Pantheon Report

Generated at 2018-08-28 08:51:59 (UTC).

Data path: GCE Sydney 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.
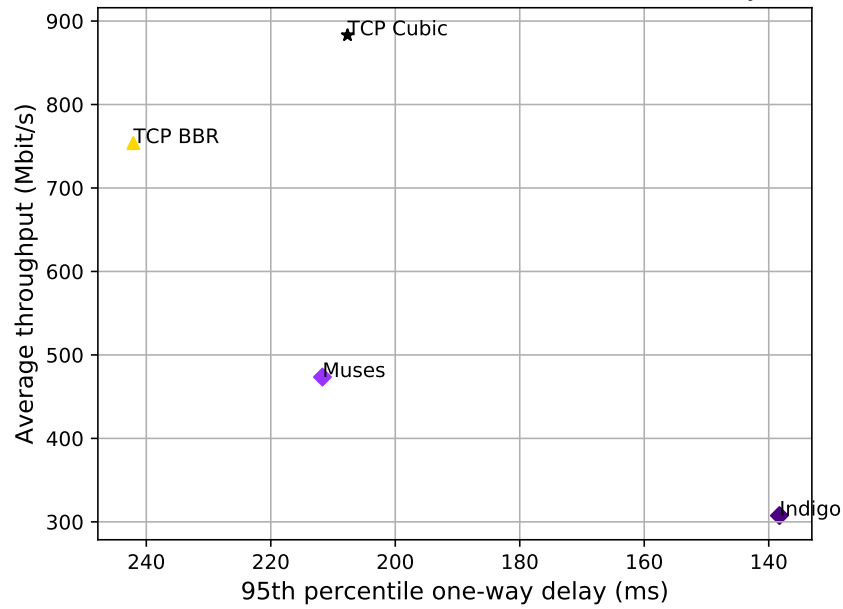
```
System info:
Linux 4.15.0-1015-gcp
net.core.default_qdisc = fq
net.core.rmem_default = 16777216
net.core.rmem_max = 536870912
net.core.wmem_default = 16777216
net.core.wmem_max = 536870912
net.ipv4.tcp_rmem = 4096 16777216 536870912
net.ipv4.tcp_wmem = 4096 16777216 536870912

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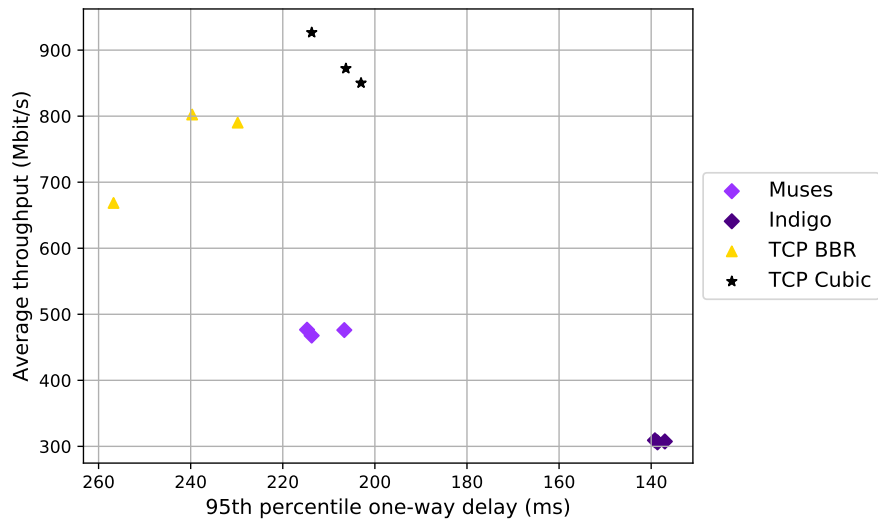
test from GCE Sydney to GCE London, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

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

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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	419.34	363.17	278.52	247.80	227.74	195.24	1.67	0.83	0.61
TCP Cubic	3	509.70	415.64	289.90	200.63	192.21	196.64	0.06	0.10	0.32
Indigo	3	177.32	130.78	136.60	137.83	138.80	140.82	0.00	0.00	0.00
Muses	3	352.09	181.68	3.55	213.16	190.38	136.10	2.56	0.38	0.05

```
Run 1: Statistics of TCP BBR

Start at: 2018-08-28 08:14:04
End at: 2018-08-28 08:14:34
Local clock offset: 0.18 ms
Remote clock offset: 0.04 ms


# Below is generated by plot.py at 2018-08-28 08:44:38
# Datalink statistics
-- Total of 3 flows:
Average throughput: 668.62 Mbit/s
95th percentile per-packet one-way delay: 256.752 ms
Loss rate: 2.15%
-- Flow 1:
Average throughput: 354.67 Mbit/s
95th percentile per-packet one-way delay: 265.581 ms
Loss rate: 3.10%
-- Flow 2:
Average throughput: 341.52 Mbit/s
95th percentile per-packet one-way delay: 238.487 ms
Loss rate: 1.34%
-- Flow 3:
Average throughput: 260.25 Mbit/s
95th percentile per-packet one-way delay: 160.155 ms
Loss rate: 0.30%
```
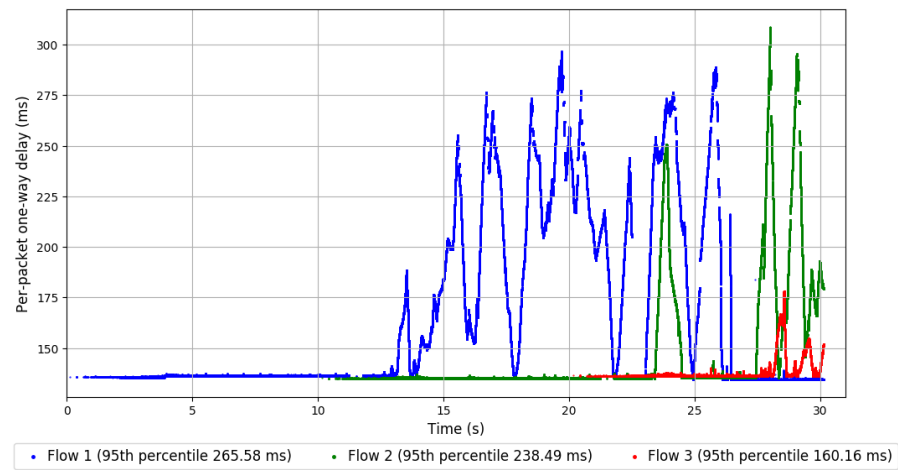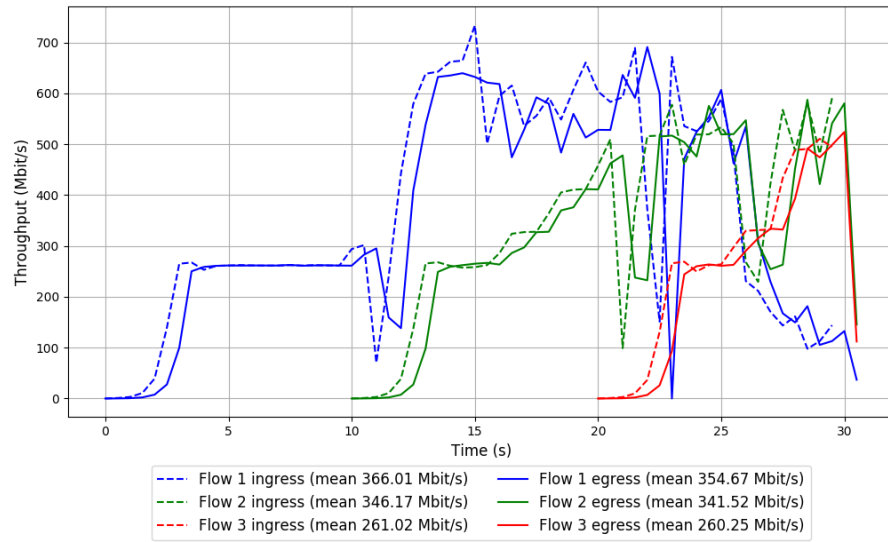
Run 1: Report of TCP BBR — Data Link

Flow 1 ingress (mean 366.01 Mbit/s) --- Flow 1 egress (mean 354.67 Mbit/s)
Flow 2 ingress (mean 346.17 Mbit/s) --- Flow 2 egress (mean 341.52 Mbit/s)
Flow 3 ingress (mean 261.02 Mbit/s) --- Flow 3 egress (mean 260.25 Mbit/s)

Flow 1 (95th percentile 265.58 ms)   Flow 2 (95th percentile 238.49 ms)   Flow 3 (95th percentile 160.16 ms)
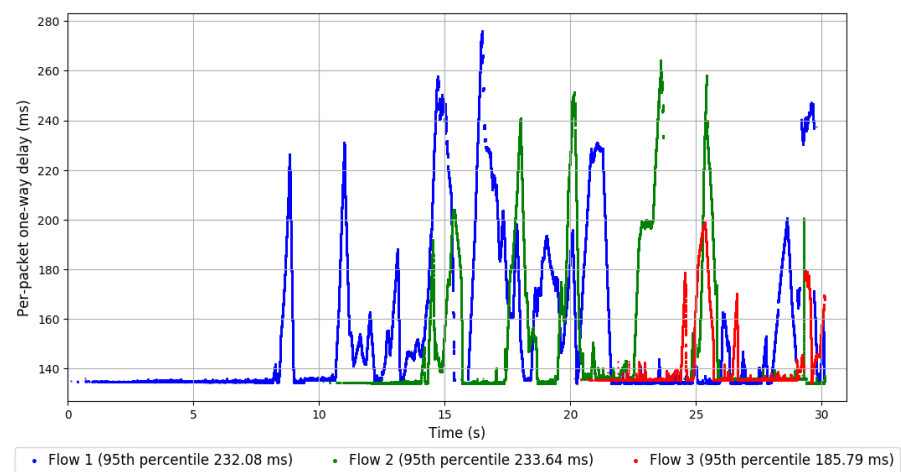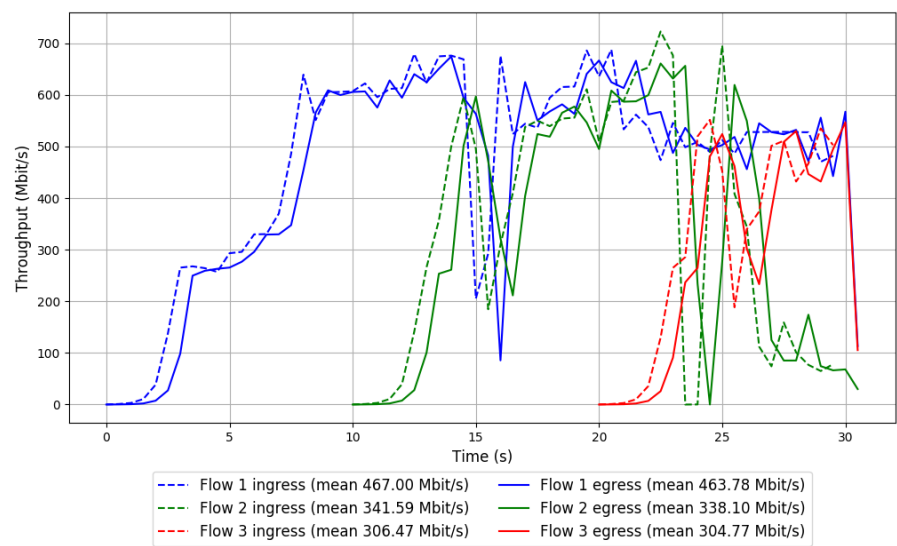
```
Run 2: Statistics of TCP BBR

Start at: 2018-08-28 08:21:49
End at: 2018-08-28 08:22:19
Local clock offset: -0.242 ms
Remote clock offset: -0.672 ms


# Below is generated by plot.py at 2018-08-28 08:46:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 790.21 Mbit/s
95th percentile per-packet one-way delay: 229.792 ms
Loss rate: 0.77%
-- Flow 1:
Average throughput: 463.78 Mbit/s
95th percentile per-packet one-way delay: 232.078 ms
Loss rate: 0.69%
-- Flow 2:
Average throughput: 338.10 Mbit/s
95th percentile per-packet one-way delay: 233.637 ms
Loss rate: 1.02%
-- Flow 3:
Average throughput: 304.77 Mbit/s
95th percentile per-packet one-way delay: 185.788 ms
Loss rate: 0.55%
```

Run 2: Report of TCP BBR — Data Link

```
Run 3: Statistics of TCP BBR

Start at: 2018-08-28 08:29:41
End at: 2018-08-28 08:30:11
Local clock offset: -0.197 ms
Remote clock offset: 0.03 ms


# Below is generated by plot.py at 2018-08-28 08:47:11
# Datalink statistics
-- Total of 3 flows:
Average throughput: 802.49 Mbit/s
95th percentile per-packet one-way delay: 239.684 ms
Loss rate: 0.82%
-- Flow 1:
Average throughput: 439.58 Mbit/s
95th percentile per-packet one-way delay: 245.753 ms
Loss rate: 1.22%
-- Flow 2:
Average throughput: 409.88 Mbit/s
95th percentile per-packet one-way delay: 211.109 ms
Loss rate: 0.13%
-- Flow 3:
Average throughput: 270.53 Mbit/s
95th percentile per-packet one-way delay: 239.784 ms
Loss rate: 0.97%
```
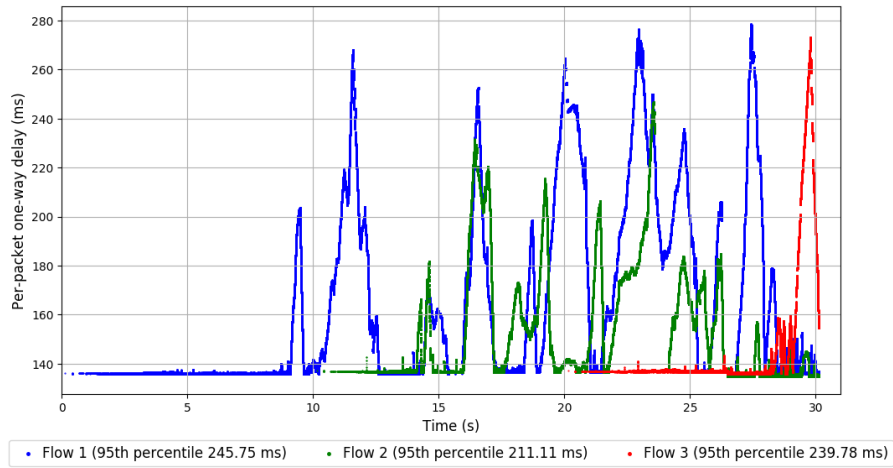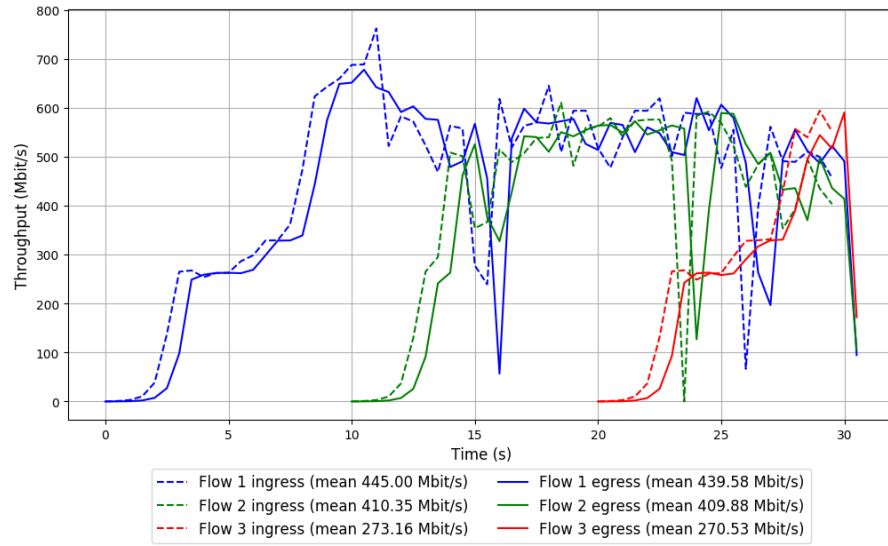
Run 3: Report of TCP BBR — Data Link

Flow 1 ingress (mean 445.00 Mbit/s)   Flow 1 egress (mean 439.58 Mbit/s)
Flow 2 ingress (mean 410.35 Mbit/s)   Flow 2 egress (mean 409.88 Mbit/s)
Flow 3 ingress (mean 273.16 Mbit/s)   Flow 3 egress (mean 270.53 Mbit/s)

Flow 1 (95th percentile 245.75 ms)   Flow 2 (95th percentile 211.11 ms)   Flow 3 (95th percentile 239.78 ms)

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```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-28 08:08:16
End at: 2018-08-28 08:08:46
Local clock offset: 0.097 ms
Remote clock offset: 0.387 ms


# Below is generated by plot.py at 2018-08-28 08:48:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 926.61 Mbit/s
95th percentile per-packet one-way delay: 213.717 ms
Loss rate: 0.08%
-- Flow 1:
Average throughput: 524.92 Mbit/s
95th percentile per-packet one-way delay: 191.782 ms
Loss rate: 0.08%
-- Flow 2:
Average throughput: 455.70 Mbit/s
95th percentile per-packet one-way delay: 228.687 ms
Loss rate: 0.12%
-- Flow 3:
Average throughput: 295.09 Mbit/s
95th percentile per-packet one-way delay: 205.096 ms
Loss rate: 0.00%
```
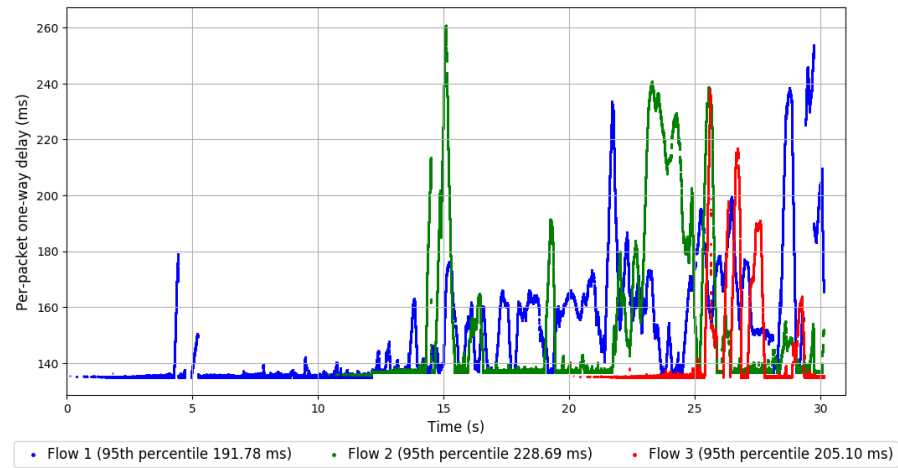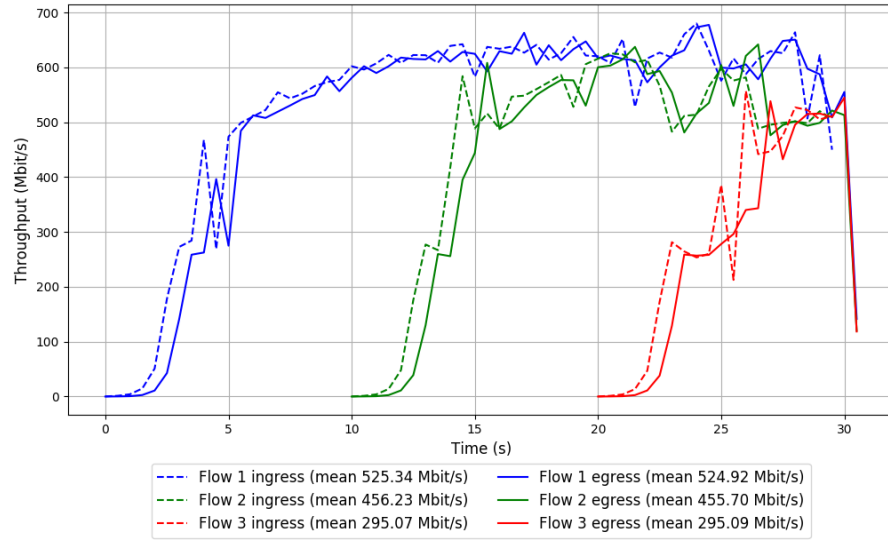
Run 1: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 525.34 Mbit/s) ---- Flow 1 egress (mean 524.92 Mbit/s) ——
Flow 2 ingress (mean 456.23 Mbit/s) ---- Flow 2 egress (mean 455.70 Mbit/s) ——
Flow 3 ingress (mean 295.07 Mbit/s) ---- Flow 3 egress (mean 295.09 Mbit/s) ——

• Flow 1 (95th percentile 191.78 ms)   • Flow 2 (95th percentile 228.69 ms)   • Flow 3 (95th percentile 205.10 ms)

```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-28 08:16:05
End at: 2018-08-28 08:16:35
Local clock offset: -0.037 ms
Remote clock offset: 0.521 ms


# Below is generated by plot.py at 2018-08-28 08:48:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 850.23 Mbit/s
95th percentile per-packet one-way delay: 203.005 ms
Loss rate: 0.12%
-- Flow 1:
Average throughput: 476.10 Mbit/s
95th percentile per-packet one-way delay: 202.674 ms
Loss rate: 0.04%
-- Flow 2:
Average throughput: 402.42 Mbit/s
95th percentile per-packet one-way delay: 147.271 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 319.17 Mbit/s
95th percentile per-packet one-way delay: 232.096 ms
Loss rate: 0.78%
```
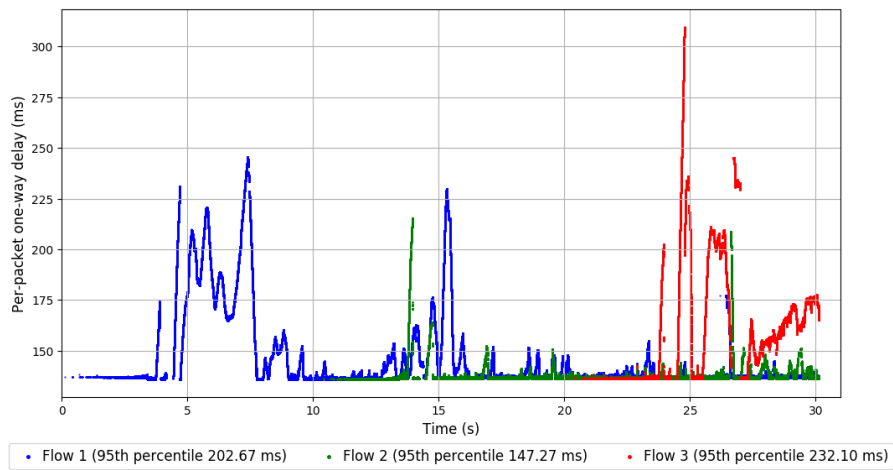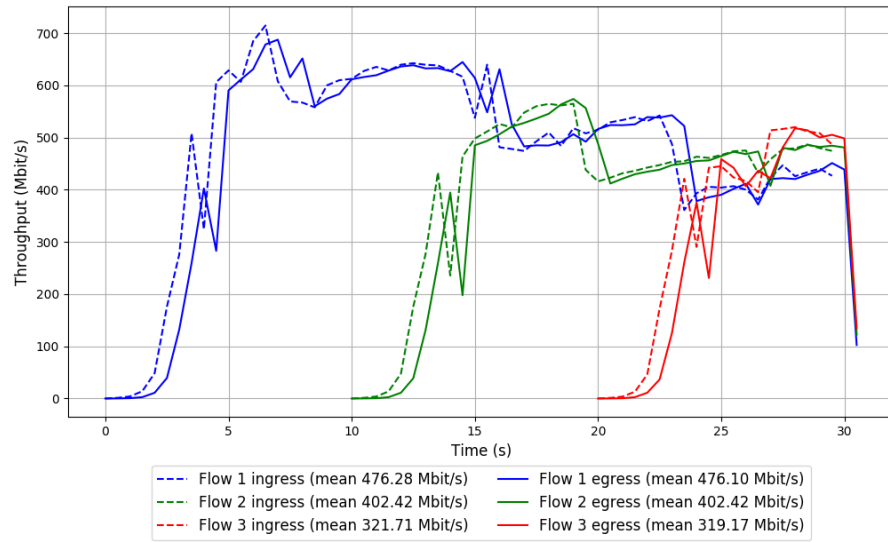
Run 2: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 476.28 Mbit/s) ----   Flow 1 egress (mean 476.10 Mbit/s)
Flow 2 ingress (mean 402.42 Mbit/s) ----   Flow 2 egress (mean 402.42 Mbit/s)
Flow 3 ingress (mean 321.71 Mbit/s) ----   Flow 3 egress (mean 319.17 Mbit/s)

Flow 1 (95th percentile 202.67 ms)   Flow 2 (95th percentile 147.27 ms)   Flow 3 (95th percentile 232.10 ms)

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```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-28 08:23:57
End at: 2018-08-28 08:24:27
Local clock offset: -0.033 ms
Remote clock offset: 0.044 ms


# Below is generated by plot.py at 2018-08-28 08:48:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 872.10 Mbit/s
95th percentile per-packet one-way delay: 206.296 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 528.09 Mbit/s
95th percentile per-packet one-way delay: 207.435 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 388.79 Mbit/s
95th percentile per-packet one-way delay: 200.674 ms
Loss rate: 0.19%
-- Flow 3:
Average throughput: 255.45 Mbit/s
95th percentile per-packet one-way delay: 152.731 ms
Loss rate: 0.19%
```
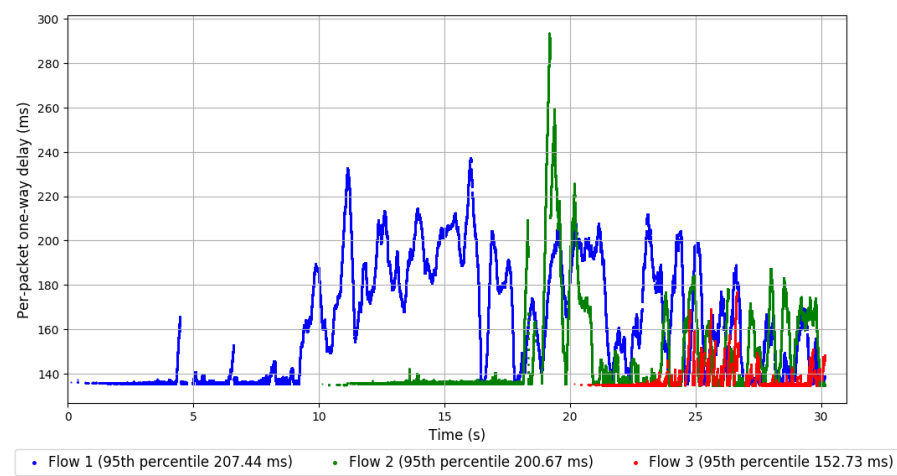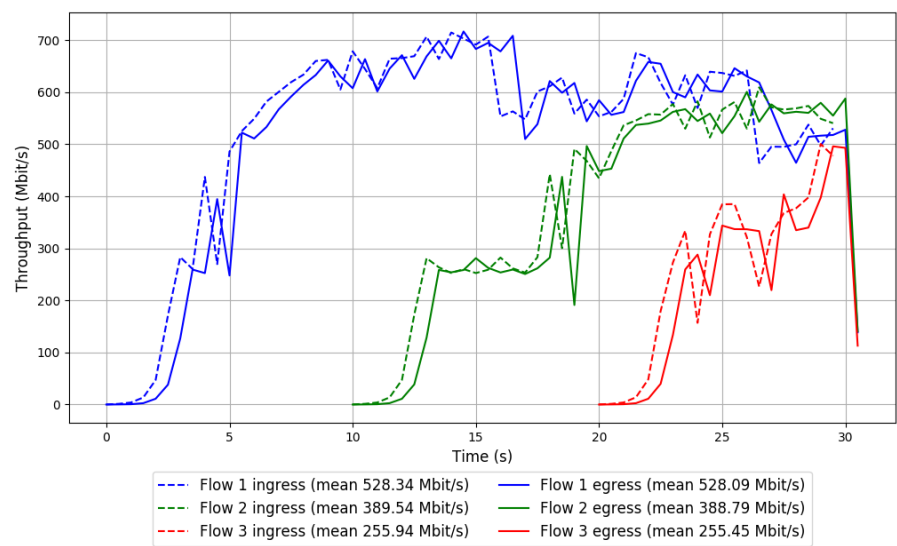
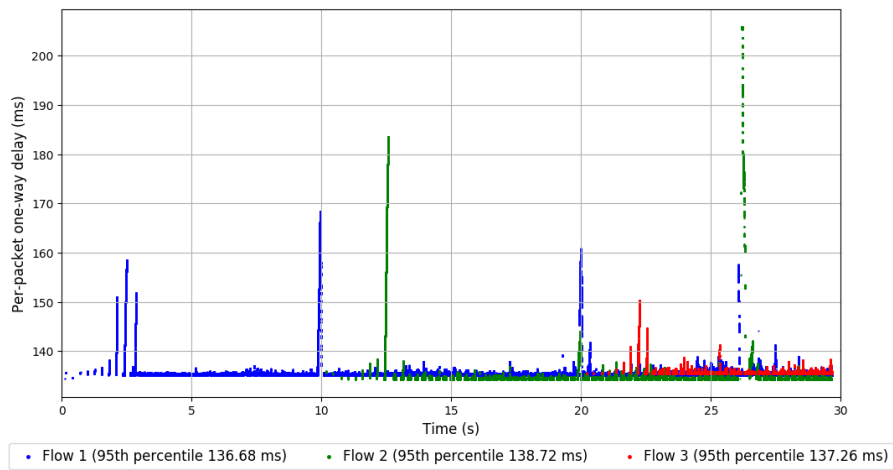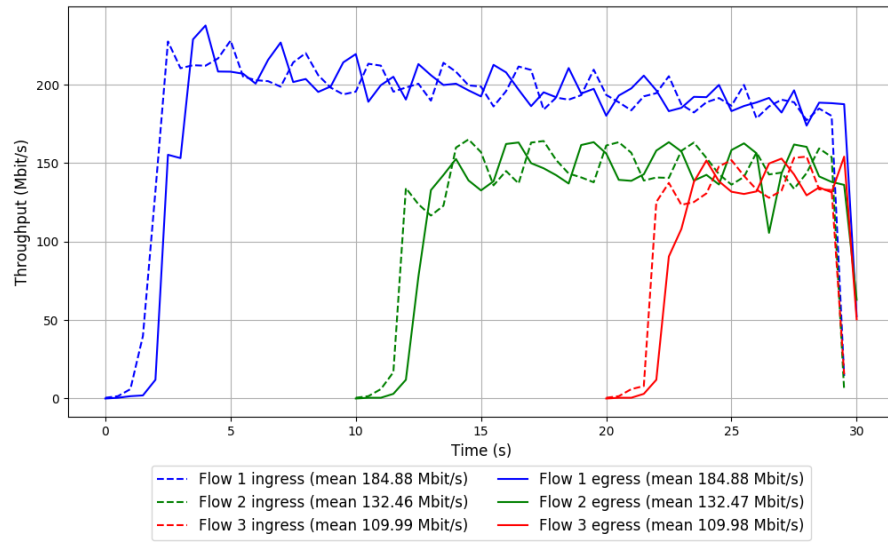Run 3: Report of TCP Cubic — Data Link

```
Run 1: Statistics of Indigo

Start at: 2018-08-28 08:10:27
End at: 2018-08-28 08:10:57
Local clock offset: -0.019 ms
Remote clock offset: -0.224 ms


# Below is generated by plot.py at 2018-08-28 08:48:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 307.43 Mbit/s
95th percentile per-packet one-way delay: 137.032 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 184.88 Mbit/s
95th percentile per-packet one-way delay: 136.679 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 132.47 Mbit/s
95th percentile per-packet one-way delay: 138.724 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 109.98 Mbit/s
95th percentile per-packet one-way delay: 137.261 ms
Loss rate: 0.00%
```
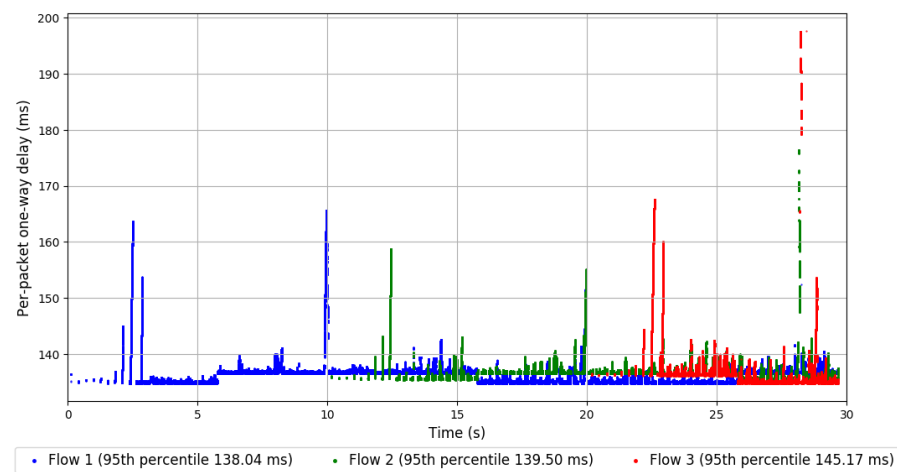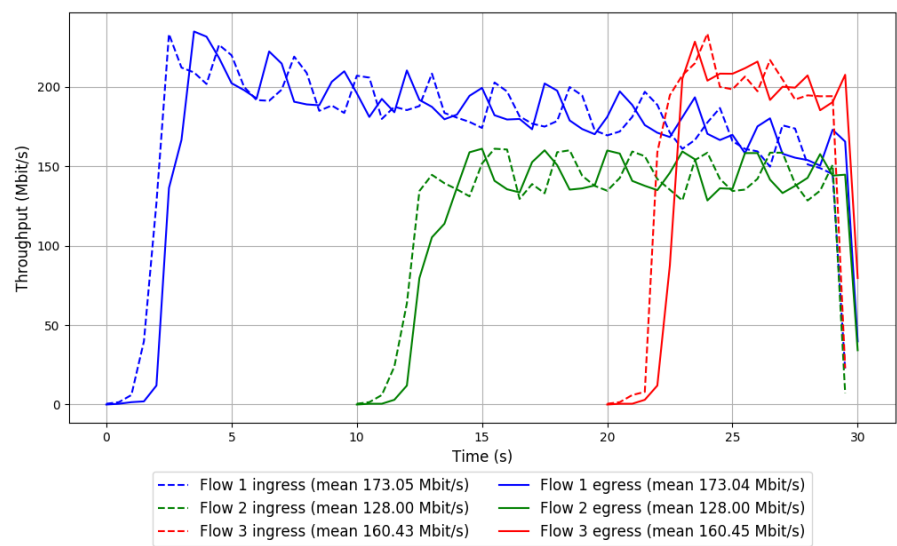
Run 1: Report of Indigo — Data Link

Flow 1 ingress (mean 184.88 Mbit/s) --- Flow 1 egress (mean 184.88 Mbit/s)
Flow 2 ingress (mean 132.46 Mbit/s) --- Flow 2 egress (mean 132.47 Mbit/s)
Flow 3 ingress (mean 109.99 Mbit/s) --- Flow 3 egress (mean 109.98 Mbit/s)

Flow 1 (95th percentile 136.68 ms)   Flow 2 (95th percentile 138.72 ms)   Flow 3 (95th percentile 137.26 ms)

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```
Run 2: Statistics of Indigo

Start at: 2018-08-28 08:18:12
End at: 2018-08-28 08:18:42
Local clock offset: -0.239 ms
Remote clock offset: -0.118 ms


# Below is generated by plot.py at 2018-08-28 08:48:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 309.16 Mbit/s
95th percentile per-packet one-way delay: 139.183 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 173.04 Mbit/s
95th percentile per-packet one-way delay: 138.043 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 128.00 Mbit/s
95th percentile per-packet one-way delay: 139.498 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 160.45 Mbit/s
95th percentile per-packet one-way delay: 145.169 ms
Loss rate: 0.00%
```

Run 2: Report of Indigo — Data Link

```
Run 3: Statistics of Indigo

Start at: 2018-08-28 08:26:05
End at: 2018-08-28 08:26:35
Local clock offset: -0.049 ms
Remote clock offset: 0.592 ms


# Below is generated by plot.py at 2018-08-28 08:50:30
# Datalink statistics
-- Total of 3 flows:
Average throughput: 306.04 Mbit/s
95th percentile per-packet one-way delay: 138.630 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 174.04 Mbit/s
95th percentile per-packet one-way delay: 138.758 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 131.87 Mbit/s
95th percentile per-packet one-way delay: 138.187 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 139.37 Mbit/s
95th percentile per-packet one-way delay: 140.029 ms
Loss rate: 0.00%
```
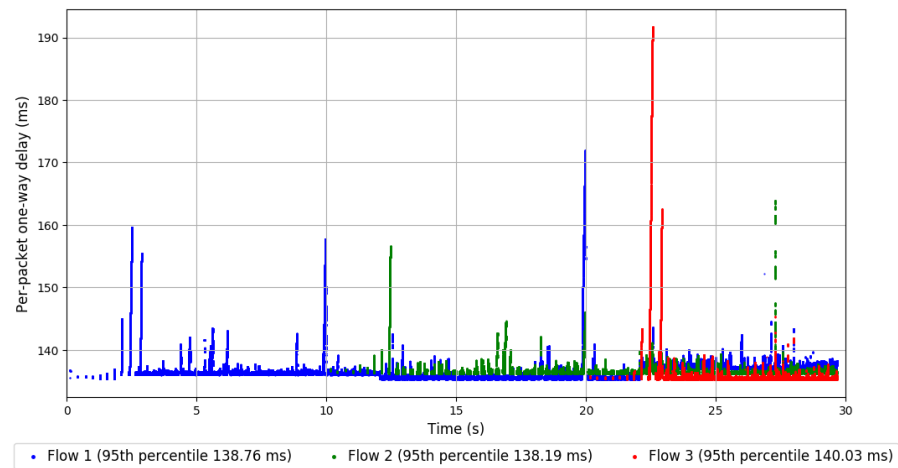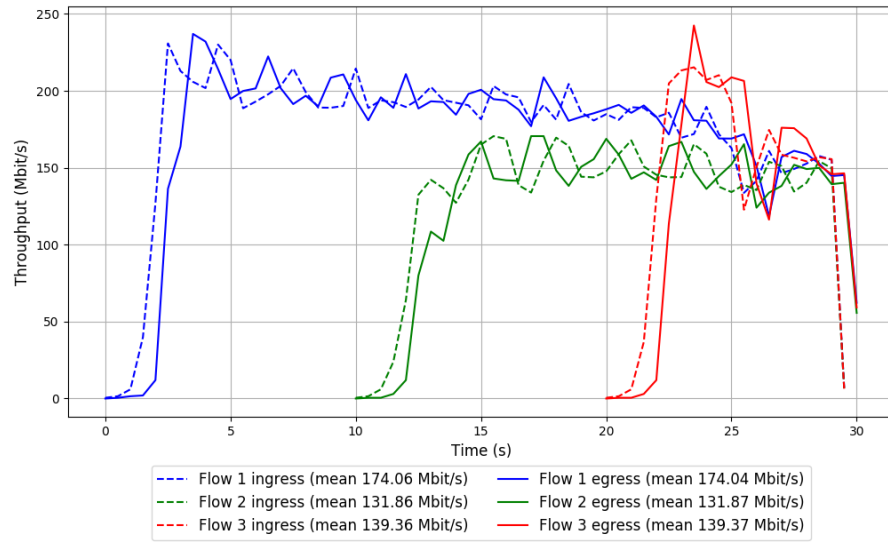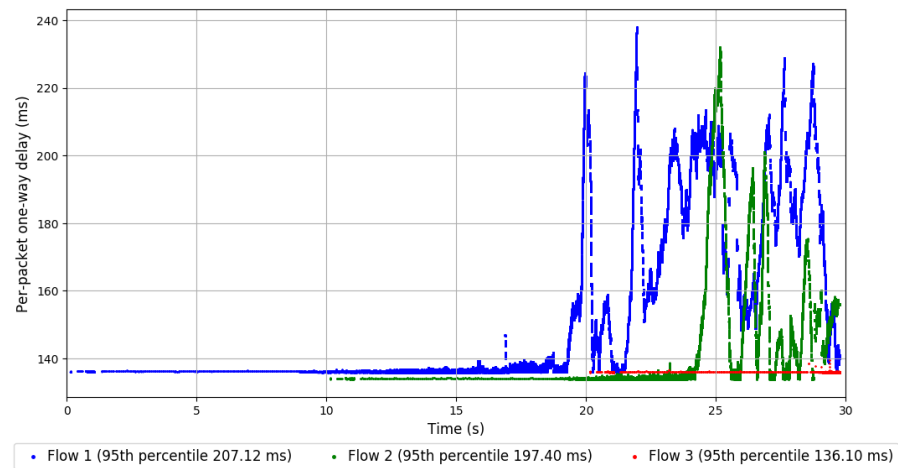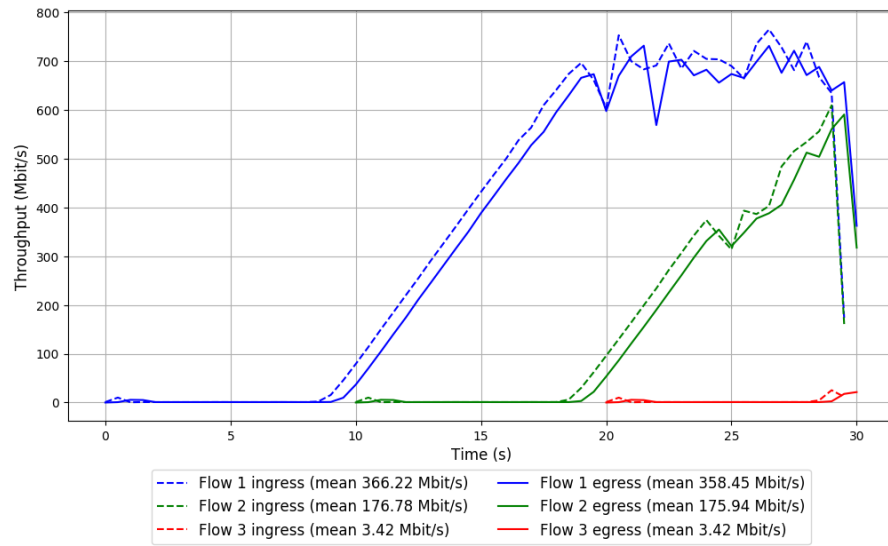
Run 3: Report of Indigo — Data Link

```
Run 1: Statistics of Muses

Start at: 2018-08-28 08:12:18
End at: 2018-08-28 08:12:48
Local clock offset: -0.071 ms
Remote clock offset: -0.496 ms


# Below is generated by plot.py at 2018-08-28 08:51:17
# Datalink statistics
-- Total of 3 flows:
Average throughput: 476.09 Mbit/s
95th percentile per-packet one-way delay: 206.636 ms
Loss rate: 1.72%
-- Flow 1:
Average throughput: 358.45 Mbit/s
95th percentile per-packet one-way delay: 207.116 ms
Loss rate: 2.13%
-- Flow 2:
Average throughput: 175.94 Mbit/s
95th percentile per-packet one-way delay: 197.395 ms
Loss rate: 0.48%
-- Flow 3:
Average throughput: 3.42 Mbit/s
95th percentile per-packet one-way delay: 136.104 ms
Loss rate: 0.12%
```
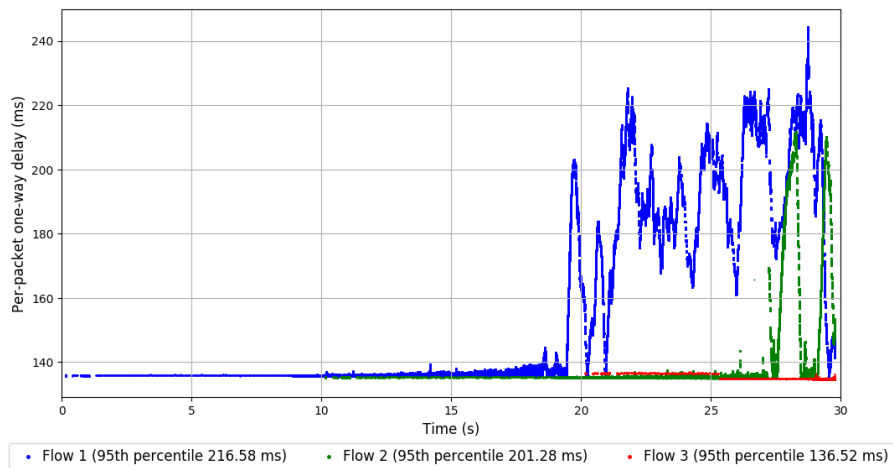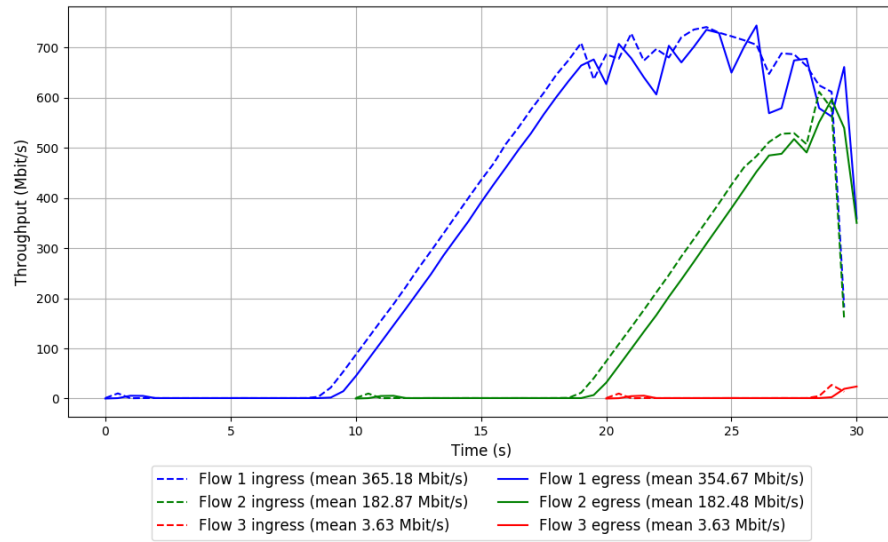
Run 1: Report of Muses — Data Link

```
Run 2: Statistics of Muses

Start at: 2018-08-28 08:20:02
End at: 2018-08-28 08:20:32
Local clock offset: -0.03 ms
Remote clock offset: -0.079 ms

# Below is generated by plot.py at 2018-08-28 08:51:50
# Datalink statistics
-- Total of 3 flows:
Average throughput: 476.64 Mbit/s
95th percentile per-packet one-way delay: 214.732 ms
Loss rate: 2.21%
-- Flow 1:
Average throughput: 354.67 Mbit/s
95th percentile per-packet one-way delay: 216.578 ms
Loss rate: 2.88%
-- Flow 2:
Average throughput: 182.48 Mbit/s
95th percentile per-packet one-way delay: 201.280 ms
Loss rate: 0.21%
-- Flow 3:
Average throughput: 3.63 Mbit/s
95th percentile per-packet one-way delay: 136.519 ms
Loss rate: 0.00%
```

Run 2: Report of Muses — Data Link

```
Run 3: Statistics of Muses

Start at: 2018-08-28 08:27:56
End at: 2018-08-28 08:28:26
Local clock offset: 0.005 ms
Remote clock offset: -0.12 ms


# Below is generated by plot.py at 2018-08-28 08:51:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 467.77 Mbit/s
95th percentile per-packet one-way delay: 213.724 ms
Loss rate: 2.08%
-- Flow 1:
Average throughput: 343.15 Mbit/s
95th percentile per-packet one-way delay: 215.788 ms
Loss rate: 2.66%
-- Flow 2:
Average throughput: 186.62 Mbit/s
95th percentile per-packet one-way delay: 172.468 ms
Loss rate: 0.44%
-- Flow 3:
Average throughput: 3.61 Mbit/s
95th percentile per-packet one-way delay: 135.662 ms
Loss rate: 0.03%
```

Run 3: Report of Muses — Data Link

Flow 1 ingress (mean 352.54 Mbit/s) --- Flow 1 egress (mean 343.15 Mbit/s)
Flow 2 ingress (mean 187.46 Mbit/s) --- Flow 2 egress (mean 186.62 Mbit/s)
Flow 3 ingress (mean 3.60 Mbit/s) --- Flow 3 egress (mean 3.61 Mbit/s)

Flow 1 (95th percentile 215.79 ms)   Flow 2 (95th percentile 172.47 ms)   Flow 3 (95th percentile 135.66 ms)

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