Pantheon Report

Generated at 2018-08-31 09:06:42 (UTC).

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

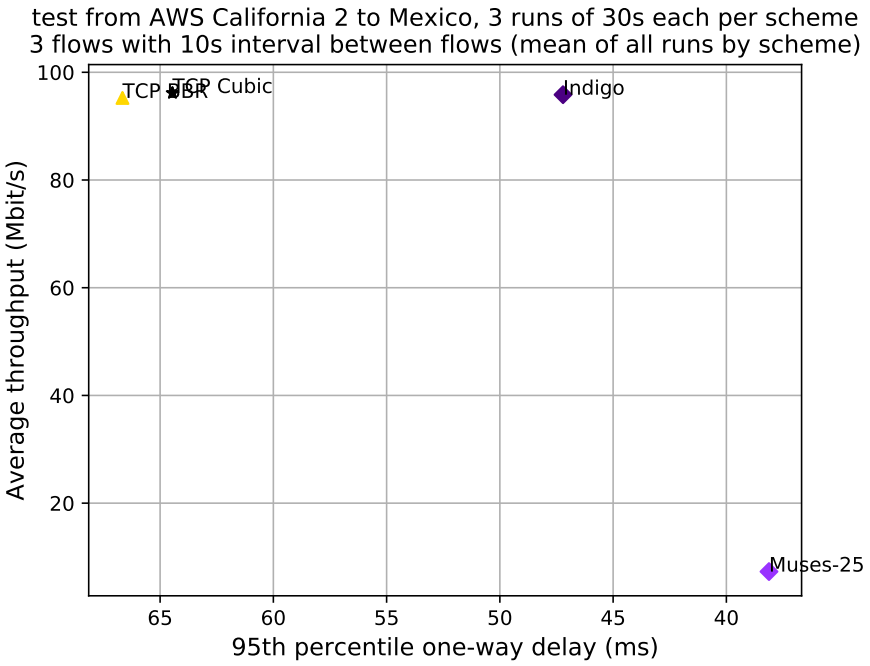
Repeated the test of 4 congestion control schemes 3 times.

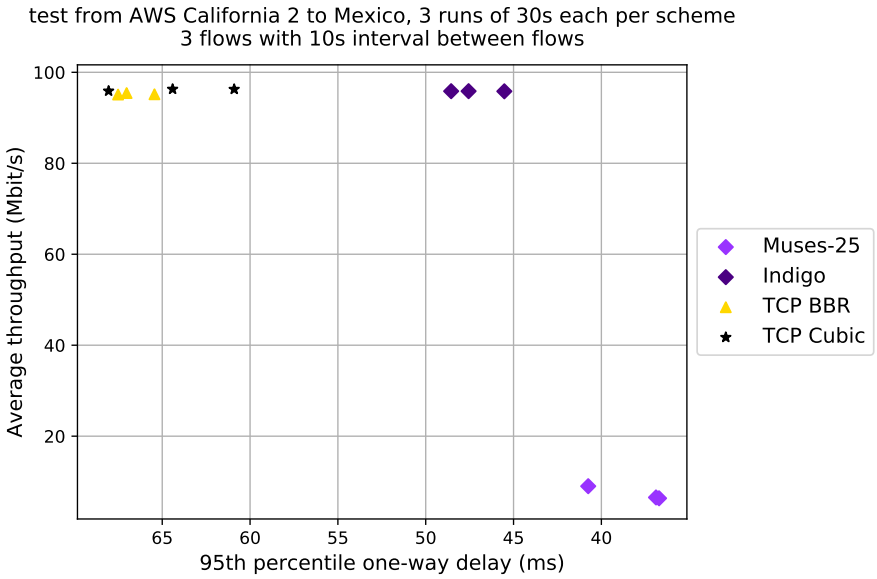
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

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 @ 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 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
TCP BBR
Indigo
Muses-25
Average throughput (Mbit/s)
95th percentile one-way delay (ms)
100
80
60
40
20
65
60
55
50
45
40


test from AWS California 2 to Mexico, 3 runs of 30s each per scheme
3 flows with 10s interval between flows
Muses-25
Indigo
TCP BBR
TCP Cubic
Average throughput (Mbit/s)
95th percentile one-way delay (ms)
100
80
60
40
20
65
60
55
50
45
40

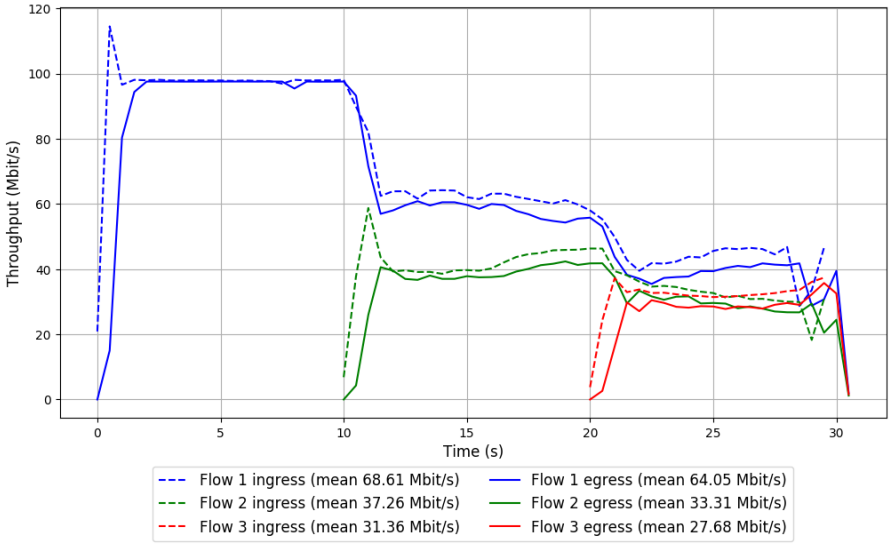
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	3	62.31	31.38	36.15	65.73	67.65	67.96	6.19	10.20	11.54
TCP Cubic	3	73.28	22.28	24.20	64.19	65.30	62.10	0.89	0.39	0.41
Indigo	3	65.59	30.19	31.40	45.18	50.18	49.46	0.04	0.11	0.19
Muses-25	3	2.74	6.66	0.54	32.36	45.51	33.84	81.46	53.33	75.69

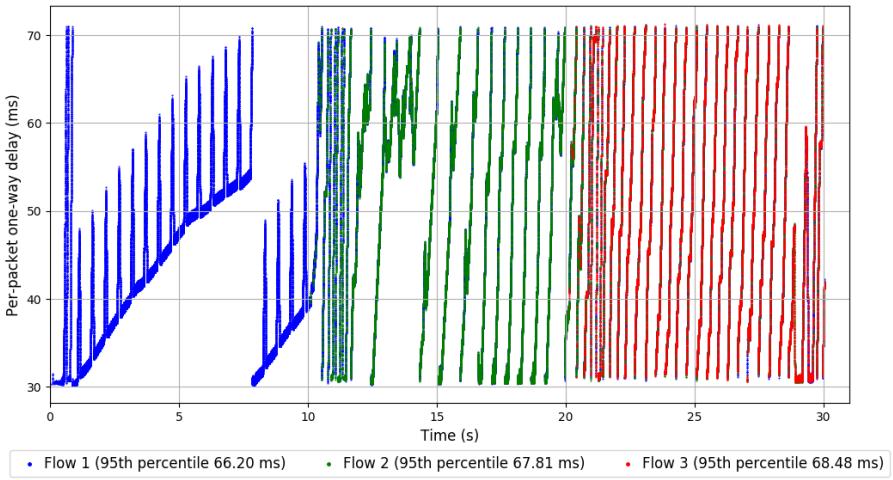
```
Run 1: Statistics of TCP BBR

Start at: 2018-08-31 08:53:51
End at: 2018-08-31 08:54:21
Local clock offset: -9.871 ms
Remote clock offset: -1.477 ms

# Below is generated by plot.py at 2018-08-31 09:06:34
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.44 Mbit/s
95th percentile per-packet one-way delay: 67.028 ms
Loss rate: 8.07%
-- Flow 1:
Average throughput: 64.05 Mbit/s
95th percentile per-packet one-way delay: 66.199 ms
Loss rate: 6.60%
-- Flow 2:
Average throughput: 33.31 Mbit/s
95th percentile per-packet one-way delay: 67.807 ms
Loss rate: 10.58%
-- Flow 3:
Average throughput: 27.68 Mbit/s
95th percentile per-packet one-way delay: 68.481 ms
Loss rate: 11.72%
```

Run 1: Report of TCP BBR — Data Link



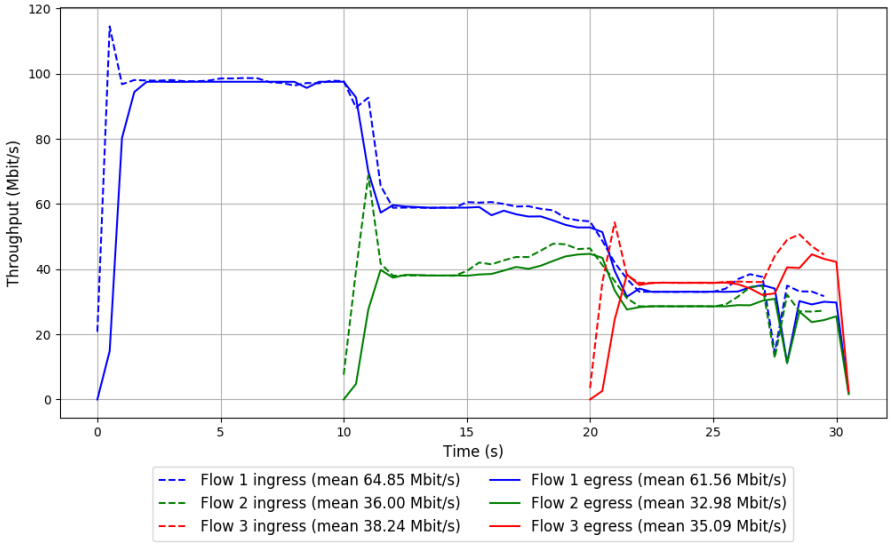


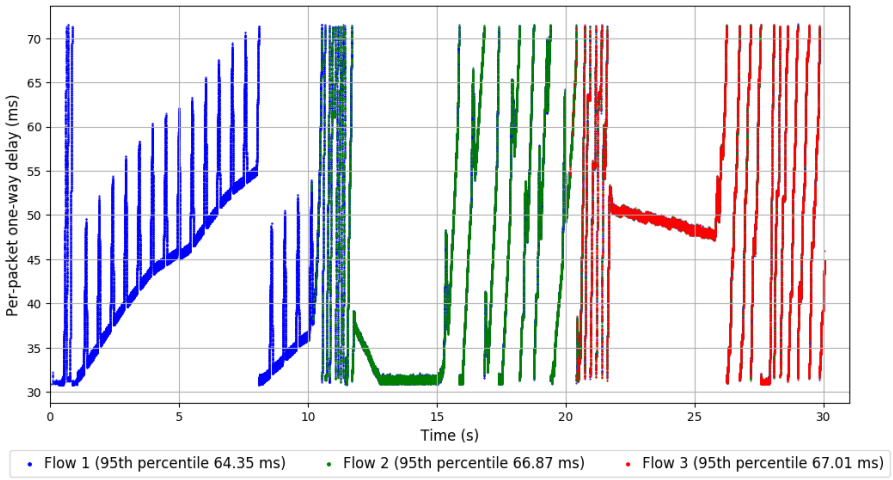
```
Run 2: Statistics of TCP BBR

Start at: 2018-08-31 08:59:11
End at: 2018-08-31 08:59:41
Local clock offset: -7.411 ms
Remote clock offset: -1.459 ms

# Below is generated by plot.py at 2018-08-31 09:06:34
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.17 Mbit/s
95th percentile per-packet one-way delay: 65.442 ms
Loss rate: 6.23%
-- Flow 1:
Average throughput: 61.56 Mbit/s
95th percentile per-packet one-way delay: 64.353 ms
Loss rate: 5.04%
-- Flow 2:
Average throughput: 32.98 Mbit/s
95th percentile per-packet one-way delay: 66.866 ms
Loss rate: 8.35%
-- Flow 3:
Average throughput: 35.09 Mbit/s
95th percentile per-packet one-way delay: 67.006 ms
Loss rate: 8.29%
```

Run 2: Report of TCP BBR — Data Link



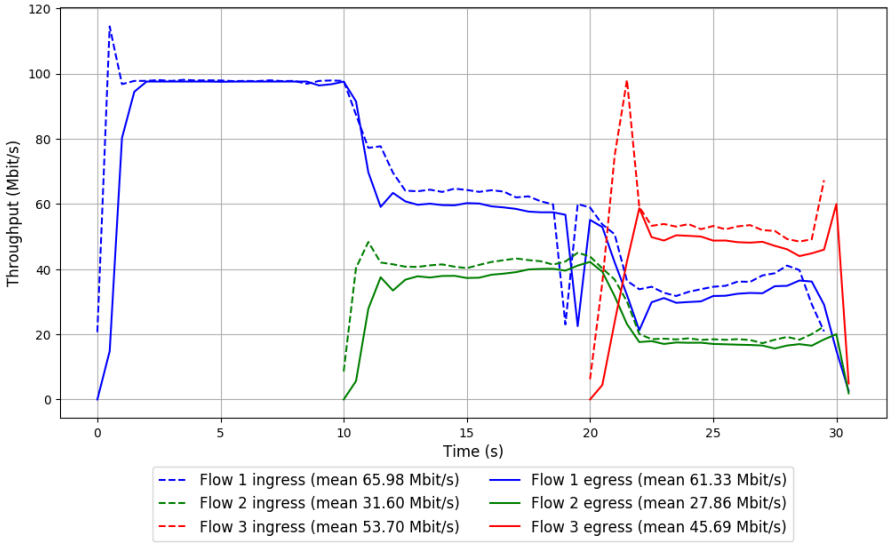


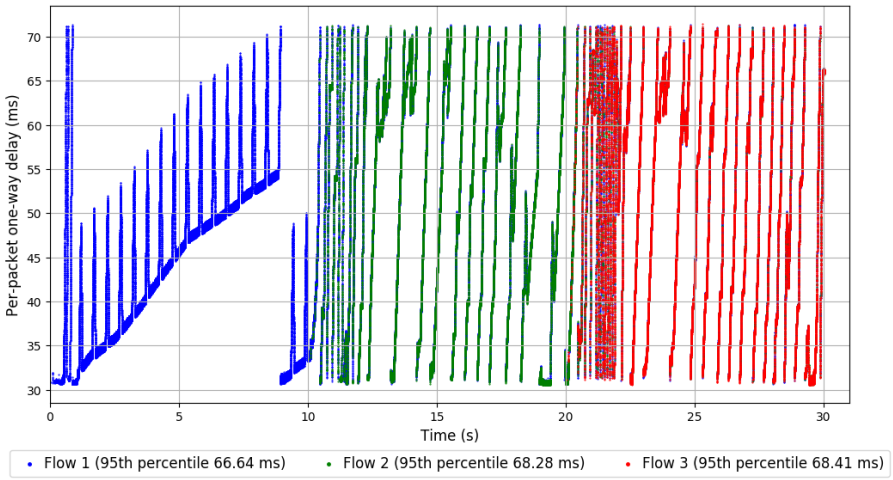
```
Run 3: Statistics of TCP BBR

Start at: 2018-08-31 09:04:31
End at: 2018-08-31 09:05:01
Local clock offset: -6.941 ms
Remote clock offset: -1.384 ms

# Below is generated by plot.py at 2018-08-31 09:06:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.12 Mbit/s
95th percentile per-packet one-way delay: 67.513 ms
Loss rate: 9.20%
-- Flow 1:
Average throughput: 61.33 Mbit/s
95th percentile per-packet one-way delay: 66.639 ms
Loss rate: 6.94%
-- Flow 2:
Average throughput: 27.86 Mbit/s
95th percentile per-packet one-way delay: 68.284 ms
Loss rate: 11.68%
-- Flow 3:
Average throughput: 45.69 Mbit/s
95th percentile per-packet one-way delay: 68.407 ms
Loss rate: 14.62%
```

Run 3: Report of TCP BBR — Data Link



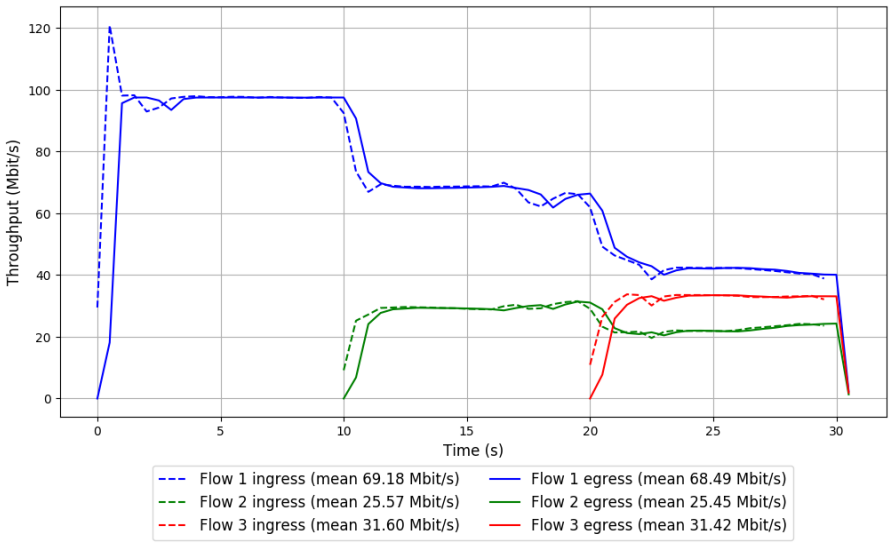


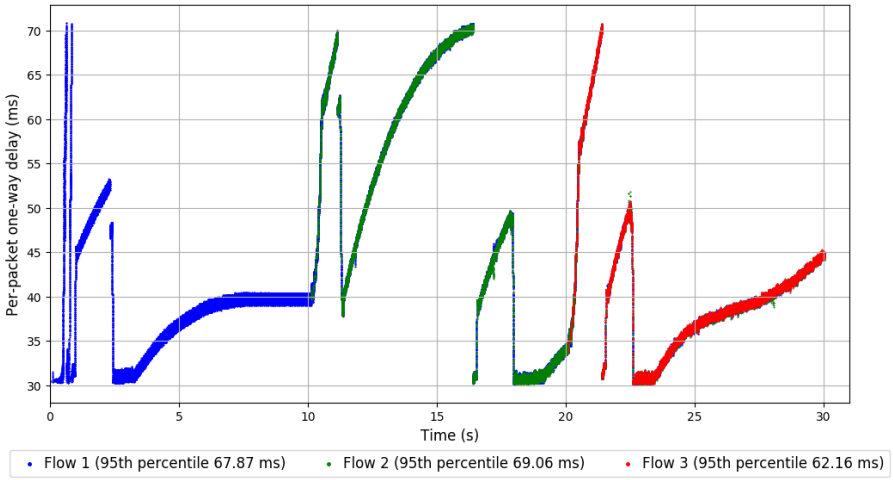
```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-31 08:49:51
End at: 2018-08-31 08:50:21
Local clock offset: -7.466 ms
Remote clock offset: -1.431 ms

# Below is generated by plot.py at 2018-08-31 09:06:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.89 Mbit/s
95th percentile per-packet one-way delay: 68.054 ms
Loss rate: 0.81%
-- Flow 1:
Average throughput: 68.49 Mbit/s
95th percentile per-packet one-way delay: 67.869 ms
Loss rate: 0.94%
-- Flow 2:
Average throughput: 25.45 Mbit/s
95th percentile per-packet one-way delay: 69.058 ms
Loss rate: 0.46%
-- Flow 3:
Average throughput: 31.42 Mbit/s
95th percentile per-packet one-way delay: 62.156 ms
Loss rate: 0.48%
```

Run 1: Report of TCP Cubic — Data Link



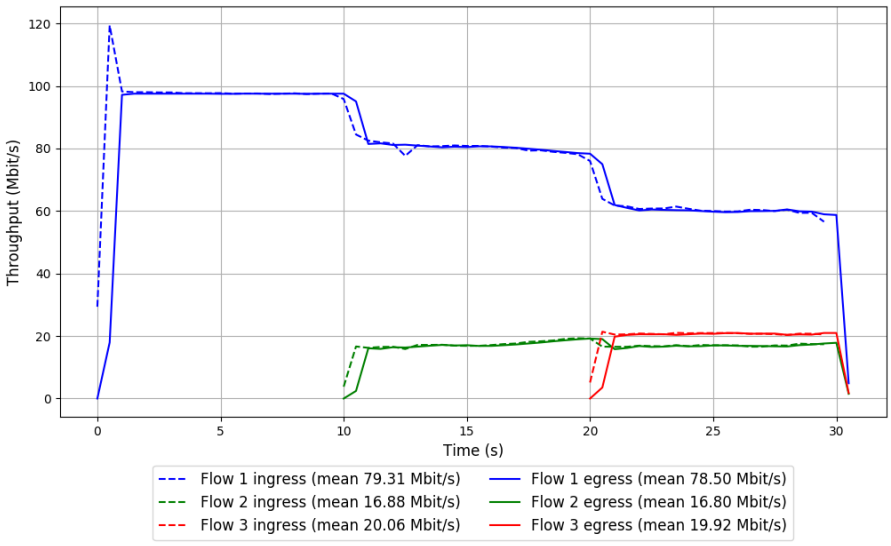


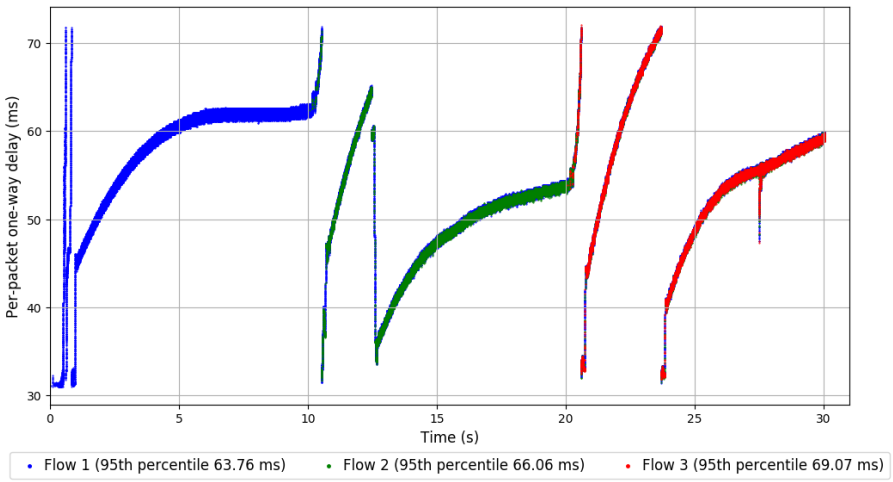
```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-31 08:55:12
End at: 2018-08-31 08:55:42
Local clock offset: -9.676 ms
Remote clock offset: -1.559 ms

# Below is generated by plot.py at 2018-08-31 09:06:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.30 Mbit/s
95th percentile per-packet one-way delay: 64.410 ms
Loss rate: 0.86%
-- Flow 1:
Average throughput: 78.50 Mbit/s
95th percentile per-packet one-way delay: 63.758 ms
Loss rate: 0.93%
-- Flow 2:
Average throughput: 16.80 Mbit/s
95th percentile per-packet one-way delay: 66.059 ms
Loss rate: 0.49%
-- Flow 3:
Average throughput: 19.92 Mbit/s
95th percentile per-packet one-way delay: 69.070 ms
Loss rate: 0.64%
```

Run 2: Report of TCP Cubic — Data Link



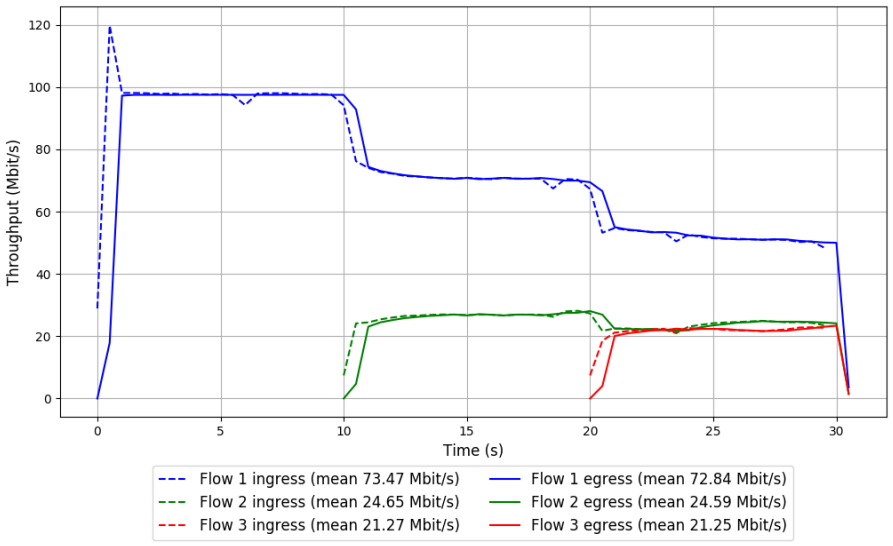


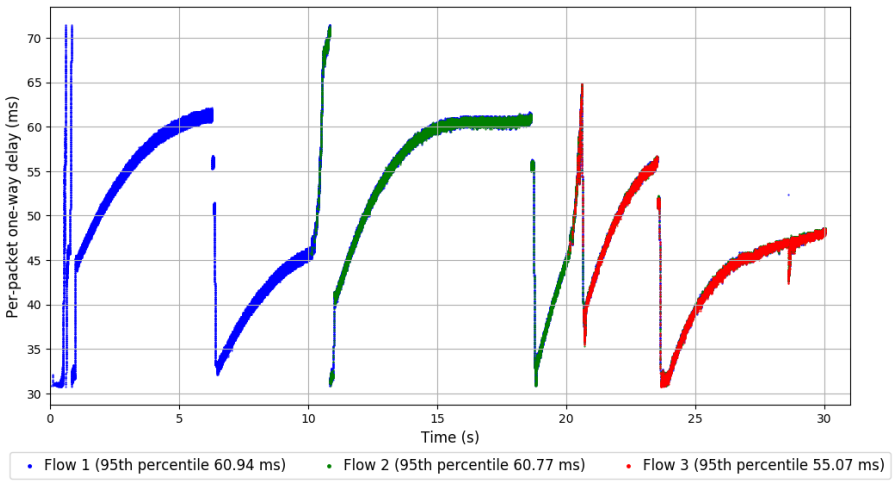
```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-31 09:00:32
End at: 2018-08-31 09:01:02
Local clock offset: -7.111 ms
Remote clock offset: -1.526 ms

# Below is generated by plot.py at 2018-08-31 09:06:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.28 Mbit/s
95th percentile per-packet one-way delay: 60.903 ms
Loss rate: 0.65%
-- Flow 1:
Average throughput: 72.84 Mbit/s
95th percentile per-packet one-way delay: 60.938 ms
Loss rate: 0.80%
-- Flow 2:
Average throughput: 24.59 Mbit/s
95th percentile per-packet one-way delay: 60.773 ms
Loss rate: 0.22%
-- Flow 3:
Average throughput: 21.25 Mbit/s
95th percentile per-packet one-way delay: 55.068 ms
Loss rate: 0.11%
```

Run 3: Report of TCP Cubic — Data Link



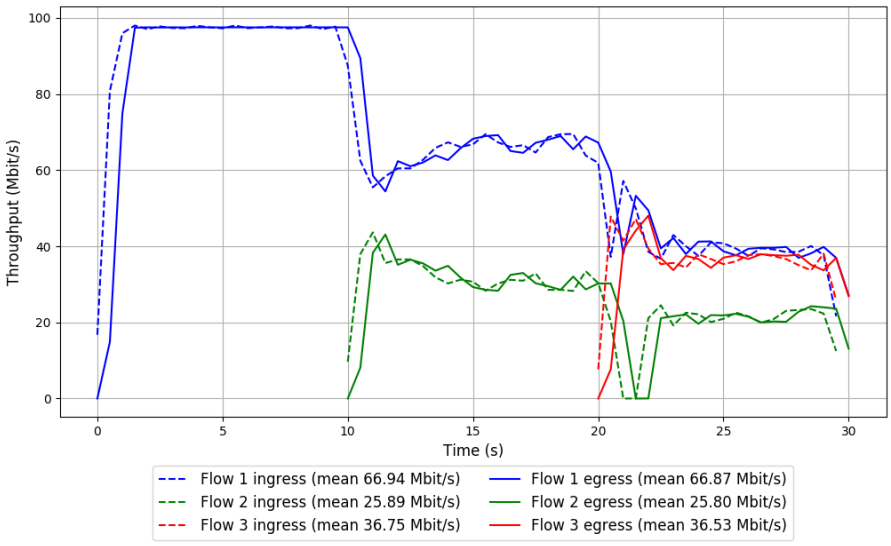


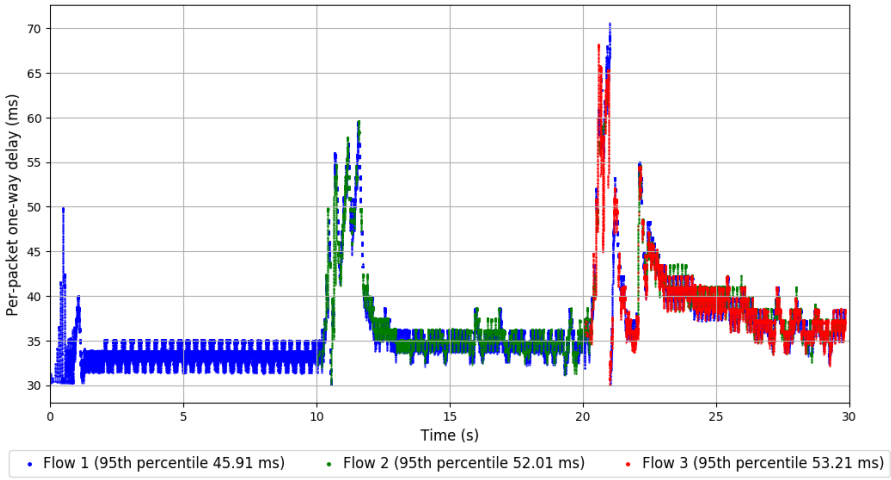
```
Run 1: Statistics of Indigo

Start at: 2018-08-31 08:51:12
End at: 2018-08-31 08:51:42
Local clock offset: -8.276 ms
Remote clock offset: -1.677 ms

# Below is generated by plot.py at 2018-08-31 09:06:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.85 Mbit/s
95th percentile per-packet one-way delay: 48.552 ms
Loss rate: 0.19%
-- Flow 1:
Average throughput: 66.87 Mbit/s
95th percentile per-packet one-way delay: 45.913 ms
Loss rate: 0.08%
-- Flow 2:
Average throughput: 25.80 Mbit/s
95th percentile per-packet one-way delay: 52.010 ms
Loss rate: 0.33%
-- Flow 3:
Average throughput: 36.53 Mbit/s
95th percentile per-packet one-way delay: 53.211 ms
Loss rate: 0.58%
```

Run 1: Report of Indigo — Data Link



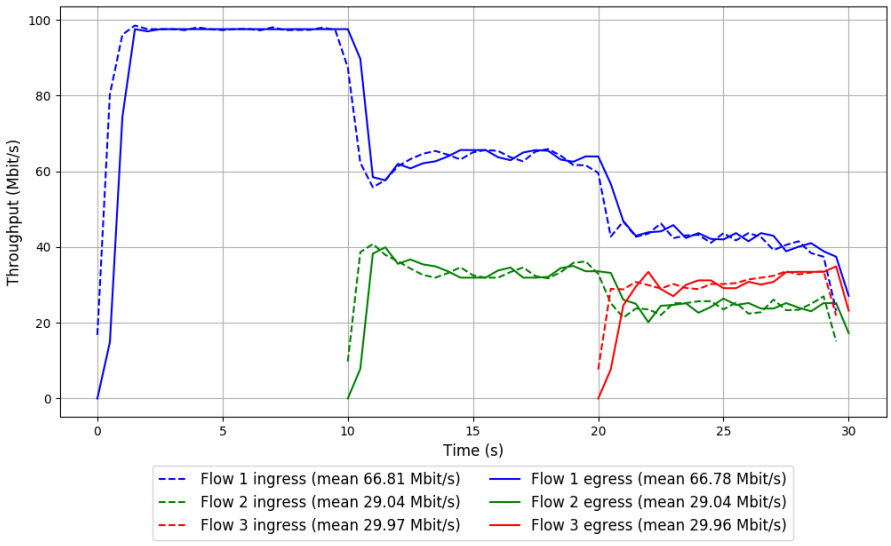


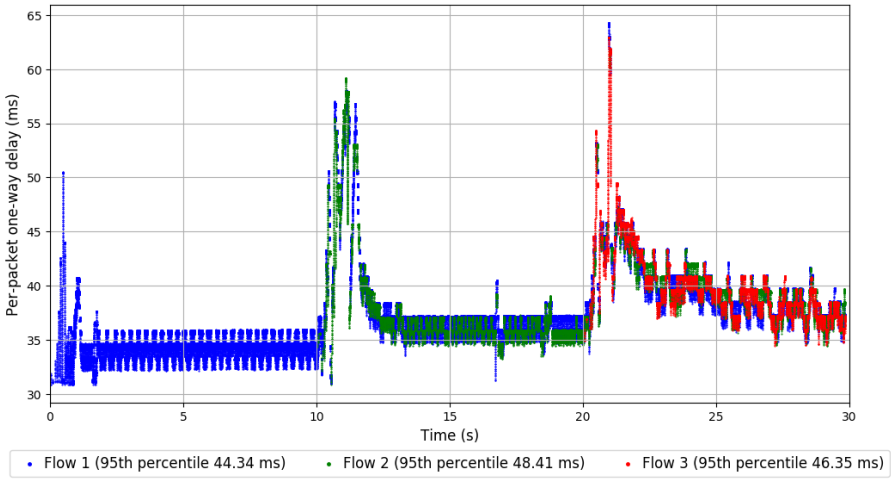
```
Run 2: Statistics of Indigo

Start at: 2018-08-31 08:56:33
End at: 2018-08-31 08:57:03
Local clock offset: -8.689 ms
Remote clock offset: -1.599 ms

# Below is generated by plot.py at 2018-08-31 09:06:35
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.82 Mbit/s
95th percentile per-packet one-way delay: 45.524 ms
Loss rate: 0.02%
-- Flow 1:
Average throughput: 66.78 Mbit/s
95th percentile per-packet one-way delay: 44.345 ms
Loss rate: 0.03%
-- Flow 2:
Average throughput: 29.04 Mbit/s
95th percentile per-packet one-way delay: 48.406 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 29.96 Mbit/s
95th percentile per-packet one-way delay: 46.351 ms
Loss rate: 0.00%
```

Run 2: Report of Indigo — Data Link



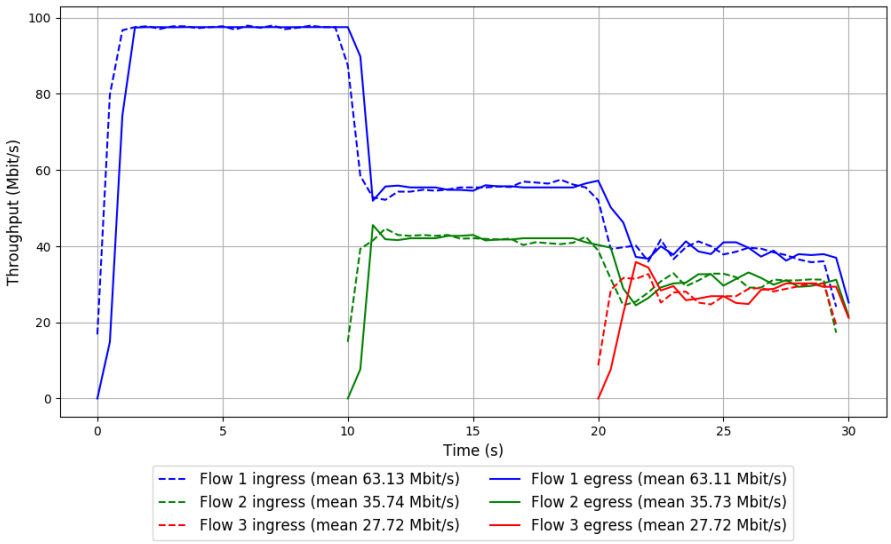


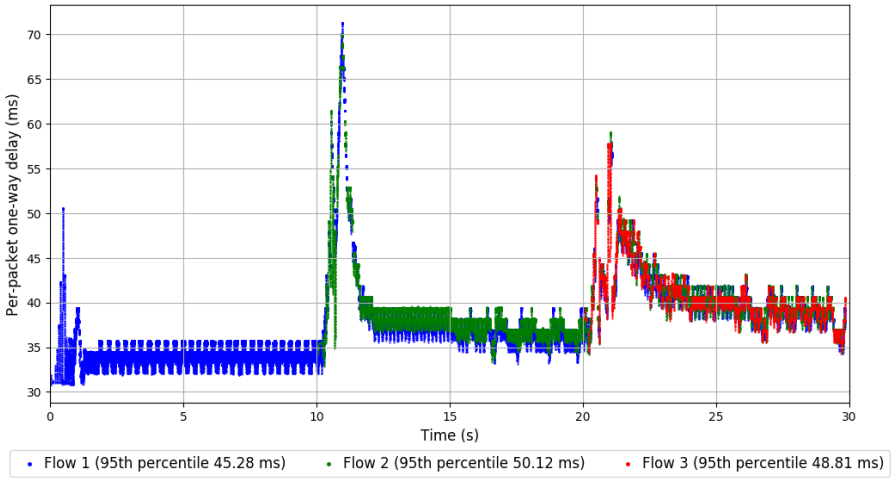
```
Run 3: Statistics of Indigo

Start at: 2018-08-31 09:01:53
End at: 2018-08-31 09:02:23
Local clock offset: -6.864 ms
Remote clock offset: -1.331 ms

# Below is generated by plot.py at 2018-08-31 09:06:41
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.85 Mbit/s
95th percentile per-packet one-way delay: 47.559 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 63.11 Mbit/s
95th percentile per-packet one-way delay: 45.284 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 35.73 Mbit/s
95th percentile per-packet one-way delay: 50.116 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 27.72 Mbit/s
95th percentile per-packet one-way delay: 48.813 ms
Loss rate: 0.00%
```

Run 3: Report of Indigo — Data Link



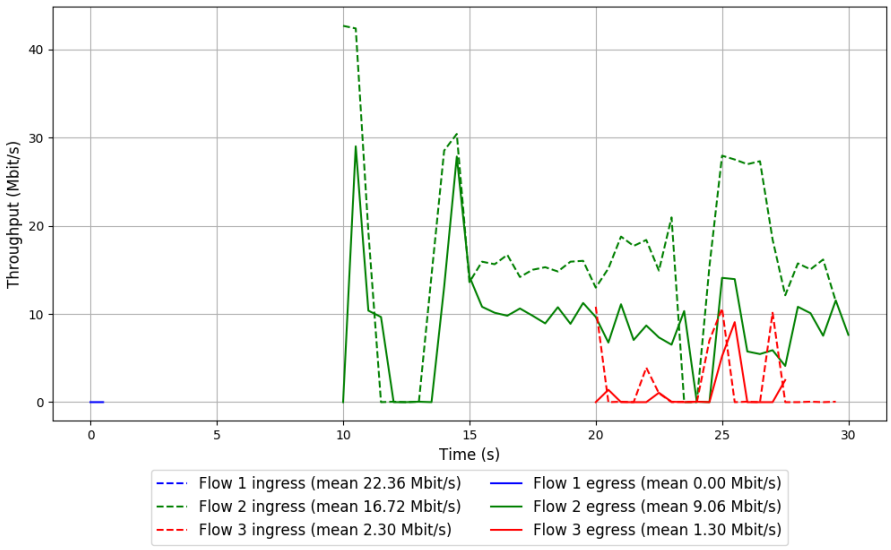


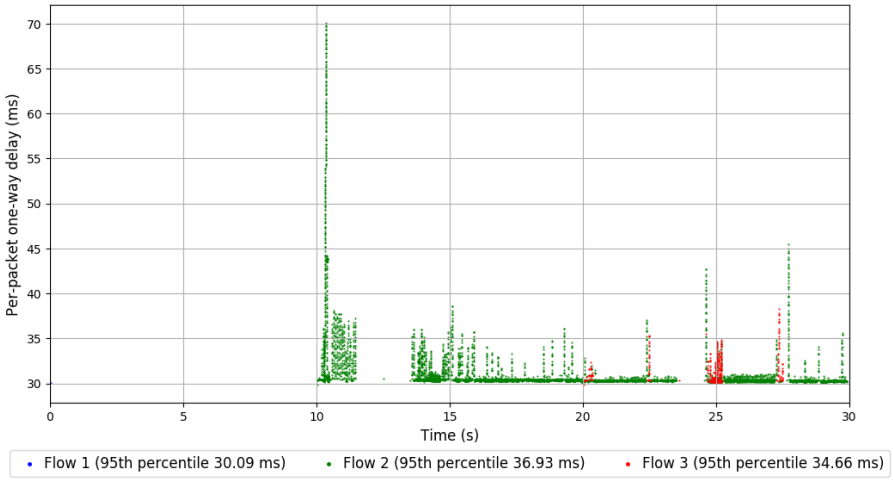
```
Run 1: Statistics of Muses-25

Start at: 2018-08-31 08:52:34
End at: 2018-08-31 08:53:04
Local clock offset: -9.109 ms
Remote clock offset: -1.677 ms

# Below is generated by plot.py at 2018-08-31 09:06:41
# Datalink statistics
-- Total of 3 flows:
Average throughput: 6.35 Mbit/s
95th percentile per-packet one-way delay: 36.717 ms
Loss rate: 46.46%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 30.091 ms
Loss rate: 97.39%
-- Flow 2:
Average throughput: 9.06 Mbit/s
95th percentile per-packet one-way delay: 36.931 ms
Loss rate: 45.85%
-- Flow 3:
Average throughput: 1.30 Mbit/s
95th percentile per-packet one-way delay: 34.661 ms
Loss rate: 55.74%
```

Run 1: Report of Muses-25 — Data Link



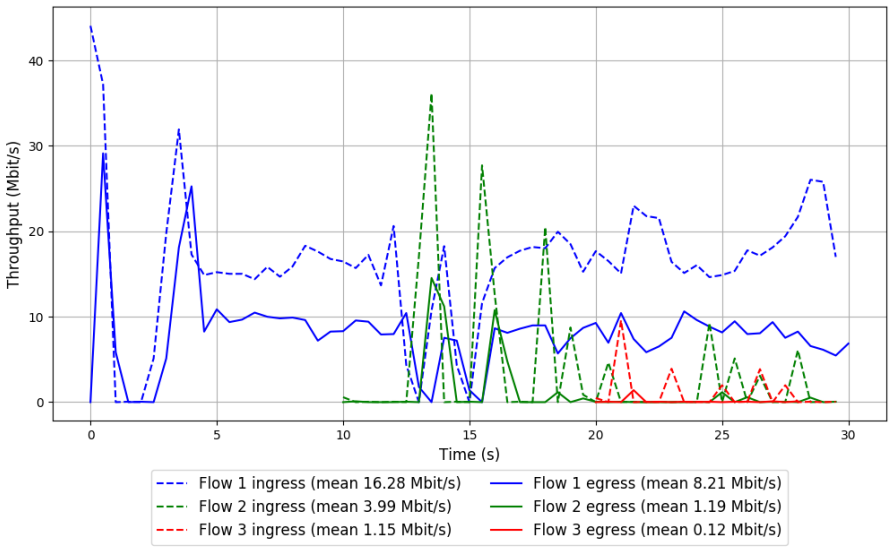


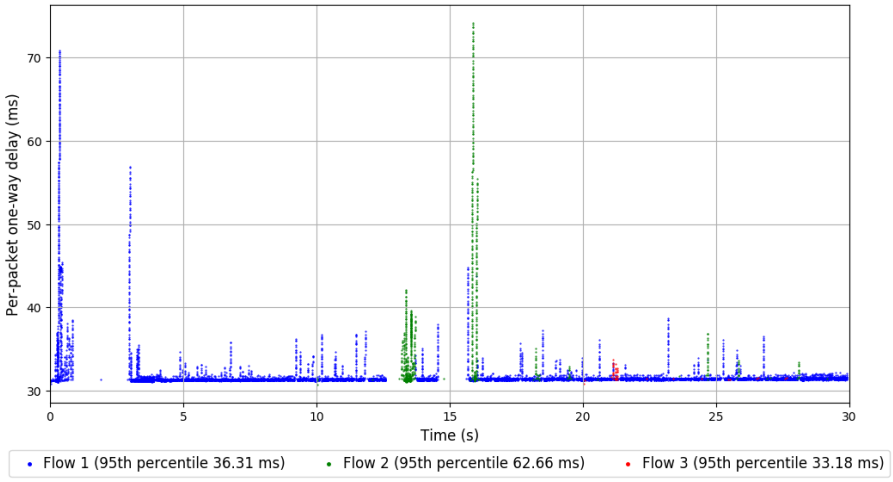
```
Run 2: Statistics of Muses-25

Start at: 2018-08-31 08:57:55
End at: 2018-08-31 08:58:25
Local clock offset: -7.883 ms
Remote clock offset: -1.452 ms

# Below is generated by plot.py at 2018-08-31 09:06:41
# Datalink statistics
-- Total of 3 flows:
Average throughput: 9.00 Mbit/s
95th percentile per-packet one-way delay: 40.749 ms
Loss rate: 53.13%
-- Flow 1:
Average throughput: 8.21 Mbit/s
95th percentile per-packet one-way delay: 36.313 ms
Loss rate: 49.60%
-- Flow 2:
Average throughput: 1.19 Mbit/s
95th percentile per-packet one-way delay: 62.655 ms
Loss rate: 70.12%
-- Flow 3:
Average throughput: 0.12 Mbit/s
95th percentile per-packet one-way delay: 33.183 ms
Loss rate: 91.44%
```

Run 2: Report of Muses-25 — Data Link





```
Run 3: Statistics of Muses-25

Start at: 2018-08-31 09:03:15
End at: 2018-08-31 09:03:45
Local clock offset: -6.817 ms
Remote clock offset: -1.324 ms

# Below is generated by plot.py at 2018-08-31 09:06:41
# Datalink statistics
-- Total of 3 flows:
Average throughput: 6.53 Mbit/s
95th percentile per-packet one-way delay: 36.890 ms
Loss rate: 44.88%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 30.670 ms
Loss rate: 97.39%
-- Flow 2:
Average throughput: 9.74 Mbit/s
95th percentile per-packet one-way delay: 36.938 ms
Loss rate: 44.01%
-- Flow 3:
Average throughput: 0.20 Mbit/s
95th percentile per-packet one-way delay: 33.686 ms
Loss rate: 79.88%
```

Run 3: Report of Muses-25 — Data Link