Pantheon Report

Generated at 2018-09-05 03:47:52 (UTC).

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

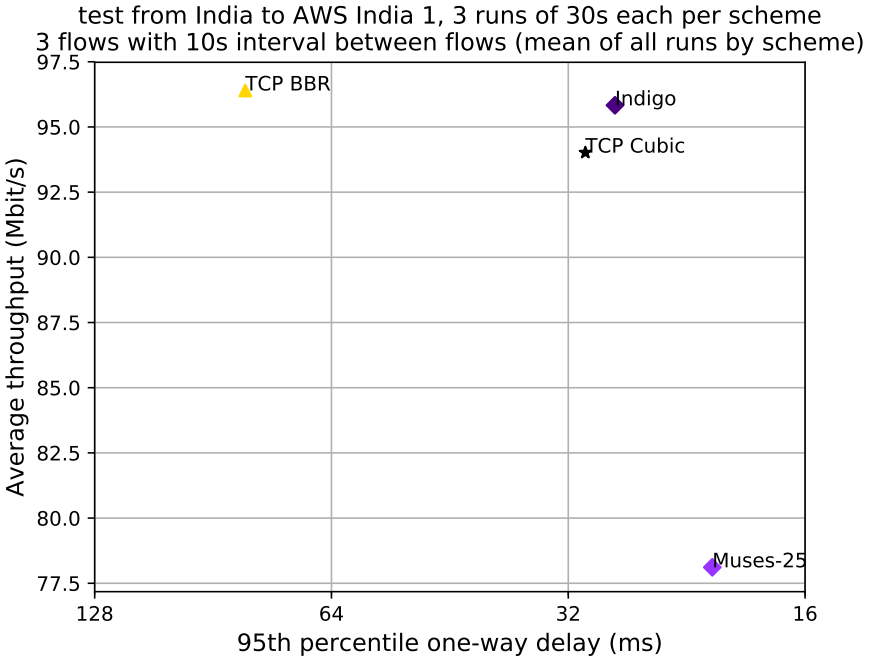
Repeated the test of 4 congestion control schemes 3 times.

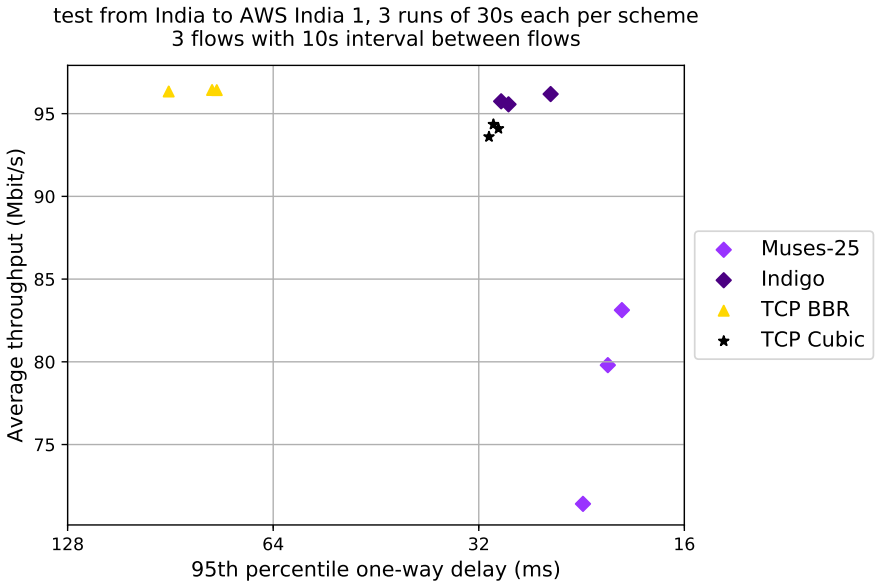
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

NTP offsets were measured against `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 @ 71e71e9a55b945431a7dea72180c1c9381097db9
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ 96fbc95fb38373d71fbc80c5a105e62e7636623b
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 India to AWS India 1, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
Average throughput (Mbit/s)
97.5
95.0
92.5
90.0
87.5
85.0
82.5
80.0
77.5
TCP BBR
Indigo
TCP Cubic
Muses-25
128
64
32
16
95th percentile one-way delay (ms)


test from India to AWS India 1, 3 runs of 30s each per scheme
3 flows with 10s interval between flows
Average throughput (Mbit/s)
95
90
85
80
75
128
64
32
16
95th percentile one-way delay (ms)
Muses-25
Indigo
TCP BBR
TCP Cubic

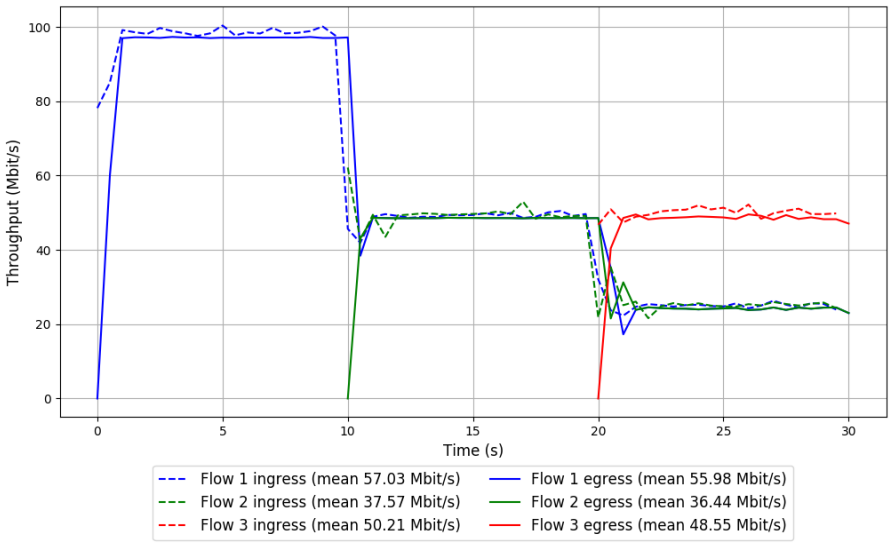
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	3	57.63	39.19	37.93	53.74	110.74	99.45	2.06	2.95	3.18
TCP Cubic	3	56.23	38.50	36.63	30.05	30.68	31.47	0.07	0.13	0.36
Indigo	3	60.26	39.35	29.76	26.05	28.33	29.22	0.05	0.14	0.37
Muses-25	3	47.22	28.77	35.54	21.04	20.73	21.70	0.06	0.06	0.23

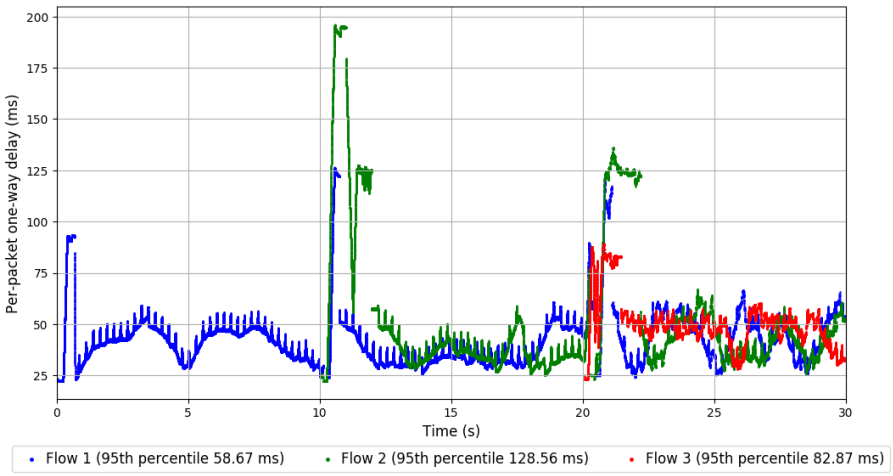
```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 03:32:52
End at: 2018-09-05 03:33:22
Local clock offset: 3.631 ms
Remote clock offset: -2.573 ms

# Below is generated by plot.py at 2018-09-05 03:47:22
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.34 Mbit/s
95th percentile per-packet one-way delay: 91.032 ms
Loss rate: 2.52%
-- Flow 1:
Average throughput: 55.98 Mbit/s
95th percentile per-packet one-way delay: 58.670 ms
Loss rate: 1.93%
-- Flow 2:
Average throughput: 36.44 Mbit/s
95th percentile per-packet one-way delay: 128.560 ms
Loss rate: 3.15%
-- Flow 3:
Average throughput: 48.55 Mbit/s
95th percentile per-packet one-way delay: 82.872 ms
Loss rate: 3.60%
```

Run 1: Report of TCP BBR — Data Link



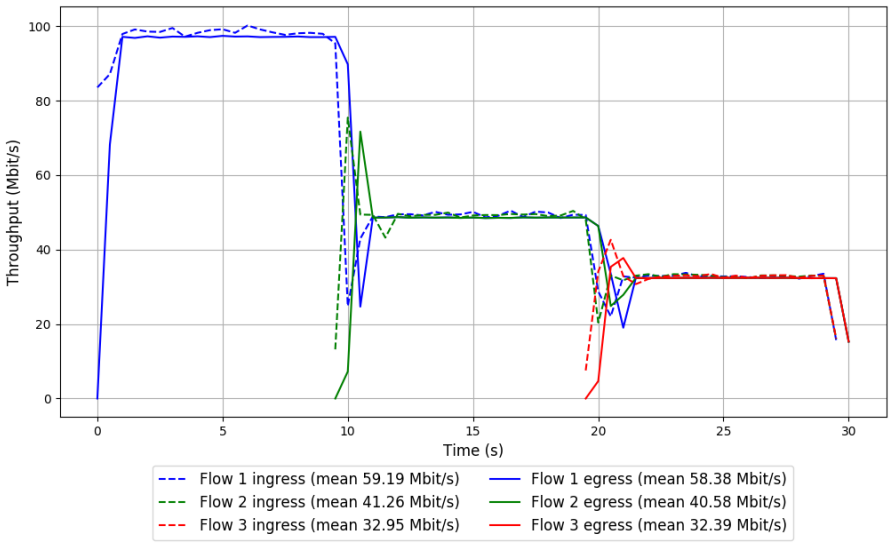


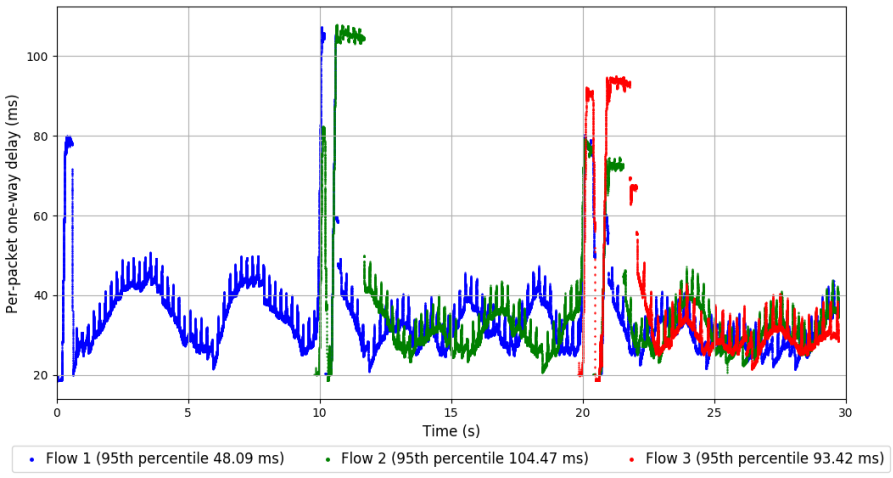
```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 03:37:47
End at: 2018-09-05 03:38:17
Local clock offset: 0.058 ms
Remote clock offset: -2.422 ms

# Below is generated by plot.py at 2018-09-05 03:47:22
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.42 Mbit/s
95th percentile per-packet one-way delay: 77.411 ms
Loss rate: 1.61%
-- Flow 1:
Average throughput: 58.38 Mbit/s
95th percentile per-packet one-way delay: 48.087 ms
Loss rate: 1.47%
-- Flow 2:
Average throughput: 40.58 Mbit/s
95th percentile per-packet one-way delay: 104.472 ms
Loss rate: 1.80%
-- Flow 3:
Average throughput: 32.39 Mbit/s
95th percentile per-packet one-way delay: 93.417 ms
Loss rate: 1.95%
```

Run 2: Report of TCP BBR — Data Link



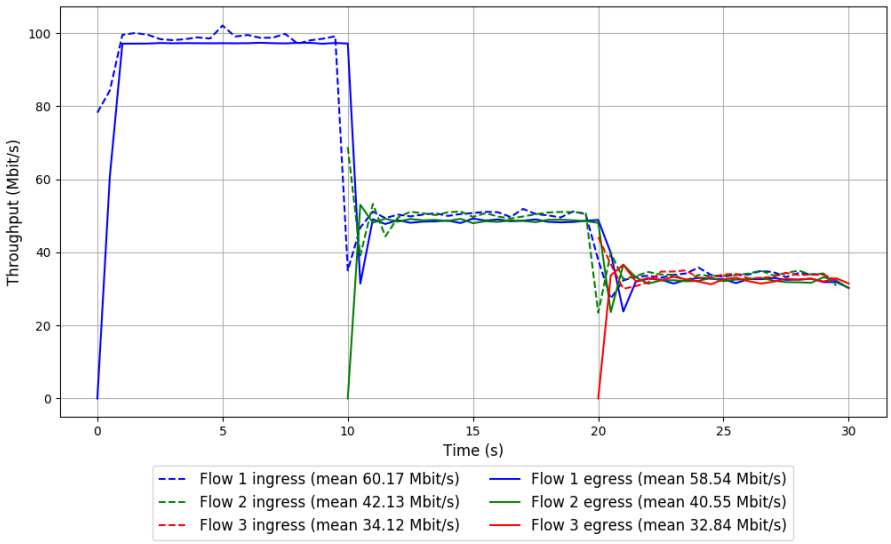


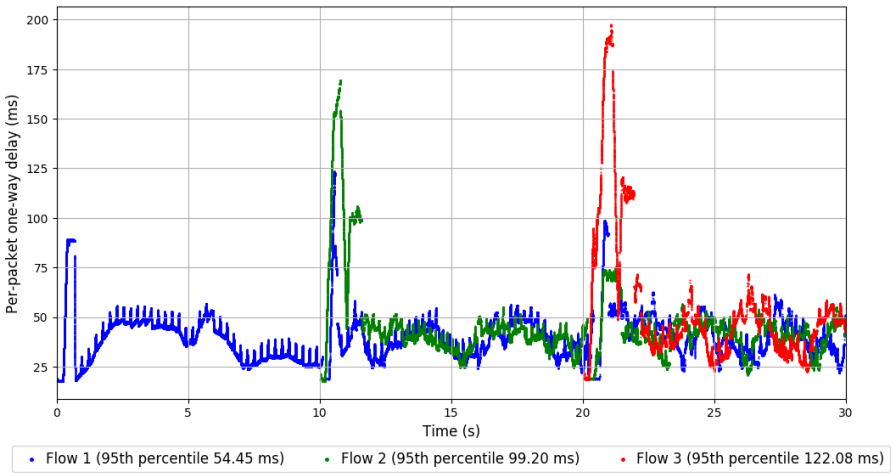
```
Run 3: Statistics of TCP BBR

Start at: 2018-09-05 03:42:48
End at: 2018-09-05 03:43:18
Local clock offset: 0.588 ms
Remote clock offset: -1.147 ms

# Below is generated by plot.py at 2018-09-05 03:47:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.43 Mbit/s
95th percentile per-packet one-way delay: 78.649 ms
Loss rate: 3.24%
-- Flow 1:
Average throughput: 58.54 Mbit/s
95th percentile per-packet one-way delay: 54.450 ms
Loss rate: 2.79%
-- Flow 2:
Average throughput: 40.55 Mbit/s
95th percentile per-packet one-way delay: 99.199 ms
Loss rate: 3.89%
-- Flow 3:
Average throughput: 32.84 Mbit/s
95th percentile per-packet one-way delay: 122.075 ms
Loss rate: 4.00%
```

Run 3: Report of TCP BBR — Data Link



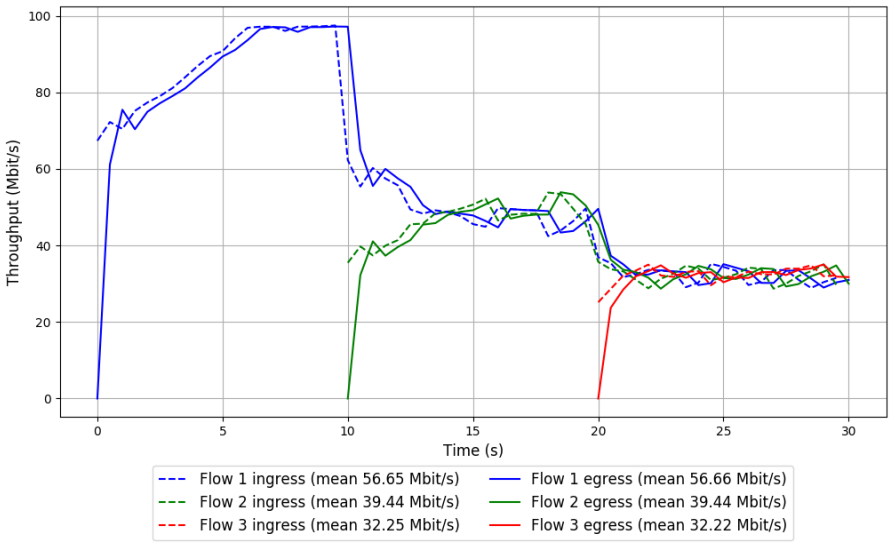


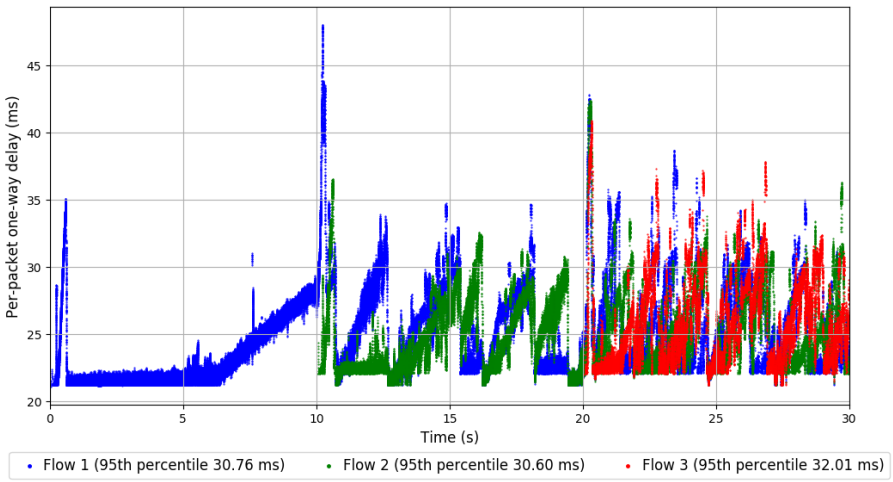
```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 03:34:08
End at: 2018-09-05 03:34:38
Local clock offset: 2.282 ms
Remote clock offset: -2.844 ms

# Below is generated by plot.py at 2018-09-05 03:47:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 93.60 Mbit/s
95th percentile per-packet one-way delay: 30.917 ms
Loss rate: 0.13%
-- Flow 1:
Average throughput: 56.66 Mbit/s
95th percentile per-packet one-way delay: 30.763 ms
Loss rate: 0.07%
-- Flow 2:
Average throughput: 39.44 Mbit/s
95th percentile per-packet one-way delay: 30.603 ms
Loss rate: 0.14%
-- Flow 3:
Average throughput: 32.22 Mbit/s
95th percentile per-packet one-way delay: 32.014 ms
Loss rate: 0.37%
```

Run 1: Report of TCP Cubic — Data Link



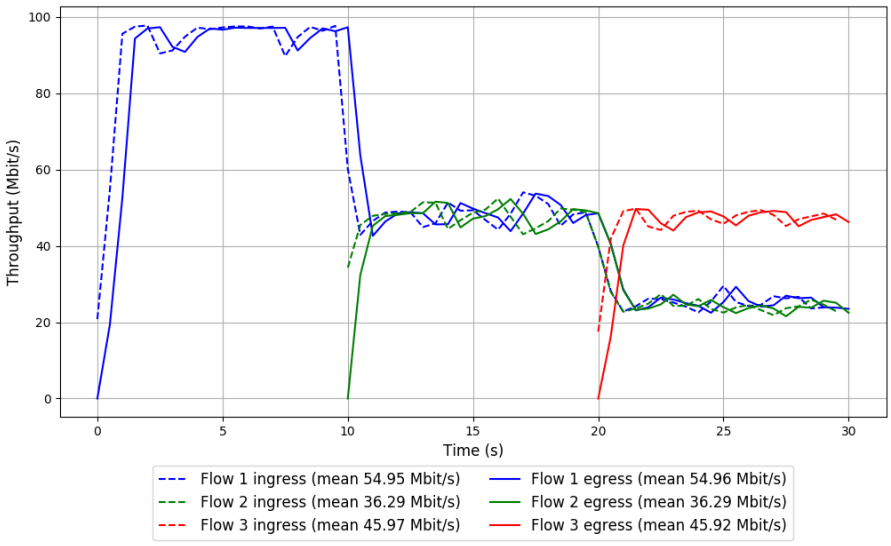


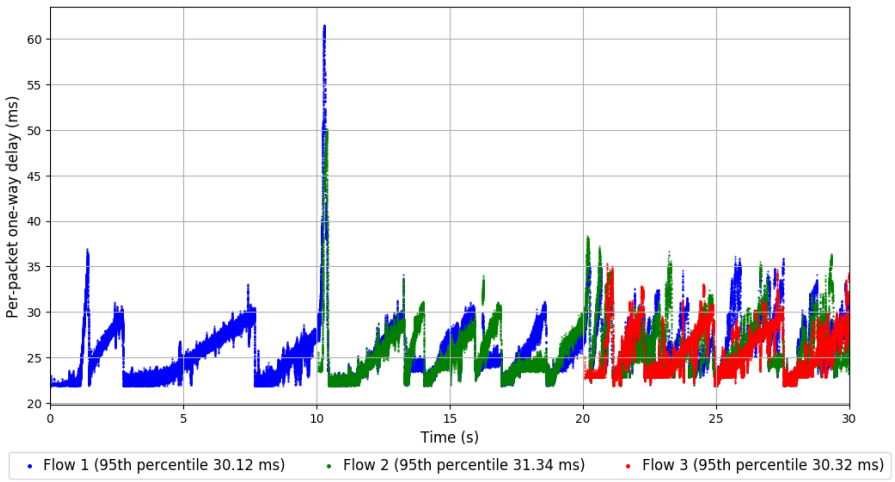
```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 03:39:01
End at: 2018-09-05 03:39:31
Local clock offset: 3.509 ms
Remote clock offset: -2.349 ms

# Below is generated by plot.py at 2018-09-05 03:47:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 94.35 Mbit/s
95th percentile per-packet one-way delay: 30.456 ms
Loss rate: 0.13%
-- Flow 1:
Average throughput: 54.96 Mbit/s
95th percentile per-packet one-way delay: 30.125 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 36.29 Mbit/s
95th percentile per-packet one-way delay: 31.342 ms
Loss rate: 0.12%
-- Flow 3:
Average throughput: 45.92 Mbit/s
95th percentile per-packet one-way delay: 30.318 ms
Loss rate: 0.38%
```

Run 2: Report of TCP Cubic — Data Link



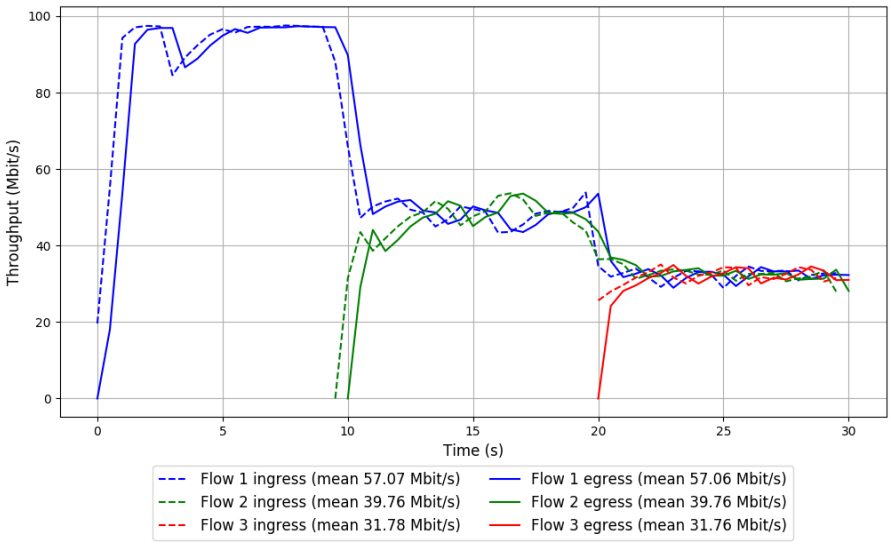


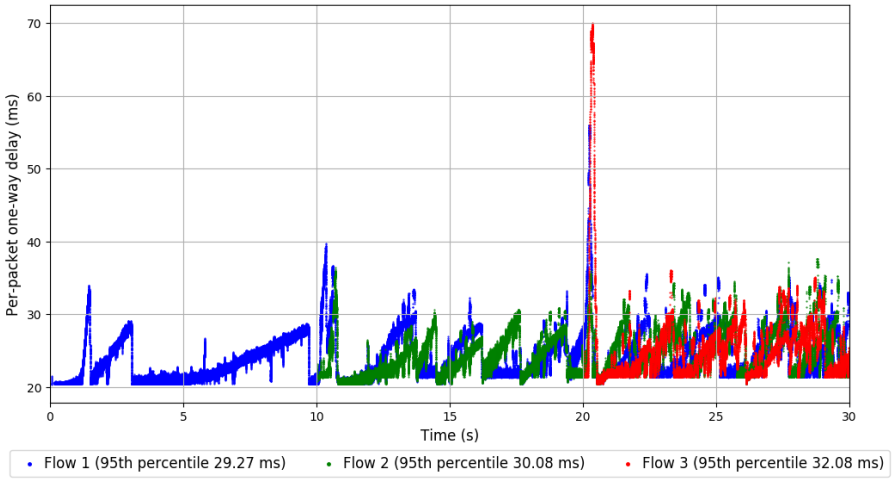
```
Run 3: Statistics of TCP Cubic

Start at: 2018-09-05 03:44:03
End at: 2018-09-05 03:44:33
Local clock offset: 2.132 ms
Remote clock offset: -2.34 ms

# Below is generated by plot.py at 2018-09-05 03:47:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 94.09 Mbit/s
95th percentile per-packet one-way delay: 29.945 ms
Loss rate: 0.13%
-- Flow 1:
Average throughput: 57.06 Mbit/s
95th percentile per-packet one-way delay: 29.267 ms
Loss rate: 0.09%
-- Flow 2:
Average throughput: 39.76 Mbit/s
95th percentile per-packet one-way delay: 30.084 ms
Loss rate: 0.13%
-- Flow 3:
Average throughput: 31.76 Mbit/s
95th percentile per-packet one-way delay: 32.081 ms
Loss rate: 0.34%
```

Run 3: Report of TCP Cubic — Data Link



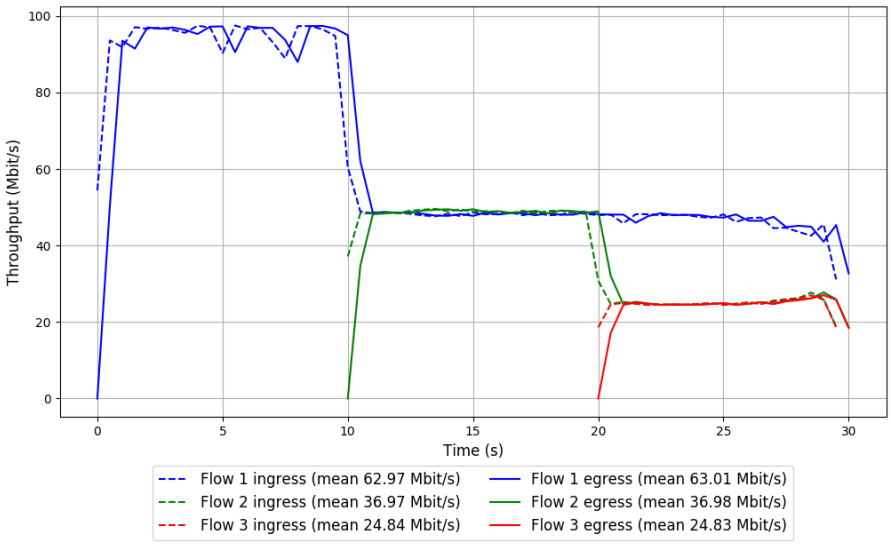


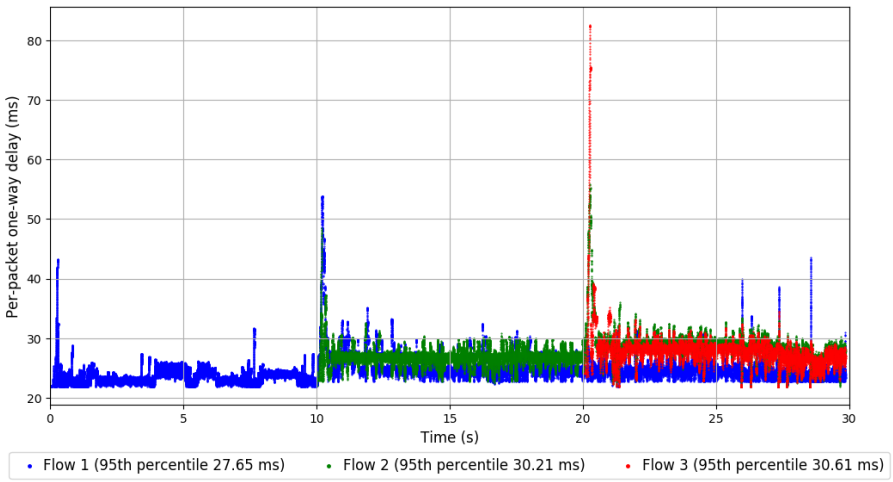
```
Run 1: Statistics of Indigo

Start at: 2018-09-05 03:35:20
End at: 2018-09-05 03:35:50
Local clock offset: 3.45 ms
Remote clock offset: -2.349 ms

# Below is generated by plot.py at 2018-09-05 03:47:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.75 Mbit/s
95th percentile per-packet one-way delay: 29.674 ms
Loss rate: 0.07%
-- Flow 1:
Average throughput: 63.01 Mbit/s
95th percentile per-packet one-way delay: 27.647 ms
Loss rate: 0.02%
-- Flow 2:
Average throughput: 36.98 Mbit/s
95th percentile per-packet one-way delay: 30.206 ms
Loss rate: 0.12%
-- Flow 3:
Average throughput: 24.83 Mbit/s
95th percentile per-packet one-way delay: 30.606 ms
Loss rate: 0.32%
```

Run 1: Report of Indigo — Data Link



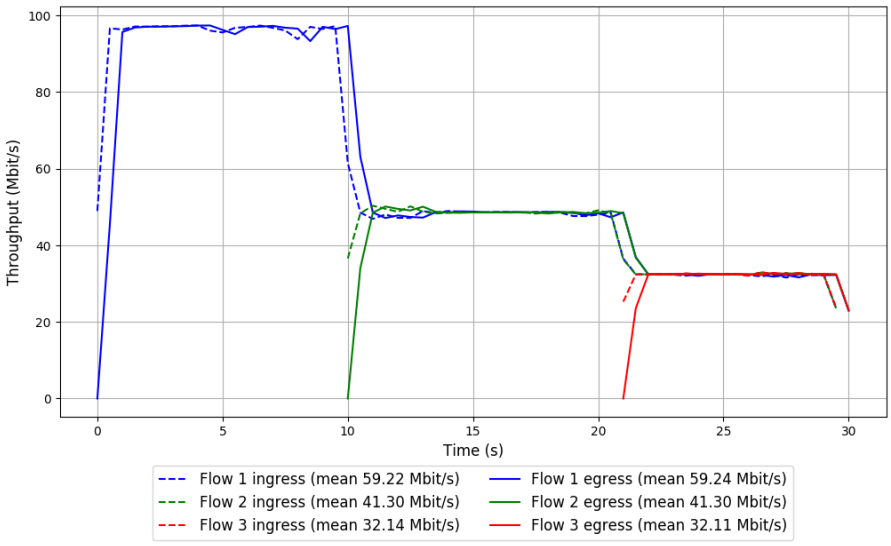


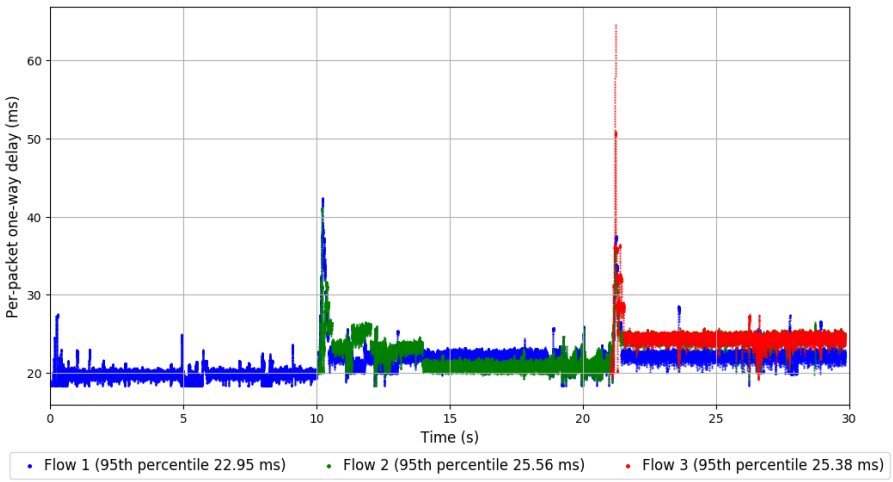
```
Run 2: Statistics of Indigo

Start at: 2018-09-05 03:40:22
End at: 2018-09-05 03:40:52
Local clock offset: -3.99 ms
Remote clock offset: -6.291 ms

# Below is generated by plot.py at 2018-09-05 03:47:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.18 Mbit/s
95th percentile per-packet one-way delay: 25.114 ms
Loss rate: 0.11%
-- Flow 1:
Average throughput: 59.24 Mbit/s
95th percentile per-packet one-way delay: 22.955 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 41.30 Mbit/s
95th percentile per-packet one-way delay: 25.558 ms
Loss rate: 0.13%
-- Flow 3:
Average throughput: 32.11 Mbit/s
95th percentile per-packet one-way delay: 25.379 ms
Loss rate: 0.39%
```

Run 2: Report of Indigo — Data Link



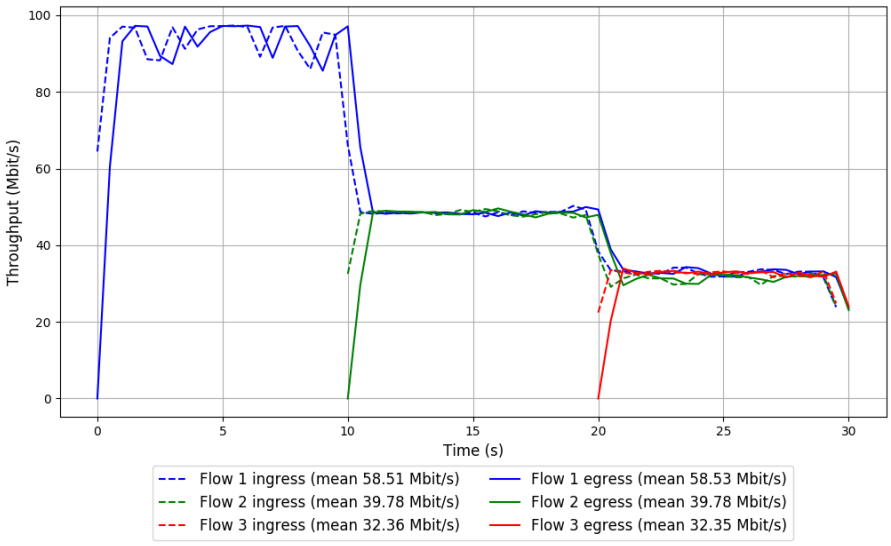


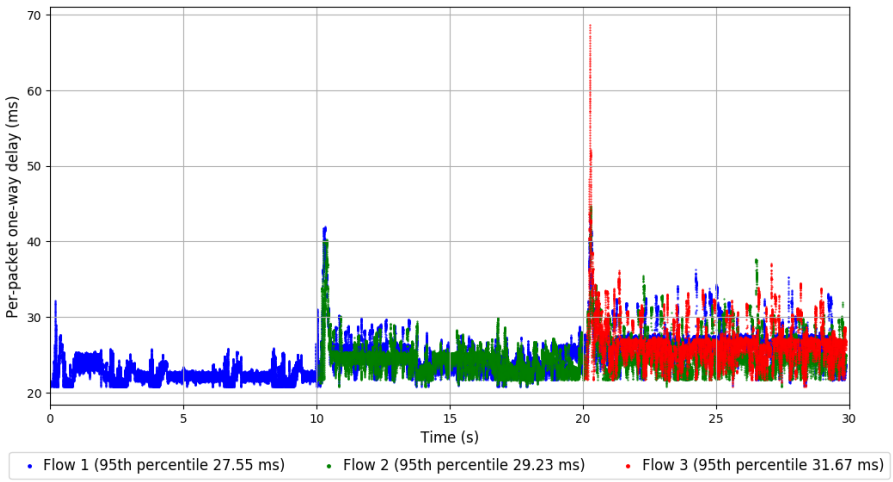
```
Run 3: Statistics of Indigo

Start at: 2018-09-05 03:45:16
End at: 2018-09-05 03:45:46
Local clock offset: 1.59 ms
Remote clock offset: -3.139 ms

# Below is generated by plot.py at 2018-09-05 03:47:51
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.56 Mbit/s
95th percentile per-packet one-way delay: 28.947 ms
Loss rate: 0.13%
-- Flow 1:
Average throughput: 58.53 Mbit/s
95th percentile per-packet one-way delay: 27.549 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 39.78 Mbit/s
95th percentile per-packet one-way delay: 29.229 ms
Loss rate: 0.17%
-- Flow 3:
Average throughput: 32.35 Mbit/s
95th percentile per-packet one-way delay: 31.669 ms
Loss rate: 0.39%
```

Run 3: Report of Indigo — Data Link



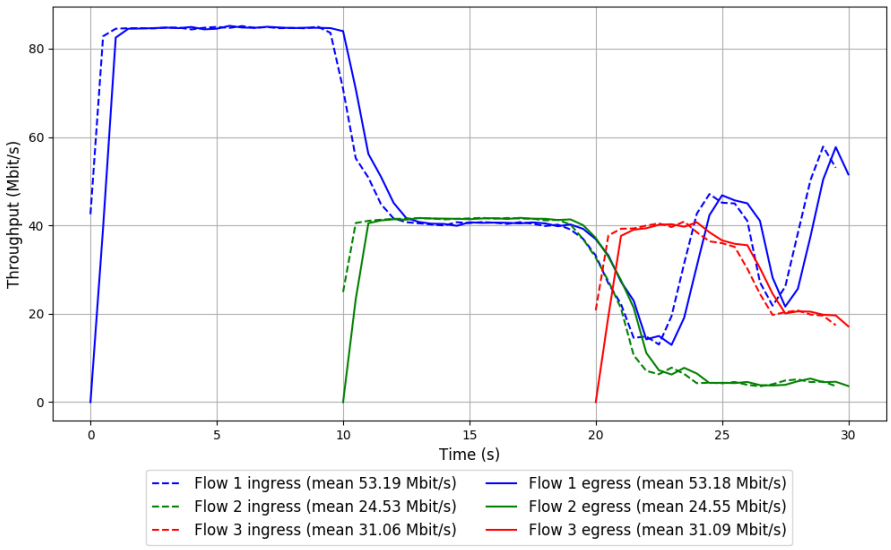


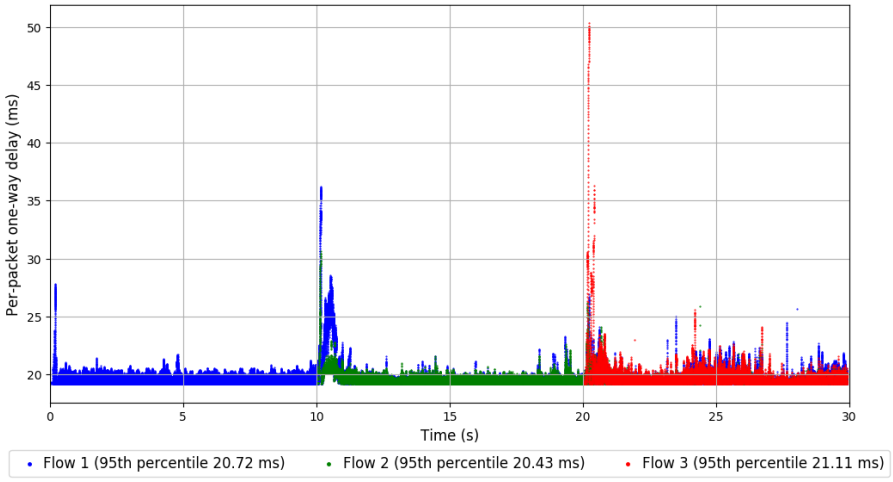
```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 03:31:40
End at: 2018-09-05 03:32:10
Local clock offset: 1.243 ms
Remote clock offset: -1.917 ms

# Below is generated by plot.py at 2018-09-05 03:47:51
# Datalink statistics
-- Total of 3 flows:
Average throughput: 79.80 Mbit/s
95th percentile per-packet one-way delay: 20.709 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 53.18 Mbit/s
95th percentile per-packet one-way delay: 20.718 ms
Loss rate: 0.11%
-- Flow 2:
Average throughput: 24.55 Mbit/s
95th percentile per-packet one-way delay: 20.428 ms
Loss rate: 0.02%
-- Flow 3:
Average throughput: 31.09 Mbit/s
95th percentile per-packet one-way delay: 21.106 ms
Loss rate: 0.17%
```

Run 1: Report of Muses-25 — Data Link



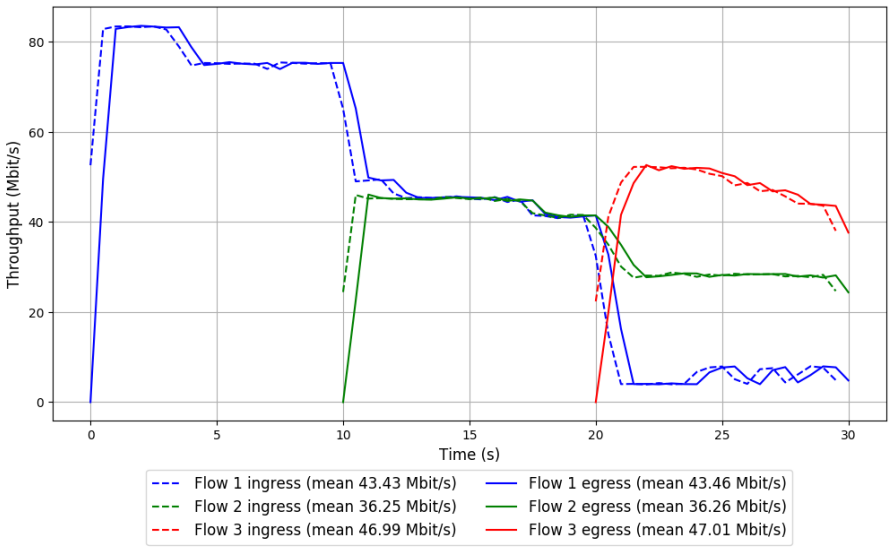


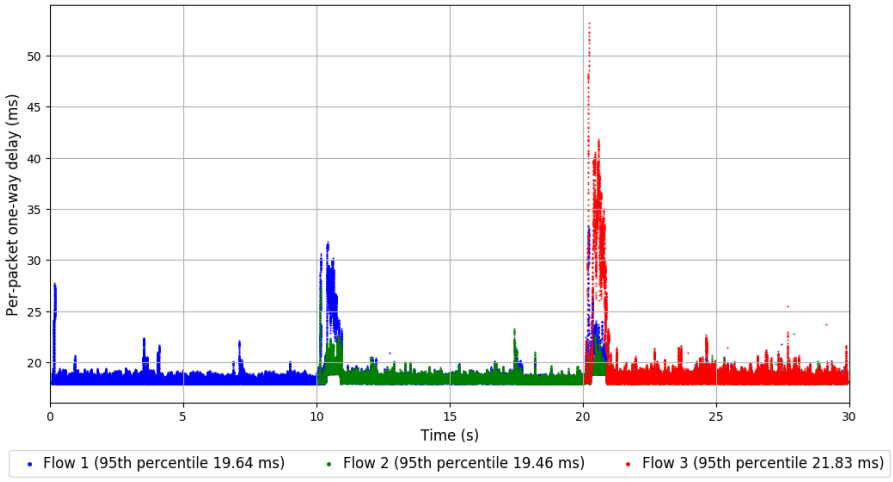
```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 03:36:34
End at: 2018-09-05 03:37:04
Local clock offset: -0.103 ms
Remote clock offset: -1.969 ms

# Below is generated by plot.py at 2018-09-05 03:47:51
# Datalink statistics
-- Total of 3 flows:
Average throughput: 83.13 Mbit/s
95th percentile per-packet one-way delay: 19.749 ms
Loss rate: 0.08%
-- Flow 1:
Average throughput: 43.46 Mbit/s
95th percentile per-packet one-way delay: 19.639 ms
Loss rate: 0.01%
-- Flow 2:
Average throughput: 36.26 Mbit/s
95th percentile per-packet one-way delay: 19.459 ms
Loss rate: 0.10%
-- Flow 3:
Average throughput: 47.01 Mbit/s
95th percentile per-packet one-way delay: 21.833 ms
Loss rate: 0.26%
```

Run 2: Report of Muses-25 — Data Link





```
Run 3: Statistics of Muses-25

Start at: 2018-09-05 03:41:37
End at: 2018-09-05 03:42:07
Local clock offset: 1.906 ms
Remote clock offset: -3.117 ms

# Below is generated by plot.py at 2018-09-05 03:47:51
# Datalink statistics
-- Total of 3 flows:
Average throughput: 71.41 Mbit/s
95th percentile per-packet one-way delay: 22.520 ms
Loss rate: 0.09%
-- Flow 1:
Average throughput: 45.01 Mbit/s
95th percentile per-packet one-way delay: 22.770 ms
Loss rate: 0.07%
-- Flow 2:
Average throughput: 25.51 Mbit/s
95th percentile per-packet one-way delay: 22.313 ms
Loss rate: 0.05%
-- Flow 3:
Average throughput: 28.52 Mbit/s
95th percentile per-packet one-way delay: 22.161 ms
Loss rate: 0.27%
```

Run 3: Report of Muses-25 — Data Link