Pantheon Report

Generated at 2018-09-05 21:41:35 (UTC).

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

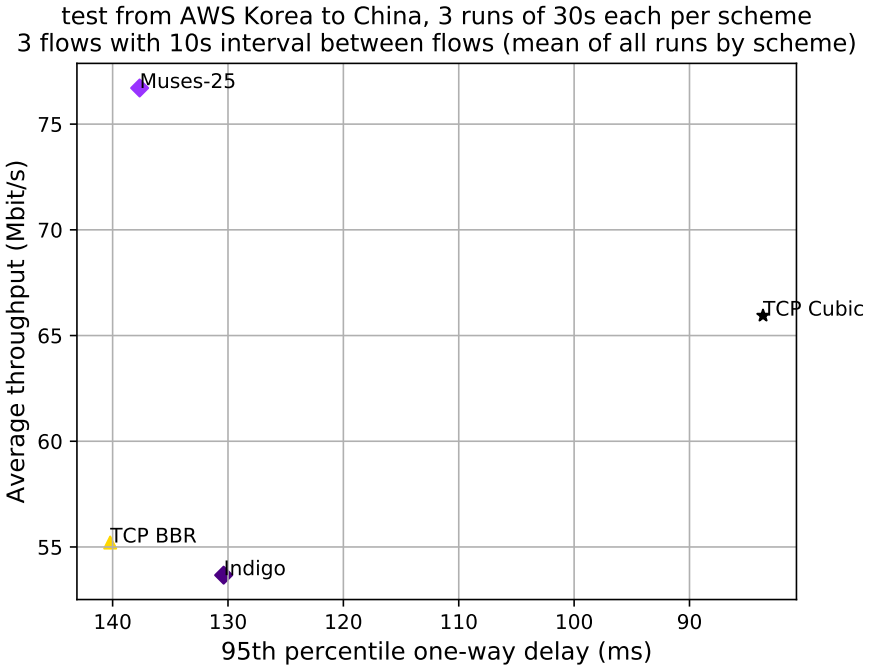
Repeated the test of 4 congestion control schemes 3 times.

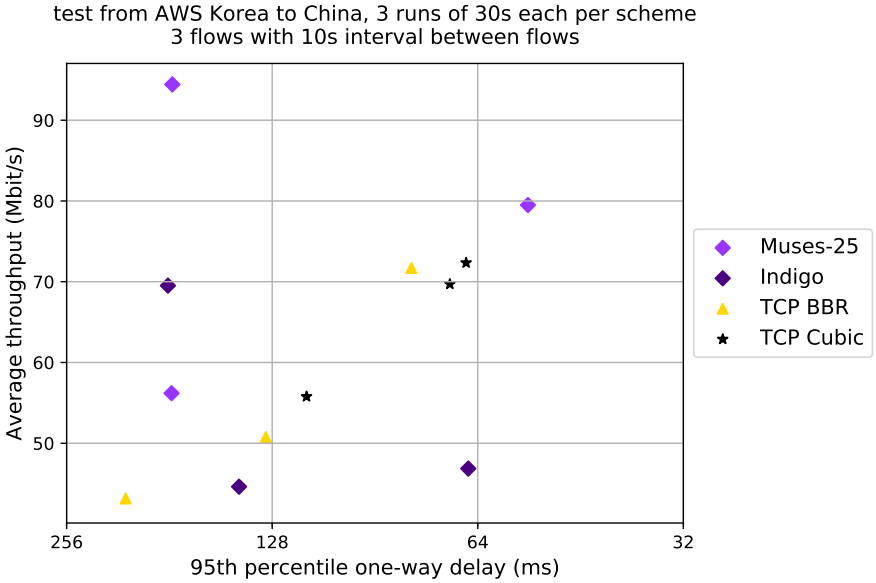
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

NTP offsets were measured against `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 AWS Korea to China, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
Muses-25
TCP Cubic
TCP BBR
Indigo
Average throughput (Mbit/s)
75
70
65
60
55
140
130
120
110
100
90
95th percentile one-way delay (ms)


test from AWS Korea to China, 3 runs of 30s each per scheme
3 flows with 10s interval between flows
Average throughput (Mbit/s)
90
80
70
60
50
256
128
64
32
95th percentile one-way delay (ms)
Muses-25
Indigo
TCP BBR
TCP Cubic

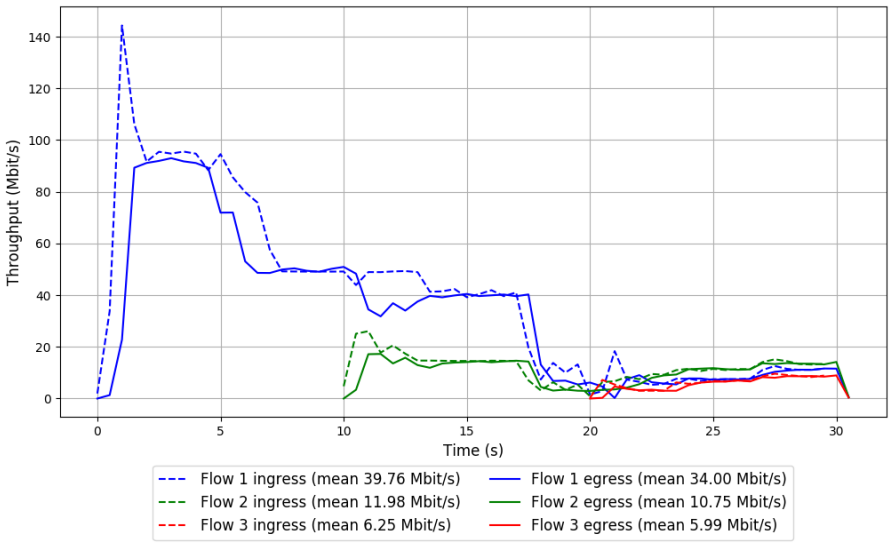
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	3	38.46	16.11	18.05	123.05	153.87	147.39	14.23	16.73	12.64
TCP Cubic	3	37.73	33.53	17.69	84.49	83.63	71.04	0.96	0.88	0.77
Indigo	3	30.43	31.09	8.66	125.19	132.16	205.18	7.61	12.79	26.50
Muses-25	3	48.55	25.89	33.67	133.98	154.07	126.95	1.71	2.31	1.66

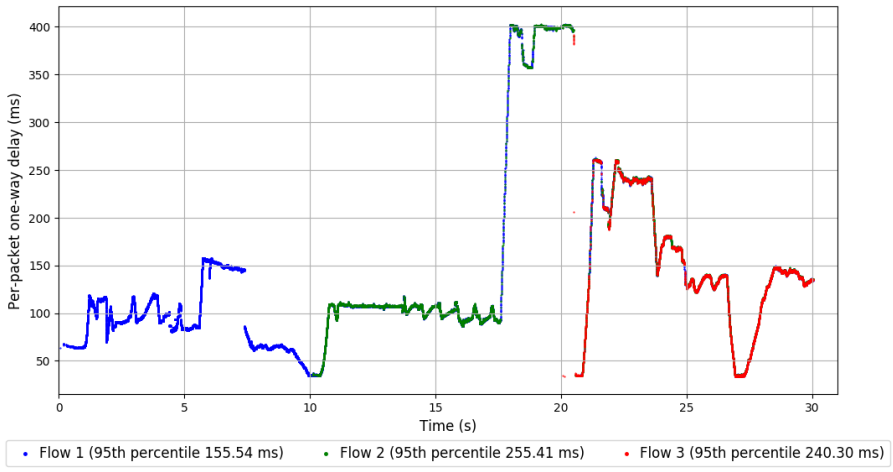
```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 21:27:43
End at: 2018-09-05 21:28:13
Local clock offset: -7.352 ms
Remote clock offset: -26.272 ms

# Below is generated by plot.py at 2018-09-05 21:40:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 43.16 Mbit/s
95th percentile per-packet one-way delay: 209.781 ms
Loss rate: 13.46%
-- Flow 1:
Average throughput: 34.00 Mbit/s
95th percentile per-packet one-way delay: 155.536 ms
Loss rate: 14.58%
-- Flow 2:
Average throughput: 10.75 Mbit/s
95th percentile per-packet one-way delay: 255.407 ms
Loss rate: 10.32%
-- Flow 3:
Average throughput: 5.99 Mbit/s
95th percentile per-packet one-way delay: 240.300 ms
Loss rate: 4.07%
```

Run 1: Report of TCP BBR — Data Link



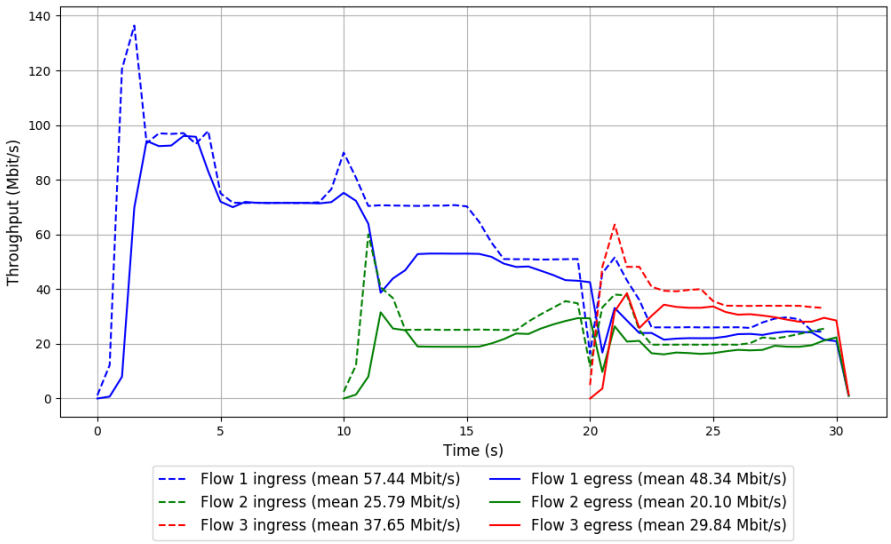


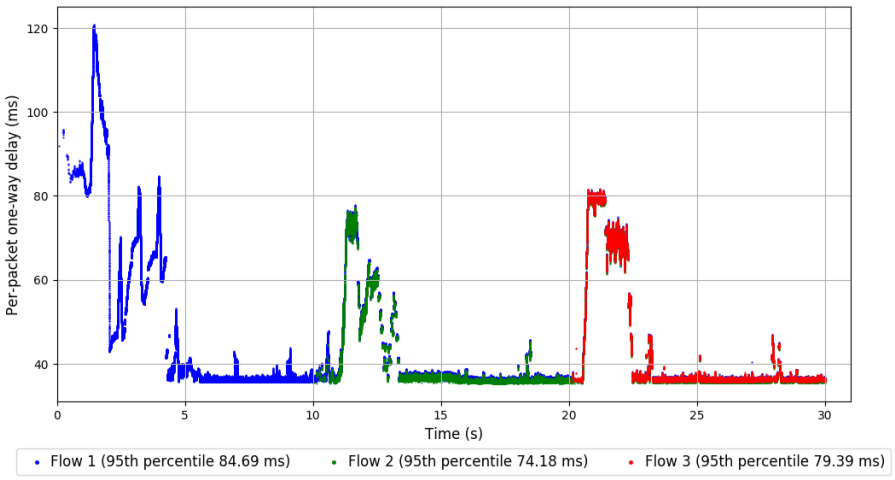
```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 21:33:04
End at: 2018-09-05 21:33:34
Local clock offset: -7.438 ms
Remote clock offset: -22.796 ms

# Below is generated by plot.py at 2018-09-05 21:41:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 71.70 Mbit/s
95th percentile per-packet one-way delay: 80.068 ms
Loss rate: 17.88%
-- Flow 1:
Average throughput: 48.34 Mbit/s
95th percentile per-packet one-way delay: 84.695 ms
Loss rate: 16.00%
-- Flow 2:
Average throughput: 20.10 Mbit/s
95th percentile per-packet one-way delay: 74.179 ms
Loss rate: 22.06%
-- Flow 3:
Average throughput: 29.84 Mbit/s
95th percentile per-packet one-way delay: 79.385 ms
Loss rate: 20.75%
```

Run 2: Report of TCP BBR — Data Link



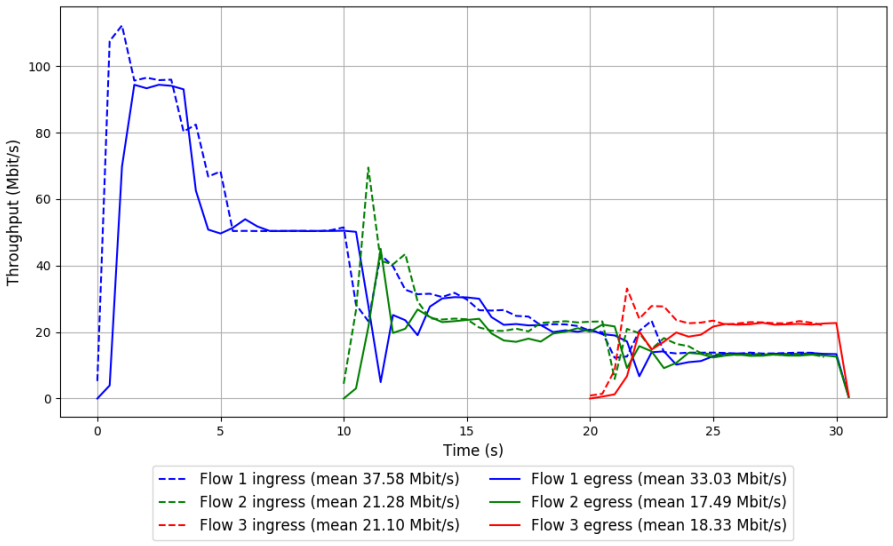


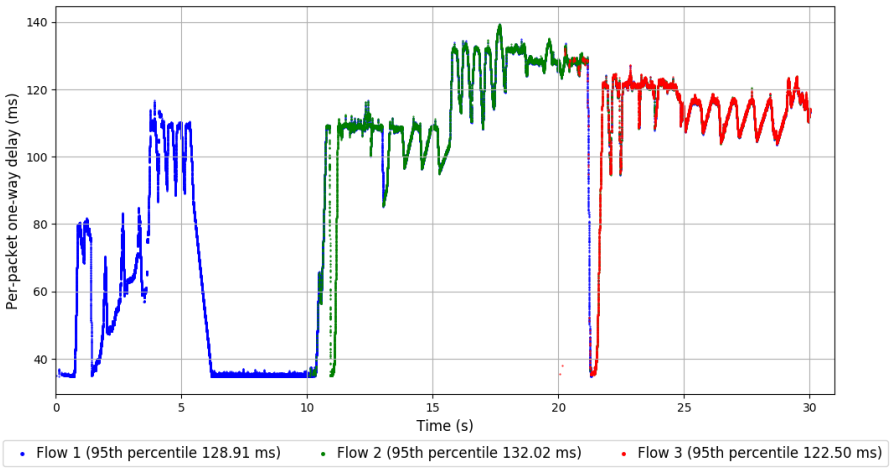
```
Run 3: Statistics of TCP BBR

Start at: 2018-09-05 21:38:15
End at: 2018-09-05 21:38:45
Local clock offset: -5.205 ms
Remote clock offset: -22.542 ms

# Below is generated by plot.py at 2018-09-05 21:41:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 50.77 Mbit/s
95th percentile per-packet one-way delay: 130.780 ms
Loss rate: 13.59%
-- Flow 1:
Average throughput: 33.03 Mbit/s
95th percentile per-packet one-way delay: 128.905 ms
Loss rate: 12.10%
-- Flow 2:
Average throughput: 17.49 Mbit/s
95th percentile per-packet one-way delay: 132.016 ms
Loss rate: 17.80%
-- Flow 3:
Average throughput: 18.33 Mbit/s
95th percentile per-packet one-way delay: 122.497 ms
Loss rate: 13.10%
```

Run 3: Report of TCP BBR — Data Link



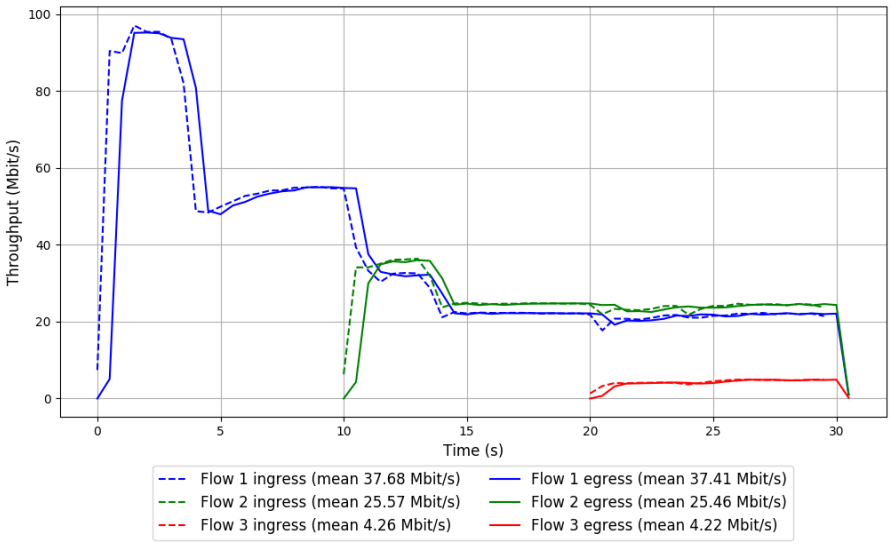


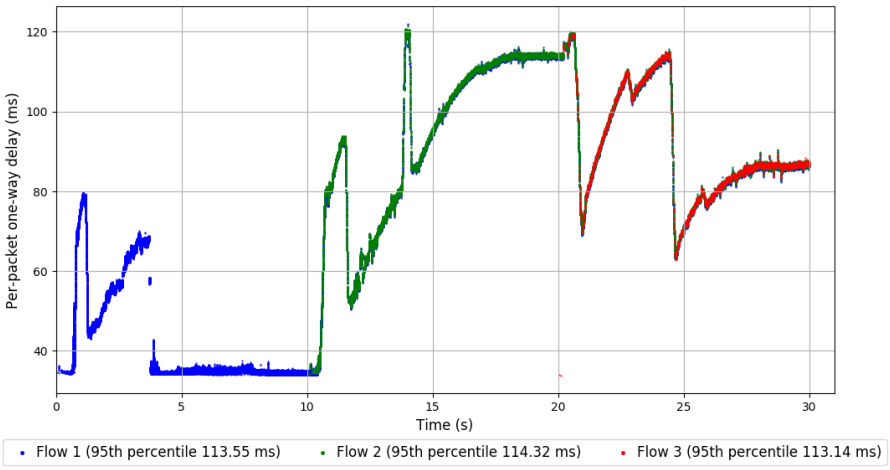
```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 21:28:59
End at: 2018-09-05 21:29:29
Local clock offset: -8.515 ms
Remote clock offset: -25.402 ms

# Below is generated by plot.py at 2018-09-05 21:41:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 55.78 Mbit/s
95th percentile per-packet one-way delay: 114.002 ms
Loss rate: 0.64%
-- Flow 1:
Average throughput: 37.41 Mbit/s
95th percentile per-packet one-way delay: 113.551 ms
Loss rate: 0.73%
-- Flow 2:
Average throughput: 25.46 Mbit/s
95th percentile per-packet one-way delay: 114.321 ms
Loss rate: 0.41%
-- Flow 3:
Average throughput: 4.22 Mbit/s
95th percentile per-packet one-way delay: 113.139 ms
Loss rate: 0.88%
```

Run 1: Report of TCP Cubic — Data Link



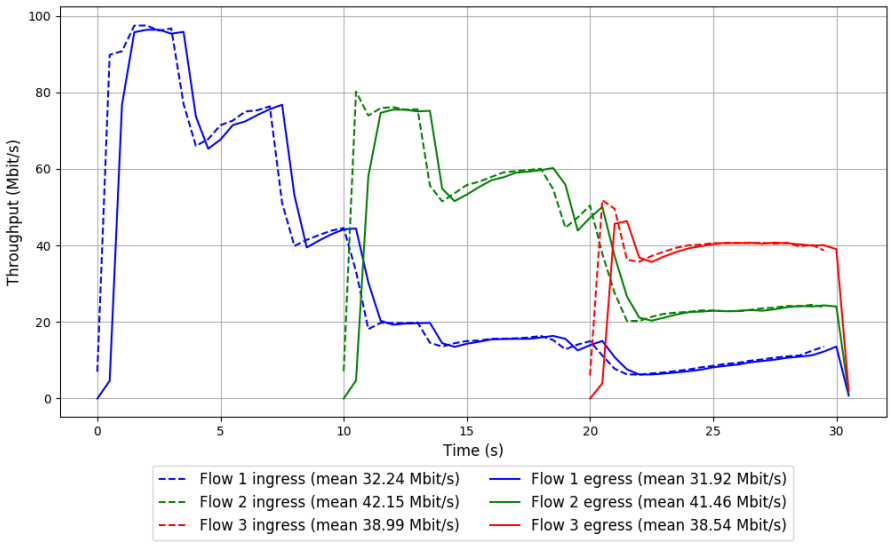


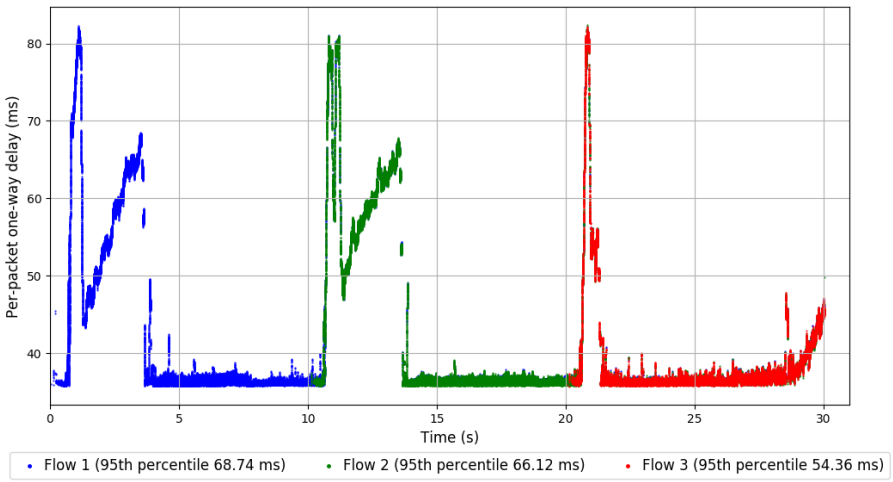
```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 21:34:22
End at: 2018-09-05 21:34:52
Local clock offset: -6.725 ms
Remote clock offset: -22.303 ms

# Below is generated by plot.py at 2018-09-05 21:41:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 72.34 Mbit/s
95th percentile per-packet one-way delay: 66.560 ms
Loss rate: 1.27%
-- Flow 1:
Average throughput: 31.92 Mbit/s
95th percentile per-packet one-way delay: 68.739 ms
Loss rate: 1.01%
-- Flow 2:
Average throughput: 41.46 Mbit/s
95th percentile per-packet one-way delay: 66.121 ms
Loss rate: 1.61%
-- Flow 3:
Average throughput: 38.54 Mbit/s
95th percentile per-packet one-way delay: 54.359 ms
Loss rate: 1.17%
```

Run 2: Report of TCP Cubic — Data Link



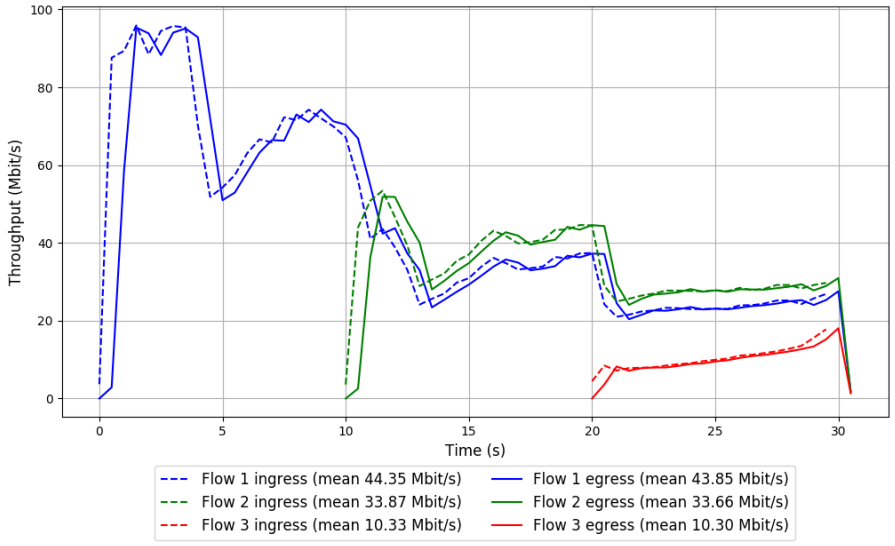


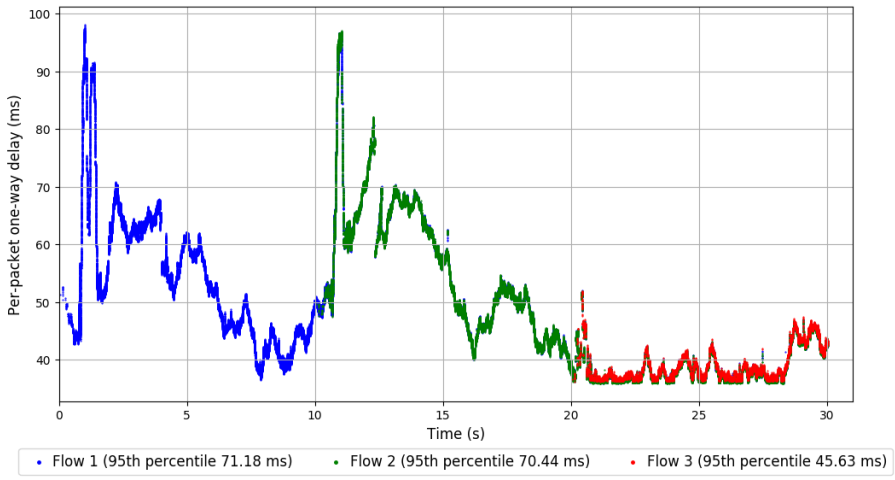
```
Run 3: Statistics of TCP Cubic

Start at: 2018-09-05 21:39:32
End at: 2018-09-05 21:40:02
Local clock offset: -5.173 ms
Remote clock offset: -21.525 ms

# Below is generated by plot.py at 2018-09-05 21:41:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 69.70 Mbit/s
95th percentile per-packet one-way delay: 70.320 ms
Loss rate: 0.93%
-- Flow 1:
Average throughput: 43.85 Mbit/s
95th percentile per-packet one-way delay: 71.182 ms
Loss rate: 1.14%
-- Flow 2:
Average throughput: 33.66 Mbit/s
95th percentile per-packet one-way delay: 70.436 ms
Loss rate: 0.63%
-- Flow 3:
Average throughput: 10.30 Mbit/s
95th percentile per-packet one-way delay: 45.629 ms
Loss rate: 0.27%
```

Run 3: Report of TCP Cubic — Data Link



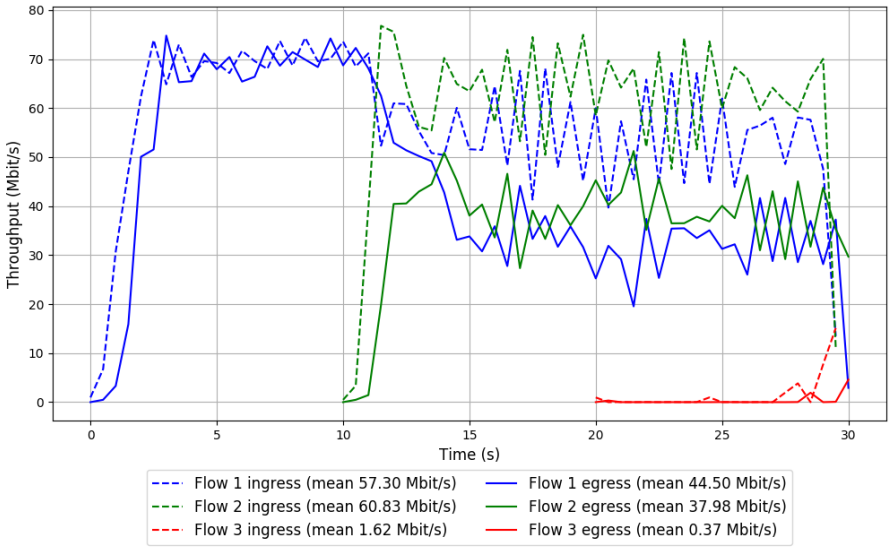


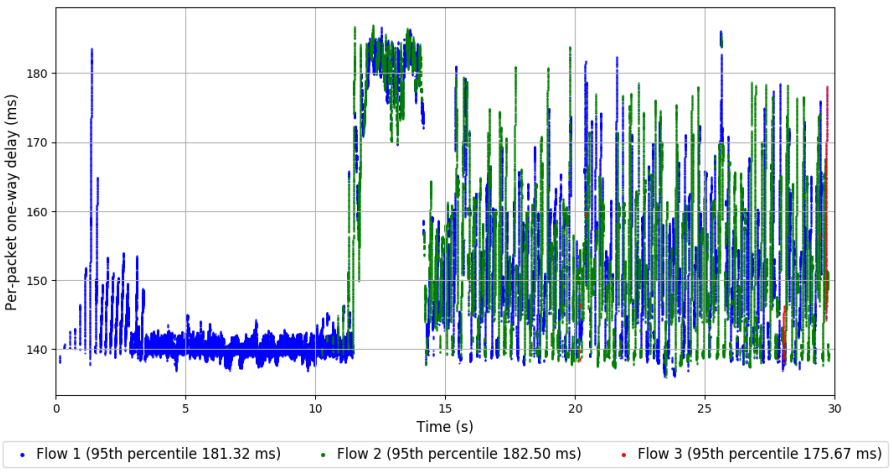
```
Run 1: Statistics of Indigo

Start at: 2018-09-05 21:26:21
End at: 2018-09-05 21:26:51
Local clock offset: -6.556 ms
Remote clock offset: -28.439 ms

# Below is generated by plot.py at 2018-09-05 21:41:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 69.52 Mbit/s
95th percentile per-packet one-way delay: 181.920 ms
Loss rate: 28.85%
-- Flow 1:
Average throughput: 44.50 Mbit/s
95th percentile per-packet one-way delay: 181.319 ms
Loss rate: 22.31%
-- Flow 2:
Average throughput: 37.98 Mbit/s
95th percentile per-packet one-way delay: 182.502 ms
Loss rate: 37.57%
-- Flow 3:
Average throughput: 0.37 Mbit/s
95th percentile per-packet one-way delay: 175.666 ms
Loss rate: 77.31%
```

Run 1: Report of Indigo — Data Link



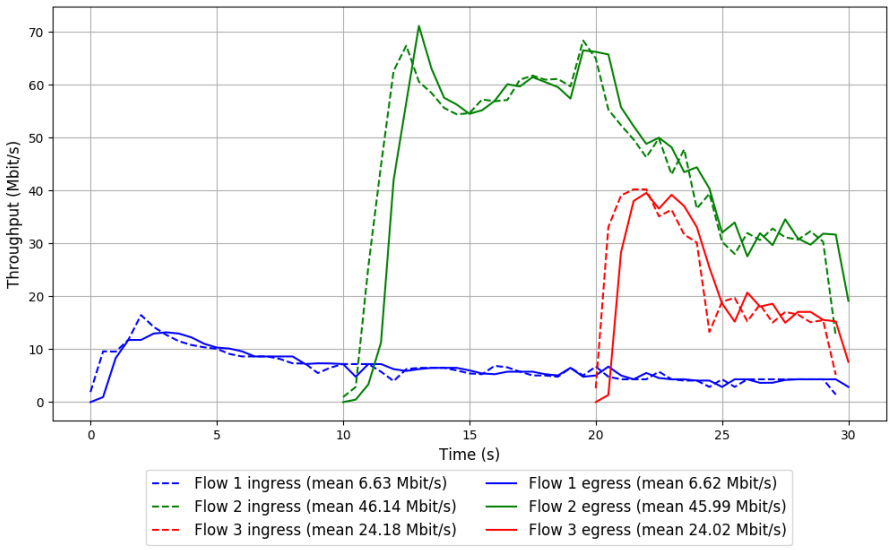


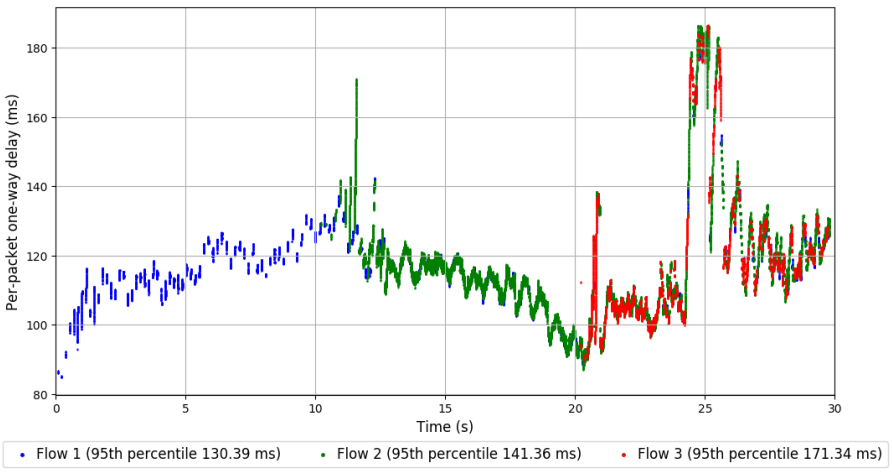
```
Run 2: Statistics of Indigo

Start at: 2018-09-05 21:31:39
End at: 2018-09-05 21:32:09
Local clock offset: -9.134 ms
Remote clock offset: -23.374 ms

# Below is generated by plot.py at 2018-09-05 21:41:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 44.62 Mbit/s
95th percentile per-packet one-way delay: 143.132 ms
Loss rate: 0.28%
-- Flow 1:
Average throughput: 6.62 Mbit/s
95th percentile per-packet one-way delay: 130.391 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 45.99 Mbit/s
95th percentile per-packet one-way delay: 141.357 ms
Loss rate: 0.34%
-- Flow 3:
Average throughput: 24.02 Mbit/s
95th percentile per-packet one-way delay: 171.335 ms
Loss rate: 0.29%
```

Run 2: Report of Indigo — Data Link



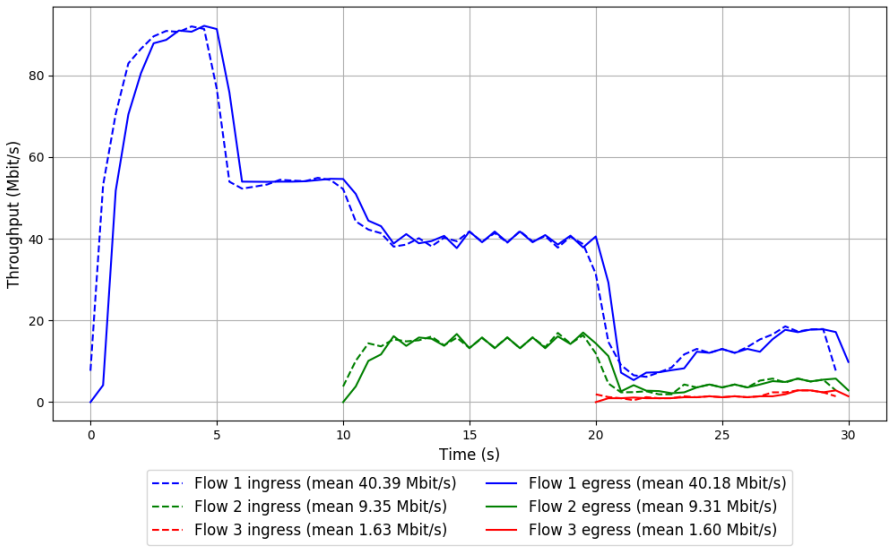


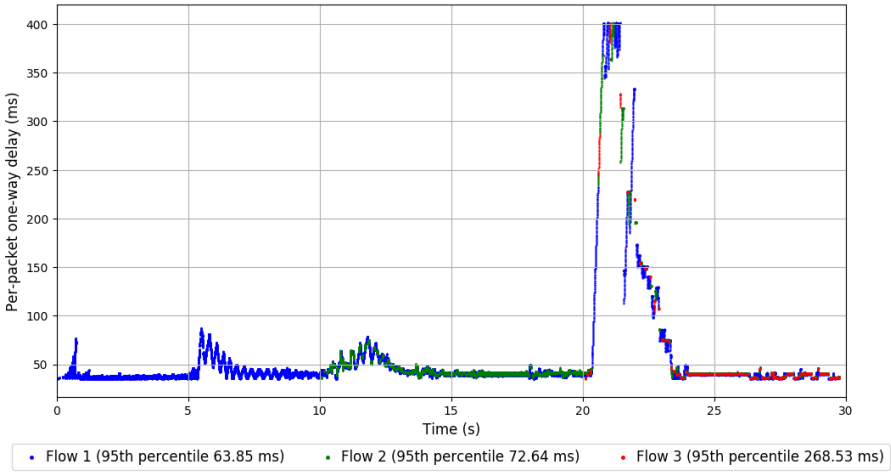
```
Run 3: Statistics of Indigo

Start at: 2018-09-05 21:36:58
End at: 2018-09-05 21:37:28
Local clock offset: -5.411 ms
Remote clock offset: -22.292 ms

# Below is generated by plot.py at 2018-09-05 21:41:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 46.86 Mbit/s
95th percentile per-packet one-way delay: 66.080 ms
Loss rate: 0.53%
-- Flow 1:
Average throughput: 40.18 Mbit/s
95th percentile per-packet one-way delay: 63.853 ms
Loss rate: 0.53%
-- Flow 2:
Average throughput: 9.31 Mbit/s
95th percentile per-packet one-way delay: 72.635 ms
Loss rate: 0.45%
-- Flow 3:
Average throughput: 1.60 Mbit/s
95th percentile per-packet one-way delay: 268.531 ms
Loss rate: 1.90%
```

Run 3: Report of Indigo — Data Link



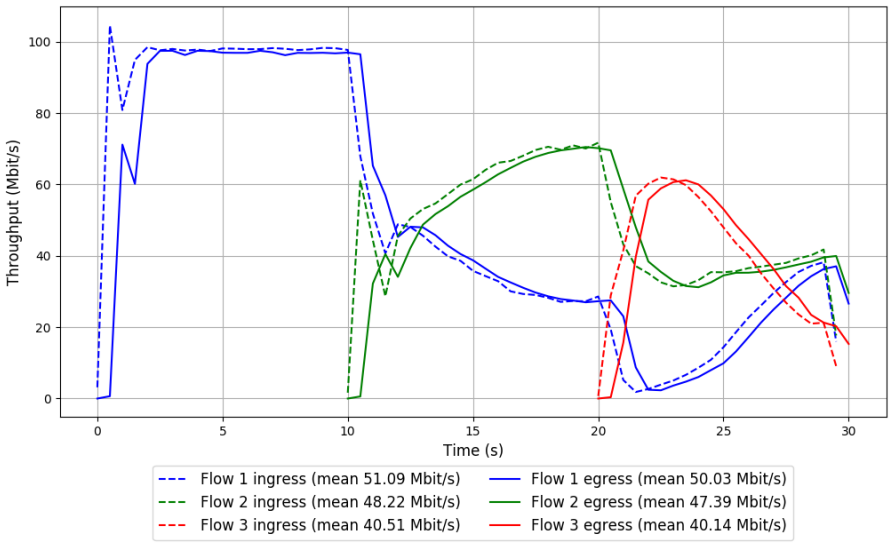


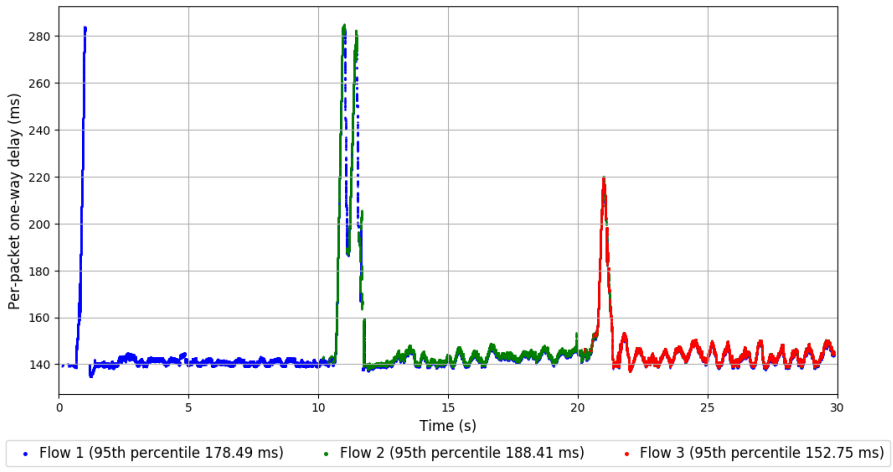
```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 21:24:51
End at: 2018-09-05 21:25:21
Local clock offset: -5.329 ms
Remote clock offset: -29.904 ms

# Below is generated by plot.py at 2018-09-05 21:41:34
# Datalink statistics
-- Total of 3 flows:
Average throughput: 94.43 Mbit/s
95th percentile per-packet one-way delay: 179.229 ms
Loss rate: 1.79%
-- Flow 1:
Average throughput: 50.03 Mbit/s
95th percentile per-packet one-way delay: 178.487 ms
Loss rate: 2.06%
-- Flow 2:
Average throughput: 47.39 Mbit/s
95th percentile per-packet one-way delay: 188.406 ms
Loss rate: 1.72%
-- Flow 3:
Average throughput: 40.14 Mbit/s
95th percentile per-packet one-way delay: 152.755 ms
Loss rate: 0.92%
```

Run 1: Report of Muses-25 — Data Link



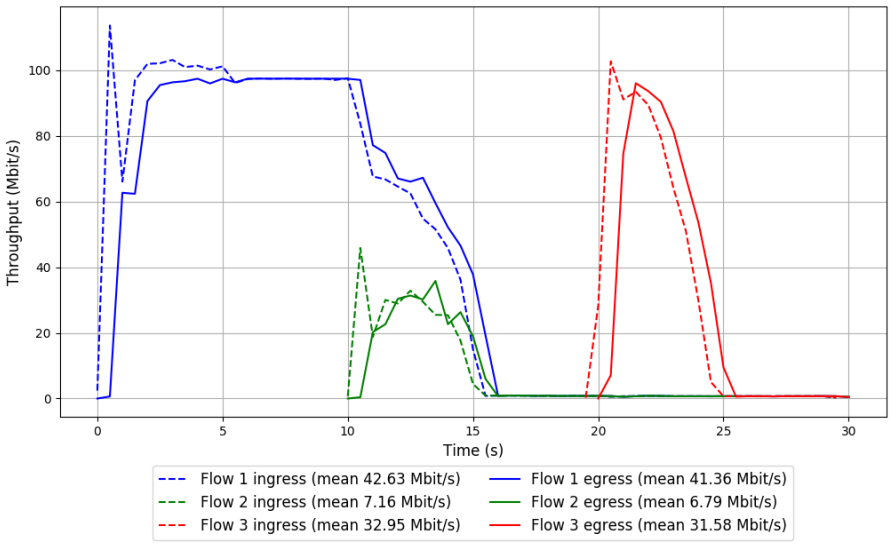


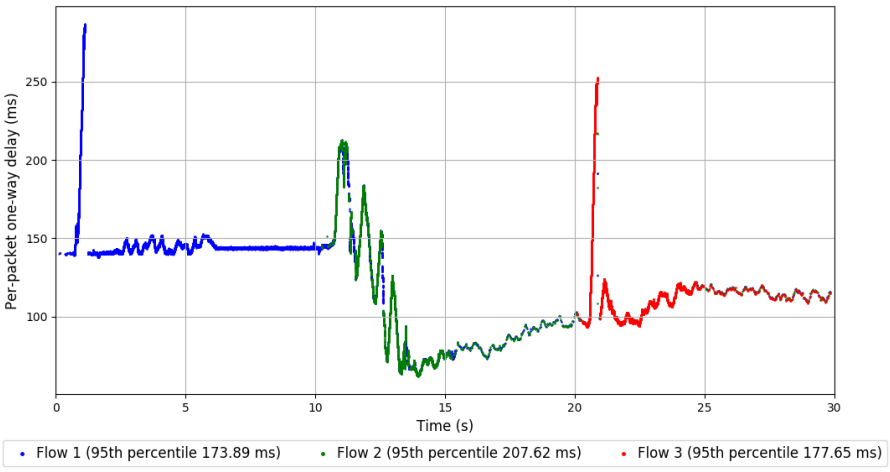
```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 21:30:18
End at: 2018-09-05 21:30:48
Local clock offset: -9.512 ms
Remote clock offset: -24.33 ms

# Below is generated by plot.py at 2018-09-05 21:41:34
# Datalink statistics
-- Total of 3 flows:
Average throughput: 56.19 Mbit/s
95th percentile per-packet one-way delay: 179.704 ms
Loss rate: 3.42%
-- Flow 1:
Average throughput: 41.36 Mbit/s
95th percentile per-packet one-way delay: 173.890 ms
Loss rate: 3.07%
-- Flow 2:
Average throughput: 6.79 Mbit/s
95th percentile per-packet one-way delay: 207.624 ms
Loss rate: 5.22%
-- Flow 3:
Average throughput: 31.58 Mbit/s
95th percentile per-packet one-way delay: 177.646 ms
Loss rate: 4.05%
```

Run 2: Report of Muses-25 — Data Link





```
Run 3: Statistics of Muses-25

Start at: 2018-09-05 21:35:40
End at: 2018-09-05 21:36:10
Local clock offset: -6.208 ms
Remote clock offset: -22.177 ms

# Below is generated by plot.py at 2018-09-05 21:41:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 79.50 Mbit/s
95th percentile per-packet one-way delay: 54.040 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 54.27 Mbit/s
95th percentile per-packet one-way delay: 49.565 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 23.50 Mbit/s
95th percentile per-packet one-way delay: 66.184 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 29.28 Mbit/s
95th percentile per-packet one-way delay: 50.461 ms
Loss rate: 0.00%
```

Run 3: Report of Muses-25 — Data Link