Pantheon Report

Generated at 2018-09-05 21:40:11 (UTC).

Data path: AWS India 1 on `ens5` (*local*) →India on `em1` (*remote*).

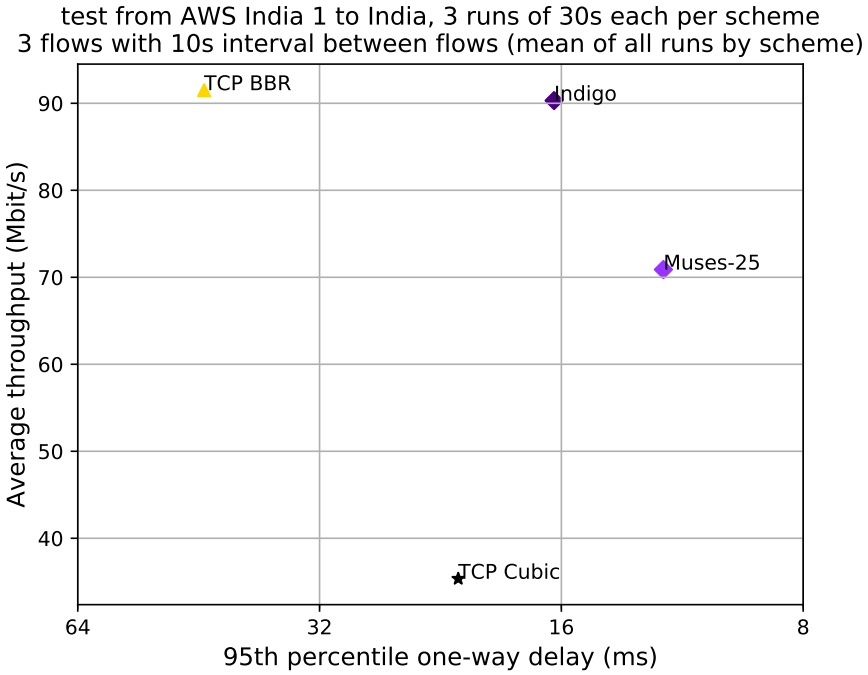
Repeated the test of 4 congestion control schemes 3 times.

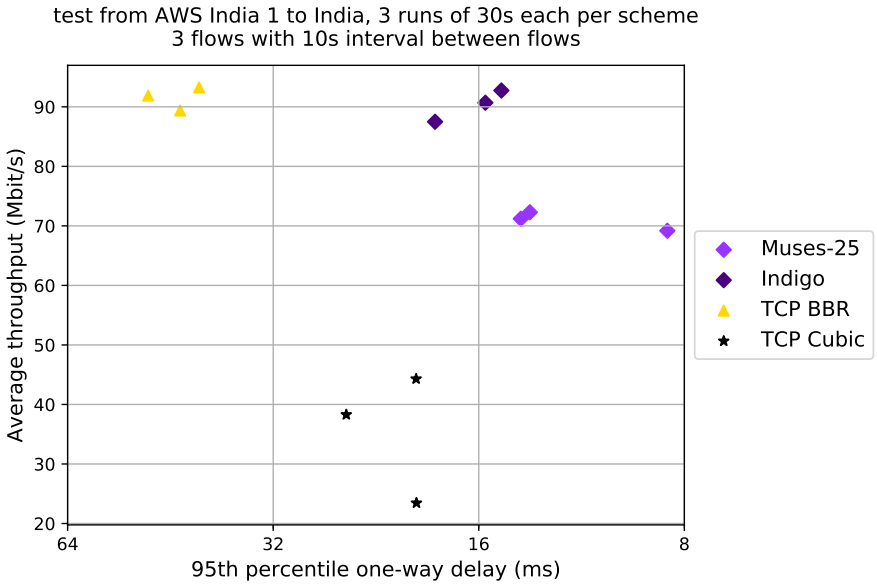
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

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 1 to India, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
TCP BBR
Indigo
Muses-25
TCP Cubic
Average throughput (Mbit/s)
95th percentile one-way delay (ms)
90
80
70
60
50
40
64
32
16
8


test from AWS India 1 to India, 3 runs of 30s each per scheme
3 flows with 10s interval between flows
Average throughput (Mbit/s)
95th percentile one-way delay (ms)
Muses-25
Indigo
TCP BBR
TCP Cubic
90
80
70
60
50
40
30
20
64
32
16
8

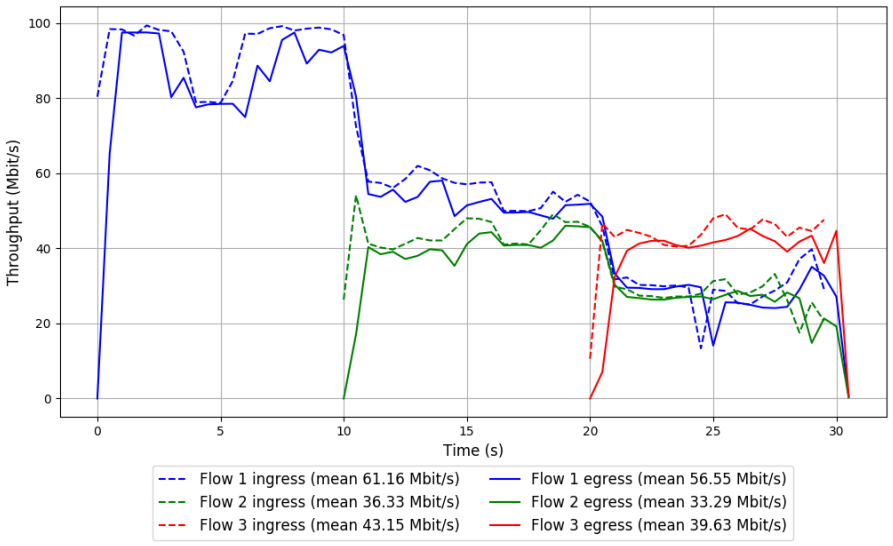
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	3	56.83	32.91	38.44	42.62	45.13	46.92	7.59	8.73	10.85
TCP Cubic	3	19.96	14.77	16.67	17.98	17.52	24.97	0.23	0.27	0.87
Indigo	3	53.32	38.46	34.97	15.59	16.50	17.07	6.80	5.43	5.96
Muses-25	3	38.61	30.73	35.87	11.23	12.06	16.68	3.36	3.74	4.55

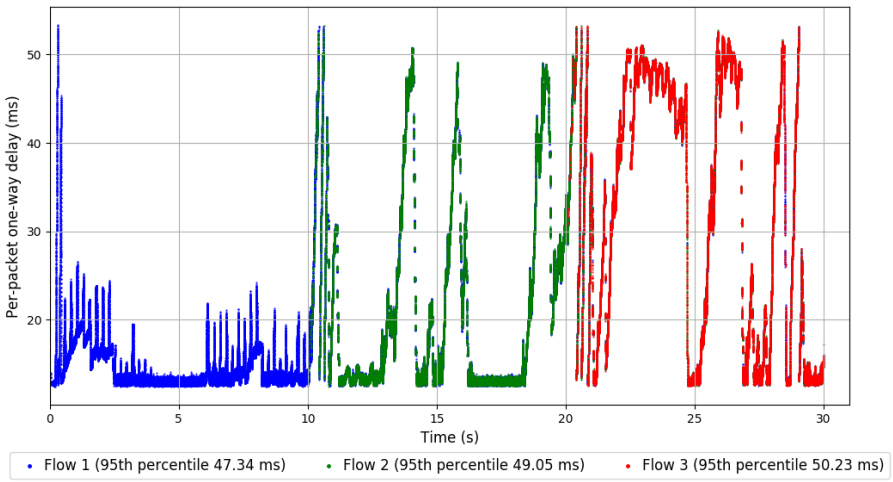
```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 21:27:07
End at: 2018-09-05 21:27:37
Local clock offset: -2.703 ms
Remote clock offset: -3.106 ms

# Below is generated by plot.py at 2018-09-05 21:39:57
# Datalink statistics
-- Total of 3 flows:
Average throughput: 91.88 Mbit/s
95th percentile per-packet one-way delay: 48.779 ms
Loss rate: 7.84%
-- Flow 1:
Average throughput: 56.55 Mbit/s
95th percentile per-packet one-way delay: 47.343 ms
Loss rate: 7.54%
-- Flow 2:
Average throughput: 33.29 Mbit/s
95th percentile per-packet one-way delay: 49.047 ms
Loss rate: 8.34%
-- Flow 3:
Average throughput: 39.63 Mbit/s
95th percentile per-packet one-way delay: 50.230 ms
Loss rate: 8.28%
```

Run 1: Report of TCP BBR — Data Link



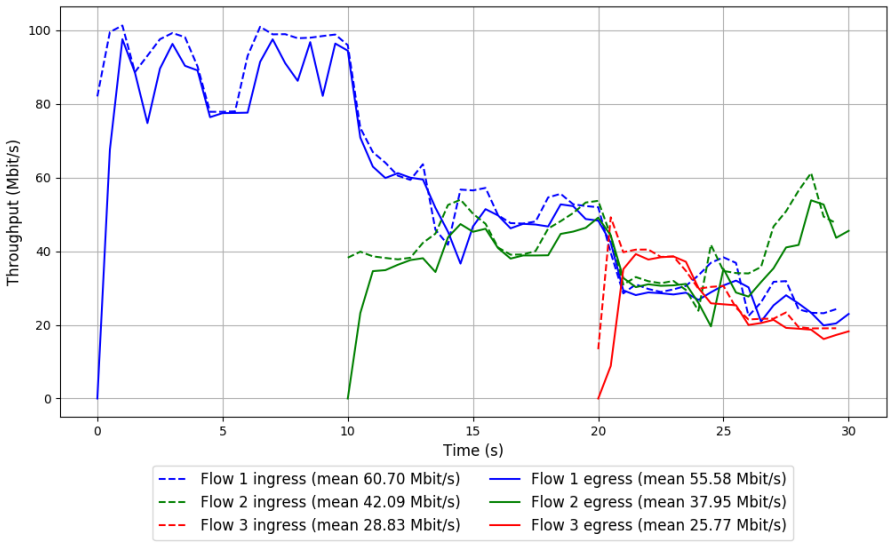


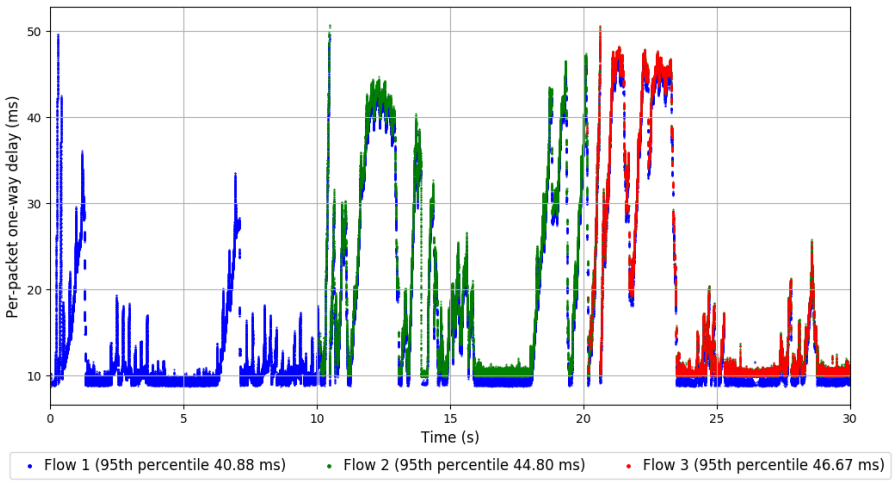
```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 21:31:51
End at: 2018-09-05 21:32:21
Local clock offset: -0.081 ms
Remote clock offset: -3.338 ms

# Below is generated by plot.py at 2018-09-05 21:39:57
# Datalink statistics
-- Total of 3 flows:
Average throughput: 89.38 Mbit/s
95th percentile per-packet one-way delay: 43.793 ms
Loss rate: 9.08%
-- Flow 1:
Average throughput: 55.58 Mbit/s
95th percentile per-packet one-way delay: 40.881 ms
Loss rate: 8.43%
-- Flow 2:
Average throughput: 37.95 Mbit/s
95th percentile per-packet one-way delay: 44.795 ms
Loss rate: 9.87%
-- Flow 3:
Average throughput: 25.77 Mbit/s
95th percentile per-packet one-way delay: 46.672 ms
Loss rate: 10.93%
```

Run 2: Report of TCP BBR — Data Link



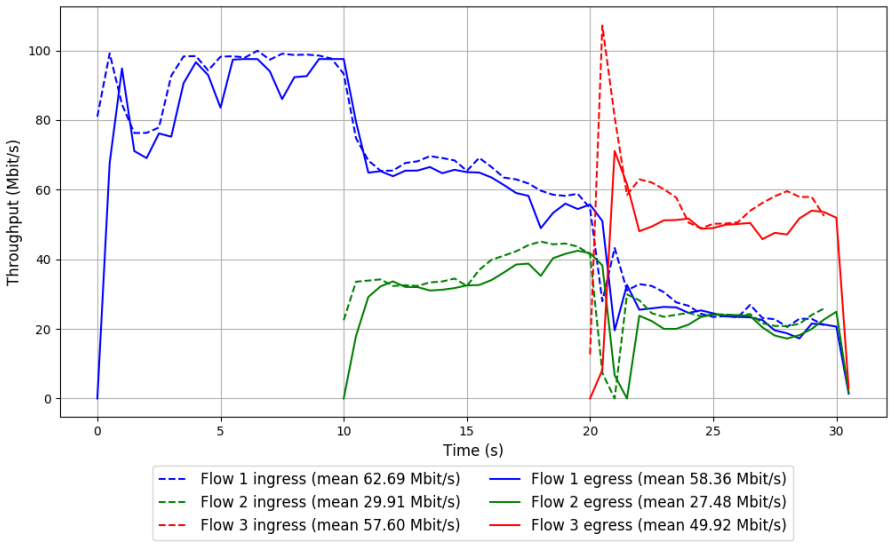


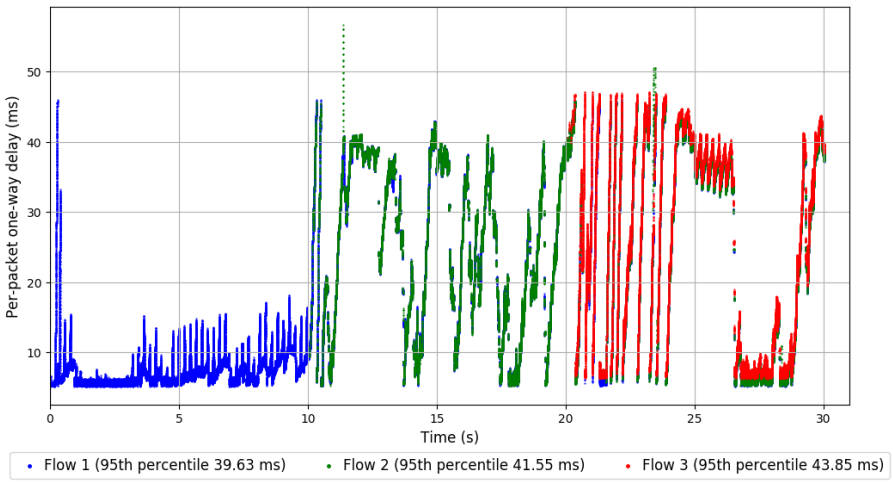
```
Run 3: Statistics of TCP BBR

Start at: 2018-09-05 21:36:38
End at: 2018-09-05 21:37:08
Local clock offset: 4.0 ms
Remote clock offset: -2.682 ms

# Below is generated by plot.py at 2018-09-05 21:39:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 93.25 Mbit/s
95th percentile per-packet one-way delay: 41.089 ms
Loss rate: 8.27%
-- Flow 1:
Average throughput: 58.36 Mbit/s
95th percentile per-packet one-way delay: 39.628 ms
Loss rate: 6.80%
-- Flow 2:
Average throughput: 27.48 Mbit/s
95th percentile per-packet one-way delay: 41.554 ms
Loss rate: 7.99%
-- Flow 3:
Average throughput: 49.92 Mbit/s
95th percentile per-packet one-way delay: 43.848 ms
Loss rate: 13.35%
```

Run 3: Report of TCP BBR — Data Link



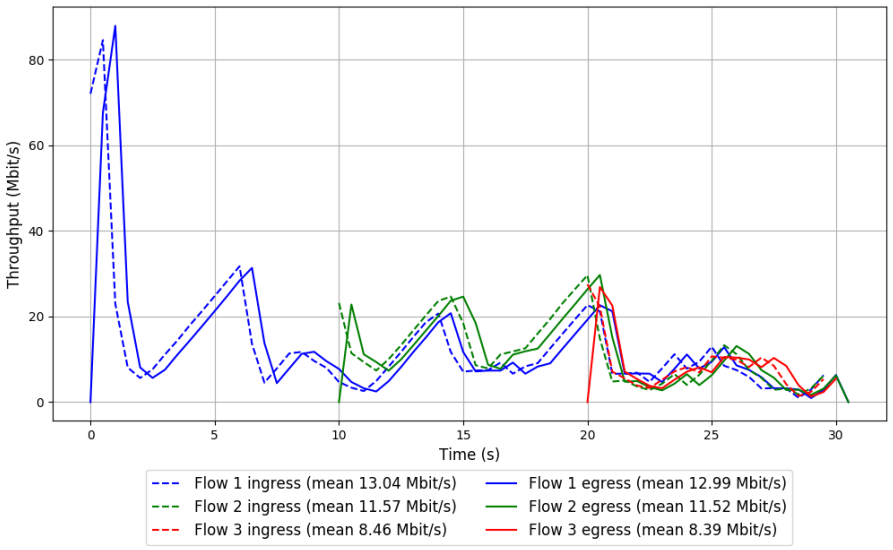


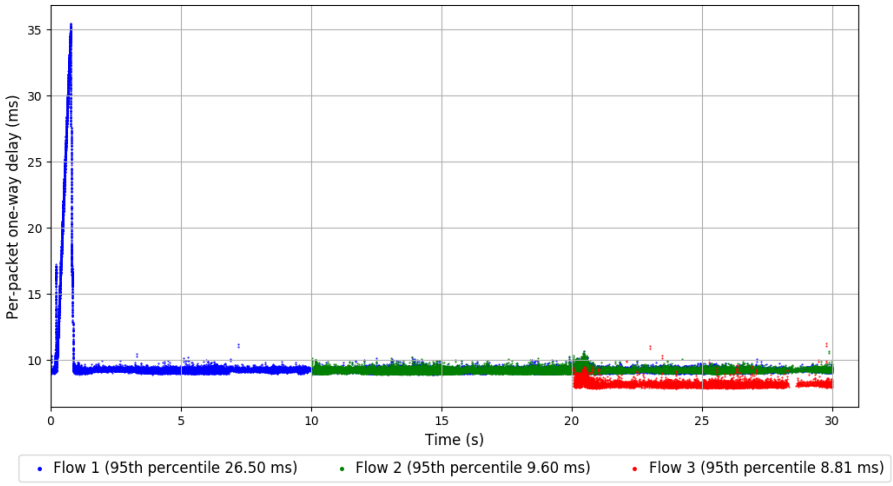
```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 21:24:48
End at: 2018-09-05 21:25:18
Local clock offset: 1.625 ms
Remote clock offset: -2.08 ms

# Below is generated by plot.py at 2018-09-05 21:39:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 23.45 Mbit/s
95th percentile per-packet one-way delay: 19.740 ms
Loss rate: 0.45%
-- Flow 1:
Average throughput: 12.99 Mbit/s
95th percentile per-packet one-way delay: 26.504 ms
Loss rate: 0.41%
-- Flow 2:
Average throughput: 11.52 Mbit/s
95th percentile per-packet one-way delay: 9.595 ms
Loss rate: 0.41%
-- Flow 3:
Average throughput: 8.39 Mbit/s
95th percentile per-packet one-way delay: 8.809 ms
Loss rate: 0.77%
```

Run 1: Report of TCP Cubic — Data Link



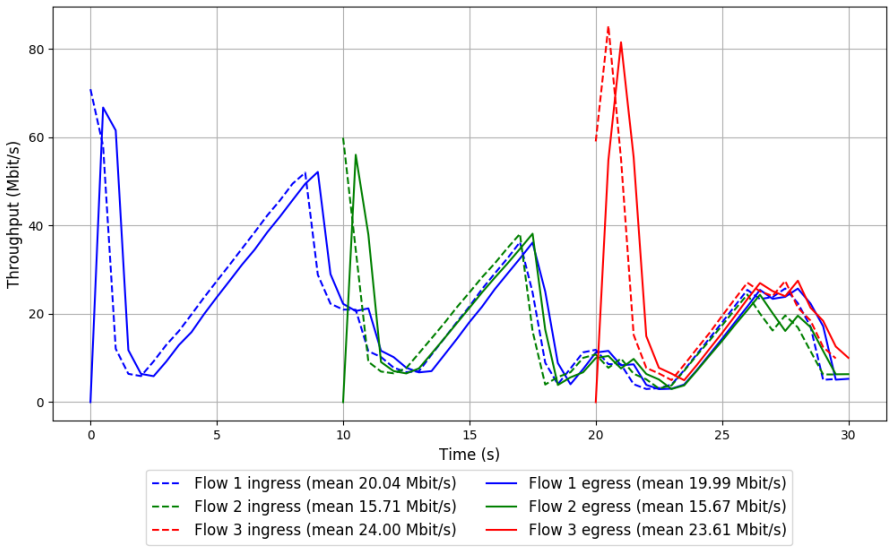


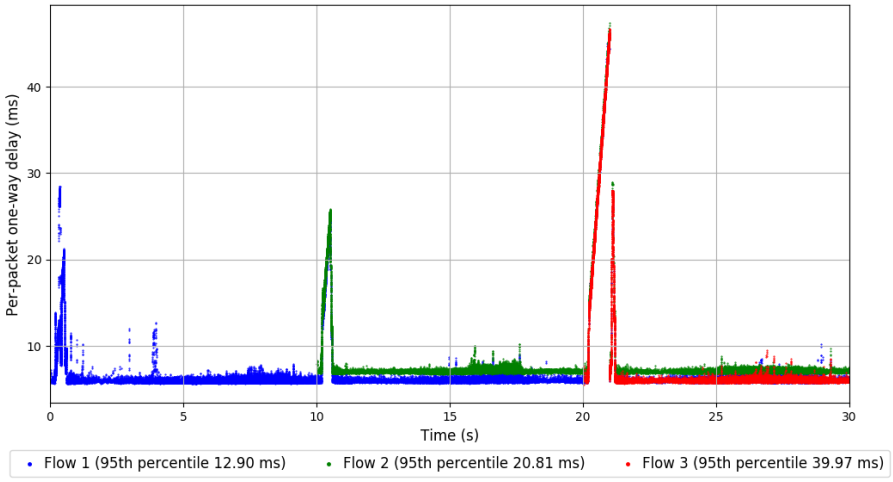
```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 21:29:33
End at: 2018-09-05 21:30:03
Local clock offset: 3.941 ms
Remote clock offset: -2.515 ms

# Below is generated by plot.py at 2018-09-05 21:39:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 38.29 Mbit/s
95th percentile per-packet one-way delay: 25.008 ms
Loss rate: 0.53%
-- Flow 1:
Average throughput: 19.99 Mbit/s
95th percentile per-packet one-way delay: 12.903 ms
Loss rate: 0.22%
-- Flow 2:
Average throughput: 15.67 Mbit/s
95th percentile per-packet one-way delay: 20.814 ms
Loss rate: 0.26%
-- Flow 3:
Average throughput: 23.61 Mbit/s
95th percentile per-packet one-way delay: 39.969 ms
Loss rate: 1.67%
```

Run 2: Report of TCP Cubic — Data Link



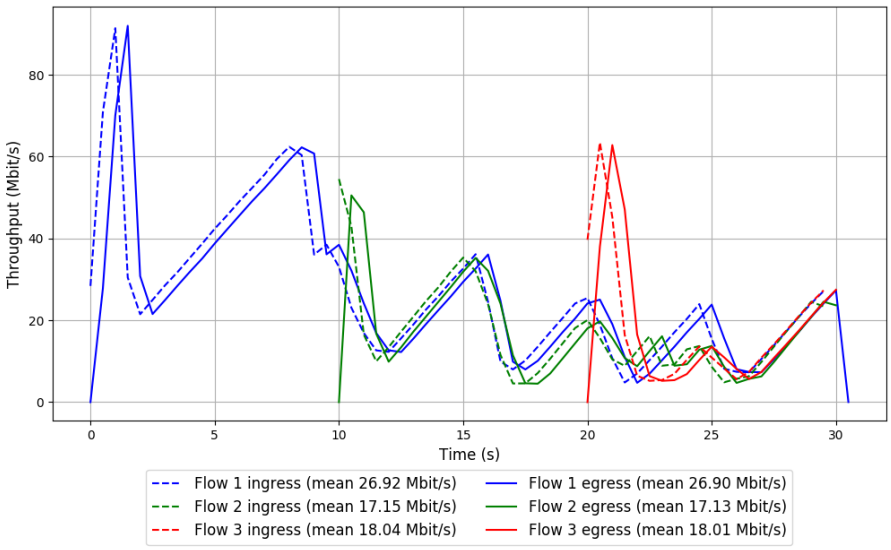


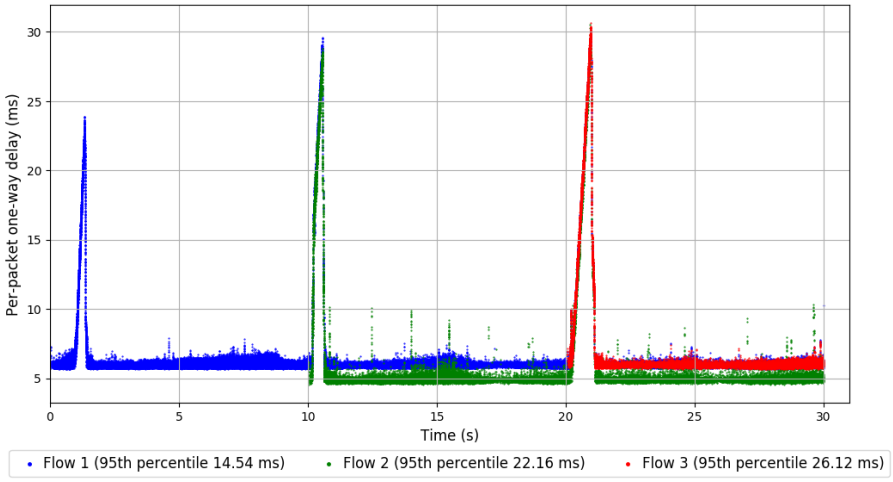
```
Run 3: Statistics of TCP Cubic

Start at: 2018-09-05 21:34:17
End at: 2018-09-05 21:34:47
Local clock offset: 4.23 ms
Remote clock offset: -3.032 ms

# Below is generated by plot.py at 2018-09-05 21:39:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 44.30 Mbit/s
95th percentile per-packet one-way delay: 19.763 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 26.90 Mbit/s
95th percentile per-packet one-way delay: 14.543 ms
Loss rate: 0.07%
-- Flow 2:
Average throughput: 17.13 Mbit/s
95th percentile per-packet one-way delay: 22.162 ms
Loss rate: 0.14%
-- Flow 3:
Average throughput: 18.01 Mbit/s
95th percentile per-packet one-way delay: 26.124 ms
Loss rate: 0.17%
```

Run 3: Report of TCP Cubic — Data Link



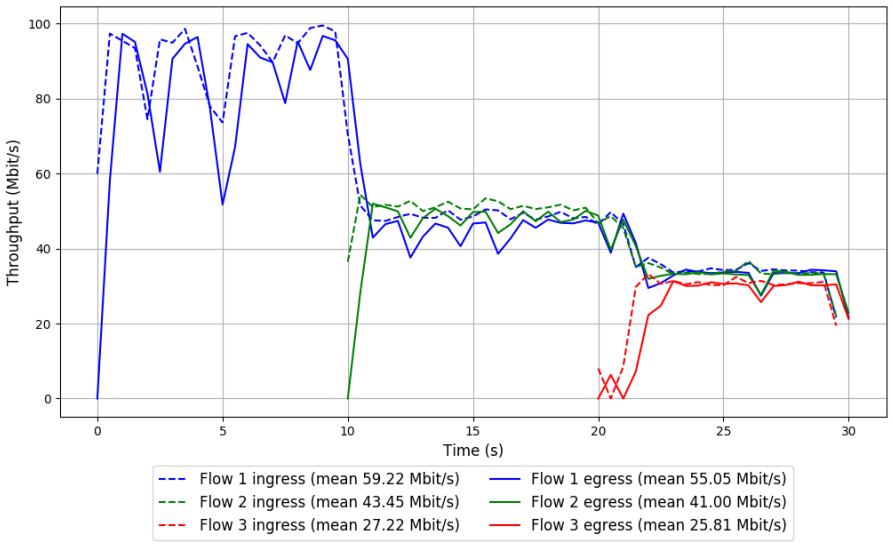


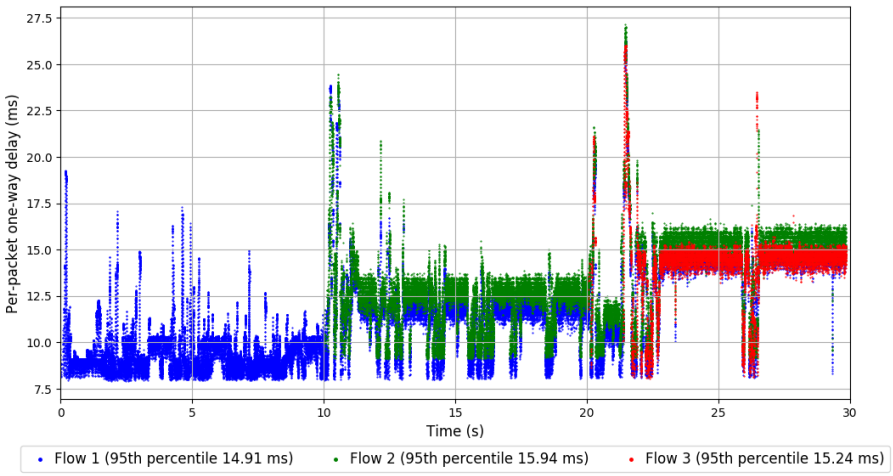
```
Run 1: Statistics of Indigo

Start at: 2018-09-05 21:28:20
End at: 2018-09-05 21:28:50
Local clock offset: 0.759 ms
Remote clock offset: -3.207 ms

# Below is generated by plot.py at 2018-09-05 21:39:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 90.69 Mbit/s
95th percentile per-packet one-way delay: 15.648 ms
Loss rate: 6.42%
-- Flow 1:
Average throughput: 55.05 Mbit/s
95th percentile per-packet one-way delay: 14.915 ms
Loss rate: 7.01%
-- Flow 2:
Average throughput: 41.00 Mbit/s
95th percentile per-packet one-way delay: 15.940 ms
Loss rate: 5.60%
-- Flow 3:
Average throughput: 25.81 Mbit/s
95th percentile per-packet one-way delay: 15.245 ms
Loss rate: 5.15%
```

Run 1: Report of Indigo — Data Link



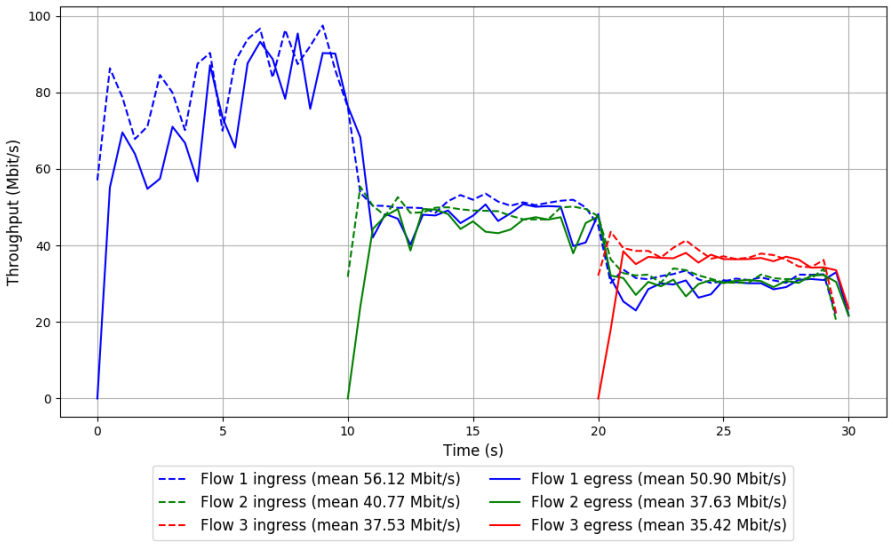


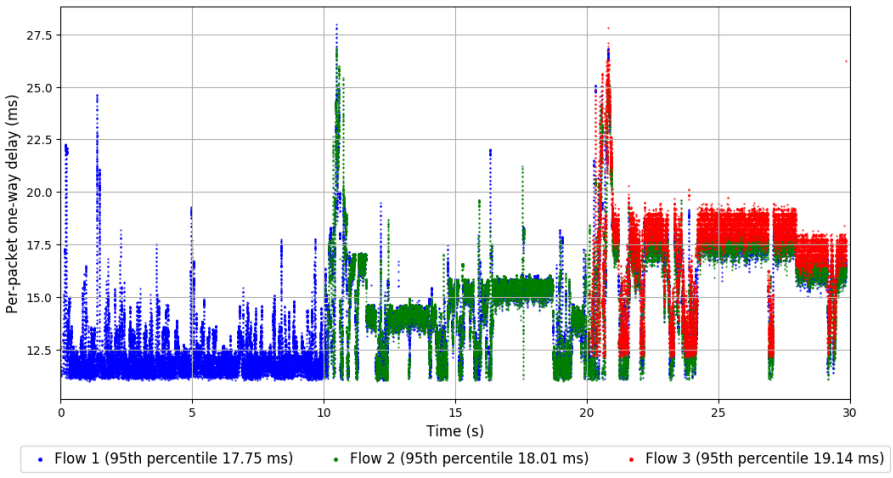
```
Run 2: Statistics of Indigo

Start at: 2018-09-05 21:33:04
End at: 2018-09-05 21:33:34
Local clock offset: -2.495 ms
Remote clock offset: -3.375 ms

# Below is generated by plot.py at 2018-09-05 21:39:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 87.49 Mbit/s
95th percentile per-packet one-way delay: 18.540 ms
Loss rate: 8.33%
-- Flow 1:
Average throughput: 50.90 Mbit/s
95th percentile per-packet one-way delay: 17.753 ms
Loss rate: 9.27%
-- Flow 2:
Average throughput: 37.63 Mbit/s
95th percentile per-packet one-way delay: 18.006 ms
Loss rate: 7.66%
-- Flow 3:
Average throughput: 35.42 Mbit/s
95th percentile per-packet one-way delay: 19.139 ms
Loss rate: 5.49%
```

Run 2: Report of Indigo — Data Link



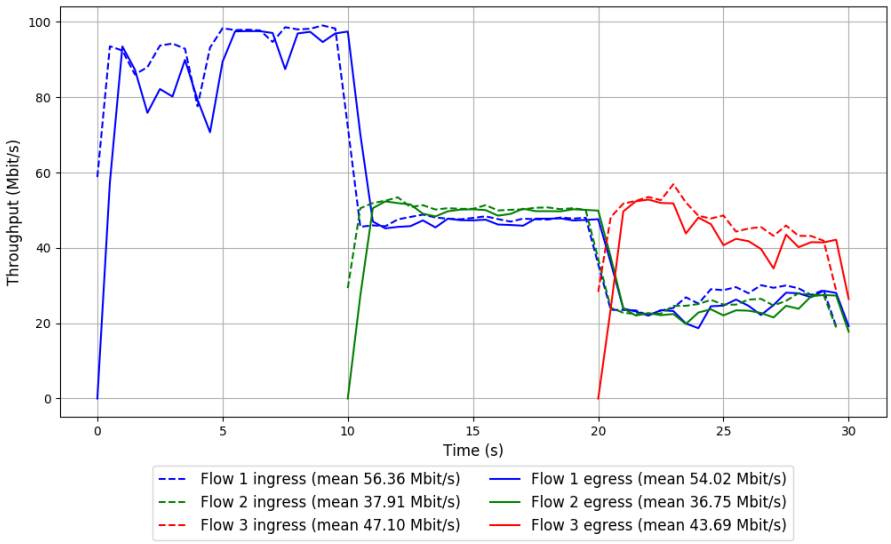


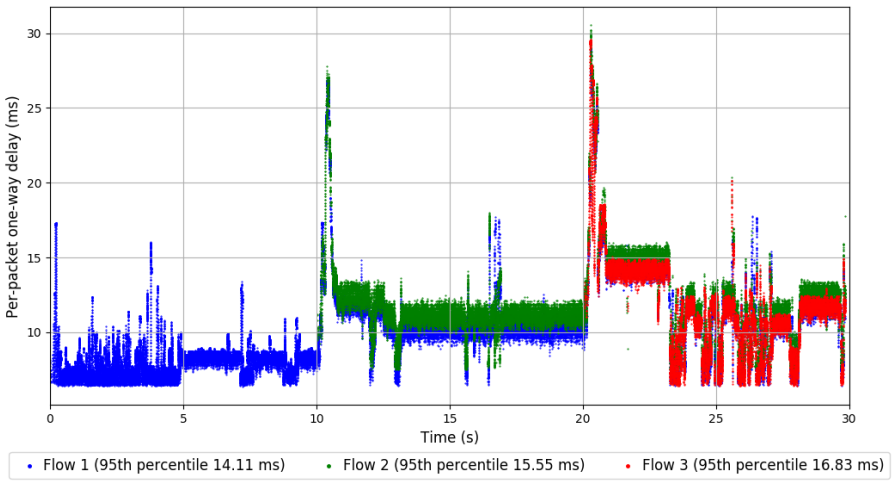
```
Run 3: Statistics of Indigo

Start at: 2018-09-05 21:37:53
End at: 2018-09-05 21:38:23
Local clock offset: 2.393 ms
Remote clock offset: -3.116 ms

# Below is generated by plot.py at 2018-09-05 21:40:06
# Datalink statistics
-- Total of 3 flows:
Average throughput: 92.75 Mbit/s
95th percentile per-packet one-way delay: 14.825 ms
Loss rate: 4.34%
-- Flow 1:
Average throughput: 54.02 Mbit/s
95th percentile per-packet one-way delay: 14.111 ms
Loss rate: 4.13%
-- Flow 2:
Average throughput: 36.75 Mbit/s
95th percentile per-packet one-way delay: 15.546 ms
Loss rate: 3.02%
-- Flow 3:
Average throughput: 43.69 Mbit/s
95th percentile per-packet one-way delay: 16.828 ms
Loss rate: 7.24%
```

Run 3: Report of Indigo — Data Link



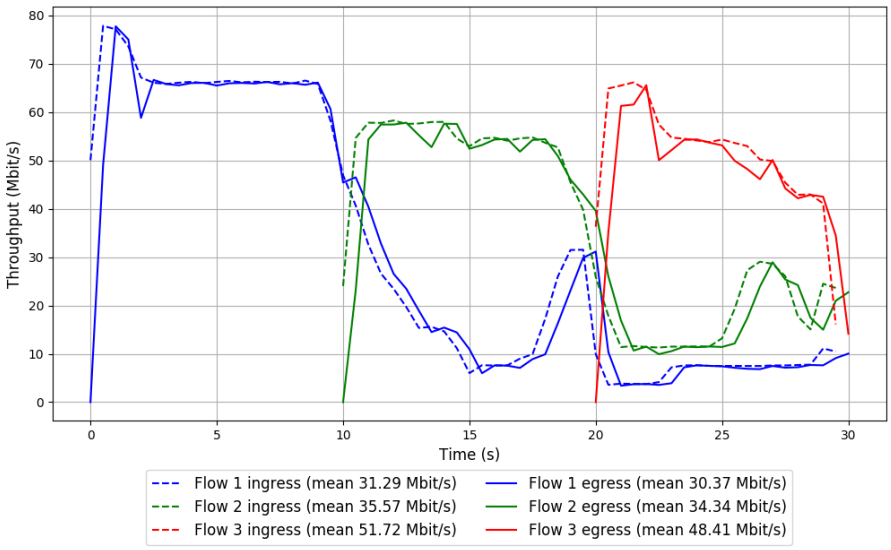


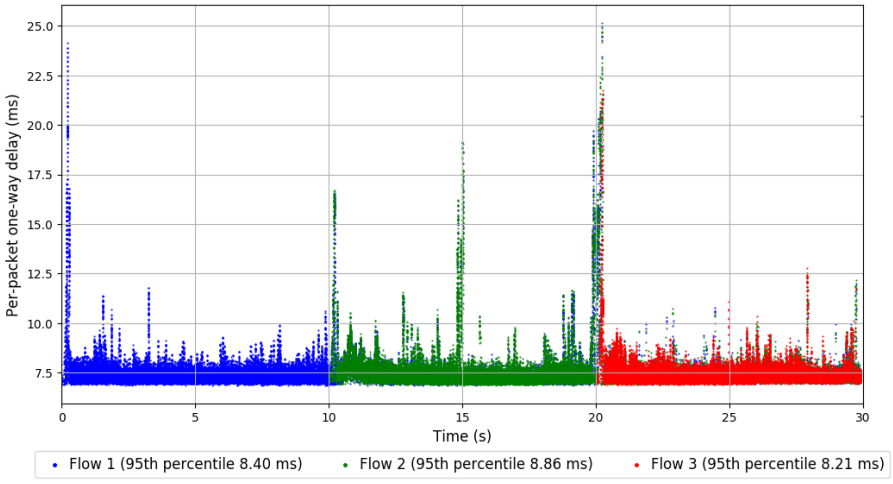
```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 21:25:56
End at: 2018-09-05 21:26:26
Local clock offset: 1.757 ms
Remote clock offset: -3.0 ms

# Below is generated by plot.py at 2018-09-05 21:40:06
# Datalink statistics
-- Total of 3 flows:
Average throughput: 69.18 Mbit/s
95th percentile per-packet one-way delay: 8.472 ms
Loss rate: 3.92%
-- Flow 1:
Average throughput: 30.37 Mbit/s
95th percentile per-packet one-way delay: 8.399 ms
Loss rate: 2.94%
-- Flow 2:
Average throughput: 34.34 Mbit/s
95th percentile per-packet one-way delay: 8.862 ms
Loss rate: 3.41%
-- Flow 3:
Average throughput: 48.41 Mbit/s
95th percentile per-packet one-way delay: 8.213 ms
Loss rate: 6.41%
```

Run 1: Report of Muses-25 — Data Link



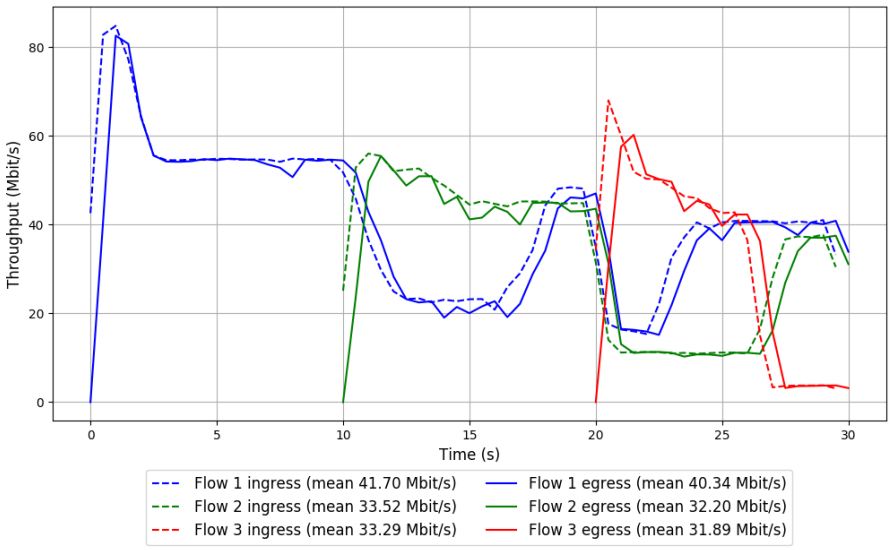


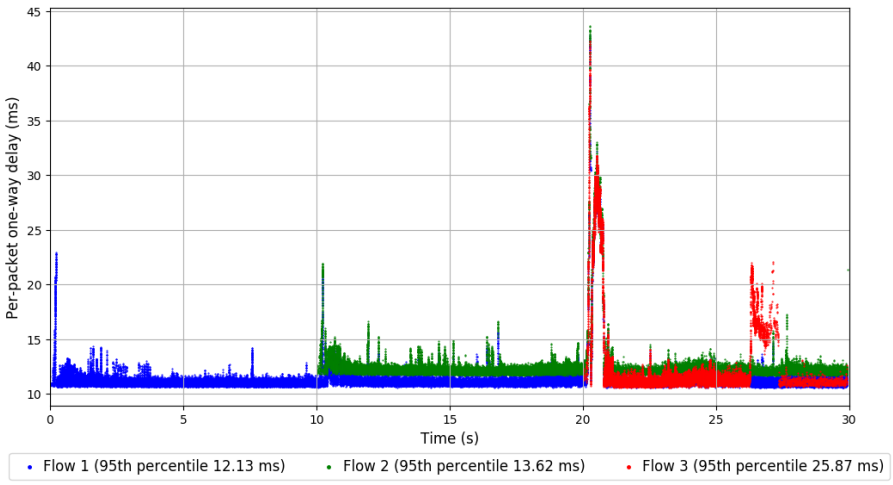
```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 21:30:41
End at: 2018-09-05 21:31:11
Local clock offset: -1.265 ms
Remote clock offset: -2.794 ms

# Below is generated by plot.py at 2018-09-05 21:40:07
# Datalink statistics
-- Total of 3 flows:
Average throughput: 72.28 Mbit/s
95th percentile per-packet one-way delay: 13.469 ms
Loss rate: 3.59%
-- Flow 1:
Average throughput: 40.34 Mbit/s
95th percentile per-packet one-way delay: 12.133 ms
Loss rate: 3.27%
-- Flow 2:
Average throughput: 32.20 Mbit/s
95th percentile per-packet one-way delay: 13.621 ms
Loss rate: 3.90%
-- Flow 3:
Average throughput: 31.89 Mbit/s
95th percentile per-packet one-way delay: 25.874 ms
Loss rate: 4.20%
```

Run 2: Report of Muses-25 — Data Link





```
Run 3: Statistics of Muses-25

Start at: 2018-09-05 21:35:27
End at: 2018-09-05 21:35:57
Local clock offset: -2.578 ms
Remote clock offset: -2.867 ms

# Below is generated by plot.py at 2018-09-05 21:40:09
# Datalink statistics
-- Total of 3 flows:
Average throughput: 71.20 Mbit/s
95th percentile per-packet one-way delay: 13.886 ms
Loss rate: 3.77%
-- Flow 1:
Average throughput: 45.13 Mbit/s
95th percentile per-packet one-way delay: 13.159 ms
Loss rate: 3.86%
-- Flow 2:
Average throughput: 25.64 Mbit/s
95th percentile per-packet one-way delay: 13.700 ms
Loss rate: 3.92%
-- Flow 3:
Average throughput: 27.30 Mbit/s
95th percentile per-packet one-way delay: 15.952 ms
Loss rate: 3.05%
```

Run 3: Report of Muses-25 — Data Link