TAEP

Traffic Analysis and Experimentation in a Production Network

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TAEP : A/B Experiments in Production

"By combining the power of software with the scientific rigor of controlled experiments, your company can create a learning lab. The returns you reap in cost savings, new revenue, and improved user experience can be huge. If you want to gain a competitive advantage, your firm should build an experimentation capability and master the science of conducting online tests."

https://hbr.org/2017/09/the-surprising-power-of-online-experiments

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TAEP : A/B Experiments in a Production Network

A/B testing on Network Traffic is harder than for UI/UX due to:

- Speed and amount of network traffic
- Missing control APIs to setup and run an experiments in an automated way
- Missing “Big Data” solutions
- Missing insights which are needed to define A, the base line
- Harder to limited impact of a failed experiment
- Missing Network Protocols

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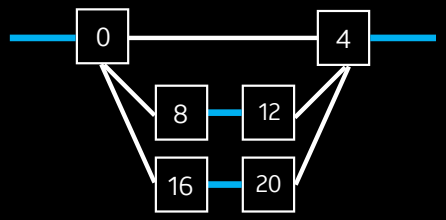
TAEP : Ingredients

Keep it simple, Cabling



Barefoot Wedge 100BF-32X

1 straight through path
2 traffic-divert options

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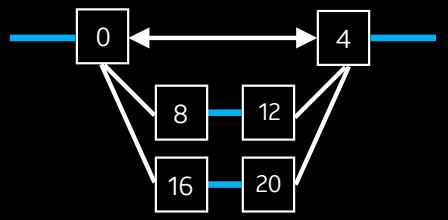
TAEP : Ingredients

Keep it simple, P4, Forward

```
/*************************************************************/
/* Forward Packet                                            */
/*************************************************************/

action set_egr(egress_spec) {
    modify_field(ig_intr_md_for_tm.ucast_egress_port, egress_spec);
}

table forward {
    reads {
        ig_intr_md.ingress_port : exact;
    }
    actions {
        set_egr;
        _nop;
    }
    size: BAREFOOT_MAX_PORTS;
}
```



ingress port	action	egress port
0	set_egr	4
4	set_egr	0

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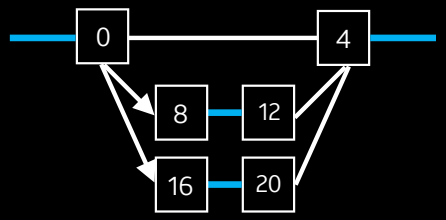
TAEP : Ingredients

Keep it simple, P4, Divert




```
/*************************************************************/
/* Divert Packet                                             */
/*************************************************************/

table divert {
    reads {
        ig_intr_md.ingress_port : exact;
        ipv4.dstAddr : ternary;
        ipv4.srcAddr : ternary;
    }
    actions {
        set_egr;
        _nop;
    }
    size: BAREFOOT_MAX_PORTS;
}
```

ingress port	ip address	prefix length	action	egress port
0	192.168.1.12	32	set_egr	8
0	192.169.1.0	24	set_egr	16

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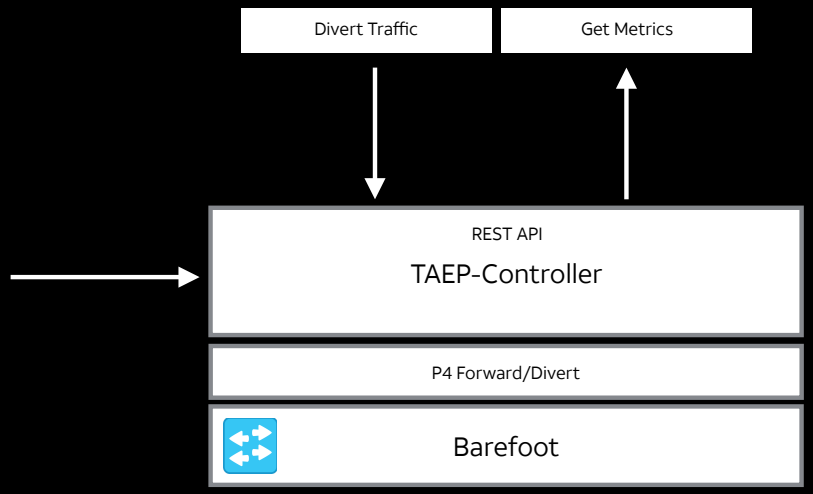
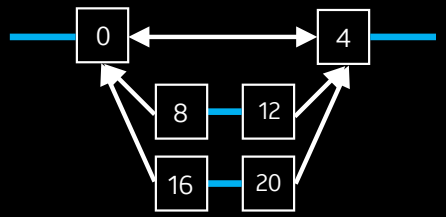
TAEP : Ingredients

Keep it simple, Controller

```
enable-labeling: true
api-port: 8100
ports:
    - number: 0
      speed: 40
      autoneg-disabled: true
   - number: 4
      speed: 40
      autoneg-disabled: true
   - number: 8
      speed: 40
    - number: 12
      speed: 40
    - number: 16
      speed: 40
    - number: 20
      speed: 40
connections:
    - from: 0
      to: 4
      type: bidirectional
    - from: 12
      to: 4
      type: unidirectional
    - from: 20
      to: 4
      type: unidirectional
    - from: 8
      to: 0
      type: unidirectional
    - from: 16
      to: 0
      type: unidirectional
```





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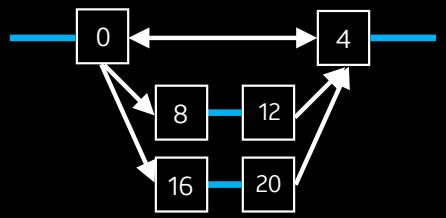
TAEP : Ingredients

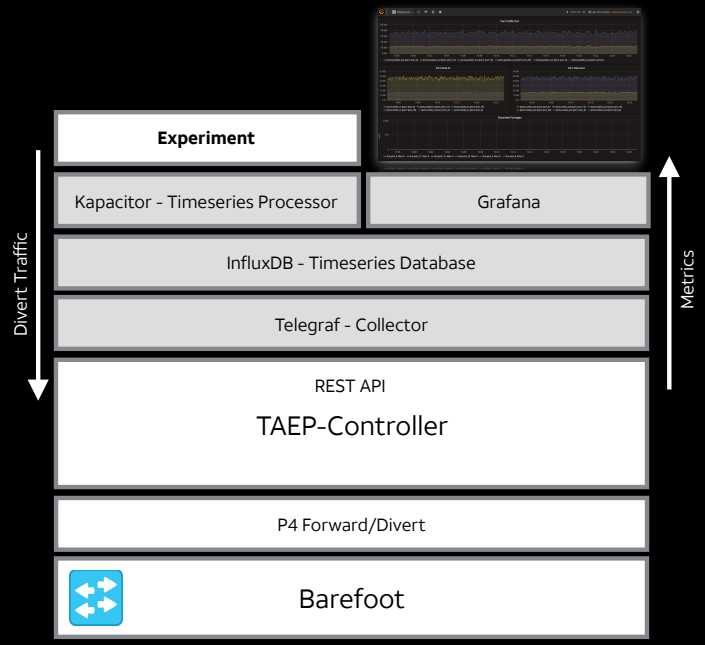
Keep it simple, Analytics Stack



Open-Source Projects:
- Timeseries Stack from InfluxData
- Dashboard by Grafana

Experiment:
- Written in Python
- Metrics pushed by Kapacitor
- Talks to Controller via REST API

Everything runs on the Barefoot Switch



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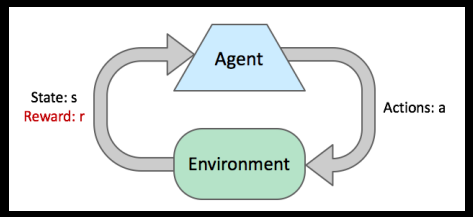
TAEP : Reinforcement Learning

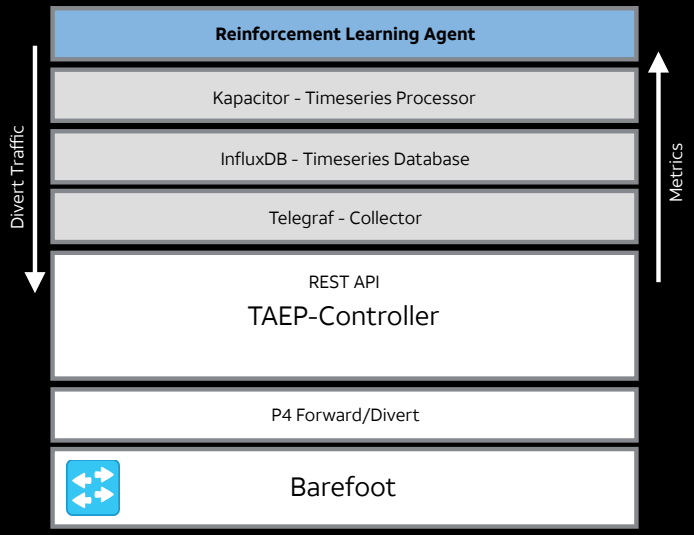
Do some advanced experiments

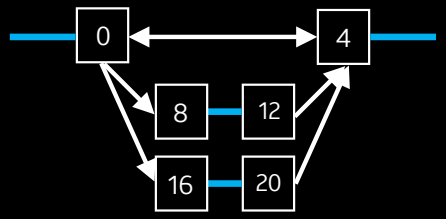
Goal:
Balance traffic between two links in a 0.3:0.7 ratio using a Reinforcement Learning Agent

Setup:
- Provide a set of pre-defined divert rules to the agent as action-space
- Agent explores different combinations of divert rules based on action- and state-space
- Agent calculates reward based on link measurements



http://ai.berkeley.edu/lecture_slides.html





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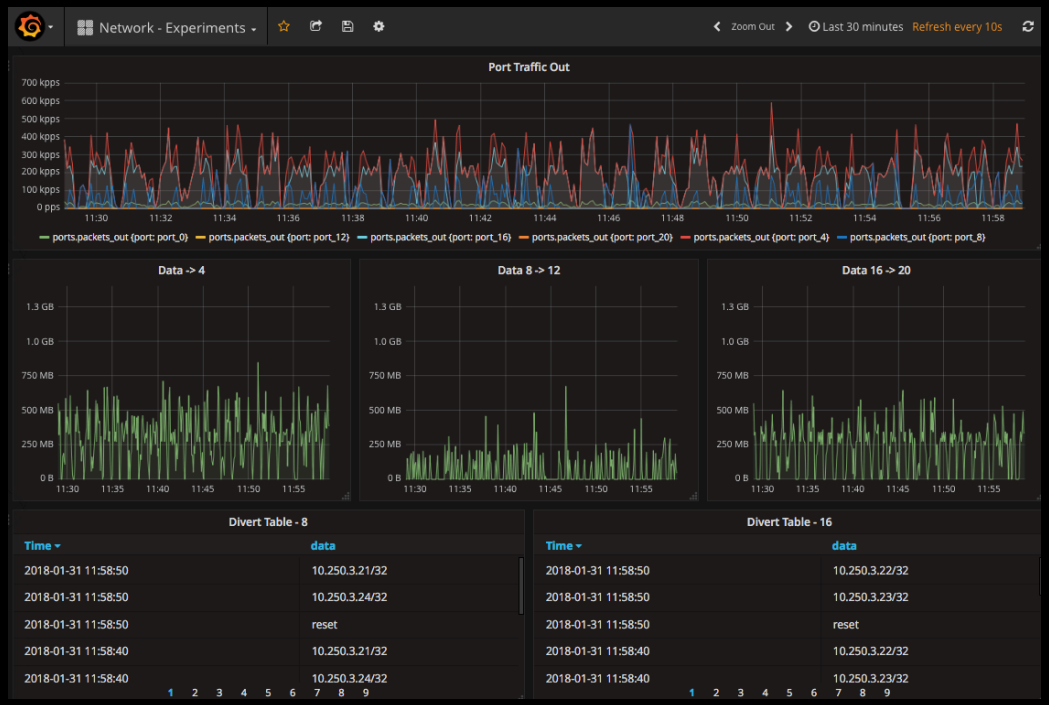
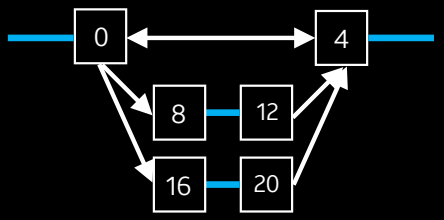
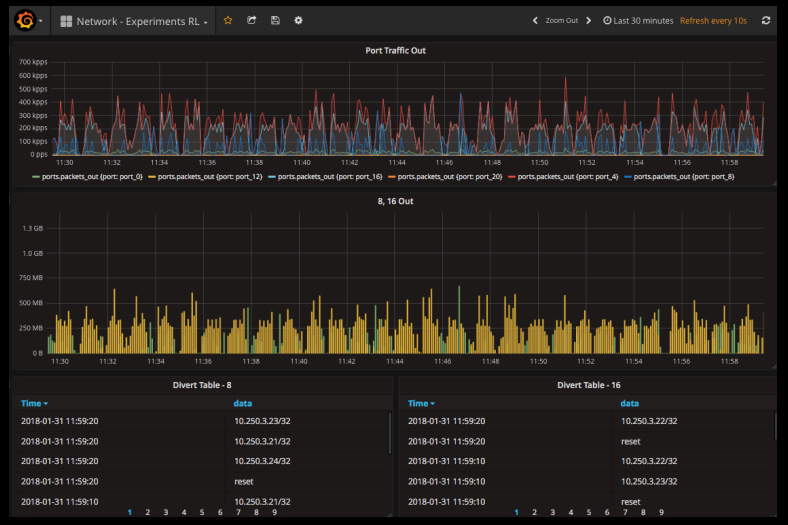
TAEP : Reinforcement Learning

Some Lab Results







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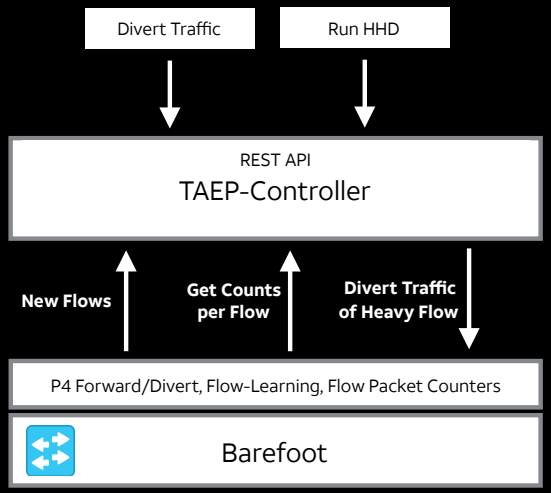
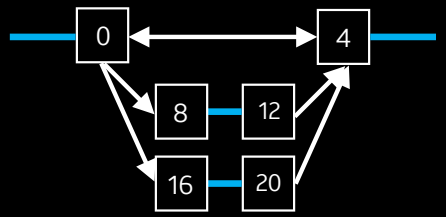
TAEP : Heavy Hitter Detection

Do some advanced experiments

Goal:
Automatically divert traffic of “heaviest” flow

Setup:
- Divert traffic of a subnet (test traffic) through 8-12
- During a predefined time window count packets of each flow in that test traffic (count-min sketch)
- Resolve flow with most packets
- Divert packets for heaviest flow during the next time window through 16-20





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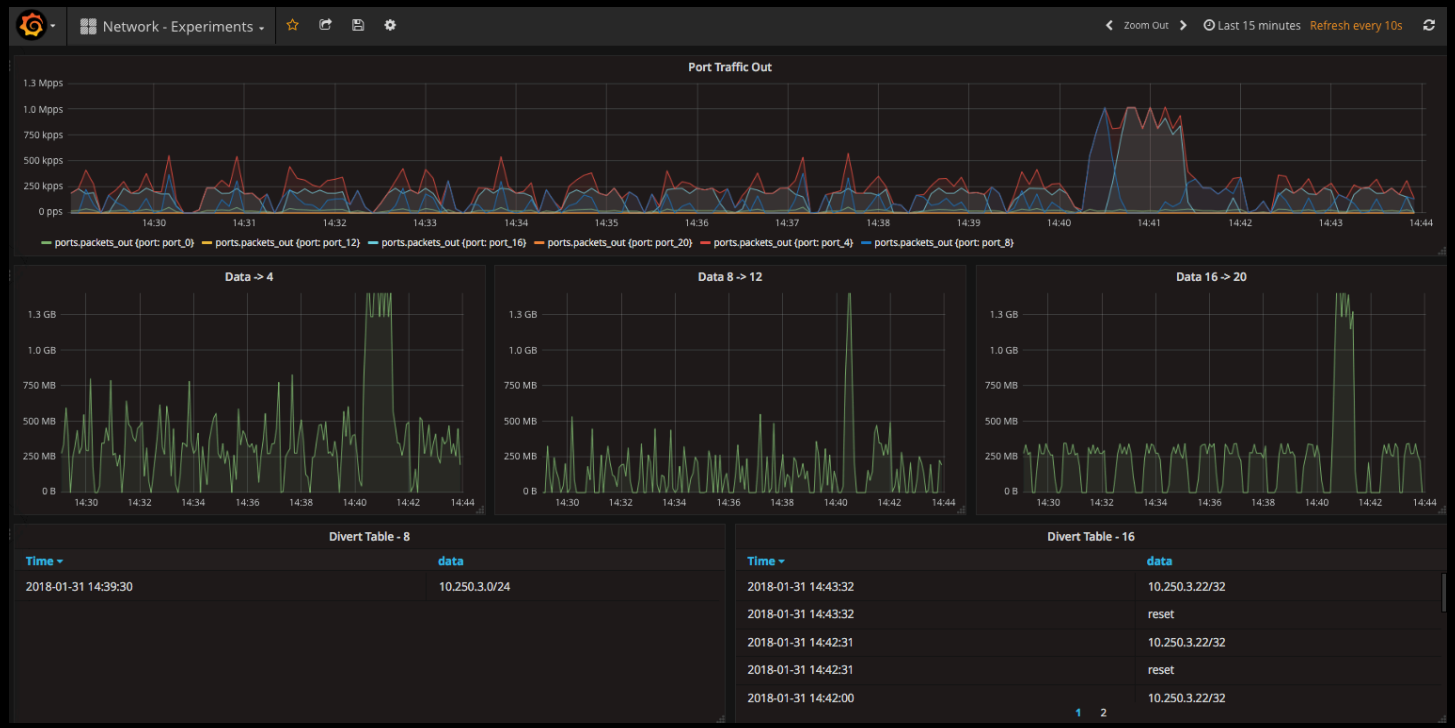
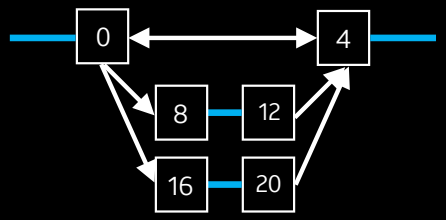
TAEP : Heavy Hitter Detection

Some Lab Results





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TAEP : Lessons Learned

(Preliminary) Lessons Learned from running TAEP in a live network:

- It works, no packets got hurt during our 4 months of live tests
- Barefoot/Tofino ASIC offers a fast and stable runtime for P4 programs
- It's hard, confronted with a new set of challenging but interesting problems
- How to control a P4 program running at high-speed in the data-plane with a massively slower control plane
- How to split your application logic (example HHD) across data-plane (P4) and control-plane
- It's fun, watching the Reinforcement Learning Algorithm trying to do its magic on production traffic

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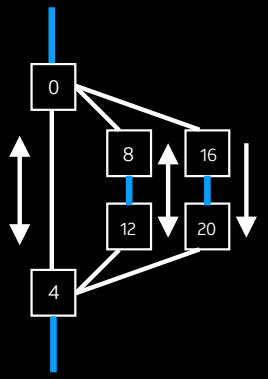
TAEP : Traffic Analysis and Experimentation Platform

Barefoot Wedge 100BF-32X

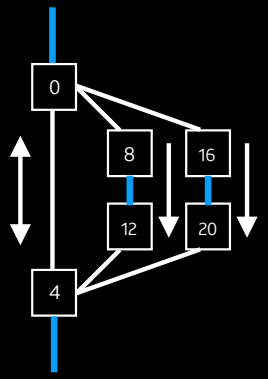
1 straight through path
2 traffic-divert options

1. Traffic Analysis



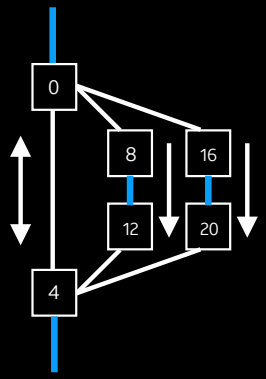
Divert areas of interest
Example:
Traffic from or to specific sub-net

2. Heavy Hitter Detection



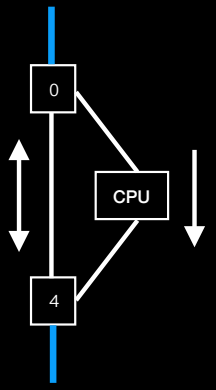
Divert test traffic through 8-12
Find heaviest flow
Divert heaviest flow through 16-20

3. Reinforcement Learning

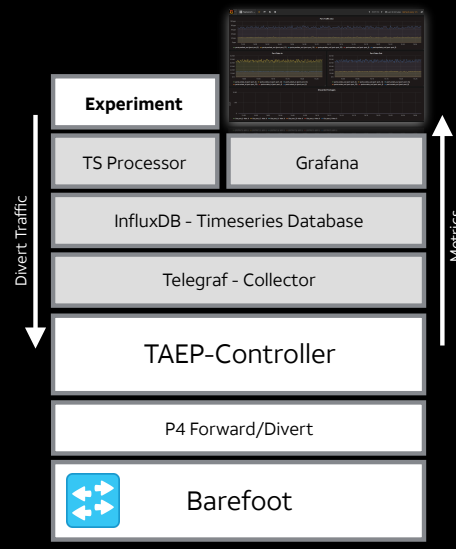


Use Reinforcement Learning Agent
Balance test traffic at a 0.3:0.7 ratio
between 8-12 and 16-20

4. Chaos Engineering



Drop certain traffic
Modify certain traffic
Add latency to certain traffic



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