Pantheon Report

Generated at 2018-08-28 07:29:34 (UTC).

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

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.

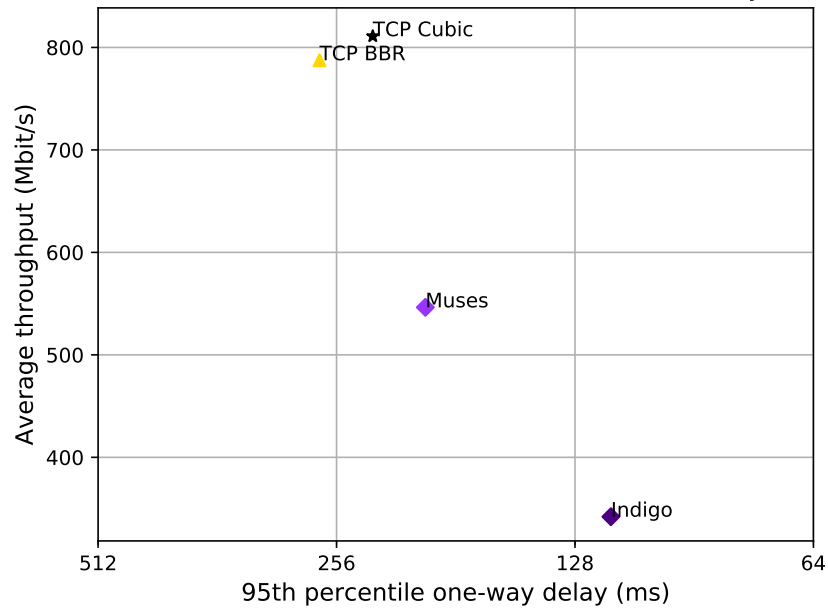NTP offsets were measured against time.google.com and have been applied to correct the timestamps in logs.

```
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
```
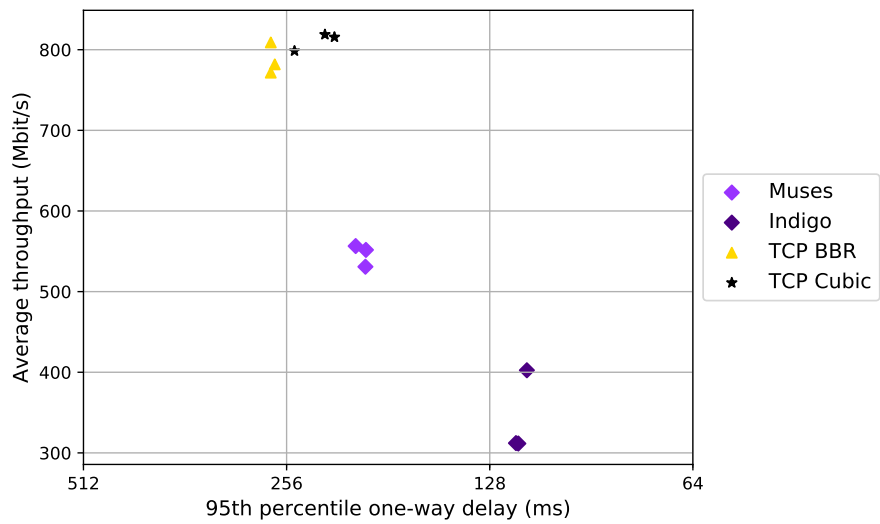
test from GCE London to GCE Tokyo, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

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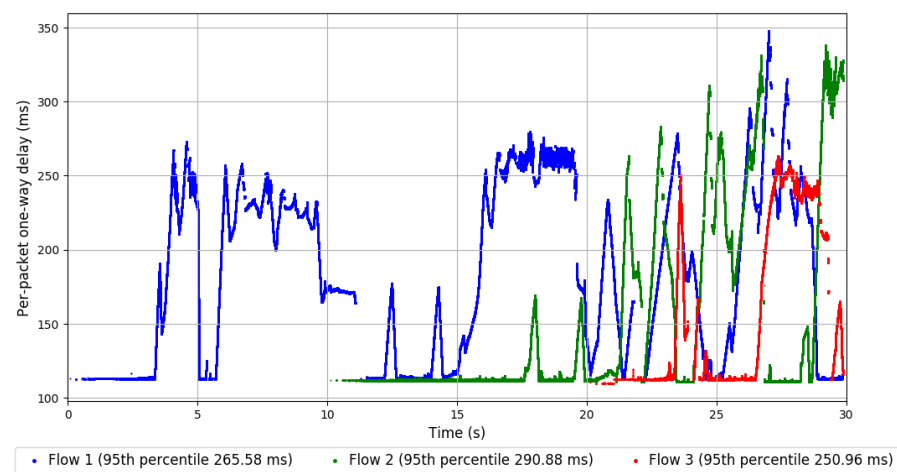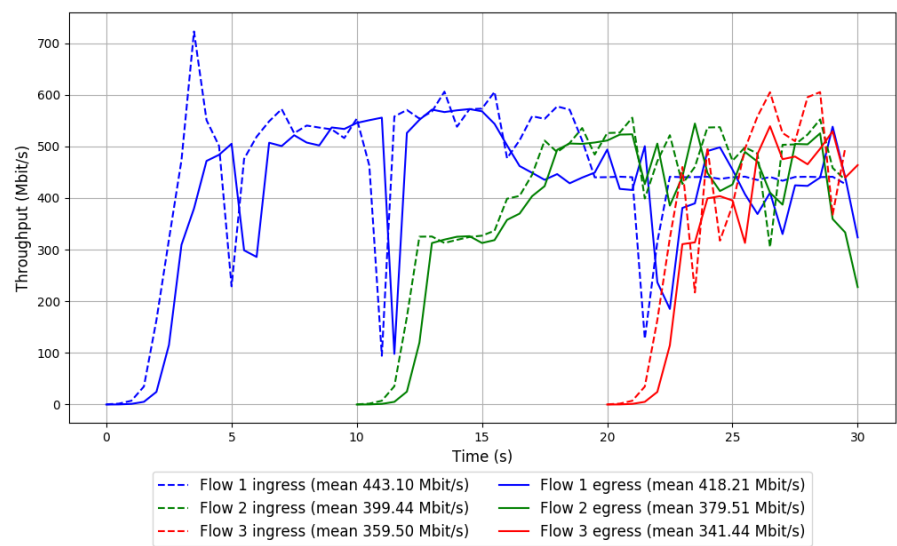3 flows with 10s interval between flows

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	430.18	378.64	323.90	266.45	275.31	261.26	6.53	5.58	6.12
TCP Cubic	3	457.63	400.45	267.64	224.17	236.14	226.59	1.02	1.57	4.64
Indigo	3	173.21	166.43	182.60	113.68	115.20	126.03	0.77	1.17	2.55
Muses	3	362.66	254.85	45.62	194.77	209.59	112.15	1.93	3.67	12.43

```
Run 1: Statistics of TCP BBR

Start at: 2018-08-28 06:46:55
End at: 2018-08-28 06:47:25
Local clock offset: -0.183 ms
Remote clock offset: -0.176 ms


# Below is generated by plot.py at 2018-08-28 07:24:25
# Datalink statistics
-- Total of 3 flows:
Average throughput: 781.86 Mbit/s
95th percentile per-packet one-way delay: 266.537 ms
Loss rate: 6.36%
-- Flow 1:
Average throughput: 418.21 Mbit/s
95th percentile per-packet one-way delay: 265.583 ms
Loss rate: 6.33%
-- Flow 2:
Average throughput: 379.51 Mbit/s
95th percentile per-packet one-way delay: 290.879 ms
Loss rate: 6.05%
-- Flow 3:
Average throughput: 341.44 Mbit/s
95th percentile per-packet one-way delay: 250.964 ms
Loss rate: 7.15%
```

Run 1: Report of TCP BBR — Data Link

Flow 1 ingress (mean 443.10 Mbit/s) —— Flow 1 egress (mean 418.21 Mbit/s)
Flow 2 ingress (mean 399.44 Mbit/s) —— Flow 2 egress (mean 379.51 Mbit/s)
Flow 3 ingress (mean 359.50 Mbit/s) —— Flow 3 egress (mean 341.44 Mbit/s)

Flow 1 (95th percentile 265.58 ms) ● Flow 2 (95th percentile 290.88 ms) ● Flow 3 (95th percentile 250.96 ms)

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```
Run 2: Statistics of TCP BBR

Start at: 2018-08-28 06:54:43
End at: 2018-08-28 06:55:13
Local clock offset: -0.045 ms
Remote clock offset: 0.078 ms


# Below is generated by plot.py at 2018-08-28 07:24:25
# Datalink statistics
-- Total of 3 flows:
Average throughput: 771.57 Mbit/s
95th percentile per-packet one-way delay: 270.214 ms
Loss rate: 6.20%
-- Flow 1:
Average throughput: 447.74 Mbit/s
95th percentile per-packet one-way delay: 260.323 ms
Loss rate: 6.31%
-- Flow 2:
Average throughput: 351.57 Mbit/s
95th percentile per-packet one-way delay: 278.349 ms
Loss rate: 6.16%
-- Flow 3:
Average throughput: 276.79 Mbit/s
95th percentile per-packet one-way delay: 274.403 ms
Loss rate: 5.76%
```
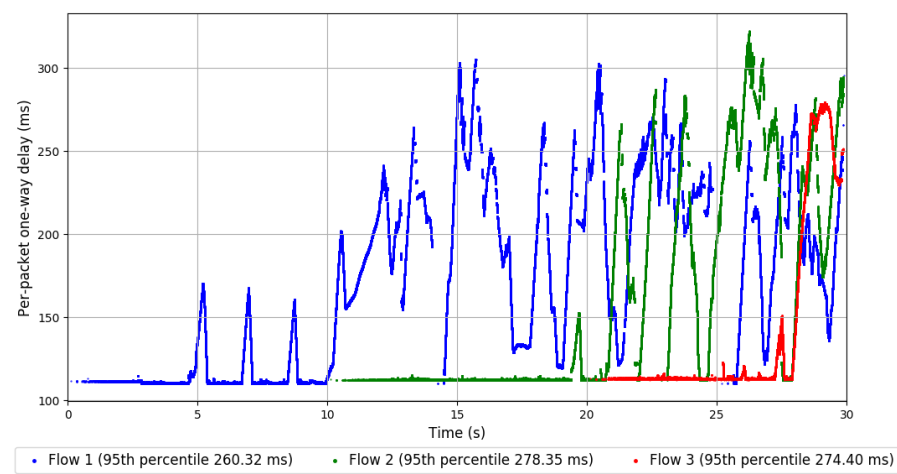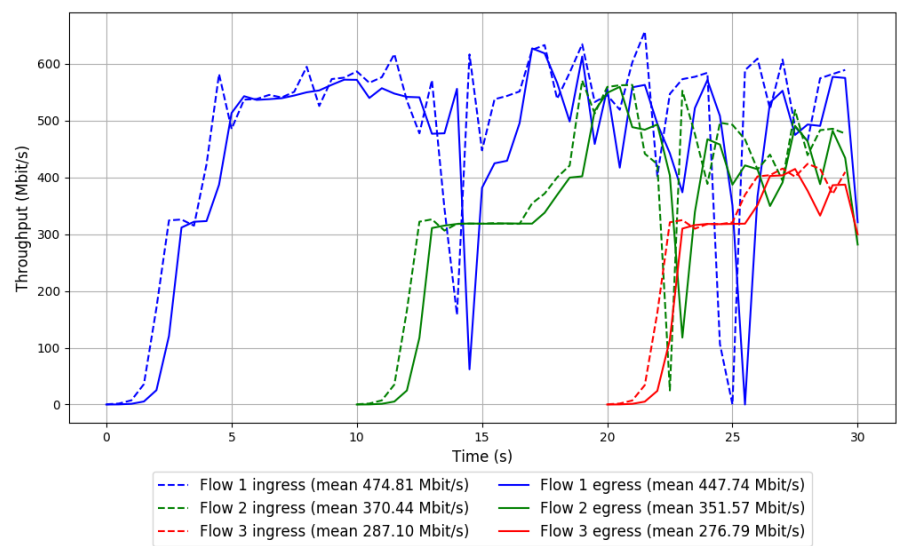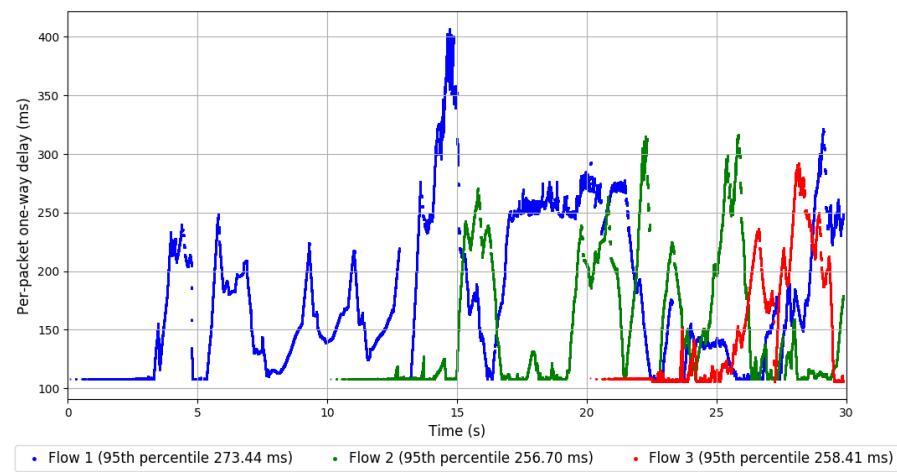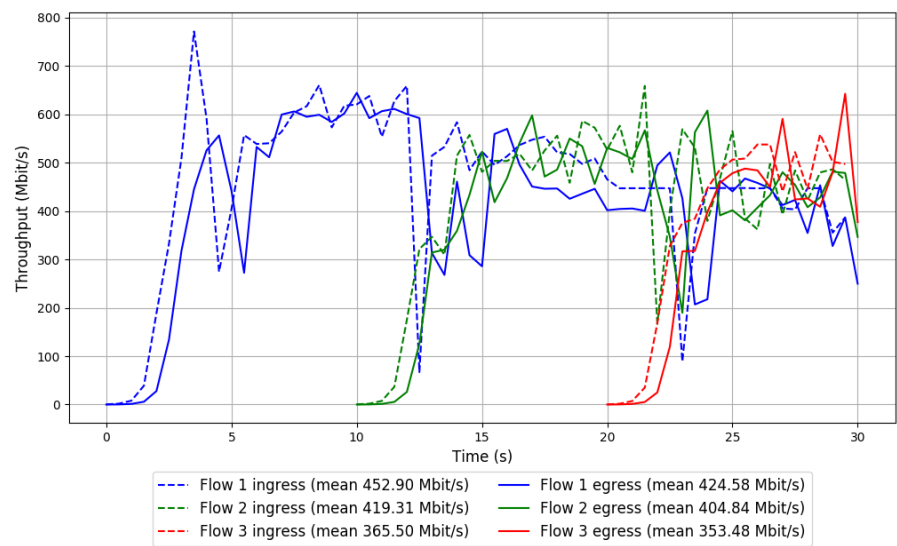
Run 2: Report of TCP BBR — Data Link

```
Run 3: Statistics of TCP BBR

Start at: 2018-08-28 07:02:23
End at: 2018-08-28 07:02:53
Local clock offset: -2.896 ms
Remote clock offset: -0.086 ms


# Below is generated by plot.py at 2018-08-28 07:24:55
# Datalink statistics
-- Total of 3 flows:
Average throughput: 809.02 Mbit/s
95th percentile per-packet one-way delay: 270.182 ms
Loss rate: 5.94%
-- Flow 1:
Average throughput: 424.58 Mbit/s
95th percentile per-packet one-way delay: 273.441 ms
Loss rate: 6.94%
-- Flow 2:
Average throughput: 404.84 Mbit/s
95th percentile per-packet one-way delay: 256.705 ms
Loss rate: 4.53%
-- Flow 3:
Average throughput: 353.48 Mbit/s
95th percentile per-packet one-way delay: 258.411 ms
Loss rate: 5.46%
```
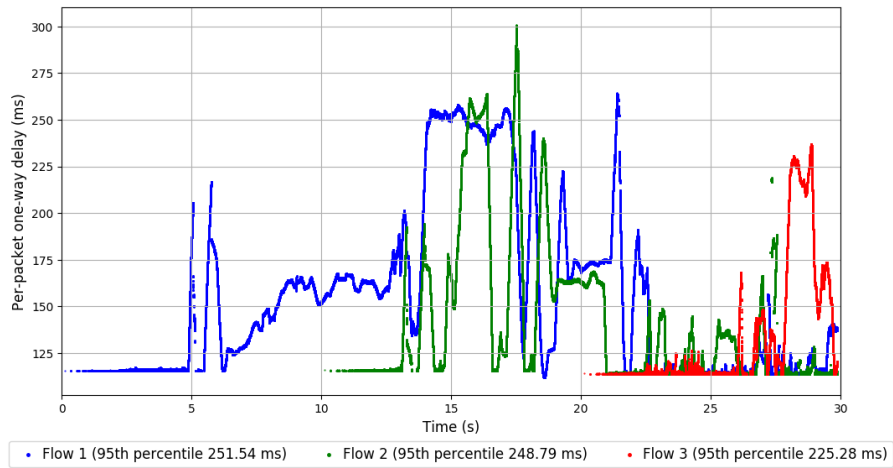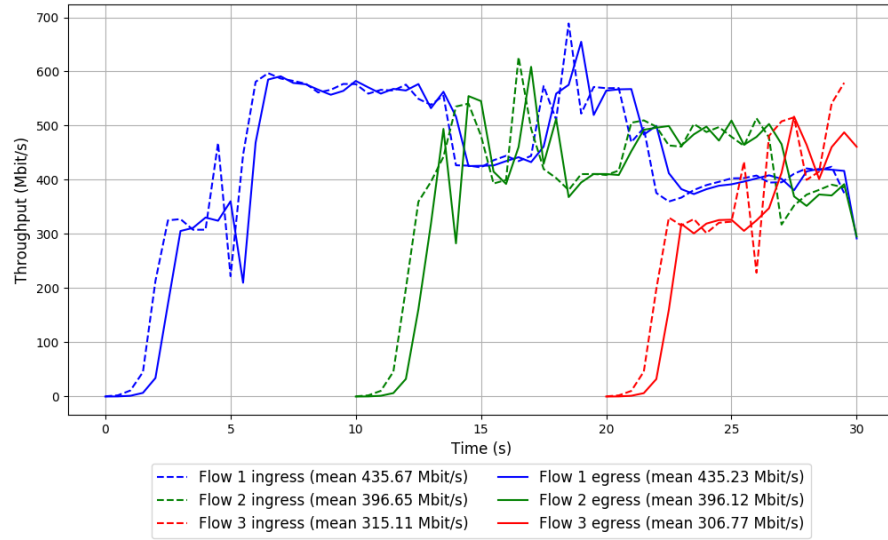
Run 3: Report of TCP BBR — Data Link

```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-28 06:50:47
End at: 2018-08-28 06:51:17
Local clock offset: 2.674 ms
Remote clock offset: -0.364 ms


# Below is generated by plot.py at 2018-08-28 07:24:55
# Datalink statistics
-- Total of 3 flows:
Average throughput: 798.47 Mbit/s
95th percentile per-packet one-way delay: 249.190 ms
Loss rate: 1.50%
-- Flow 1:
Average throughput: 435.23 Mbit/s
95th percentile per-packet one-way delay: 251.542 ms
Loss rate: 0.84%
-- Flow 2:
Average throughput: 396.12 Mbit/s
95th percentile per-packet one-way delay: 248.793 ms
Loss rate: 1.25%
-- Flow 3:
Average throughput: 306.77 Mbit/s
95th percentile per-packet one-way delay: 225.276 ms
Loss rate: 4.82%
```

Run 1: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 435.67 Mbit/s) — — —   Flow 1 egress (mean 435.23 Mbit/s)
Flow 2 ingress (mean 396.65 Mbit/s) — — —   Flow 2 egress (mean 396.12 Mbit/s)
Flow 3 ingress (mean 315.11 Mbit/s) — — —   Flow 3 egress (mean 306.77 Mbit/s)

Flow 1 (95th percentile 251.54 ms)   Flow 2 (95th percentile 248.79 ms)   Flow 3 (95th percentile 225.28 ms)
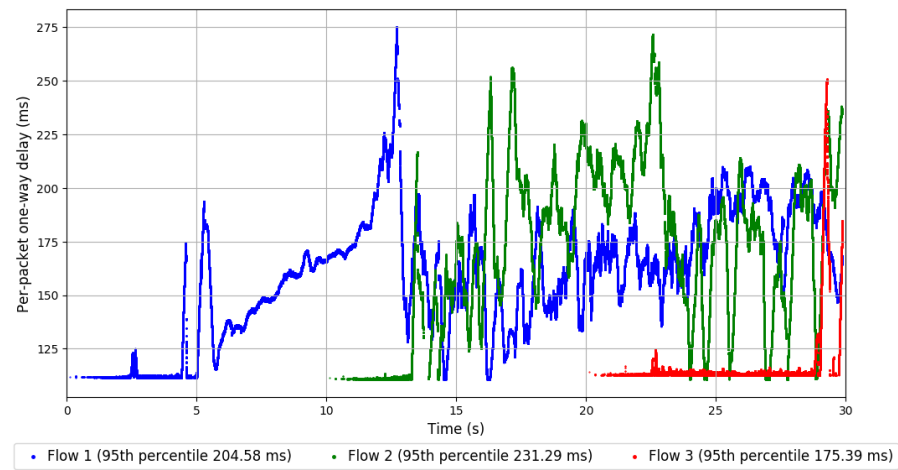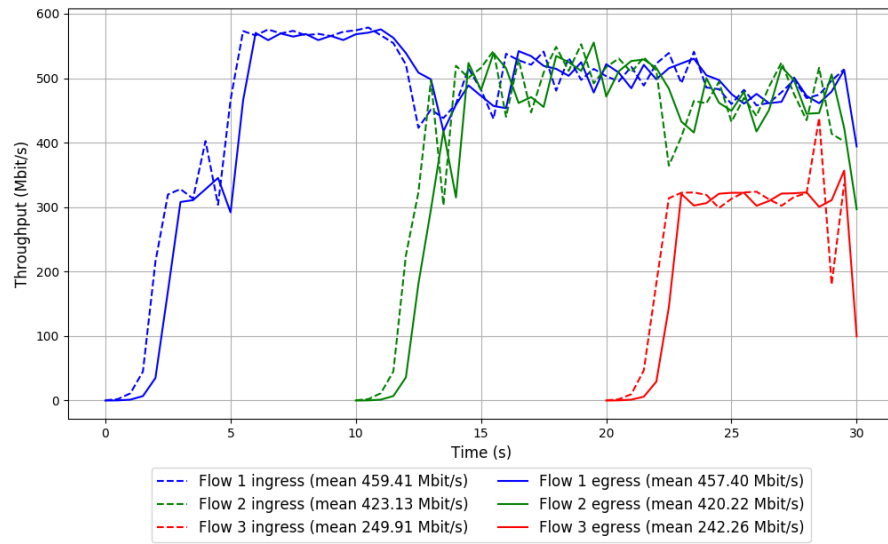
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```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-28 06:58:36
End at: 2018-08-28 06:59:06
Local clock offset: -0.109 ms
Remote clock offset: -0.137 ms


# Below is generated by plot.py at 2018-08-28 07:24:55
# Datalink statistics
-- Total of 3 flows:
Average throughput: 815.63 Mbit/s
95th percentile per-packet one-way delay: 217.430 ms
Loss rate: 1.80%
-- Flow 1:
Average throughput: 457.40 Mbit/s
95th percentile per-packet one-way delay: 204.584 ms
Loss rate: 1.17%
-- Flow 2:
Average throughput: 420.22 Mbit/s
95th percentile per-packet one-way delay: 231.287 ms
Loss rate: 1.79%
-- Flow 3:
Average throughput: 242.26 Mbit/s
95th percentile per-packet one-way delay: 175.388 ms
Loss rate: 5.27%
```

Run 2: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 459.41 Mbit/s) --- Flow 1 egress (mean 457.40 Mbit/s)
Flow 2 ingress (mean 423.13 Mbit/s) --- Flow 2 egress (mean 420.22 Mbit/s)
Flow 3 ingress (mean 249.91 Mbit/s) --- Flow 3 egress (mean 242.26 Mbit/s)

Flow 1 (95th percentile 204.58 ms)   Flow 2 (95th percentile 231.29 ms)   Flow 3 (95th percentile 175.39 ms)

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```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-28 07:06:21
End at: 2018-08-28 07:06:51
Local clock offset: -0.015 ms
Remote clock offset: 0.286 ms


# Below is generated by plot.py at 2018-08-28 07:24:59
# Datalink statistics
-- Total of 3 flows:
Average throughput: 818.80 Mbit/s
95th percentile per-packet one-way delay: 224.616 ms
Loss rate: 1.53%
-- Flow 1:
Average throughput: 480.26 Mbit/s
95th percentile per-packet one-way delay: 216.375 ms
Loss rate: 1.05%
-- Flow 2:
Average throughput: 385.01 Mbit/s
95th percentile per-packet one-way delay: 228.344 ms
Loss rate: 1.67%
-- Flow 3:
Average throughput: 253.89 Mbit/s
95th percentile per-packet one-way delay: 279.101 ms
Loss rate: 3.84%
```
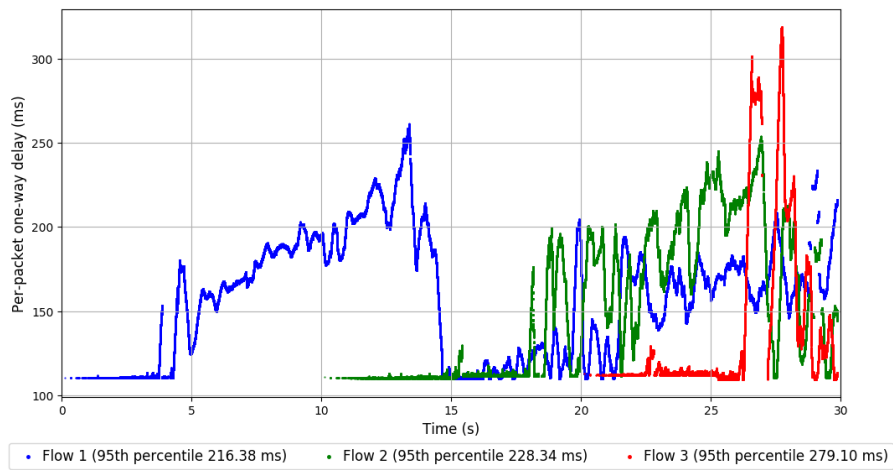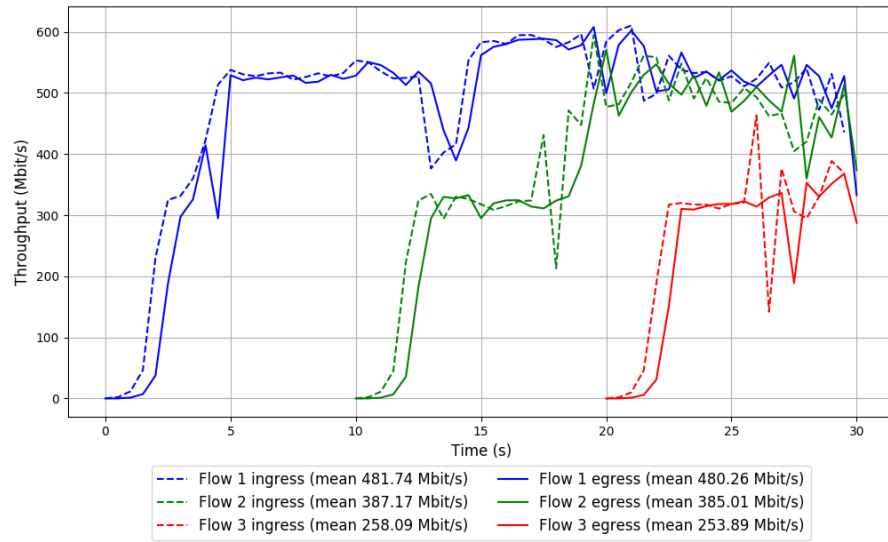
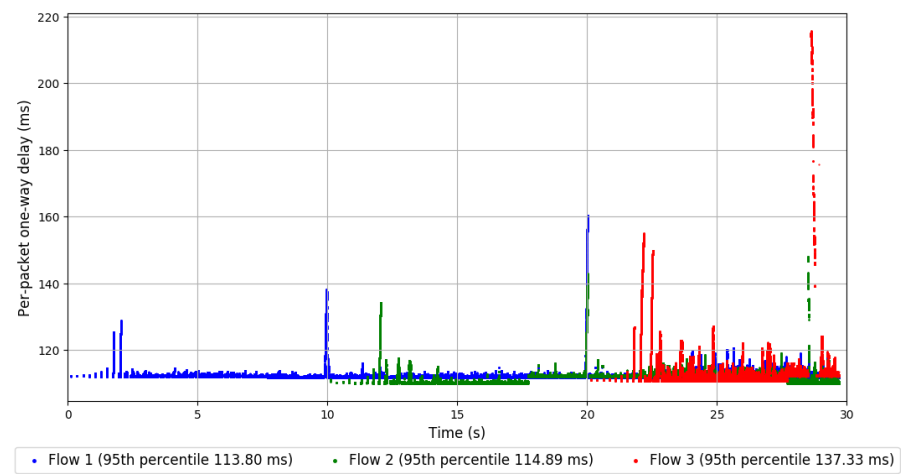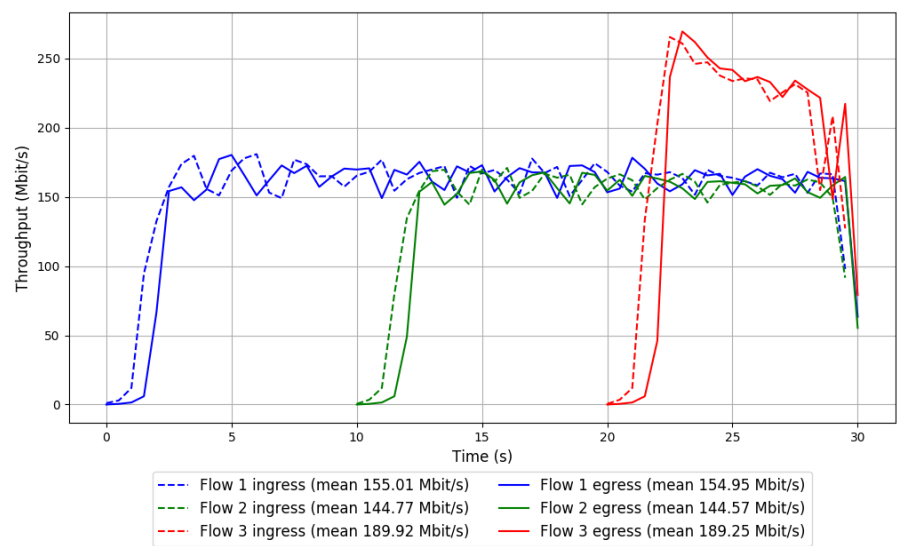Run 3: Report of TCP Cubic — Data Link

```
Run 1: Statistics of Indigo

Start at: 2018-08-28 06:45:08
End at: 2018-08-28 06:45:38
Local clock offset: -0.237 ms
Remote clock offset: 0.454 ms


# Below is generated by plot.py at 2018-08-28 07:24:59
# Datalink statistics
-- Total of 3 flows:
Average throughput: 311.60 Mbit/s
95th percentile per-packet one-way delay: 116.107 ms
Loss rate: 1.28%
-- Flow 1:
Average throughput: 154.95 Mbit/s
95th percentile per-packet one-way delay: 113.798 ms
Loss rate: 0.80%
-- Flow 2:
Average throughput: 144.57 Mbit/s
95th percentile per-packet one-way delay: 114.891 ms
Loss rate: 1.25%
-- Flow 3:
Average throughput: 189.25 Mbit/s
95th percentile per-packet one-way delay: 137.328 ms
Loss rate: 2.55%
```
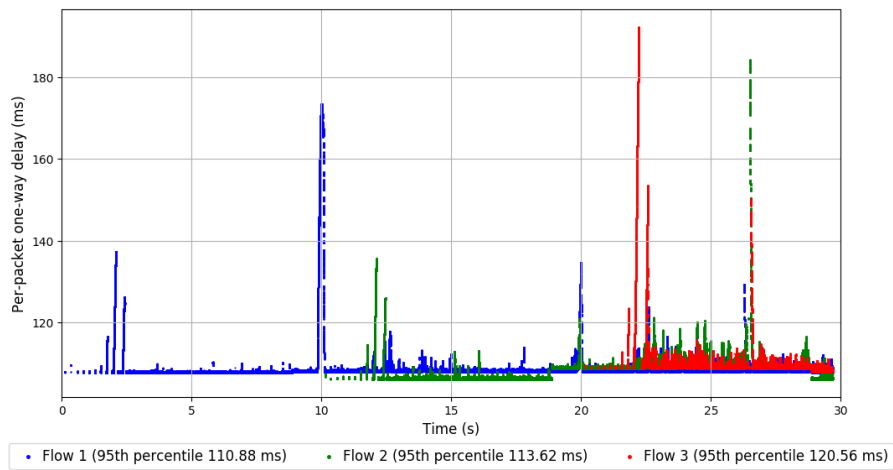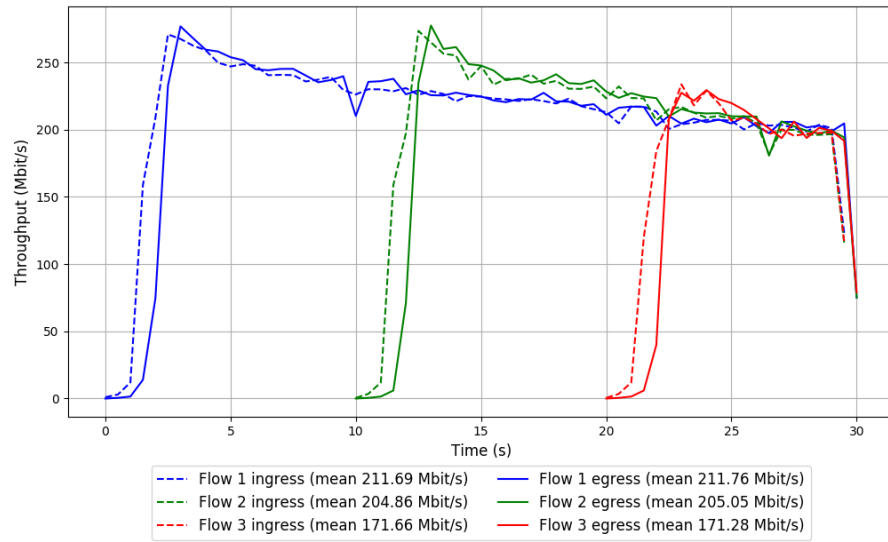
Run 1: Report of Indigo — Data Link

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```
Run 2: Statistics of Indigo

Start at: 2018-08-28 06:52:47
End at: 2018-08-28 06:53:17
Local clock offset: -2.886 ms
Remote clock offset: -0.163 ms

# Below is generated by plot.py at 2018-08-28 07:24:59
# Datalink statistics
-- Total of 3 flows:
Average throughput: 402.46 Mbit/s
95th percentile per-packet one-way delay: 112.768 ms
Loss rate: 1.07%
-- Flow 1:
Average throughput: 211.76 Mbit/s
95th percentile per-packet one-way delay: 110.878 ms
Loss rate: 0.72%
-- Flow 2:
Average throughput: 205.05 Mbit/s
95th percentile per-packet one-way delay: 113.623 ms
Loss rate: 1.03%
-- Flow 3:
Average throughput: 171.28 Mbit/s
95th percentile per-packet one-way delay: 120.557 ms
Loss rate: 2.52%
```
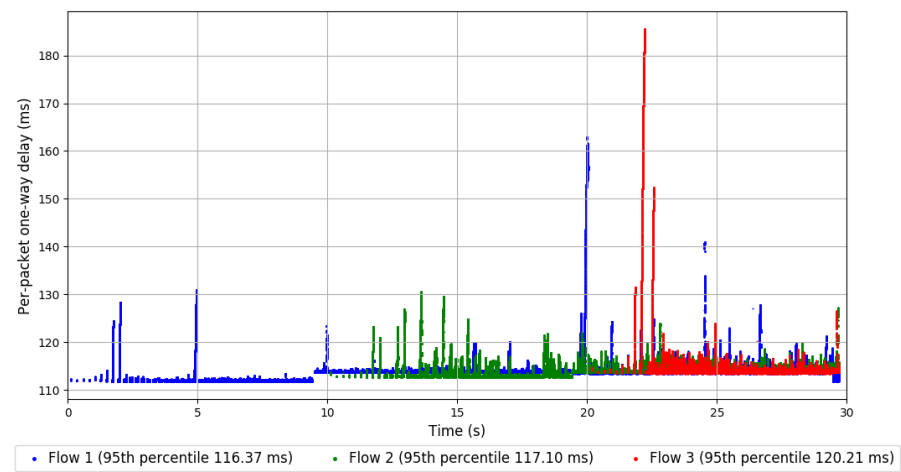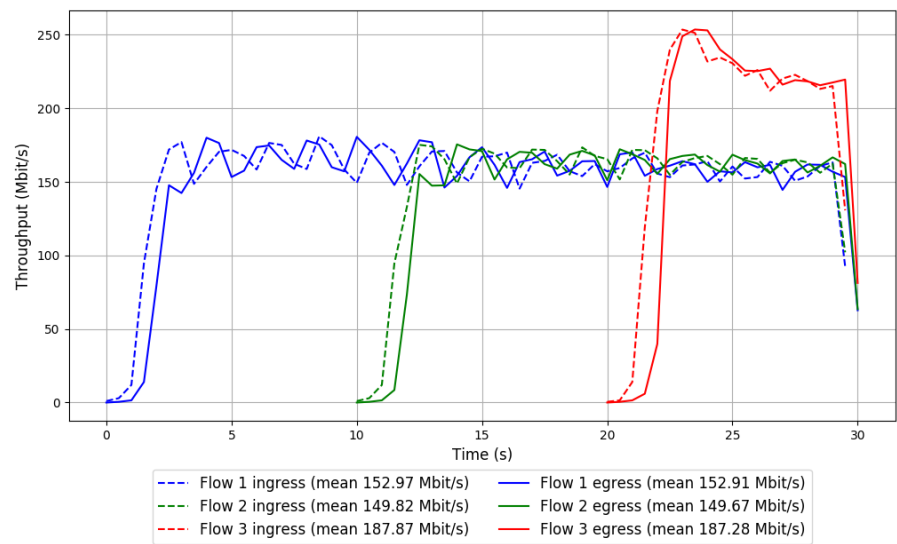
Run 2: Report of Indigo — Data Link

```
Run 3: Statistics of Indigo

Start at: 2018-08-28 07:00:36
End at: 2018-08-28 07:01:06
Local clock offset: 2.727 ms
Remote clock offset: -0.195 ms

# Below is generated by plot.py at 2018-08-28 07:27:23
# Datalink statistics
-- Total of 3 flows:
Average throughput: 312.12 Mbit/s
95th percentile per-packet one-way delay: 117.044 ms
Loss rate: 1.27%
-- Flow 1:
Average throughput: 152.91 Mbit/s
95th percentile per-packet one-way delay: 116.372 ms
Loss rate: 0.78%
-- Flow 2:
Average throughput: 149.67 Mbit/s
95th percentile per-packet one-way delay: 117.097 ms
Loss rate: 1.22%
-- Flow 3:
Average throughput: 187.28 Mbit/s
95th percentile per-packet one-way delay: 120.211 ms
Loss rate: 2.59%
```

Run 3: Report of Indigo — Data Link

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```
Run 1: Statistics of Muses

Start at: 2018-08-28 06:49:00
End at: 2018-08-28 06:49:30
Local clock offset: 0.02 ms
Remote clock offset: 0.414 ms


# Below is generated by plot.py at 2018-08-28 07:29:06
# Datalink statistics
-- Total of 3 flows:
Average throughput: 530.87 Mbit/s
95th percentile per-packet one-way delay: 195.635 ms
Loss rate: 2.32%
-- Flow 1:
Average throughput: 351.74 Mbit/s
95th percentile per-packet one-way delay: 194.065 ms
Loss rate: 1.76%
-- Flow 2:
Average throughput: 251.17 Mbit/s
95th percentile per-packet one-way delay: 208.073 ms
Loss rate: 2.57%
-- Flow 3:
Average throughput: 39.15 Mbit/s
95th percentile per-packet one-way delay: 112.508 ms
Loss rate: 13.24%
```

Run 1: Report of Muses — Data Link

Flow 1 ingress (mean 355.40 Mbit/s) --- Flow 1 egress (mean 351.74 Mbit/s)
Flow 2 ingress (mean 254.80 Mbit/s) --- Flow 2 egress (mean 251.17 Mbit/s)
Flow 3 ingress (mean 44.10 Mbit/s) --- Flow 3 egress (mean 39.15 Mbit/s)

Flow 1 (95th percentile 194.06 ms)   Flow 2 (95th percentile 208.07 ms)   Flow 3 (95th percentile 112.51 ms)

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```
Run 2: Statistics of Muses

Start at: 2018-08-28 06:56:47
End at: 2018-08-28 06:57:17
Local clock offset: -0.194 ms
Remote clock offset: -0.314 ms


# Below is generated by plot.py at 2018-08-28 07:29:28
# Datalink statistics
-- Total of 3 flows:
Average throughput: 551.73 Mbit/s
95th percentile per-packet one-way delay: 195.295 ms
Loss rate: 2.57%
-- Flow 1:
Average throughput: 365.44 Mbit/s
95th percentile per-packet one-way delay: 192.754 ms
Loss rate: 1.66%
-- Flow 2:
Average throughput: 256.38 Mbit/s
95th percentile per-packet one-way delay: 207.017 ms
Loss rate: 3.53%
-- Flow 3:
Average throughput: 50.18 Mbit/s
95th percentile per-packet one-way delay: 110.225 ms
Loss rate: 11.80%
```
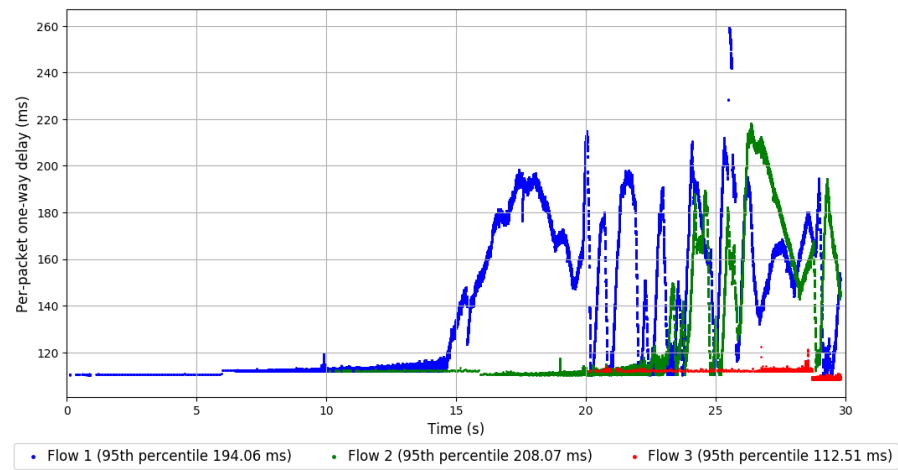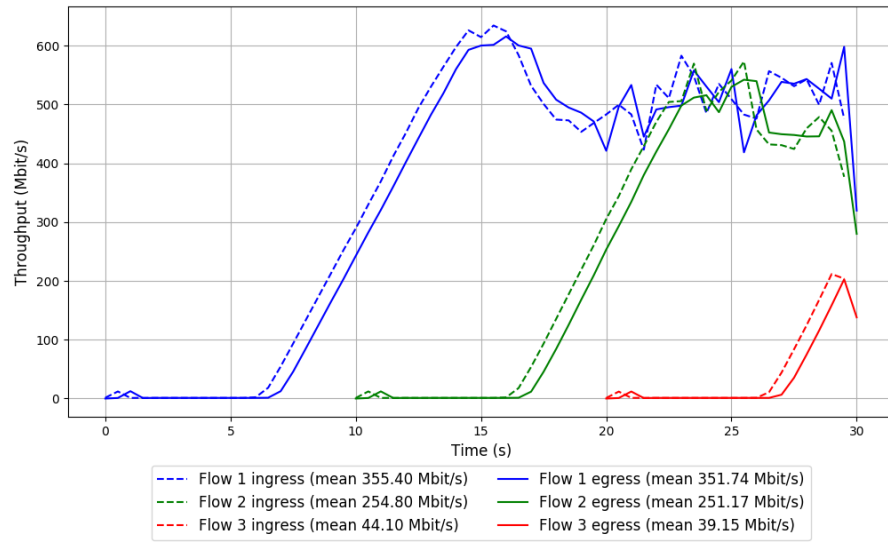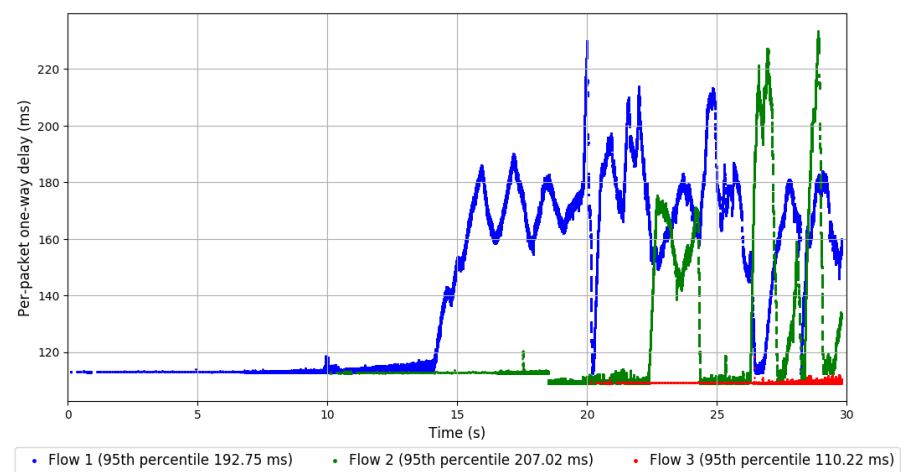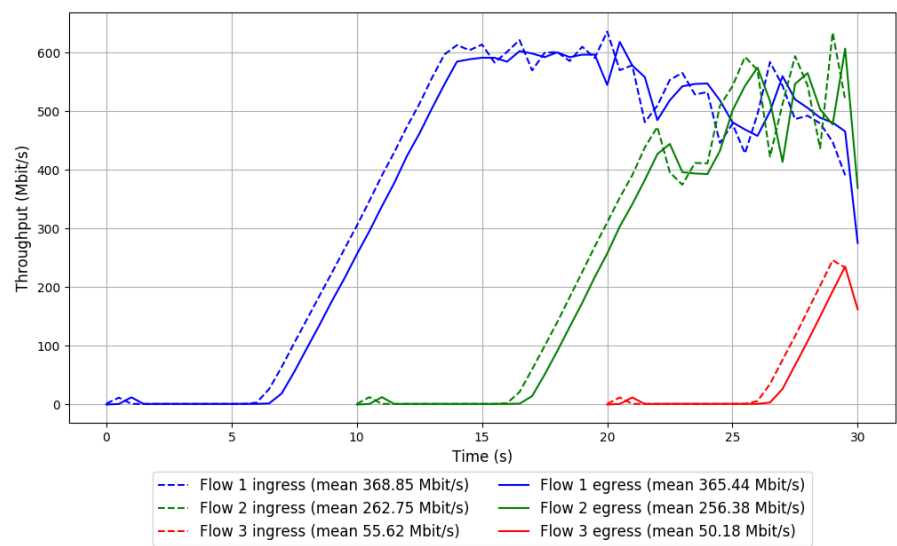
Run 2: Report of Muses — Data Link

Flow 1 ingress (mean 368.85 Mbit/s)   Flow 1 egress (mean 365.44 Mbit/s)
Flow 2 ingress (mean 262.75 Mbit/s)   Flow 2 egress (mean 256.38 Mbit/s)
Flow 3 ingress (mean 55.62 Mbit/s)   Flow 3 egress (mean 50.18 Mbit/s)

Flow 1 (95th percentile 192.75 ms)   Flow 2 (95th percentile 207.02 ms)   Flow 3 (95th percentile 110.22 ms)

```
Run 3: Statistics of Muses

Start at: 2018-08-28 07:04:31
End at: 2018-08-28 07:05:01
Local clock offset: -0.044 ms
Remote clock offset: -1.063 ms


# Below is generated by plot.py at 2018-08-28 07:29:31
# Datalink statistics
-- Total of 3 flows:
Average throughput: 556.49 Mbit/s
95th percentile per-packet one-way delay: 202.253 ms
Loss rate: 3.45%
-- Flow 1:
Average throughput: 370.81 Mbit/s
95th percentile per-packet one-way delay: 197.479 ms
Loss rate: 2.36%
-- Flow 2:
Average throughput: 257.00 Mbit/s
95th percentile per-packet one-way delay: 213.686 ms
Loss rate: 4.92%
-- Flow 3:
Average throughput: 47.52 Mbit/s
95th percentile per-packet one-way delay: 113.718 ms
Loss rate: 12.25%
```

Run 3: Report of Muses — Data Link

Flow 1 ingress (mean 376.93 Mbit/s) --- Flow 1 egress (mean 370.81 Mbit/s)
Flow 2 ingress (mean 267.22 Mbit/s) --- Flow 2 egress (mean 257.00 Mbit/s)
Flow 3 ingress (mean 52.91 Mbit/s) --- Flow 3 egress (mean 47.52 Mbit/s)

Flow 1 (95th percentile 197.48 ms)   Flow 2 (95th percentile 213.69 ms)   Flow 3 (95th percentile 113.72 ms)