Pantheon Report

Generated at 2018-08-28 08:54:25 (UTC).

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

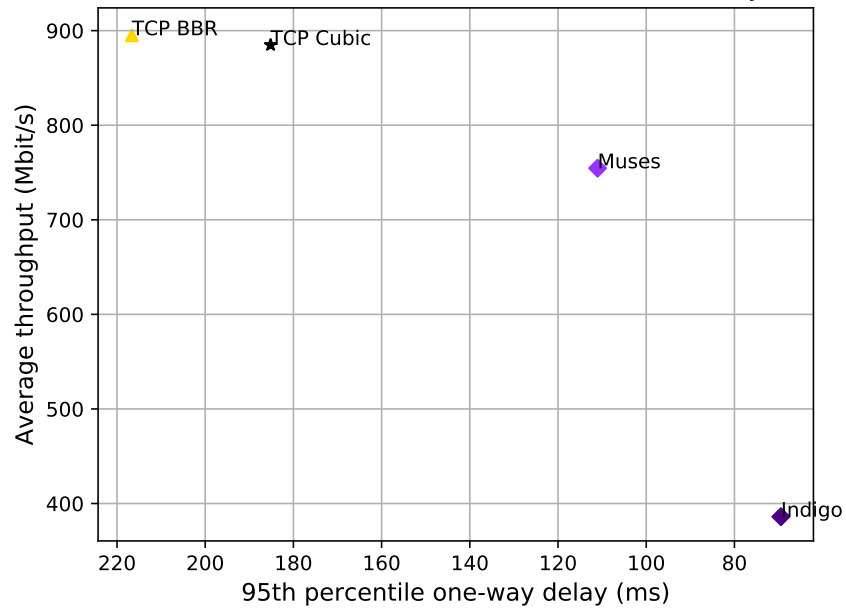NTP offsets were measured against `time.google.com` and have been applied to correct the timestamps in logs.

```
System info:
Linux 4.15.0-1017-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
```
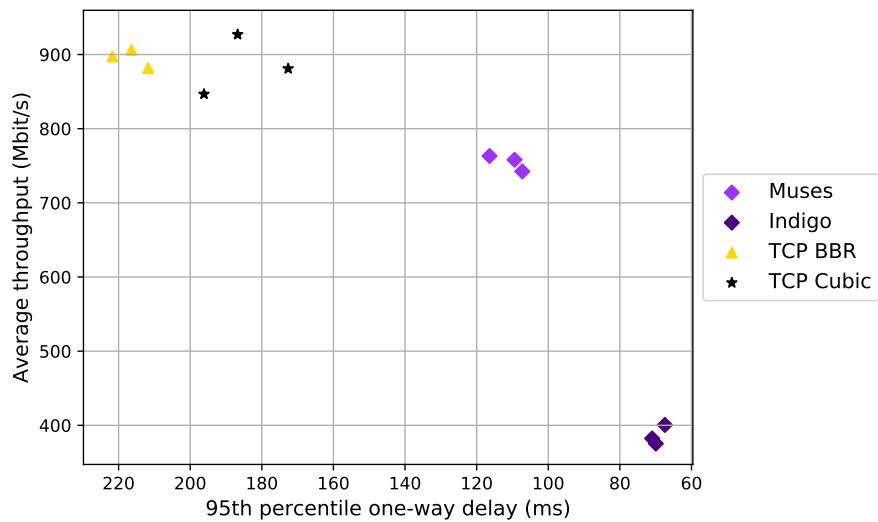
test from GCE Iowa to GCE Tokyo, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

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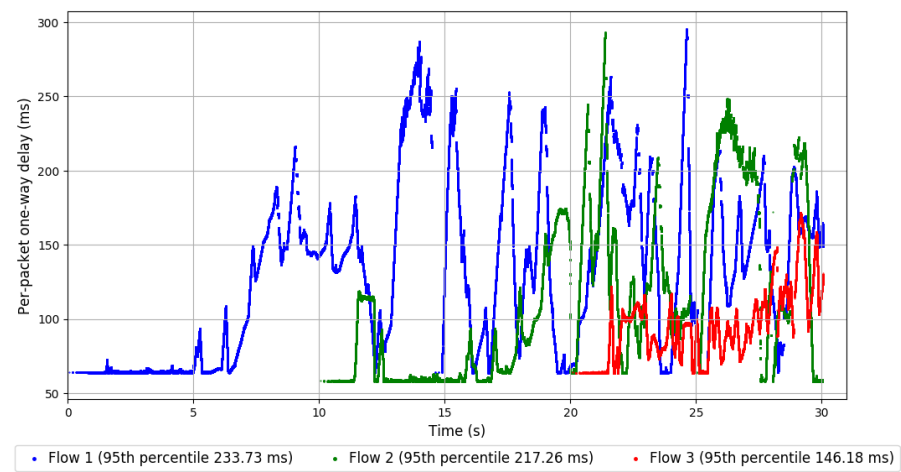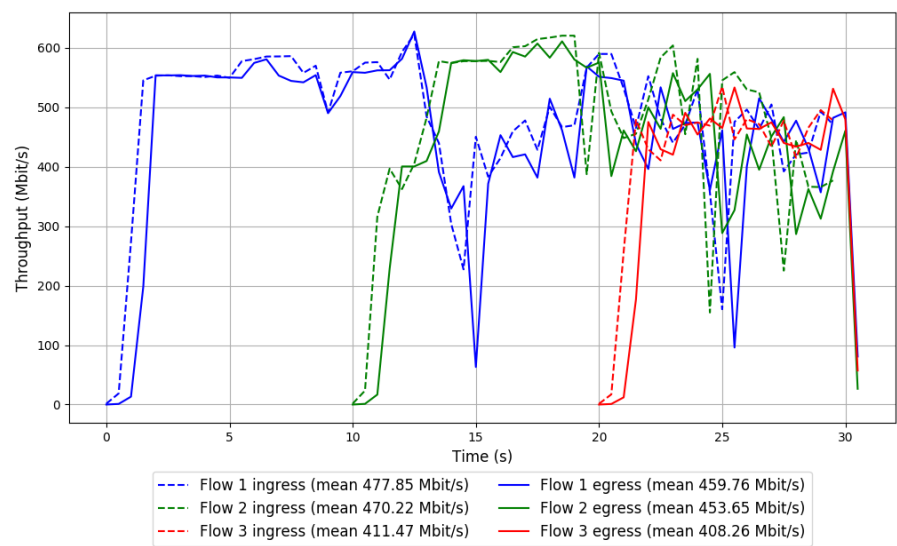3 flows with 10s interval between flows

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	469.99	430.33	417.28	218.85	212.94	182.78	2.66	2.27	1.78
TCP Cubic	3	466.90	434.62	386.73	162.08	196.35	132.41	0.27	0.15	0.14
Indigo	3	212.98	179.46	168.70	68.98	69.18	69.67	0.01	0.00	0.06
Muses	3	435.69	363.97	238.23	109.44	111.66	102.63	0.07	0.07	0.61

```
Run 1: Statistics of TCP BBR

Start at: 2018-08-28 08:11:55
End at: 2018-08-28 08:12:25
Local clock offset: 0.401 ms
Remote clock offset: -2.908 ms


# Below is generated by plot.py at 2018-08-28 08:48:06
# Datalink statistics
-- Total of 3 flows:
Average throughput: 897.45 Mbit/s
95th percentile per-packet one-way delay: 221.750 ms
Loss rate: 3.17%
-- Flow 1:
Average throughput: 459.76 Mbit/s
95th percentile per-packet one-way delay: 233.733 ms
Loss rate: 3.70%
-- Flow 2:
Average throughput: 453.65 Mbit/s
95th percentile per-packet one-way delay: 217.259 ms
Loss rate: 3.53%
-- Flow 3:
Average throughput: 408.26 Mbit/s
95th percentile per-packet one-way delay: 146.181 ms
Loss rate: 0.49%
```

Run 1: Report of TCP BBR — Data Link

```
Run 2: Statistics of TCP BBR

Start at: 2018-08-28 08:19:23
End at: 2018-08-28 08:19:53
Local clock offset: 0.327 ms
Remote clock offset: 2.759 ms


# Below is generated by plot.py at 2018-08-28 08:48:12
# Datalink statistics
-- Total of 3 flows:
Average throughput: 906.28 Mbit/s
95th percentile per-packet one-way delay: 216.421 ms
Loss rate: 2.20%
-- Flow 1:
Average throughput: 473.26 Mbit/s
95th percentile per-packet one-way delay: 205.038 ms
Loss rate: 1.66%
-- Flow 2:
Average throughput: 428.77 Mbit/s
95th percentile per-packet one-way delay: 236.975 ms
Loss rate: 2.66%
-- Flow 3:
Average throughput: 444.03 Mbit/s
95th percentile per-packet one-way delay: 202.379 ms
Loss rate: 2.99%
```
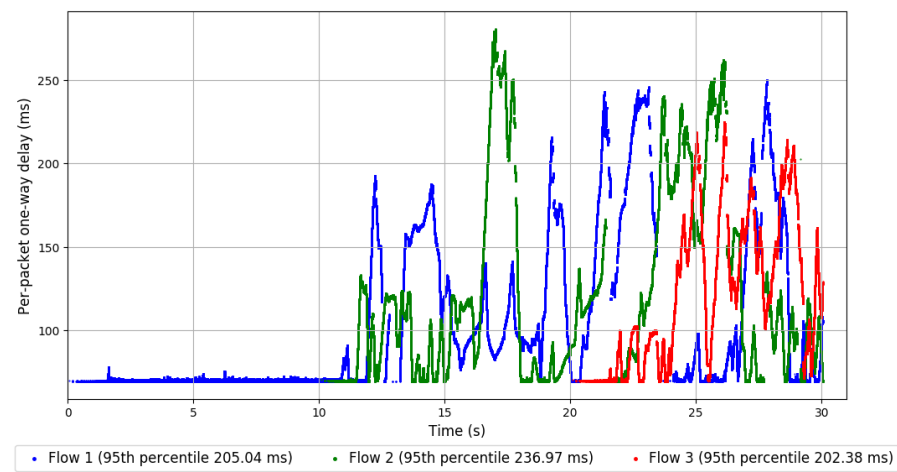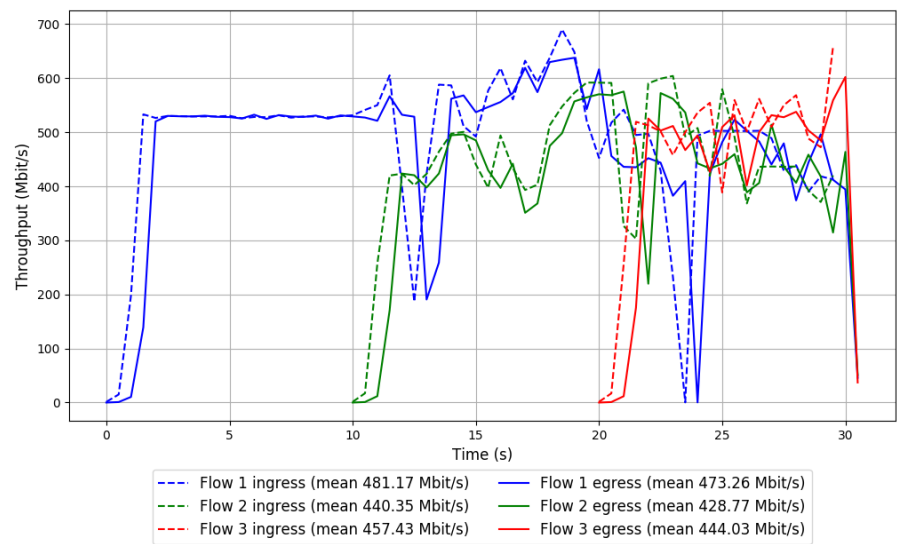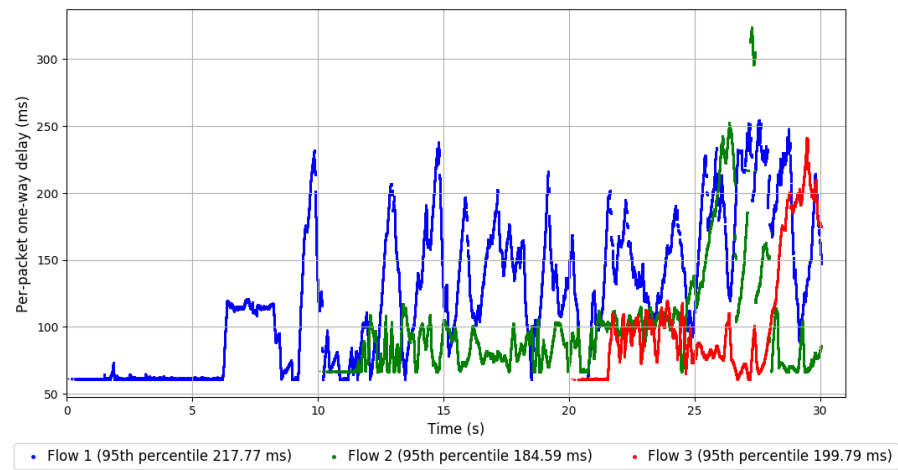
Run 2: Report of TCP BBR — Data Link

Flow 1 ingress (mean 481.17 Mbit/s) --- Flow 1 egress (mean 473.26 Mbit/s)
Flow 2 ingress (mean 440.35 Mbit/s) --- Flow 2 egress (mean 428.77 Mbit/s)
Flow 3 ingress (mean 457.43 Mbit/s) --- Flow 3 egress (mean 444.03 Mbit/s)

Flow 1 (95th percentile 205.04 ms)   Flow 2 (95th percentile 236.97 ms)   Flow 3 (95th percentile 202.38 ms)
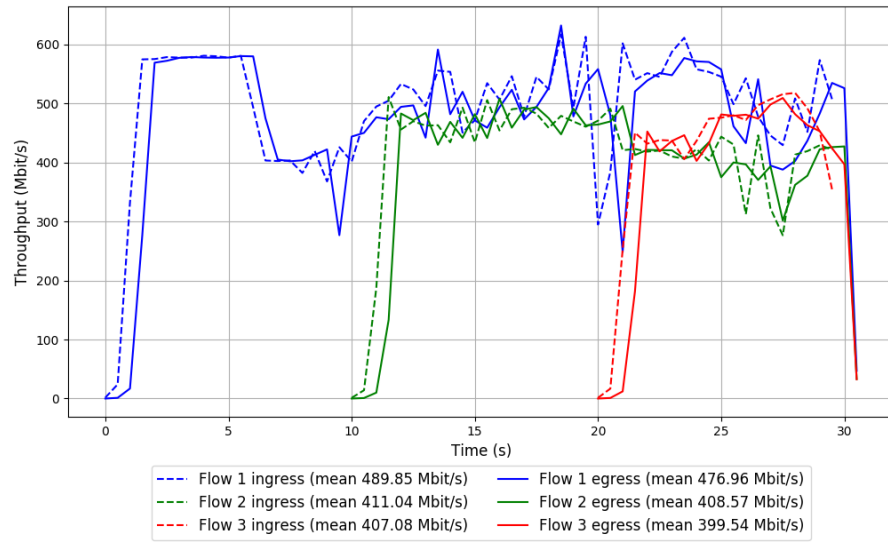
```
Run 3: Statistics of TCP BBR

Start at: 2018-08-28 08:26:48
End at: 2018-08-28 08:27:18
Local clock offset: 0.375 ms
Remote clock offset: -0.131 ms


# Below is generated by plot.py at 2018-08-28 08:48:12
# Datalink statistics
-- Total of 3 flows:
Average throughput: 881.73 Mbit/s
95th percentile per-packet one-way delay: 211.741 ms
Loss rate: 1.90%
-- Flow 1:
Average throughput: 476.96 Mbit/s
95th percentile per-packet one-way delay: 217.773 ms
Loss rate: 2.63%
-- Flow 2:
Average throughput: 408.57 Mbit/s
95th percentile per-packet one-way delay: 184.591 ms
Loss rate: 0.63%
-- Flow 3:
Average throughput: 399.54 Mbit/s
95th percentile per-packet one-way delay: 199.788 ms
Loss rate: 1.86%
```
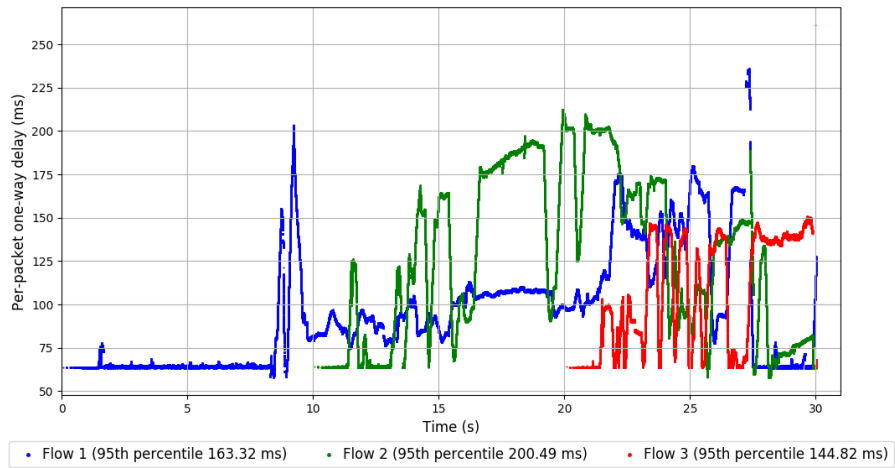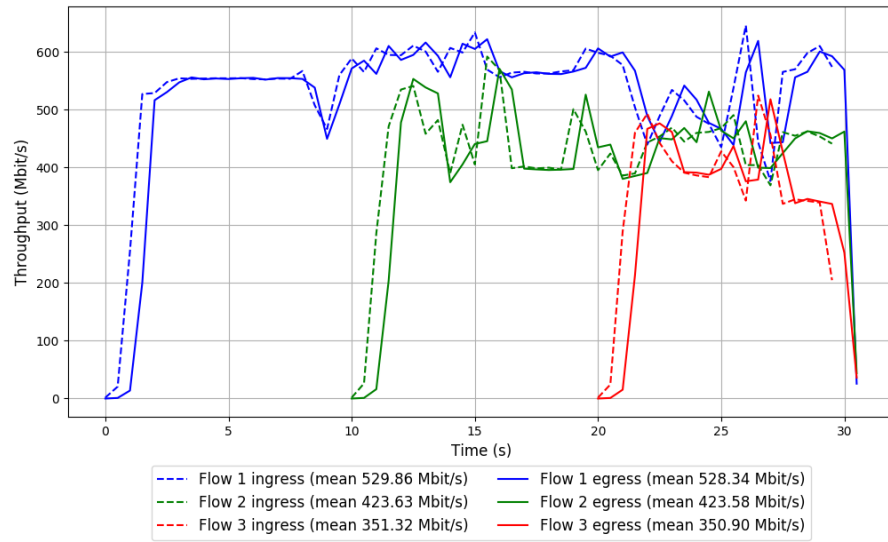
Run 3: Report of TCP BBR — Data Link

Flow 1 ingress (mean 489.85 Mbit/s) --- Flow 1 egress (mean 476.96 Mbit/s) ---
Flow 2 ingress (mean 411.04 Mbit/s) --- Flow 2 egress (mean 408.57 Mbit/s) ---
Flow 3 ingress (mean 407.08 Mbit/s) --- Flow 3 egress (mean 399.54 Mbit/s) ---

Flow 1 (95th percentile 217.77 ms)　　Flow 2 (95th percentile 184.59 ms)　　Flow 3 (95th percentile 199.79 ms)

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```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-28 08:08:14
End at: 2018-08-28 08:08:44
Local clock offset: 0.44 ms
Remote clock offset: -2.956 ms


# Below is generated by plot.py at 2018-08-28 08:48:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 927.01 Mbit/s
95th percentile per-packet one-way delay: 186.745 ms
Loss rate: 0.21%
-- Flow 1:
Average throughput: 528.34 Mbit/s
95th percentile per-packet one-way delay: 163.324 ms
Loss rate: 0.30%
-- Flow 2:
Average throughput: 423.58 Mbit/s
95th percentile per-packet one-way delay: 200.488 ms
Loss rate: 0.04%
-- Flow 3:
Average throughput: 350.90 Mbit/s
95th percentile per-packet one-way delay: 144.820 ms
Loss rate: 0.18%
```
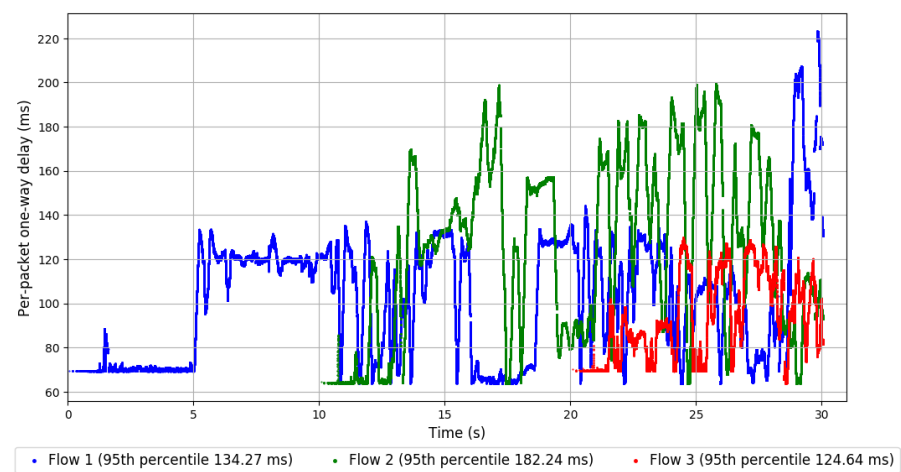
Run 1: Report of TCP Cubic — Data Link

```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-28 08:15:44
End at: 2018-08-28 08:16:14
Local clock offset: 0.326 ms
Remote clock offset: 2.821 ms


# Below is generated by plot.py at 2018-08-28 08:48:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 880.89 Mbit/s
95th percentile per-packet one-way delay: 172.642 ms
Loss rate: 0.18%
-- Flow 1:
Average throughput: 436.29 Mbit/s
95th percentile per-packet one-way delay: 134.267 ms
Loss rate: 0.21%
-- Flow 2:
Average throughput: 472.07 Mbit/s
95th percentile per-packet one-way delay: 182.235 ms
Loss rate: 0.15%
-- Flow 3:
Average throughput: 391.58 Mbit/s
95th percentile per-packet one-way delay: 124.636 ms
Loss rate: 0.12%
```
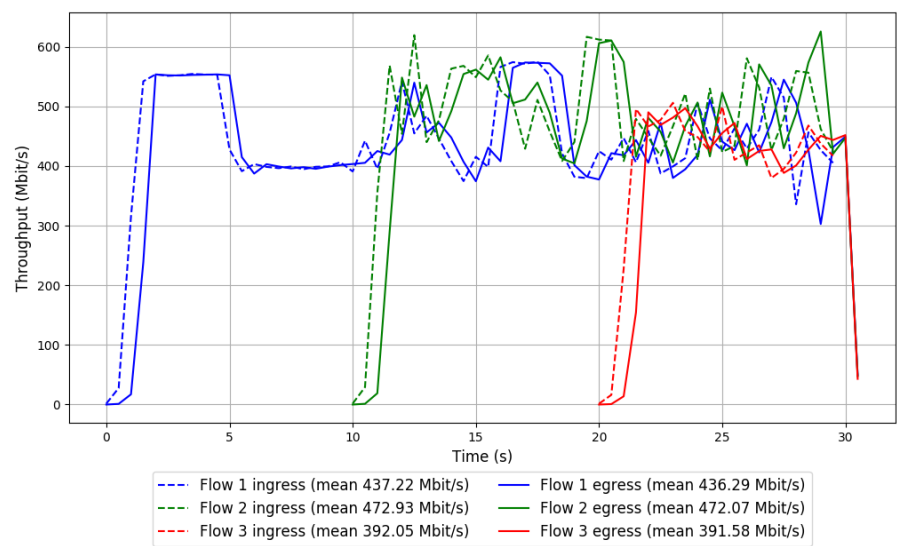
Run 2: Report of TCP Cubic — Data Link

```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-28 08:23:09
End at: 2018-08-28 08:23:39
Local clock offset: 0.357 ms
Remote clock offset: 2.714 ms


# Below is generated by plot.py at 2018-08-28 08:48:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 846.65 Mbit/s
95th percentile per-packet one-way delay: 196.150 ms
Loss rate: 0.25%
-- Flow 1:
Average throughput: 436.08 Mbit/s
95th percentile per-packet one-way delay: 188.634 ms
Loss rate: 0.29%
-- Flow 2:
Average throughput: 408.21 Mbit/s
95th percentile per-packet one-way delay: 206.341 ms
Loss rate: 0.25%
-- Flow 3:
Average throughput: 417.72 Mbit/s
95th percentile per-packet one-way delay: 127.760 ms
Loss rate: 0.12%
```
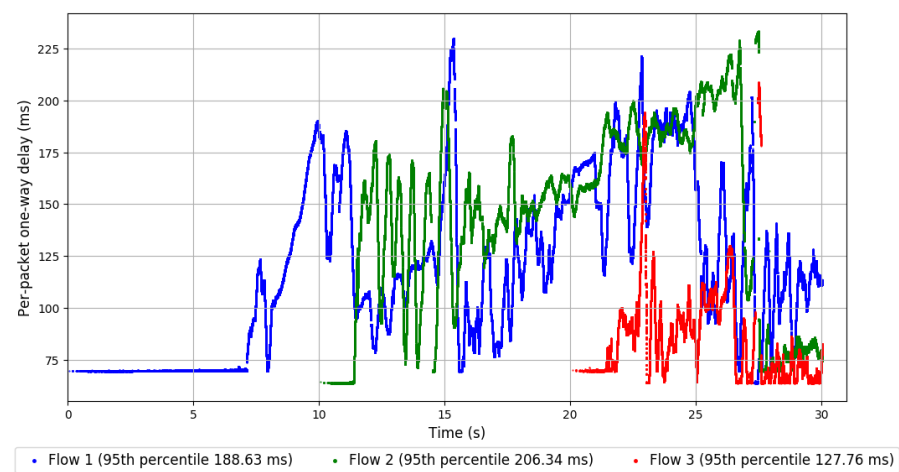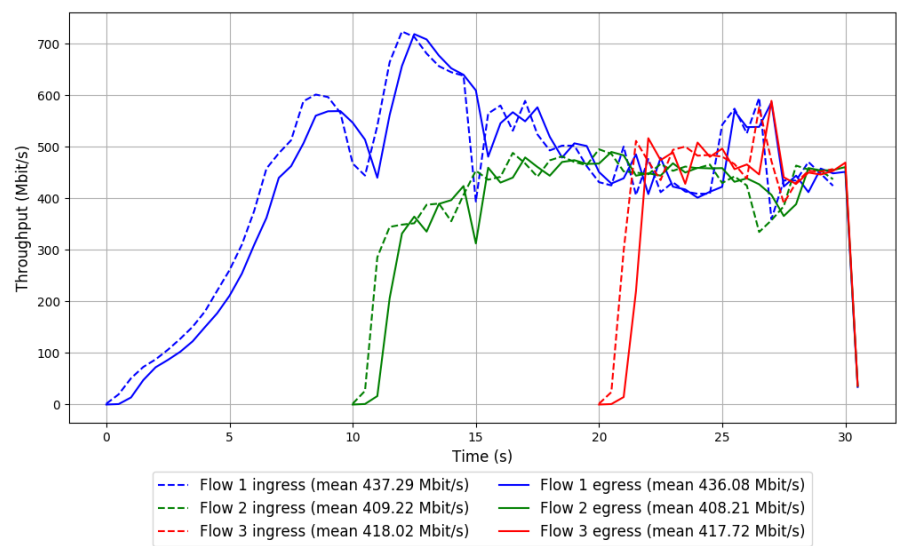
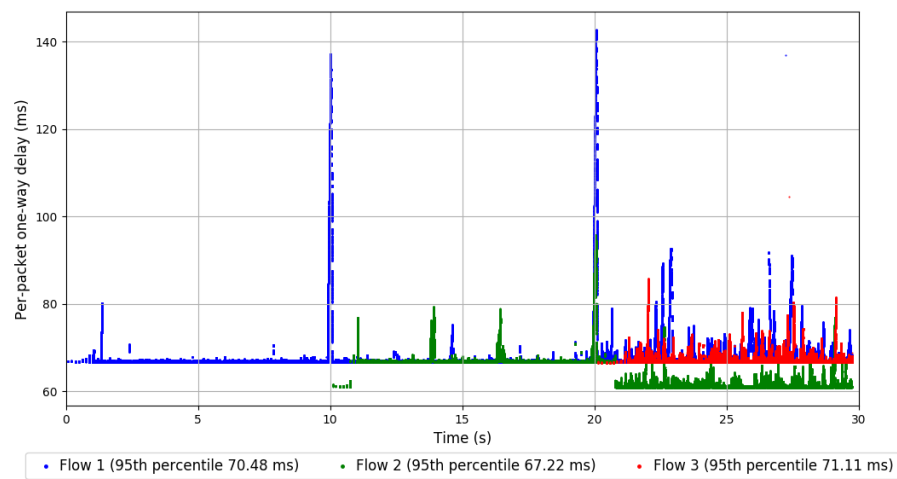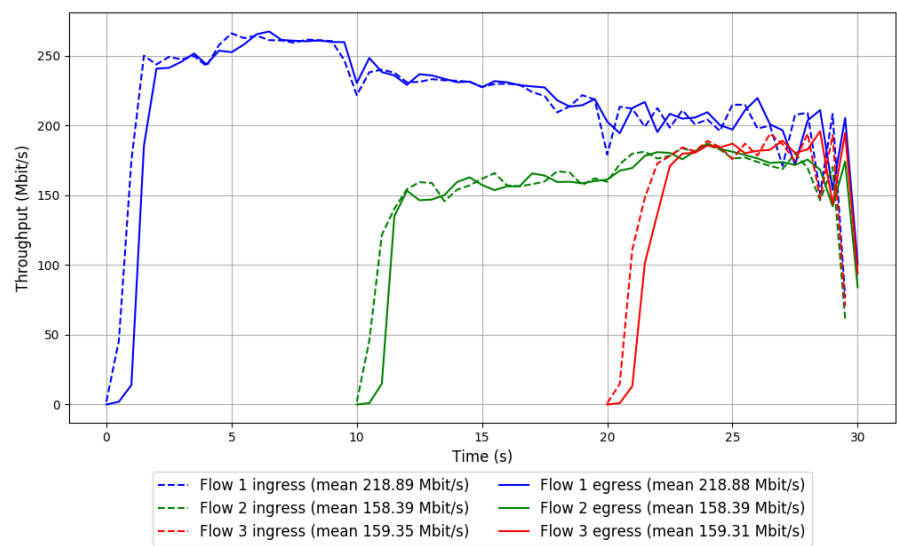Run 3: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 437.29 Mbit/s)   Flow 1 egress (mean 436.08 Mbit/s)
Flow 2 ingress (mean 409.22 Mbit/s)   Flow 2 egress (mean 408.21 Mbit/s)
Flow 3 ingress (mean 418.02 Mbit/s)   Flow 3 egress (mean 417.72 Mbit/s)

Flow 1 (95th percentile 188.63 ms)   Flow 2 (95th percentile 206.34 ms)   Flow 3 (95th percentile 127.76 ms)

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```
Run 1: Statistics of Indigo

Start at: 2018-08-28 08:10:11
End at: 2018-08-28 08:10:41
Local clock offset: 0.354 ms
Remote clock offset: -0.02 ms


# Below is generated by plot.py at 2018-08-28 08:48:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 375.35 Mbit/s
95th percentile per-packet one-way delay: 69.963 ms
Loss rate: 0.02%
-- Flow 1:
Average throughput: 218.88 Mbit/s
95th percentile per-packet one-way delay: 70.482 ms
Loss rate: 0.02%
-- Flow 2:
Average throughput: 158.39 Mbit/s
95th percentile per-packet one-way delay: 67.215 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 159.31 Mbit/s
95th percentile per-packet one-way delay: 71.106 ms
Loss rate: 0.07%
```

Run 1: Report of Indigo — Data Link

```
Run 2: Statistics of Indigo

Start at: 2018-08-28 08:17:38
End at: 2018-08-28 08:18:08
Local clock offset: 0.36 ms
Remote clock offset: 2.73 ms


# Below is generated by plot.py at 2018-08-28 08:48:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 382.27 Mbit/s
95th percentile per-packet one-way delay: 70.985 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 211.71 Mbit/s
95th percentile per-packet one-way delay: 69.187 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 173.84 Mbit/s
95th percentile per-packet one-way delay: 71.550 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 172.83 Mbit/s
95th percentile per-packet one-way delay: 71.632 ms
Loss rate: 0.00%
```
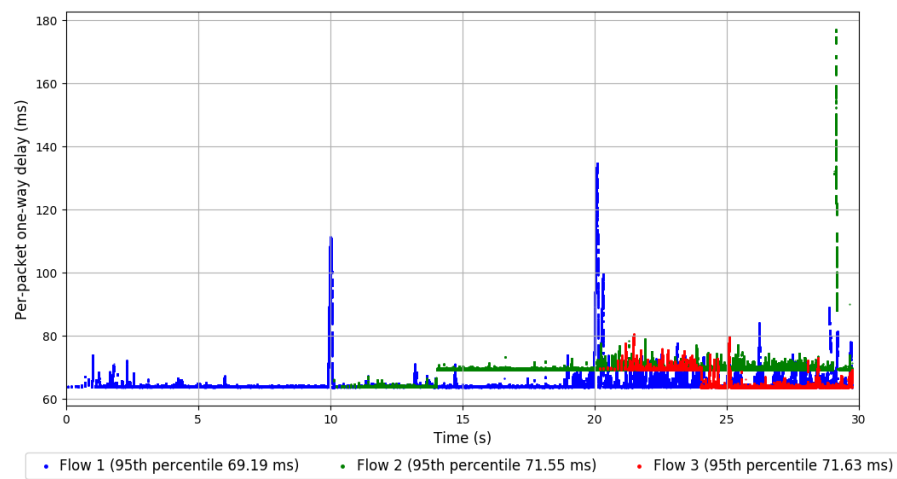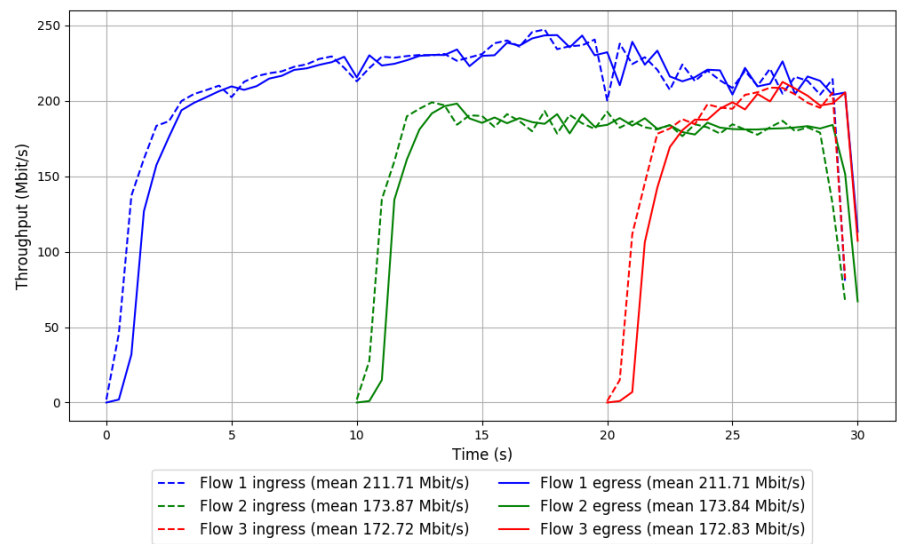
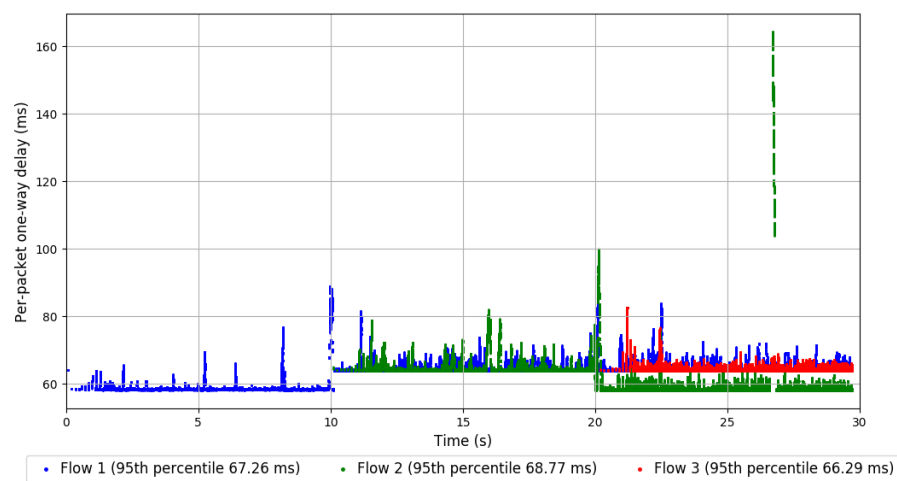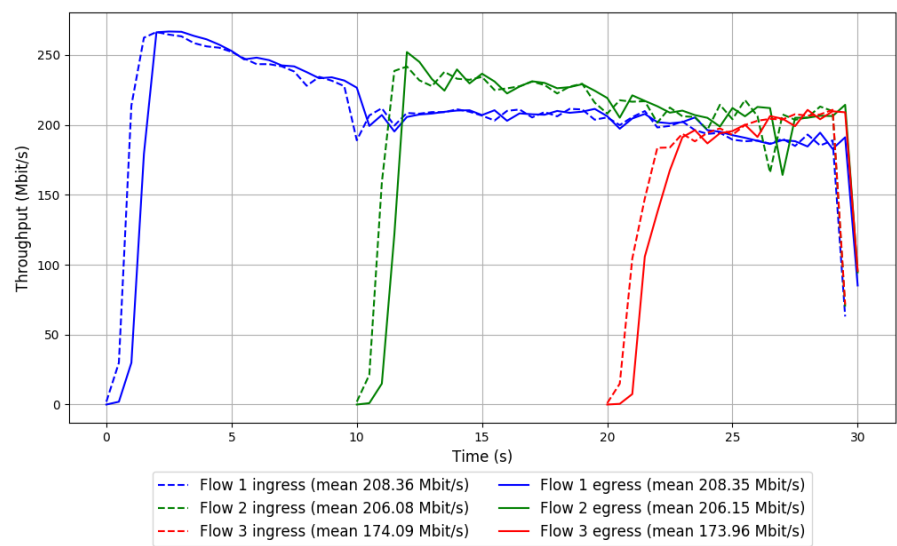Run 2: Report of Indigo — Data Link

```
Run 3: Statistics of Indigo

Start at: 2018-08-28 08:25:02
End at: 2018-08-28 08:25:32
Local clock offset: 0.291 ms
Remote clock offset: -2.902 ms


# Below is generated by plot.py at 2018-08-28 08:51:36
# Datalink statistics
-- Total of 3 flows:
Average throughput: 400.56 Mbit/s
95th percentile per-packet one-way delay: 67.433 ms
Loss rate: 0.02%
-- Flow 1:
Average throughput: 208.35 Mbit/s
95th percentile per-packet one-way delay: 67.264 ms
Loss rate: 0.01%
-- Flow 2:
Average throughput: 206.15 Mbit/s
95th percentile per-packet one-way delay: 68.771 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 173.96 Mbit/s
95th percentile per-packet one-way delay: 66.286 ms
Loss rate: 0.12%
```

Run 3: Report of Indigo — Data Link

```
Run 1: Statistics of Muses

Start at: 2018-08-28 08:13:53
End at: 2018-08-28 08:14:23
Local clock offset: 0.363 ms
Remote clock offset: 2.736 ms


# Below is generated by plot.py at 2018-08-28 08:53:40
# Datalink statistics
-- Total of 3 flows:
Average throughput: 758.07 Mbit/s
95th percentile per-packet one-way delay: 109.417 ms
Loss rate: 0.15%
-- Flow 1:
Average throughput: 442.53 Mbit/s
95th percentile per-packet one-way delay: 110.061 ms
Loss rate: 0.10%
-- Flow 2:
Average throughput: 367.68 Mbit/s
95th percentile per-packet one-way delay: 108.139 ms
Loss rate: 0.05%
-- Flow 3:
Average throughput: 218.58 Mbit/s
95th percentile per-packet one-way delay: 103.794 ms
Loss rate: 0.81%
```
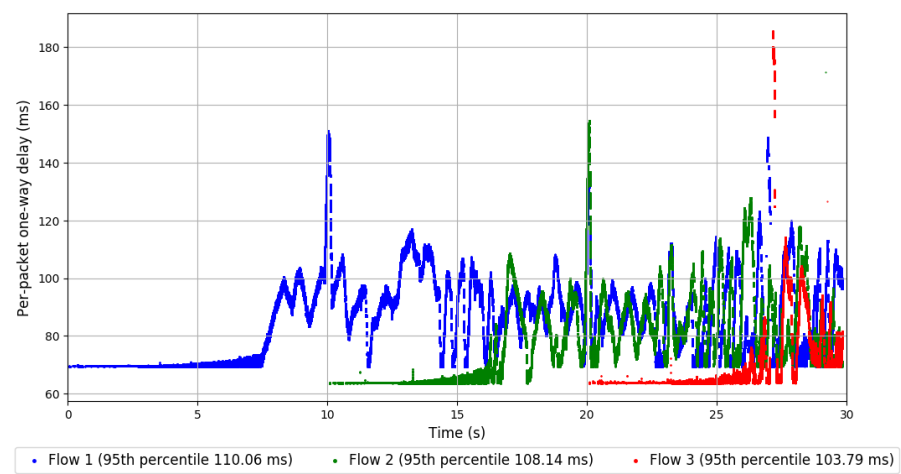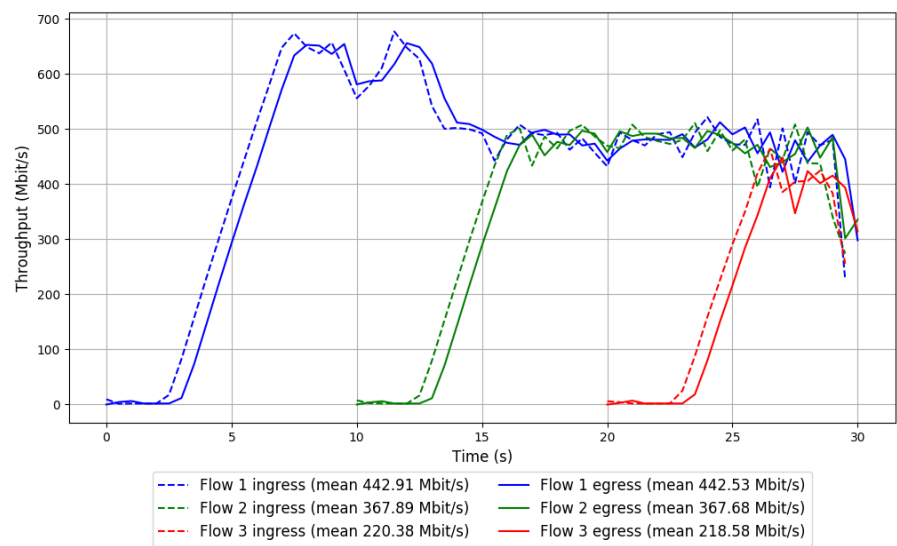
Run 1: Report of Muses — Data Link

```
Run 2: Statistics of Muses

Start at: 2018-08-28 08:21:21
End at: 2018-08-28 08:21:51
Local clock offset: 0.343 ms
Remote clock offset: 0.035 ms

# Below is generated by plot.py at 2018-08-28 08:54:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 742.33 Mbit/s
95th percentile per-packet one-way delay: 107.247 ms
Loss rate: 0.14%
-- Flow 1:
Average throughput: 435.28 Mbit/s
95th percentile per-packet one-way delay: 109.979 ms
Loss rate: 0.10%
-- Flow 2:
Average throughput: 335.78 Mbit/s
95th percentile per-packet one-way delay: 100.262 ms
Loss rate: 0.06%
-- Flow 3:
Average throughput: 260.36 Mbit/s
95th percentile per-packet one-way delay: 104.573 ms
Loss rate: 0.54%
```
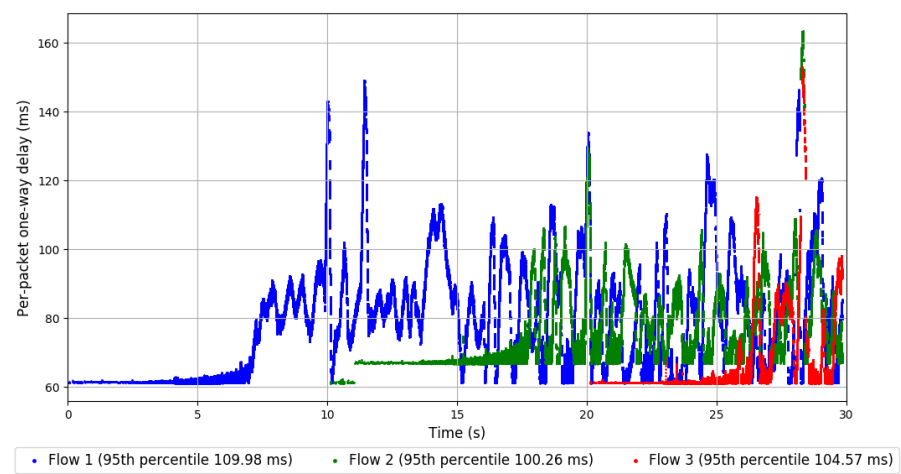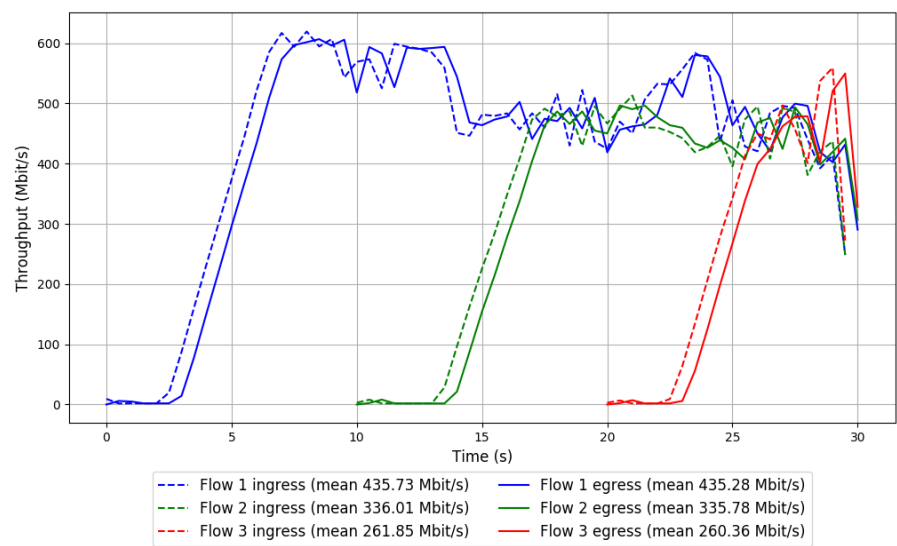
Run 2: Report of Muses — Data Link

```
Run 3: Statistics of Muses

Start at: 2018-08-28 08:28:44
End at: 2018-08-28 08:29:14
Local clock offset: 0.357 ms
Remote clock offset: 2.754 ms


# Below is generated by plot.py at 2018-08-28 08:54:23
# Datalink statistics
-- Total of 3 flows:
Average throughput: 763.18 Mbit/s
95th percentile per-packet one-way delay: 116.406 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 429.26 Mbit/s
95th percentile per-packet one-way delay: 108.282 ms
Loss rate: 0.02%
-- Flow 2:
Average throughput: 388.45 Mbit/s
95th percentile per-packet one-way delay: 126.591 ms
Loss rate: 0.10%
-- Flow 3:
Average throughput: 235.75 Mbit/s
95th percentile per-packet one-way delay: 99.533 ms
Loss rate: 0.48%
```

Run 3: Report of Muses — Data Link