Pantheon Report

Generated at 2018-08-31 10:01:36 (UTC).

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

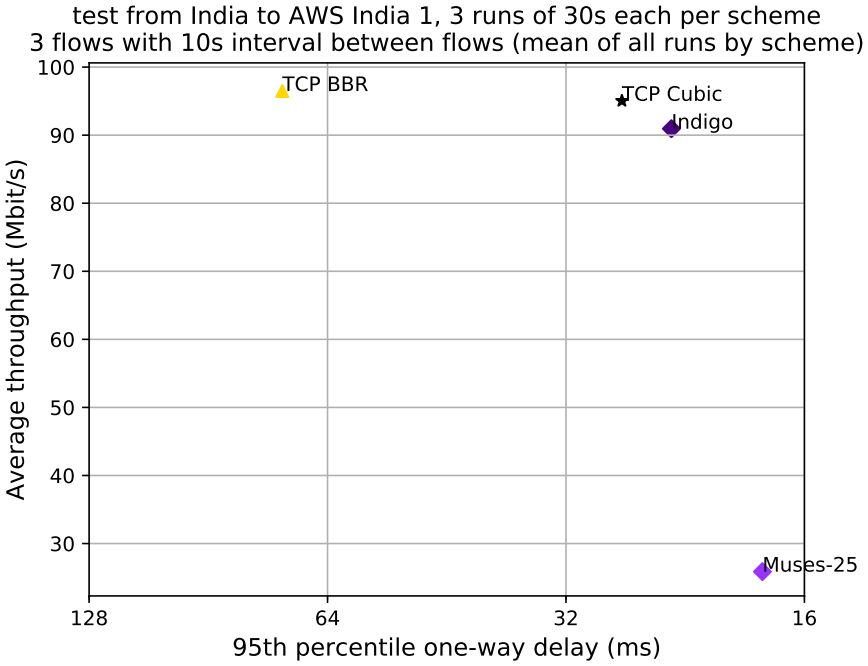
Repeated the test of 4 congestion control schemes 3 times.

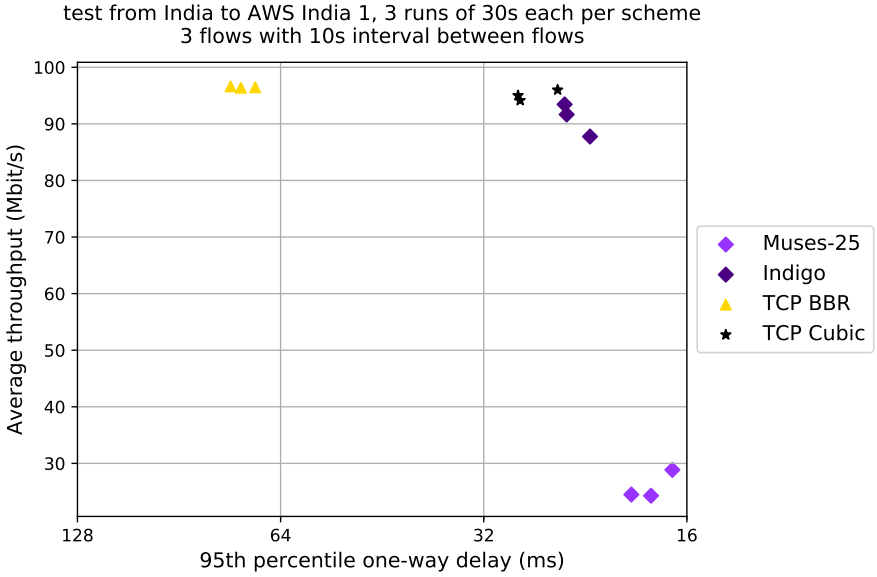
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

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 @ e3c5aa19ca94c3066828fb83f16a8fb6b2731e7a
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ b59e0d118c50af3579569c462d33045741c85981
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)
95th percentile one-way delay (ms)
TCP BBR
TCP Cubic
Indigo
Muses-25
100
90
80
70
60
50
40
30
128
64
32
16


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)
95th percentile one-way delay (ms)
Muses-25
Indigo
TCP BBR
TCP Cubic
100
90
80
70
60
50
40
30
128
64
32
16

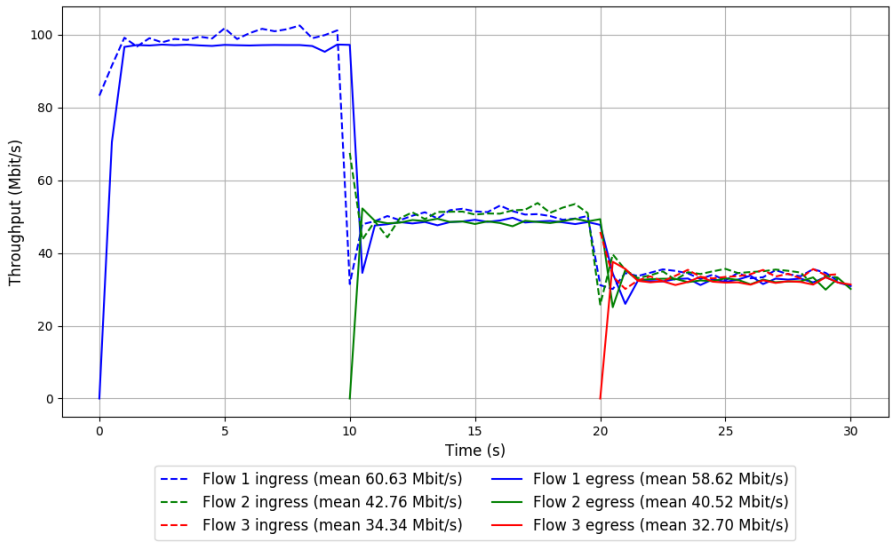
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	3	59.48	37.93	35.39	47.81	100.69	94.56	3.53	4.80	4.77
TCP Cubic	3	57.48	41.84	29.25	26.62	27.44	29.00	0.06	0.16	0.35
Indigo	3	52.86	40.62	34.55	22.85	23.67	24.69	0.05	0.12	0.33
Muses-25	3	13.28	13.57	10.77	17.83	18.44	18.42	0.05	0.08	0.21

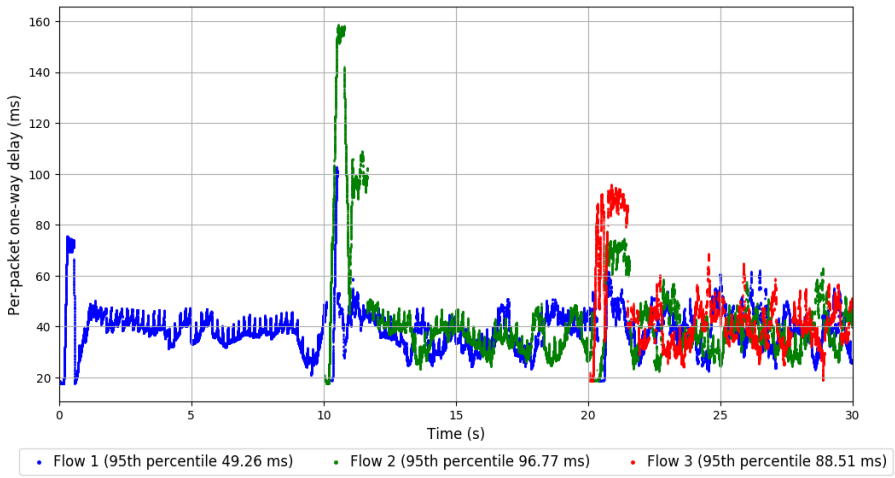
```
Run 1: Statistics of TCP BBR

Start at: 2018-08-31 09:47:11
End at: 2018-08-31 09:47:41
Local clock offset: 3.005 ms
Remote clock offset: -3.547 ms

# Below is generated by plot.py at 2018-08-31 10:01:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.45 Mbit/s
95th percentile per-packet one-way delay: 69.782 ms
Loss rate: 4.13%
-- Flow 1:
Average throughput: 58.62 Mbit/s
95th percentile per-packet one-way delay: 49.255 ms
Loss rate: 3.39%
-- Flow 2:
Average throughput: 40.52 Mbit/s
95th percentile per-packet one-way delay: 96.774 ms
Loss rate: 5.35%
-- Flow 3:
Average throughput: 32.70 Mbit/s
95th percentile per-packet one-way delay: 88.508 ms
Loss rate: 5.02%
```

Run 1: Report of TCP BBR — Data Link



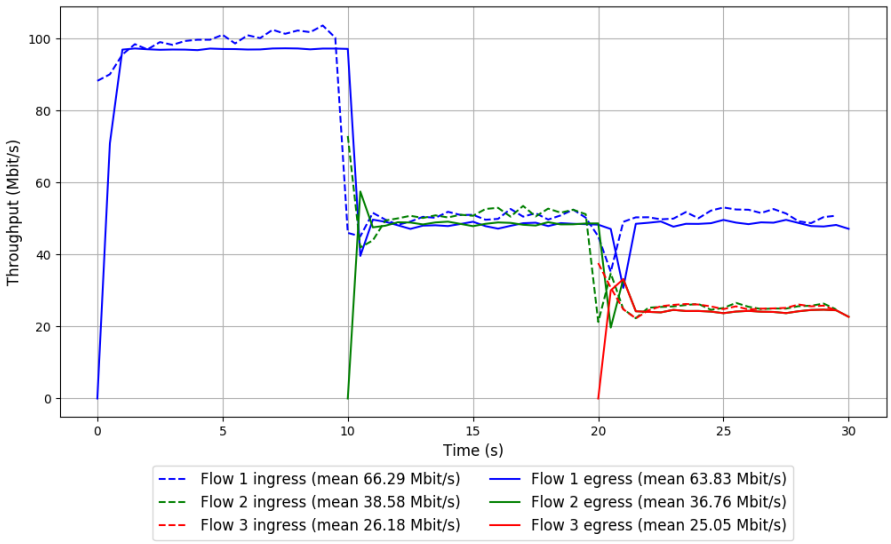


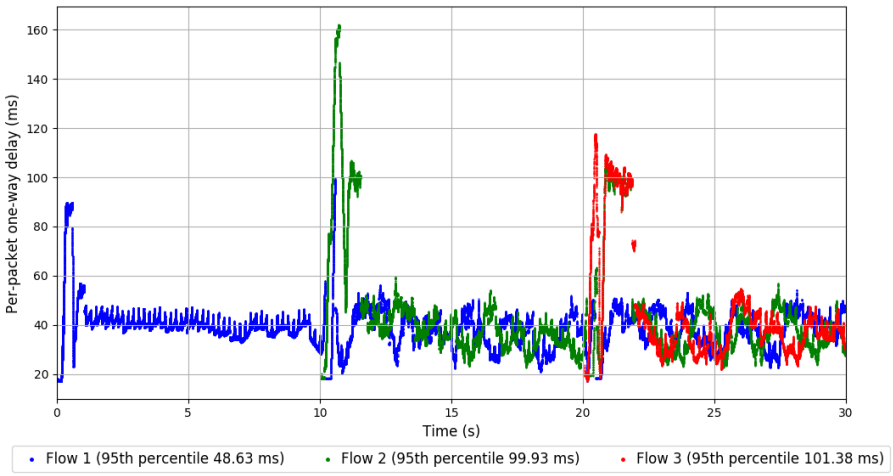
```
Run 2: Statistics of TCP BBR

Start at: 2018-08-31 09:51:57
End at: 2018-08-31 09:52:27
Local clock offset: 2.467 ms
Remote clock offset: -3.874 ms

# Below is generated by plot.py at 2018-08-31 10:01:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.61 Mbit/s
95th percentile per-packet one-way delay: 75.911 ms
Loss rate: 4.14%
-- Flow 1:
Average throughput: 63.83 Mbit/s
95th percentile per-packet one-way delay: 48.629 ms
Loss rate: 3.80%
-- Flow 2:
Average throughput: 36.76 Mbit/s
95th percentile per-packet one-way delay: 99.931 ms
Loss rate: 4.85%
-- Flow 3:
Average throughput: 25.05 Mbit/s
95th percentile per-packet one-way delay: 101.384 ms
Loss rate: 4.63%
```

Run 2: Report of TCP BBR — Data Link



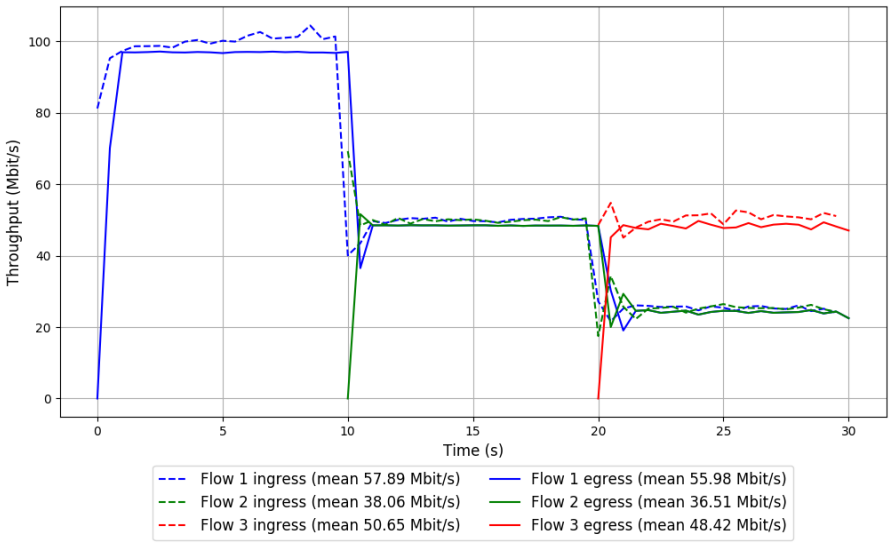


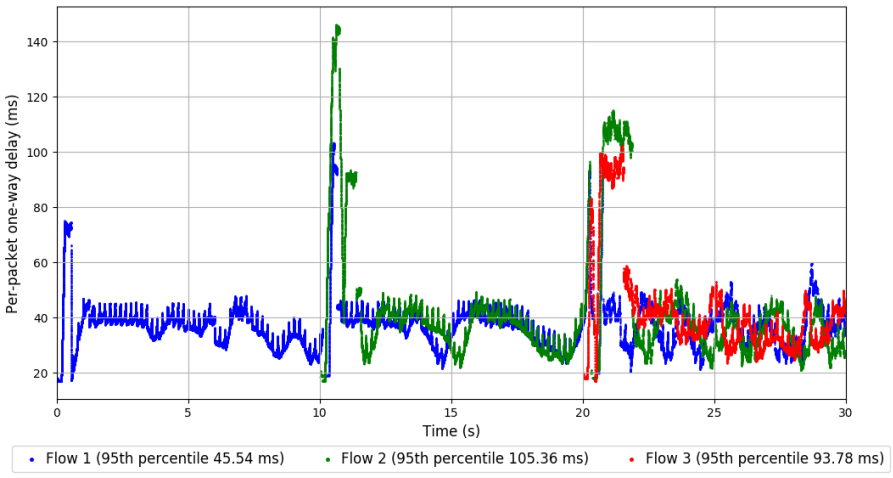
```
Run 3: Statistics of TCP BBR

Start at: 2018-08-31 09:56:51
End at: 2018-08-31 09:57:21
Local clock offset: 2.197 ms
Remote clock offset: -3.636 ms

# Below is generated by plot.py at 2018-08-31 10:01:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.37 Mbit/s
95th percentile per-packet one-way delay: 73.271 ms
Loss rate: 3.81%
-- Flow 1:
Average throughput: 55.98 Mbit/s
95th percentile per-packet one-way delay: 45.543 ms
Loss rate: 3.39%
-- Flow 2:
Average throughput: 36.51 Mbit/s
95th percentile per-packet one-way delay: 105.359 ms
Loss rate: 4.20%
-- Flow 3:
Average throughput: 48.42 Mbit/s
95th percentile per-packet one-way delay: 93.779 ms
Loss rate: 4.65%
```

Run 3: Report of TCP BBR — Data Link



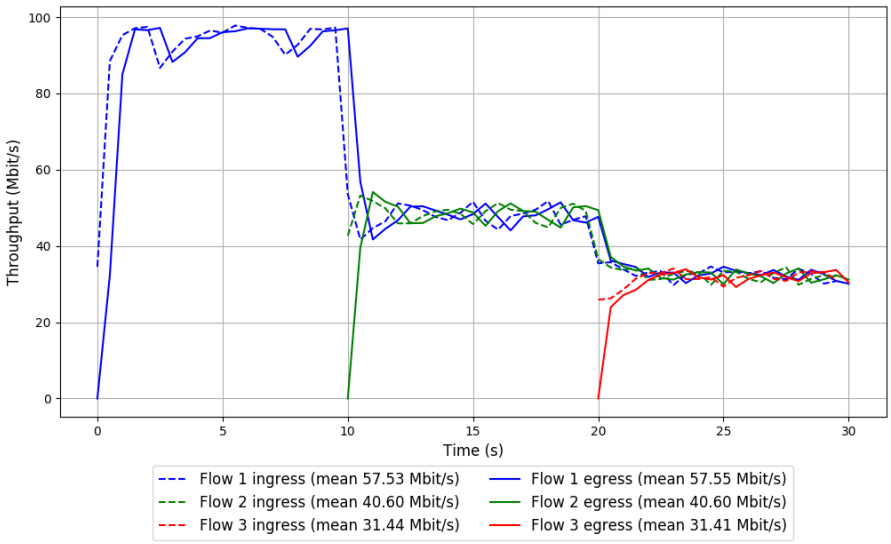


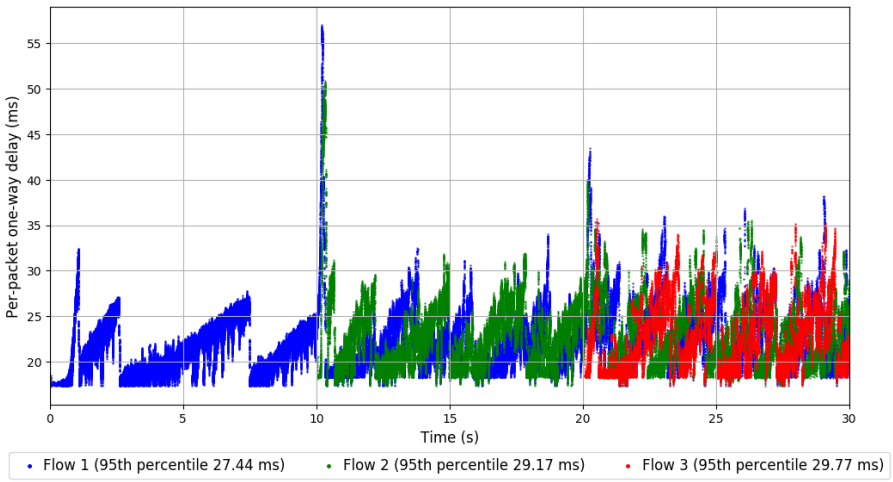
```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-31 09:49:39
End at: 2018-08-31 09:50:09
Local clock offset: -2.846 ms
Remote clock offset: -9.189 ms

# Below is generated by plot.py at 2018-08-31 10:01:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.00 Mbit/s
95th percentile per-packet one-way delay: 28.464 ms
Loss rate: 0.12%
-- Flow 1:
Average throughput: 57.55 Mbit/s
95th percentile per-packet one-way delay: 27.436 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 40.60 Mbit/s
95th percentile per-packet one-way delay: 29.169 ms
Loss rate: 0.15%
-- Flow 3:
Average throughput: 31.41 Mbit/s
95th percentile per-packet one-way delay: 29.767 ms
Loss rate: 0.34%
```

Run 1: Report of TCP Cubic — Data Link



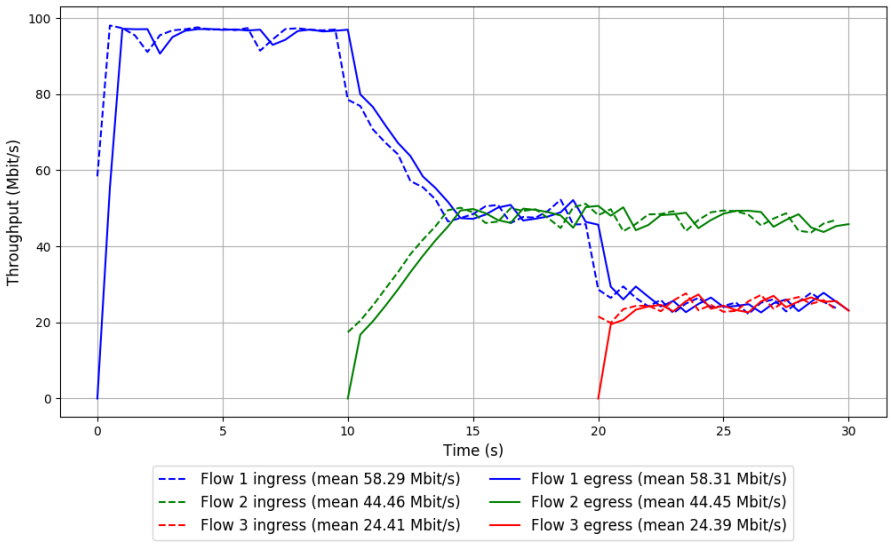


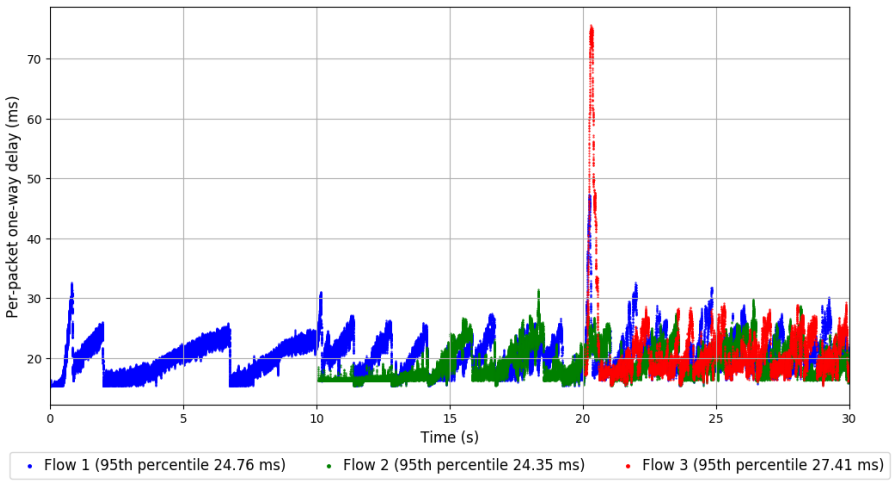
```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-31 09:54:27
End at: 2018-08-31 09:54:57
Local clock offset: 1.947 ms
Remote clock offset: -2.61 ms

# Below is generated by plot.py at 2018-08-31 10:01:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.99 Mbit/s
95th percentile per-packet one-way delay: 24.870 ms
Loss rate: 0.12%
-- Flow 1:
Average throughput: 58.31 Mbit/s
95th percentile per-packet one-way delay: 24.756 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 44.45 Mbit/s
95th percentile per-packet one-way delay: 24.352 ms
Loss rate: 0.18%
-- Flow 3:
Average throughput: 24.39 Mbit/s
95th percentile per-packet one-way delay: 27.410 ms
Loss rate: 0.37%
```

Run 2: Report of TCP Cubic — Data Link



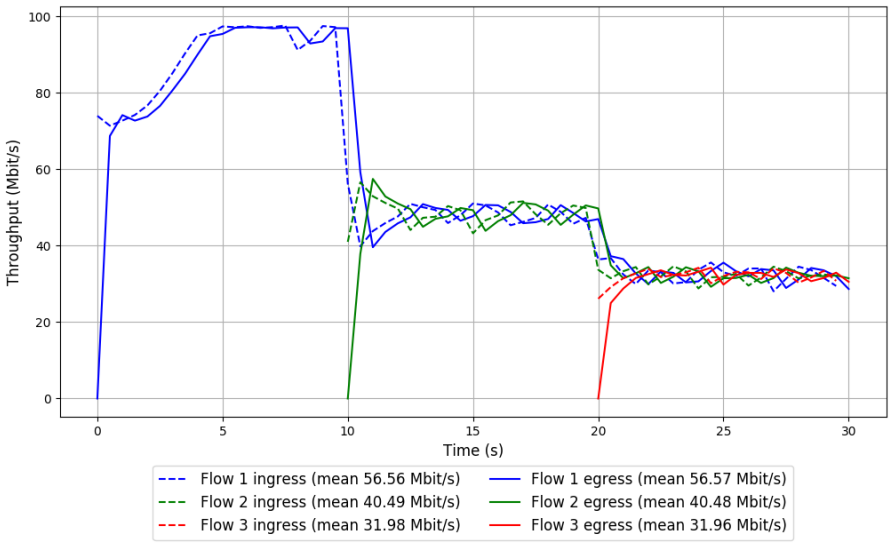


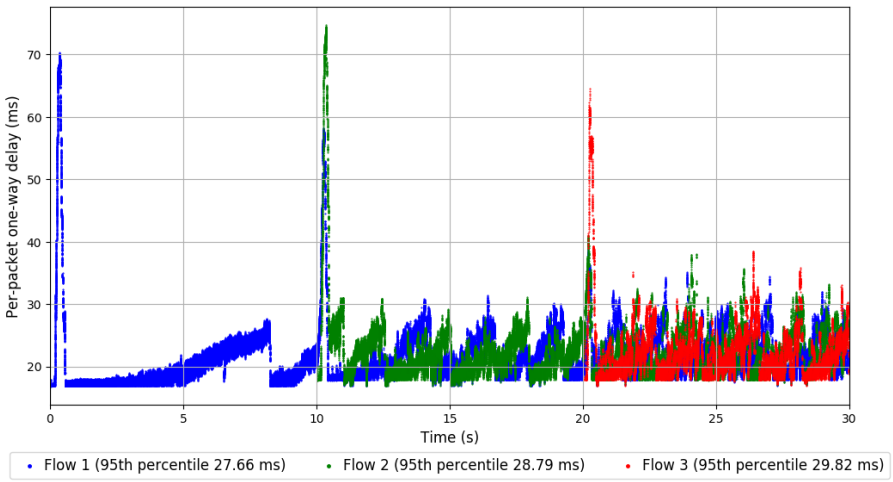
```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-31 09:59:17
End at: 2018-08-31 09:59:47
Local clock offset: 1.468 ms
Remote clock offset: -4.096 ms

# Below is generated by plot.py at 2018-08-31 10:01:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 94.13 Mbit/s
95th percentile per-packet one-way delay: 28.265 ms
Loss rate: 0.13%
-- Flow 1:
Average throughput: 56.57 Mbit/s
95th percentile per-packet one-way delay: 27.664 ms
Loss rate: 0.07%
-- Flow 2:
Average throughput: 40.48 Mbit/s
95th percentile per-packet one-way delay: 28.793 ms
Loss rate: 0.16%
-- Flow 3:
Average throughput: 31.96 Mbit/s
95th percentile per-packet one-way delay: 29.824 ms
Loss rate: 0.34%
```

Run 3: Report of TCP Cubic — Data Link



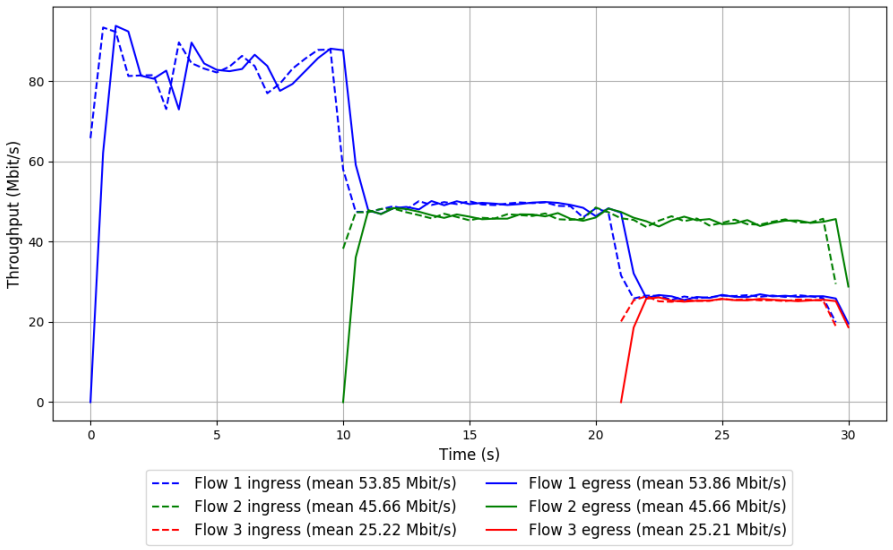


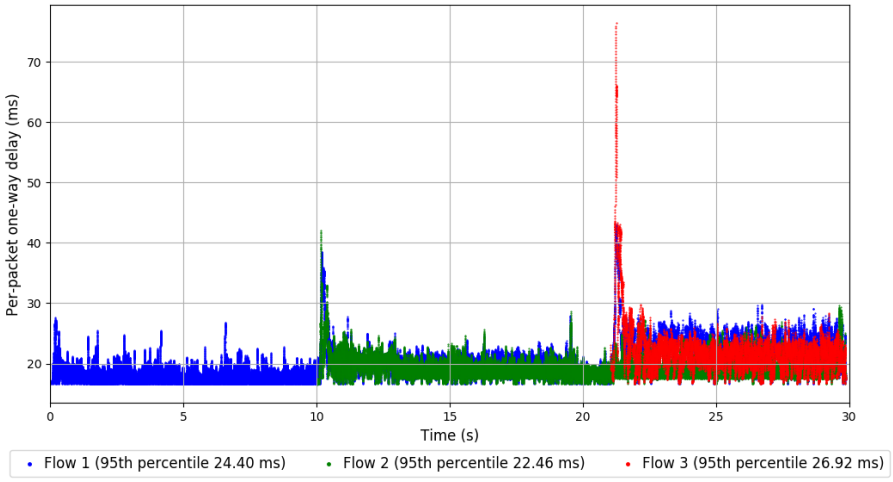
```
Run 1: Statistics of Indigo

Start at: 2018-08-31 09:48:25
End at: 2018-08-31 09:48:56
Local clock offset: 1.589 ms
Remote clock offset: -3.924 ms

# Below is generated by plot.py at 2018-08-31 10:01:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 91.65 Mbit/s
95th percentile per-packet one-way delay: 24.112 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 53.86 Mbit/s
95th percentile per-packet one-way delay: 24.396 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 45.66 Mbit/s
95th percentile per-packet one-way delay: 22.458 ms
Loss rate: 0.13%
-- Flow 3:
Average throughput: 25.21 Mbit/s
95th percentile per-packet one-way delay: 26.922 ms
Loss rate: 0.37%
```

Run 1: Report of Indigo — Data Link



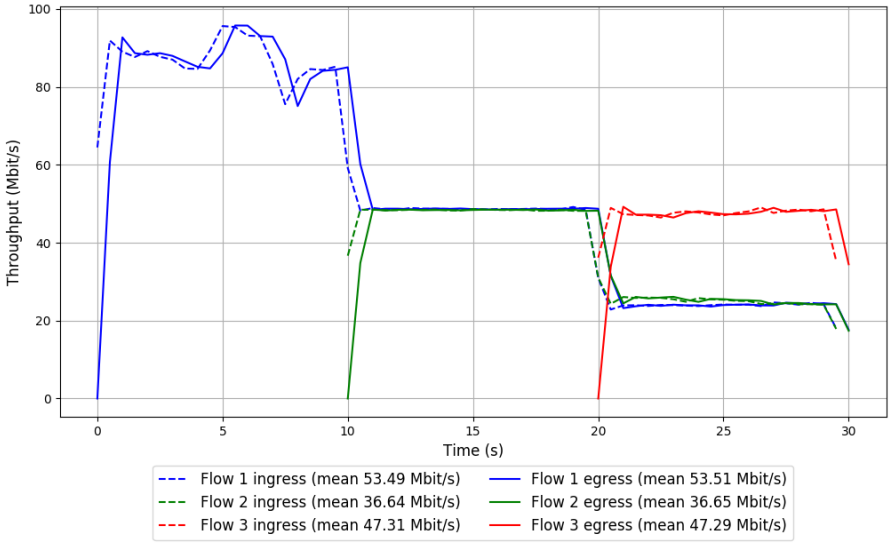


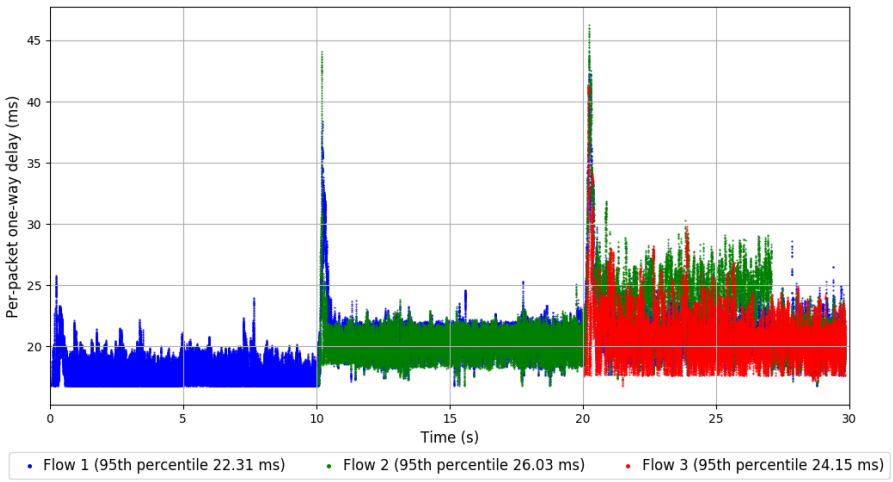
```
Run 2: Statistics of Indigo

Start at: 2018-08-31 09:53:14
End at: 2018-08-31 09:53:44
Local clock offset: 2.742 ms
Remote clock offset: -3.277 ms

# Below is generated by plot.py at 2018-08-31 10:01:20
# Datalink statistics
-- Total of 3 flows:
Average throughput: 93.44 Mbit/s
95th percentile per-packet one-way delay: 24.284 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 53.51 Mbit/s
95th percentile per-packet one-way delay: 22.313 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 36.65 Mbit/s
95th percentile per-packet one-way delay: 26.031 ms
Loss rate: 0.10%
-- Flow 3:
Average throughput: 47.29 Mbit/s
95th percentile per-packet one-way delay: 24.148 ms
Loss rate: 0.30%
```

Run 2: Report of Indigo — Data Link



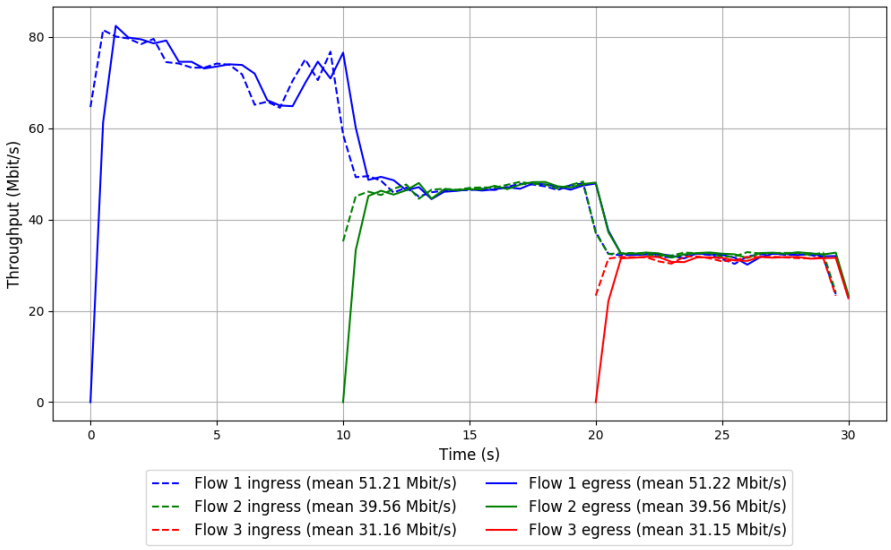


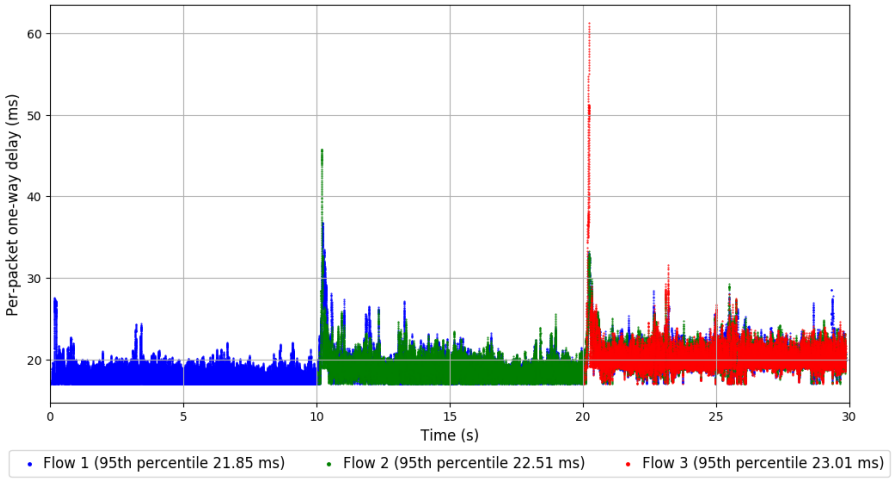
```
Run 3: Statistics of Indigo

Start at: 2018-08-31 09:58:04
End at: 2018-08-31 09:58:34
Local clock offset: 2.1 ms
Remote clock offset: -3.664 ms

# Below is generated by plot.py at 2018-08-31 10:01:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 87.76 Mbit/s
95th percentile per-packet one-way delay: 22.267 ms
Loss rate: 0.11%
-- Flow 1:
Average throughput: 51.22 Mbit/s
95th percentile per-packet one-way delay: 21.854 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 39.56 Mbit/s
95th percentile per-packet one-way delay: 22.513 ms
Loss rate: 0.12%
-- Flow 3:
Average throughput: 31.15 Mbit/s
95th percentile per-packet one-way delay: 23.010 ms
Loss rate: 0.31%
```

Run 3: Report of Indigo — Data Link



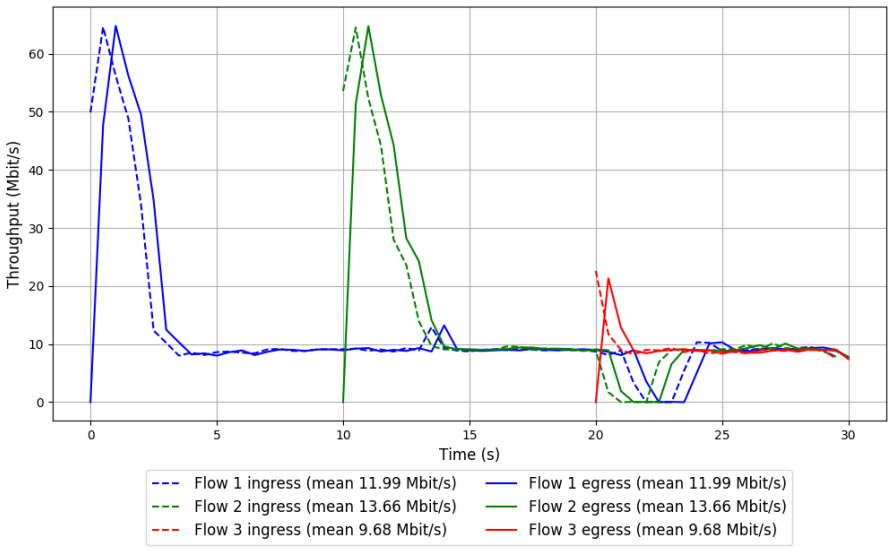


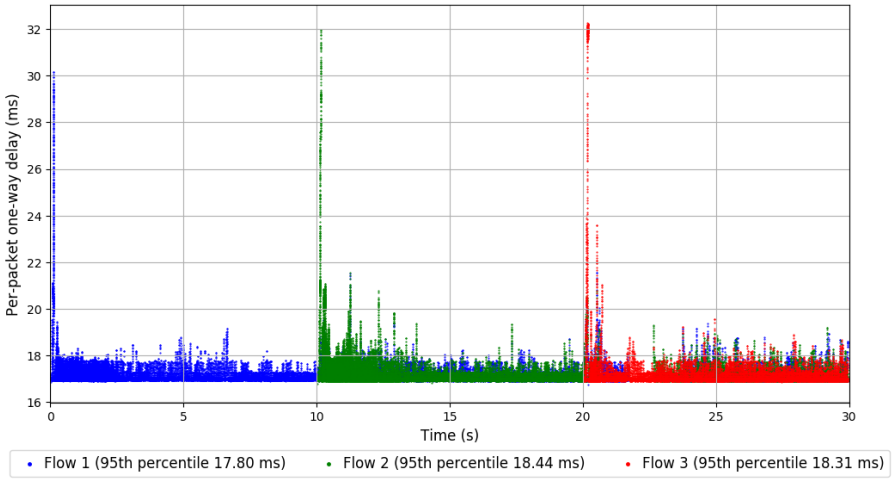
```
Run 1: Statistics of Muses-25

Start at: 2018-08-31 09:46:04
End at: 2018-08-31 09:46:34
Local clock offset: 2.916 ms
Remote clock offset: -2.673 ms

# Below is generated by plot.py at 2018-08-31 10:01:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 24.28 Mbit/s
95th percentile per-packet one-way delay: 18.082 ms
Loss rate: 0.08%
-- Flow 1:
Average throughput: 11.99 Mbit/s
95th percentile per-packet one-way delay: 17.800 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 13.66 Mbit/s
95th percentile per-packet one-way delay: 18.442 ms
Loss rate: 0.07%
-- Flow 3:
Average throughput: 9.68 Mbit/s
95th percentile per-packet one-way delay: 18.312 ms
Loss rate: 0.21%
```

Run 1: Report of Muses-25 — Data Link



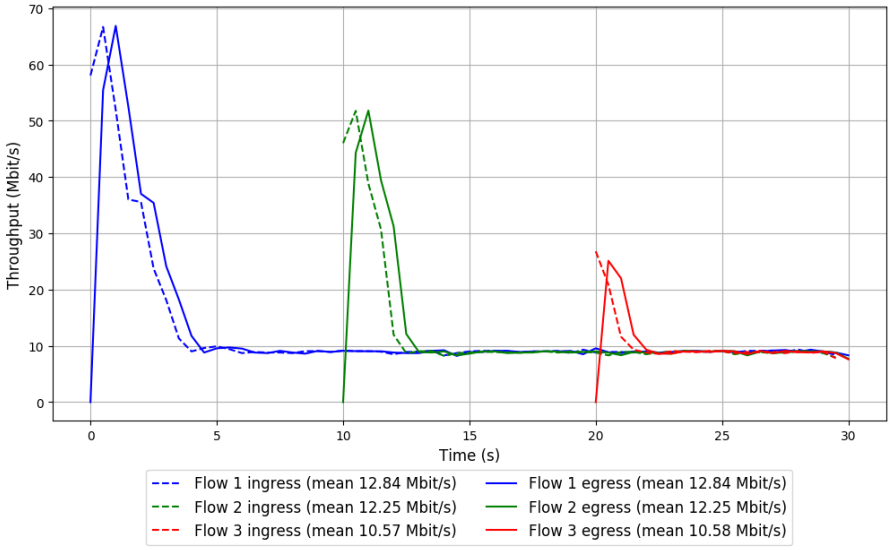


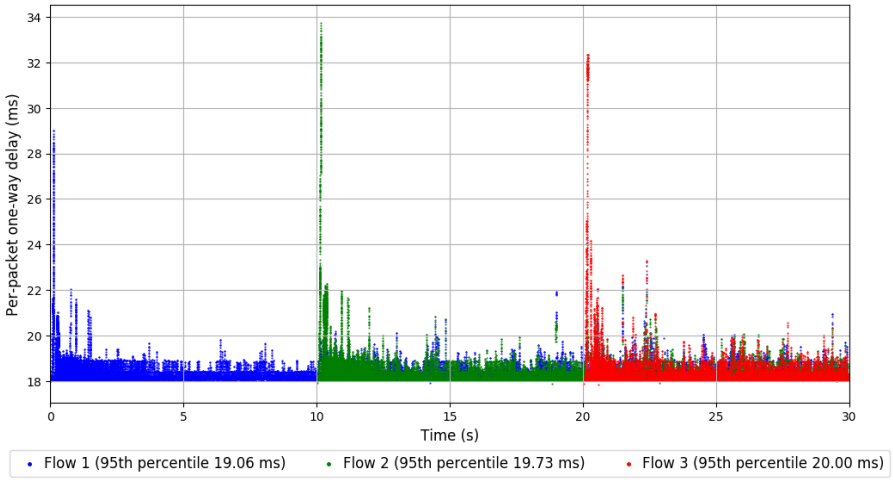
```
Run 2: Statistics of Muses-25

Start at: 2018-08-31 09:50:50
End at: 2018-08-31 09:51:20
Local clock offset: 2.919 ms
Remote clock offset: -4.167 ms

# Below is generated by plot.py at 2018-08-31 10:01:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 24.49 Mbit/s
95th percentile per-packet one-way delay: 19.337 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 12.84 Mbit/s
95th percentile per-packet one-way delay: 19.060 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 12.25 Mbit/s
95th percentile per-packet one-way delay: 19.726 ms
Loss rate: 0.10%
-- Flow 3:
Average throughput: 10.58 Mbit/s
95th percentile per-packet one-way delay: 20.000 ms
Loss rate: 0.24%
```

Run 2: Report of Muses-25 — Data Link





```
Run 3: Statistics of Muses-25

Start at: 2018-08-31 09:55:44
End at: 2018-08-31 09:56:14
Local clock offset: 1.745 ms
Remote clock offset: -3.03 ms

# Below is generated by plot.py at 2018-08-31 10:01:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 28.85 Mbit/s
95th percentile per-packet one-way delay: 16.814 ms
Loss rate: 0.07%
-- Flow 1:
Average throughput: 15.01 Mbit/s
95th percentile per-packet one-way delay: 16.625 ms
Loss rate: 0.04%
-- Flow 2:
Average throughput: 14.81 Mbit/s
95th percentile per-packet one-way delay: 17.147 ms
Loss rate: 0.08%
-- Flow 3:
Average throughput: 12.06 Mbit/s
95th percentile per-packet one-way delay: 16.950 ms
Loss rate: 0.17%
```

Run 3: Report of Muses-25 — Data Link