# Pantheon Report

Generated at 2018-08-31 04:56:00 (UTC).

Data path: AWS Brazil 1 on `ens5` (*local*) →Brazil on `p4p1` (*remote*).

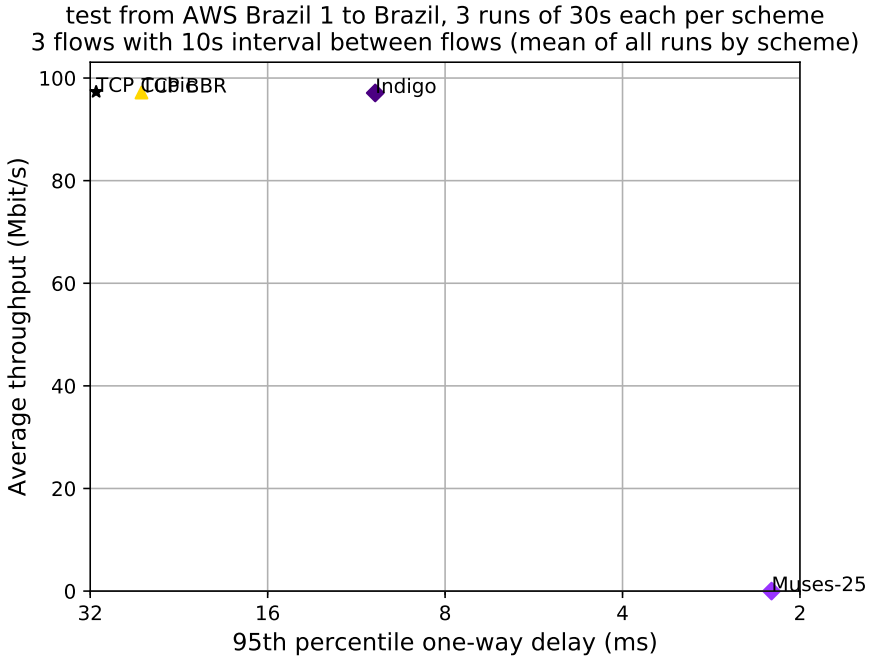
Repeated the test of 4 congestion control schemes 3 times.

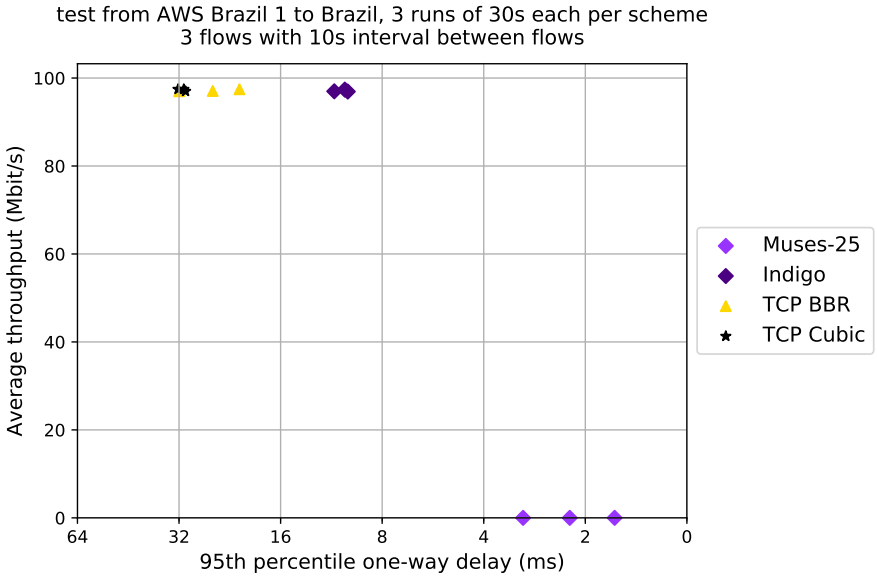
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

NTP offsets were measured against `gps.ntp.br` and have been applied to correct the timestamps in logs.

```
System info:
Linux 4.15.0-1020-aws
net.core.default_qdisc = fq
net.core.rmem_default = 16777216
net.core.rmem_max = 536870912
net.core.wmem_default = 16777216
net.core.wmem_max = 536870912
net.ipv4.tcp_rmem = 4096 16777216 536870912
net.ipv4.tcp_wmem = 4096 16777216 536870912
net.ipv4.tcp_mem = 536870912 536870912 536870912
```

```
Git summary:
branch: muses @ 2de97ca91a065473c29a25fffe63fb137c97a67c
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ b59e0d118c50af3579569c462d33045741c85981
third_party/pantheon-tunnel @ cbfce6db5ff5740dafe1771f813cd646339e1952
third_party/pcc @ 1afc958fa0d66d18b623c091a55fec872b4981e1
 M receiver/src/buffer.h
 M receiver/src/core.cpp
 M sender/src/buffer.h
 M sender/src/core.cpp
third_party/pcc-experimental @ cd43e34e3f5f5613e8acd08fab92c4eb24f974ab
third_party/proto-quic @ 77961f1a82733a86b42f1bc8143ebc978f3cff42
third_party/scream-reproduce @ f099118d1421aa3131bf11ff1964974e1da3bdb2
 M src/ScreamClient
 M src/ScreamServer
third_party/sprout @ 366e35c6178b01e31d4a46ad18c74f9415f19a26
third_party/verus @ d4b447ea74c6c60a261149af2629562939f9a494
 M src/verus.hpp
 M tools/plot.py
third_party/vivace @ 2baf86211435ae071a32f96b7d8c504587f5d7f4
third_party/webrtc @ 3f0cc2a9061a41b6f9dde4735770d143a1fa2851
```


test from AWS Brazil 1 to Brazil, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
Average throughput (Mbit/s)
95th percentile one-way delay (ms)
TCP Cubic
TCP BBR
Indigo
Muses-25
100
80
60
40
20
0
32
16
8
4
2


test from AWS Brazil 1 to Brazil, 3 runs of 30s each per scheme
3 flows with 10s interval between flows
Average throughput (Mbit/s)
95th percentile one-way delay (ms)
Muses-25
Indigo
TCP BBR
TCP Cubic
100
80
60
40
20
0
64
32
16
8
4
2
0

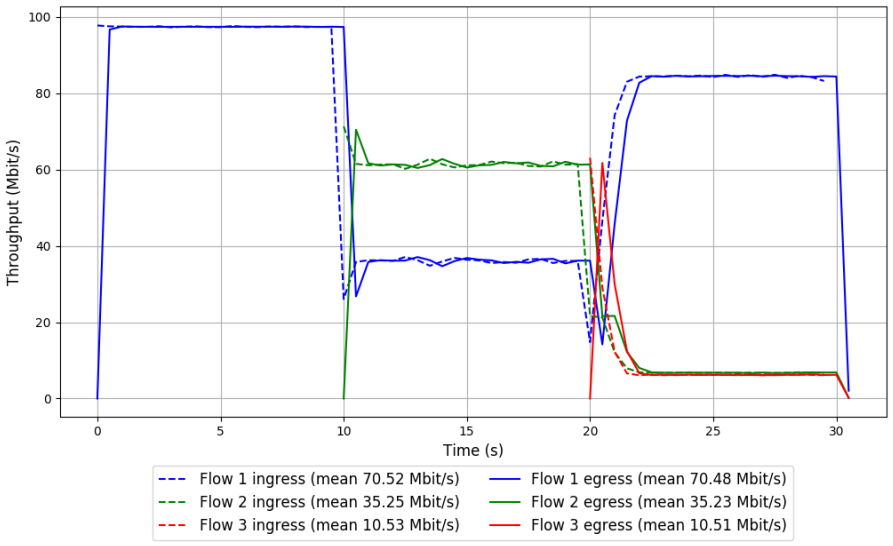
| scheme | # runs | mean avg tput (Mbit/s) | | | mean 95th-%ile delay (ms) | | | mean loss rate (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | flow 1 | flow 2 | flow 3 | flow 1 | flow 2 | flow 3 | flow 1 | flow 2 | flow 3 |
| TCP BBR | 3 | 74.77 | 28.47 | 10.33 | 26.28 | 24.67 | 27.15 | 0.16 | 0.02 | 0.09 |
| TCP Cubic | 3 | 64.35 | 35.54 | 28.00 | 30.95 | 31.55 | 31.58 | 0.04 | 0.05 | 0.04 |
| Indigo | 3 | 44.31 | 42.23 | 75.83 | 9.65 | 10.67 | 10.09 | 0.00 | 0.00 | 0.00 |
| Muses-25 | 3 | 0.00 | 0.00 | 0.00 | 2.27 | 1.18 | 1.64 | 0.00 | 0.00 | 0.00 |

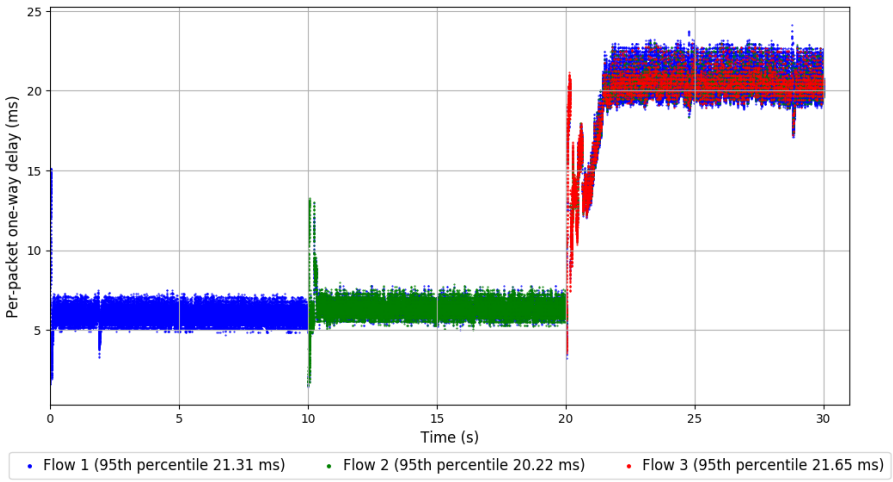
```
Run 1: Statistics of TCP BBR

Start at: 2018-08-31 04:41:41
End at: 2018-08-31 04:42:11
Local clock offset: -9.915 ms
Remote clock offset: 0.265 ms

# Below is generated by plot.py at 2018-08-31 04:55:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.45 Mbit/s
95th percentile per-packet one-way delay: 21.187 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 70.48 Mbit/s
95th percentile per-packet one-way delay: 21.308 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 35.23 Mbit/s
95th percentile per-packet one-way delay: 20.217 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 10.51 Mbit/s
95th percentile per-packet one-way delay: 21.652 ms
Loss rate: 0.00%
```

Run 1: Report of TCP BBR — Data Link



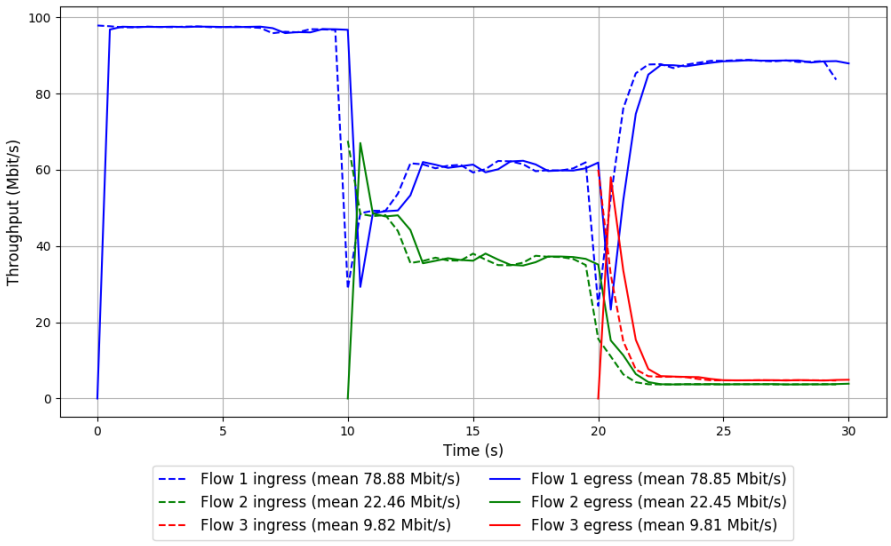



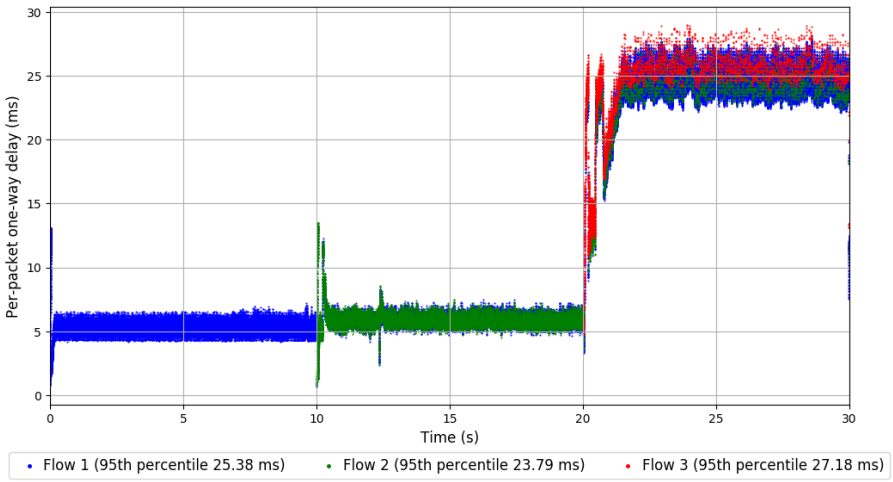
```
Run 2: Statistics of TCP BBR

Start at: 2018-08-31 04:46:08
End at: 2018-08-31 04:46:38
Local clock offset: -10.716 ms
Remote clock offset: 0.263 ms

# Below is generated by plot.py at 2018-08-31 04:55:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.06 Mbit/s
95th percentile per-packet one-way delay: 25.427 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 78.85 Mbit/s
95th percentile per-packet one-way delay: 25.383 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 22.45 Mbit/s
95th percentile per-packet one-way delay: 23.791 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 9.81 Mbit/s
95th percentile per-packet one-way delay: 27.175 ms
Loss rate: 0.00%
```

Run 2: Report of TCP BBR — Data Link



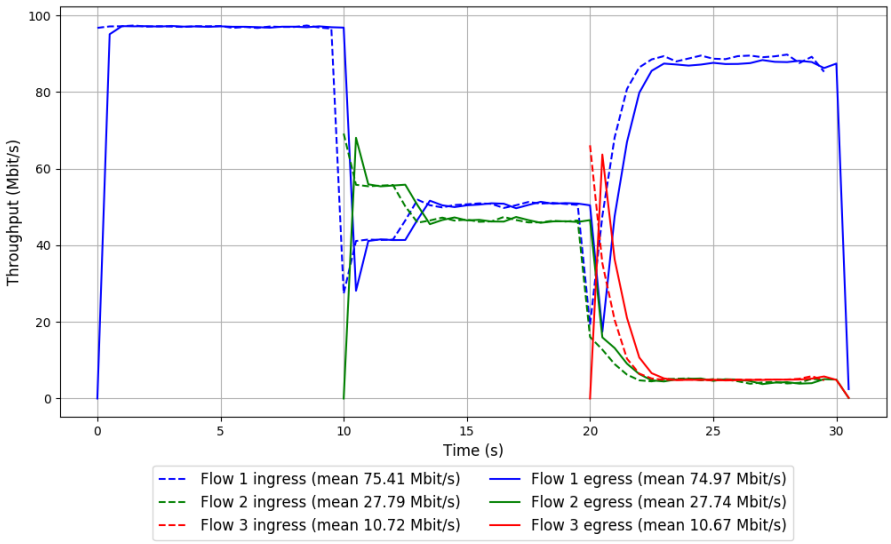



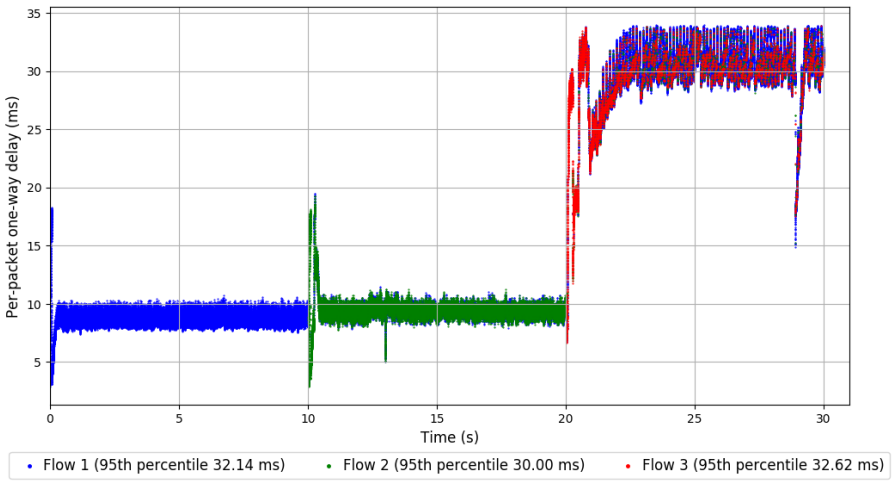
```
Run 3: Statistics of TCP BBR

Start at: 2018-08-31 04:50:36
End at: 2018-08-31 04:51:06
Local clock offset: -12.994 ms
Remote clock offset: 0.26 ms

# Below is generated by plot.py at 2018-08-31 04:55:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.01 Mbit/s
95th percentile per-packet one-way delay: 31.963 ms
Loss rate: 0.40%
-- Flow 1:
Average throughput: 74.97 Mbit/s
95th percentile per-packet one-way delay: 32.140 ms
Loss rate: 0.48%
-- Flow 2:
Average throughput: 27.74 Mbit/s
95th percentile per-packet one-way delay: 30.000 ms
Loss rate: 0.07%
-- Flow 3:
Average throughput: 10.67 Mbit/s
95th percentile per-packet one-way delay: 32.616 ms
Loss rate: 0.28%
```

Run 3: Report of TCP BBR — Data Link



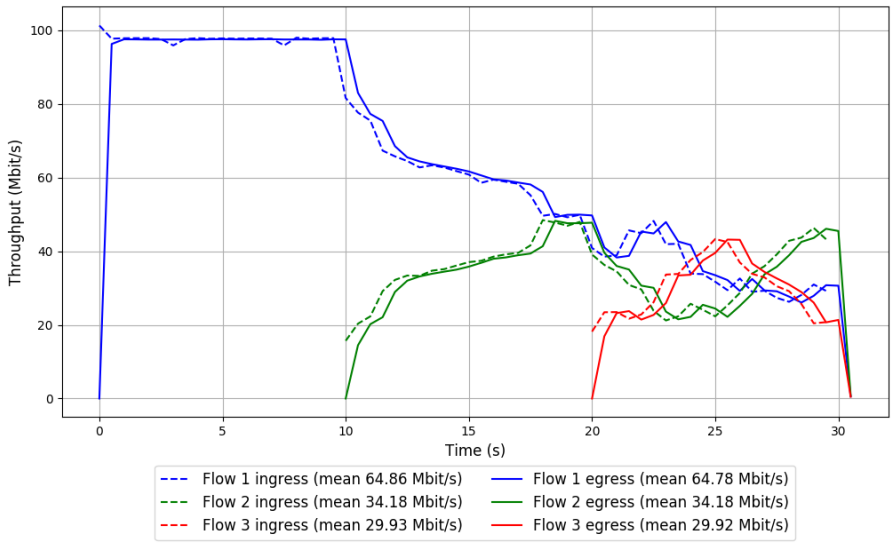



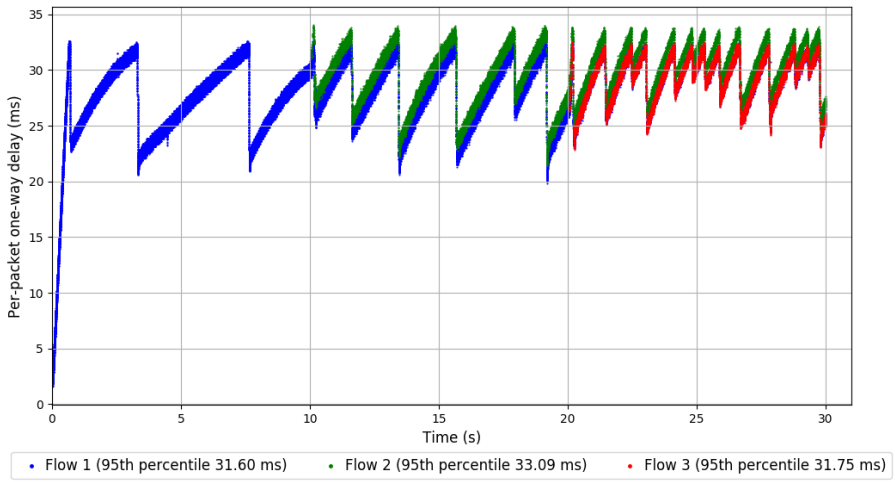
```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-31 04:43:52
End at: 2018-08-31 04:44:22
Local clock offset: -10.708 ms
Remote clock offset: 0.264 ms

# Below is generated by plot.py at 2018-08-31 04:55:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.46 Mbit/s
95th percentile per-packet one-way delay: 32.216 ms
Loss rate: 0.04%
-- Flow 1:
Average throughput: 64.78 Mbit/s
95th percentile per-packet one-way delay: 31.598 ms
Loss rate: 0.04%
-- Flow 2:
Average throughput: 34.18 Mbit/s
95th percentile per-packet one-way delay: 33.093 ms
Loss rate: 0.04%
-- Flow 3:
Average throughput: 29.92 Mbit/s
95th percentile per-packet one-way delay: 31.745 ms
Loss rate: 0.05%
```

Run 1: Report of TCP Cubic — Data Link



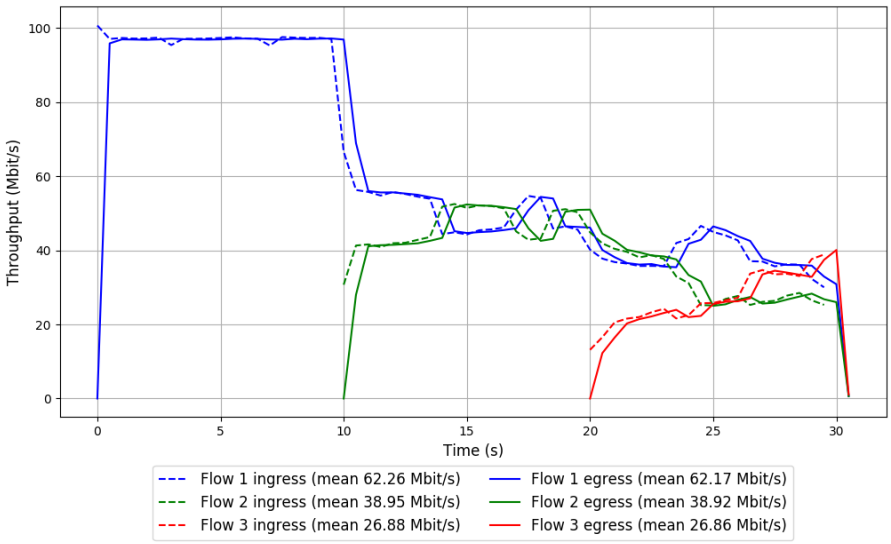



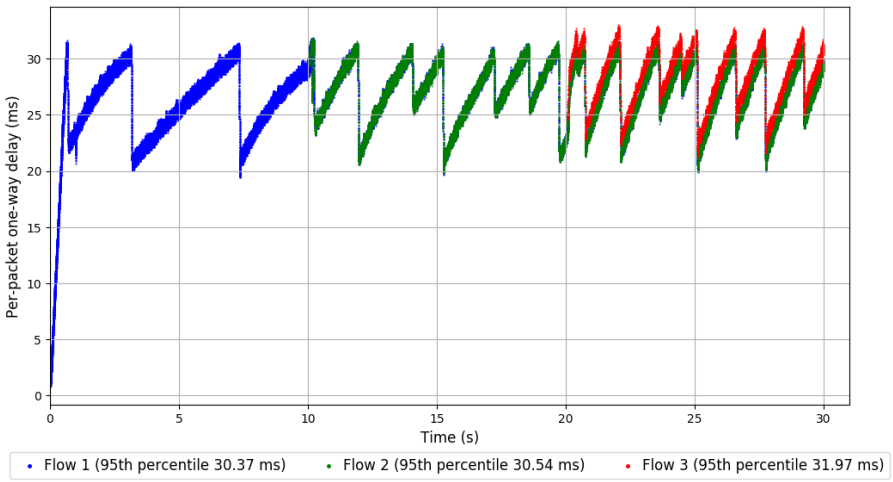
```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-31 04:48:19
End at: 2018-08-31 04:48:49
Local clock offset: -11.546 ms
Remote clock offset: 0.237 ms

# Below is generated by plot.py at 2018-08-31 04:55:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.00 Mbit/s
95th percentile per-packet one-way delay: 30.611 ms
Loss rate: 0.05%
-- Flow 1:
Average throughput: 62.17 Mbit/s
95th percentile per-packet one-way delay: 30.372 ms
Loss rate: 0.04%
-- Flow 2:
Average throughput: 38.92 Mbit/s
95th percentile per-packet one-way delay: 30.535 ms
Loss rate: 0.07%
-- Flow 3:
Average throughput: 26.86 Mbit/s
95th percentile per-packet one-way delay: 31.968 ms
Loss rate: 0.03%
```

Run 2: Report of TCP Cubic — Data Link



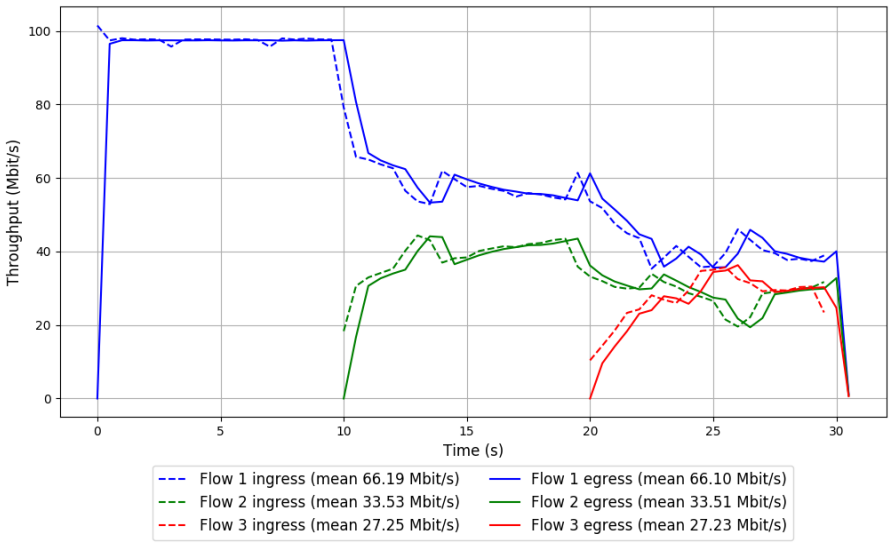



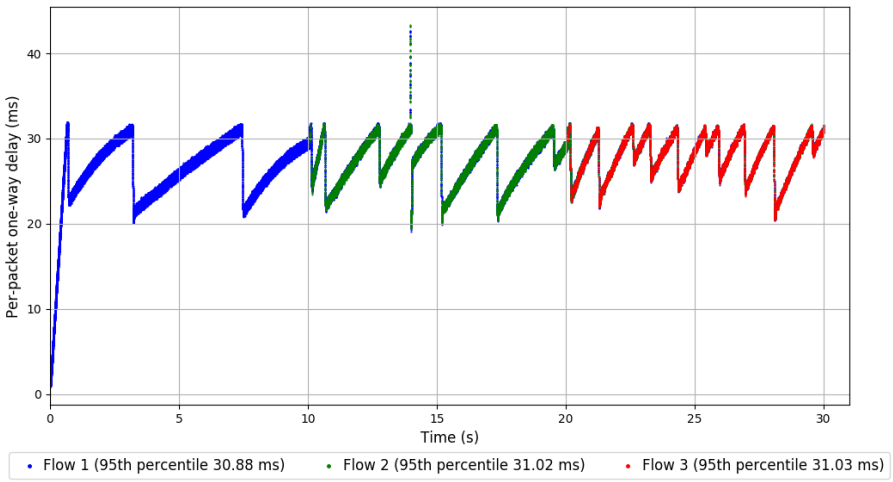
```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-31 04:52:47
End at: 2018-08-31 04:53:17
Local clock offset: -13.072 ms
Remote clock offset: 0.247 ms

# Below is generated by plot.py at 2018-08-31 04:55:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.45 Mbit/s
95th percentile per-packet one-way delay: 30.976 ms
Loss rate: 0.03%
-- Flow 1:
Average throughput: 66.10 Mbit/s
95th percentile per-packet one-way delay: 30.883 ms
Loss rate: 0.03%
-- Flow 2:
Average throughput: 33.51 Mbit/s
95th percentile per-packet one-way delay: 31.023 ms
Loss rate: 0.03%
-- Flow 3:
Average throughput: 27.23 Mbit/s
95th percentile per-packet one-way delay: 31.028 ms
Loss rate: 0.05%
```

Run 3: Report of TCP Cubic — Data Link



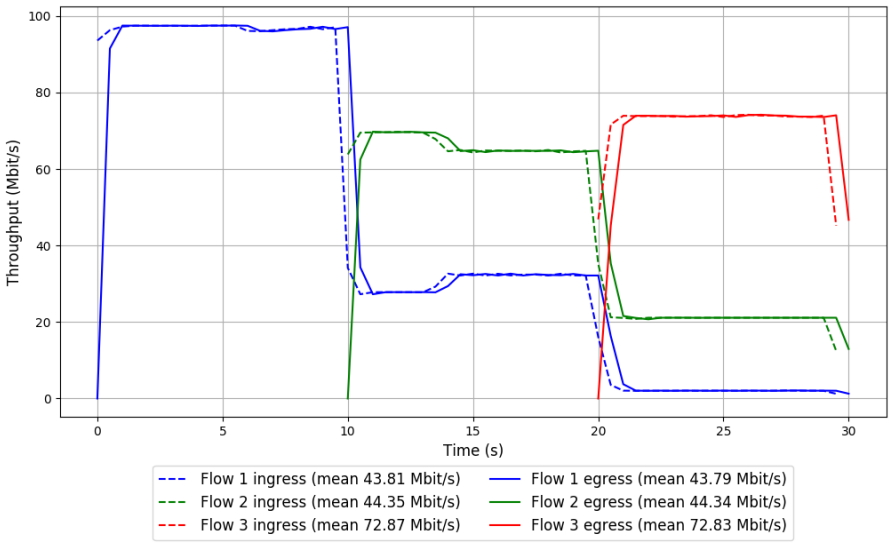



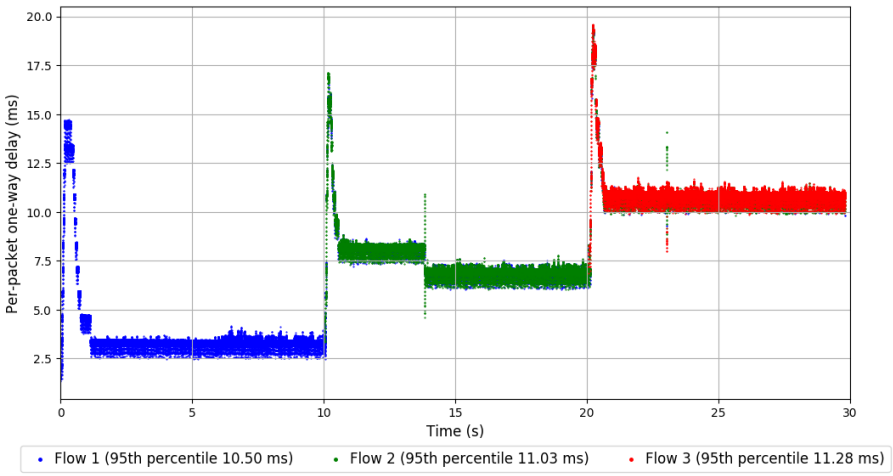
```
Run 1: Statistics of Indigo

Start at: 2018-08-31 04:45:00
End at: 2018-08-31 04:45:30
Local clock offset: -11.019 ms
Remote clock offset: 0.249 ms

# Below is generated by plot.py at 2018-08-31 04:55:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.98 Mbit/s
95th percentile per-packet one-way delay: 11.092 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 43.79 Mbit/s
95th percentile per-packet one-way delay: 10.501 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 44.34 Mbit/s
95th percentile per-packet one-way delay: 11.033 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 72.83 Mbit/s
95th percentile per-packet one-way delay: 11.282 ms
Loss rate: 0.00%
```

Run 1: Report of Indigo — Data Link



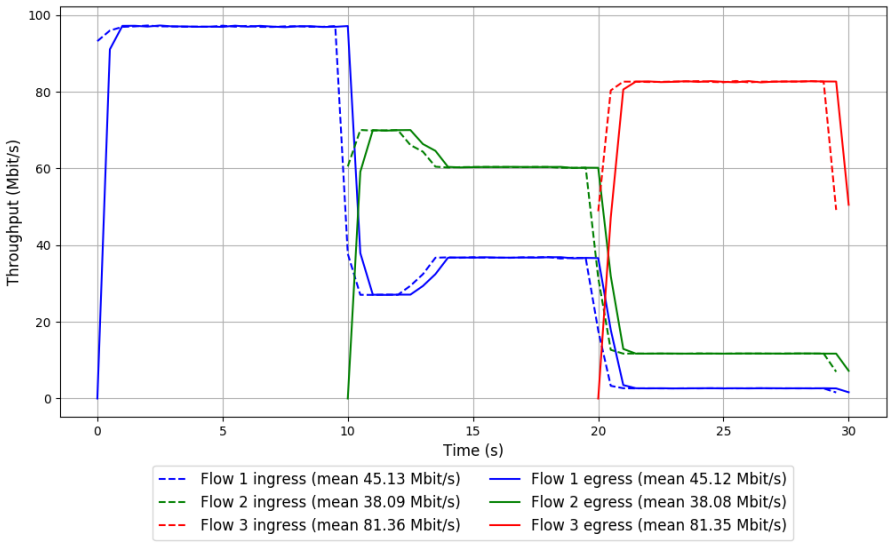



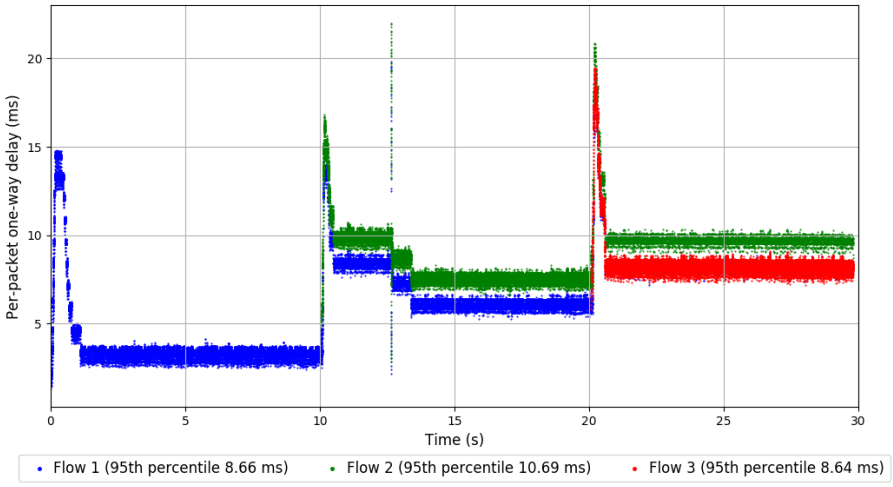
```
Run 2: Statistics of Indigo

Start at: 2018-08-31 04:49:27
End at: 2018-08-31 04:49:57
Local clock offset: -12.67 ms
Remote clock offset: 0.198 ms

# Below is generated by plot.py at 2018-08-31 04:55:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.93 Mbit/s
95th percentile per-packet one-way delay: 10.116 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 45.12 Mbit/s
95th percentile per-packet one-way delay: 8.659 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 38.08 Mbit/s
95th percentile per-packet one-way delay: 10.687 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 81.35 Mbit/s
95th percentile per-packet one-way delay: 8.644 ms
Loss rate: 0.00%
```

Run 2: Report of Indigo — Data Link



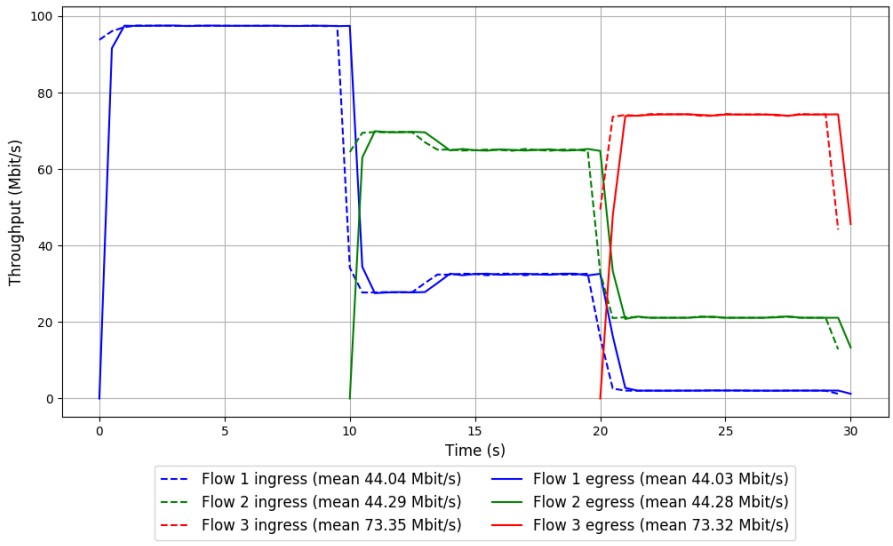



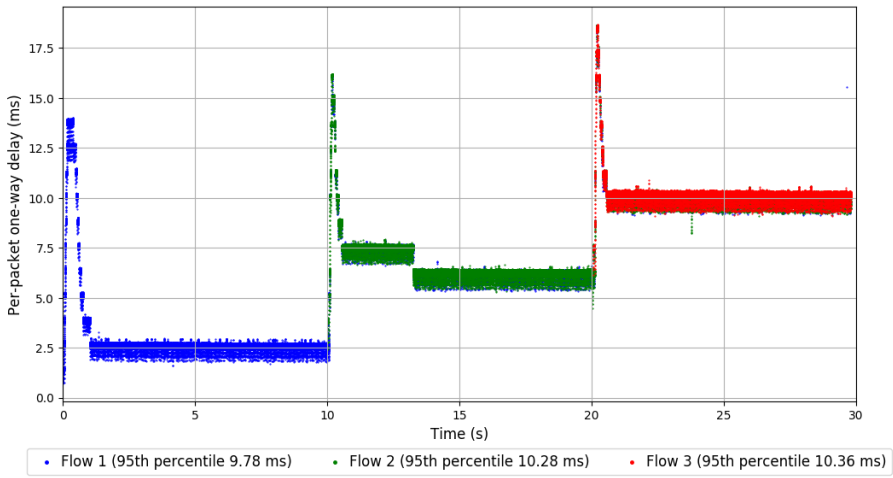
```
Run 3: Statistics of Indigo

Start at: 2018-08-31 04:53:54
End at: 2018-08-31 04:54:24
Local clock offset: -13.359 ms
Remote clock offset: 0.254 ms

# Below is generated by plot.py at 2018-08-31 04:55:59
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.37 Mbit/s
95th percentile per-packet one-way delay: 10.323 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 44.03 Mbit/s
95th percentile per-packet one-way delay: 9.783 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 44.28 Mbit/s
95th percentile per-packet one-way delay: 10.277 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 73.32 Mbit/s
95th percentile per-packet one-way delay: 10.358 ms
Loss rate: 0.00%
```

Run 3: Report of Indigo — Data Link



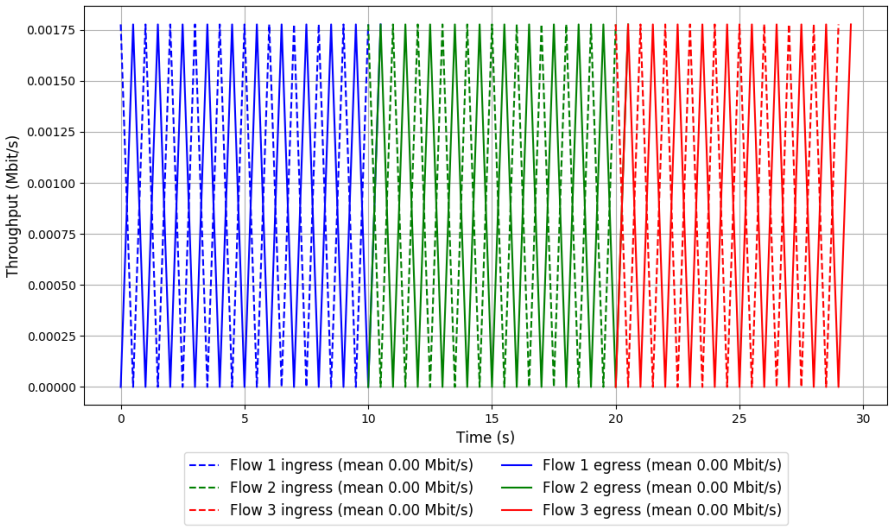



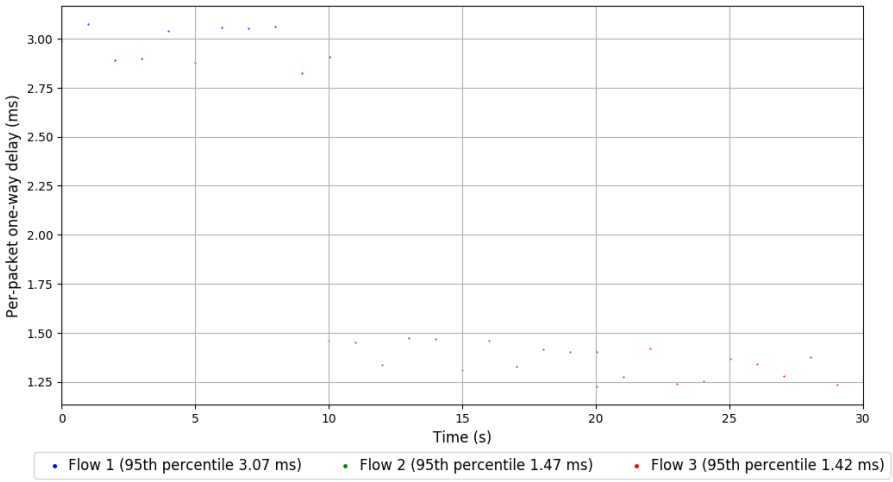
```
Run 1: Statistics of Muses-25

Start at: 2018-08-31 04:42:49
End at: 2018-08-31 04:43:19
Local clock offset: -10.311 ms
Remote clock offset: 0.268 ms

# Below is generated by plot.py at 2018-08-31 04:55:59
# Datalink statistics
-- Total of 3 flows:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 3.058 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 3.073 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 1.473 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 1.419 ms
Loss rate: 0.00%
```

Run 1: Report of Muses-25 — Data Link



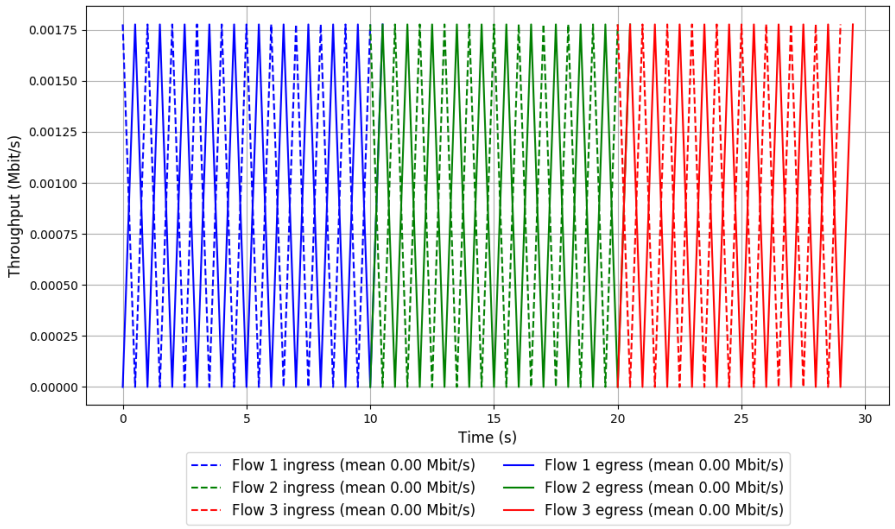



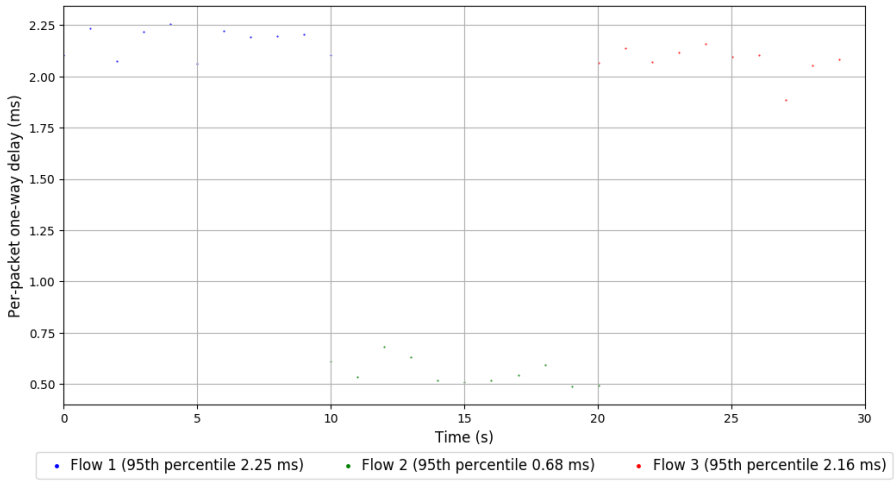
```
Run 2: Statistics of Muses-25

Start at: 2018-08-31 04:47:16
End at: 2018-08-31 04:47:46
Local clock offset: -11.14 ms
Remote clock offset: 0.19 ms

# Below is generated by plot.py at 2018-08-31 04:55:59
# Datalink statistics
-- Total of 3 flows:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 2.224 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 2.255 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 0.682 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 2.158 ms
Loss rate: 0.00%
```

Run 2: Report of Muses-25 — Data Link



```
Run 3: Statistics of Muses-25

Start at: 2018-08-31 04:51:43
End at: 2018-08-31 04:52:13
Local clock offset: -11.826 ms
Remote clock offset: 0.225 ms

# Below is generated by plot.py at 2018-08-31 04:55:59
# Datalink statistics
-- Total of 3 flows:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 1.423 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 1.467 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 1.388 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 1.350 ms
Loss rate: 0.00%
```

Run 3: Report of Muses-25 — Data Link