Pantheon Report

Generated at 2018-08-28 06:04:13 (UTC).

Data path: GCE Tokyo on `ens4` (*local*) →GCE London on `ens4` (*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 `time.google.com` and have been applied to correct the timestamps in logs.
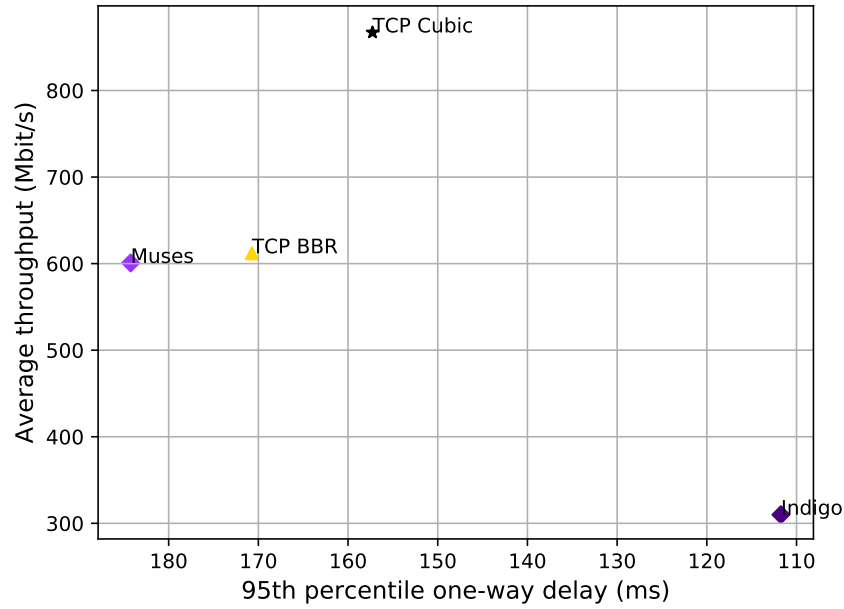
```
System info:
Linux 4.15.0-1015-gcp
net.core.default_qdisc = fq
net.core.rmem_default = 16777216
net.core.rmem_max = 536870912
net.core.wmem_default = 16777216
net.core.wmem_max = 536870912
net.ipv4.tcp_rmem = 4096 16777216 536870912
net.ipv4.tcp_wmem = 4096 16777216 536870912

Git summary:
branch: muses @ 86ef433b09b2f4ecae1186d6940af93bcf0969cd
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ b261c9e99c63be452bc16f94ce0caa99a4c9d39a
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
```
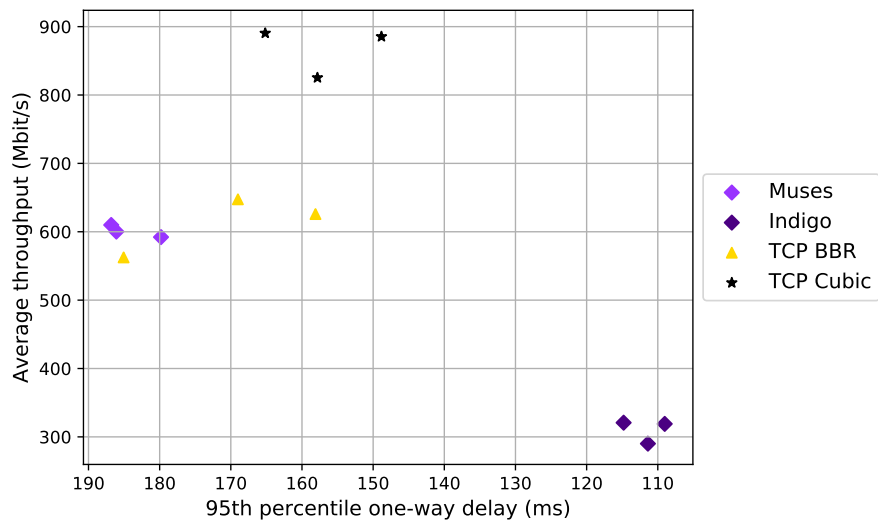
test from GCE Tokyo to GCE London, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

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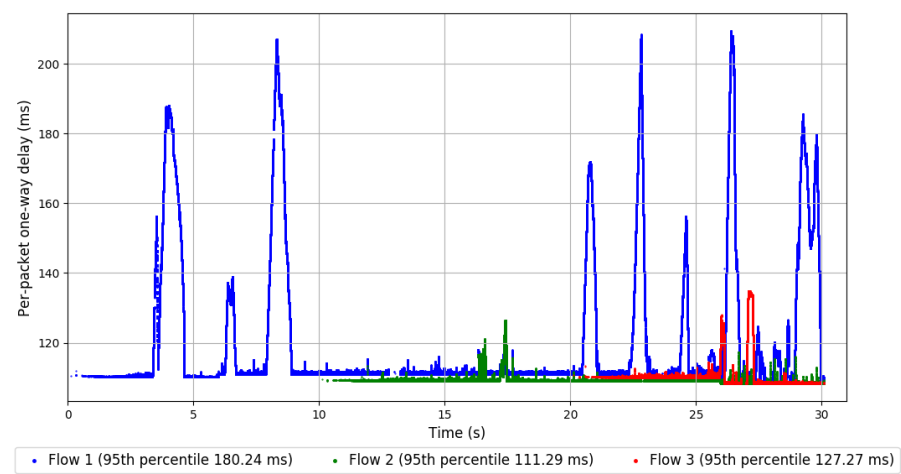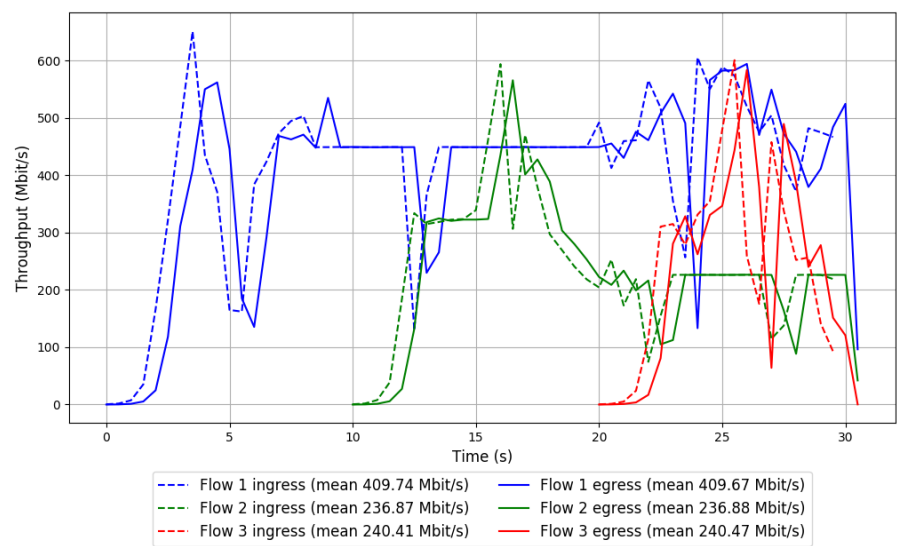### 3 flows with 10s interval between flows

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	3	317.56	308.56	267.25	177.03	143.38	141.51	0.48	0.22	0.00
TCP Cubic	3	486.85	429.27	283.75	137.91	161.50	147.15	0.05	0.09	0.11
Indigo	3	171.11	145.73	132.01	111.30	111.96	111.13	0.00	0.00	0.00
Muses	3	406.17	284.07	19.77	186.21	176.66	116.53	1.04	0.43	0.20

```
Run 1: Statistics of TCP BBR

Start at: 2018-08-28 05:21:50
End at: 2018-08-28 05:22:20
Local clock offset: -0.12 ms
Remote clock offset: -0.379 ms


# Below is generated by plot.py at 2018-08-28 05:57:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 647.45 Mbit/s
95th percentile per-packet one-way delay: 169.003 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 409.67 Mbit/s
95th percentile per-packet one-way delay: 180.238 ms
Loss rate: 0.02%
-- Flow 2:
Average throughput: 236.88 Mbit/s
95th percentile per-packet one-way delay: 111.288 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 240.47 Mbit/s
95th percentile per-packet one-way delay: 127.267 ms
Loss rate: 0.00%
```

Run 1: Report of TCP BBR — Data Link

Flow 1 ingress (mean 409.74 Mbit/s) --- Flow 1 egress (mean 409.67 Mbit/s)
Flow 2 ingress (mean 236.87 Mbit/s) --- Flow 2 egress (mean 236.88 Mbit/s)
Flow 3 ingress (mean 240.41 Mbit/s) --- Flow 3 egress (mean 240.47 Mbit/s)

Flow 1 (95th percentile 180.24 ms)   Flow 2 (95th percentile 111.29 ms)   Flow 3 (95th percentile 127.27 ms)
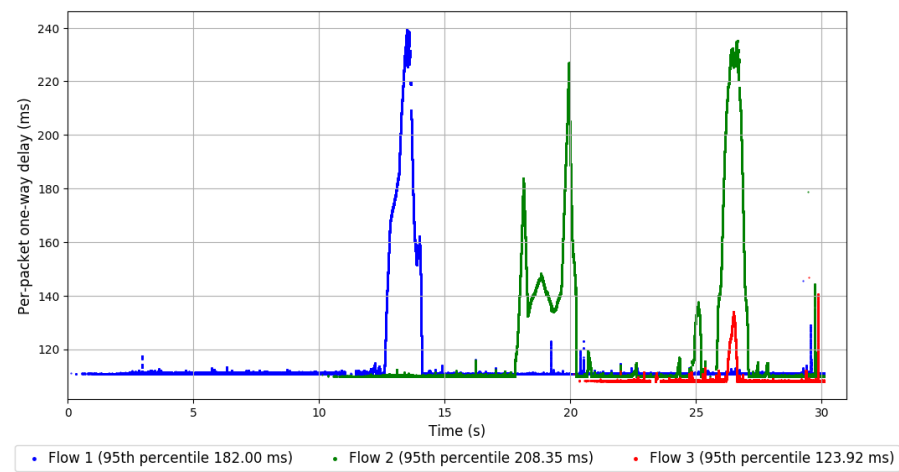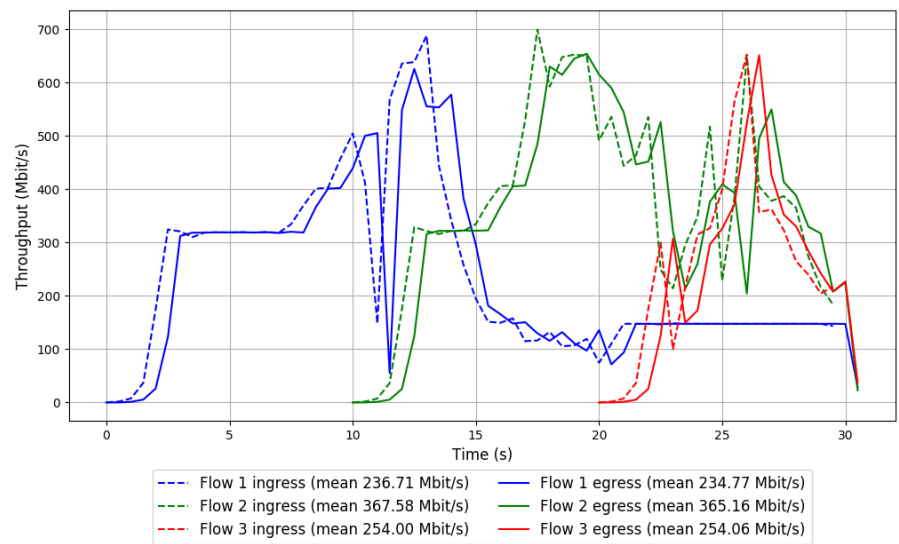
```
Run 2: Statistics of TCP BBR

Start at: 2018-08-28 05:29:24
End at: 2018-08-28 05:29:54
Local clock offset: 0.16 ms
Remote clock offset: -0.399 ms


# Below is generated by plot.py at 2018-08-28 05:57:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 562.48 Mbit/s
95th percentile per-packet one-way delay: 185.064 ms
Loss rate: 0.63%
-- Flow 1:
Average throughput: 234.77 Mbit/s
95th percentile per-packet one-way delay: 182.000 ms
Loss rate: 0.82%
-- Flow 2:
Average throughput: 365.16 Mbit/s
95th percentile per-packet one-way delay: 208.355 ms
Loss rate: 0.66%
-- Flow 3:
Average throughput: 254.06 Mbit/s
95th percentile per-packet one-way delay: 123.925 ms
Loss rate: 0.00%
```

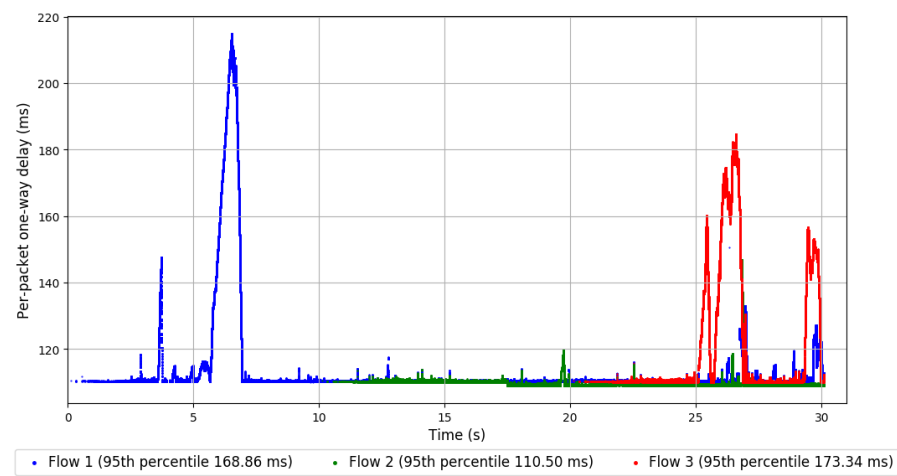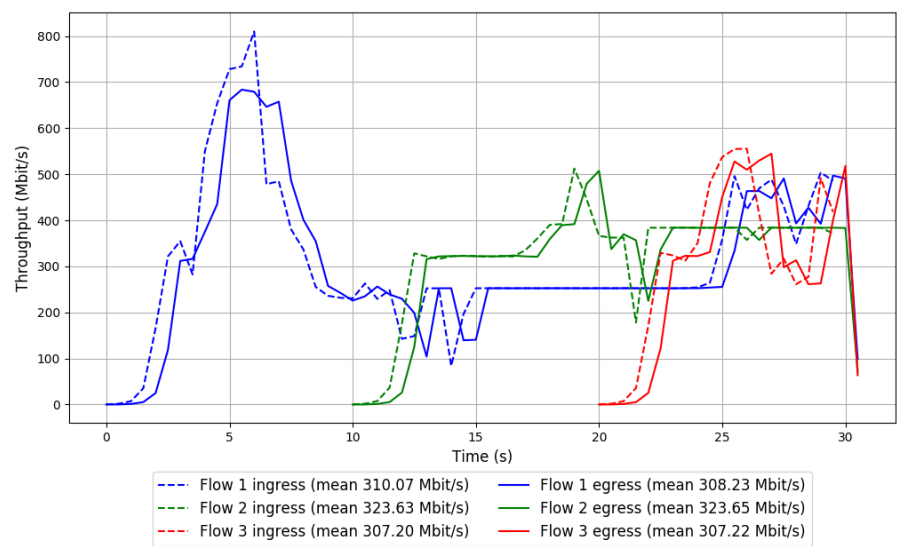Run 2: Report of TCP BBR — Data Link

```
Run 3: Statistics of TCP BBR

Start at: 2018-08-28 05:36:59
End at: 2018-08-28 05:37:29
Local clock offset: -0.044 ms
Remote clock offset: -0.365 ms


# Below is generated by plot.py at 2018-08-28 05:57:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 625.90 Mbit/s
95th percentile per-packet one-way delay: 158.102 ms
Loss rate: 0.29%
-- Flow 1:
Average throughput: 308.23 Mbit/s
95th percentile per-packet one-way delay: 168.863 ms
Loss rate: 0.59%
-- Flow 2:
Average throughput: 323.65 Mbit/s
95th percentile per-packet one-way delay: 110.504 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 307.22 Mbit/s
95th percentile per-packet one-way delay: 173.339 ms
Loss rate: 0.00%
```

Run 3: Report of TCP BBR — Data Link

Flow 1 ingress (mean 310.07 Mbit/s)   Flow 1 egress (mean 308.23 Mbit/s)
Flow 2 ingress (mean 323.63 Mbit/s)   Flow 2 egress (mean 323.65 Mbit/s)
Flow 3 ingress (mean 307.20 Mbit/s)   Flow 3 egress (mean 307.22 Mbit/s)

Flow 1 (95th percentile 168.86 ms)   Flow 2 (95th percentile 110.50 ms)   Flow 3 (95th percentile 173.34 ms)
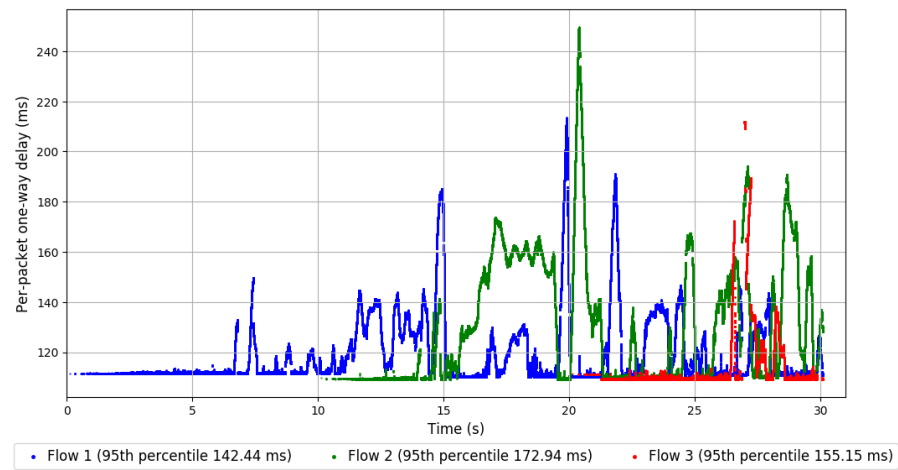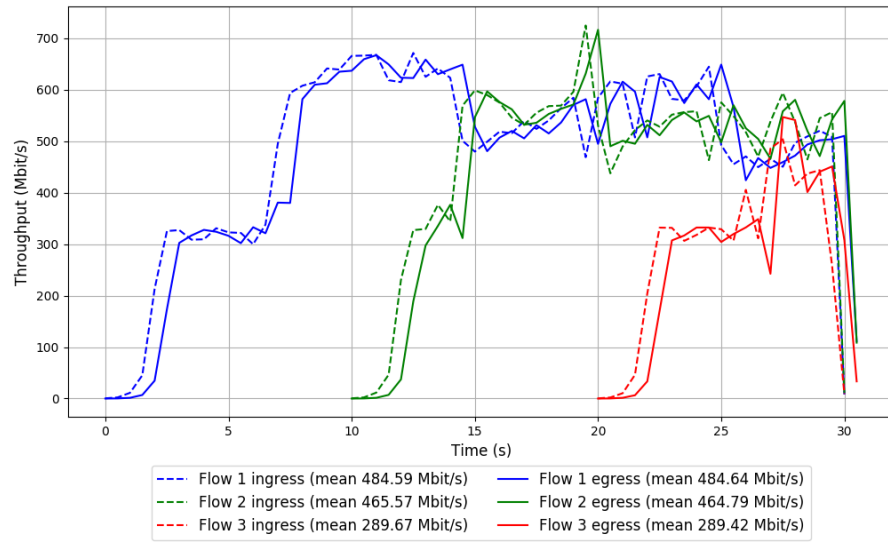
9

```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-28 05:25:35
End at: 2018-08-28 05:26:05
Local clock offset: -0.085 ms
Remote clock offset: -0.189 ms


# Below is generated by plot.py at 2018-08-28 06:00:30
# Datalink statistics
-- Total of 3 flows:
Average throughput: 890.47 Mbit/s
95th percentile per-packet one-way delay: 165.162 ms
Loss rate: 0.17%
-- Flow 1:
Average throughput: 484.64 Mbit/s
95th percentile per-packet one-way delay: 142.437 ms
Loss rate: 0.07%
-- Flow 2:
Average throughput: 464.79 Mbit/s
95th percentile per-packet one-way delay: 172.939 ms
Loss rate: 0.27%
-- Flow 3:
Average throughput: 289.42 Mbit/s
95th percentile per-packet one-way delay: 155.146 ms
Loss rate: 0.32%
```

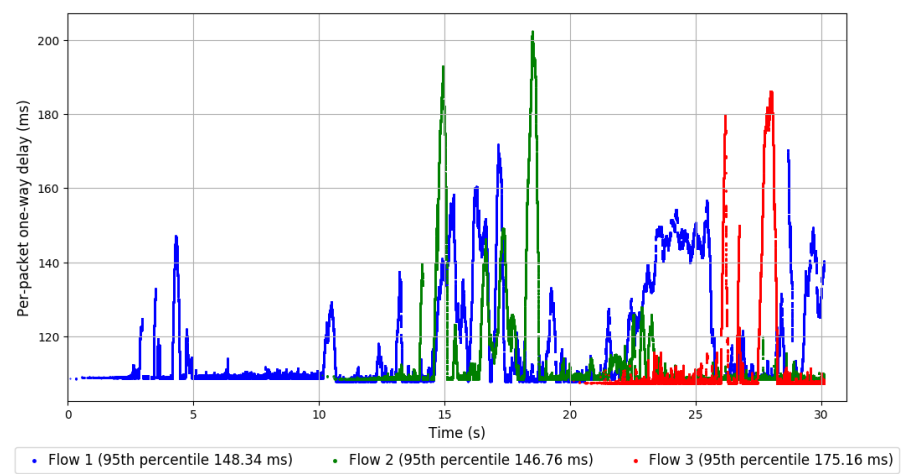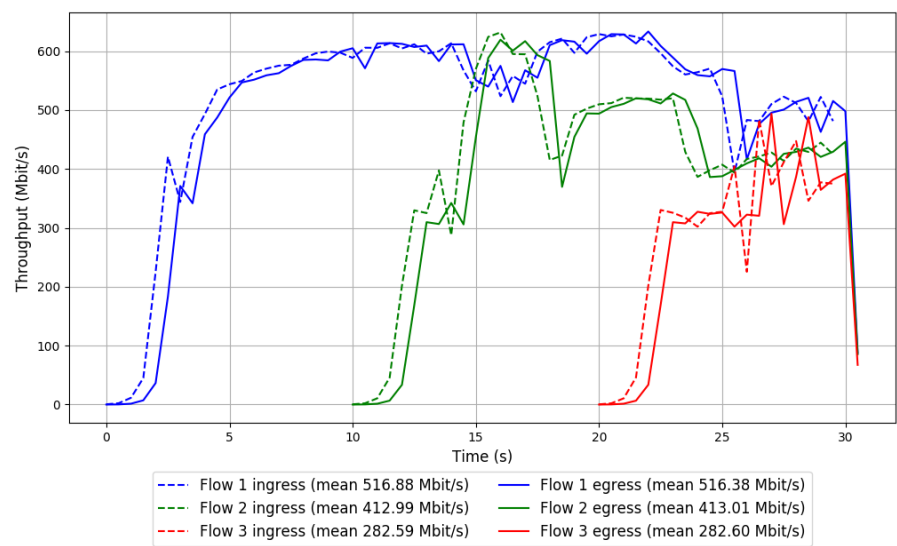Run 1: Report of TCP Cubic — Data Link

```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-28 05:33:06
End at: 2018-08-28 05:33:36
Local clock offset: 2.751 ms
Remote clock offset: -0.228 ms


# Below is generated by plot.py at 2018-08-28 06:00:30
# Datalink statistics
-- Total of 3 flows:
Average throughput: 885.36 Mbit/s
95th percentile per-packet one-way delay: 148.833 ms
Loss rate: 0.05%
-- Flow 1:
Average throughput: 516.38 Mbit/s
95th percentile per-packet one-way delay: 148.340 ms
Loss rate: 0.09%
-- Flow 2:
Average throughput: 413.01 Mbit/s
95th percentile per-packet one-way delay: 146.759 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 282.60 Mbit/s
95th percentile per-packet one-way delay: 175.161 ms
Loss rate: 0.00%
```

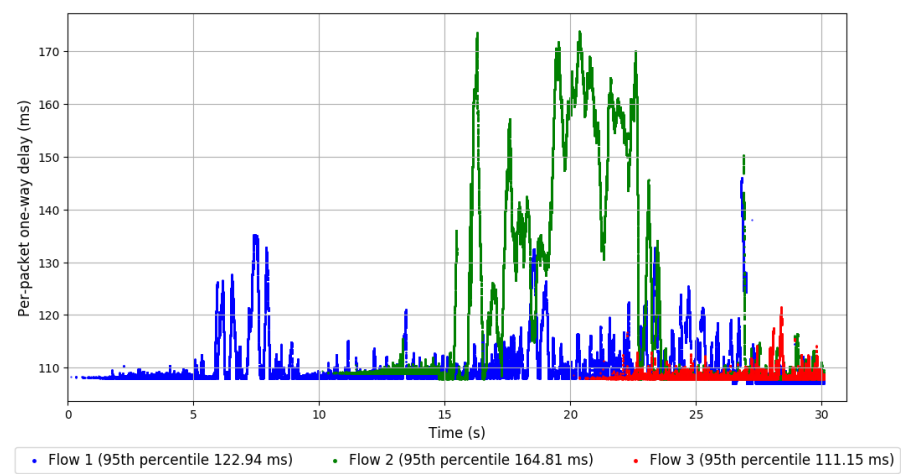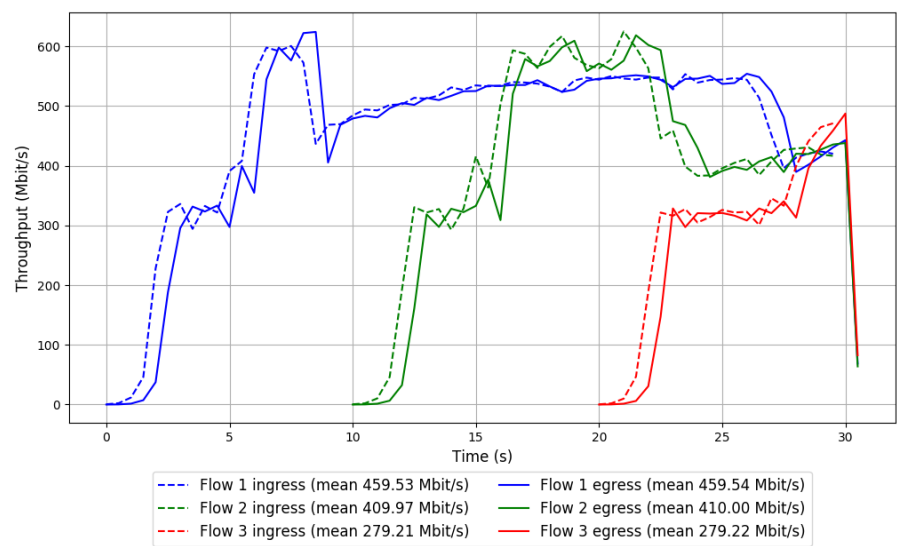Run 2: Report of TCP Cubic — Data Link

```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-28 05:40:42
End at: 2018-08-28 05:41:12
Local clock offset: 2.885 ms
Remote clock offset: -0.123 ms


# Below is generated by plot.py at 2018-08-28 06:00:30
# Datalink statistics
-- Total of 3 flows:
Average throughput: 825.27 Mbit/s
95th percentile per-packet one-way delay: 157.828 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 459.54 Mbit/s
95th percentile per-packet one-way delay: 122.944 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 410.00 Mbit/s
95th percentile per-packet one-way delay: 164.811 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 279.22 Mbit/s
95th percentile per-packet one-way delay: 111.150 ms
Loss rate: 0.00%
```

Run 3: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 459.53 Mbit/s) --- Flow 1 egress (mean 459.54 Mbit/s)
Flow 2 ingress (mean 409.97 Mbit/s) --- Flow 2 egress (mean 410.00 Mbit/s)
Flow 3 ingress (mean 279.21 Mbit/s) --- Flow 3 egress (mean 279.22 Mbit/s)

Flow 1 (95th percentile 122.94 ms)   Flow 2 (95th percentile 164.81 ms)   Flow 3 (95th percentile 111.15 ms)
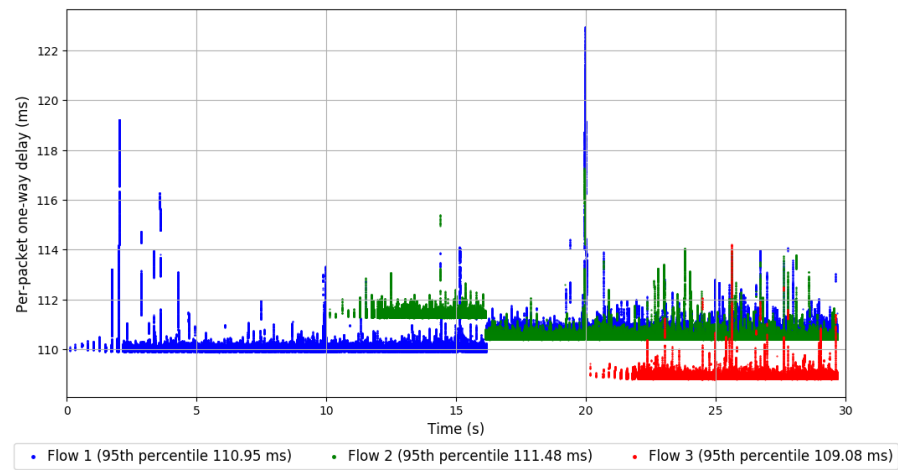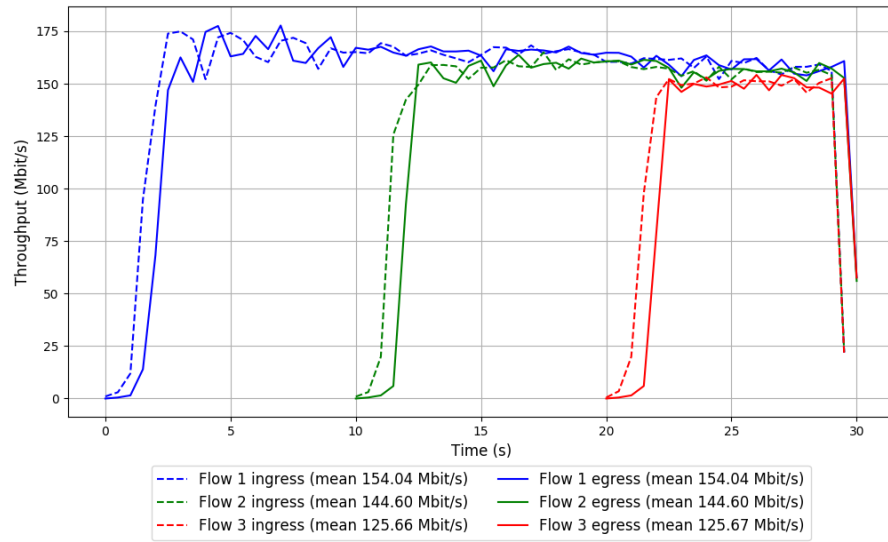
15

```
Run 1: Statistics of Indigo

Start at: 2018-08-28 05:27:40
End at: 2018-08-28 05:28:10
Local clock offset: -0.057 ms
Remote clock offset: -0.471 ms


# Below is generated by plot.py at 2018-08-28 06:00:30
# Datalink statistics
-- Total of 3 flows:
Average throughput: 290.11 Mbit/s
95th percentile per-packet one-way delay: 111.391 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 154.04 Mbit/s
95th percentile per-packet one-way delay: 110.950 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 144.60 Mbit/s
95th percentile per-packet one-way delay: 111.483 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 125.67 Mbit/s
95th percentile per-packet one-way delay: 109.075 ms
Loss rate: 0.00%
```

Run 1: Report of Indigo — Data Link

- - - Flow 1 ingress (mean 154.04 Mbit/s) ——— Flow 1 egress (mean 154.04 Mbit/s)
- - - Flow 2 ingress (mean 144.60 Mbit/s) ——— Flow 2 egress (mean 144.60 Mbit/s)
- - - Flow 3 ingress (mean 125.66 Mbit/s) ——— Flow 3 egress (mean 125.67 Mbit/s)

• Flow 1 (95th percentile 110.95 ms)   • Flow 2 (95th percentile 111.48 ms)   • Flow 3 (95th percentile 109.08 ms)
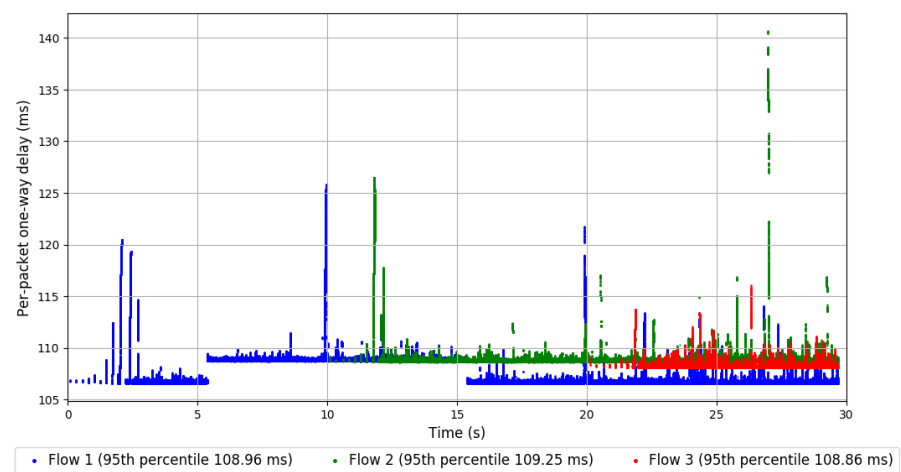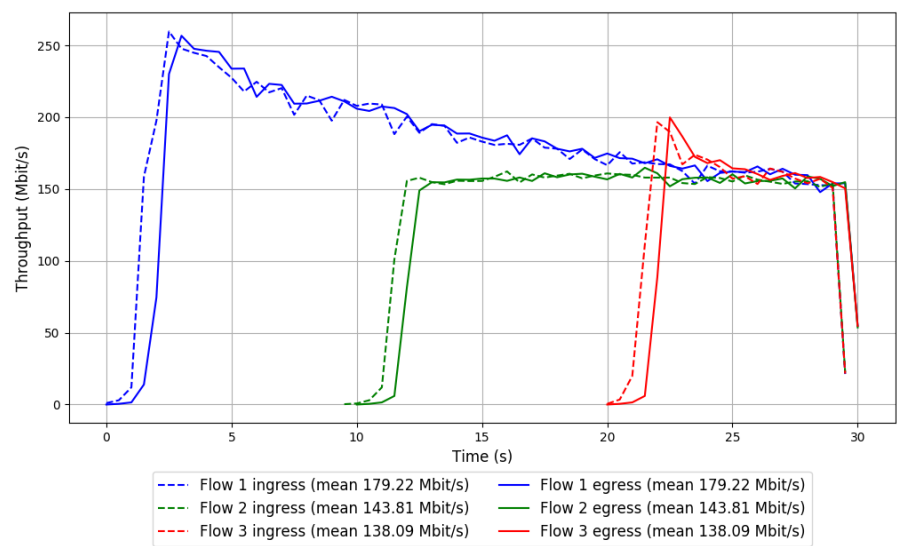
17

```
Run 2: Statistics of Indigo

Start at: 2018-08-28 05:35:10
End at: 2018-08-28 05:35:40
Local clock offset: 2.771 ms
Remote clock offset: -0.085 ms


# Below is generated by plot.py at 2018-08-28 06:00:30
# Datalink statistics
-- Total of 3 flows:
Average throughput: 318.98 Mbit/s
95th percentile per-packet one-way delay: 109.027 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 179.22 Mbit/s
95th percentile per-packet one-way delay: 108.963 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 143.81 Mbit/s
95th percentile per-packet one-way delay: 109.251 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 138.09 Mbit/s
95th percentile per-packet one-way delay: 108.857 ms
Loss rate: 0.00%
```
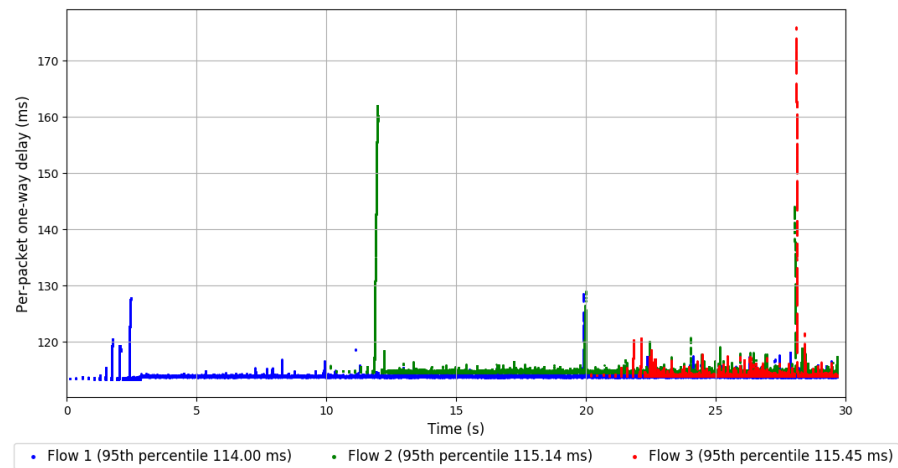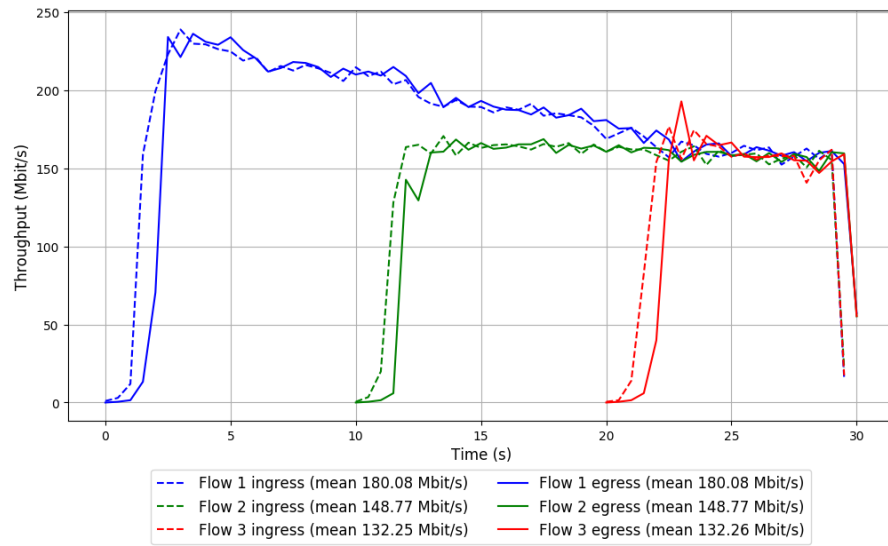
Run 2: Report of Indigo — Data Link

```
Run 3: Statistics of Indigo

Start at: 2018-08-28 05:42:43
End at: 2018-08-28 05:43:13
Local clock offset: -2.991 ms
Remote clock offset: -0.174 ms


# Below is generated by plot.py at 2018-08-28 06:01:59
# Datalink statistics
-- Total of 3 flows:
Average throughput: 320.75 Mbit/s
95th percentile per-packet one-way delay: 114.802 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 180.08 Mbit/s
95th percentile per-packet one-way delay: 113.999 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 148.77 Mbit/s
95th percentile per-packet one-way delay: 115.140 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 132.26 Mbit/s
95th percentile per-packet one-way delay: 115.449 ms
Loss rate: 0.00%
```

Run 3: Report of Indigo — Data Link

Flow 1 ingress (mean 180.08 Mbit/s) ---- Flow 1 egress (mean 180.08 Mbit/s) ——
Flow 2 ingress (mean 148.77 Mbit/s) ---- Flow 2 egress (mean 148.77 Mbit/s) ——
Flow 3 ingress (mean 132.25 Mbit/s) ---- Flow 3 egress (mean 132.26 Mbit/s) ——

Flow 1 (95th percentile 114.00 ms)   Flow 2 (95th percentile 115.14 ms)   Flow 3 (95th percentile 115.45 ms)

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```
Run 1: Statistics of Muses

Start at: 2018-08-28 05:23:45
End at: 2018-08-28 05:24:15
Local clock offset: 2.781 ms
Remote clock offset: -0.25 ms


# Below is generated by plot.py at 2018-08-28 06:04:03
# Datalink statistics
-- Total of 3 flows:
Average throughput: 600.26 Mbit/s
95th percentile per-packet one-way delay: 186.082 ms
Loss rate: 1.24%
-- Flow 1:
Average throughput: 408.39 Mbit/s
95th percentile per-packet one-way delay: 188.784 ms
Loss rate: 1.37%
-- Flow 2:
Average throughput: 280.32 Mbit/s
95th percentile per-packet one-way delay: 177.164 ms
Loss rate: 0.97%
-- Flow 3:
Average throughput: 19.13 Mbit/s
95th percentile per-packet one-way delay: 108.281 ms
Loss rate: 0.15%
```
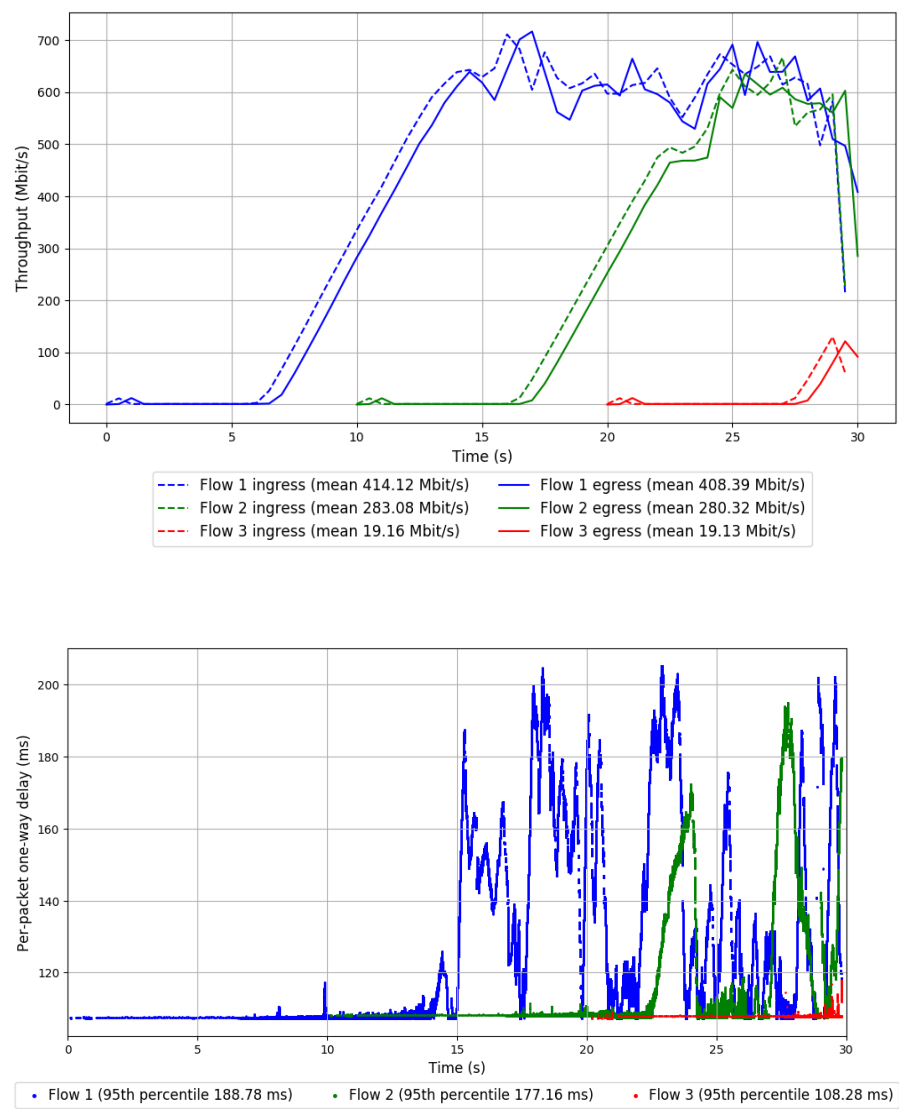
Run 1: Report of Muses — Data Link

Flow 1 ingress (mean 414.12 Mbit/s) --- Flow 1 egress (mean 408.39 Mbit/s)
Flow 2 ingress (mean 283.08 Mbit/s) --- Flow 2 egress (mean 280.32 Mbit/s)
Flow 3 ingress (mean 19.16 Mbit/s) --- Flow 3 egress (mean 19.13 Mbit/s)

Flow 1 (95th percentile 188.78 ms)　Flow 2 (95th percentile 177.16 ms)　Flow 3 (95th percentile 108.28 ms)
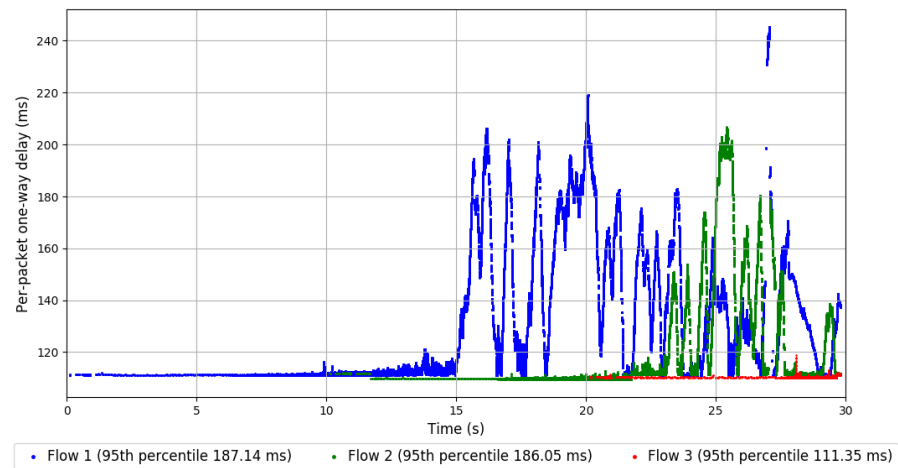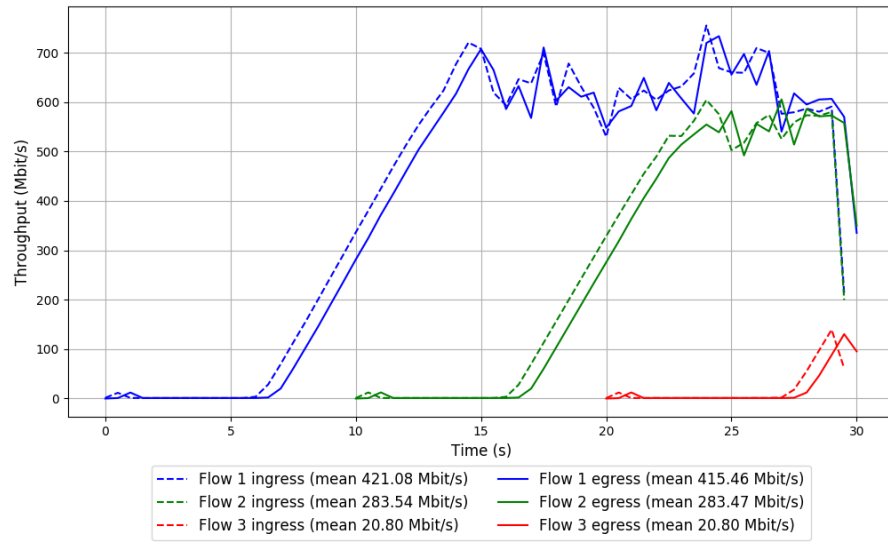
```
Run 2: Statistics of Muses

Start at: 2018-08-28 05:31:14
End at: 2018-08-28 05:31:44
Local clock offset: -0.065 ms
Remote clock offset: -0.371 ms


# Below is generated by plot.py at 2018-08-28 06:04:08
# Datalink statistics
-- Total of 3 flows:
Average throughput: 609.93 Mbit/s
95th percentile per-packet one-way delay: 186.807 ms
Loss rate: 0.92%
-- Flow 1:
Average throughput: 415.46 Mbit/s
95th percentile per-packet one-way delay: 187.141 ms
Loss rate: 1.33%
-- Flow 2:
Average throughput: 283.47 Mbit/s
95th percentile per-packet one-way delay: 186.050 ms
Loss rate: 0.03%
-- Flow 3:
Average throughput: 20.80 Mbit/s
95th percentile per-packet one-way delay: 111.354 ms
Loss rate: 0.00%
```

Run 2: Report of Muses — Data Link

```
Run 3: Statistics of Muses

Start at: 2018-08-28 05:38:52
End at: 2018-08-28 05:39:22
Local clock offset: -0.023 ms
Remote clock offset: -0.432 ms


# Below is generated by plot.py at 2018-08-28 06:04:11
# Datalink statistics
-- Total of 3 flows:
Average throughput: 592.20 Mbit/s
95th percentile per-packet one-way delay: 179.810 ms
Loss rate: 0.37%
-- Flow 1:
Average throughput: 394.65 Mbit/s
95th percentile per-packet one-way delay: 182.708 ms
Loss rate: 0.41%
-- Flow 2:
Average throughput: 288.43 Mbit/s
95th percentile per-packet one-way delay: 166.755 ms
Loss rate: 0.28%
-- Flow 3:
Average throughput: 19.39 Mbit/s
95th percentile per-packet one-way delay: 129.958 ms
Loss rate: 0.45%
```

Run 3: Report of Muses — Data Link