Pantheon Report

Generated at 2018-09-05 21:40:12 (UTC).

Data path: AWS Brazil 1 on `ens5` (*local*) →Brazil on `p4p1` (*remote*).

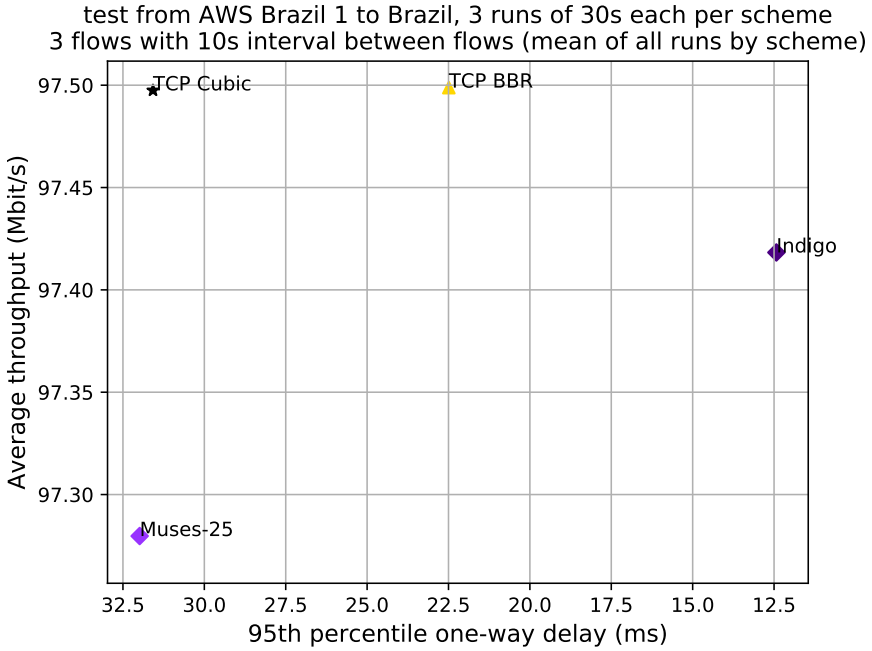
Repeated the test of 4 congestion control schemes 3 times.

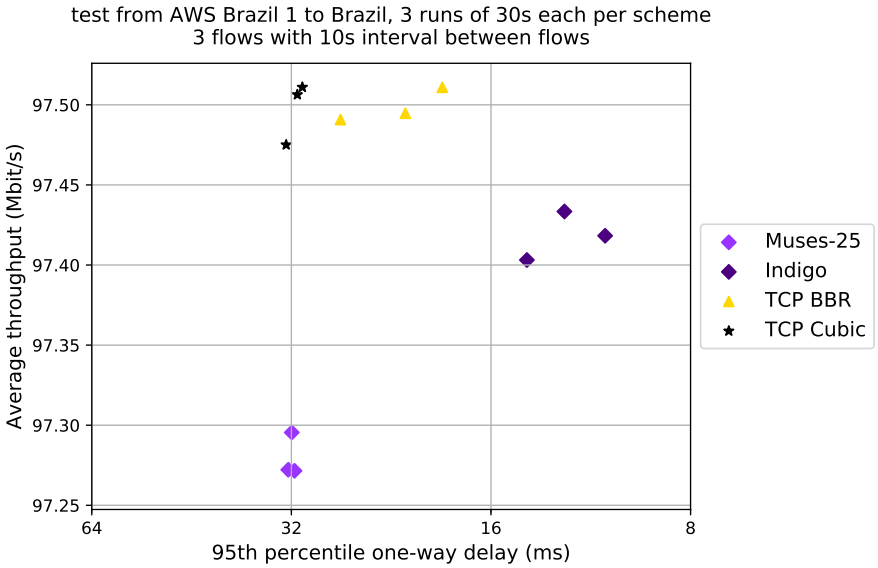
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

NTP offsets were measured against `gps.ntp.br` 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 Brazil 1 to Brazil, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
TCP Cubic
TCP BBR
Indigo
Muses-25
Average throughput (Mbit/s)
97.50
97.45
97.40
97.35
97.30
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
95th percentile one-way delay (ms)


test from AWS Brazil 1 to Brazil, 3 runs of 30s each per scheme
3 flows with 10s interval between flows
Average throughput (Mbit/s)
97.50
97.45
97.40
97.35
97.30
97.25
64
32
16
8
95th percentile one-way delay (ms)
Muses-25
Indigo
TCP BBR
TCP Cubic

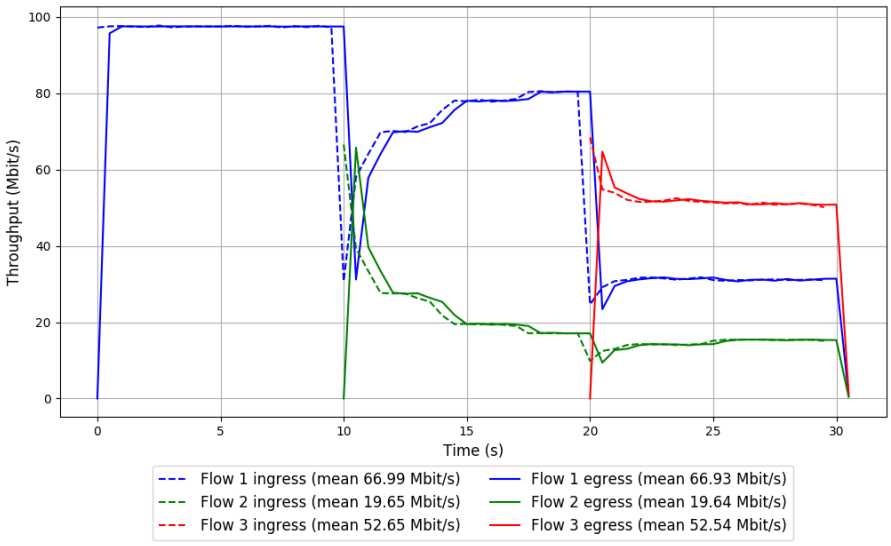
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	3	70.32	28.58	24.47	22.38	21.72	24.59	0.01	0.00	0.03
TCP Cubic	3	64.99	34.46	28.80	31.49	31.12	32.18	0.04	0.03	0.04
Indigo	3	45.55	43.79	69.98	10.83	12.21	11.98	0.00	0.00	0.00
Muses-25	3	70.96	37.49	4.33	28.52	31.97	30.96	11.39	21.75	6.22

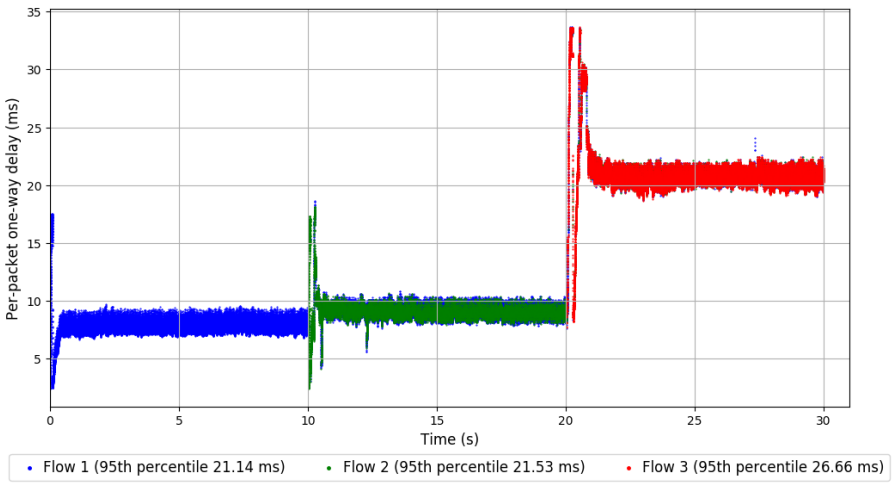
```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 21:27:07
End at: 2018-09-05 21:27:37
Local clock offset: 9.784 ms
Remote clock offset: 0.133 ms

# Below is generated by plot.py at 2018-09-05 21:39:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.49 Mbit/s
95th percentile per-packet one-way delay: 21.540 ms
Loss rate: 0.03%
-- Flow 1:
Average throughput: 66.93 Mbit/s
95th percentile per-packet one-way delay: 21.138 ms
Loss rate: 0.02%
-- Flow 2:
Average throughput: 19.64 Mbit/s
95th percentile per-packet one-way delay: 21.527 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 52.54 Mbit/s
95th percentile per-packet one-way delay: 26.662 ms
Loss rate: 0.09%
```

Run 1: Report of TCP BBR — Data Link



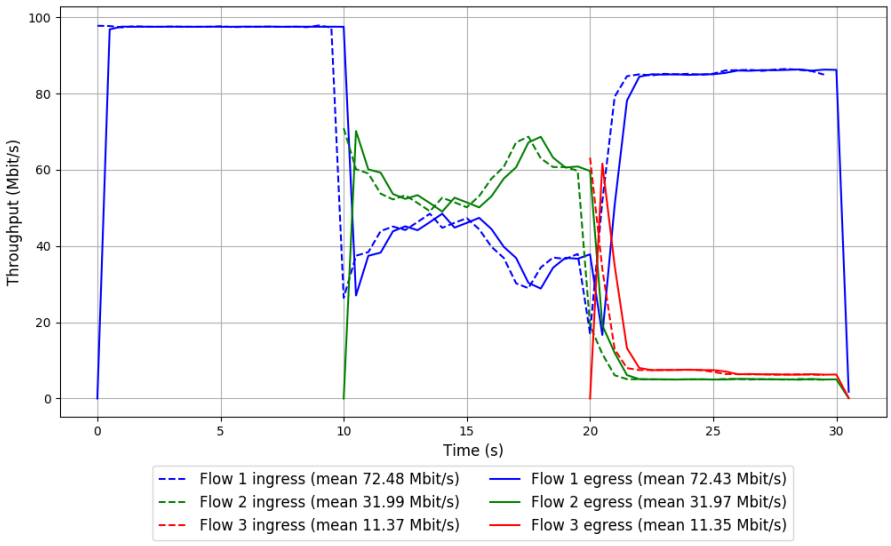


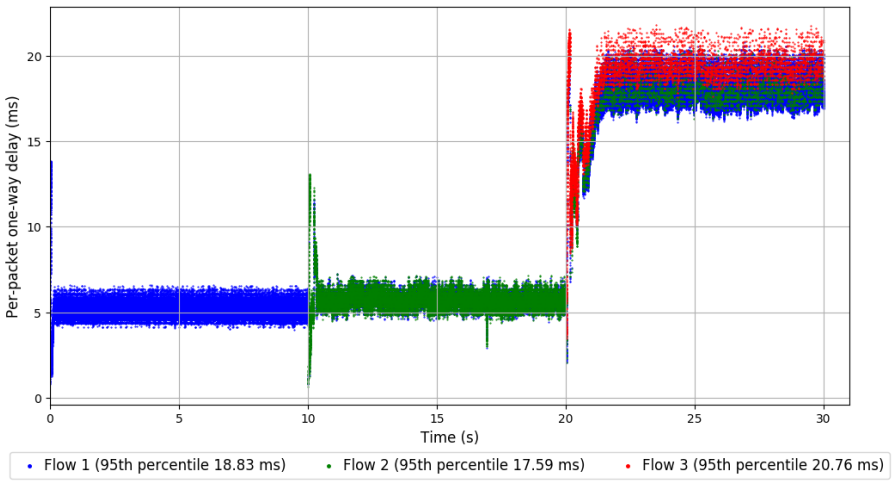
```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 21:31:45
End at: 2018-09-05 21:32:15
Local clock offset: 11.572 ms
Remote clock offset: 0.229 ms

# Below is generated by plot.py at 2018-09-05 21:39:36
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.51 Mbit/s
95th percentile per-packet one-way delay: 18.946 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 72.43 Mbit/s
95th percentile per-packet one-way delay: 18.827 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 31.97 Mbit/s
95th percentile per-packet one-way delay: 17.595 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 11.35 Mbit/s
95th percentile per-packet one-way delay: 20.757 ms
Loss rate: 0.00%
```

Run 2: Report of TCP BBR — Data Link



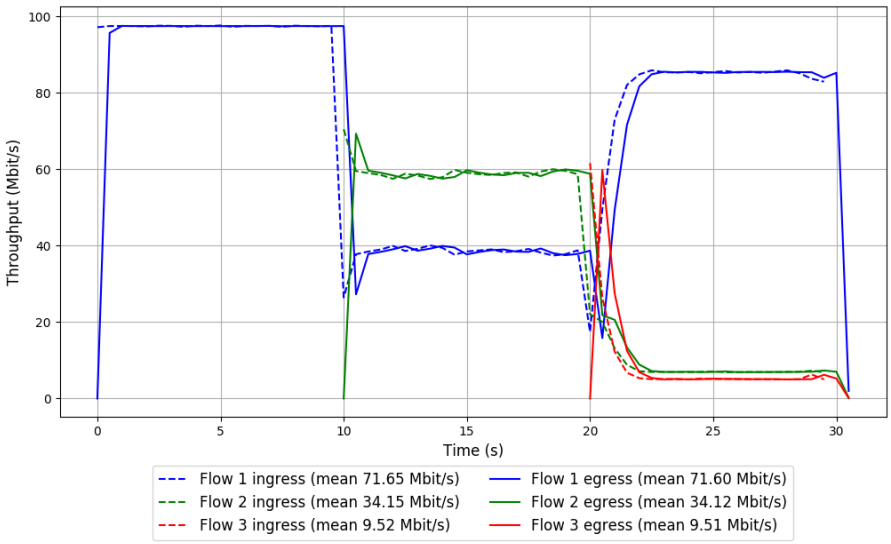


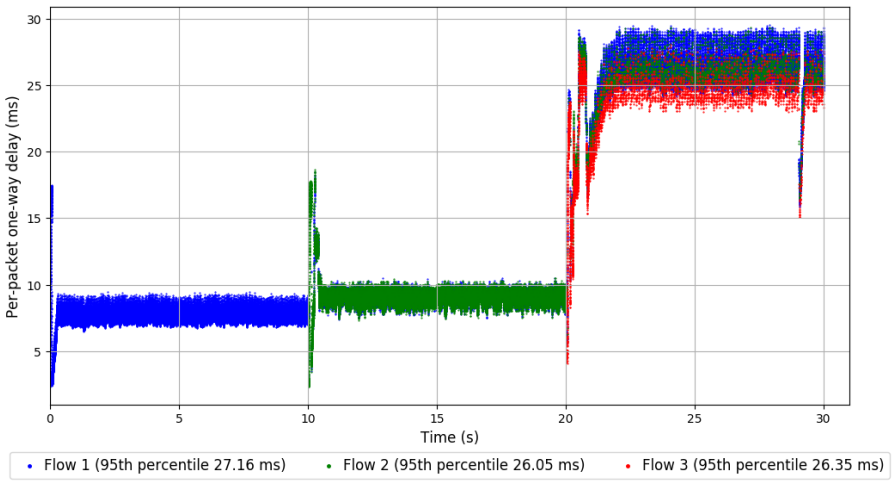
```
Run 3: Statistics of TCP BBR

Start at: 2018-09-05 21:36:23
End at: 2018-09-05 21:36:53
Local clock offset: 11.954 ms
Remote clock offset: 0.223 ms

# Below is generated by plot.py at 2018-09-05 21:39:36
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.49 Mbit/s
95th percentile per-packet one-way delay: 26.983 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 71.60 Mbit/s
95th percentile per-packet one-way delay: 27.161 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 34.12 Mbit/s
95th percentile per-packet one-way delay: 26.049 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 9.51 Mbit/s
95th percentile per-packet one-way delay: 26.352 ms
Loss rate: 0.00%
```

Run 3: Report of TCP BBR — Data Link



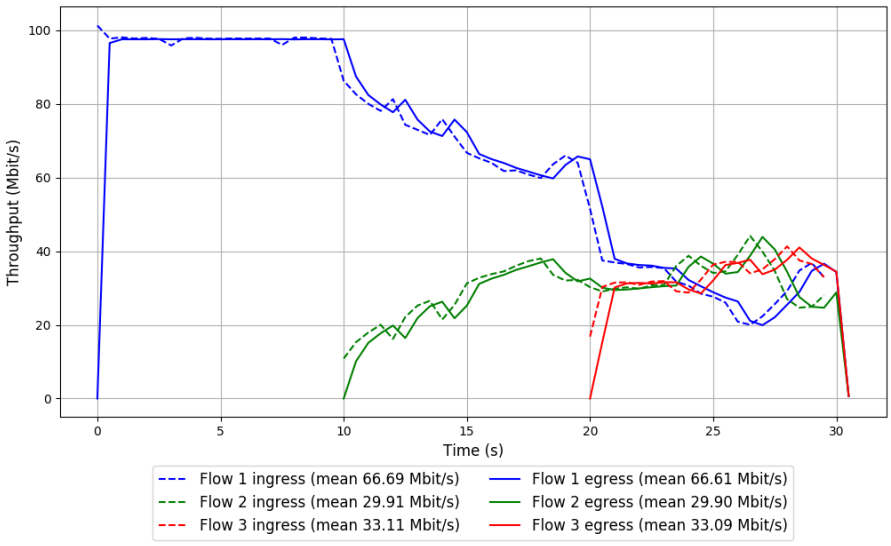


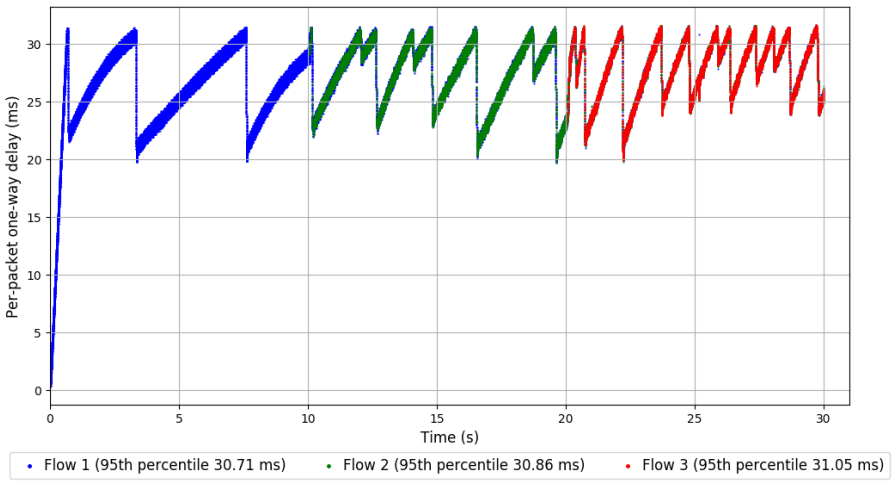
```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 21:28:16
End at: 2018-09-05 21:28:46
Local clock offset: 11.067 ms
Remote clock offset: 0.256 ms

# Below is generated by plot.py at 2018-09-05 21:39:36
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.51 Mbit/s
95th percentile per-packet one-way delay: 30.801 ms
Loss rate: 0.03%
-- Flow 1:
Average throughput: 66.61 Mbit/s
95th percentile per-packet one-way delay: 30.711 ms
Loss rate: 0.03%
-- Flow 2:
Average throughput: 29.90 Mbit/s
95th percentile per-packet one-way delay: 30.857 ms
Loss rate: 0.04%
-- Flow 3:
Average throughput: 33.09 Mbit/s
95th percentile per-packet one-way delay: 31.055 ms
Loss rate: 0.03%
```

Run 1: Report of TCP Cubic — Data Link



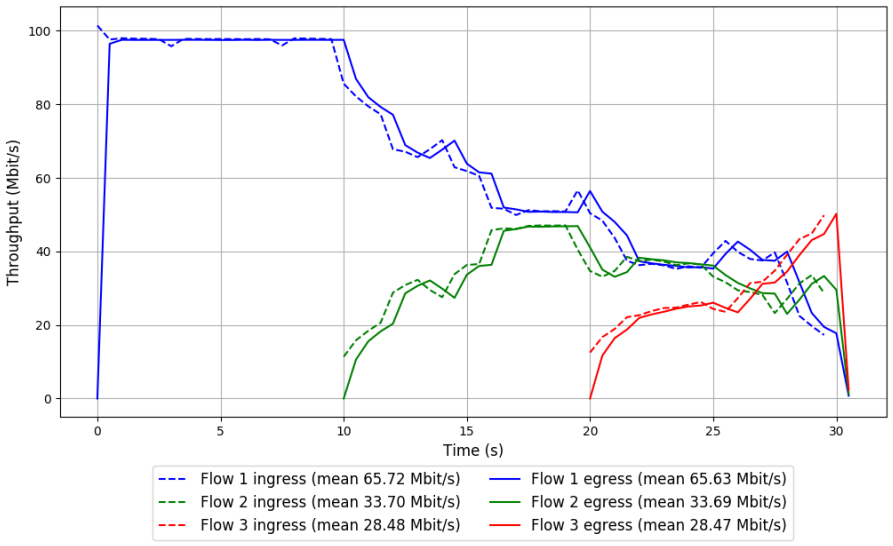


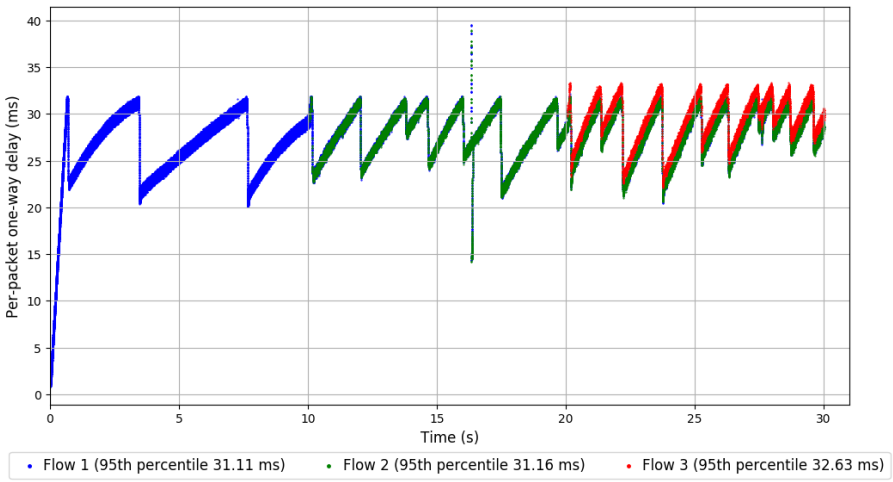
```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 21:32:54
End at: 2018-09-05 21:33:24
Local clock offset: 11.588 ms
Remote clock offset: 0.237 ms

# Below is generated by plot.py at 2018-09-05 21:39:36
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.51 Mbit/s
95th percentile per-packet one-way delay: 31.346 ms
Loss rate: 0.04%
-- Flow 1:
Average throughput: 65.63 Mbit/s
95th percentile per-packet one-way delay: 31.111 ms
Loss rate: 0.04%
-- Flow 2:
Average throughput: 33.69 Mbit/s
95th percentile per-packet one-way delay: 31.155 ms
Loss rate: 0.03%
-- Flow 3:
Average throughput: 28.47 Mbit/s
95th percentile per-packet one-way delay: 32.634 ms
Loss rate: 0.03%
```

Run 2: Report of TCP Cubic — Data Link



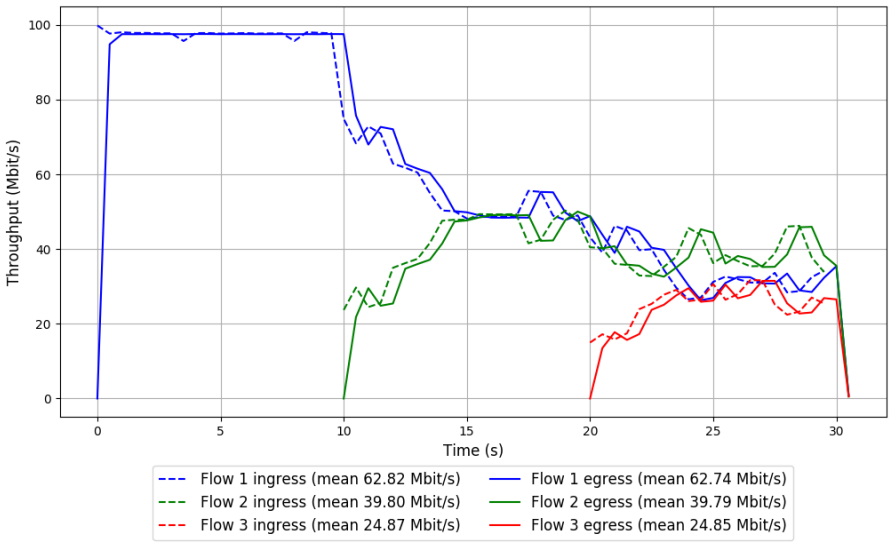


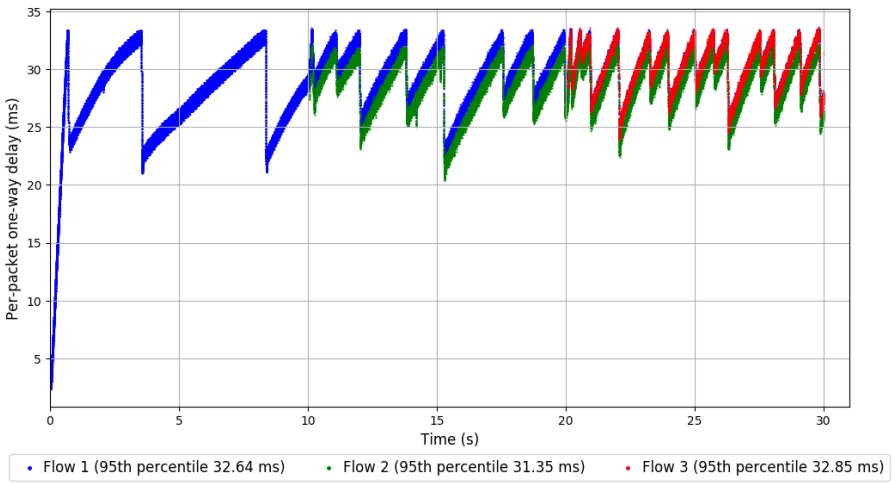
```
Run 3: Statistics of TCP Cubic

Start at: 2018-09-05 21:37:32
End at: 2018-09-05 21:38:02
Local clock offset: 12.24 ms
Remote clock offset: 0.3 ms

# Below is generated by plot.py at 2018-09-05 21:39:36
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.48 Mbit/s
95th percentile per-packet one-way delay: 32.584 ms
Loss rate: 0.04%
-- Flow 1:
Average throughput: 62.74 Mbit/s
95th percentile per-packet one-way delay: 32.640 ms
Loss rate: 0.04%
-- Flow 2:
Average throughput: 39.79 Mbit/s
95th percentile per-packet one-way delay: 31.348 ms
Loss rate: 0.03%
-- Flow 3:
Average throughput: 24.85 Mbit/s
95th percentile per-packet one-way delay: 32.851 ms
Loss rate: 0.05%
```

Run 3: Report of TCP Cubic — Data Link



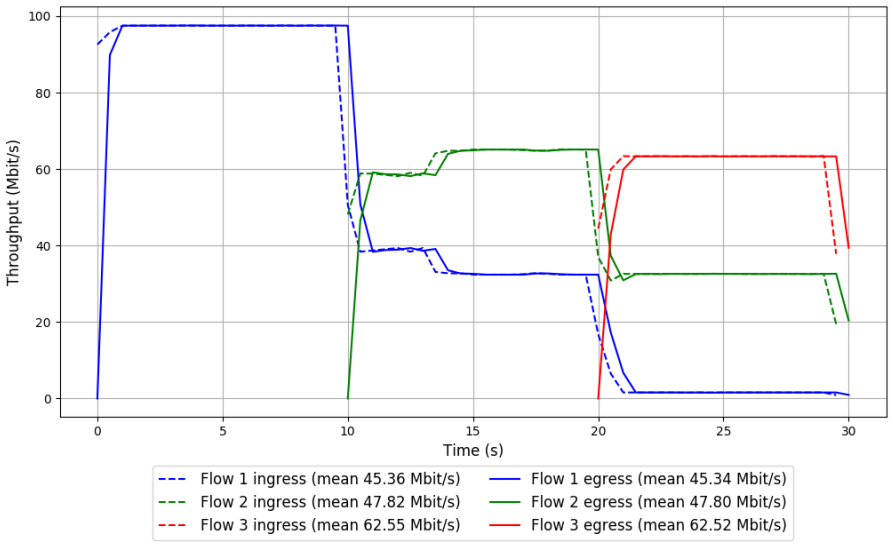


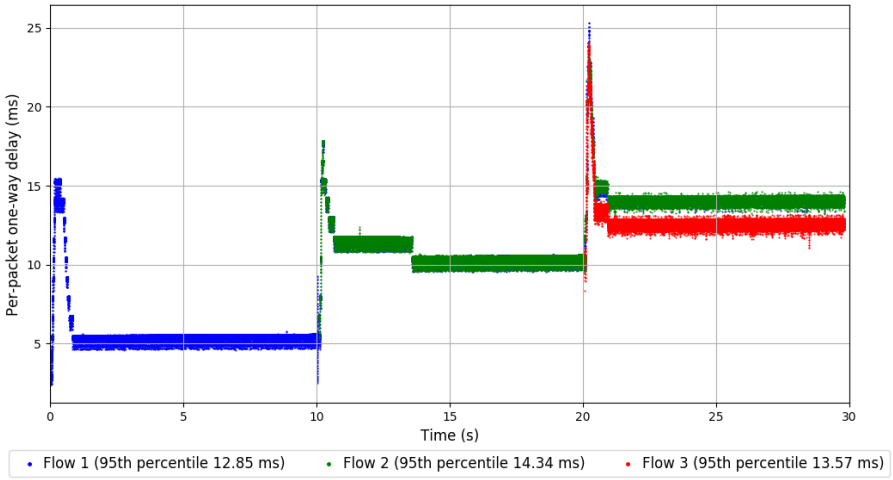
```
Run 1: Statistics of Indigo

Start at: 2018-09-05 21:24:47
End at: 2018-09-05 21:25:17
Local clock offset: 8.852 ms
Remote clock offset: 0.228 ms

# Below is generated by plot.py at 2018-09-05 21:39:36
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.40 Mbit/s
95th percentile per-packet one-way delay: 14.124 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 45.34 Mbit/s
95th percentile per-packet one-way delay: 12.847 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 47.80 Mbit/s
95th percentile per-packet one-way delay: 14.341 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 62.52 Mbit/s
95th percentile per-packet one-way delay: 13.566 ms
Loss rate: 0.00%
```

Run 1: Report of Indigo — Data Link



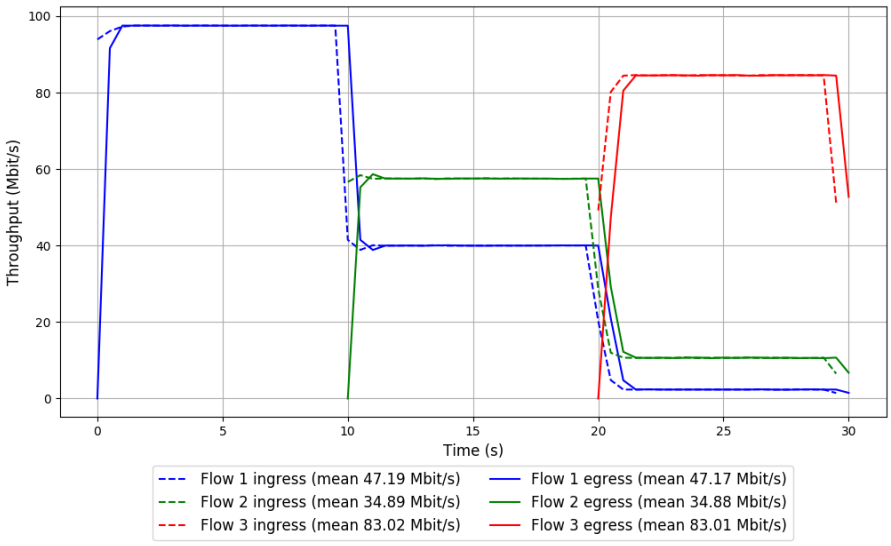


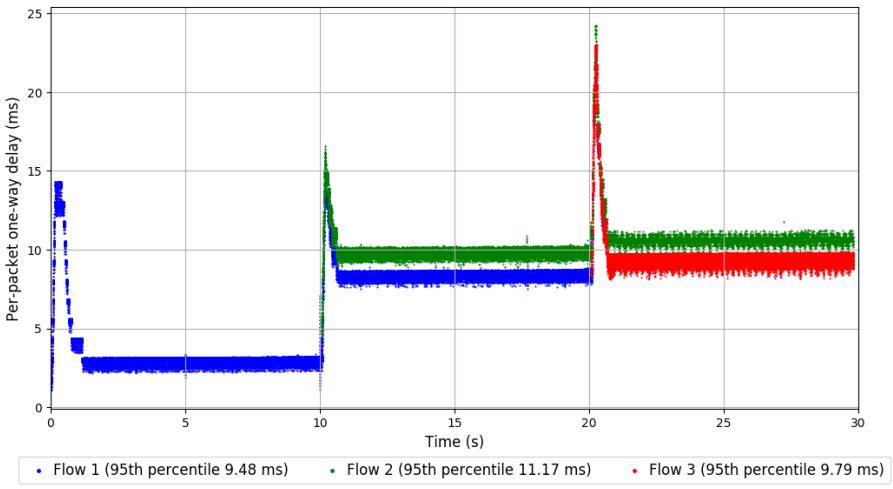
```
Run 2: Statistics of Indigo

Start at: 2018-09-05 21:29:25
End at: 2018-09-05 21:29:55
Local clock offset: 10.827 ms
Remote clock offset: 0.248 ms

# Below is generated by plot.py at 2018-09-05 21:39:36
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.42 Mbit/s
95th percentile per-packet one-way delay: 10.764 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 47.17 Mbit/s
95th percentile per-packet one-way delay: 9.484 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 34.88 Mbit/s
95th percentile per-packet one-way delay: 11.171 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 83.01 Mbit/s
95th percentile per-packet one-way delay: 9.786 ms
Loss rate: 0.00%
```

Run 2: Report of Indigo — Data Link



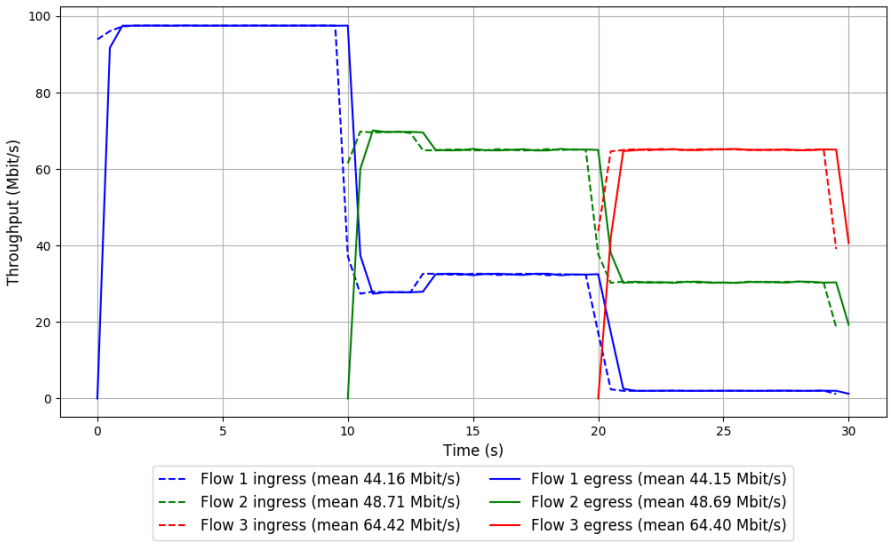


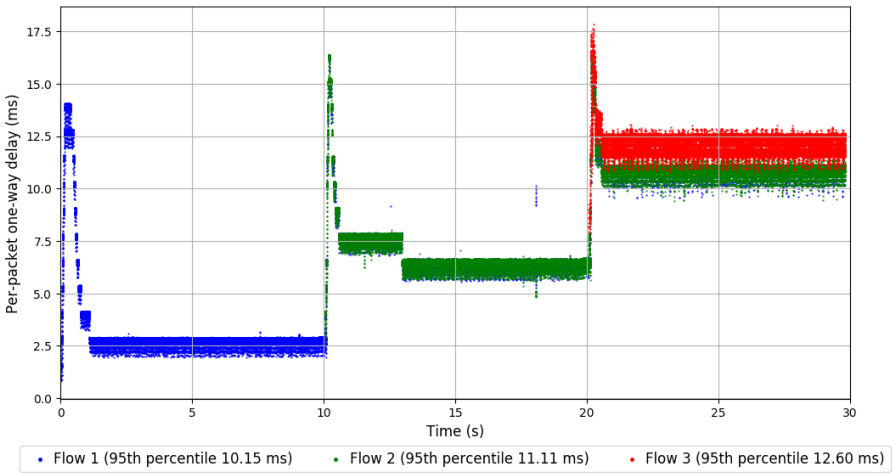
```
Run 3: Statistics of Indigo

Start at: 2018-09-05 21:34:03
End at: 2018-09-05 21:34:33
Local clock offset: 11.69 ms
Remote clock offset: 0.271 ms

# Below is generated by plot.py at 2018-09-05 21:40:07
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.43 Mbit/s
95th percentile per-packet one-way delay: 12.397 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 44.15 Mbit/s
95th percentile per-packet one-way delay: 10.151 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 48.69 Mbit/s
95th percentile per-packet one-way delay: 11.112 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 64.40 Mbit/s
95th percentile per-packet one-way delay: 12.598 ms
Loss rate: 0.00%
```

Run 3: Report of Indigo — Data Link



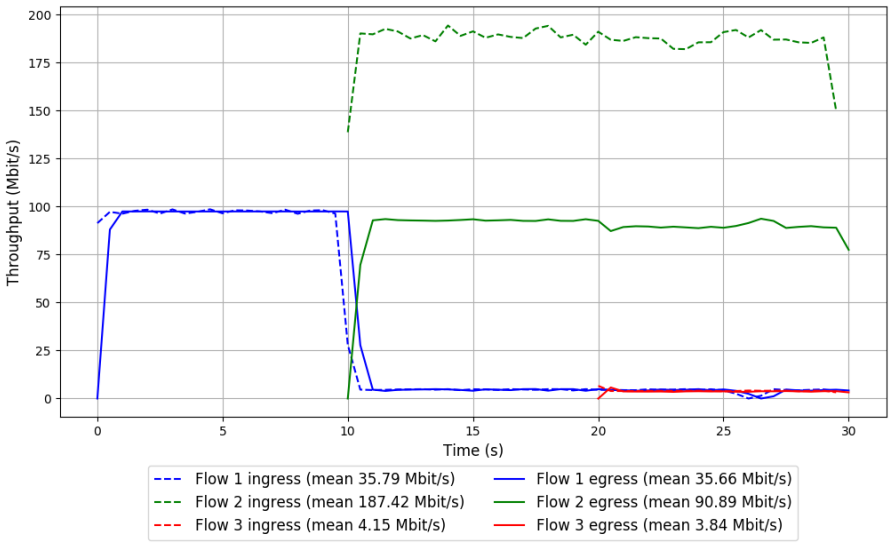


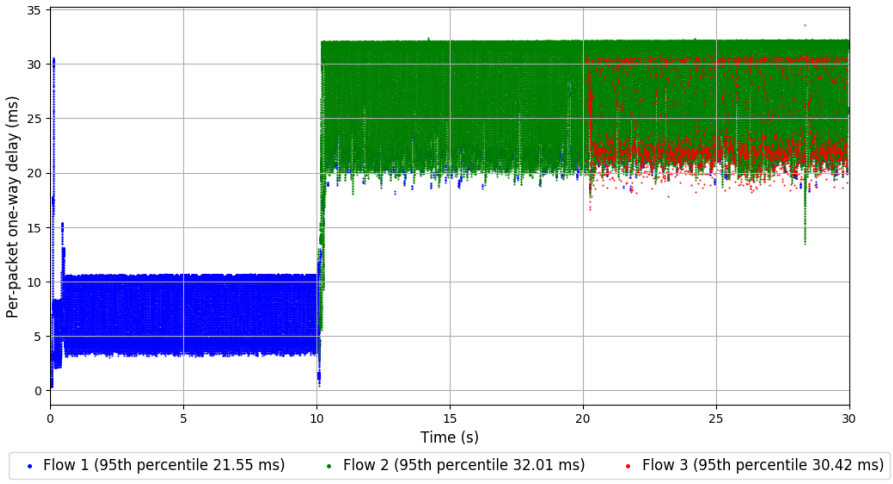
```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 21:25:57
End at: 2018-09-05 21:26:27
Local clock offset: 10.007 ms
Remote clock offset: 0.229 ms

# Below is generated by plot.py at 2018-09-05 21:40:11
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.30 Mbit/s
95th percentile per-packet one-way delay: 31.958 ms
Loss rate: 39.78%
-- Flow 1:
Average throughput: 35.66 Mbit/s
95th percentile per-packet one-way delay: 21.546 ms
Loss rate: 0.31%
-- Flow 2:
Average throughput: 90.89 Mbit/s
95th percentile per-packet one-way delay: 32.012 ms
Loss rate: 51.47%
-- Flow 3:
Average throughput: 3.84 Mbit/s
95th percentile per-packet one-way delay: 30.417 ms
Loss rate: 7.53%
```

Run 1: Report of Muses-25 — Data Link



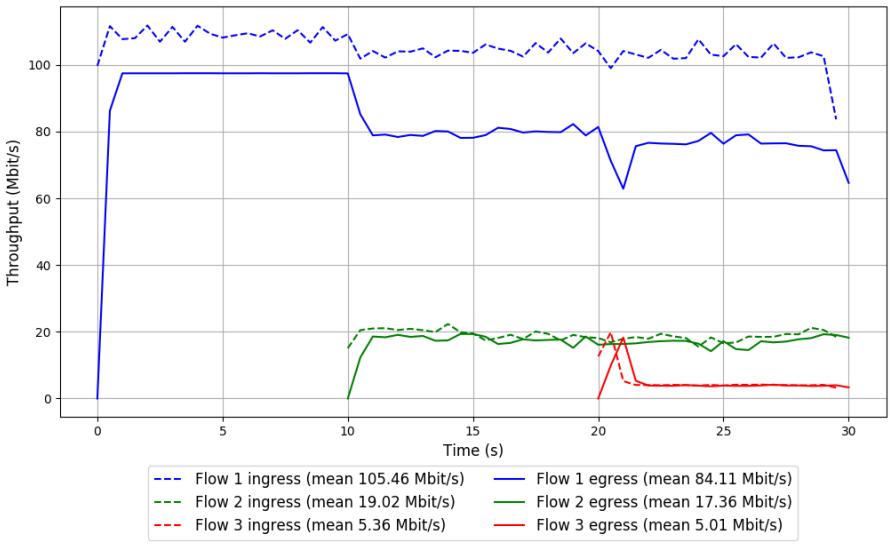


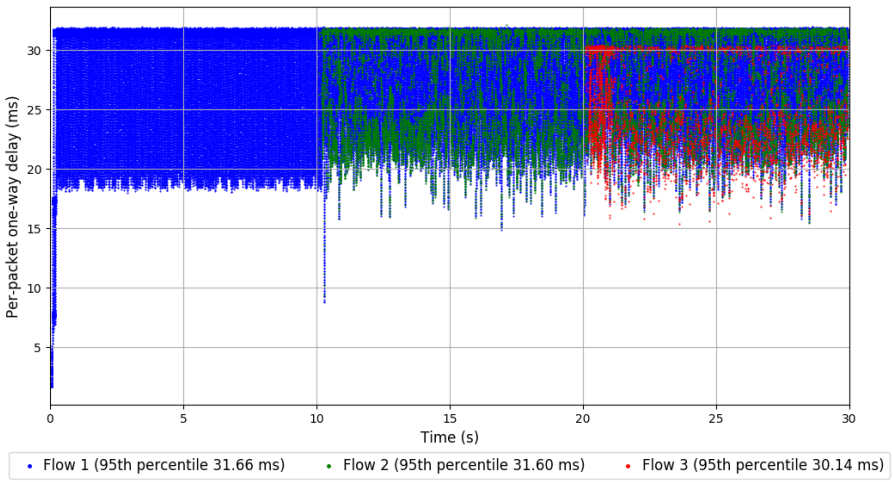
```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 21:30:36
End at: 2018-09-05 21:31:06
Local clock offset: 12.303 ms
Remote clock offset: 0.334 ms

# Below is generated by plot.py at 2018-09-05 21:40:11
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.27 Mbit/s
95th percentile per-packet one-way delay: 31.654 ms
Loss rate: 18.76%
-- Flow 1:
Average throughput: 84.11 Mbit/s
95th percentile per-packet one-way delay: 31.660 ms
Loss rate: 20.17%
-- Flow 2:
Average throughput: 17.36 Mbit/s
95th percentile per-packet one-way delay: 31.600 ms
Loss rate: 8.70%
-- Flow 3:
Average throughput: 5.01 Mbit/s
95th percentile per-packet one-way delay: 30.142 ms
Loss rate: 6.42%
```

Run 2: Report of Muses-25 — Data Link





```
Run 3: Statistics of Muses-25

Start at: 2018-09-05 21:35:14
End at: 2018-09-05 21:35:44
Local clock offset: 11.81 ms
Remote clock offset: 0.214 ms

# Below is generated by plot.py at 2018-09-05 21:40:11
# Datalink statistics
-- Total of 3 flows:
Average throughput: 97.27 Mbit/s
95th percentile per-packet one-way delay: 32.348 ms
Loss rate: 13.34%
-- Flow 1:
Average throughput: 93.11 Mbit/s
95th percentile per-packet one-way delay: 32.348 ms
Loss rate: 13.68%
-- Flow 2:
Average throughput: 4.23 Mbit/s
95th percentile per-packet one-way delay: 32.304 ms
Loss rate: 5.08%
-- Flow 3:
Average throughput: 4.13 Mbit/s
95th percentile per-packet one-way delay: 32.335 ms
Loss rate: 4.72%
```

Run 3: Report of Muses-25 — Data Link