Pantheon Report

Generated at 2018-08-31 05:08:50 (UTC).

Data path: AWS California 1 on `ens5` (*local*) →Stanford on `eno1` (*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.stanford.edu` and have been applied to correct the timestamps in logs.
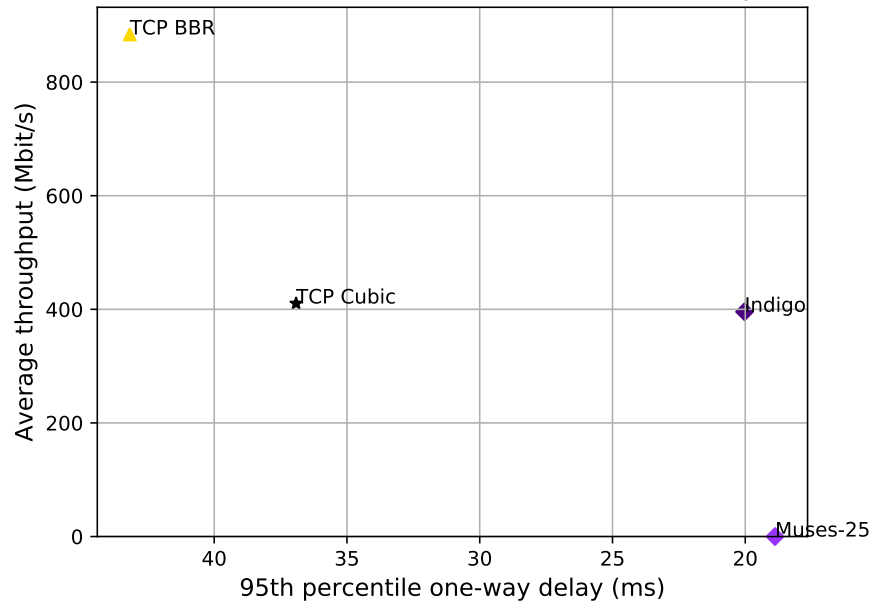
```
System info:
Linux 4.15.0-1020-aws
net.core.default_qdisc = fq
net.core.rmem_default = 16777216
net.core.rmem_max = 536870912
net.core.wmem_default = 16777216
net.core.wmem_max = 536870912
net.ipv4.tcp_rmem = 4096 16777216 536870912
net.ipv4.tcp_wmem = 4096 16777216 536870912
net.ipv4.tcp_mem = 536870912 536870912 536870912

Git summary:
branch: muses @ 2de97ca91a065473c29a25fffe63fb137c97a67c
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ b59e0d118c50af3579569c462d33045741c85981
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
```
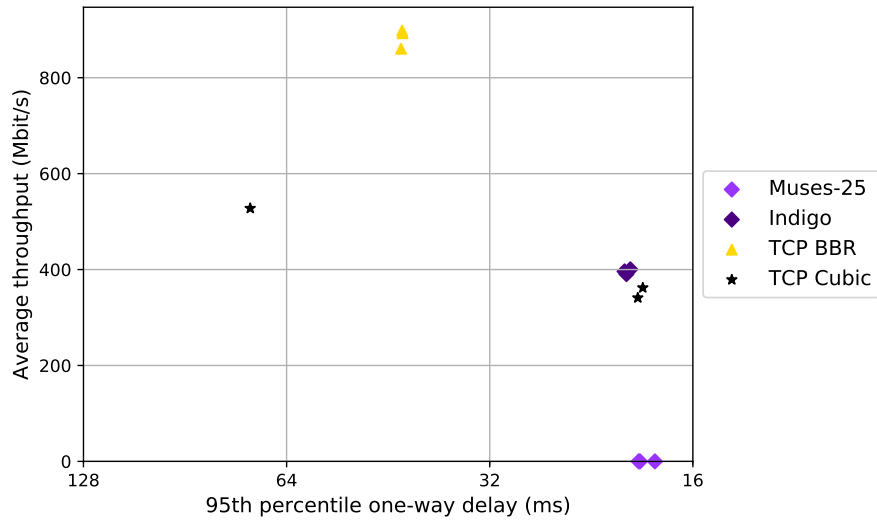
test from AWS California 1 to Stanford, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

test from AWS California 1 to Stanford, 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	480.63	406.30	398.37	45.95	33.71	23.53	6.48	10.55	10.95
TCP Cubic	3	212.34	209.67	174.99	40.23	18.59	19.35	0.06	0.05	0.04
Indigo	3	200.63	200.31	192.07	19.65	20.11	20.43	0.01	0.02	0.04
Muses-25	3	0.00	0.00	0.00	18.33	18.90	18.57	0.00	0.00	0.00

```
Run 1: Statistics of TCP BBR

Start at: 2018-08-31 04:43:12
End at: 2018-08-31 04:43:42
Local clock offset: 1.947 ms
Remote clock offset: 3.884 ms


# Below is generated by plot.py at 2018-08-31 05:08:41
# Datalink statistics
-- Total of 3 flows:
Average throughput: 860.45 Mbit/s
95th percentile per-packet one-way delay: 43.312 ms
Loss rate: 8.77%
-- Flow 1:
Average throughput: 454.91 Mbit/s
95th percentile per-packet one-way delay: 49.618 ms
Loss rate: 6.91%
-- Flow 2:
Average throughput: 370.84 Mbit/s
95th percentile per-packet one-way delay: 30.519 ms
Loss rate: 11.77%
-- Flow 3:
Average throughput: 477.11 Mbit/s
95th percentile per-packet one-way delay: 28.088 ms
Loss rate: 9.18%
```
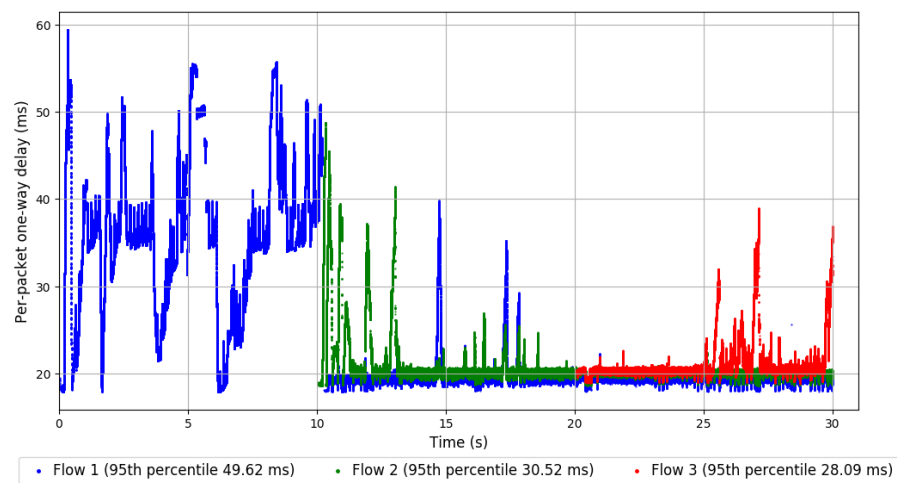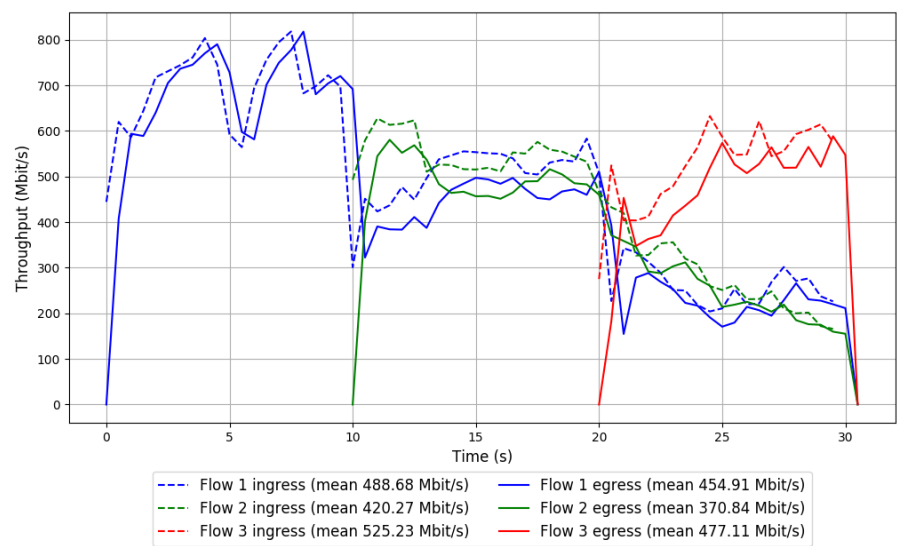
Run 1: Report of TCP BBR — Data Link

```
Run 2: Statistics of TCP BBR

Start at: 2018-08-31 04:49:36
End at: 2018-08-31 04:50:06
Local clock offset: 2.055 ms
Remote clock offset: 4.423 ms


# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 892.72 Mbit/s
95th percentile per-packet one-way delay: 43.076 ms
Loss rate: 8.00%
-- Flow 1:
Average throughput: 483.67 Mbit/s
95th percentile per-packet one-way delay: 43.982 ms
Loss rate: 6.34%
-- Flow 2:
Average throughput: 406.31 Mbit/s
95th percentile per-packet one-way delay: 37.908 ms
Loss rate: 9.64%
-- Flow 3:
Average throughput: 415.41 Mbit/s
95th percentile per-packet one-way delay: 22.555 ms
Loss rate: 10.40%
```
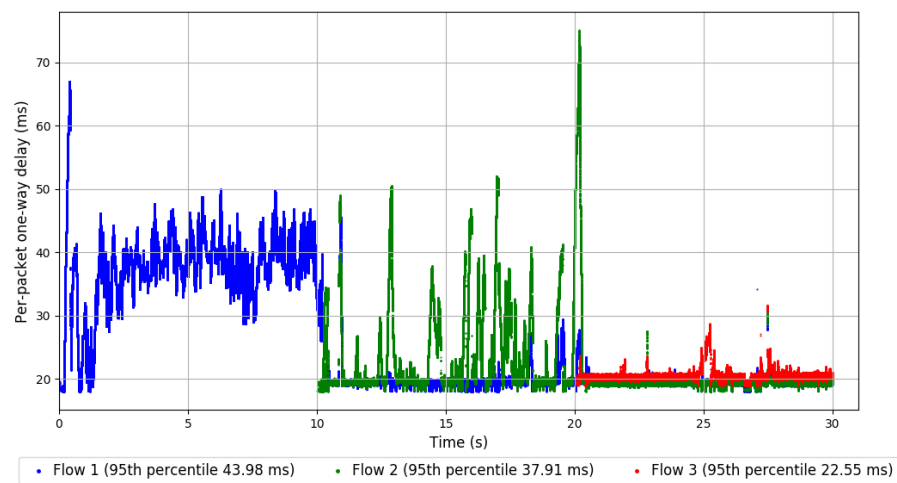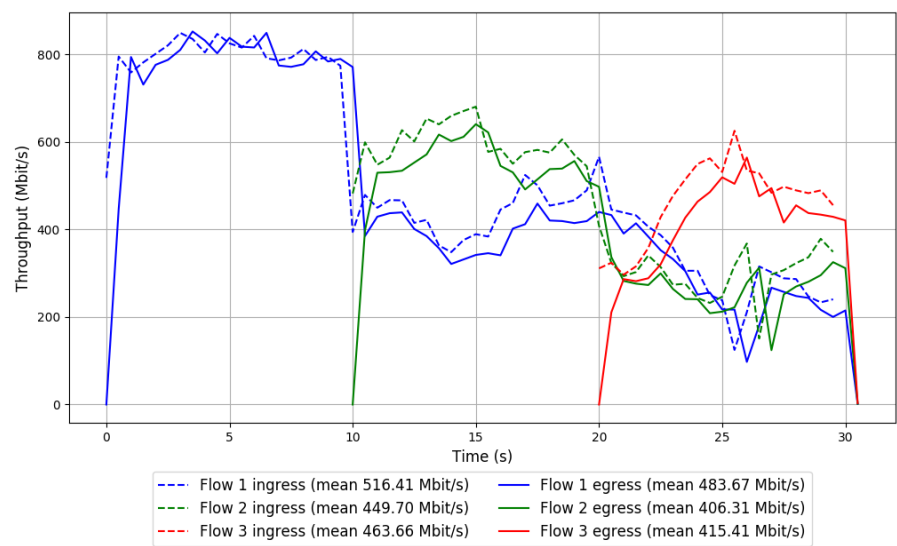
Run 2: Report of TCP BBR — Data Link

```
Run 3: Statistics of TCP BBR

Start at: 2018-08-31 04:55:55
End at: 2018-08-31 04:56:25
Local clock offset: 2.129 ms
Remote clock offset: 4.333 ms


# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 898.26 Mbit/s
95th percentile per-packet one-way delay: 43.151 ms
Loss rate: 8.39%
-- Flow 1:
Average throughput: 503.30 Mbit/s
95th percentile per-packet one-way delay: 44.257 ms
Loss rate: 6.20%
-- Flow 2:
Average throughput: 441.76 Mbit/s
95th percentile per-packet one-way delay: 32.711 ms
Loss rate: 10.24%
-- Flow 3:
Average throughput: 302.59 Mbit/s
95th percentile per-packet one-way delay: 19.940 ms
Loss rate: 13.26%
```
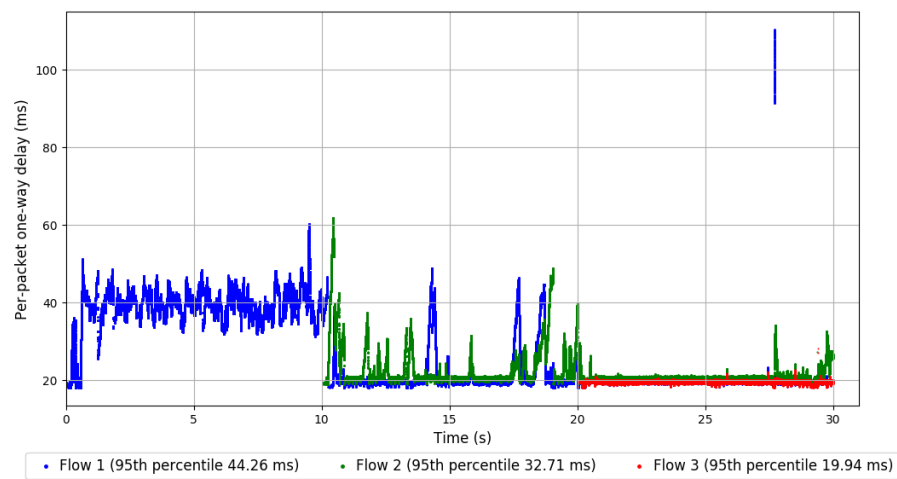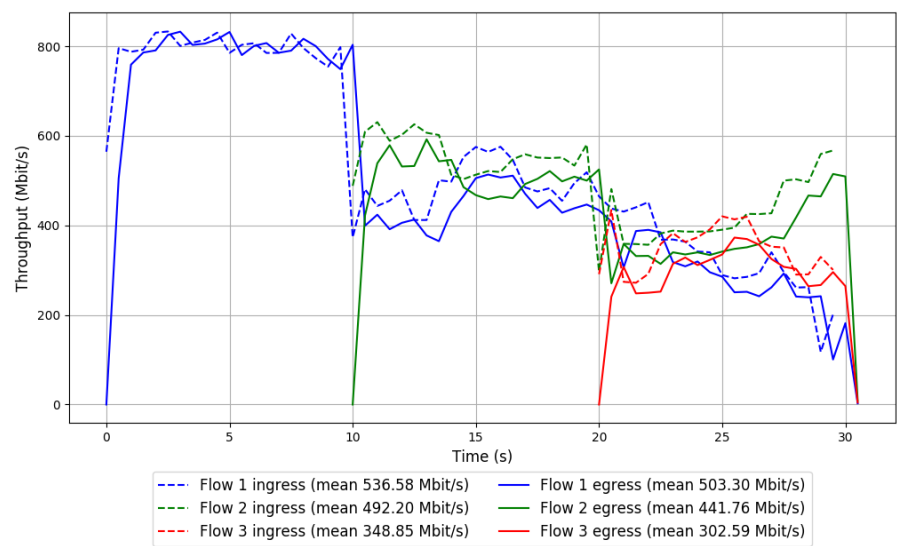
Run 3: Report of TCP BBR — Data Link

```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-31 04:45:06
End at: 2018-08-31 04:45:36
Local clock offset: 2.065 ms
Remote clock offset: 4.022 ms


# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 527.66 Mbit/s
95th percentile per-packet one-way delay: 72.458 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 327.62 Mbit/s
95th percentile per-packet one-way delay: 83.702 ms
Loss rate: 0.13%
-- Flow 2:
Average throughput: 168.65 Mbit/s
95th percentile per-packet one-way delay: 18.590 ms
Loss rate: 0.03%
-- Flow 3:
Average throughput: 263.37 Mbit/s
95th percentile per-packet one-way delay: 19.396 ms
Loss rate: 0.08%
```
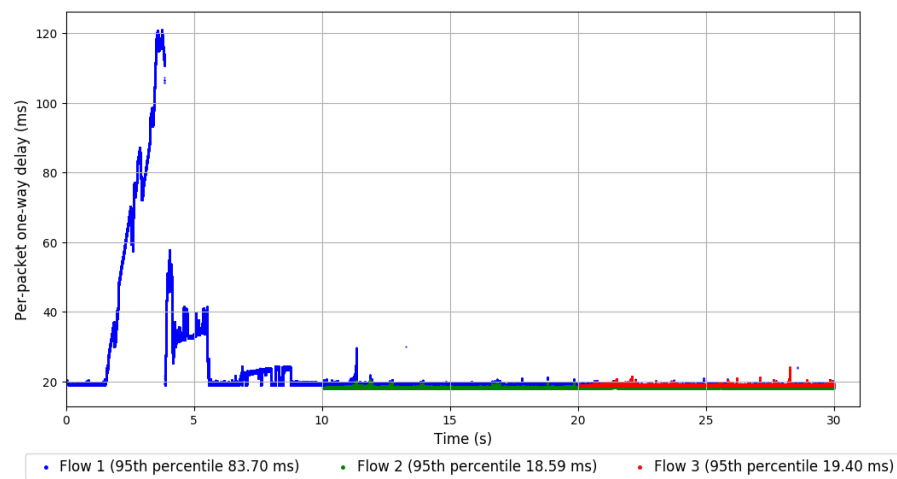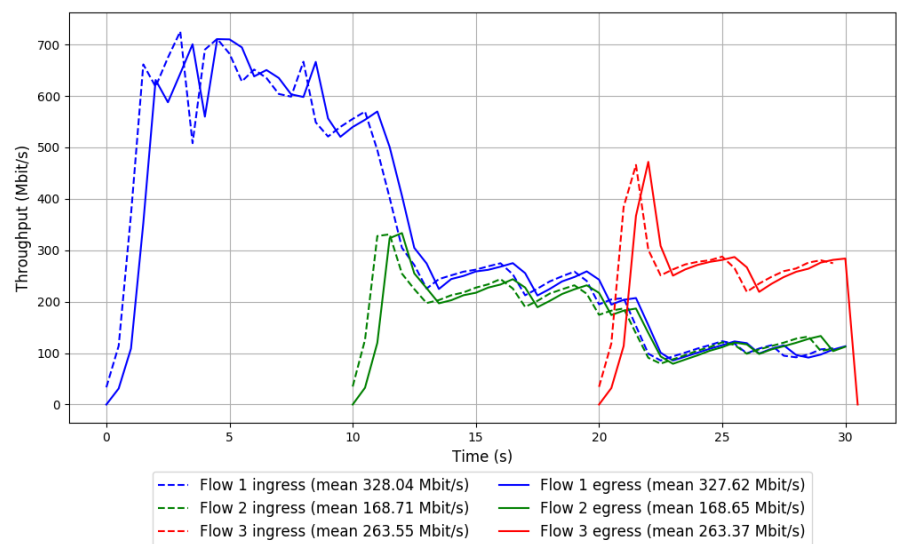
Run 1: Report of TCP Cubic — Data Link

```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-31 04:51:31
End at: 2018-08-31 04:52:01
Local clock offset: 2.108 ms
Remote clock offset: 4.565 ms


# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 362.00 Mbit/s
95th percentile per-packet one-way delay: 18.982 ms
Loss rate: 0.04%
-- Flow 1:
Average throughput: 177.16 Mbit/s
95th percentile per-packet one-way delay: 17.707 ms
Loss rate: 0.03%
-- Flow 2:
Average throughput: 223.21 Mbit/s
95th percentile per-packet one-way delay: 18.541 ms
Loss rate: 0.06%
-- Flow 3:
Average throughput: 108.73 Mbit/s
95th percentile per-packet one-way delay: 19.207 ms
Loss rate: 0.02%
```
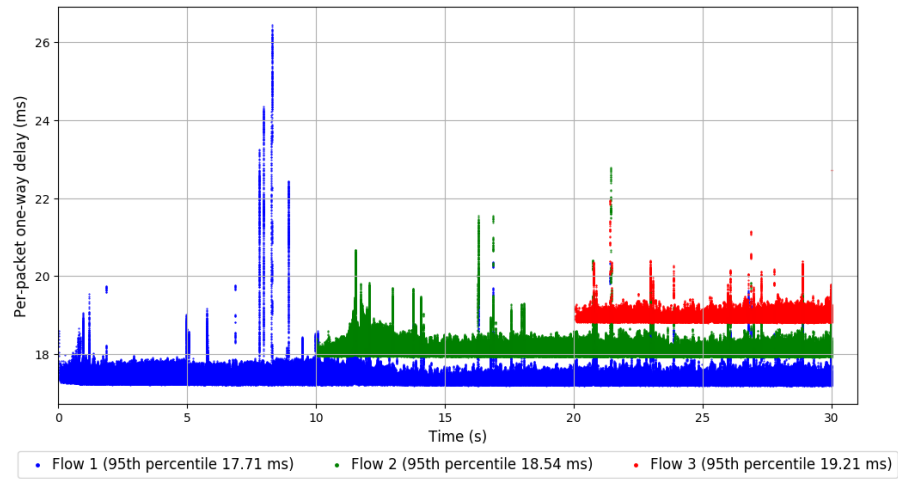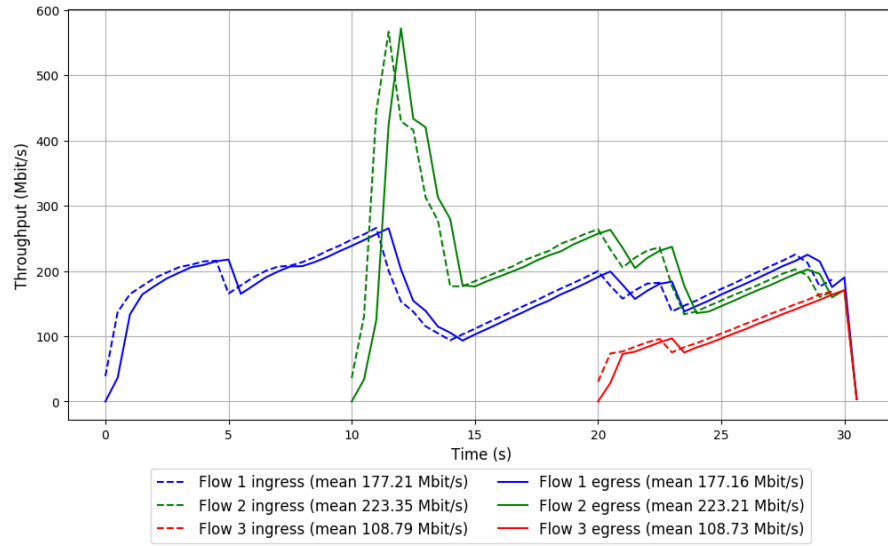
Run 2: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 177.21 Mbit/s)   Flow 1 egress (mean 177.16 Mbit/s)
Flow 2 ingress (mean 223.35 Mbit/s)   Flow 2 egress (mean 223.21 Mbit/s)
Flow 3 ingress (mean 108.79 Mbit/s)   Flow 3 egress (mean 108.73 Mbit/s)

Flow 1 (95th percentile 17.71 ms)   Flow 2 (95th percentile 18.54 ms)   Flow 3 (95th percentile 19.21 ms)

```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-31 04:57:50
End at: 2018-08-31 04:58:20
Local clock offset: 2.331 ms
Remote clock offset: 4.154 ms


# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 341.06 Mbit/s
95th percentile per-packet one-way delay: 19.308 ms
Loss rate: 0.04%
-- Flow 1:
Average throughput: 132.24 Mbit/s
95th percentile per-packet one-way delay: 19.282 ms
Loss rate: 0.03%
-- Flow 2:
Average throughput: 237.16 Mbit/s
95th percentile per-packet one-way delay: 18.638 ms
Loss rate: 0.06%
-- Flow 3:
Average throughput: 152.86 Mbit/s
95th percentile per-packet one-way delay: 19.438 ms
Loss rate: 0.03%
```
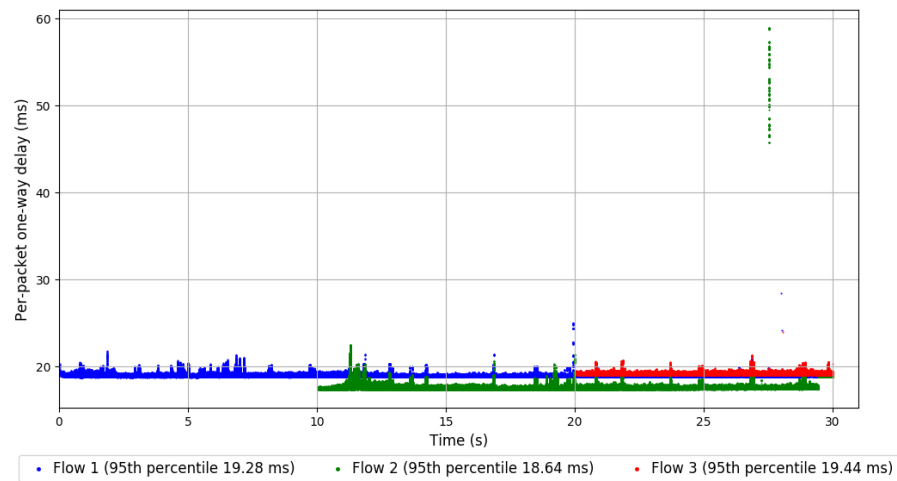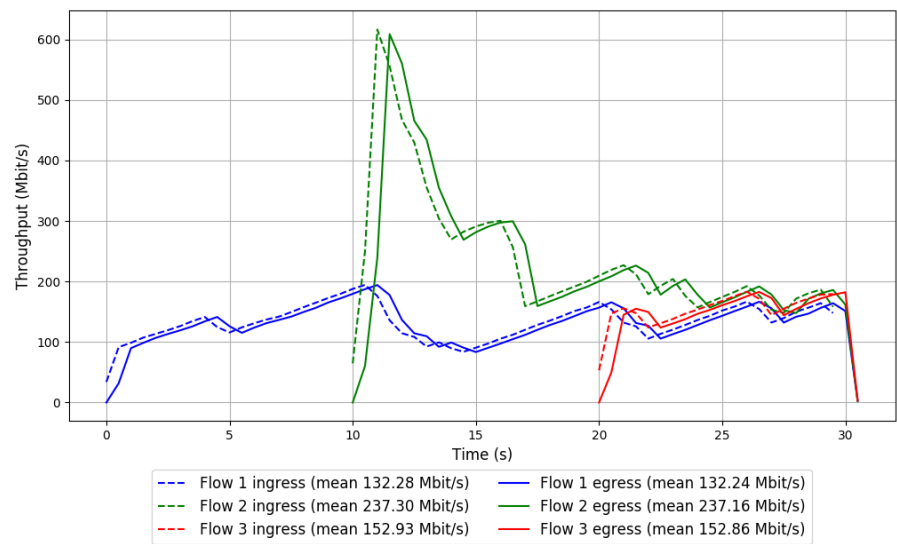
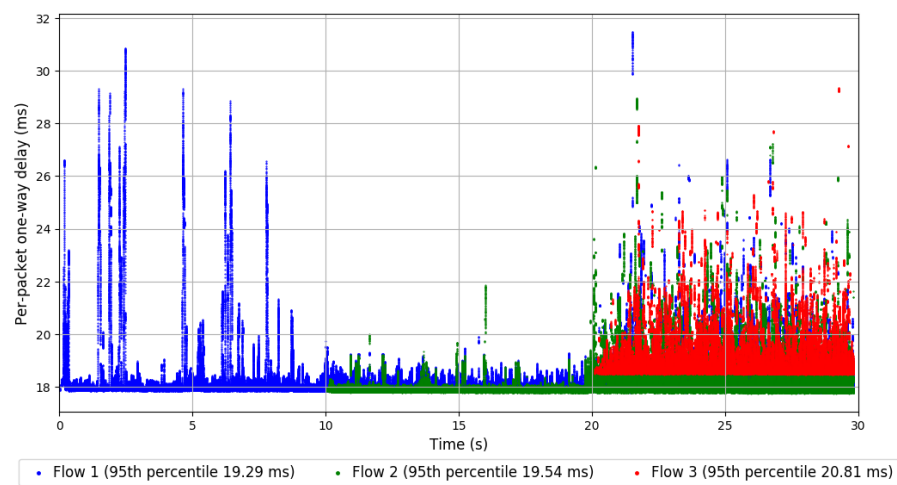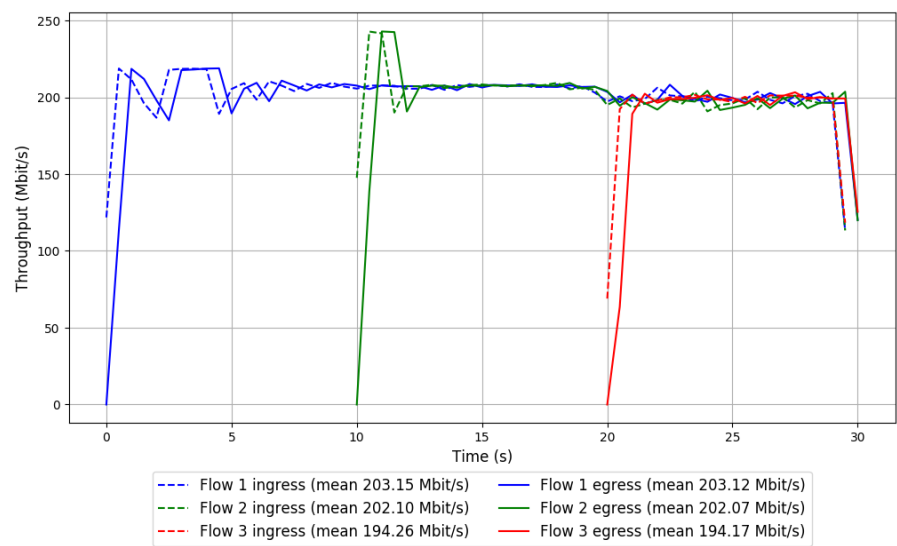Run 3: Report of TCP Cubic — Data Link

```
Run 1: Statistics of Indigo

Start at: 2018-08-31 04:46:42
End at: 2018-08-31 04:47:12
Local clock offset: 2.323 ms
Remote clock offset: 4.169 ms


# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 400.48 Mbit/s
95th percentile per-packet one-way delay: 19.808 ms
Loss rate: 0.03%
-- Flow 1:
Average throughput: 203.12 Mbit/s
95th percentile per-packet one-way delay: 19.288 ms
Loss rate: 0.02%
-- Flow 2:
Average throughput: 202.07 Mbit/s
95th percentile per-packet one-way delay: 19.540 ms
Loss rate: 0.02%
-- Flow 3:
Average throughput: 194.17 Mbit/s
95th percentile per-packet one-way delay: 20.809 ms
Loss rate: 0.06%
```

Run 1: Report of Indigo — Data Link

Flow 1 ingress (mean 203.15 Mbit/s)   Flow 1 egress (mean 203.12 Mbit/s)
Flow 2 ingress (mean 202.10 Mbit/s)   Flow 2 egress (mean 202.07 Mbit/s)
Flow 3 ingress (mean 194.26 Mbit/s)   Flow 3 egress (mean 194.17 Mbit/s)

Flow 1 (95th percentile 19.29 ms)   Flow 2 (95th percentile 19.54 ms)   Flow 3 (95th percentile 20.81 ms)

```
Run 2: Statistics of Indigo

Start at: 2018-08-31 04:53:01
End at: 2018-08-31 04:53:31
Local clock offset: 2.14 ms
Remote clock offset: 4.608 ms

# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 390.49 Mbit/s
95th percentile per-packet one-way delay: 20.070 ms
Loss rate: 0.02%
-- Flow 1:
Average throughput: 196.89 Mbit/s
95th percentile per-packet one-way delay: 19.934 ms
Loss rate: 0.01%
-- Flow 2:
Average throughput: 199.86 Mbit/s
95th percentile per-packet one-way delay: 20.252 ms
Loss rate: 0.02%
-- Flow 3:
Average throughput: 188.23 Mbit/s
95th percentile per-packet one-way delay: 20.071 ms
Loss rate: 0.04%
```
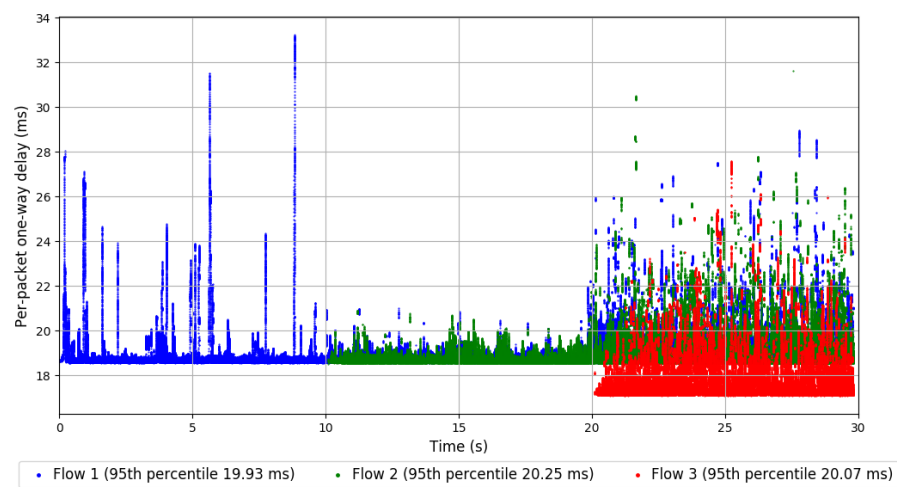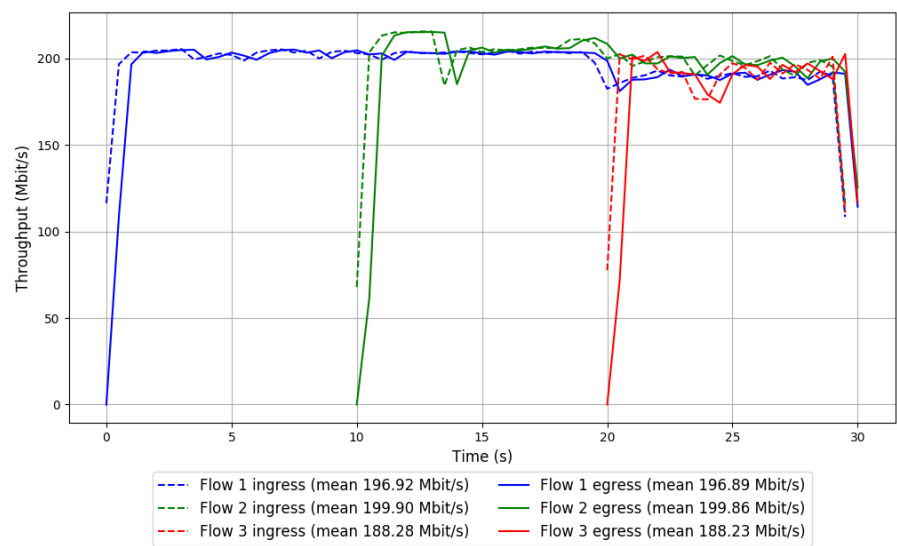
Run 2: Report of Indigo — Data Link

- - - Flow 1 ingress (mean 196.92 Mbit/s) ——— Flow 1 egress (mean 196.89 Mbit/s)
- - - Flow 2 ingress (mean 199.90 Mbit/s) ——— Flow 2 egress (mean 199.86 Mbit/s)
- - - Flow 3 ingress (mean 188.28 Mbit/s) ——— Flow 3 egress (mean 188.23 Mbit/s)

• Flow 1 (95th percentile 19.93 ms)　　• Flow 2 (95th percentile 20.25 ms)　　• Flow 3 (95th percentile 20.07 ms)

19

```
Run 3: Statistics of Indigo

Start at: 2018-08-31 04:59:20
End at: 2018-08-31 04:59:50
Local clock offset: 2.343 ms
Remote clock offset: 3.99 ms


# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 396.17 Mbit/s
95th percentile per-packet one-way delay: 20.202 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 201.89 Mbit/s
95th percentile per-packet one-way delay: 19.734 ms
Loss rate: 0.01%
-- Flow 2:
Average throughput: 199.01 Mbit/s
95th percentile per-packet one-way delay: 20.538 ms
Loss rate: 0.01%
-- Flow 3:
Average throughput: 193.81 Mbit/s
95th percentile per-packet one-way delay: 20.413 ms
Loss rate: 0.01%
```
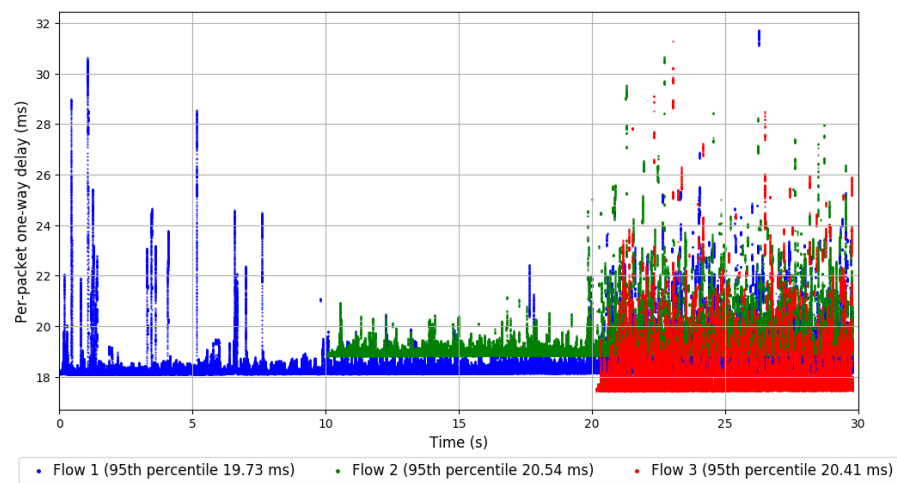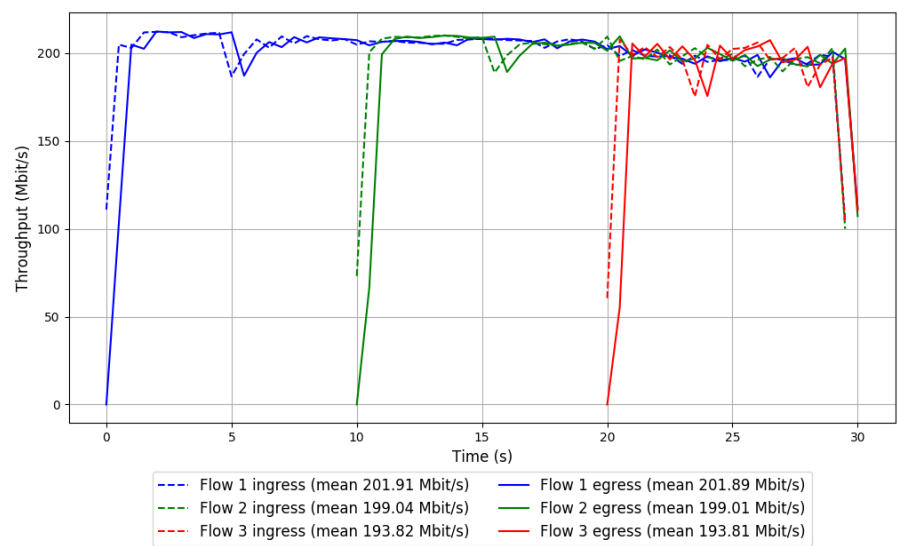
Run 3: Report of Indigo — Data Link

Flow 1 ingress (mean 201.91 Mbit/s)   Flow 1 egress (mean 201.89 Mbit/s)
Flow 2 ingress (mean 199.04 Mbit/s)   Flow 2 egress (mean 199.01 Mbit/s)
Flow 3 ingress (mean 193.82 Mbit/s)   Flow 3 egress (mean 193.81 Mbit/s)

Flow 1 (95th percentile 19.73 ms)   Flow 2 (95th percentile 20.54 ms)   Flow 3 (95th percentile 20.41 ms)

```
Run 1: Statistics of Muses-25

Start at: 2018-08-31 04:41:54
End at: 2018-08-31 04:42:24
Local clock offset: 1.724 ms
Remote clock offset: 3.793 ms

# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 19.251 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 19.149 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 19.285 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 19.099 ms
Loss rate: 0.00%
```
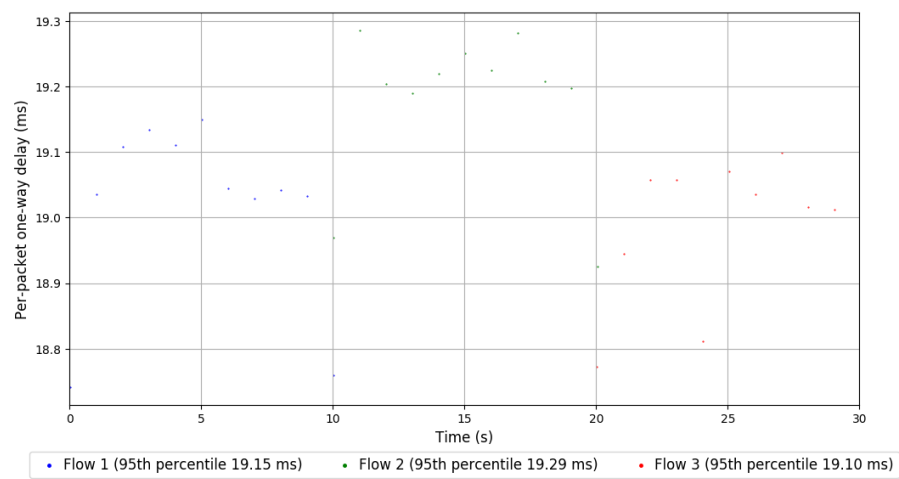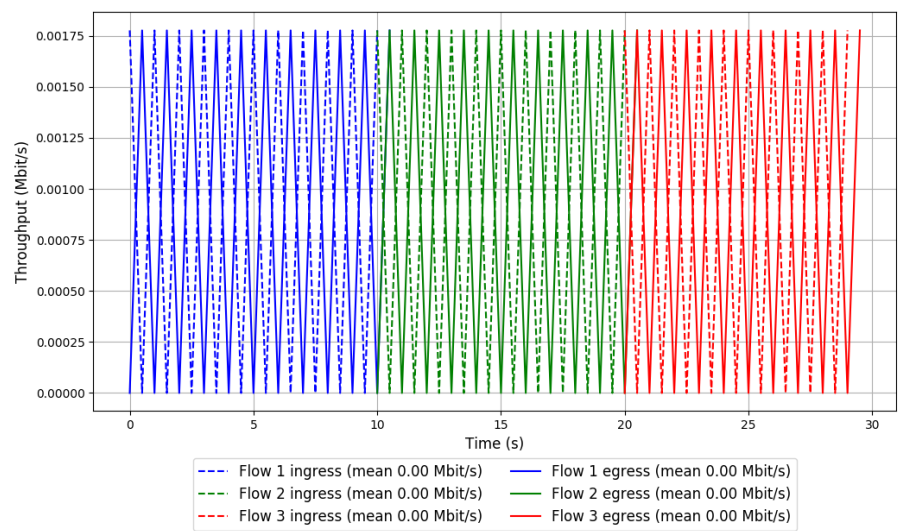
Run 1: Report of Muses-25 — Data Link

```
Run 2: Statistics of Muses-25

Start at: 2018-08-31 04:48:17
End at: 2018-08-31 04:48:47
Local clock offset: 2.216 ms
Remote clock offset: 4.322 ms


# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 18.214 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 17.464 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 18.224 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 17.447 ms
Loss rate: 0.00%
```
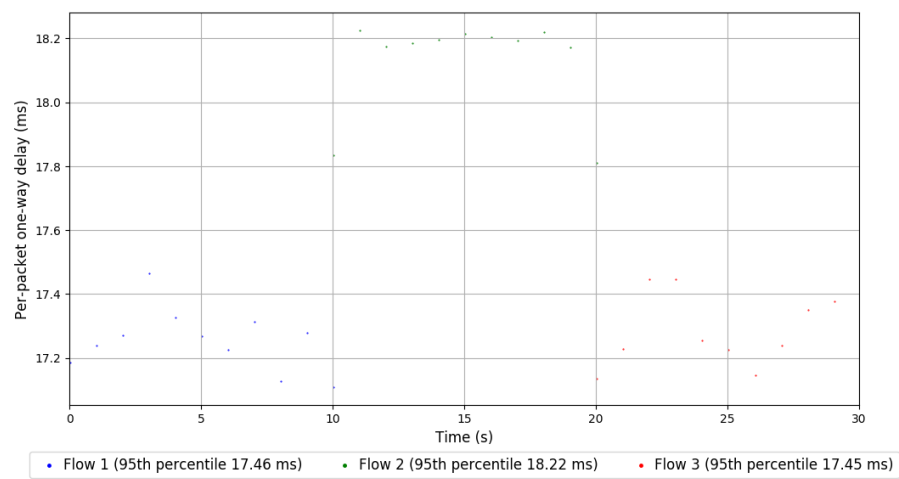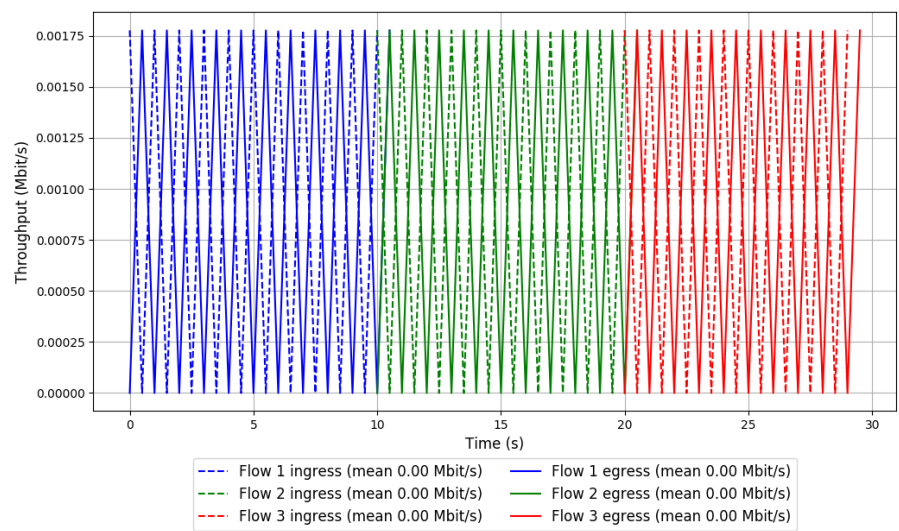
Run 2: Report of Muses-25 — Data Link

```
Run 3: Statistics of Muses-25

Start at: 2018-08-31 04:54:37
End at: 2018-08-31 04:55:07
Local clock offset: 2.064 ms
Remote clock offset: 4.493 ms


# Below is generated by plot.py at 2018-08-31 05:08:48
# Datalink statistics
-- Total of 3 flows:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 19.168 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 18.382 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 19.189 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 19.171 ms
Loss rate: 0.00%
```

Run 3: Report of Muses-25 — Data Link