Pantheon Report

Generated at 2018-09-05 22:43:04 (UTC).

Data path: China on `eno1` (*remote*) →AWS Korea on `ens5` (*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.

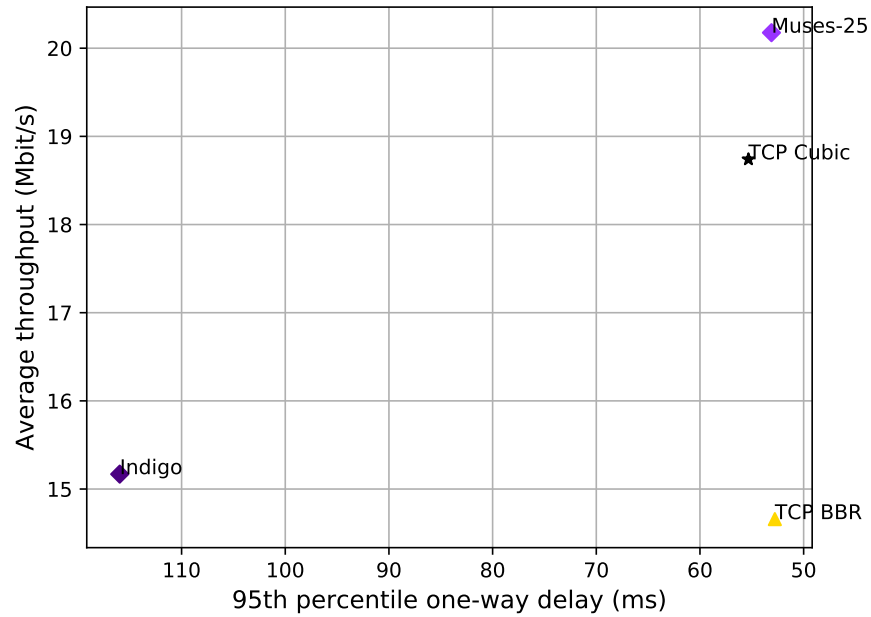NTP offsets were measured against `ntp.nict.jp` and have been applied to correct the timestamps in logs.

```
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
```
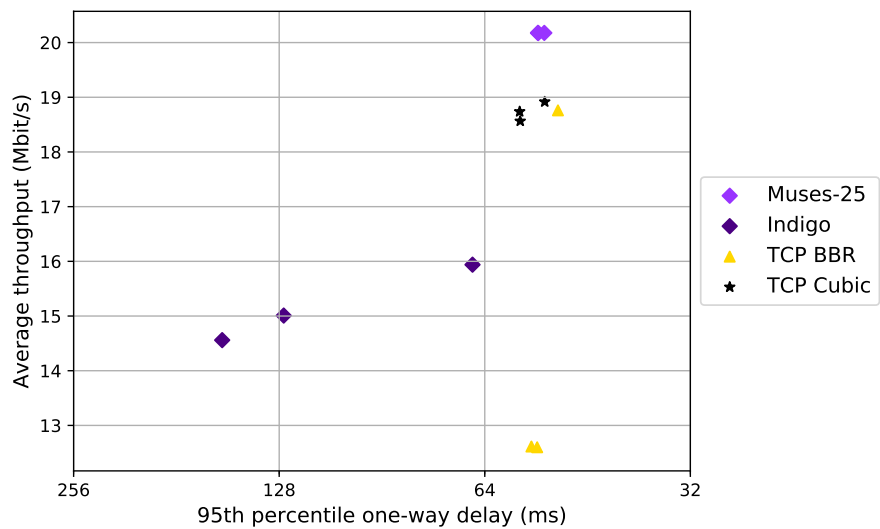
test from China to AWS Korea, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

test from China to AWS Korea, 3 runs of 30s each per scheme
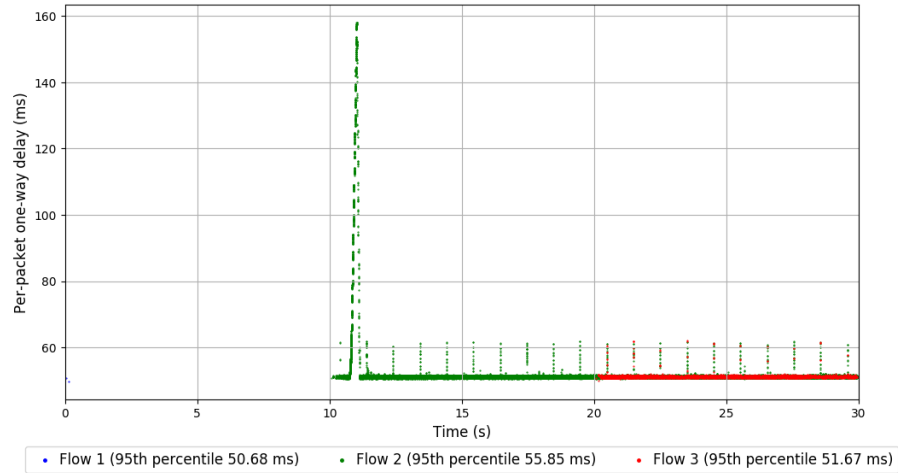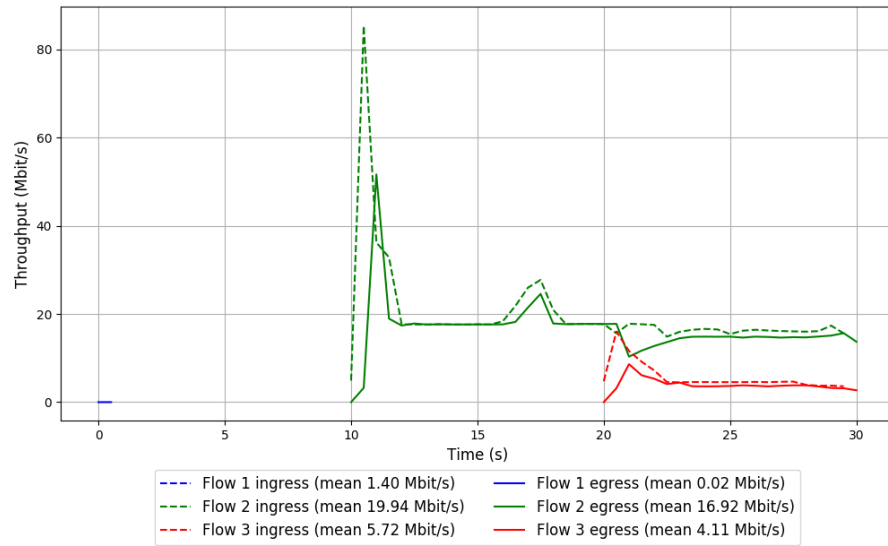3 flows with 10s interval between flows

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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	4.69	12.63	4.78	51.13	53.42	50.51	71.12	17.82	25.18
TCP Cubic	3	8.95	8.24	13.06	58.89	51.26	55.16	10.58	11.03	11.75
Indigo	3	12.31	2.43	3.82	115.78	89.64	96.09	80.07	83.95	85.56
Muses-25	3	17.76	2.62	2.06	53.53	51.30	51.83	40.68	47.25	50.45

```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 22:27:53
End at: 2018-09-05 22:28:23
Local clock offset: -17.861 ms
Remote clock offset: -13.276 ms


# Below is generated by plot.py at 2018-09-05 22:42:43
# Datalink statistics
-- Total of 3 flows:
Average throughput: 12.61 Mbit/s
95th percentile per-packet one-way delay: 54.687 ms
Loss rate: 17.16%
-- Flow 1:
Average throughput: 0.02 Mbit/s
95th percentile per-packet one-way delay: 50.683 ms
Loss rate: 98.79%
-- Flow 2:
Average throughput: 16.92 Mbit/s
95th percentile per-packet one-way delay: 55.848 ms
Loss rate: 15.49%
-- Flow 3:
Average throughput: 4.11 Mbit/s
95th percentile per-packet one-way delay: 51.668 ms
Loss rate: 28.67%
```

Run 1: Report of TCP BBR — Data Link

Flow 1 ingress (mean 1.40 Mbit/s) --------- Flow 1 egress (mean 0.02 Mbit/s) ———
Flow 2 ingress (mean 19.94 Mbit/s) --------- Flow 2 egress (mean 16.92 Mbit/s) ———
Flow 3 ingress (mean 5.72 Mbit/s) --------- Flow 3 egress (mean 4.11 Mbit/s) ———

• Flow 1 (95th percentile 50.68 ms)   • Flow 2 (95th percentile 55.85 ms)   • Flow 3 (95th percentile 51.67 ms)
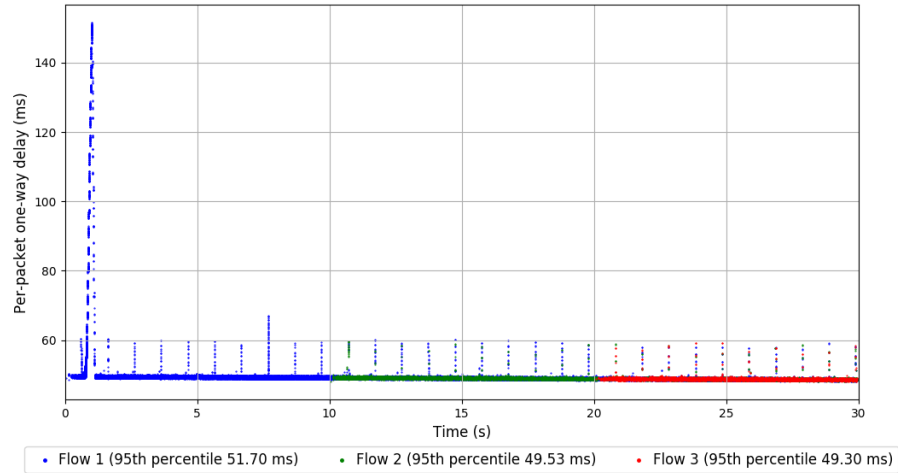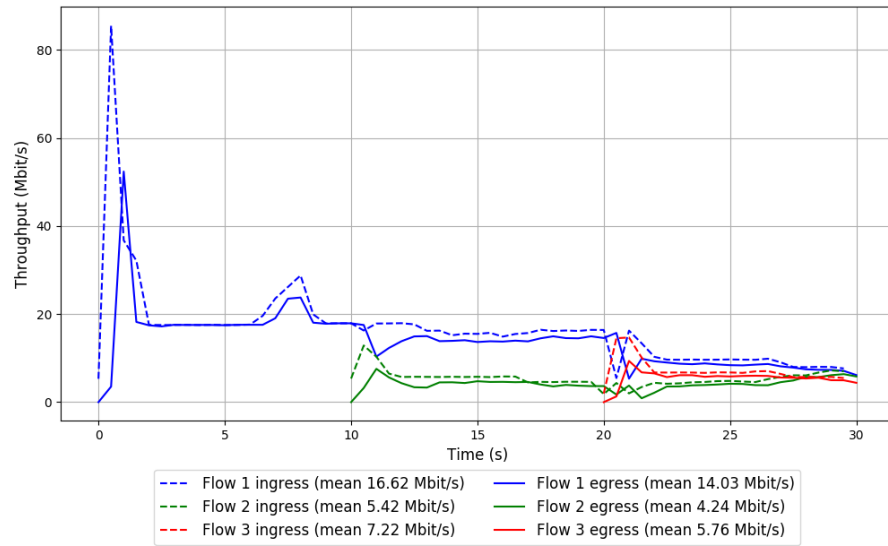
```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 22:32:56
End at: 2018-09-05 22:33:26
Local clock offset: -14.159 ms
Remote clock offset: -12.62 ms


# Below is generated by plot.py at 2018-09-05 22:42:49
# Datalink statistics
-- Total of 3 flows:
Average throughput: 18.76 Mbit/s
95th percentile per-packet one-way delay: 50.005 ms
Loss rate: 17.31%
-- Flow 1:
Average throughput: 14.03 Mbit/s
95th percentile per-packet one-way delay: 51.702 ms
Loss rate: 15.78%
-- Flow 2:
Average throughput: 4.24 Mbit/s
95th percentile per-packet one-way delay: 49.532 ms
Loss rate: 21.98%
-- Flow 3:
Average throughput: 5.76 Mbit/s
95th percentile per-packet one-way delay: 49.296 ms
Loss rate: 20.90%
```

Run 2: Report of TCP BBR — Data Link

Flow 1 ingress (mean 16.62 Mbit/s) --- Flow 1 egress (mean 14.03 Mbit/s)
Flow 2 ingress (mean 5.42 Mbit/s) --- Flow 2 egress (mean 4.24 Mbit/s)
Flow 3 ingress (mean 7.22 Mbit/s) --- Flow 3 egress (mean 5.76 Mbit/s)

Flow 1 (95th percentile 51.70 ms)   Flow 2 (95th percentile 49.53 ms)   Flow 3 (95th percentile 49.30 ms)
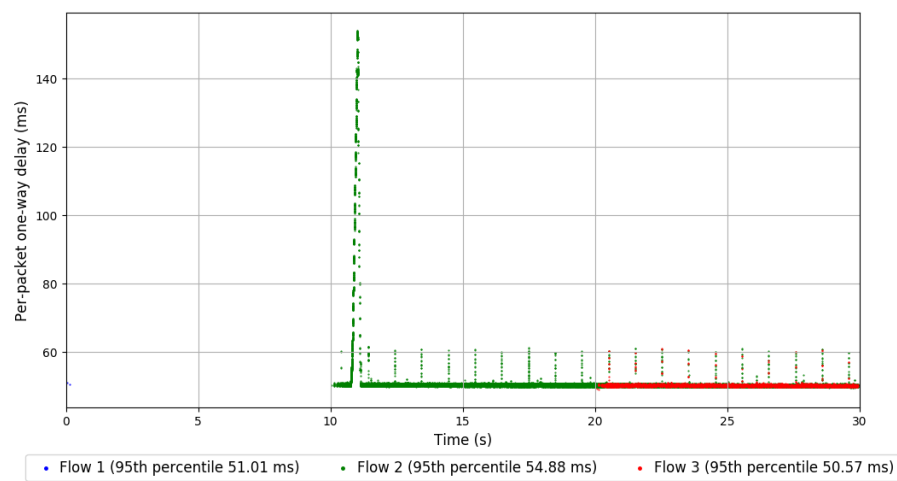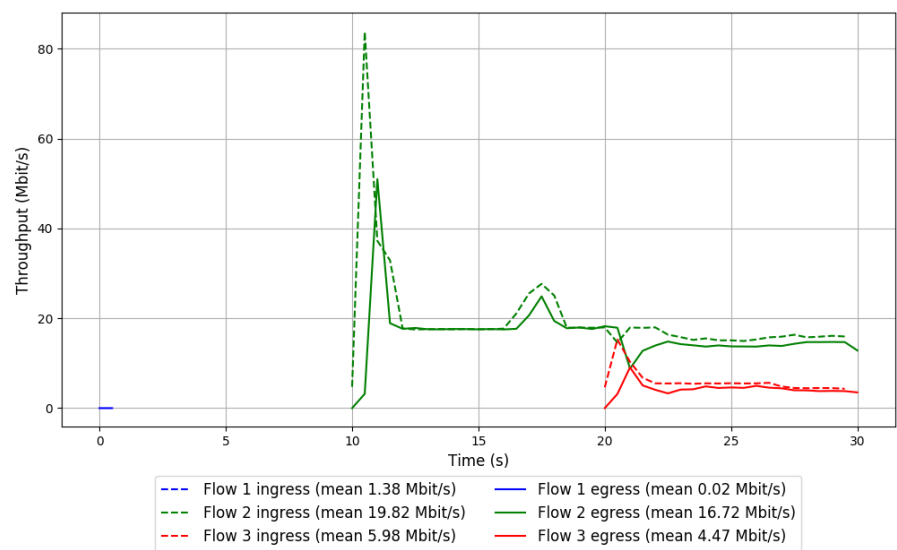
```
Run 3: Statistics of TCP BBR

Start at: 2018-09-05 22:38:09
End at: 2018-09-05 22:38:39
Local clock offset: -6.382 ms
Remote clock offset: -12.989 ms


# Below is generated by plot.py at 2018-09-05 22:42:49
# Datalink statistics
-- Total of 3 flows:
Average throughput: 12.60 Mbit/s
95th percentile per-packet one-way delay: 53.636 ms
Loss rate: 17.33%
-- Flow 1:
Average throughput: 0.02 Mbit/s
95th percentile per-packet one-way delay: 51.008 ms
Loss rate: 98.79%
-- Flow 2:
Average throughput: 16.72 Mbit/s
95th percentile per-packet one-way delay: 54.877 ms
Loss rate: 16.00%
-- Flow 3:
Average throughput: 4.47 Mbit/s
95th percentile per-packet one-way delay: 50.569 ms
Loss rate: 25.97%
```
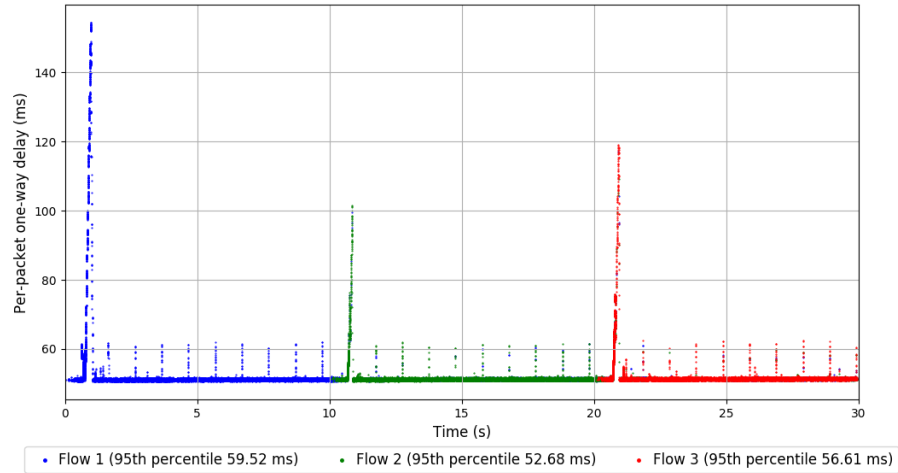
Run 3: Report of TCP BBR — Data Link

- - - Flow 1 ingress (mean 1.38 Mbit/s)   —— Flow 1 egress (mean 0.02 Mbit/s)
- - - Flow 2 ingress (mean 19.82 Mbit/s)   —— Flow 2 egress (mean 16.72 Mbit/s)
- - - Flow 3 ingress (mean 5.98 Mbit/s)   —— Flow 3 egress (mean 4.47 Mbit/s)

- Flow 1 (95th percentile 51.01 ms)   • Flow 2 (95th percentile 54.88 ms)   • Flow 3 (95th percentile 50.57 ms)
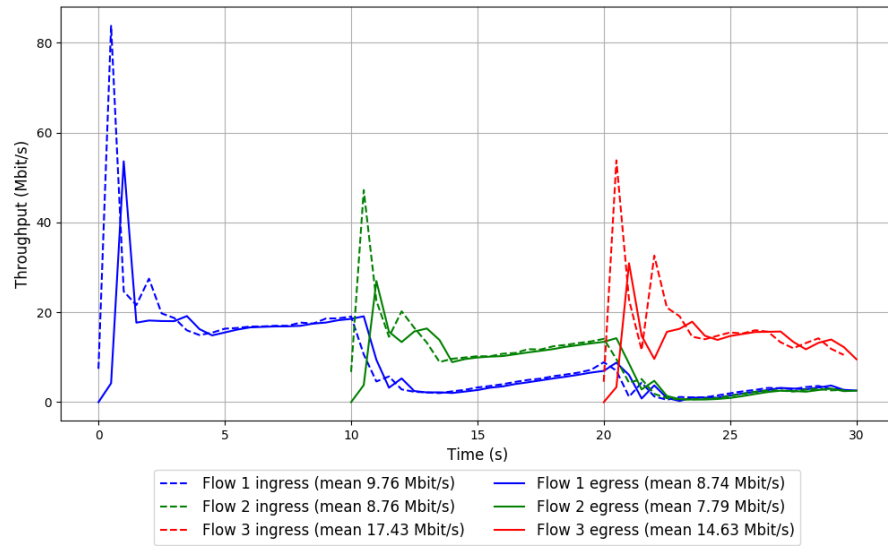
9

```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 22:29:05
End at: 2018-09-05 22:29:35
Local clock offset: -18.435 ms
Remote clock offset: -13.318 ms


# Below is generated by plot.py at 2018-09-05 22:42:49
# Datalink statistics
-- Total of 3 flows:
Average throughput: 18.74 Mbit/s
95th percentile per-packet one-way delay: 56.898 ms
Loss rate: 12.59%
-- Flow 1:
Average throughput: 8.74 Mbit/s
95th percentile per-packet one-way delay: 59.516 ms
Loss rate: 10.74%
-- Flow 2:
Average throughput: 7.79 Mbit/s
95th percentile per-packet one-way delay: 52.678 ms
Loss rate: 11.51%
-- Flow 3:
Average throughput: 14.63 Mbit/s
95th percentile per-packet one-way delay: 56.610 ms
Loss rate: 16.81%
```

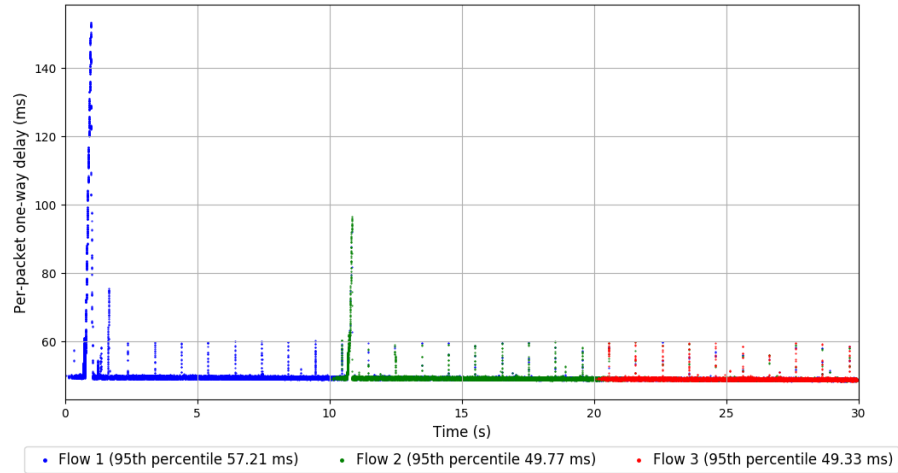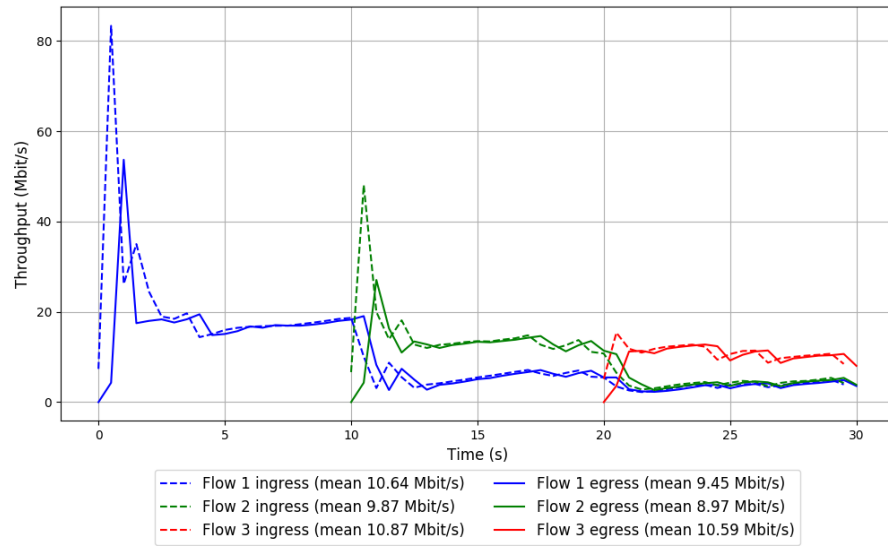Run 1: Report of TCP Cubic — Data Link

```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 22:34:10
End at: 2018-09-05 22:34:40
Local clock offset: -11.847 ms
Remote clock offset: -12.418 ms


# Below is generated by plot.py at 2018-09-05 22:42:49
# Datalink statistics
-- Total of 3 flows:
Average throughput: 18.92 Mbit/s
95th percentile per-packet one-way delay: 52.289 ms
Loss rate: 9.39%
-- Flow 1:
Average throughput: 9.45 Mbit/s
95th percentile per-packet one-way delay: 57.211 ms
Loss rate: 11.38%
-- Flow 2:
Average throughput: 8.97 Mbit/s
95th percentile per-packet one-way delay: 49.773 ms
Loss rate: 9.47%
-- Flow 3:
Average throughput: 10.59 Mbit/s
95th percentile per-packet one-way delay: 49.326 ms
Loss rate: 3.38%
```

Run 2: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 10.64 Mbit/s) --- Flow 1 egress (mean 9.45 Mbit/s)
Flow 2 ingress (mean 9.87 Mbit/s) --- Flow 2 egress (mean 8.97 Mbit/s)
Flow 3 ingress (mean 10.87 Mbit/s) --- Flow 3 egress (mean 10.59 Mbit/s)

Flow 1 (95th percentile 57.21 ms)   Flow 2 (95th percentile 49.77 ms)   Flow 3 (95th percentile 49.33 ms)
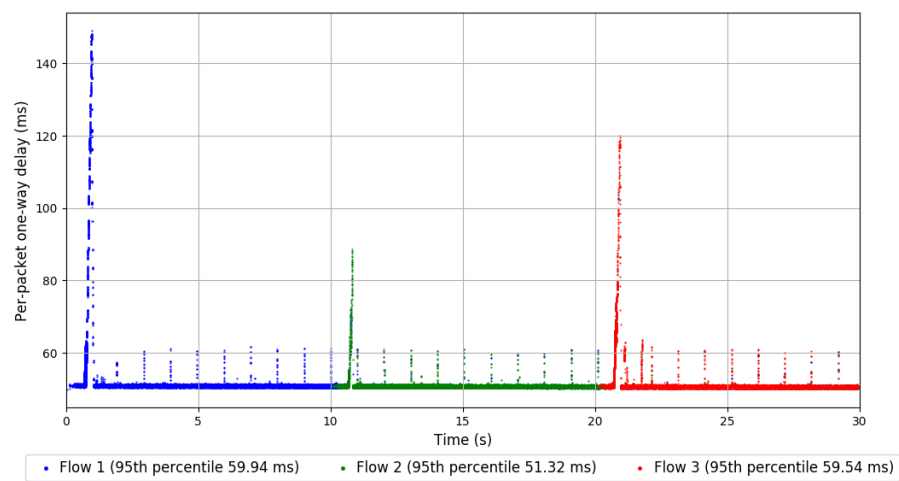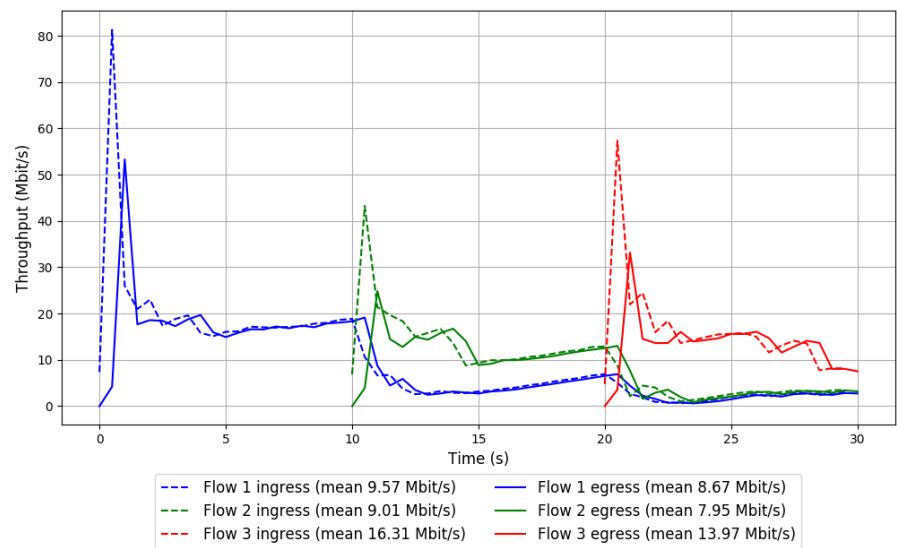
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```
Run 3: Statistics of TCP Cubic

Start at: 2018-09-05 22:39:21
End at: 2018-09-05 22:39:51
Local clock offset: -4.961 ms
Remote clock offset: -13.043 ms


# Below is generated by plot.py at 2018-09-05 22:42:49
# Datalink statistics
-- Total of 3 flows:
Average throughput: 18.56 Mbit/s
95th percentile per-packet one-way delay: 56.787 ms
Loss rate: 11.73%
-- Flow 1:
Average throughput: 8.67 Mbit/s
95th percentile per-packet one-way delay: 59.936 ms
Loss rate: 9.62%
-- Flow 2:
Average throughput: 7.95 Mbit/s
95th percentile per-packet one-way delay: 51.319 ms
Loss rate: 12.11%
-- Flow 3:
Average throughput: 13.97 Mbit/s
95th percentile per-packet one-way delay: 59.536 ms
Loss rate: 15.06%
```
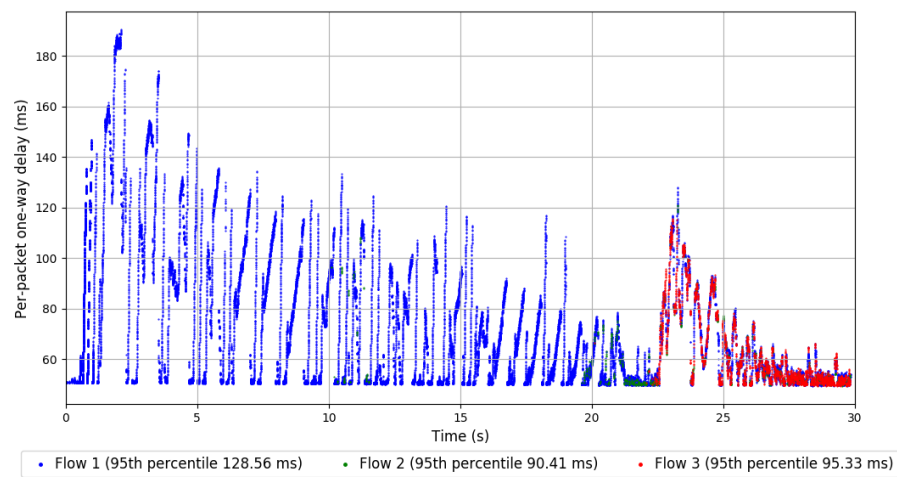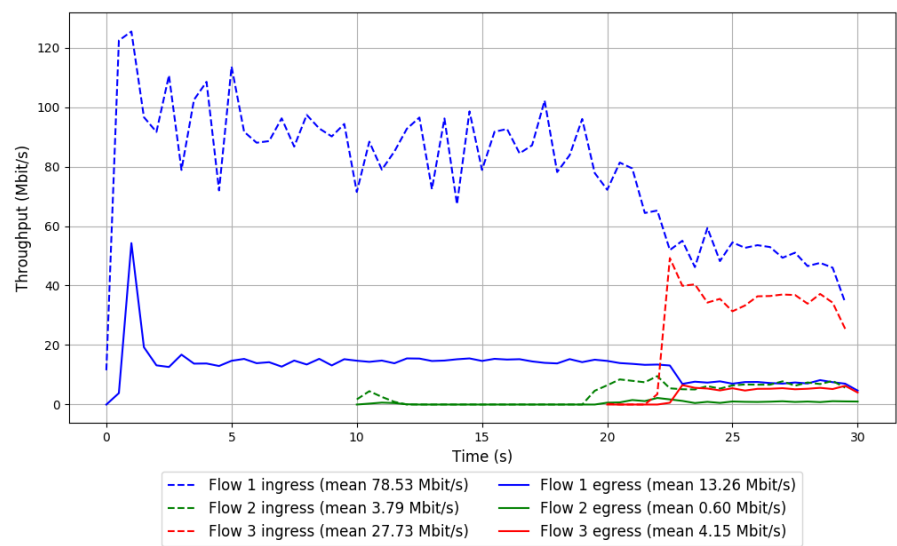
Run 3: Report of TCP Cubic — Data Link

```
Run 1: Statistics of Indigo

Start at: 2018-09-05 22:30:19
End at: 2018-09-05 22:30:49
Local clock offset: -19.152 ms
Remote clock offset: -13.24 ms


# Below is generated by plot.py at 2018-09-05 22:42:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 15.01 Mbit/s
95th percentile per-packet one-way delay: 126.068 ms
Loss rate: 83.40%
-- Flow 1:
Average throughput: 13.26 Mbit/s
95th percentile per-packet one-way delay: 128.562 ms
Loss rate: 83.16%
-- Flow 2:
Average throughput: 0.60 Mbit/s
95th percentile per-packet one-way delay: 90.411 ms
Loss rate: 84.39%
-- Flow 3:
Average throughput: 4.15 Mbit/s
95th percentile per-packet one-way delay: 95.325 ms
Loss rate: 85.19%
```

Run 1: Report of Indigo — Data Link

Flow 1 ingress (mean 78.53 Mbit/s)   Flow 1 egress (mean 13.26 Mbit/s)
Flow 2 ingress (mean 3.79 Mbit/s)   Flow 2 egress (mean 0.60 Mbit/s)
Flow 3 ingress (mean 27.73 Mbit/s)   Flow 3 egress (mean 4.15 Mbit/s)

Flow 1 (95th percentile 128.56 ms)   Flow 2 (95th percentile 90.41 ms)   Flow 3 (95th percentile 95.33 ms)
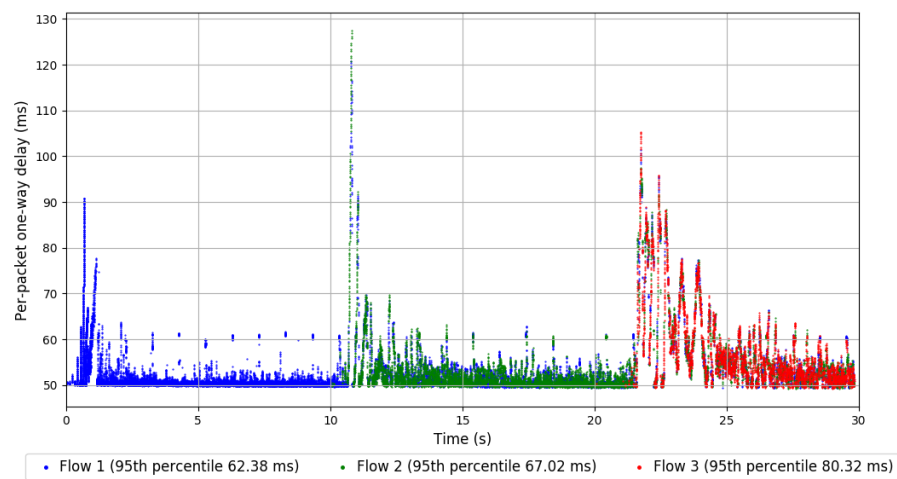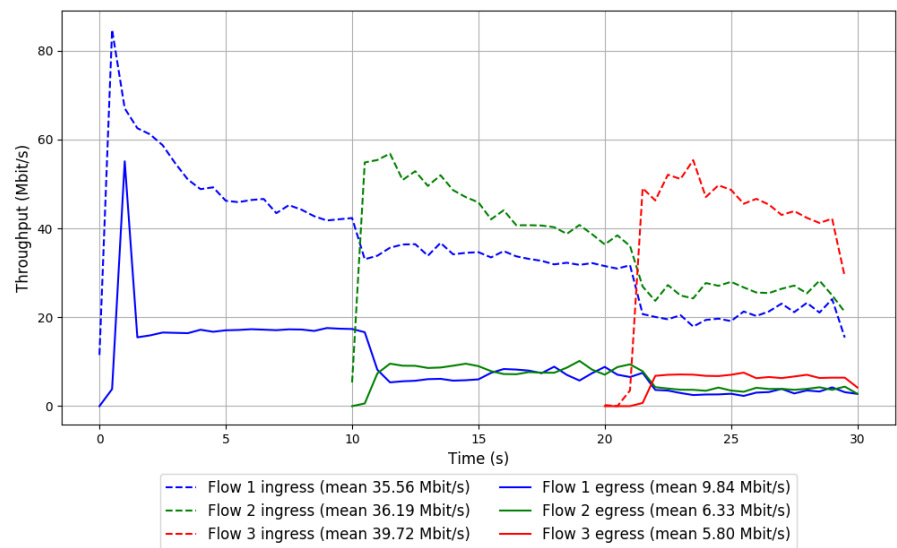
```
Run 2: Statistics of Indigo

Start at: 2018-09-05 22:35:23
End at: 2018-09-05 22:35:53
Local clock offset: -9.511 ms
Remote clock offset: -12.776 ms


# Below is generated by plot.py at 2018-09-05 22:42:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 15.94 Mbit/s
95th percentile per-packet one-way delay: 66.700 ms
Loss rate: 78.13%
-- Flow 1:
Average throughput: 9.84 Mbit/s
95th percentile per-packet one-way delay: 62.376 ms
Loss rate: 72.40%
-- Flow 2:
Average throughput: 6.33 Mbit/s
95th percentile per-packet one-way delay: 67.016 ms
Loss rate: 82.58%
-- Flow 3:
Average throughput: 5.80 Mbit/s
95th percentile per-packet one-way delay: 80.323 ms
Loss rate: 85.53%
```

Run 2: Report of Indigo — Data Link

Flow 1 ingress (mean 35.56 Mbit/s)   Flow 1 egress (mean 9.84 Mbit/s)
Flow 2 ingress (mean 36.19 Mbit/s)   Flow 2 egress (mean 6.33 Mbit/s)
Flow 3 ingress (mean 39.72 Mbit/s)   Flow 3 egress (mean 5.80 Mbit/s)

Flow 1 (95th percentile 62.38 ms)   Flow 2 (95th percentile 67.02 ms)   Flow 3 (95th percentile 80.32 ms)
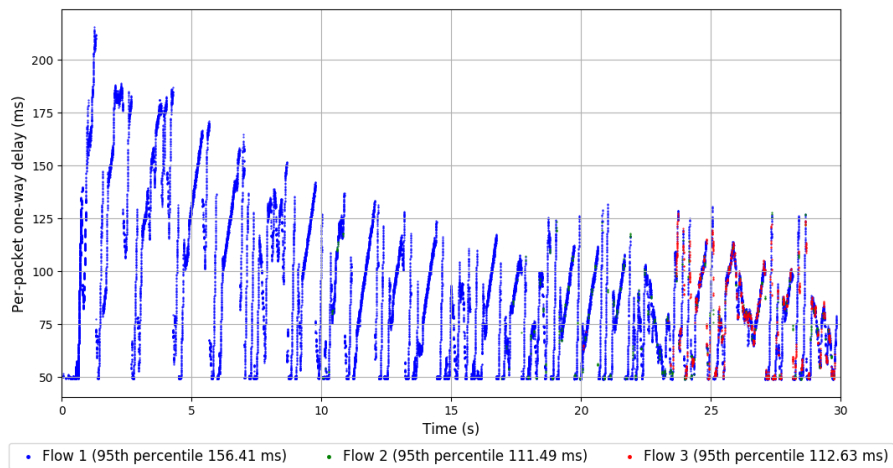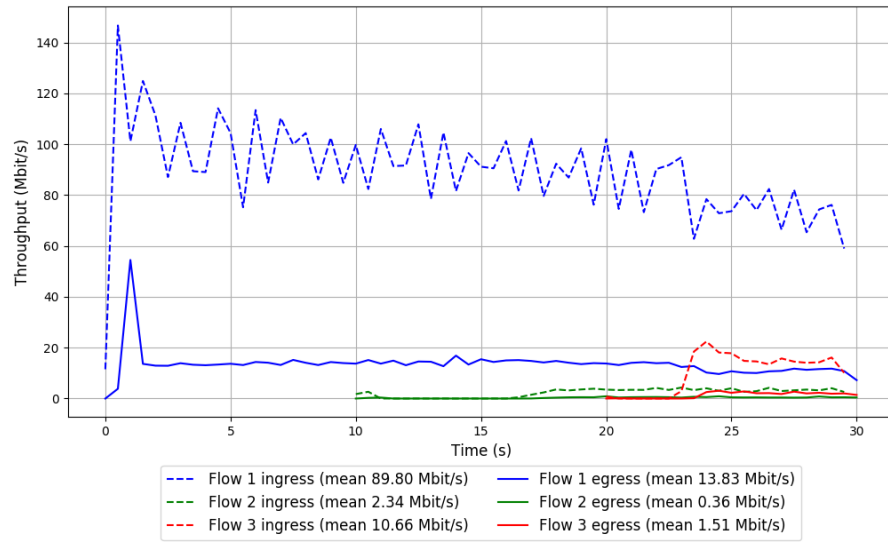
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```
Run 3: Statistics of Indigo

Start at: 2018-09-05 22:40:35
End at: 2018-09-05 22:41:05
Local clock offset: -4.122 ms
Remote clock offset: -11.981 ms


# Below is generated by plot.py at 2018-09-05 22:43:03
# Datalink statistics
-- Total of 3 flows:
Average throughput: 14.56 Mbit/s
95th percentile per-packet one-way delay: 155.132 ms
Loss rate: 84.70%
-- Flow 1:
Average throughput: 13.83 Mbit/s
95th percentile per-packet one-way delay: 156.414 ms
Loss rate: 84.64%
-- Flow 2:
Average throughput: 0.36 Mbit/s
95th percentile per-packet one-way delay: 111.492 ms
Loss rate: 84.87%
-- Flow 3:
Average throughput: 1.51 Mbit/s
95th percentile per-packet one-way delay: 112.634 ms
Loss rate: 85.97%
```
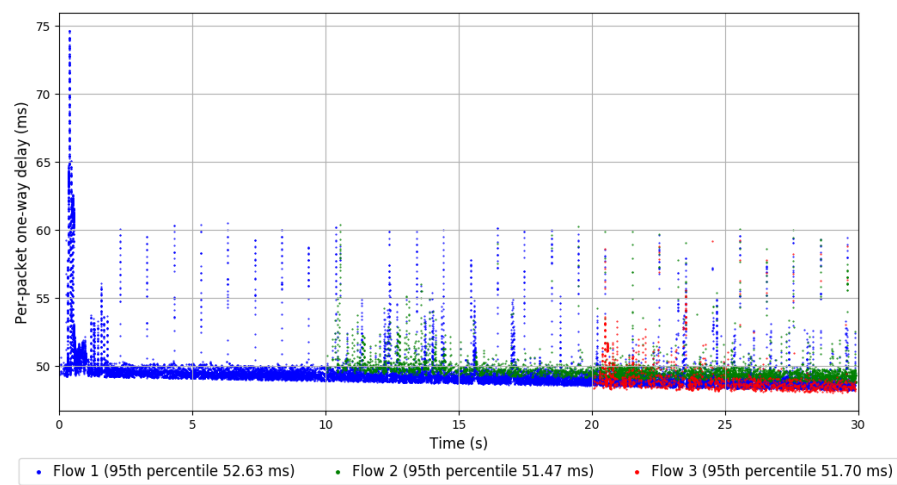
Run 3: Report of Indigo — Data Link

Flow 1 ingress (mean 89.80 Mbit/s) — — —   Flow 1 egress (mean 13.83 Mbit/s) ———
Flow 2 ingress (mean 2.34 Mbit/s) — — —   Flow 2 egress (mean 0.36 Mbit/s) ———
Flow 3 ingress (mean 10.66 Mbit/s) — — —   Flow 3 egress (mean 1.51 Mbit/s) ———

Flow 1 (95th percentile 156.41 ms)   Flow 2 (95th percentile 111.49 ms)   Flow 3 (95th percentile 112.63 ms)
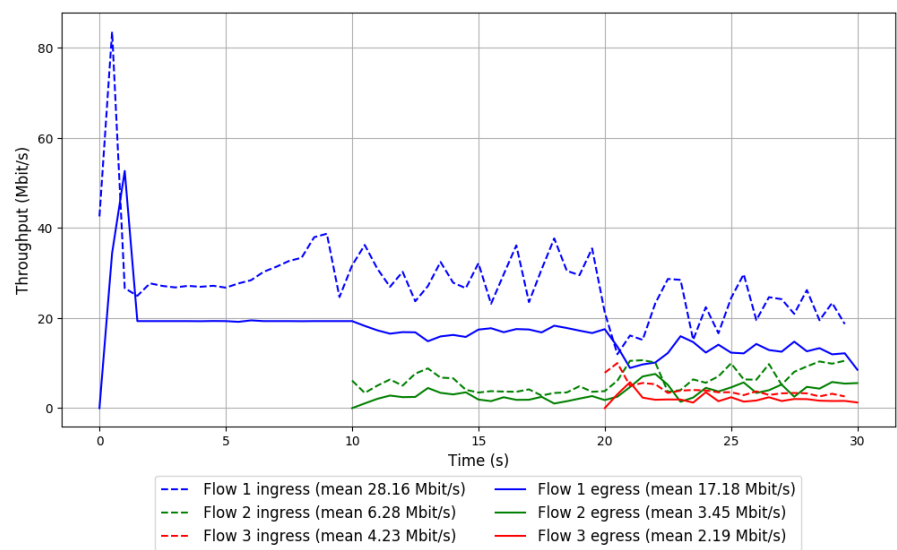
```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 22:31:35
End at: 2018-09-05 22:32:05
Local clock offset: -17.209 ms
Remote clock offset: -13.67 ms


# Below is generated by plot.py at 2018-09-05 22:43:03
# Datalink statistics
-- Total of 3 flows:
Average throughput: 20.18 Mbit/s
95th percentile per-packet one-way delay: 52.361 ms
Loss rate: 40.39%
-- Flow 1:
Average throughput: 17.18 Mbit/s
95th percentile per-packet one-way delay: 52.635 ms
Loss rate: 39.23%
-- Flow 2:
Average throughput: 3.45 Mbit/s
95th percentile per-packet one-way delay: 51.465 ms
Loss rate: 45.31%
-- Flow 3:
Average throughput: 2.19 Mbit/s
95th percentile per-packet one-way delay: 51.702 ms
Loss rate: 48.90%
```

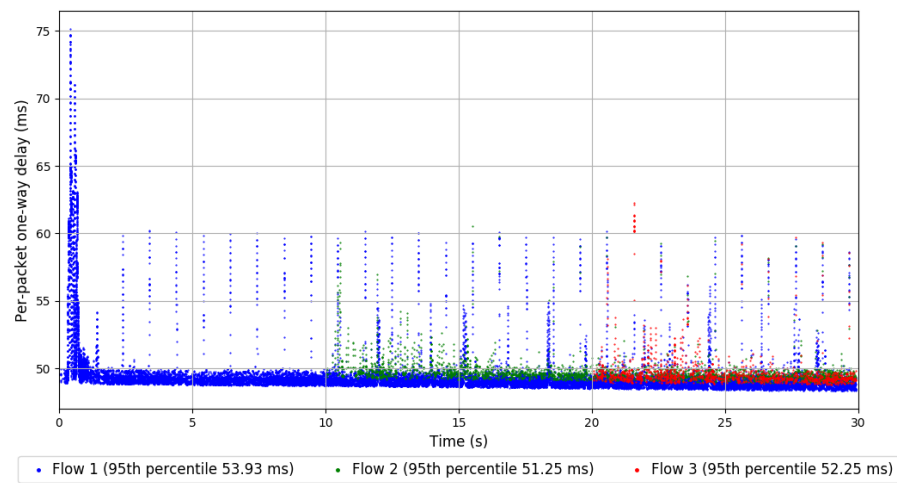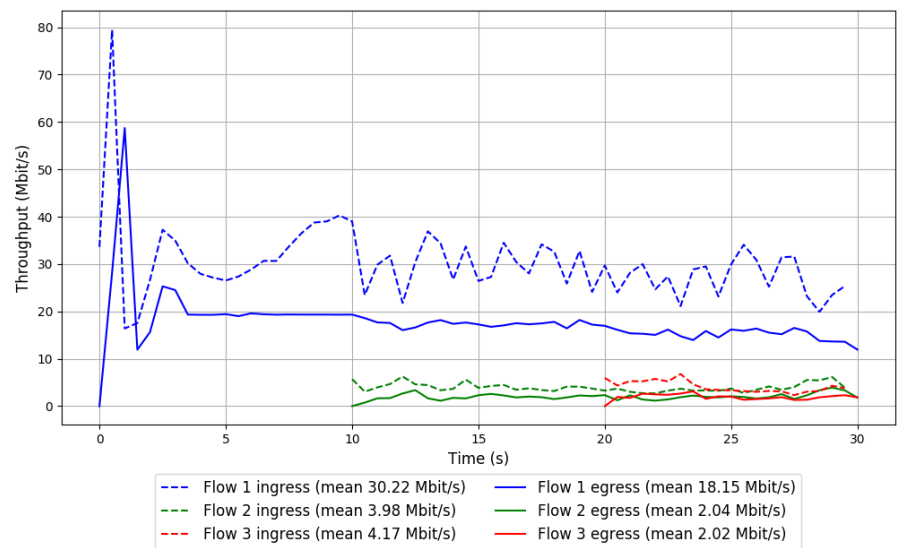Run 1: Report of Muses-25 — Data Link

```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 22:36:47
End at: 2018-09-05 22:37:17
Local clock offset: -7.835 ms
Remote clock offset: -12.448 ms


# Below is generated by plot.py at 2018-09-05 22:43:03
# Datalink statistics
-- Total of 3 flows:
Average throughput: 20.17 Mbit/s
95th percentile per-packet one-way delay: 53.458 ms
Loss rate: 41.27%
-- Flow 1:
Average throughput: 18.15 Mbit/s
95th percentile per-packet one-way delay: 53.933 ms
Loss rate: 40.11%
-- Flow 2:
Average throughput: 2.04 Mbit/s
95th percentile per-packet one-way delay: 51.246 ms
Loss rate: 48.96%
-- Flow 3:
Average throughput: 2.02 Mbit/s
95th percentile per-packet one-way delay: 52.248 ms
Loss rate: 51.94%
```

Run 2: Report of Muses-25 — Data Link

```
Run 3: Statistics of Muses-25

Start at: 2018-09-05 22:41:50
End at: 2018-09-05 22:42:20
Local clock offset: -3.013 ms
Remote clock offset: -12.614 ms

# Below is generated by plot.py at 2018-09-05 22:43:03
# Datalink statistics
-- Total of 3 flows:
Average throughput: 20.18 Mbit/s
95th percentile per-packet one-way delay: 53.490 ms
Loss rate: 43.40%
-- Flow 1:
Average throughput: 17.96 Mbit/s
95th percentile per-packet one-way delay: 54.017 ms
Loss rate: 42.71%
-- Flow 2:
Average throughput: 2.37 Mbit/s
95th percentile per-packet one-way delay: 51.195 ms
Loss rate: 47.49%
-- Flow 3:
Average throughput: 1.97 Mbit/s
95th percentile per-packet one-way delay: 51.546 ms
Loss rate: 50.52%
```

Run 3: Report of Muses-25 — Data Link