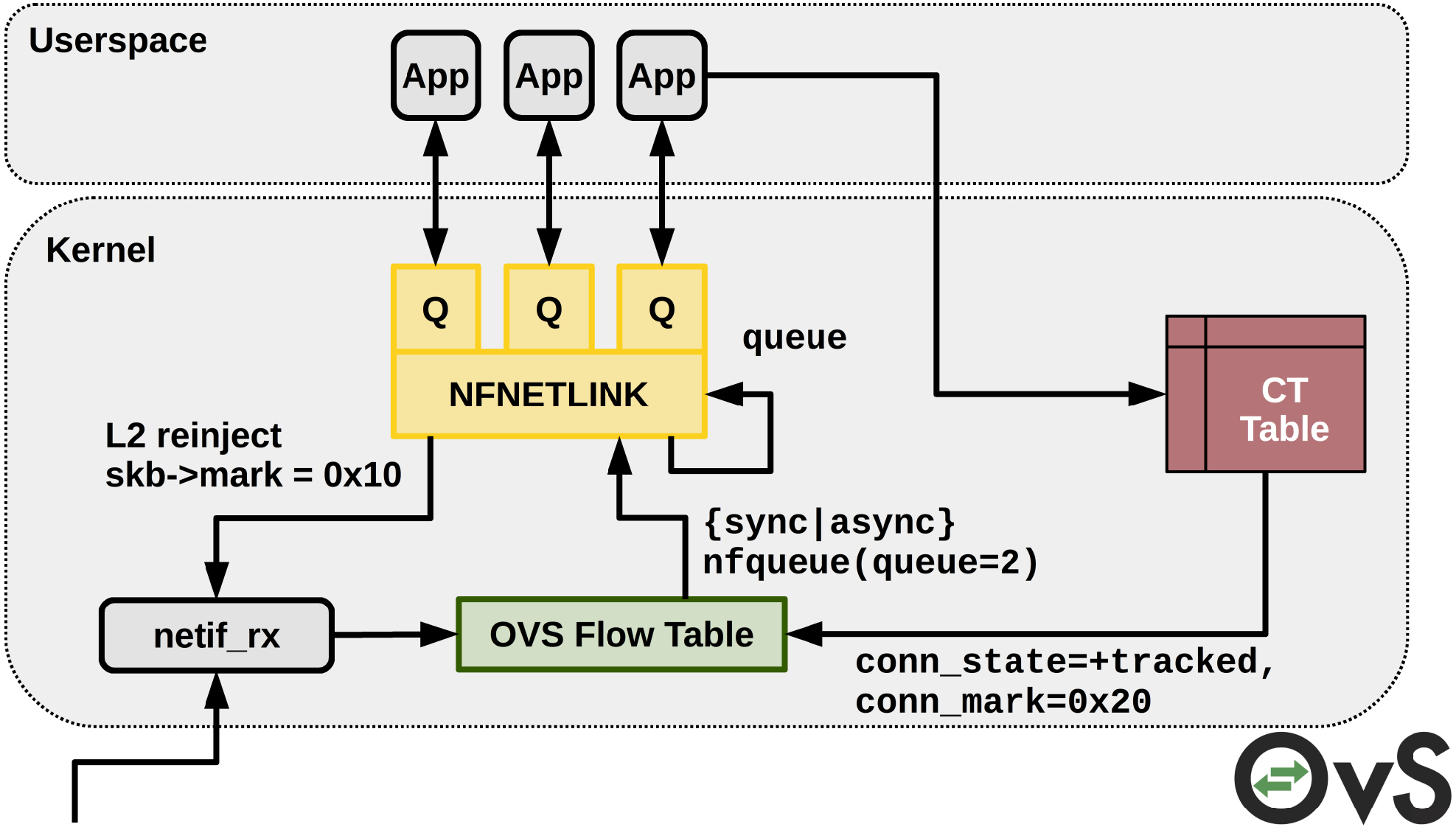
Match	Action

`in_port(1),tcp`	`conntrack(zone=10),`
	`nat(type=src,`
	`  min=10.0.0.1,`
	`  max=10.0.0.255,`
	`  type=hash)`

`in_port(2),tcp,conn_state=-tracked`	`conntrack(zone=10,flags=recirc)`
`in_port(2),tcp,conn_state=+established`	`nat(reverse)`
`in_port(2),tcp,conn_state=+new`	`drop`

Open vSwitch

Stateful services integration: NFQUEUE action



Open vSwitch

NFQUEUE action

- Can reuse existing Netfilter queueing mechanism and libnfnetlink + libctnetlink
- Operational Modes:
    1. Steal/Drop – Async verdict via CT template
    2. Reinjection – Sync verdict via NFQA_MARK
- Needed netfilter modifications:
  - Reinjection routine for NFPROTO_BRIDGE back into netif_rx()
- OVS modifications
  - New nfqueue action

Open vSwitch

Q&A

- More Information:
  - http://openvswitch.org/

- Code:
  - Conntrack (WIP):
    - https://github.com/justinpettit/ovs/tree/conntrack
  - Stateful NAT (WIP):
    - https://github.com/tgraf/ovs/tree/nat

Open vSwitch