Pantheon Report

Generated at 2018-09-05 21:47:32 (UTC).

Data path: AWS India 2 on `ens5` (*local*) →Saudi Arabia on `enp2s0` (*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.

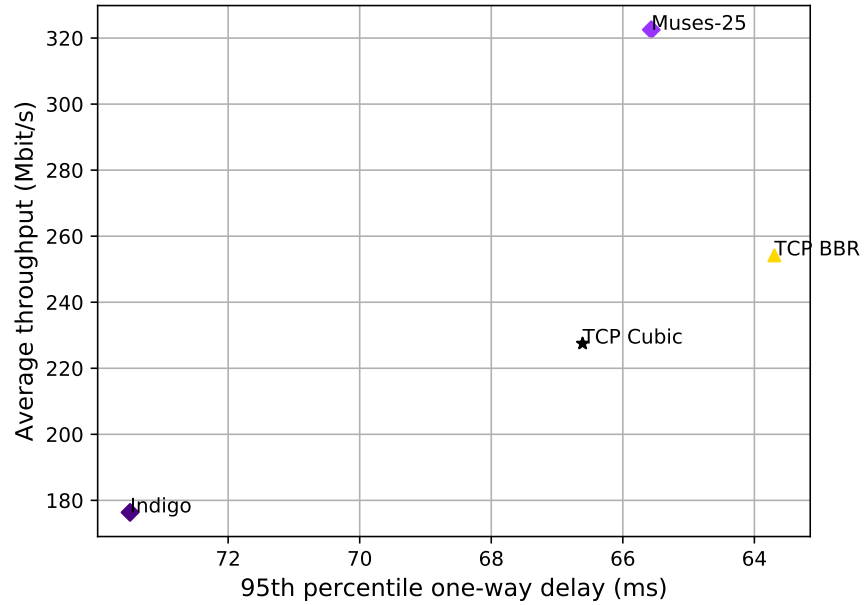NTP offsets were measured against `nets.org.sg` and have been applied to correct the timestamps in logs.

```
System info:
Linux 4.15.0-1020-aws
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
```
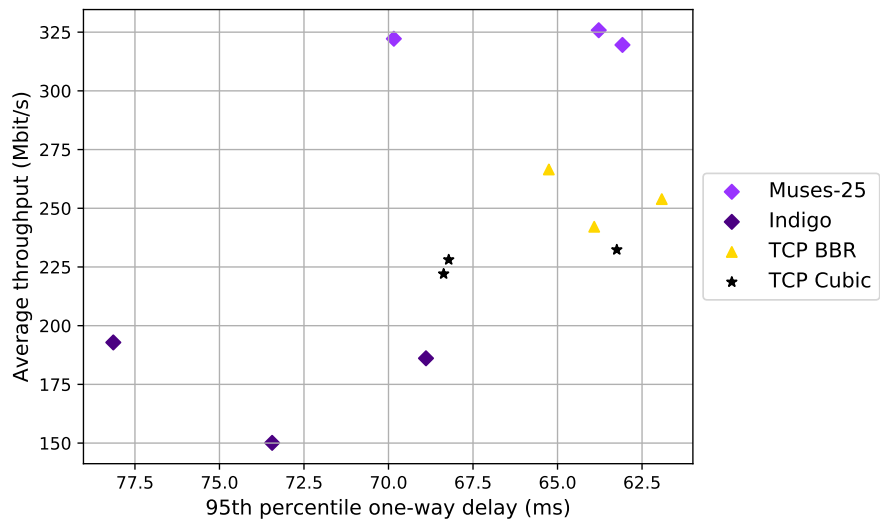
```
Git summary:
branch: muses @ 18b9165265c8ba2915c862e8713fd9ad82c1ac21
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ a28d20fb82a95a965a3da65fd1eb71b8994e9b84
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 AWS India 2 to Saudi Arabia, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

test from AWS India 2 to Saudi Arabia, 3 runs of 30s each per scheme
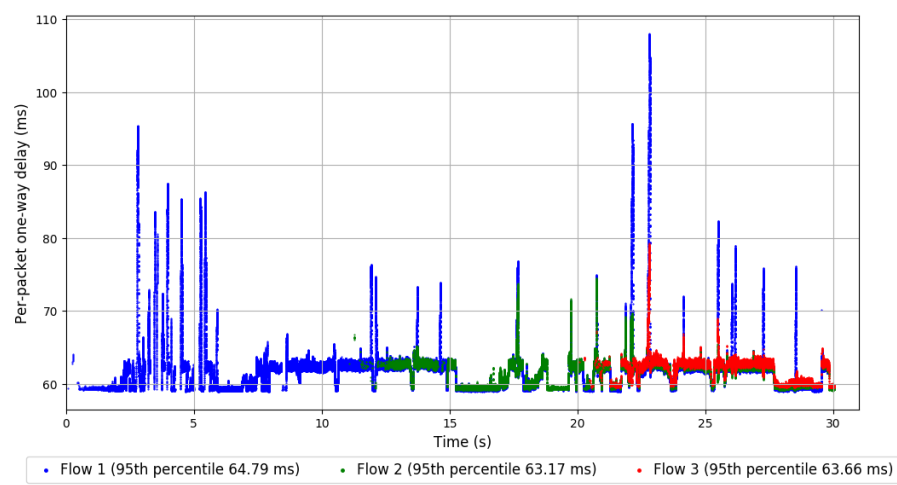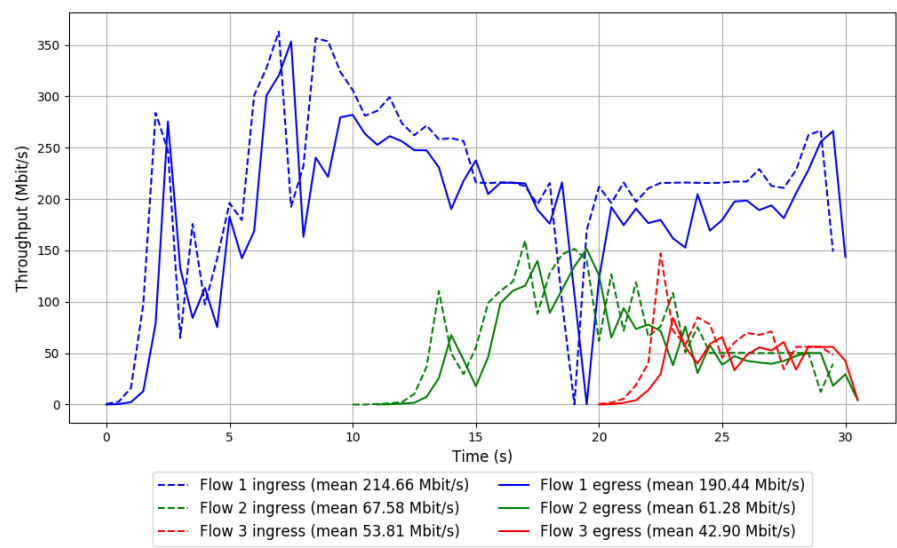### 3 flows with 10s interval between flows

2

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	197.66	60.08	53.11	64.69	62.34	62.42	11.25	16.00	20.71
TCP Cubic	3	156.09	65.52	83.42	66.92	65.15	66.95	1.23	0.97	1.35
Indigo	3	99.21	92.51	51.99	72.86	74.92	65.34	15.30	23.36	30.96
Muses-25	3	236.64	99.25	62.36	66.80	64.65	64.96	9.04	12.15	18.99

```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 21:26:22
End at: 2018-09-05 21:26:52
Local clock offset: -0.591 ms
Remote clock offset: -38.12 ms


# Below is generated by plot.py at 2018-09-05 21:46:04
# Datalink statistics
-- Total of 3 flows:
Average throughput: 242.13 Mbit/s
95th percentile per-packet one-way delay: 63.915 ms
Loss rate: 12.29%
-- Flow 1:
Average throughput: 190.44 Mbit/s
95th percentile per-packet one-way delay: 64.788 ms
Loss rate: 11.27%
-- Flow 2:
Average throughput: 61.28 Mbit/s
95th percentile per-packet one-way delay: 63.173 ms
Loss rate: 13.91%
-- Flow 3:
Average throughput: 42.90 Mbit/s
95th percentile per-packet one-way delay: 63.658 ms
Loss rate: 20.30%
```

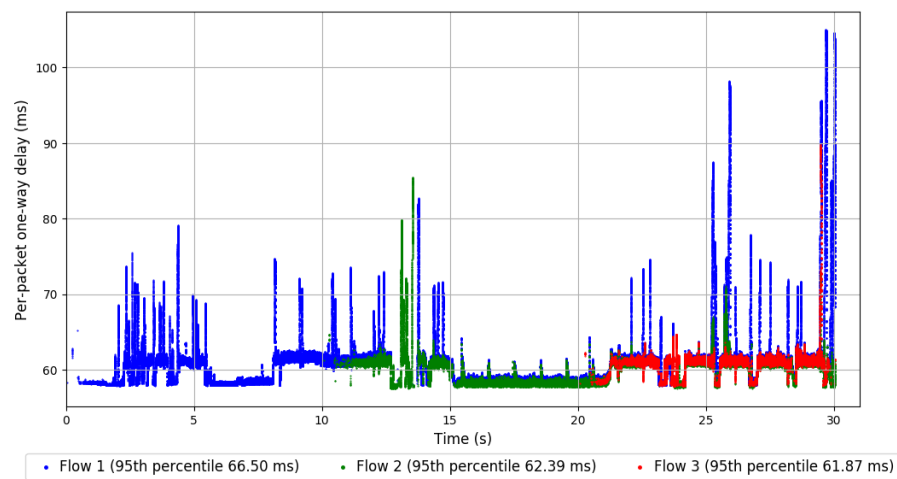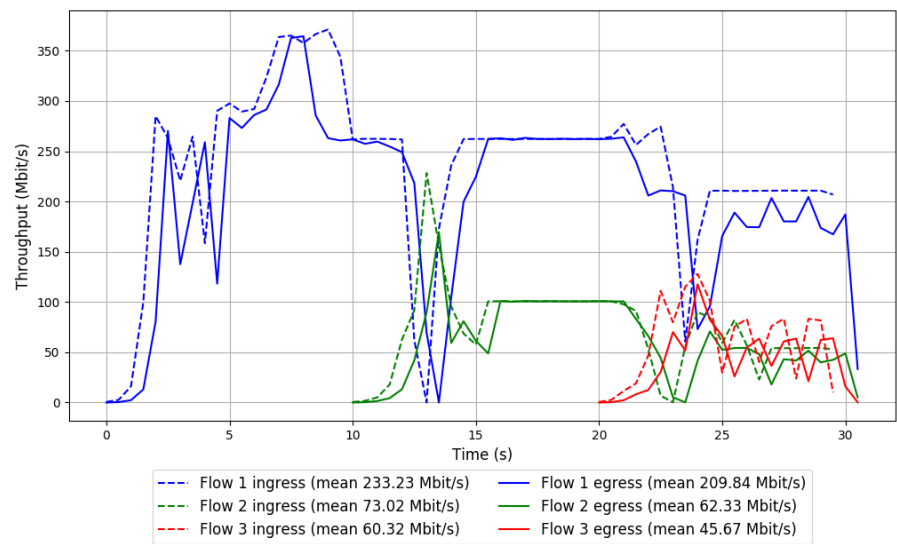Run 1: Report of TCP BBR — Data Link

```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 21:32:31
End at: 2018-09-05 21:33:01
Local clock offset: 1.532 ms
Remote clock offset: -37.244 ms


# Below is generated by plot.py at 2018-09-05 21:46:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 266.53 Mbit/s
95th percentile per-packet one-way delay: 65.257 ms
Loss rate: 11.71%
-- Flow 1:
Average throughput: 209.84 Mbit/s
95th percentile per-packet one-way delay: 66.505 ms
Loss rate: 10.01%
-- Flow 2:
Average throughput: 62.33 Mbit/s
95th percentile per-packet one-way delay: 62.388 ms
Loss rate: 14.66%
-- Flow 3:
Average throughput: 45.67 Mbit/s
95th percentile per-packet one-way delay: 61.868 ms
Loss rate: 24.28%
```

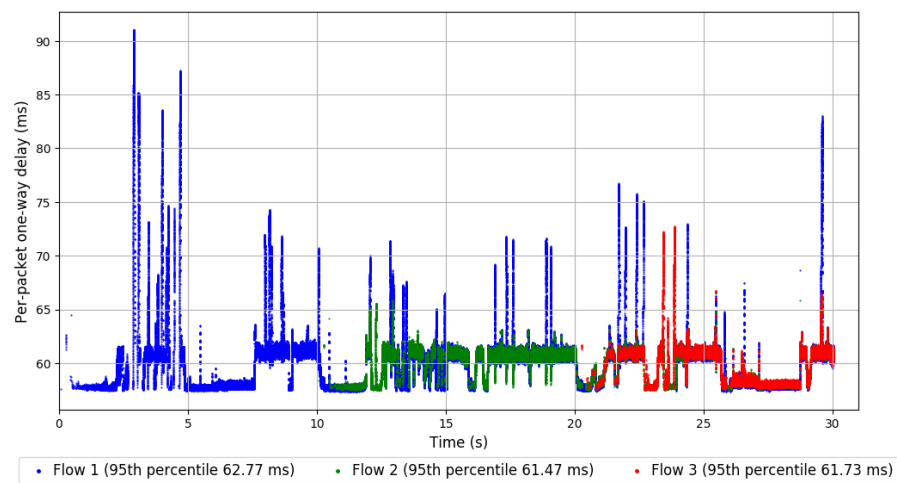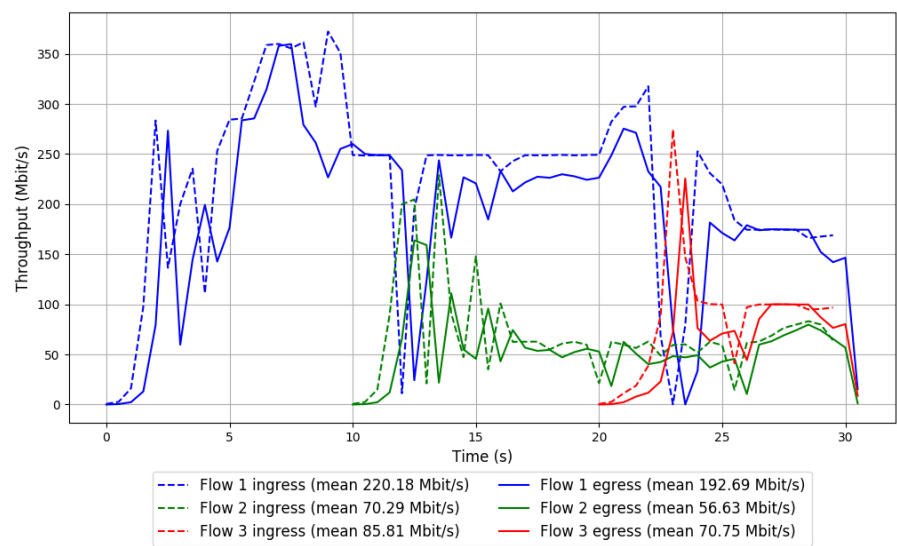Run 2: Report of TCP BBR — Data Link

```
Run 3: Statistics of TCP BBR

Start at: 2018-09-05 21:38:37
End at: 2018-09-05 21:39:07
Local clock offset: 1.696 ms
Remote clock offset: -37.337 ms


# Below is generated by plot.py at 2018-09-05 21:46:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 253.91 Mbit/s
95th percentile per-packet one-way delay: 61.916 ms
Loss rate: 14.07%
-- Flow 1:
Average throughput: 192.69 Mbit/s
95th percentile per-packet one-way delay: 62.771 ms
Loss rate: 12.48%
-- Flow 2:
Average throughput: 56.63 Mbit/s
95th percentile per-packet one-way delay: 61.472 ms
Loss rate: 19.43%
-- Flow 3:
Average throughput: 70.75 Mbit/s
95th percentile per-packet one-way delay: 61.734 ms
Loss rate: 17.54%
```

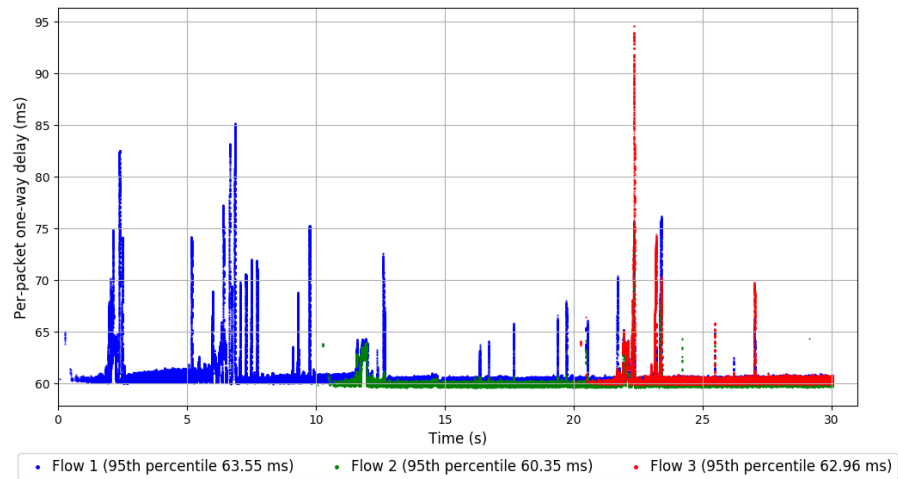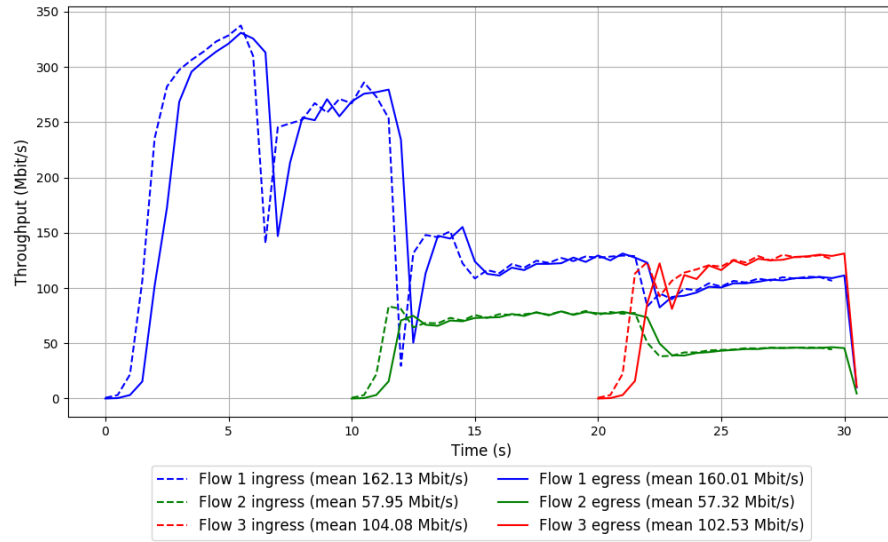Run 3: Report of TCP BBR — Data Link

9

```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 21:27:55
End at: 2018-09-05 21:28:25
Local clock offset: -0.818 ms
Remote clock offset: -39.92 ms


# Below is generated by plot.py at 2018-09-05 21:46:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 232.33 Mbit/s
95th percentile per-packet one-way delay: 63.247 ms
Loss rate: 1.30%
-- Flow 1:
Average throughput: 160.01 Mbit/s
95th percentile per-packet one-way delay: 63.555 ms
Loss rate: 1.31%
-- Flow 2:
Average throughput: 57.32 Mbit/s
95th percentile per-packet one-way delay: 60.354 ms
Loss rate: 1.09%
-- Flow 3:
Average throughput: 102.53 Mbit/s
95th percentile per-packet one-way delay: 62.964 ms
Loss rate: 1.48%
```

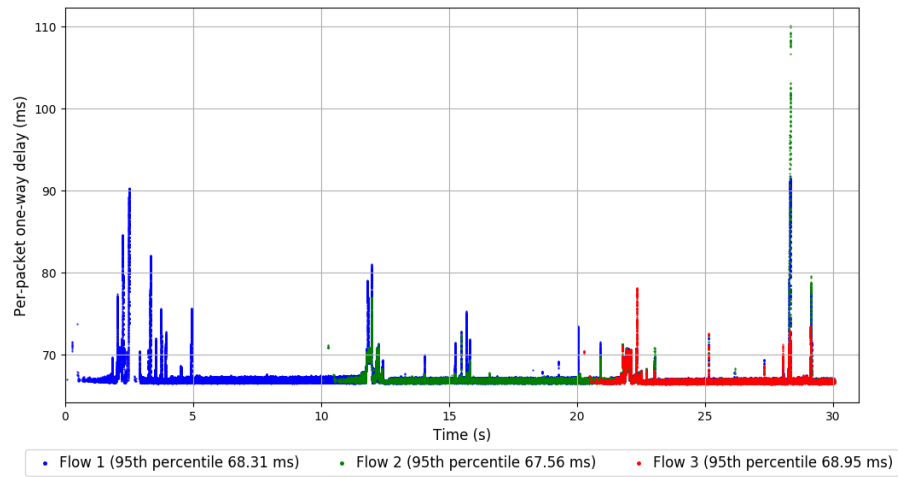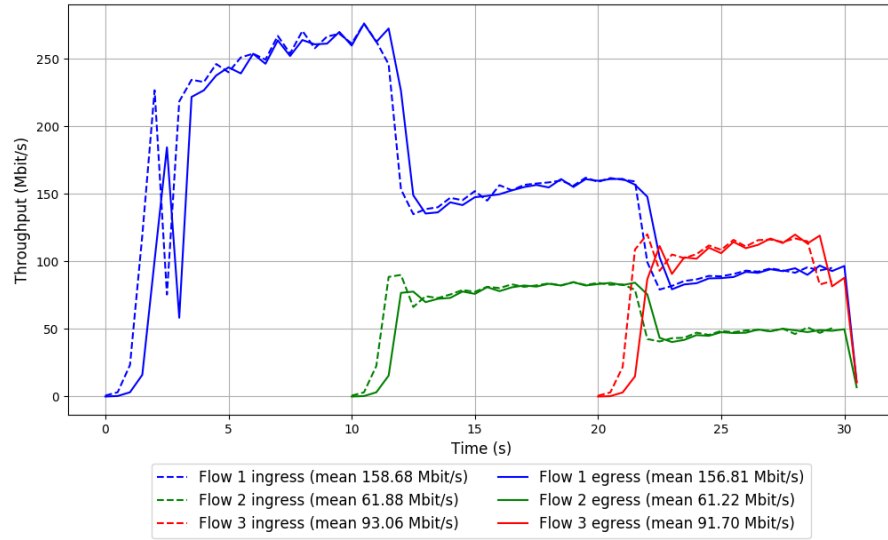Run 1: Report of TCP Cubic — Data Link

```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 21:34:05
End at: 2018-09-05 21:34:35
Local clock offset: -2.848 ms
Remote clock offset: -32.934 ms


# Below is generated by plot.py at 2018-09-05 21:46:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 228.08 Mbit/s
95th percentile per-packet one-way delay: 68.219 ms
Loss rate: 1.20%
-- Flow 1:
Average throughput: 156.81 Mbit/s
95th percentile per-packet one-way delay: 68.311 ms
Loss rate: 1.18%
-- Flow 2:
Average throughput: 61.22 Mbit/s
95th percentile per-packet one-way delay: 67.558 ms
Loss rate: 1.08%
-- Flow 3:
Average throughput: 91.70 Mbit/s
95th percentile per-packet one-way delay: 68.949 ms
Loss rate: 1.46%
```

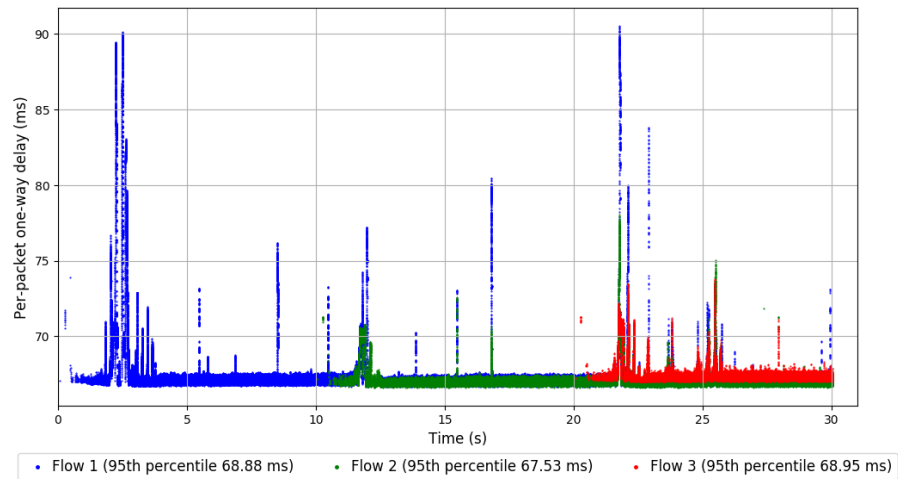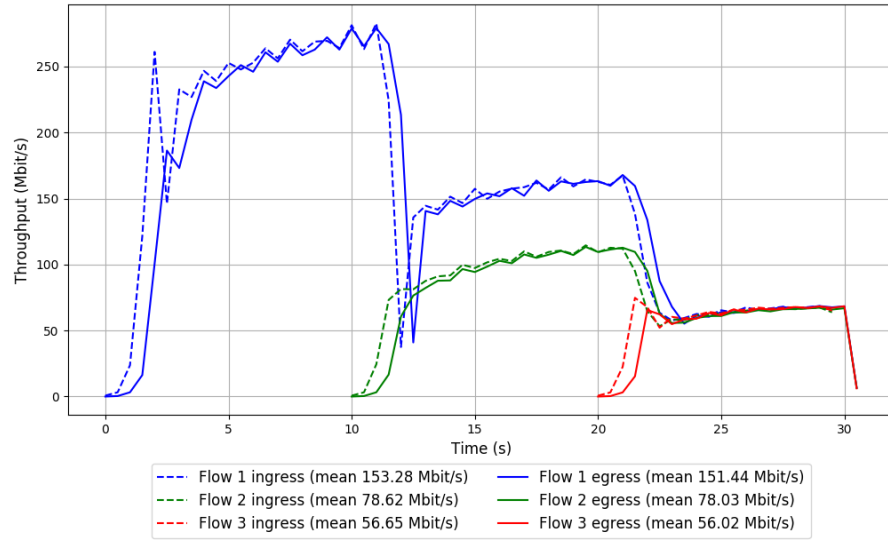Run 2: Report of TCP Cubic — Data Link

```
Run 3: Statistics of TCP Cubic

Start at: 2018-09-05 21:40:11
End at: 2018-09-05 21:40:41
Local clock offset: -3.203 ms
Remote clock offset: -32.982 ms

# Below is generated by plot.py at 2018-09-05 21:46:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 222.06 Mbit/s
95th percentile per-packet one-way delay: 68.369 ms
Loss rate: 1.09%
-- Flow 1:
Average throughput: 151.44 Mbit/s
95th percentile per-packet one-way delay: 68.880 ms
Loss rate: 1.20%
-- Flow 2:
Average throughput: 78.03 Mbit/s
95th percentile per-packet one-way delay: 67.534 ms
Loss rate: 0.75%
-- Flow 3:
Average throughput: 56.02 Mbit/s
95th percentile per-packet one-way delay: 68.949 ms
Loss rate: 1.10%
```

Run 3: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 153.28 Mbit/s) -- -- -- Flow 1 egress (mean 151.44 Mbit/s)
Flow 2 ingress (mean 78.62 Mbit/s) -- -- -- Flow 2 egress (mean 78.03 Mbit/s)
Flow 3 ingress (mean 56.65 Mbit/s) -- -- -- Flow 3 egress (mean 56.02 Mbit/s)

Flow 1 (95th percentile 68.88 ms) • Flow 2 (95th percentile 67.53 ms) • Flow 3 (95th percentile 68.95 ms)
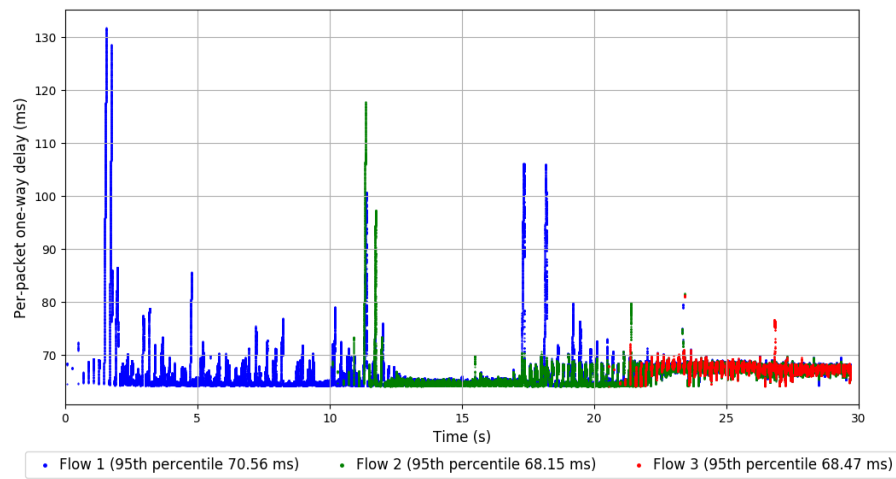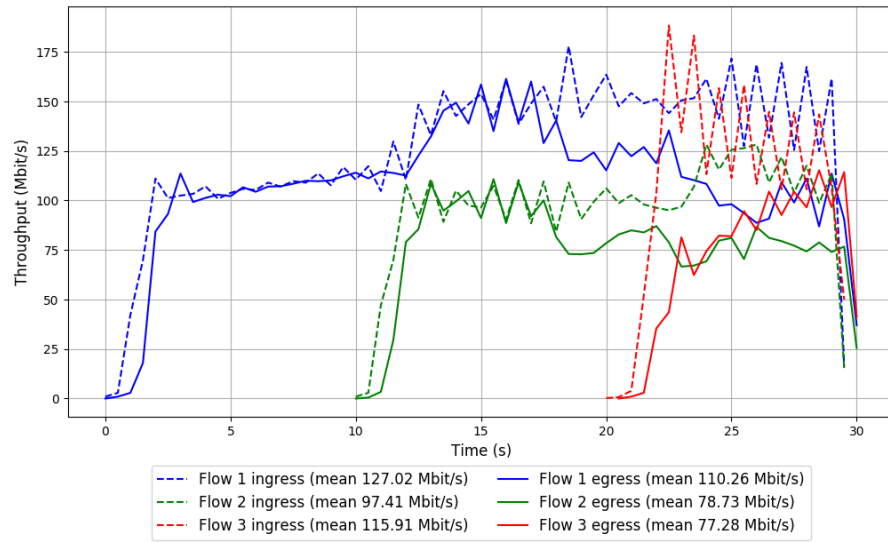
```
Run 1: Statistics of Indigo

Start at: 2018-09-05 21:24:51
End at: 2018-09-05 21:25:21
Local clock offset: -4.979 ms
Remote clock offset: -37.693 ms


# Below is generated by plot.py at 2018-09-05 21:46:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 186.11 Mbit/s
95th percentile per-packet one-way delay: 68.891 ms
Loss rate: 18.05%
-- Flow 1:
Average throughput: 110.26 Mbit/s
95th percentile per-packet one-way delay: 70.559 ms
Loss rate: 13.18%
-- Flow 2:
Average throughput: 78.73 Mbit/s
95th percentile per-packet one-way delay: 68.151 ms
Loss rate: 19.18%
-- Flow 3:
Average throughput: 77.28 Mbit/s
95th percentile per-packet one-way delay: 68.471 ms
Loss rate: 33.30%
```

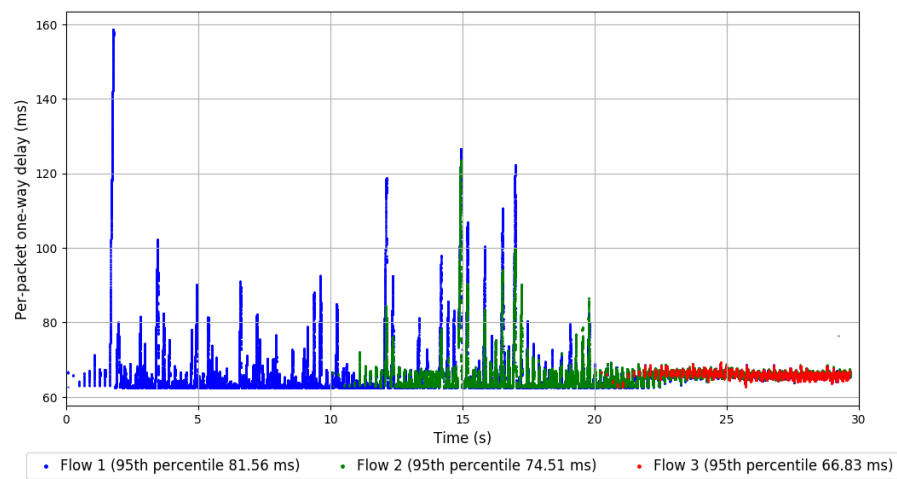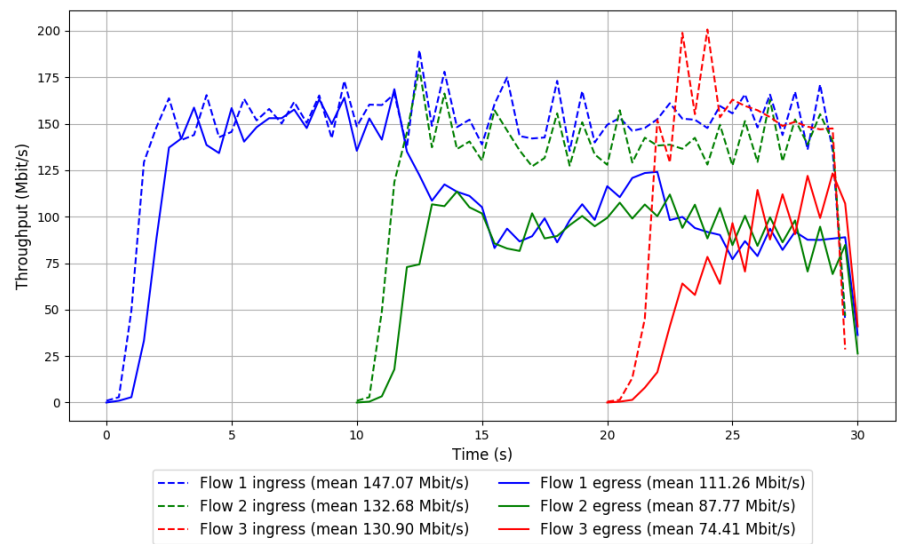Run 1: Report of Indigo — Data Link

```
Run 2: Statistics of Indigo

Start at: 2018-09-05 21:30:59
End at: 2018-09-05 21:31:29
Local clock offset: -4.214 ms
Remote clock offset: -38.171 ms


# Below is generated by plot.py at 2018-09-05 21:46:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 192.86 Mbit/s
95th percentile per-packet one-way delay: 78.140 ms
Loss rate: 30.17%
-- Flow 1:
Average throughput: 111.26 Mbit/s
95th percentile per-packet one-way delay: 81.557 ms
Loss rate: 24.34%
-- Flow 2:
Average throughput: 87.77 Mbit/s
95th percentile per-packet one-way delay: 74.513 ms
Loss rate: 33.84%
-- Flow 3:
Average throughput: 74.41 Mbit/s
95th percentile per-packet one-way delay: 66.829 ms
Loss rate: 43.13%
```

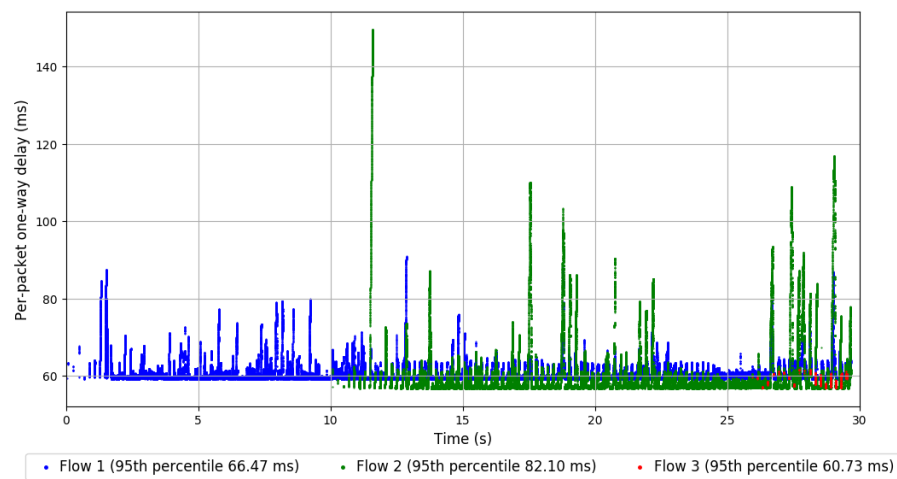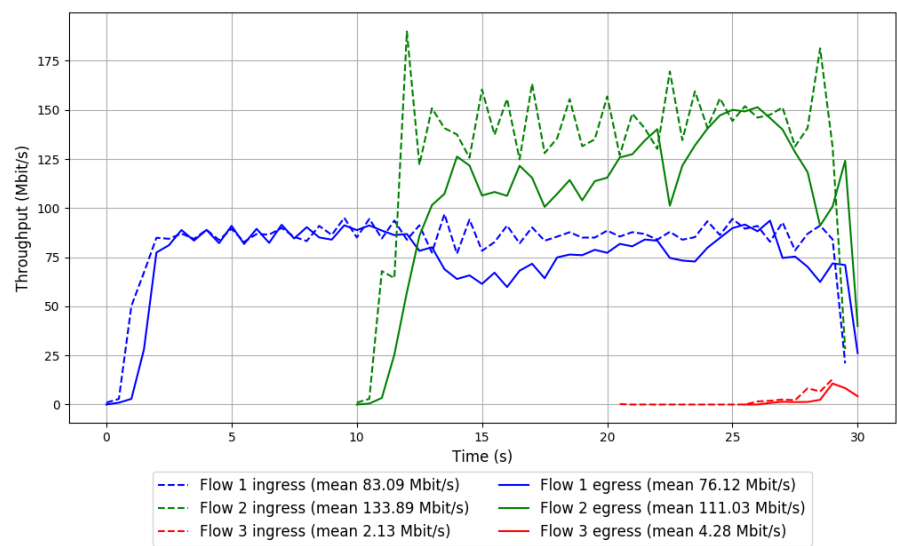Run 2: Report of Indigo — Data Link

```
Run 3: Statistics of Indigo

Start at: 2018-09-05 21:37:09
End at: 2018-09-05 21:37:39
Local clock offset: 0.285 ms
Remote clock offset: -39.492 ms

# Below is generated by plot.py at 2018-09-05 21:46:37
# Datalink statistics
-- Total of 3 flows:
Average throughput: 150.09 Mbit/s
95th percentile per-packet one-way delay: 73.442 ms
Loss rate: 12.87%
-- Flow 1:
Average throughput: 76.12 Mbit/s
95th percentile per-packet one-way delay: 66.466 ms
Loss rate: 8.38%
-- Flow 2:
Average throughput: 111.03 Mbit/s
95th percentile per-packet one-way delay: 82.102 ms
Loss rate: 17.06%
-- Flow 3:
Average throughput: 4.28 Mbit/s
95th percentile per-packet one-way delay: 60.731 ms
Loss rate: 16.44%
```

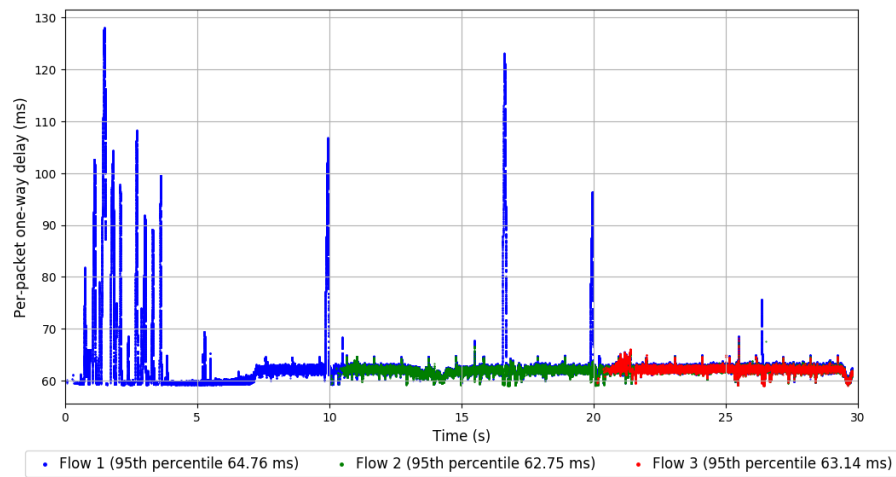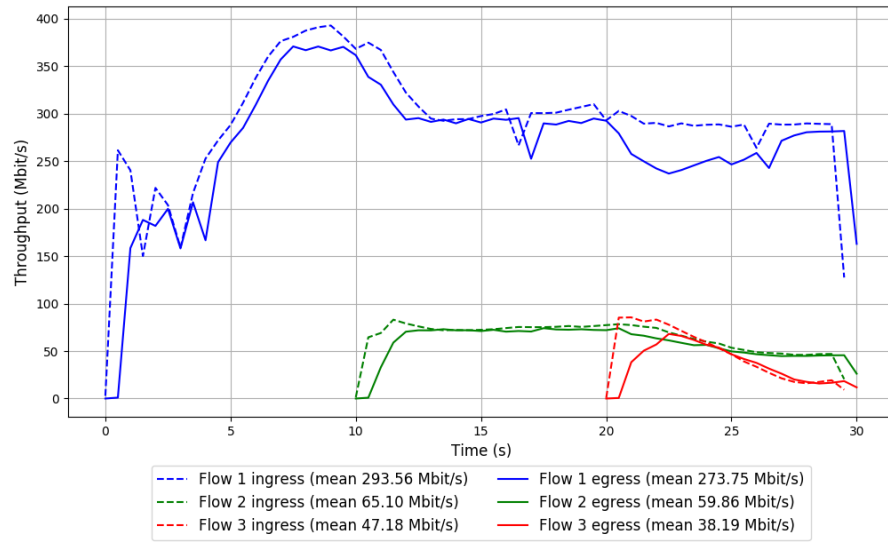Run 3: Report of Indigo — Data Link

```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 21:29:25
End at: 2018-09-05 21:29:55
Local clock offset: 0.105 ms
Remote clock offset: -37.347 ms

# Below is generated by plot.py at 2018-09-05 21:47:29
# Datalink statistics
-- Total of 3 flows:
Average throughput: 325.82 Mbit/s
95th percentile per-packet one-way delay: 63.781 ms
Loss rate: 7.43%
-- Flow 1:
Average throughput: 273.75 Mbit/s
95th percentile per-packet one-way delay: 64.764 ms
Loss rate: 6.74%
-- Flow 2:
Average throughput: 59.86 Mbit/s
95th percentile per-packet one-way delay: 62.753 ms
Loss rate: 8.03%
-- Flow 3:
Average throughput: 38.19 Mbit/s
95th percentile per-packet one-way delay: 63.143 ms
Loss rate: 19.03%
```

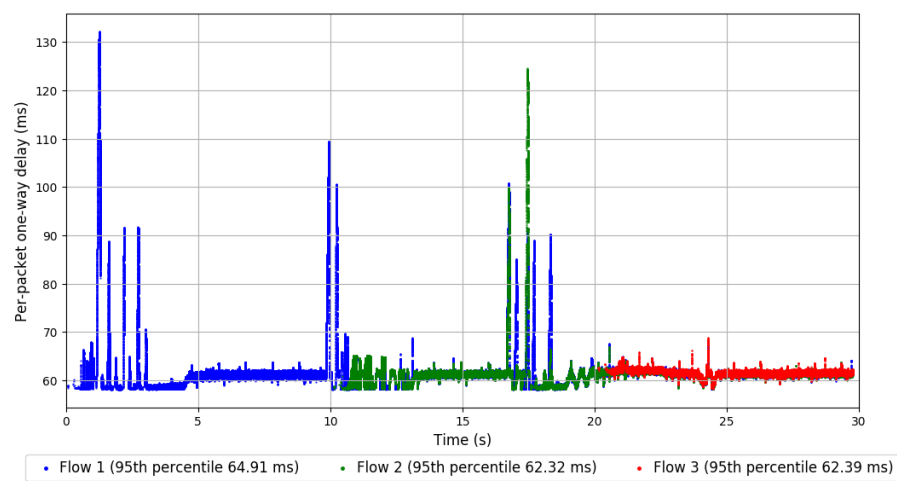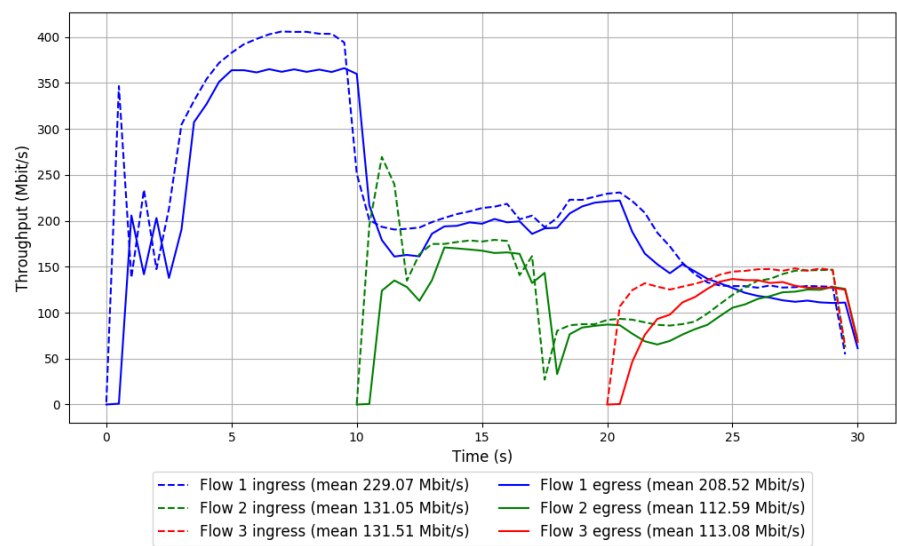Run 1: Report of Muses-25 — Data Link

```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 21:35:35
End at: 2018-09-05 21:36:05
Local clock offset: 0.087 ms
Remote clock offset: -38.331 ms

# Below is generated by plot.py at 2018-09-05 21:47:30
# Datalink statistics
-- Total of 3 flows:
Average throughput: 319.56 Mbit/s
95th percentile per-packet one-way delay: 63.079 ms
Loss rate: 10.80%
-- Flow 1:
Average throughput: 208.52 Mbit/s
95th percentile per-packet one-way delay: 64.911 ms
Loss rate: 8.96%
-- Flow 2:
Average throughput: 112.59 Mbit/s
95th percentile per-packet one-way delay: 62.317 ms
Loss rate: 14.07%
-- Flow 3:
Average throughput: 113.08 Mbit/s
95th percentile per-packet one-way delay: 62.392 ms
Loss rate: 14.07%
```

Run 2: Report of Muses-25 — Data Link

```
Run 3: Statistics of Muses-25

Start at: 2018-09-05 21:41:40
End at: 2018-09-05 21:42:10
Local clock offset: -3.315 ms
Remote clock offset: -34.8 ms

# Below is generated by plot.py at 2018-09-05 21:47:31
# Datalink statistics
-- Total of 3 flows:
Average throughput: 322.19 Mbit/s
95th percentile per-packet one-way delay: 69.842 ms
Loss rate: 12.69%
-- Flow 1:
Average throughput: 227.66 Mbit/s
95th percentile per-packet one-way delay: 70.718 ms
Loss rate: 11.41%
-- Flow 2:
Average throughput: 125.31 Mbit/s
95th percentile per-packet one-way delay: 68.895 ms
Loss rate: 14.34%
-- Flow 3:
Average throughput: 35.82 Mbit/s
95th percentile per-packet one-way delay: 69.344 ms
Loss rate: 23.86%
```

Run 3: Report of Muses-25 — Data Link