Pantheon Report

Generated at 2018-09-05 02:51:43 (UTC).

Data path: AWS California 2 on `ens5` (*local*) →Mexico on `em1` (*remote*).

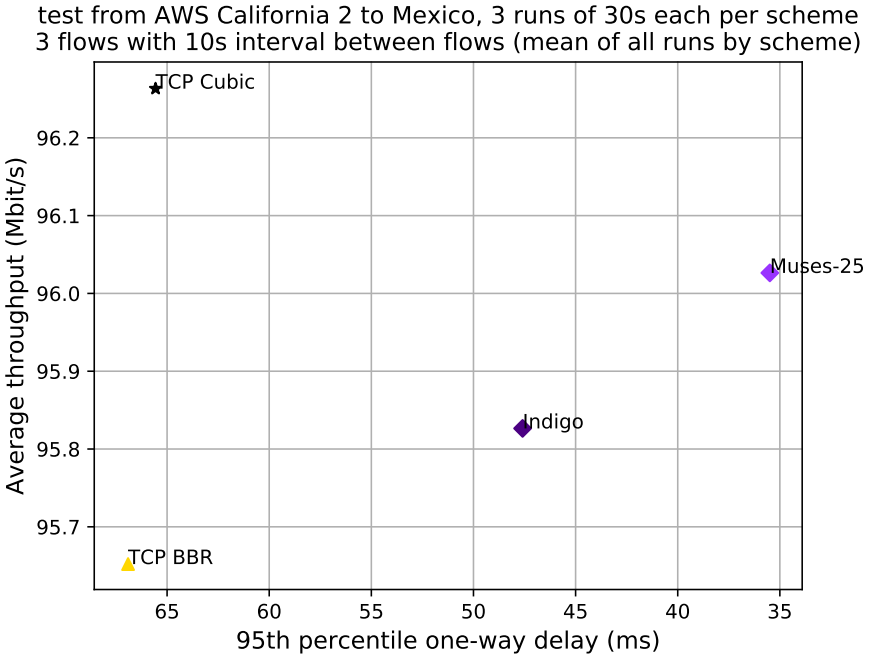
Repeated the test of 4 congestion control schemes 3 times.

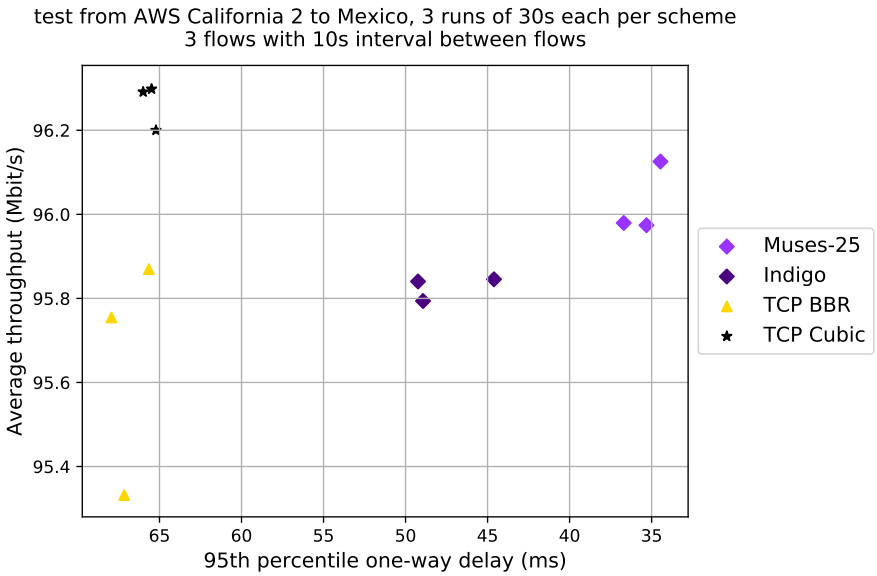
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

NTP offsets were measured against `time.stanford.edu` 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 AWS California 2 to Mexico, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
TCP Cubic
Muses-25
Indigo
TCP BBR
Average throughput (Mbit/s)
96.2
96.1
96.0
95.9
95.8
95.7
65
60
55
50
45
40
35
95th percentile one-way delay (ms)


test from AWS California 2 to Mexico, 3 runs of 30s each per scheme
3 flows with 10s interval between flows
Average throughput (Mbit/s)
96.2
96.0
95.8
95.6
95.4
65
60
55
50
45
40
35
95th percentile one-way delay (ms)
Muses-25
Indigo
TCP BBR
TCP Cubic

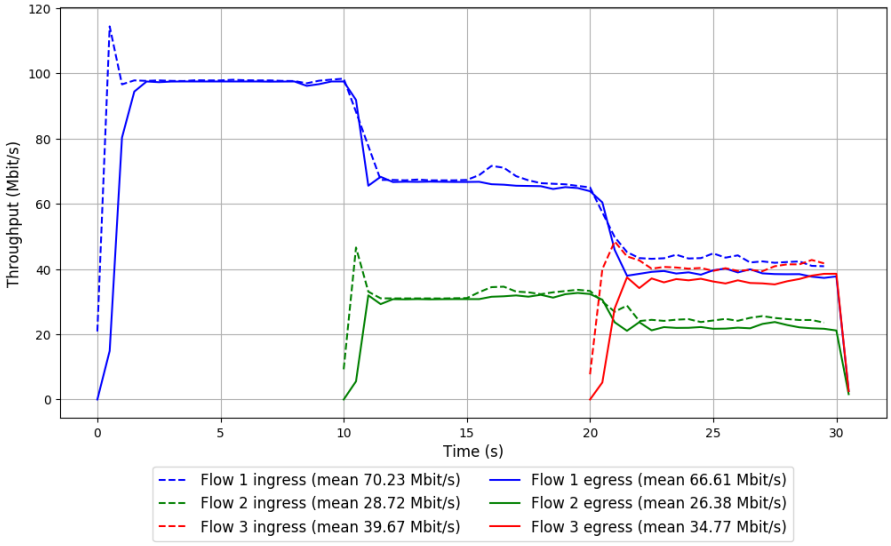
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	3	62.13	32.47	35.75	65.73	67.96	68.51	5.90	9.65	11.05
TCP Cubic	3	76.29	20.62	18.79	65.00	66.69	66.66	0.89	0.47	0.34
Indigo	3	68.25	24.23	35.28	43.97	50.03	57.92	0.01	0.00	0.00
Muses-25	3	61.75	38.65	26.01	34.82	37.78	37.89	0.11	0.20	0.10

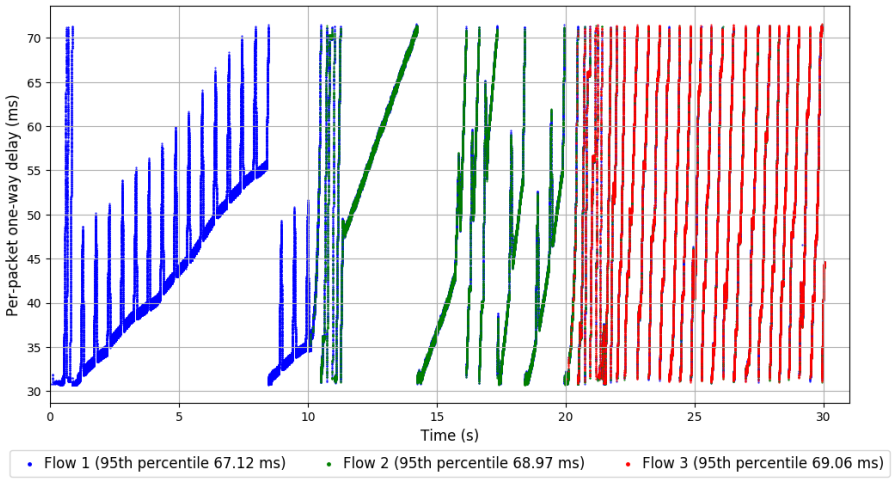
```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 02:36:16
End at: 2018-09-05 02:36:46
Local clock offset: 4.801 ms
Remote clock offset: -5.283 ms

# Below is generated by plot.py at 2018-09-05 02:51:07
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.75 Mbit/s
95th percentile per-packet one-way delay: 67.929 ms
Loss rate: 6.58%
-- Flow 1:
Average throughput: 66.61 Mbit/s
95th percentile per-packet one-way delay: 67.124 ms
Loss rate: 5.10%
-- Flow 2:
Average throughput: 26.38 Mbit/s
95th percentile per-packet one-way delay: 68.975 ms
Loss rate: 8.11%
-- Flow 3:
Average throughput: 34.77 Mbit/s
95th percentile per-packet one-way delay: 69.063 ms
Loss rate: 12.24%
```

Run 1: Report of TCP BBR — Data Link



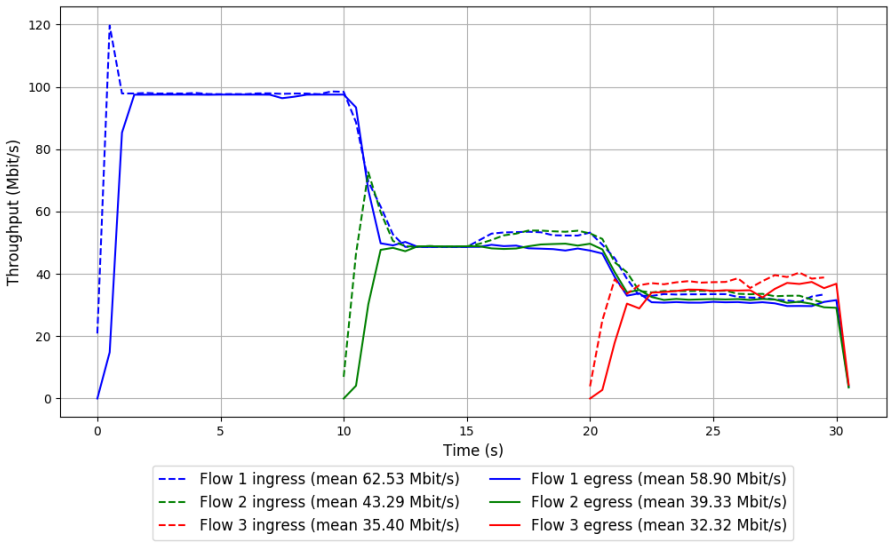


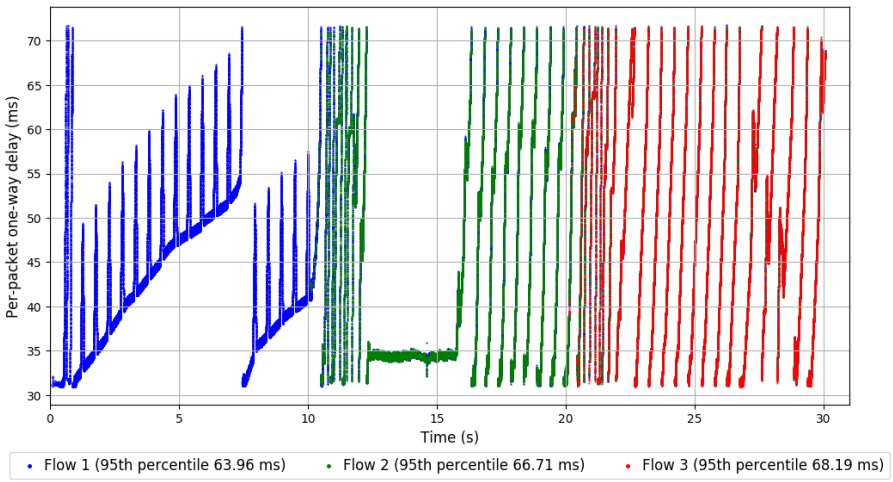
```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 02:41:55
End at: 2018-09-05 02:42:25
Local clock offset: 5.417 ms
Remote clock offset: -5.365 ms

# Below is generated by plot.py at 2018-09-05 02:51:07
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.87 Mbit/s
95th percentile per-packet one-way delay: 65.651 ms
Loss rate: 6.93%
-- Flow 1:
Average throughput: 58.90 Mbit/s
95th percentile per-packet one-way delay: 63.956 ms
Loss rate: 5.68%
-- Flow 2:
Average throughput: 39.33 Mbit/s
95th percentile per-packet one-way delay: 66.713 ms
Loss rate: 9.05%
-- Flow 3:
Average throughput: 32.32 Mbit/s
95th percentile per-packet one-way delay: 68.195 ms
Loss rate: 8.37%
```

Run 2: Report of TCP BBR — Data Link



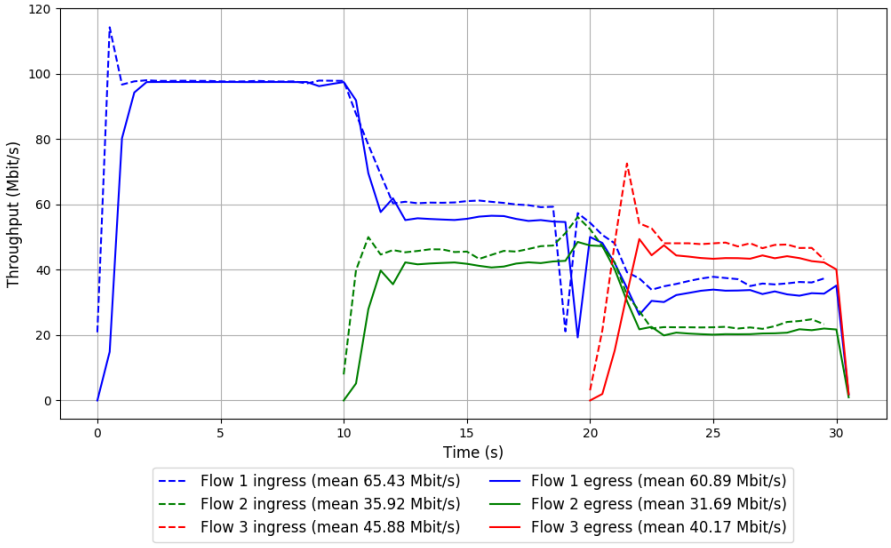


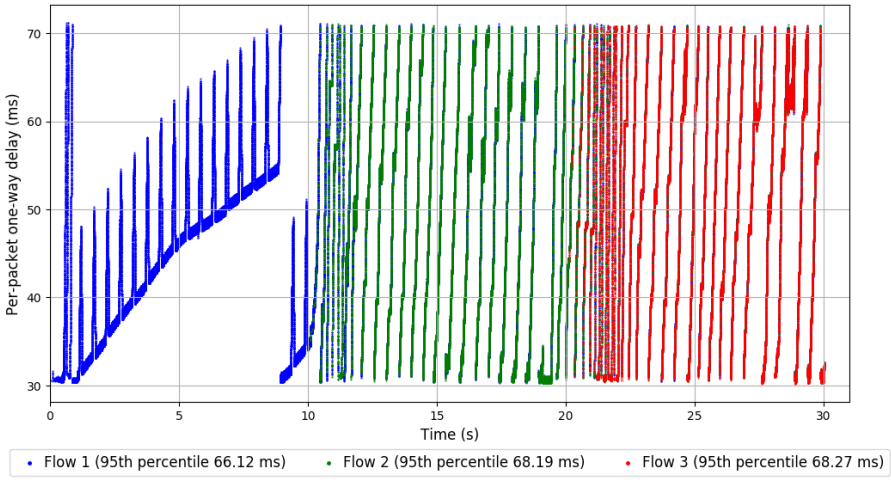
```
Run 3: Statistics of TCP BBR

Start at: 2018-09-05 02:47:35
End at: 2018-09-05 02:48:05
Local clock offset: 4.516 ms
Remote clock offset: -5.713 ms

# Below is generated by plot.py at 2018-09-05 02:51:08
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.33 Mbit/s
95th percentile per-packet one-way delay: 67.150 ms
Loss rate: 8.86%
-- Flow 1:
Average throughput: 60.89 Mbit/s
95th percentile per-packet one-way delay: 66.122 ms
Loss rate: 6.93%
-- Flow 2:
Average throughput: 31.69 Mbit/s
95th percentile per-packet one-way delay: 68.191 ms
Loss rate: 11.80%
-- Flow 3:
Average throughput: 40.17 Mbit/s
95th percentile per-packet one-way delay: 68.265 ms
Loss rate: 12.54%
```

Run 3: Report of TCP BBR — Data Link



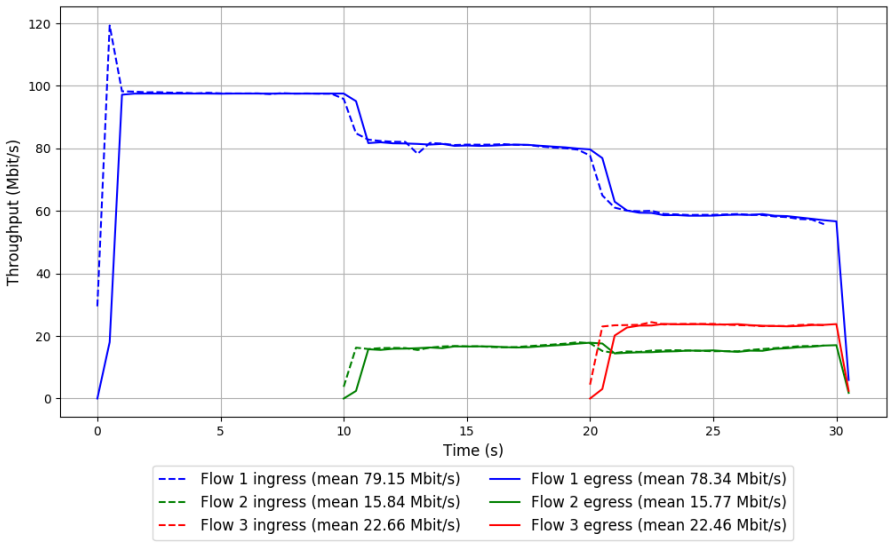


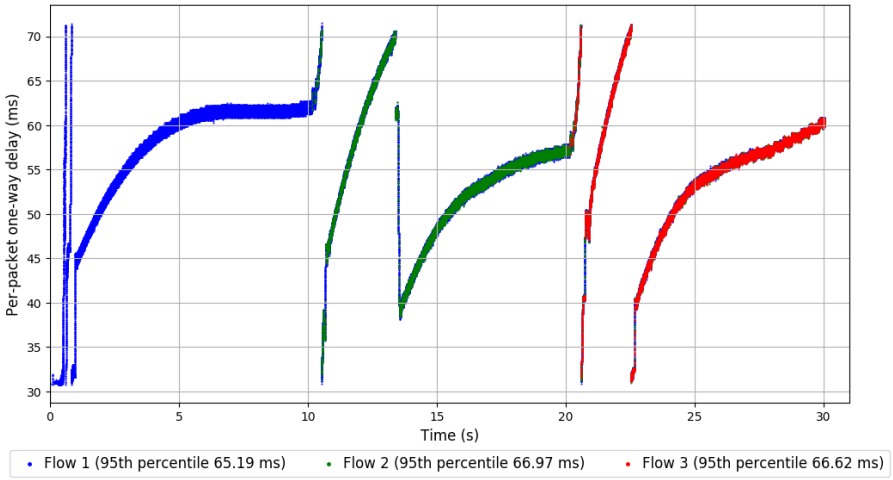
```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 02:33:23
End at: 2018-09-05 02:33:53
Local clock offset: 4.704 ms
Remote clock offset: -4.955 ms

# Below is generated by plot.py at 2018-09-05 02:51:08
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.30 Mbit/s
95th percentile per-packet one-way delay: 65.485 ms
Loss rate: 0.88%
-- Flow 1:
Average throughput: 78.34 Mbit/s
95th percentile per-packet one-way delay: 65.187 ms
Loss rate: 0.93%
-- Flow 2:
Average throughput: 15.77 Mbit/s
95th percentile per-packet one-way delay: 66.975 ms
Loss rate: 0.48%
-- Flow 3:
Average throughput: 22.46 Mbit/s
95th percentile per-packet one-way delay: 66.624 ms
Loss rate: 0.84%
```

Run 1: Report of TCP Cubic — Data Link



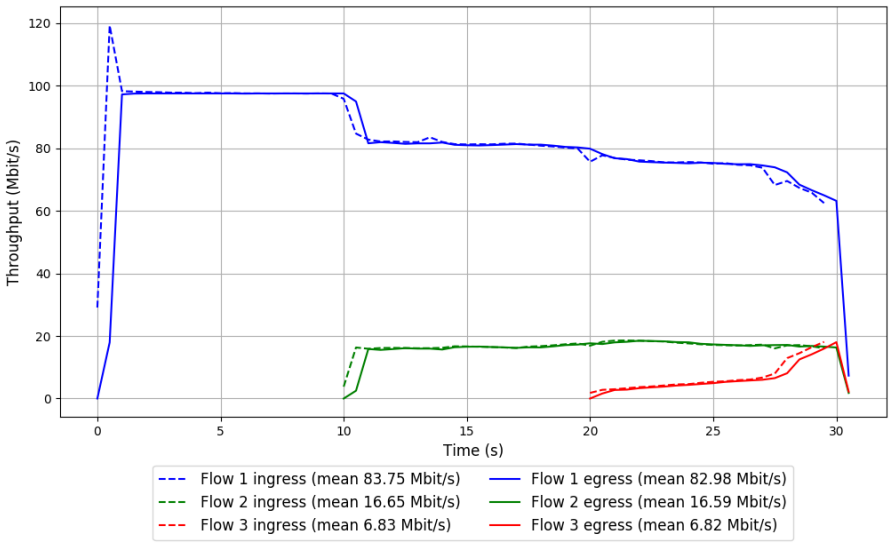


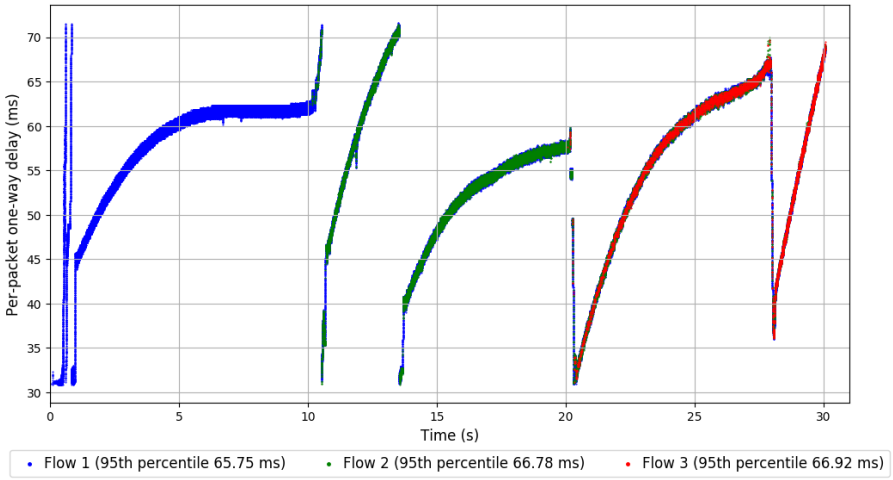
```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 02:39:04
End at: 2018-09-05 02:39:34
Local clock offset: 5.15 ms
Remote clock offset: -5.351 ms

# Below is generated by plot.py at 2018-09-05 02:51:08
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.29 Mbit/s
95th percentile per-packet one-way delay: 65.994 ms
Loss rate: 0.72%
-- Flow 1:
Average throughput: 82.98 Mbit/s
95th percentile per-packet one-way delay: 65.755 ms
Loss rate: 0.79%
-- Flow 2:
Average throughput: 16.59 Mbit/s
95th percentile per-packet one-way delay: 66.780 ms
Loss rate: 0.32%
-- Flow 3:
Average throughput: 6.82 Mbit/s
95th percentile per-packet one-way delay: 66.925 ms
Loss rate: 0.04%
```

Run 2: Report of TCP Cubic — Data Link



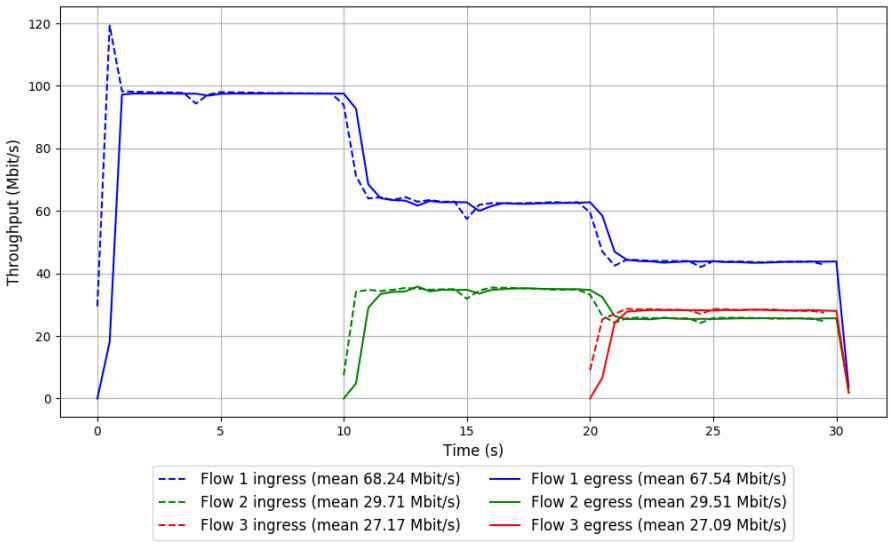


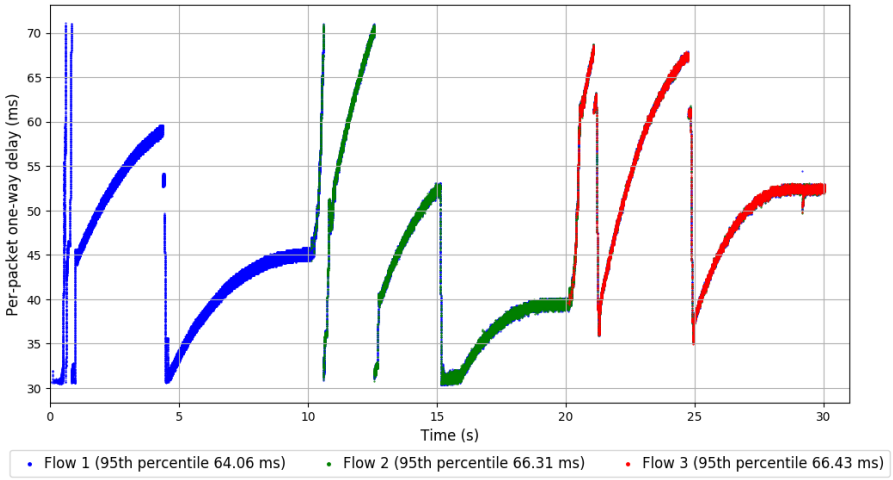
```
Run 3: Statistics of TCP Cubic

Start at: 2018-09-05 02:44:45
End at: 2018-09-05 02:45:15
Local clock offset: 5.902 ms
Remote clock offset: -5.394 ms

# Below is generated by plot.py at 2018-09-05 02:51:08
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.20 Mbit/s
95th percentile per-packet one-way delay: 65.215 ms
Loss rate: 0.81%
-- Flow 1:
Average throughput: 67.54 Mbit/s
95th percentile per-packet one-way delay: 64.064 ms
Loss rate: 0.95%
-- Flow 2:
Average throughput: 29.51 Mbit/s
95th percentile per-packet one-way delay: 66.307 ms
Loss rate: 0.62%
-- Flow 3:
Average throughput: 27.09 Mbit/s
95th percentile per-packet one-way delay: 66.431 ms
Loss rate: 0.15%
```

Run 3: Report of TCP Cubic — Data Link



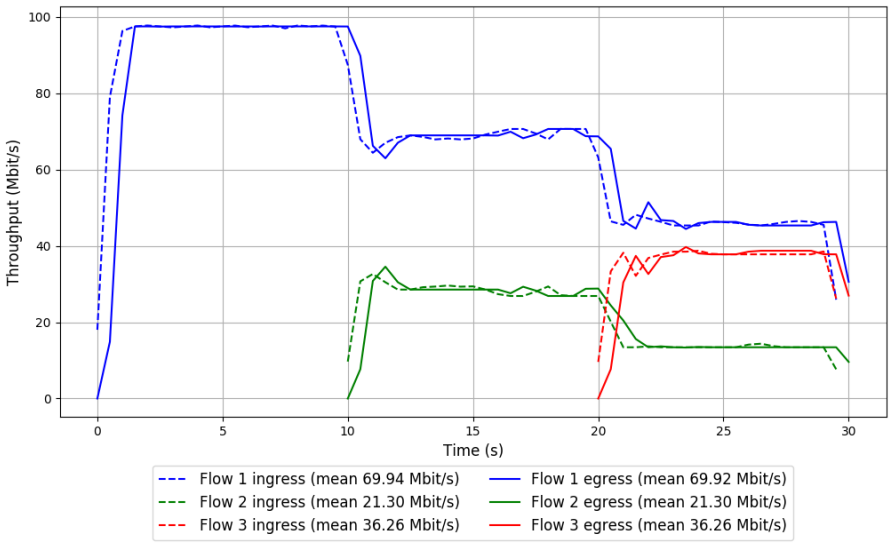


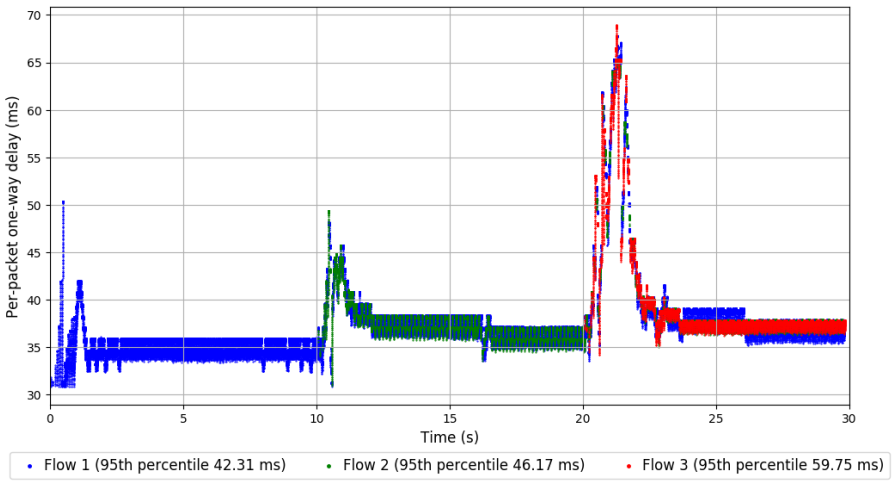
```
Run 1: Statistics of Indigo

Start at: 2018-09-05 02:34:46
End at: 2018-09-05 02:35:16
Local clock offset: 4.772 ms
Remote clock offset: -4.92 ms

# Below is generated by plot.py at 2018-09-05 02:51:08
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.85 Mbit/s
95th percentile per-packet one-way delay: 44.610 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 69.92 Mbit/s
95th percentile per-packet one-way delay: 42.306 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 21.30 Mbit/s
95th percentile per-packet one-way delay: 46.169 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 36.26 Mbit/s
95th percentile per-packet one-way delay: 59.748 ms
Loss rate: 0.00%
```

Run 1: Report of Indigo — Data Link



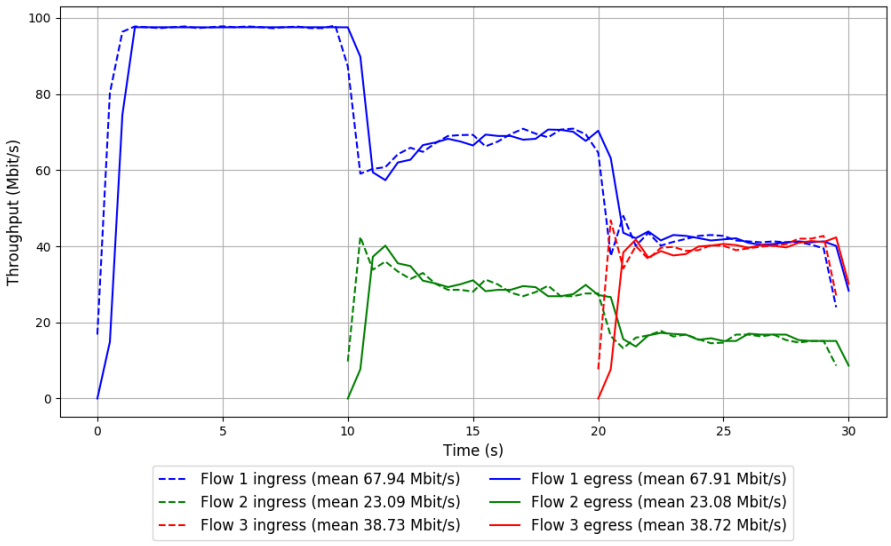


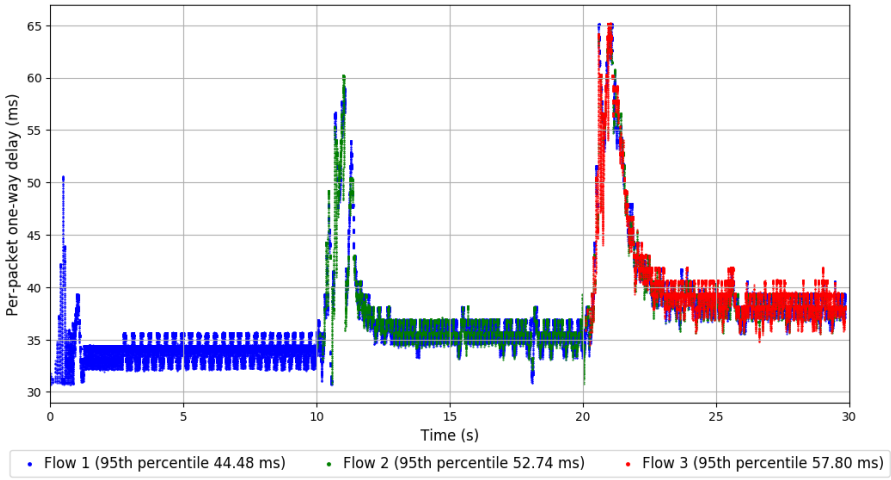
```
Run 2: Statistics of Indigo

Start at: 2018-09-05 02:40:28
End at: 2018-09-05 02:40:58
Local clock offset: 5.314 ms
Remote clock offset: -5.502 ms

# Below is generated by plot.py at 2018-09-05 02:51:08
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.84 Mbit/s
95th percentile per-packet one-way delay: 49.241 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 67.91 Mbit/s
95th percentile per-packet one-way delay: 44.476 ms
Loss rate: 0.02%
-- Flow 2:
Average throughput: 23.08 Mbit/s
95th percentile per-packet one-way delay: 52.737 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 38.72 Mbit/s
95th percentile per-packet one-way delay: 57.795 ms
Loss rate: 0.00%
```

Run 2: Report of Indigo — Data Link



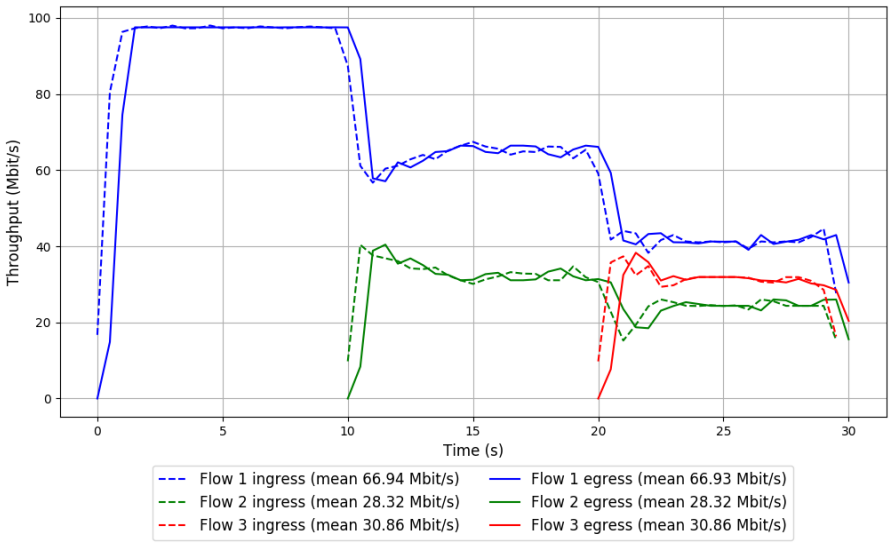


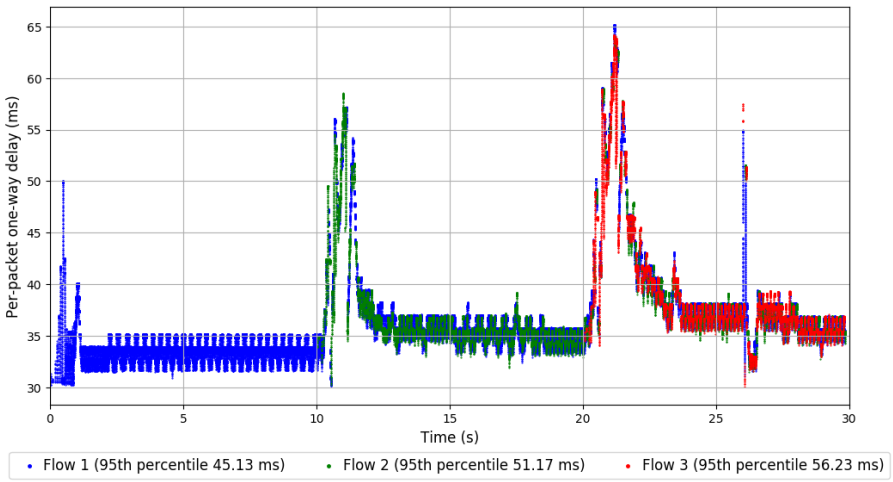
```
Run 3: Statistics of Indigo

Start at: 2018-09-05 02:46:09
End at: 2018-09-05 02:46:39
Local clock offset: 5.286 ms
Remote clock offset: -5.684 ms

# Below is generated by plot.py at 2018-09-05 02:51:40
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.79 Mbit/s
95th percentile per-packet one-way delay: 48.935 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 66.93 Mbit/s
95th percentile per-packet one-way delay: 45.126 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 28.32 Mbit/s
95th percentile per-packet one-way delay: 51.173 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 30.86 Mbit/s
95th percentile per-packet one-way delay: 56.229 ms
Loss rate: 0.00%
```

Run 3: Report of Indigo — Data Link



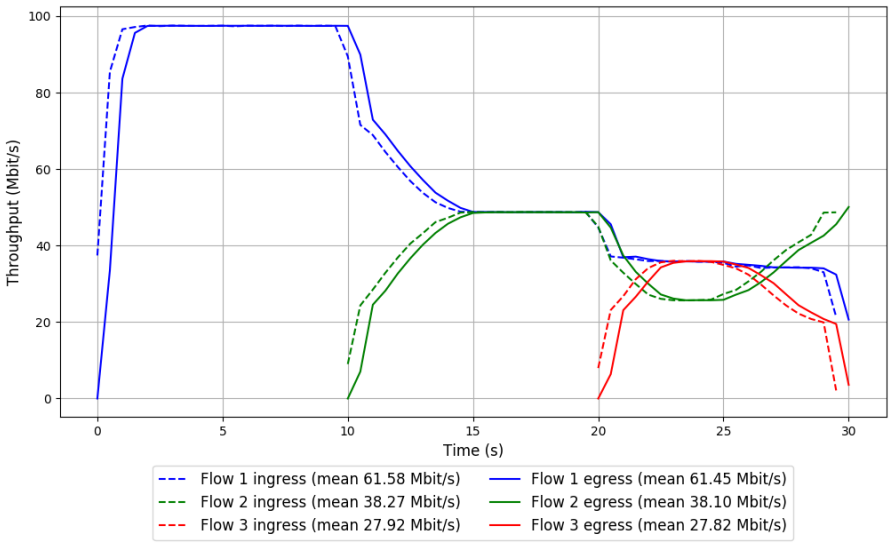


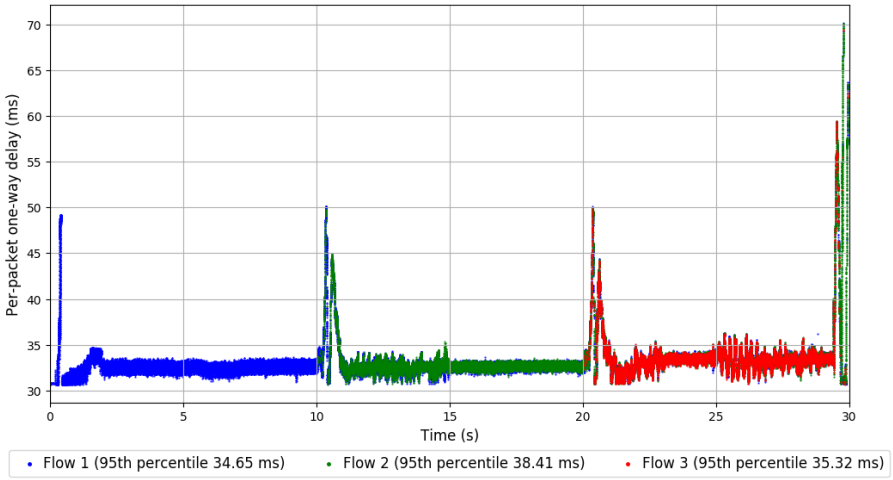
```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 02:37:40
End at: 2018-09-05 02:38:10
Local clock offset: 5.048 ms
Remote clock offset: -5.378 ms

# Below is generated by plot.py at 2018-09-05 02:51:42
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.97 Mbit/s
95th percentile per-packet one-way delay: 35.313 ms
Loss rate: 0.15%
-- Flow 1:
Average throughput: 61.45 Mbit/s
95th percentile per-packet one-way delay: 34.654 ms
Loss rate: 0.10%
-- Flow 2:
Average throughput: 38.10 Mbit/s
95th percentile per-packet one-way delay: 38.407 ms
Loss rate: 0.30%
-- Flow 3:
Average throughput: 27.82 Mbit/s
95th percentile per-packet one-way delay: 35.317 ms
Loss rate: 0.05%
```

Run 1: Report of Muses-25 — Data Link



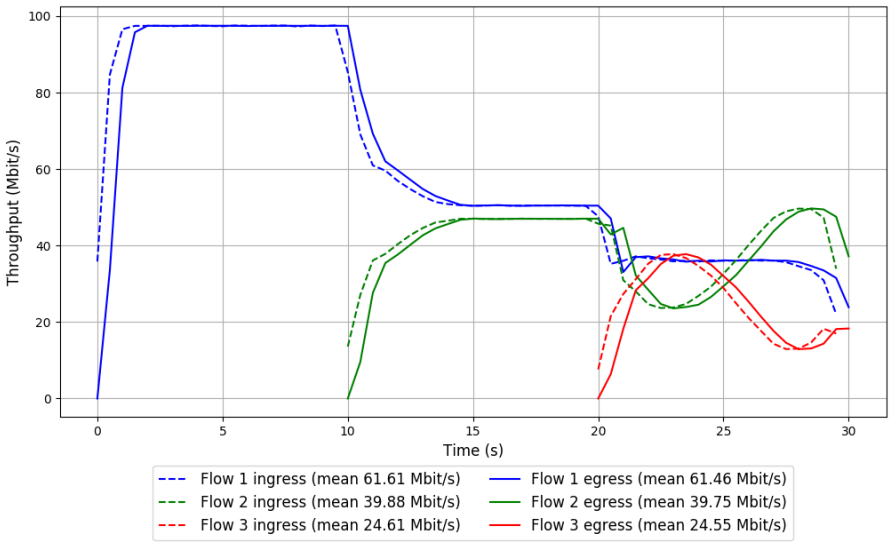


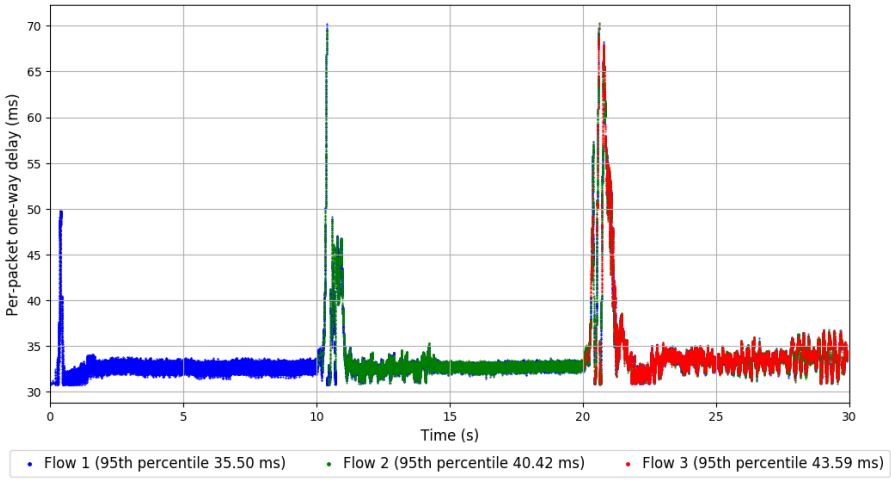
```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 02:43:21
End at: 2018-09-05 02:43:51
Local clock offset: 5.719 ms
Remote clock offset: -5.41 ms

# Below is generated by plot.py at 2018-09-05 02:51:42
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.98 Mbit/s
95th percentile per-packet one-way delay: 36.698 ms
Loss rate: 0.25%
-- Flow 1:
Average throughput: 61.46 Mbit/s
95th percentile per-packet one-way delay: 35.501 ms
Loss rate: 0.23%
-- Flow 2:
Average throughput: 39.75 Mbit/s
95th percentile per-packet one-way delay: 40.424 ms
Loss rate: 0.31%
-- Flow 3:
Average throughput: 24.55 Mbit/s
95th percentile per-packet one-way delay: 43.587 ms
Loss rate: 0.24%
```

Run 2: Report of Muses-25 — Data Link





```
Run 3: Statistics of Muses-25

Start at: 2018-09-05 02:48:58
End at: 2018-09-05 02:49:28
Local clock offset: 4.172 ms
Remote clock offset: -5.66 ms

# Below is generated by plot.py at 2018-09-05 02:51:42
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.13 Mbit/s
95th percentile per-packet one-way delay: 34.462 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 62.34 Mbit/s
95th percentile per-packet one-way delay: 34.307 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 38.09 Mbit/s
95th percentile per-packet one-way delay: 34.515 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 25.67 Mbit/s
95th percentile per-packet one-way delay: 34.759 ms
Loss rate: 0.00%
```

Run 3: Report of Muses-25 — Data Link