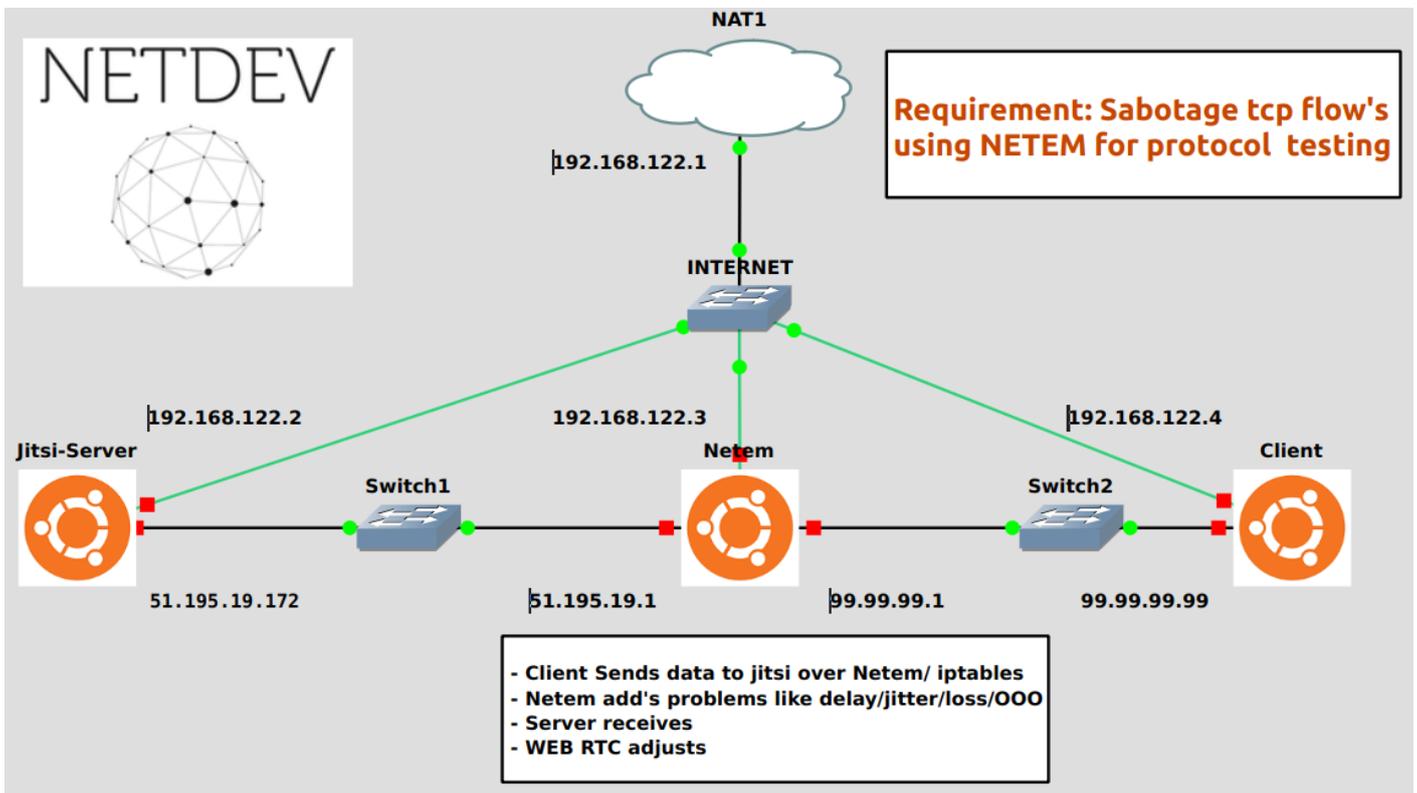


Network

- [Delay and loss tests using netem on a healthy network](#)
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Delay and loss tests using netem on a healthy network



Purpose of this document

We needed a lab environment that can provide a "break on purpose network" to developers to test their code on it. You can add;

- delay
- packet loss
- jitter
- duplicate packets
- unordered flows

to a connection on the fly. To do it we need "netem" modules help.

NETEM

Since kernel 2.6 netem is included in iproute2 package, basically all modern distro's has it now.
You can find a documentation on [Netem](#)

i am going to explain the required steps here ;

- create a master traffic class on interface ens8

```
sudo tc qdisc add dev ens8 root handle 1: prio
```

- Attach a subclass to tc 1: as 3

```
sudo tc qdisc add dev ens8 parent 1:3 handle 30: netem delay 1000ms  
sudo tc filter add dev ens8 protocol ip parent 1:0 prio 3 u32 match ip dst 51.195.19.172 flowid 1:3
```


Requirements:

- 2 ubuntu 18.04 machines on both data centers
- for each ubuntu vm 1 interface for I3 tunnel as underlay and one interface to use as tap to extend vlan
- 2 cores were quite powerfull for 200 mbits of througput
- 1 gb ram per machine
- Allowing forged ethernet frames on both tap ports
- 1 cup of coffee and a slice of good chestnut cake

Some caveats ;

- good cpu = good throughput, and the opposite
- do not loop !
- be carefull with the Xstp or you might have a lame root bridge
- My config was interface per vlan, so someone might have a trunk solution.
- No HA solution, those machines needs to be monitored closely, use observium and it's agent

install wireguard

To install wireguard vpn on ubuntu 18.04

```
#sudo apt update
#sudo apt-get install libmnl-dev libelf-dev linux-headers-$(uname -r) build-essential pkg-config
#sudo apt install wireguard
```

After installation you'll need to restart operating system and check for installed module, output should be as shown below.

```
#lsmod | grep wireguard
udp_tunnel 16384 1 wireguard
ip6_udp_tunnel 16384 1 wireguard
```

generete keys

Wireguard need public and private keys to operate, there is a tool called wg which can generate them as shown below

```
#wg genkey | sudo tee /etc/wireguard/privatekey | wg pubkey | sudo tee /etc/wireguard/publickey
```

You can find the keys at /etc/wireguard

create wireguard0.conf

You'll need to create a file called wireguard0.conf at /etc/wireguard

Contents of the file should be like this ;

For initiator:

```
[interface]
private_key= the_private_key_you_generated
address= 10.10.10.1/24 #ip address of the wireguard0

[peer]
PublicKey = #he public key that you generated on the responder host
AllowedIPs = 10.10.10.0/24 #and the other networks that you'd like route through
EndPoint = internet_address:port
PersistenKeepAlive = 15 #seconds
```

For responder:

```
[interface]
private_key= the_private_key_you_generated
address= 10.10.10.2/24 #ip address of the wireguard0
listenPort = 4900

[peer]
PublicKey = #he public key that you generated on the initiator host
AllowedIPs = 10.10.10.0/24 #nd the other networks that you'd like route through
PersistenKeepAlive = 15 #seconds
```

initiate tunnel

to start the tunnel

```
wg-quick up wireguard0
```

to check the status

```
wg show wireguard0
interface: wireguard0
  public key: +/1R3JqLKlszbaGUSBtckoxNOMuSvLYKUCI03ShoFw8=
  private key: (hidden)
  listening port: 4900

peer: 2f/RmbuvKtR/L2ZFIQBHsVGkTXkA6d1pJO1ay5EjwSQ=
  endpoint: 172.21.23.111:49792
  allowed ips: 10.10.10.0/24, 192.168.5.0/24
  latest handshake: 1 minute, 31 seconds ago
  transfer: 19.10 MiB received, 11.95 MiB sent
```

install bridge-utils

To install bridge utils

```
#apt install bridge-utils
```

enable br_netfilter

to enable

```
#modprobe br_netfilter
```

to keep loading on boot

```
#sudo sh -c 'echo "br_netfilter" > /etc/modules-load.d/br_netfilter.conf'
#cat net.bridge.bridge-nf-call-ip6tables = 1 >> /etc/sysctl.d/bridge.conf
```

enable routing

To enable routing on the fly

```
sysctl -w net.ipv4.ip_forward=1
```

to make it permanent, add lines below to `/etc/sysctl.conf` ;

```
# Uncomment the next line to enable packet forwarding for IPv4
net.ipv4.ip_forward=1
```

fix mss on exit interface

When you are going to use ip tunnel for underlay and gretap for overlay, there will be some serious mss/mtu size problems to fix that, we need the `br_netfilter` module that we installed before and a special chain to limit the mss size to the max mtu of interface

```
#iptables -I FORWARD -p tcp --tcp-flags SYN,RST SYN -j TCPMSS --clamp-mss-to-pmtu
```

We specially use `-I` to put it at the top of the forward chain.

configure gretap interface

For the initiator:

```
ip link add gretap0 type gretap local 172.16.5.2 remote 192.168.5.2
```

For responder

```
ip link add gretap0 type gretap local 192.168.5.2 remote 172.16.5.2
```

configure bridge

Now you will add the interfaces to bridge

```
#brctl addbr br0
```

add interfaces to bridge br0

```
#brctl addif br0 ens4
#brctl addif br0 gretap0
```

Bring everything up

```
#wp-quick up wireguard0  
#ip link set up dev br0  
#ip link set up dev gretap0  
#ip link et up dev ens4
```

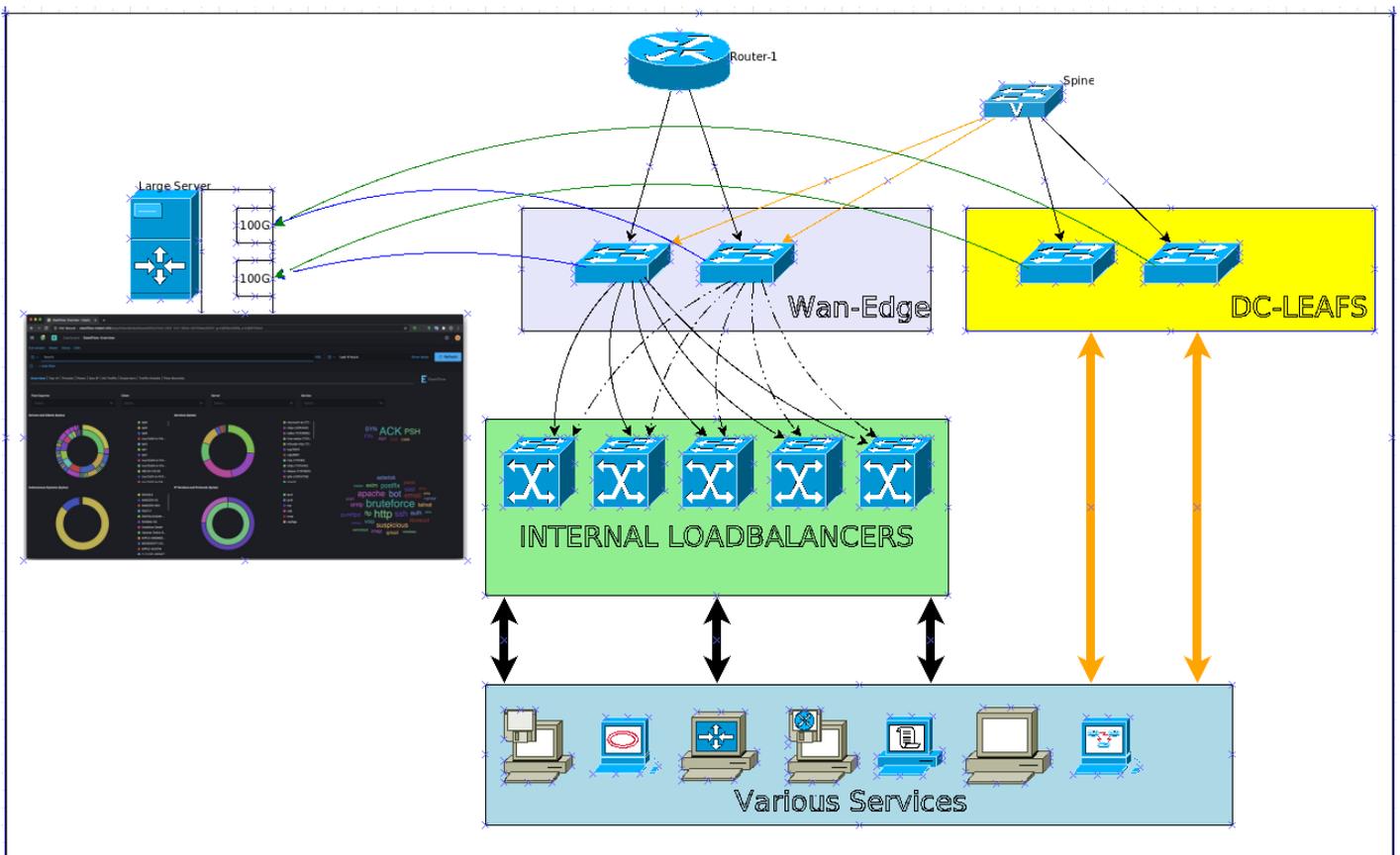
tests

do pings i've checked that dhcp is working,

what needs to be done are ;

- Multicast packets
- the situation about protocols like vrrp and hsrp
- The effect of broadcast packets to cpu

Generating 1:1 ipfix from 10g pipeline - Getting the data - Part 1



Goal : generate lossless ipfix flow's from distributed pipe to monitor application or network performance, identify bottlenecks and generate alerts if possible.

Why this way ? : It was expensive to do it with proprietary solutions. Plus we needed to have a flexible, open source option to work on. The closest solution cost was \$1M

Challenges ;

- We are going to do it using cpu, so lot's of flows require lots of processing power,
- short flows create large ipfix messages than themselves, any dns flow is mostly 100 bytes long but a ipfix message for that flow costs us 1000 bytes
- many packets traversing the kernel would create losses so we needed to bypass that

- we need to create custom dashboards, or create alerts.
- deduplication

Plan :

- get mirrors from devices
- produce ipfix from mirrors
- send ipfix data to elastiflow
- design custom dashboards
- design monitor and alerters

What happened along the way;

- Obviously there will be lot's of storage requirement and cpu requirements how ever the current write rate wasn't going to be deadly so we decided to go with using only one server with many ssd drives. We lost the array drives because of a failure in array controller
- We were going to aggregate mirrors from fabric using a Mellanox switch by utilizing it's bridge functions, the asic couldn't manage packet replication this step failed, we bought additional cards and skipped aggregation layer.
- The intel x810-CAQxx cards failed to go in Zero Copy mode, we needed to wait for 2 months for a new firmware from intel
- The tool that we used created problems with intel cards firmware and kernel module. We had to reflash them twice till we found a working state
- The tool had a bug with combining mirrors so we waited for a bugfix.

Current status

We have a working setup, using this version of intel module

```
filename:      /lib/modules/5.4.0-128-generic/kernel/drivers/net/ethernet/intel/ice/ice.ko
firmware:     intel/ice/ddp/ice.pkg
version:      0.8.1-k
license:      GPL v2
description:  Intel(R) Ethernet Connection E800 Series Linux Driver
```

With this version of firmware

```
root@TTPOP-PNPR-LNTW001:/etc/apt# ethtool -i ens2f1
driver: ice_zc
version: 1.9.11
firmware-version: 4.01 0x80013c9a 1.3256.0
expansion-rom-version:
bus-info: 0000:5f:00.1
supports-statistics: yes
supports-test: yes
supports-eeprom-access: yes
supports-register-dump: yes
supports-priv-flags: yes
```

You can find some performance outputs as shown below

Server's status

```
1 [|||||] 18.0% 25 [|||||] 22.5% 49 [|||||] 10.9% 75 [|||||] 7.8%
2 [|||||] 9.1% 26 [|||||] 28.7% 50 [|||||] 3.6% 74 [|||||] 1.9%
3 [|||||] 19.6% 27 [|||||] 10.3% 51 [|||||] 9.1% 75 [|||||] 10.8%
4 [|||||] 3.2% 28 [|||||] 3.9% 52 [|||||] 2.6% 76 [|||||] 2.6%
5 [|||||] 7.7% 29 [|||||] 7.3% 53 [|||||] 13.1% 77 [|||||] 7.1%
6 [|||||] 6.2% 30 [|||||] 2.6% 54 [|||||] 2.6% 78 [|||||] 1.9%
7 [|||||] 9.1% 31 [|||||] 9.7% 55 [|||||] 11.6% 79 [|||||] 6.5%
8 [|||||] 3.2% 32 [|||||] 58.7% 56 [|||||] 2.6% 80 [|||||] 1.9%
9 [|||||] 4.6% 33 [|||||] 9.2% 57 [|||||] 10.9% 81 [|||||] 12.3%
10 [|||||] 3.6% 34 [|||||] 57.6% 58 [|||||] 1.9% 82 [|||||] 1.9%
11 [|||||] 10.3% 35 [|||||] 8.4% 59 [|||||] 7.1% 83 [|||||] 8.3%
12 [|||||] 3.6% 36 [|||||] 59.1% 60 [|||||] 2.6% 84 [|||||] 2.6%
13 [|||||] 7.8% 37 [|||||] 8.5% 61 [|||||] 9.1% 85 [|||||] 5.2%
14 [|||||] 2.6% 38 [|||||] 4.6% 62 [|||||] 2.6% 86 [|||||] 1.9%
15 [|||||] 35.5% 39 [|||||] 10.3% 63 [|||||] 9.0% 87 [|||||] 8.5%
16 [|||||] 2.6% 40 [|||||] 2.6% 64 [|||||] 1.9% 88 [|||||] 1.9%
17 [|||||] 36.2% 41 [|||||] 7.2% 65 [|||||] 11.0% 89 [|||||] 26.4%
18 [|||||] 1.9% 42 [|||||] 1.9% 66 [|||||] 1.9% 90 [|||||] 2.0%
19 [|||||] 25.7% 43 [|||||] 9.8% 67 [|||||] 9.0% 91 [|||||] 20.5%
20 [|||||] 1.9% 44 [|||||] 2.6% 68 [|||||] 2.6% 92 [|||||] 4.5%
21 [|||||] 6.4% 45 [|||||] 2.6% 69 [|||||] 12.6% 93 [|||||] 100.0%
22 [|||||] 2.6% 46 [|||||] 2.6% 70 [|||||] 2.6% 94 [|||||] 4.5%
23 [|||||] 6.4% 47 [|||||] 8.5% 71 [|||||] 3.9% 95 [|||||] 5.9%
24 [|||||] 4.5% 48 [|||||] 2.6% 72 [|||||] 4.5% 96 [|||||] 4.5%
Mem[|||||] 74.50/504G
Swap[|||||] 0K/8.00G
Tasks: 144, 972 thr; 13 running
Load average: 10.20 8.78 6.82
Uptime: 6 days, 0:35:28

PID USER PRI NI VIRT RES SHR S CPU% MEM% TIME+ Command
1 root 0 0 167M 13420 1956 S 0.0 0.0 0:13.20 /sbin/init
235767 nprobe 20 0 1269M 941N 21932 S 78.0 0.2 2:53:48 /usr/bin/nprobe /run/nprobe-flow.conf
235819 nprobe 20 0 1269M 941N 21932 S 75.2 0.2 2:50:33 /usr/bin/nprobe /run/nprobe-flow.conf
235818 nprobe 20 0 1269M 941N 21932 S 0.0 0.2 0:01:02 /usr/bin/nprobe /run/nprobe-flow.conf
235817 nprobe 20 0 1269M 941N 21932 S 2.6 0.2 6:12:61 /usr/bin/nprobe /run/nprobe-flow.conf
215535 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:53 /usr/lib/snapsd/snapsd
215533 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:23 /usr/lib/snapsd/snapsd
215532 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:22 /usr/lib/snapsd/snapsd
215531 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:06 /usr/lib/snapsd/snapsd
215989 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:24 /usr/lib/snapsd/snapsd
215988 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:25 /usr/lib/snapsd/snapsd
215987 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:31 /usr/lib/snapsd/snapsd
215986 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:25 /usr/lib/snapsd/snapsd
215985 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:26 /usr/lib/snapsd/snapsd
215984 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:27 /usr/lib/snapsd/snapsd
215982 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:22 /usr/lib/snapsd/snapsd
215981 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:26 /usr/lib/snapsd/snapsd
215976 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:28 /usr/lib/snapsd/snapsd
215975 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:21 /usr/lib/snapsd/snapsd
215974 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:35 /usr/lib/snapsd/snapsd
215973 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:24 /usr/lib/snapsd/snapsd
215972 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:28 /usr/lib/snapsd/snapsd
215945 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:36 /usr/lib/snapsd/snapsd
215947 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:14 /usr/lib/snapsd/snapsd
215916 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:35 /usr/lib/snapsd/snapsd
215915 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:29 /usr/lib/snapsd/snapsd
215914 root 20 0 2730M 47260 19656 S 0.0 0.0 0:00:28 /usr/lib/snapsd/snapsd
[0] @iback-2-1@top
```

Current traffic rate

```
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4206] -----
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4209] Average traffic: [316.03 K pps][All Traffic 2.32 Gb/sec][IP Traffic 2.21 Gb/sec][ratio 0.96]
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4217] Current traffic: [476.94 K pps][3.53 Gb/sec]
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4258] Flows exports (including drops) [32504914 flows][avg: 541748.6 flows/sec][latest 60 sec avg: 2445.4 flows/sec]
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4266] Flow drops [export queue full: 0]
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4269] Packet drops [too many flow buckets: 0]
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4272] Flow buckets [active: 374649][all located: 374649][toBeExported: 0]
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4276] Export Queue [current: 0][max: 10685760][fill level: 0.0]
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4010] Processed packets: 6448290598 (max bucket search: 7)
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:3993] Fragment queue length: 281
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4041] Flow export stats: [1704116834 bytes/2056566499 pkts][32504914 flows/9521355 pkts sent]
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4047] Flow export drop stats: [0 bytes/0 pkts][0 flows/0.00 %]
Nov 16 15:42:43 TTPOF-PNPR-LNTW001 nprobe[235767]: 16/Nov/2022 15:42:43 [nprobe.c:4055] Total flow stats: [1704116834 bytes/2056566499 pkts][32504914 flows/9521355 pkts sent]
[0] @iback-2-1@top
```

Current io rate

```
Total DISK READ: 0.00 B/s | Total DISK WRITE: 14.25 M/s
Current DISK READ: 0.00 B/s | Current DISK WRITE: 28.14 M/s

TID PRIO USER DISK READ DISK WRITE SWAPIN IO> COMMAND
2006 be/3 root 0.00 B/s 13.03 K/s 0.00 % 2.19 % [jbd2/sdal-8]
5756 be/4 elastics 0.00 B/s 172.71 K/s 0.00 % 0.13 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
5876 be/4 elastics 0.00 B/s 192.26 K/s 0.00 % 0.11 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
5877 be/4 elastics 0.00 B/s 192.26 K/s 0.00 % 0.11 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
5878 be/4 elastics 0.00 B/s 175.97 K/s 0.00 % 0.11 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
6326 be/4 elastics 0.00 B/s 172.71 K/s 0.00 % 0.10 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
247066 be/4 root 0.00 B/s 0.00 B/s 0.00 % 0.08 % [kworker/u193:1-events_power_efficient]
6425 be/4 elastics 0.00 B/s 143.38 K/s 0.00 % 0.08 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
6013 be/4 elastics 0.00 B/s 101.02 K/s 0.00 % 0.06 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
6466 be/4 elastics 0.00 B/s 101.02 K/s 0.00 % 0.04 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
6464 be/4 elastics 0.00 B/s 140.12 K/s 0.00 % 0.04 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
6420 be/4 elastics 0.00 B/s 97.76 K/s 0.00 % 0.04 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
6419 be/4 elastics 0.00 B/s 87.98 K/s 0.00 % 0.04 % java -Xshare:auto -Des.networkaddress.cache.ttl=60
```

Disk config

```

root@TTPOP-PNPR-LNTW001:/etc/apt# df -h
Filesystem                Size      Used Avail Use% Mounted on
udev                      252G         0   252G   0% /dev
tmpfs                     51G         2.9M    51G   1% /run
/dev/mapper/ubuntu--vg-ubuntu--lv 109G        23G    81G  22% /
tmpfs                     252G         0   252G   0% /dev/shm
tmpfs                     5.0M         0    5.0M   0% /run/lock
tmpfs                     252G         0   252G   0% /sys/fs/cgroup
/dev/sdb2                 974M       206M   701M  23% /boot
/dev/sdb1                 511M        5.3M   506M   2% /boot/efi
/dev/sda1                 11T         5.0T   4.7T  52% /opt
/dev/loop1                56M         56M     0 100% /snap/core18/2566
/dev/loop3                64M         64M     0 100% /snap/core20/1623
/dev/loop4                68M         68M     0 100% /snap/lxd/22526
/dev/loop7                68M         68M     0 100% /snap/lxd/22753
/dev/loop8                48M         48M     0 100% /snap/snapd/17336
tmpfs                     51G         0    51G   0% /run/user/1001
/dev/loop5                56M         56M     0 100% /snap/core18/2620
/dev/loop9                64M         64M     0 100% /snap/core20/1695
/dev/loop0                50M         50M     0 100% /snap/snapd/17576
root@TTPOP-PNPR-LNTW001:/etc/apt# lsblk
NAME                MAJ:MIN RM   SIZE RO TYPE MOUNTPOINT
loop0                7:0      0  49.7M  1 loop /snap/snapd/17576
loop1                7:1      0  55.6M  1 loop /snap/core18/2566
loop3                7:3      0  63.2M  1 loop /snap/core20/1623
loop4                7:4      0  67.9M  1 loop /snap/lxd/22526
loop5                7:5      0  55.6M  1 loop /snap/core18/2620
loop6                7:6      0   48M   1 loop
loop7                7:7      0  67.8M  1 loop /snap/lxd/22753
loop8                7:8      0   48M   1 loop /snap/snapd/17336
loop9                7:9      0  63.2M  1 loop /snap/core20/1695
sda                  8:0      0  10.2T  0 disk
└─sda1                8:1      0  10.2T  0 part /opt
sdb                  8:16     0  223.5G  0 disk
├─sdb1                8:17     0   512M  0 part /boot/efi
├─sdb2                8:18     0    1G   0 part /boot
└─sdb3                8:19     0  222G  0 part
   └─ubuntu--vg-ubuntu--lv 253:0    0  111G  0 lvm /

```

What's Next:

Well, we started to deep dive into traffic and analyze, create widgets and all the necessary stuff to have a Management dashboard. We saw some interesting stuff too which will need a lot of troubleshooting and investigation.