# Pantheon Report

Generated at 2018-09-05 22:56:19 (UTC).

Data path: GCE Iowa on `ens4` (*remote*) →GCE Sydney on `ens4` (*local*).

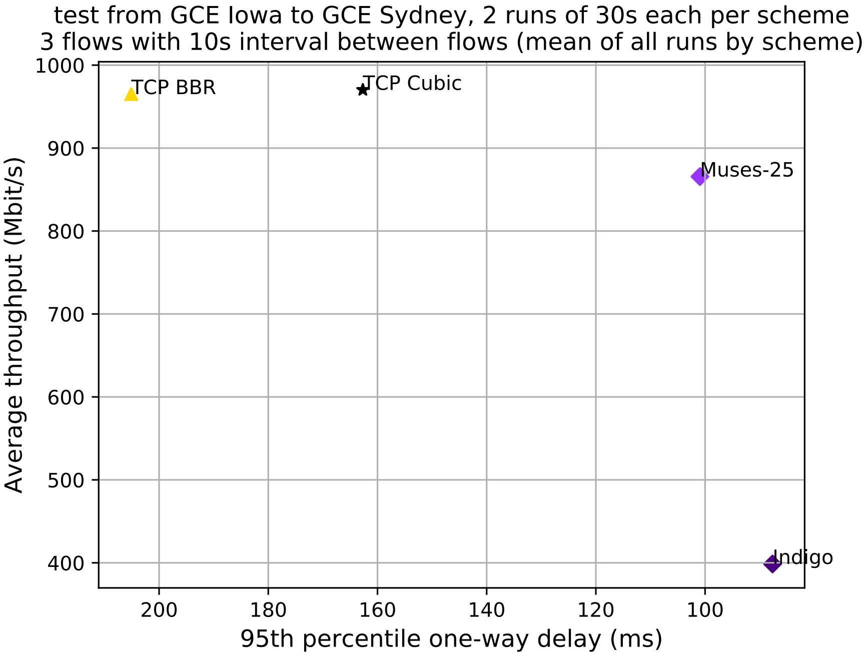
Repeated the test of 4 congestion control schemes twice.

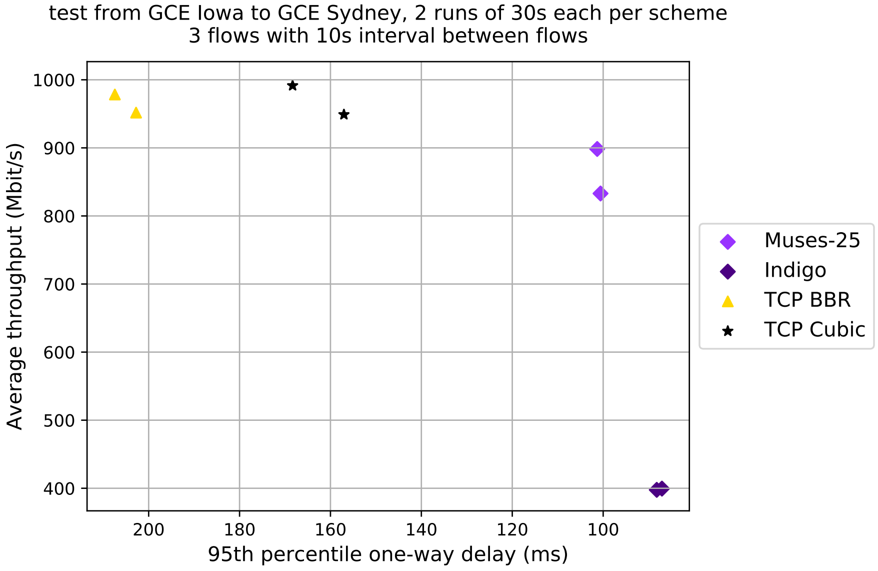
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

NTP offsets were measured against `time.google.com` and have been applied to correct the timestamps in logs.

```
System info:
Linux 4.15.0-1018-gcp
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 @ 18b9165265c8ba2915c862e8713fd9ad82c1ac21
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ a28d20fb82a95a965a3da65fd1eb71b8994e9b84
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
```

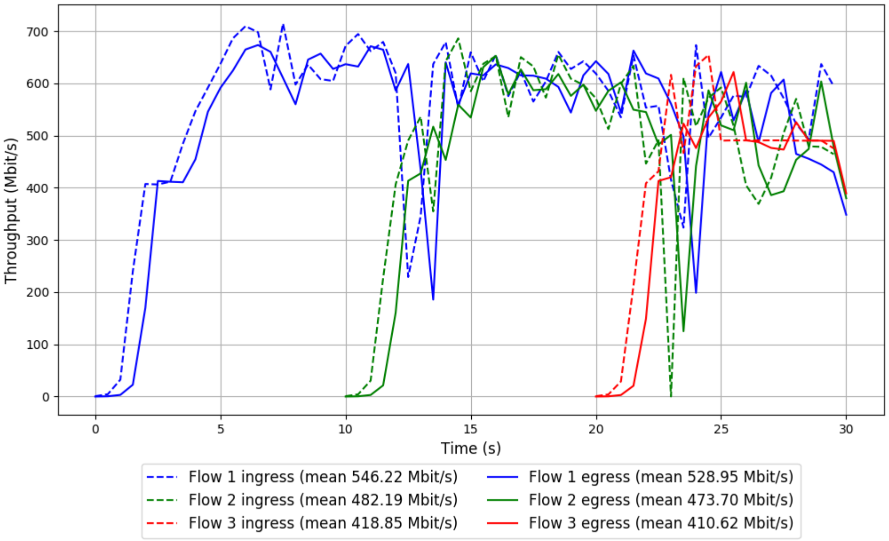

test from GCE Iowa to GCE Sydney, 2 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
Average throughput (Mbit/s)
1000
900
800
700
600
500
400
TCP BBR
TCP Cubic
Muses-25
Indigo
200
180
160
140
120
100
95th percentile one-way delay (ms)

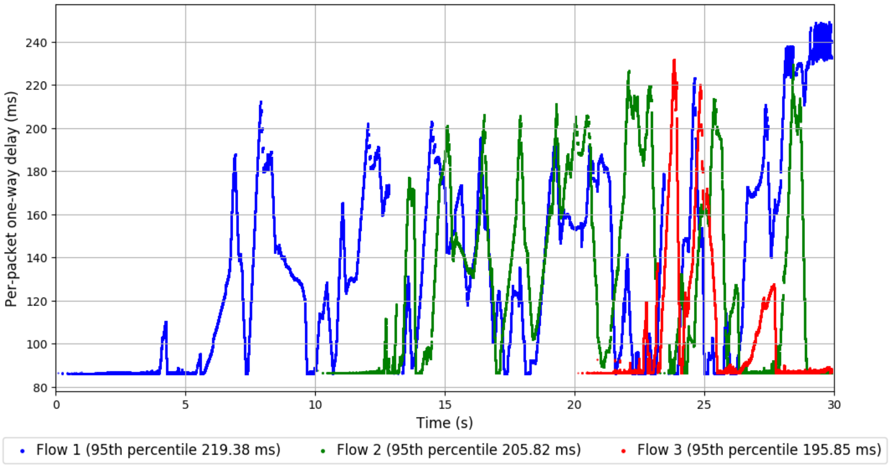

test from GCE Iowa to GCE Sydney, 2 runs of 30s each per scheme
3 flows with 10s interval between flows
Average throughput (Mbit/s)
1000
900
800
700
600
500
400
200
180
160
140
120
100
95th percentile one-way delay (ms)
Muses-25
Indigo
TCP BBR
TCP Cubic

|  |  | mean avg tput (Mbit/s) |  |  | mean 95th-%ile delay (ms) |  |  | mean loss rate (%) |  |  |
|---|---|---|---|---|---|---|---|---|---|---|
| scheme | # runs | flow 1 | flow 2 | flow 3 | flow 1 | flow 2 | flow 3 | flow 1 | flow 2 | flow 3 |
| TCP BBR | 2 | 504.62 | 487.46 | 416.25 | 216.29 | 201.94 | 192.53 | 3.67 | 3.00 | 3.50 |
| TCP Cubic | 2 | 546.83 | 447.94 | 382.44 | 155.73 | 173.65 | 173.96 | 0.70 | 1.33 | 3.38 |
| Indigo | 2 | 210.18 | 202.82 | 167.93 | 87.63 | 87.55 | 87.95 | 0.55 | 0.96 | 2.17 |
| Muses-25 | 2 | 446.16 | 435.49 | 401.56 | 104.06 | 98.13 | 97.54 | 0.62 | 1.08 | 1.18 |

```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 22:25:31
End at: 2018-09-05 22:26:01
Local clock offset: 15.818 ms
Remote clock offset: 4.834 ms

# Below is generated by plot.py at 2018-09-05 22:56:14
# Datalink statistics
-- Total of 3 flows:
Average throughput: 978.39 Mbit/s
95th percentile per-packet one-way delay: 207.434 ms
Loss rate: 3.36%
-- Flow 1:
Average throughput: 528.95 Mbit/s
95th percentile per-packet one-way delay: 219.378 ms
Loss rate: 3.72%
-- Flow 2:
Average throughput: 473.70 Mbit/s
95th percentile per-packet one-way delay: 205.818 ms
Loss rate: 2.62%
-- Flow 3:
Average throughput: 410.62 Mbit/s
95th percentile per-packet one-way delay: 195.849 ms
Loss rate: 3.68%
```

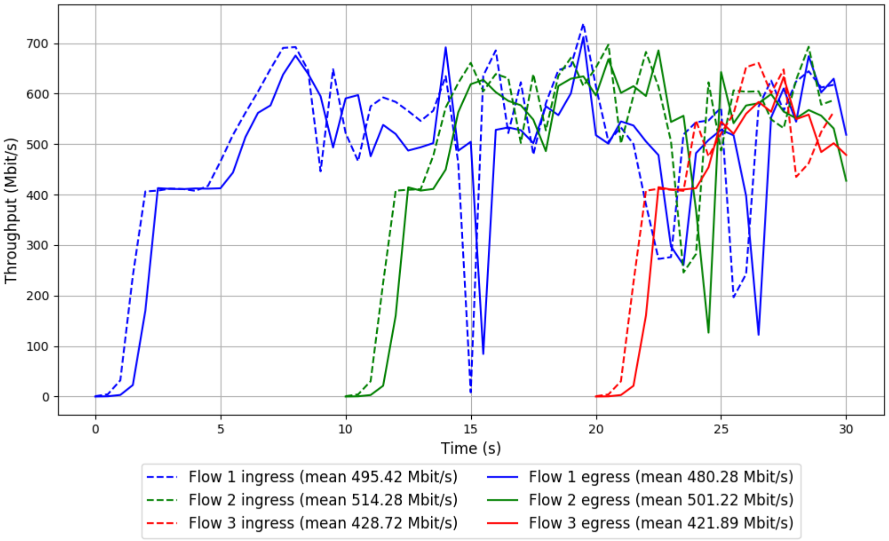
# Run 1: Report of TCP BBR — Data Link

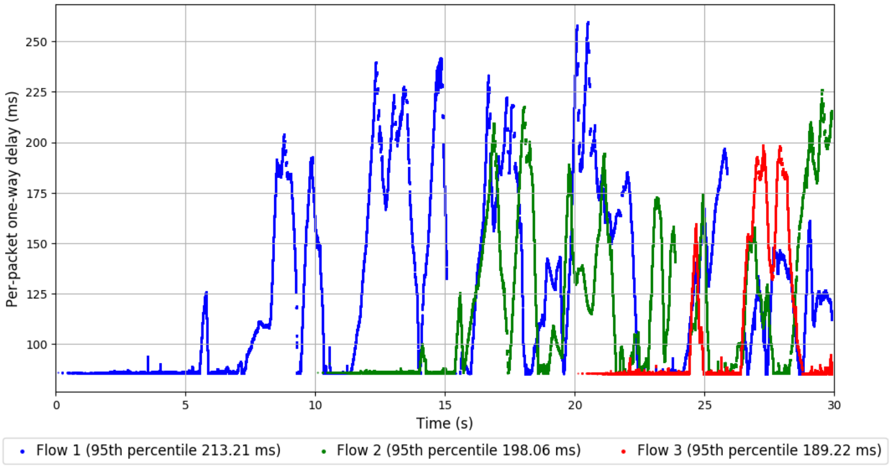




```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 22:33:41
End at: 2018-09-05 22:34:11
Local clock offset: 16.87 ms
Remote clock offset: 2.78 ms

# Below is generated by plot.py at 2018-09-05 22:56:14
# Datalink statistics
-- Total of 3 flows:
Average throughput: 951.76 Mbit/s
95th percentile per-packet one-way delay: 202.766 ms
Loss rate: 3.49%
-- Flow 1:
Average throughput: 480.28 Mbit/s
95th percentile per-packet one-way delay: 213.210 ms
Loss rate: 3.62%
-- Flow 2:
Average throughput: 501.22 Mbit/s
95th percentile per-packet one-way delay: 198.065 ms
Loss rate: 3.39%
-- Flow 3:
Average throughput: 421.89 Mbit/s
95th percentile per-packet one-way delay: 189.220 ms
Loss rate: 3.32%
```

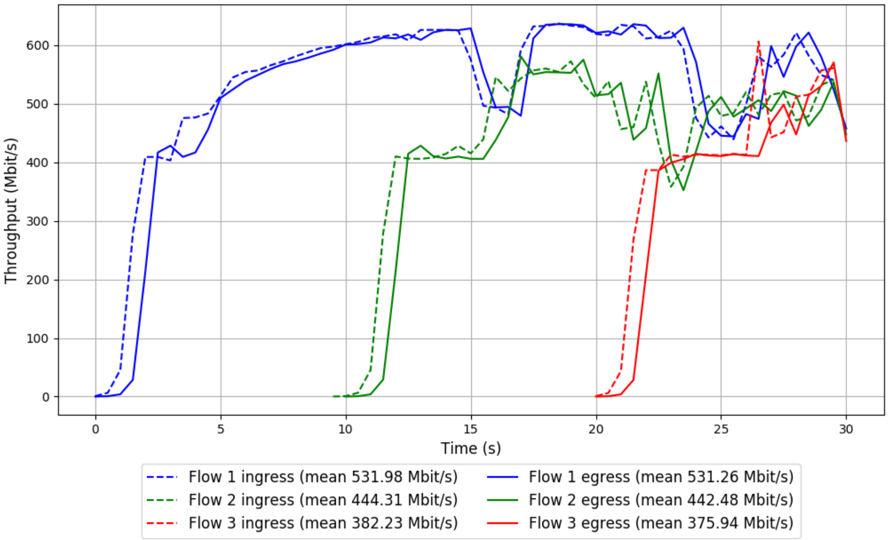
## Run 2: Report of TCP BBR — Data Link

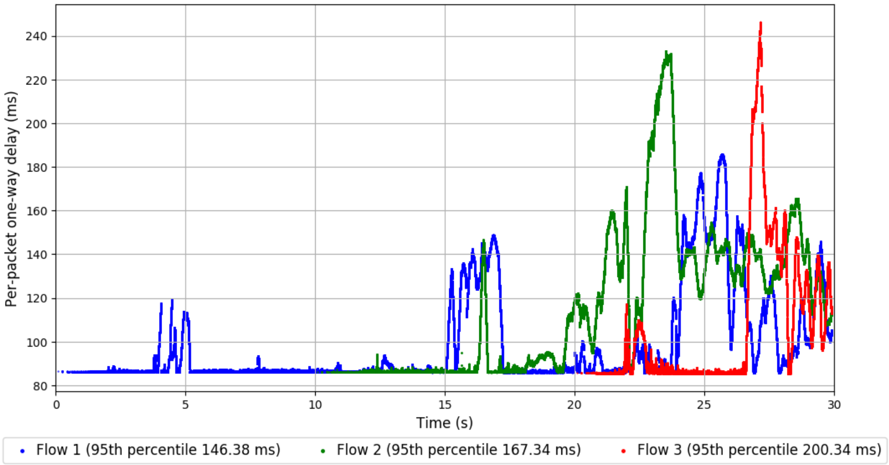




```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 22:29:38
End at: 2018-09-05 22:30:08
Local clock offset: 15.96 ms
Remote clock offset: 4.231 ms

# Below is generated by plot.py at 2018-09-05 22:56:14
# Datalink statistics
-- Total of 3 flows:
Average throughput: 948.87 Mbit/s
95th percentile per-packet one-way delay: 157.038 ms
Loss rate: 1.24%
-- Flow 1:
Average throughput: 531.26 Mbit/s
95th percentile per-packet one-way delay: 146.378 ms
Loss rate: 0.71%
-- Flow 2:
Average throughput: 442.48 Mbit/s
95th percentile per-packet one-way delay: 167.338 ms
Loss rate: 1.27%
-- Flow 3:
Average throughput: 375.94 Mbit/s
95th percentile per-packet one-way delay: 200.336 ms
Loss rate: 3.35%
```

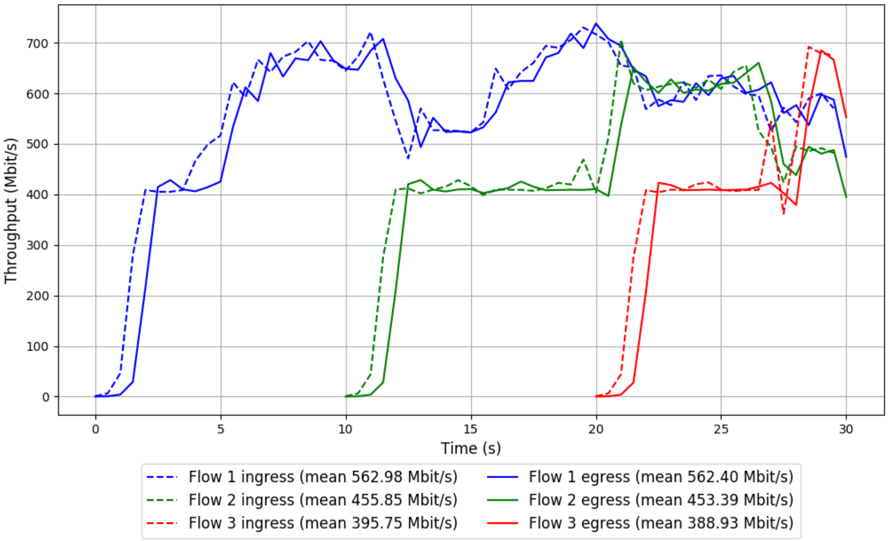
Run 1: Report of TCP Cubic — Data Link

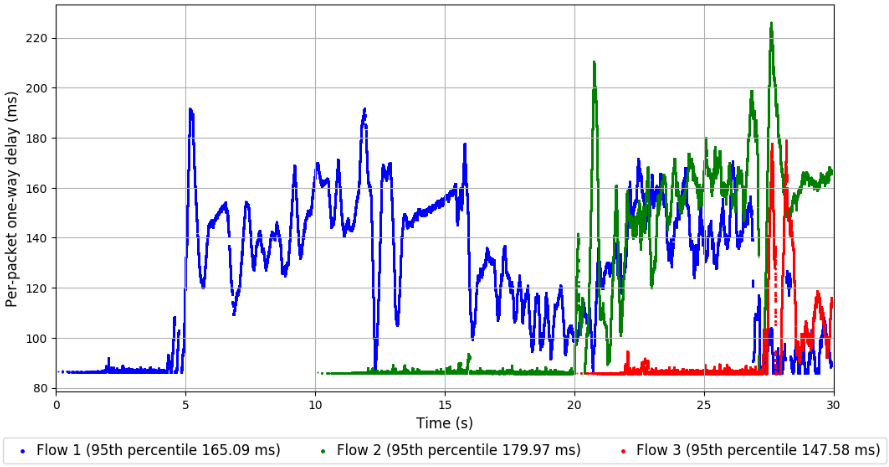




```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 22:37:45
End at: 2018-09-05 22:38:15
Local clock offset: 18.813 ms
Remote clock offset: 1.867 ms

# Below is generated by plot.py at 2018-09-05 22:56:17
# Datalink statistics
-- Total of 3 flows:
Average throughput: 991.44 Mbit/s
95th percentile per-packet one-way delay: 168.328 ms
Loss rate: 1.26%
-- Flow 1:
Average throughput: 562.40 Mbit/s
95th percentile per-packet one-way delay: 165.086 ms
Loss rate: 0.68%
-- Flow 2:
Average throughput: 453.39 Mbit/s
95th percentile per-packet one-way delay: 179.970 ms
Loss rate: 1.40%
-- Flow 3:
Average throughput: 388.93 Mbit/s
95th percentile per-packet one-way delay: 147.584 ms
Loss rate: 3.42%
```

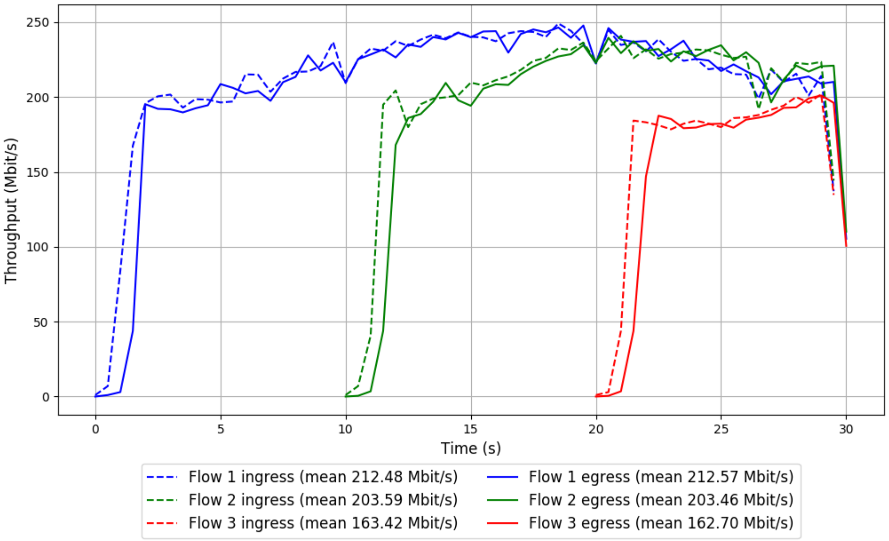
## Run 2: Report of TCP Cubic — Data Link

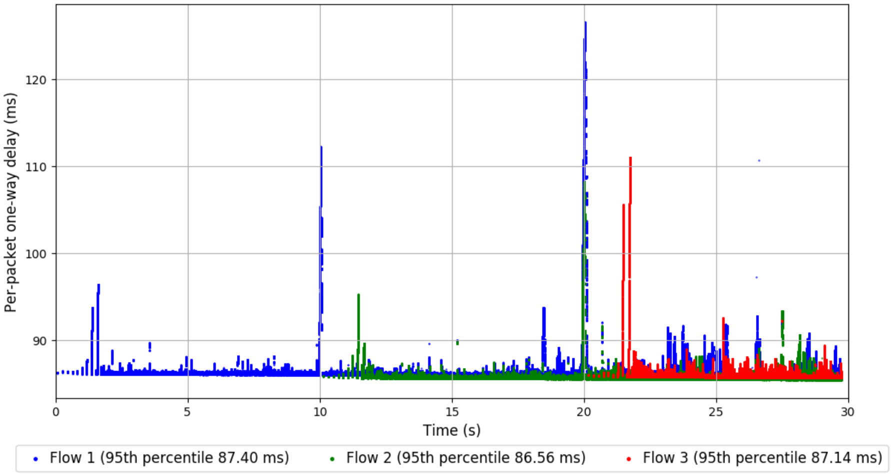




```
Run 1: Statistics of Indigo

Start at: 2018-09-05 22:27:44
End at: 2018-09-05 22:28:14
Local clock offset: 15.57 ms
Remote clock offset: 5.091 ms

# Below is generated by plot.py at 2018-09-05 22:56:17
# Datalink statistics
-- Total of 3 flows:
Average throughput: 399.49 Mbit/s
95th percentile per-packet one-way delay: 87.068 ms
Loss rate: 0.90%
-- Flow 1:
Average throughput: 212.57 Mbit/s
95th percentile per-packet one-way delay: 87.399 ms
Loss rate: 0.54%
-- Flow 2:
Average throughput: 203.46 Mbit/s
95th percentile per-packet one-way delay: 86.558 ms
Loss rate: 0.94%
-- Flow 3:
Average throughput: 162.70 Mbit/s
95th percentile per-packet one-way delay: 87.143 ms
Loss rate: 2.20%
```

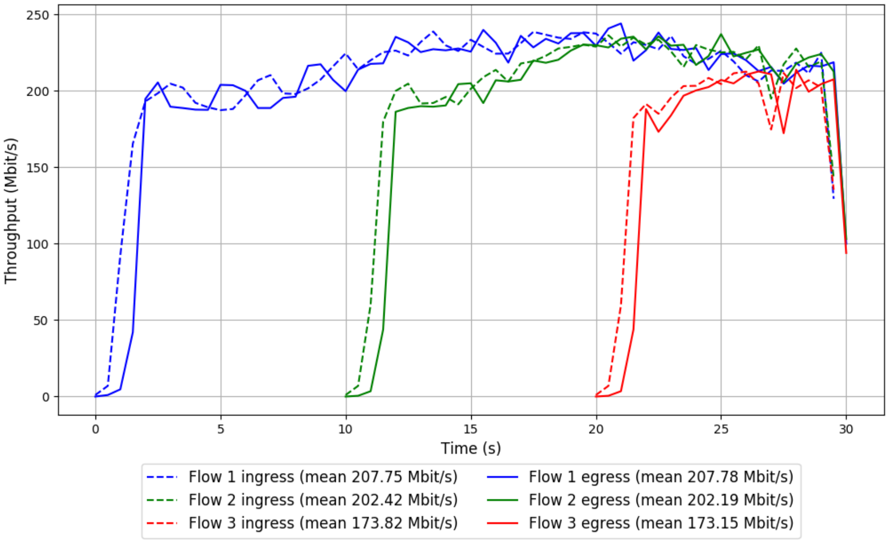
## Run 1: Report of Indigo — Data Link

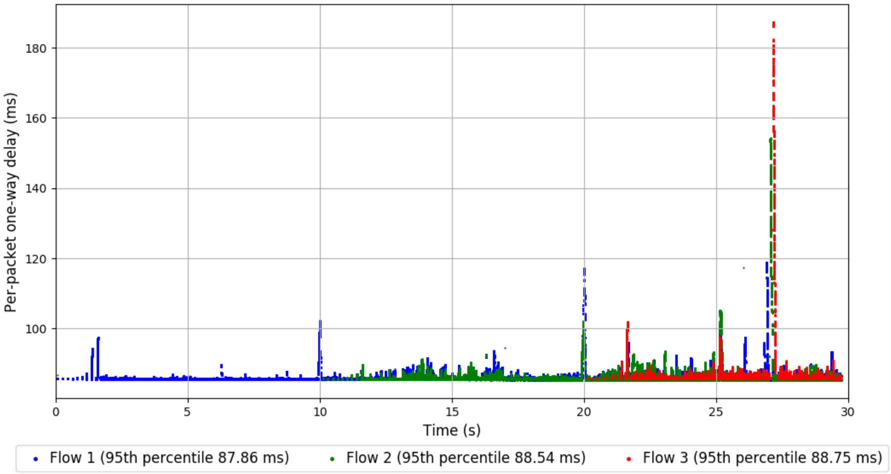




```
Run 2: Statistics of Indigo

Start at: 2018-09-05 22:35:52
End at: 2018-09-05 22:36:22
Local clock offset: 17.765 ms
Remote clock offset: 2.195 ms

# Below is generated by plot.py at 2018-09-05 22:56:17
# Datalink statistics
-- Total of 3 flows:
Average throughput: 397.67 Mbit/s
95th percentile per-packet one-way delay: 88.209 ms
Loss rate: 0.93%
-- Flow 1:
Average throughput: 207.78 Mbit/s
95th percentile per-packet one-way delay: 87.857 ms
Loss rate: 0.57%
-- Flow 2:
Average throughput: 202.19 Mbit/s
95th percentile per-packet one-way delay: 88.539 ms
Loss rate: 0.98%
-- Flow 3:
Average throughput: 173.15 Mbit/s
95th percentile per-packet one-way delay: 88.749 ms
Loss rate: 2.13%
```

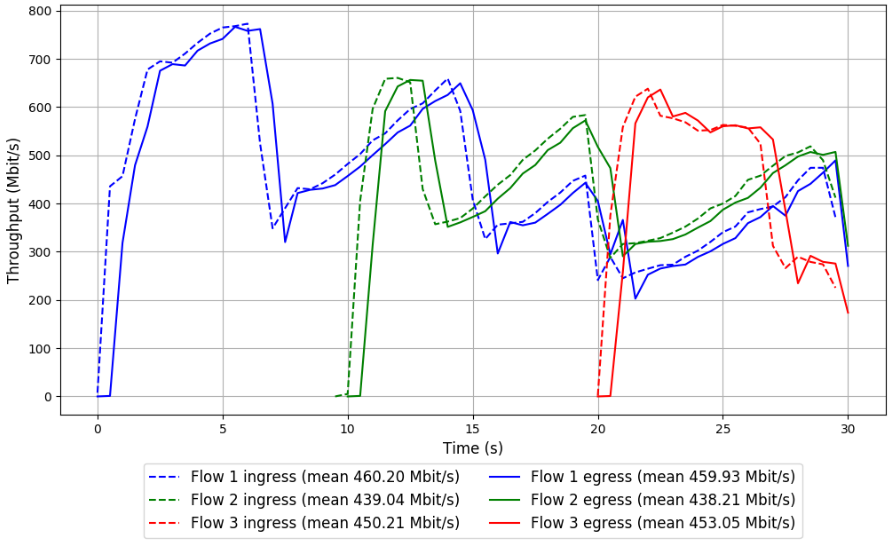
Run 2: Report of Indigo — Data Link

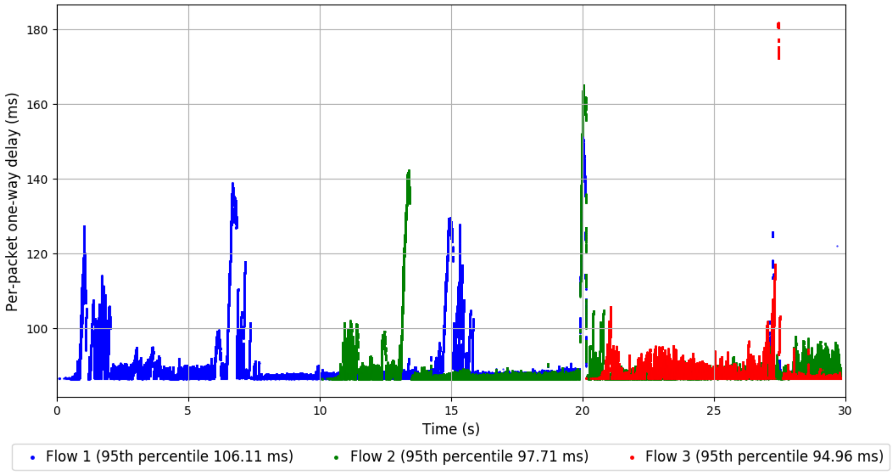




```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 22:23:30
End at: 2018-09-05 22:24:00
Local clock offset: 15.932 ms
Remote clock offset: 4.563 ms

# Below is generated by plot.py at 2018-09-05 22:56:17
# Datalink statistics
-- Total of 3 flows:
Average throughput: 898.38 Mbit/s
95th percentile per-packet one-way delay: 101.309 ms
Loss rate: 0.84%
-- Flow 1:
Average throughput: 459.93 Mbit/s
95th percentile per-packet one-way delay: 106.109 ms
Loss rate: 0.63%
-- Flow 2:
Average throughput: 438.21 Mbit/s
95th percentile per-packet one-way delay: 97.714 ms
Loss rate: 1.05%
-- Flow 3:
Average throughput: 453.05 Mbit/s
95th percentile per-packet one-way delay: 94.963 ms
Loss rate: 1.11%
```

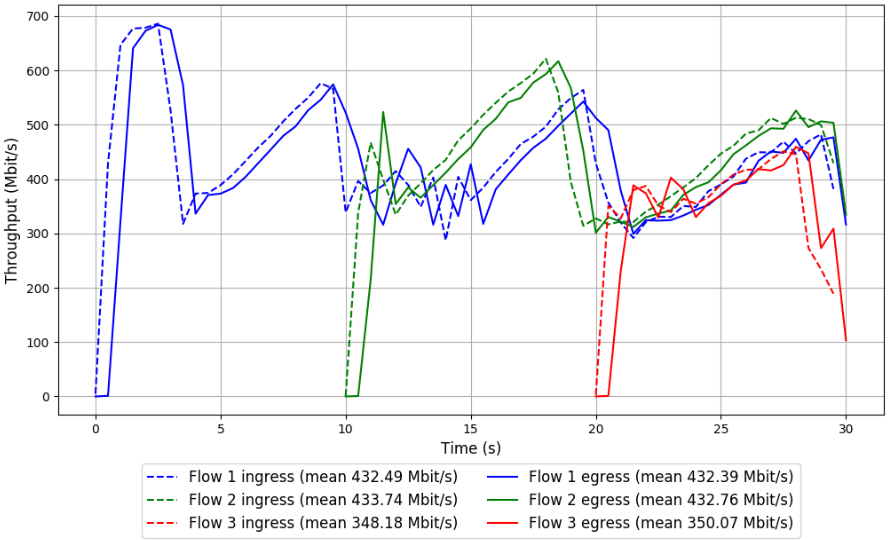
Run 1: Report of Muses-25 — Data Link



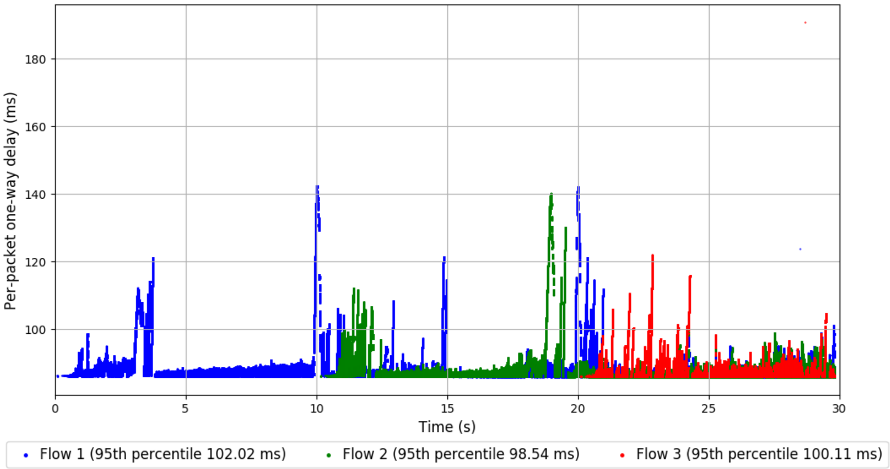


```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 22:31:43
End at: 2018-09-05 22:32:13
Local clock offset: 16.399 ms
Remote clock offset: 3.352 ms

# Below is generated by plot.py at 2018-09-05 22:56:17
# Datalink statistics
-- Total of 3 flows:
Average throughput: 832.98 Mbit/s
95th percentile per-packet one-way delay: 100.580 ms
Loss rate: 0.86%
-- Flow 1:
Average throughput: 432.39 Mbit/s
95th percentile per-packet one-way delay: 102.018 ms
Loss rate: 0.61%
-- Flow 2:
Average throughput: 432.76 Mbit/s
95th percentile per-packet one-way delay: 98.544 ms
Loss rate: 1.10%
-- Flow 3:
Average throughput: 350.07 Mbit/s
95th percentile per-packet one-way delay: 100.109 ms
Loss rate: 1.25%
```

Run 2: Report of Muses-25 — Data Link



700
600
500
400
300
200
100
0
Throughput (Mbit/s)
0
5
10
15
20
25
30
Time (s)
Flow 1 ingress (mean 432.49 Mbit/s)
Flow 1 egress (mean 432.39 Mbit/s)
Flow 2 ingress (mean 433.74 Mbit/s)
Flow 2 egress (mean 432.76 Mbit/s)
Flow 3 ingress (mean 348.18 Mbit/s)
Flow 3 egress (mean 350.07 Mbit/s)



180
160
140
120
100
Per-packet one-way delay (ms)
0
5
10
15
20
25
30
Time (s)
Flow 1 (95th percentile 102.02 ms)
Flow 2 (95th percentile 98.54 ms)
Flow 3 (95th percentile 100.11 ms)