# Pantheon Report

Generated at 2018-09-05 06:48:30 (UTC).

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

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.
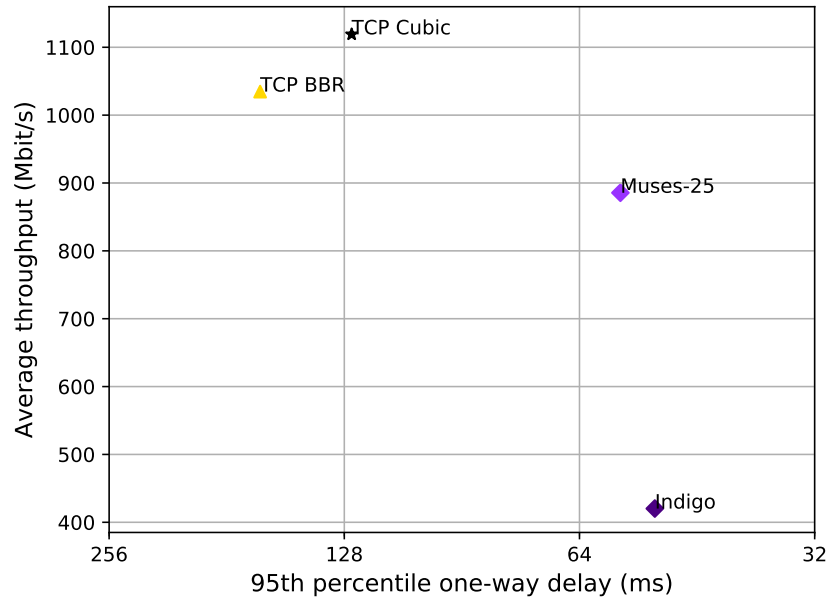
```
System info:
Linux 4.15.0-1018-gcp
net.core.default_qdisc = fq
net.core.rmem_default = 16777216
net.core.rmem_max = 536870912
net.core.wmem_default = 16777216
net.core.wmem_max = 536870912
net.ipv4.tcp_rmem = 4096 16777216 536870912
net.ipv4.tcp_wmem = 4096 16777216 536870912
net.ipv4.tcp_mem = 536870912 536870912 536870912
```
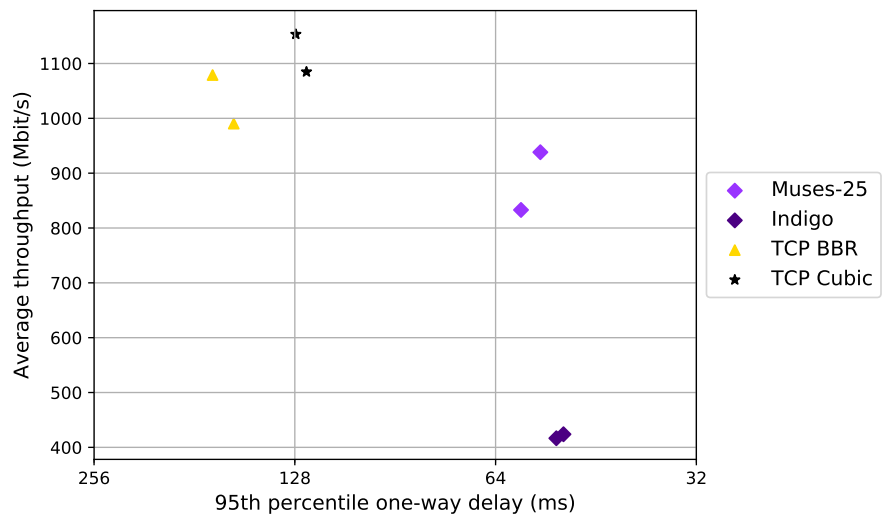
```
Git summary:
branch: muses @ 71e71e9a55b945431a7dea72180c1c9381097db9
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ 96fbc95fb38373d71fbc80c5a105e62e7636623b
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 London to GCE Iowa, 2 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)



test from GCE London to GCE Iowa, 2 runs of 30s each per scheme
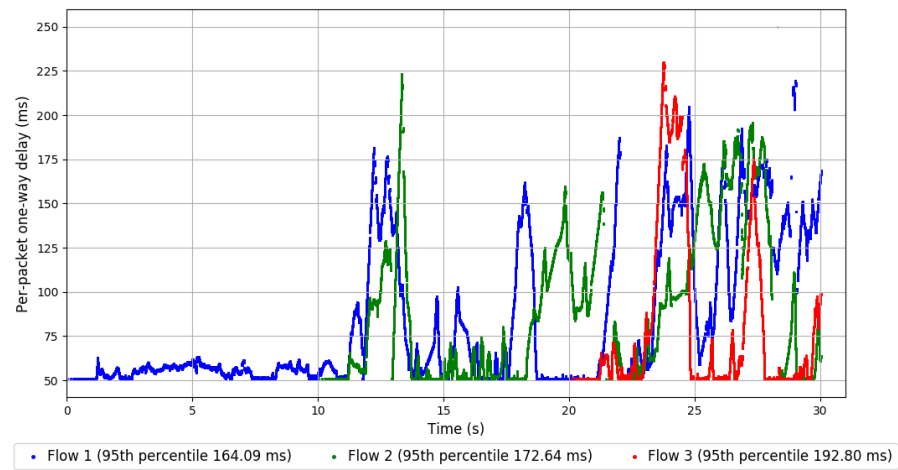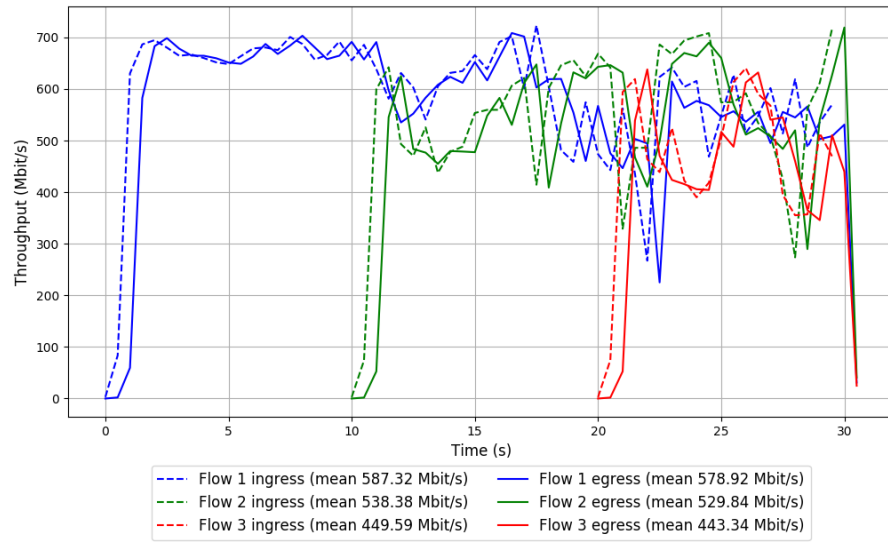3 flows with 10s interval between flows

| 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 | 2 | 551.15 | 486.27 | 480.79 | 165.62 | 140.25 | 170.79 | 1.39 | 0.80 | 1.12 |
| TCP Cubic | 2 | 597.21 | 531.20 | 505.36 | 134.11 | 106.87 | 85.51 | 0.14 | 0.15 | 0.03 |
| Indigo | 2 | 221.28 | 207.06 | 189.85 | 50.32 | 52.06 | 50.98 | 0.00 | 0.00 | 0.00 |
| Muses-25 | 2 | 477.36 | 439.78 | 355.98 | 56.03 | 58.28 | 54.35 | 0.00 | 0.01 | 0.00 |

```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 06:18:02
End at: 2018-09-05 06:18:32
Local clock offset: -0.638 ms
Remote clock offset: -0.002 ms


# Below is generated by plot.py at 2018-09-05 06:48:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1079.01 Mbit/s
95th percentile per-packet one-way delay: 170.032 ms
Loss rate: 1.47%
-- Flow 1:
Average throughput: 578.92 Mbit/s
95th percentile per-packet one-way delay: 164.086 ms
Loss rate: 1.43%
-- Flow 2:
Average throughput: 529.84 Mbit/s
95th percentile per-packet one-way delay: 172.644 ms
Loss rate: 1.59%
-- Flow 3:
Average throughput: 443.34 Mbit/s
95th percentile per-packet one-way delay: 192.799 ms
Loss rate: 1.38%
```

Run 1: Report of TCP BBR — Data Link



Flow 1 ingress (mean 587.32 Mbit/s) --- Flow 1 egress (mean 578.92 Mbit/s)
Flow 2 ingress (mean 538.38 Mbit/s) --- Flow 2 egress (mean 529.84 Mbit/s)
Flow 3 ingress (mean 449.59 Mbit/s) --- Flow 3 egress (mean 443.34 Mbit/s)



Flow 1 (95th percentile 164.09 ms)  Flow 2 (95th percentile 172.64 ms)  Flow 3 (95th percentile 192.80 ms)
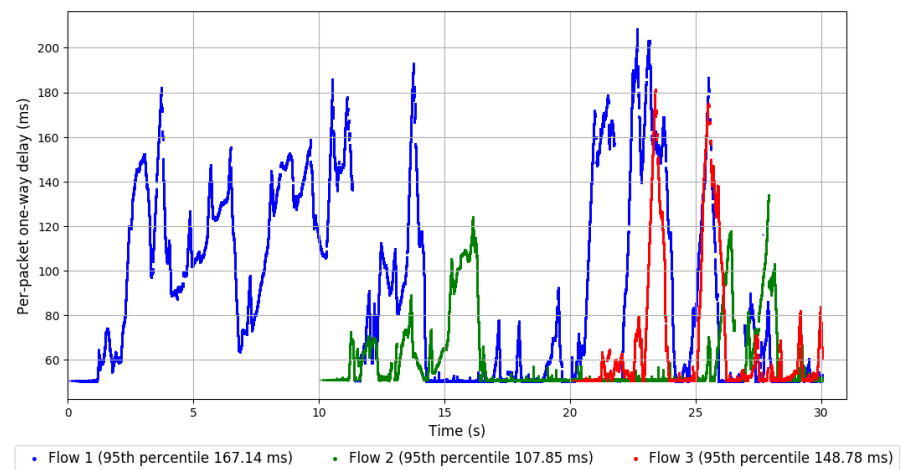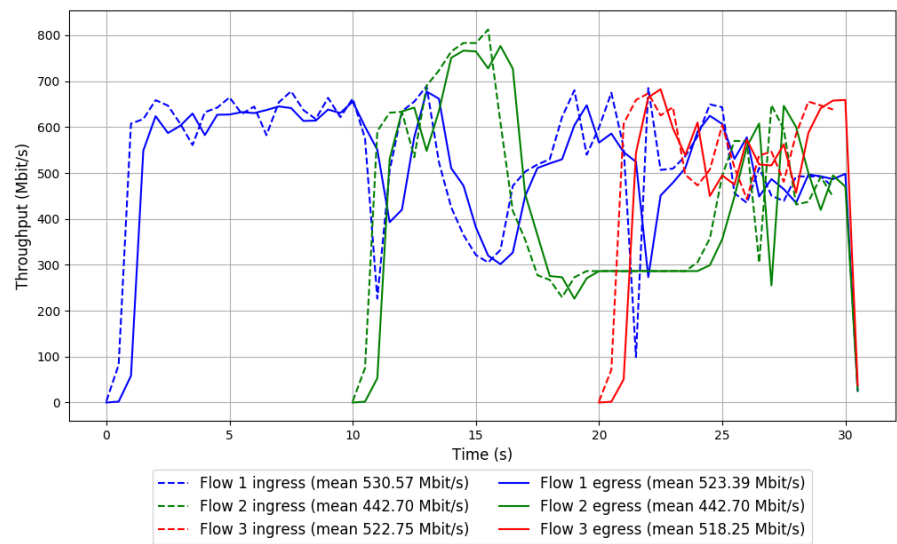
5

```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 06:25:53
End at: 2018-09-05 06:26:23
Local clock offset: -0.332 ms
Remote clock offset: -0.082 ms


# Below is generated by plot.py at 2018-09-05 06:48:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 990.36 Mbit/s
95th percentile per-packet one-way delay: 158.044 ms
Loss rate: 0.87%
-- Flow 1:
Average throughput: 523.39 Mbit/s
95th percentile per-packet one-way delay: 167.144 ms
Loss rate: 1.35%
-- Flow 2:
Average throughput: 442.70 Mbit/s
95th percentile per-packet one-way delay: 107.850 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 518.25 Mbit/s
95th percentile per-packet one-way delay: 148.785 ms
Loss rate: 0.87%
```
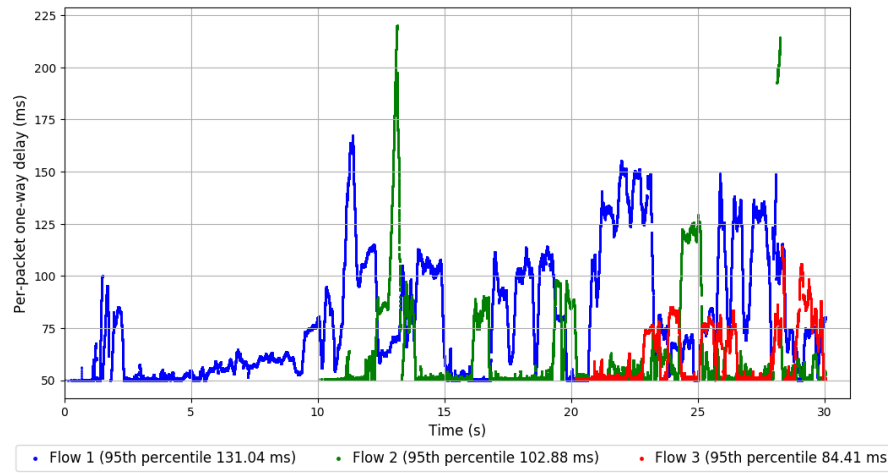
Run 2: Report of TCP BBR — Data Link



Flow 1 ingress (mean 530.57 Mbit/s) ---- Flow 1 egress (mean 523.39 Mbit/s)
Flow 2 ingress (mean 442.70 Mbit/s) ---- Flow 2 egress (mean 442.70 Mbit/s)
Flow 3 ingress (mean 522.75 Mbit/s) ---- Flow 3 egress (mean 518.25 Mbit/s)



Flow 1 (95th percentile 167.14 ms) • Flow 2 (95th percentile 107.85 ms) • Flow 3 (95th percentile 148.78 ms)
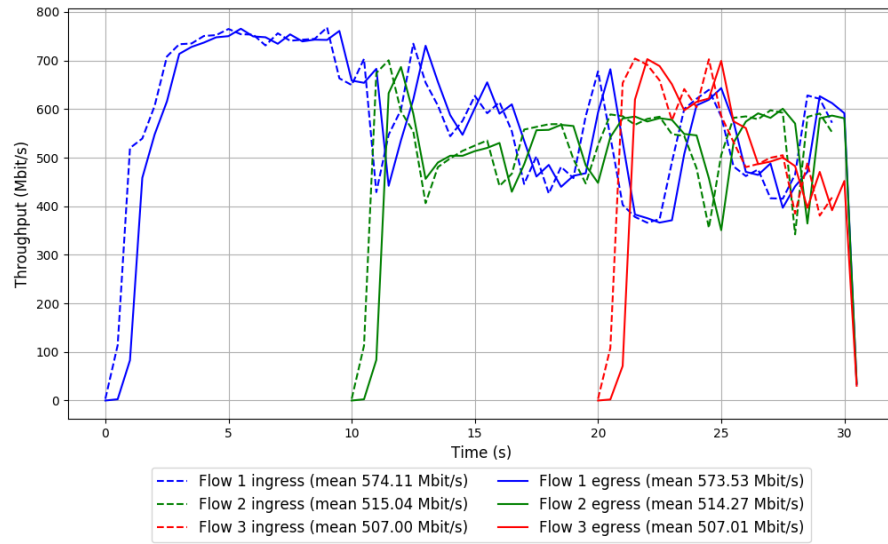
7

```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 06:22:01
End at: 2018-09-05 06:22:31
Local clock offset: -1.255 ms
Remote clock offset: -0.082 ms


# Below is generated by plot.py at 2018-09-05 06:48:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1084.77 Mbit/s
95th percentile per-packet one-way delay: 122.953 ms
Loss rate: 0.09%
-- Flow 1:
Average throughput: 573.53 Mbit/s
95th percentile per-packet one-way delay: 131.039 ms
Loss rate: 0.10%
-- Flow 2:
Average throughput: 514.27 Mbit/s
95th percentile per-packet one-way delay: 102.882 ms
Loss rate: 0.14%
-- Flow 3:
Average throughput: 507.01 Mbit/s
95th percentile per-packet one-way delay: 84.406 ms
Loss rate: 0.00%
```

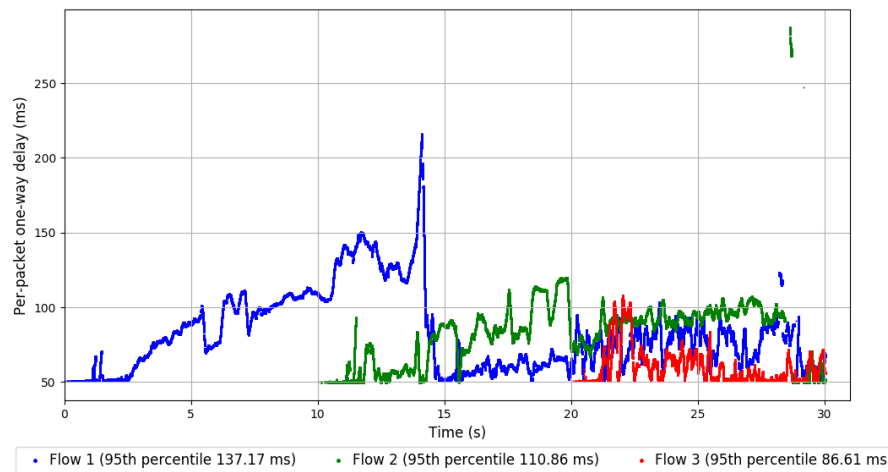Run 1: Report of TCP Cubic — Data Link
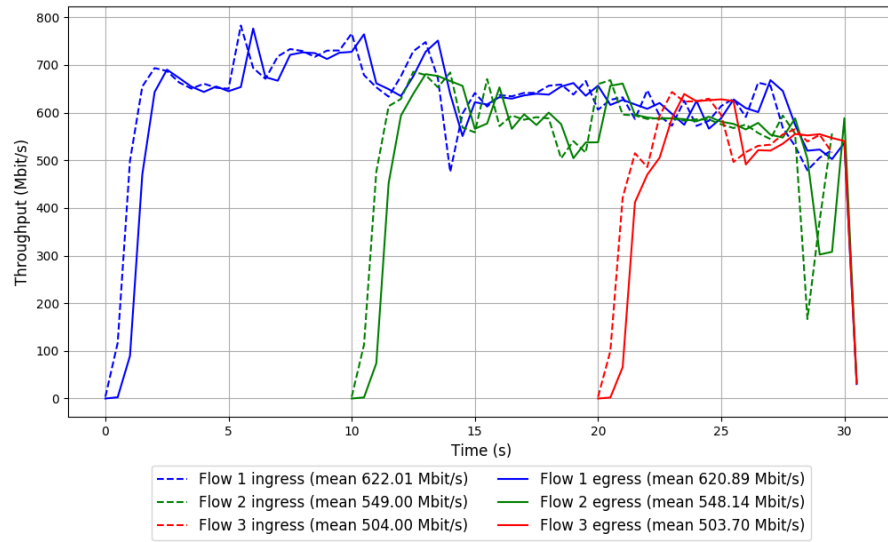




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```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 06:29:53
End at: 2018-09-05 06:30:23
Local clock offset: -0.039 ms
Remote clock offset: -0.035 ms


# Below is generated by plot.py at 2018-09-05 06:48:28
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1153.33 Mbit/s
95th percentile per-packet one-way delay: 127.562 ms
Loss rate: 0.15%
-- Flow 1:
Average throughput: 620.89 Mbit/s
95th percentile per-packet one-way delay: 137.173 ms
Loss rate: 0.18%
-- Flow 2:
Average throughput: 548.14 Mbit/s
95th percentile per-packet one-way delay: 110.855 ms
Loss rate: 0.15%
-- Flow 3:
Average throughput: 503.70 Mbit/s
95th percentile per-packet one-way delay: 86.605 ms
Loss rate: 0.05%
```

Run 2: Report of TCP Cubic — Data Link



Flow 1 ingress (mean 622.01 Mbit/s)    Flow 1 egress (mean 620.89 Mbit/s)
Flow 2 ingress (mean 549.00 Mbit/s)    Flow 2 egress (mean 548.14 Mbit/s)
Flow 3 ingress (mean 504.00 Mbit/s)    Flow 3 egress (mean 503.70 Mbit/s)



Flow 1 (95th percentile 137.17 ms)    Flow 2 (95th percentile 110.86 ms)    Flow 3 (95th percentile 86.61 ms)
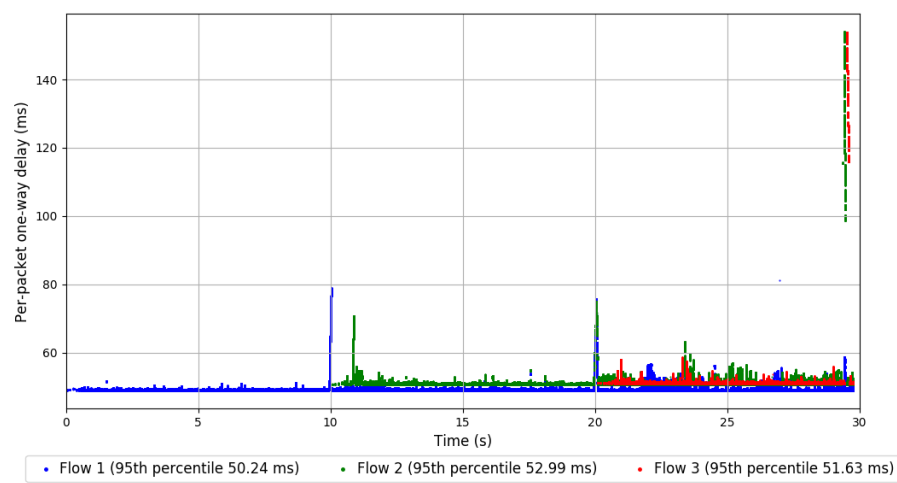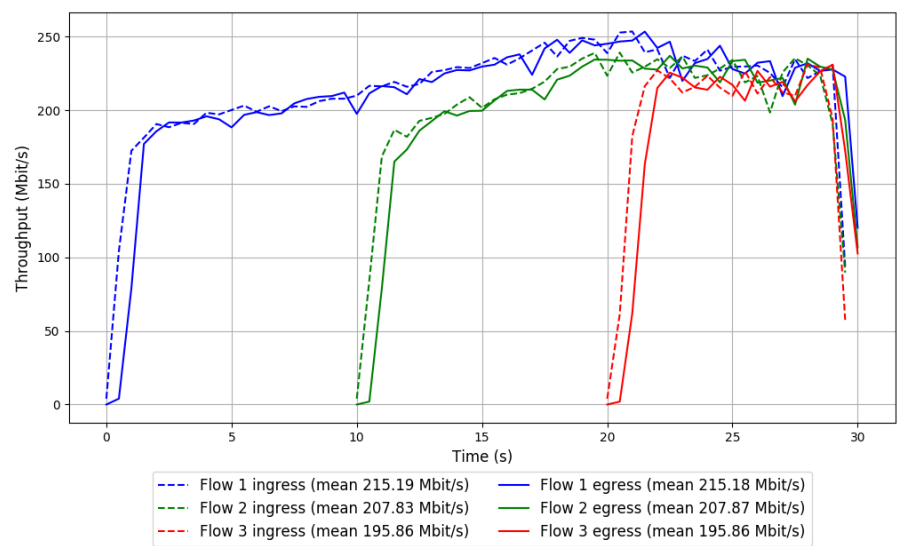
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```
Run 1: Statistics of Indigo

Start at: 2018-09-05 06:16:13
End at: 2018-09-05 06:16:43
Local clock offset: -0.345 ms
Remote clock offset: 0.036 ms


# Below is generated by plot.py at 2018-09-05 06:48:28
# Datalink statistics
-- Total of 3 flows:
Average throughput: 416.59 Mbit/s
95th percentile per-packet one-way delay: 51.889 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 215.18 Mbit/s
95th percentile per-packet one-way delay: 50.236 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 207.87 Mbit/s
95th percentile per-packet one-way delay: 52.990 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 195.86 Mbit/s
95th percentile per-packet one-way delay: 51.630 ms
Loss rate: 0.00%
```
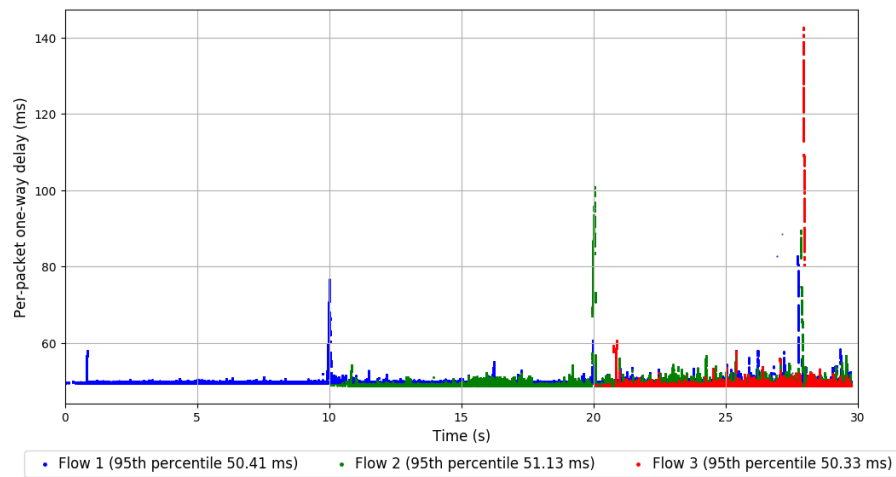
Run 1: Report of Indigo — Data Link



Flow 1 ingress (mean 215.19 Mbit/s) --- Flow 1 egress (mean 215.18 Mbit/s)
Flow 2 ingress (mean 207.83 Mbit/s) --- Flow 2 egress (mean 207.87 Mbit/s)
Flow 3 ingress (mean 195.86 Mbit/s) --- Flow 3 egress (mean 195.86 Mbit/s)



Flow 1 (95th percentile 50.24 ms)   Flow 2 (95th percentile 52.99 ms)   Flow 3 (95th percentile 51.63 ms)
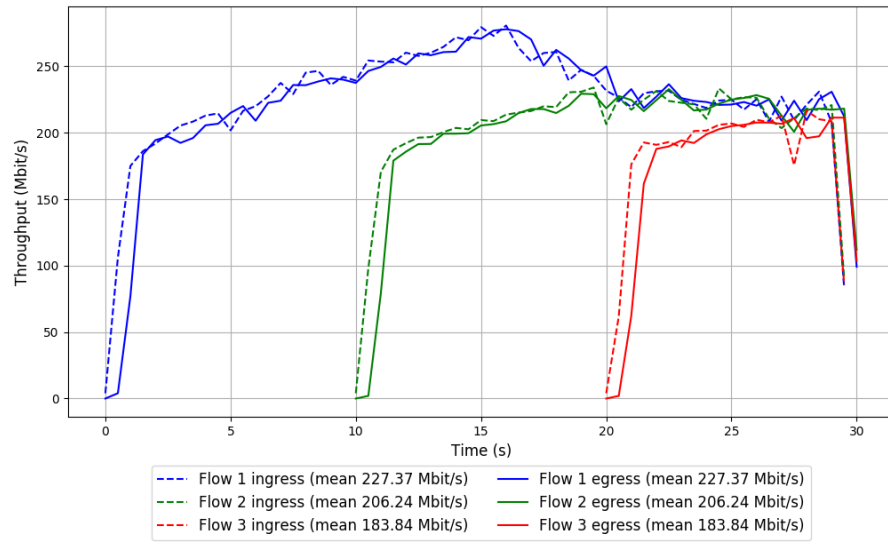
13

```
Run 2: Statistics of Indigo

Start at: 2018-09-05 06:24:04
End at: 2018-09-05 06:24:34
Local clock offset: -0.187 ms
Remote clock offset: -0.048 ms


# Below is generated by plot.py at 2018-09-05 06:48:28
# Datalink statistics
-- Total of 3 flows:
Average throughput: 423.89 Mbit/s
95th percentile per-packet one-way delay: 50.627 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 227.37 Mbit/s
95th percentile per-packet one-way delay: 50.411 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 206.24 Mbit/s
95th percentile per-packet one-way delay: 51.127 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 183.84 Mbit/s
95th percentile per-packet one-way delay: 50.333 ms
Loss rate: 0.00%
```

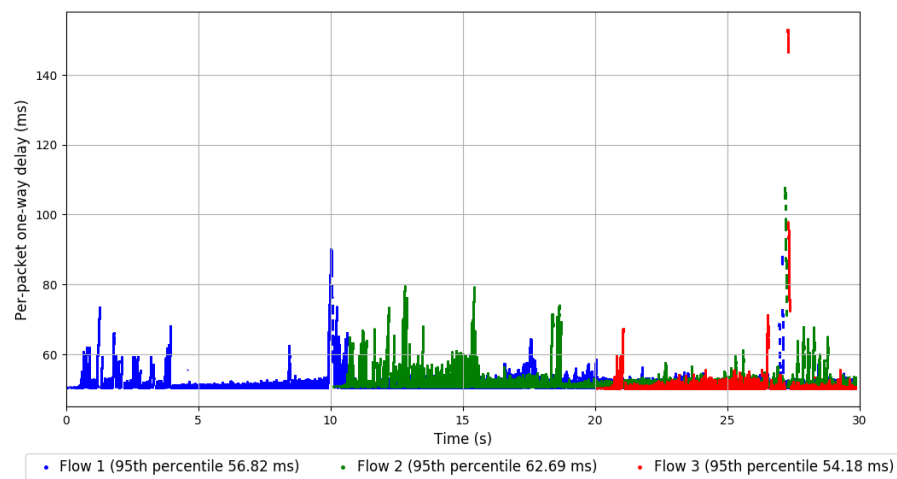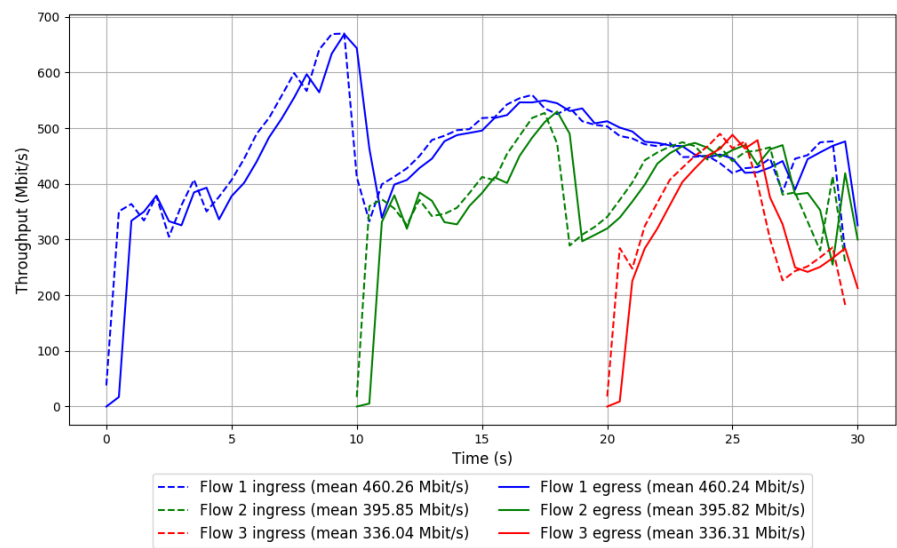Run 2: Report of Indigo — Data Link

```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 06:20:10
End at: 2018-09-05 06:20:40
Local clock offset: -0.364 ms
Remote clock offset: -0.065 ms


# Below is generated by plot.py at 2018-09-05 06:48:28
# Datalink statistics
-- Total of 3 flows:
Average throughput: 832.94 Mbit/s
95th percentile per-packet one-way delay: 58.623 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 460.24 Mbit/s
95th percentile per-packet one-way delay: 56.821 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 395.82 Mbit/s
95th percentile per-packet one-way delay: 62.691 ms
Loss rate: 0.01%
-- Flow 3:
Average throughput: 336.31 Mbit/s
95th percentile per-packet one-way delay: 54.181 ms
Loss rate: 0.00%
```

Run 1: Report of Muses-25 — Data Link

```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 06:27:57
End at: 2018-09-05 06:28:27
Local clock offset: -0.543 ms
Remote clock offset: -0.091 ms

# Below is generated by plot.py at 2018-09-05 06:48:28
# Datalink statistics
-- Total of 3 flows:
Average throughput: 938.21 Mbit/s
95th percentile per-packet one-way delay: 54.835 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 494.48 Mbit/s
95th percentile per-packet one-way delay: 55.243 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 483.74 Mbit/s
95th percentile per-packet one-way delay: 53.865 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 375.64 Mbit/s
95th percentile per-packet one-way delay: 54.524 ms
Loss rate: 0.00%
```

Run 2: Report of Muses-25 — Data Link