Pantheon Report

Generated at 2018-08-31 09:17:18 (UTC).

Data path: AWS California 1 on `ens5` (*local*) →Stanford on `eno1` (*remote*).

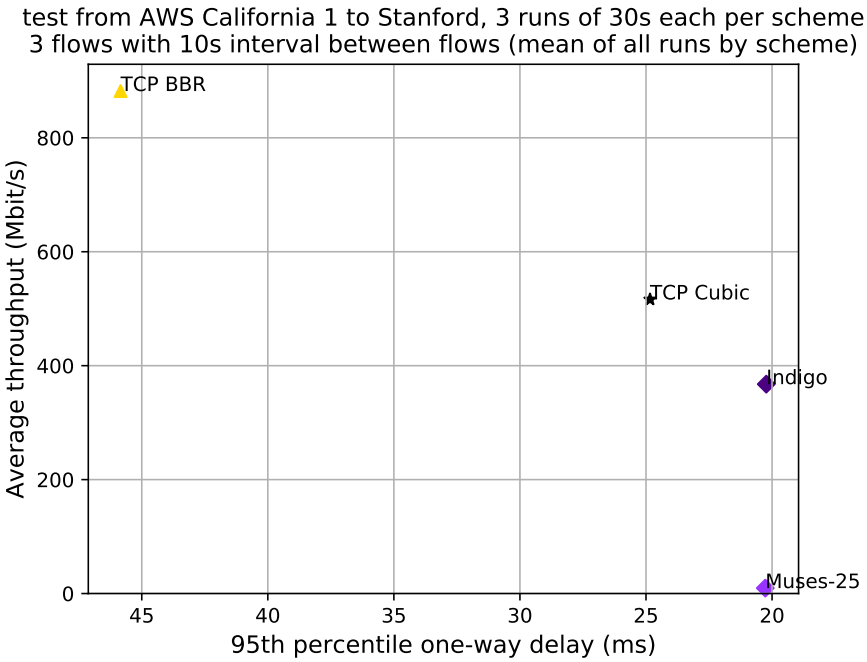
Repeated the test of 4 congestion control schemes 3 times.

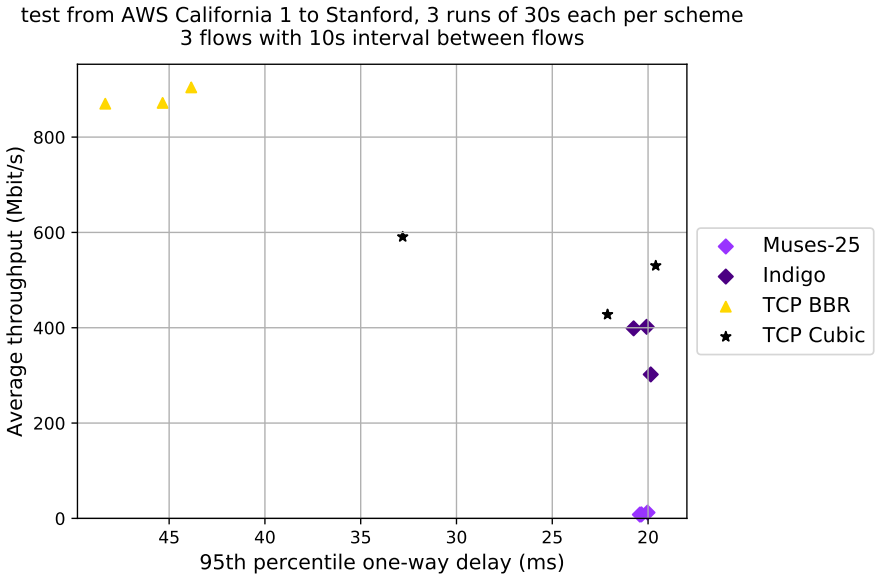
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.

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 1 to Stanford, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
TCP BBR
TCP Cubic
Indigo
Muses-25
Average throughput (Mbit/s)
95th percentile one-way delay (ms)
0
200
400
600
800
45
40
35
30
25
20


test from AWS California 1 to Stanford, 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)
0
200
400
600
800
45
40
35
30
25
20

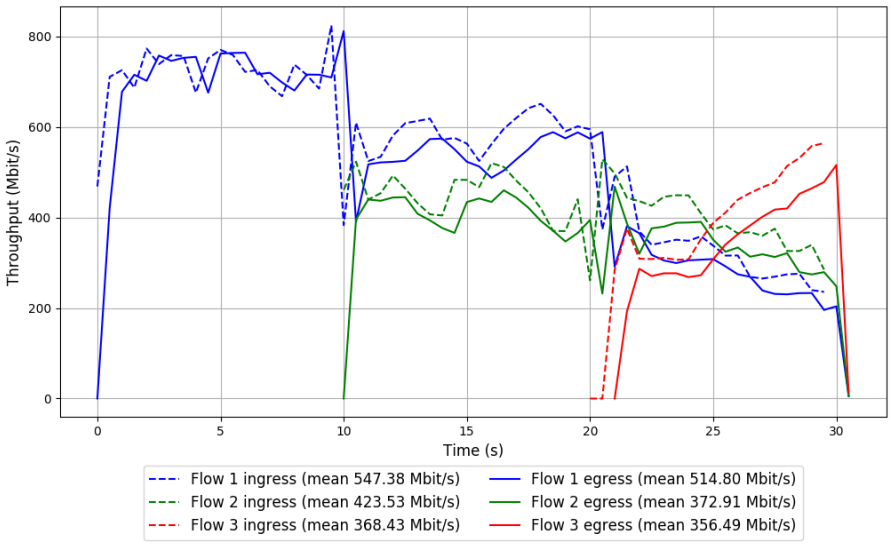
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	3	511.89	396.54	330.56	46.97	32.88	21.54	6.08	10.79	12.36
TCP Cubic	3	305.78	240.65	150.81	30.90	20.51	18.40	0.06	0.05	0.03
Indigo	3	170.61	202.18	194.52	20.14	19.71	20.97	0.01	0.01	0.02
Muses-25	3	2.57	7.32	6.58	18.51	21.37	21.14	67.34	13.85	18.42

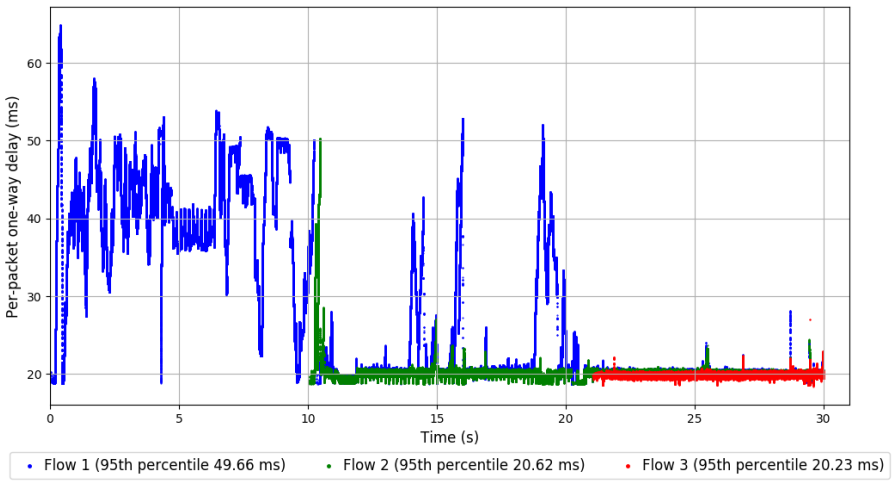
```
Run 1: Statistics of TCP BBR

Start at: 2018-08-31 08:51:30
End at: 2018-08-31 08:52:00
Local clock offset: -5.971 ms
Remote clock offset: -0.023 ms

# Below is generated by plot.py at 2018-08-31 09:17:15
# Datalink statistics
-- Total of 3 flows:
Average throughput: 870.08 Mbit/s
95th percentile per-packet one-way delay: 48.334 ms
Loss rate: 8.64%
-- Flow 1:
Average throughput: 514.80 Mbit/s
95th percentile per-packet one-way delay: 49.655 ms
Loss rate: 5.95%
-- Flow 2:
Average throughput: 372.91 Mbit/s
95th percentile per-packet one-way delay: 20.623 ms
Loss rate: 11.94%
-- Flow 3:
Average throughput: 356.49 Mbit/s
95th percentile per-packet one-way delay: 20.228 ms
Loss rate: 13.02%
```

Run 1: Report of TCP BBR — Data Link



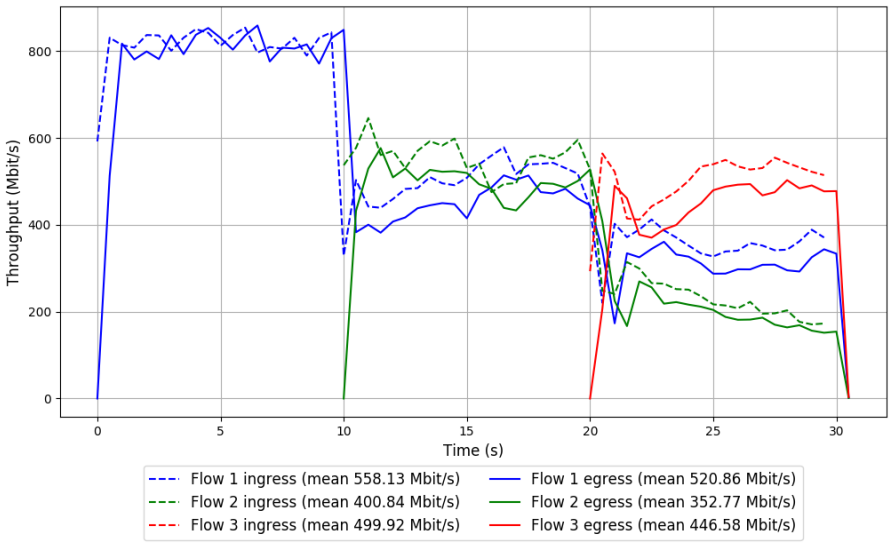


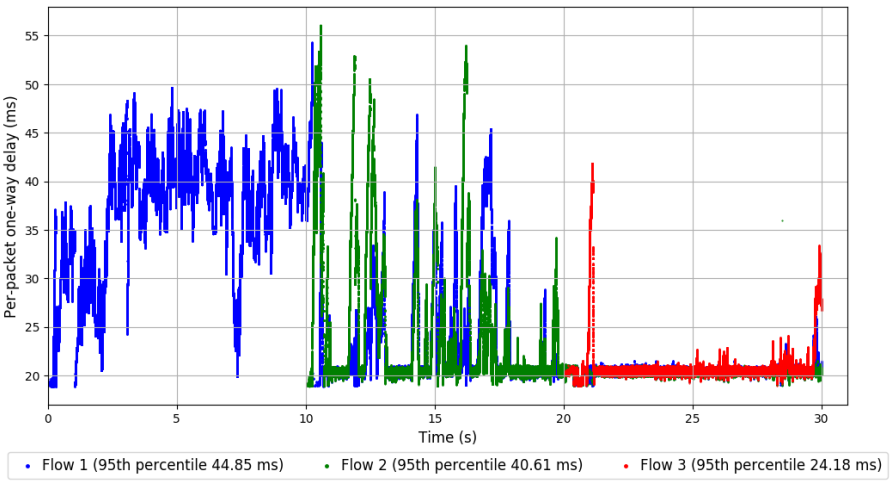
```
Run 2: Statistics of TCP BBR

Start at: 2018-08-31 08:57:56
End at: 2018-08-31 08:58:26
Local clock offset: -6.519 ms
Remote clock offset: -1.542 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 904.32 Mbit/s
95th percentile per-packet one-way delay: 43.846 ms
Loss rate: 8.77%
-- Flow 1:
Average throughput: 520.86 Mbit/s
95th percentile per-packet one-way delay: 44.846 ms
Loss rate: 6.67%
-- Flow 2:
Average throughput: 352.77 Mbit/s
95th percentile per-packet one-way delay: 40.611 ms
Loss rate: 11.98%
-- Flow 3:
Average throughput: 446.58 Mbit/s
95th percentile per-packet one-way delay: 24.179 ms
Loss rate: 10.67%
```

Run 2: Report of TCP BBR — Data Link



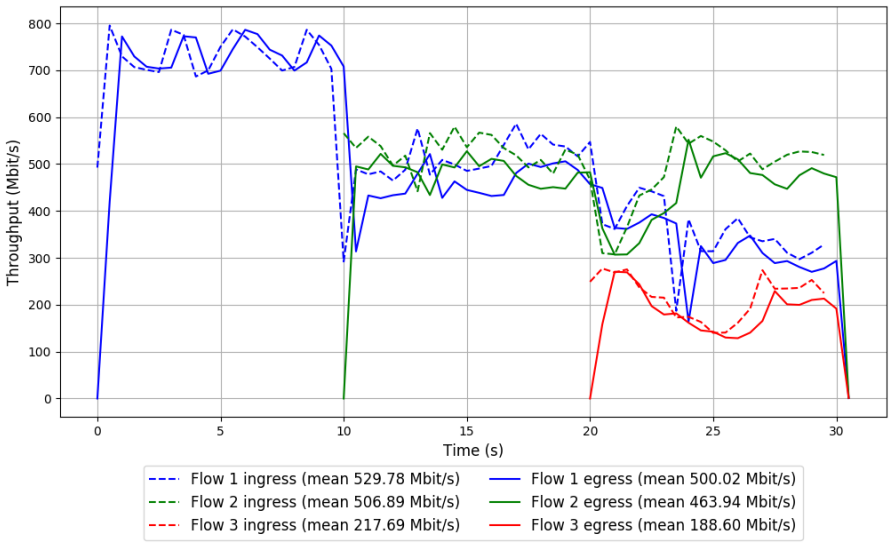


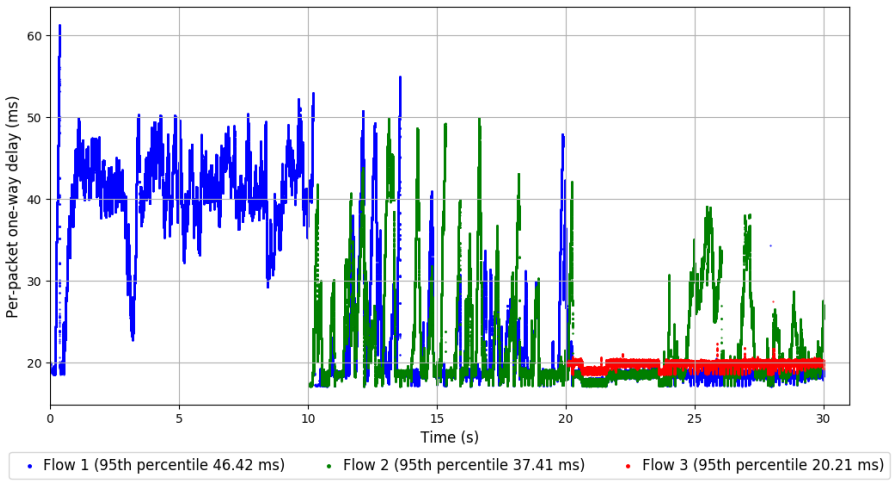
```
Run 3: Statistics of TCP BBR

Start at: 2018-08-31 09:04:13
End at: 2018-08-31 09:04:43
Local clock offset: -6.671 ms
Remote clock offset: -2.658 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 871.80 Mbit/s
95th percentile per-packet one-way delay: 45.340 ms
Loss rate: 7.24%
-- Flow 1:
Average throughput: 500.02 Mbit/s
95th percentile per-packet one-way delay: 46.422 ms
Loss rate: 5.62%
-- Flow 2:
Average throughput: 463.94 Mbit/s
95th percentile per-packet one-way delay: 37.412 ms
Loss rate: 8.46%
-- Flow 3:
Average throughput: 188.60 Mbit/s
95th percentile per-packet one-way delay: 20.207 ms
Loss rate: 13.38%
```

Run 3: Report of TCP BBR — Data Link



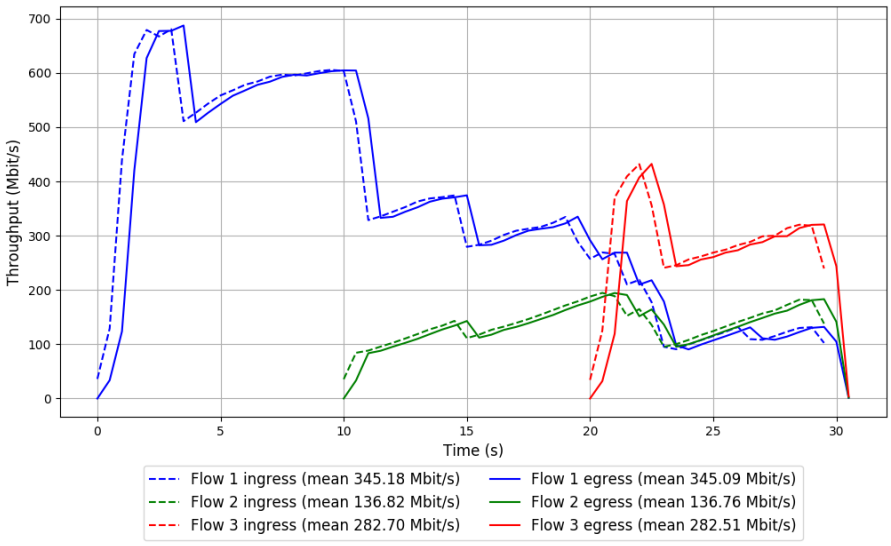


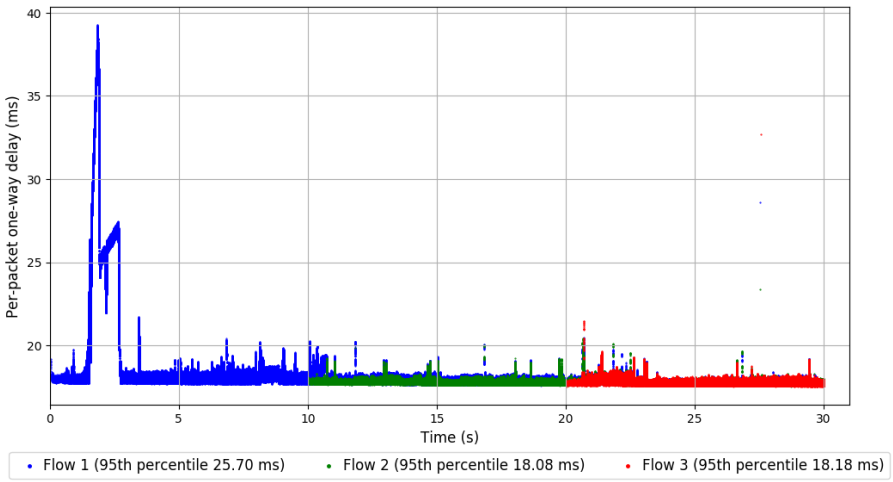
```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-31 08:49:54
End at: 2018-08-31 08:50:24
Local clock offset: -5.352 ms
Remote clock offset: -0.084 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 530.10 Mbit/s
95th percentile per-packet one-way delay: 19.599 ms
Loss rate: 0.04%
-- Flow 1:
Average throughput: 345.09 Mbit/s
95th percentile per-packet one-way delay: 25.704 ms
Loss rate: 0.03%
-- Flow 2:
Average throughput: 136.76 Mbit/s
95th percentile per-packet one-way delay: 18.083 ms
Loss rate: 0.05%
-- Flow 3:
Average throughput: 282.51 Mbit/s
95th percentile per-packet one-way delay: 18.184 ms
Loss rate: 0.07%
```

Run 1: Report of TCP Cubic — Data Link



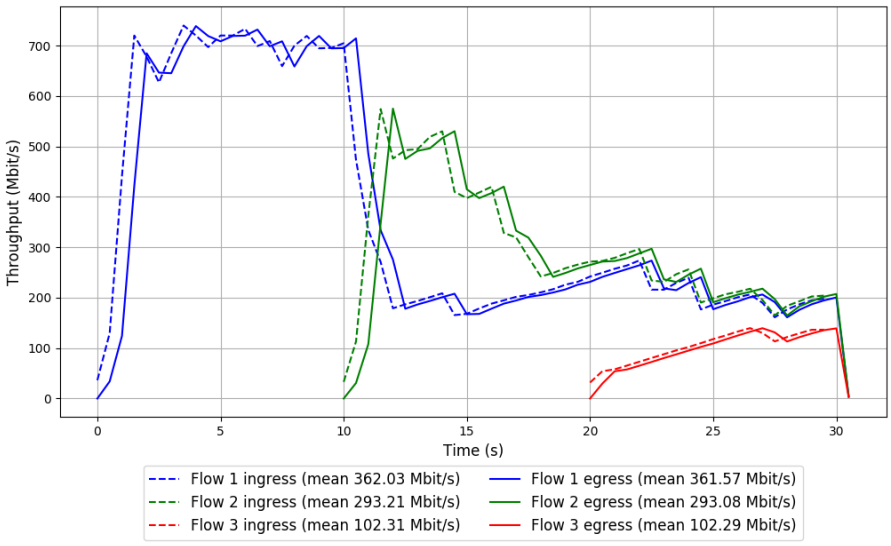


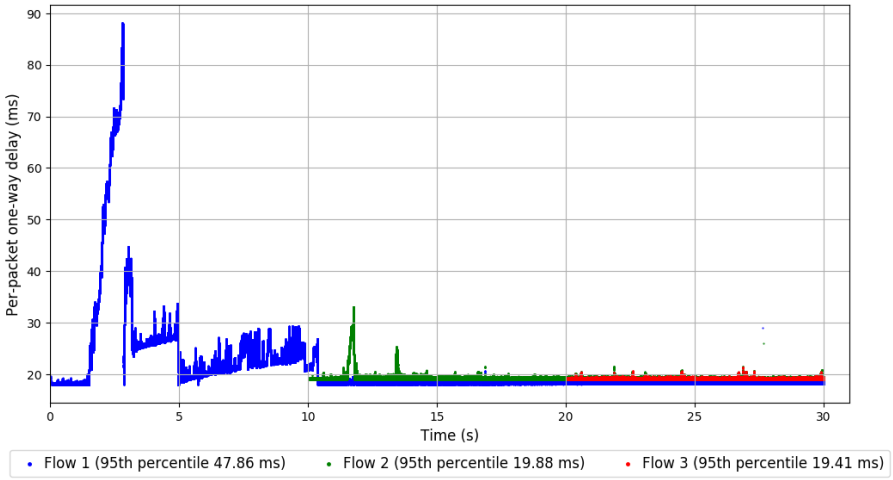
```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-31 08:56:18
End at: 2018-08-31 08:56:48
Local clock offset: -6.572 ms
Remote clock offset: -1.252 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 590.81 Mbit/s
95th percentile per-packet one-way delay: 32.808 ms
Loss rate: 0.09%
-- Flow 1:
Average throughput: 361.57 Mbit/s
95th percentile per-packet one-way delay: 47.856 ms
Loss rate: 0.12%
-- Flow 2:
Average throughput: 293.08 Mbit/s
95th percentile per-packet one-way delay: 19.882 ms
Loss rate: 0.04%
-- Flow 3:
Average throughput: 102.29 Mbit/s
95th percentile per-packet one-way delay: 19.412 ms
Loss rate: 0.01%
```

Run 2: Report of TCP Cubic — Data Link



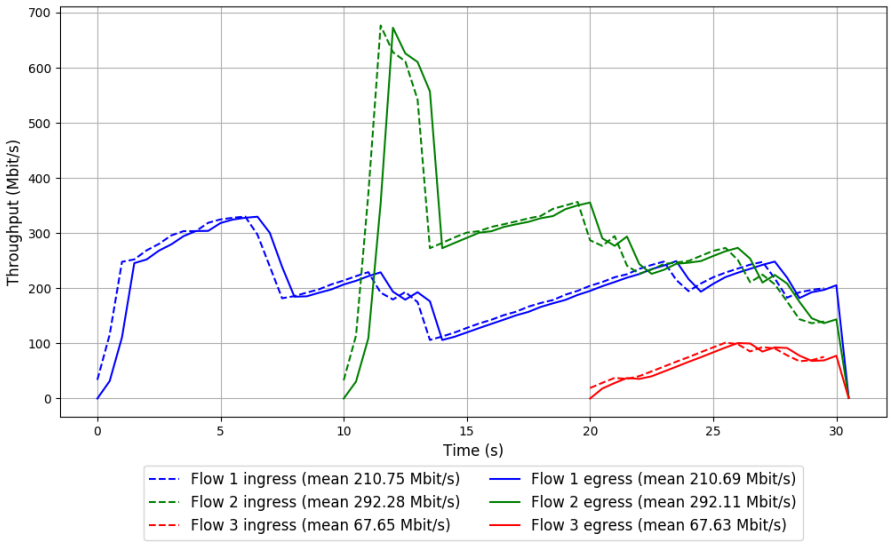


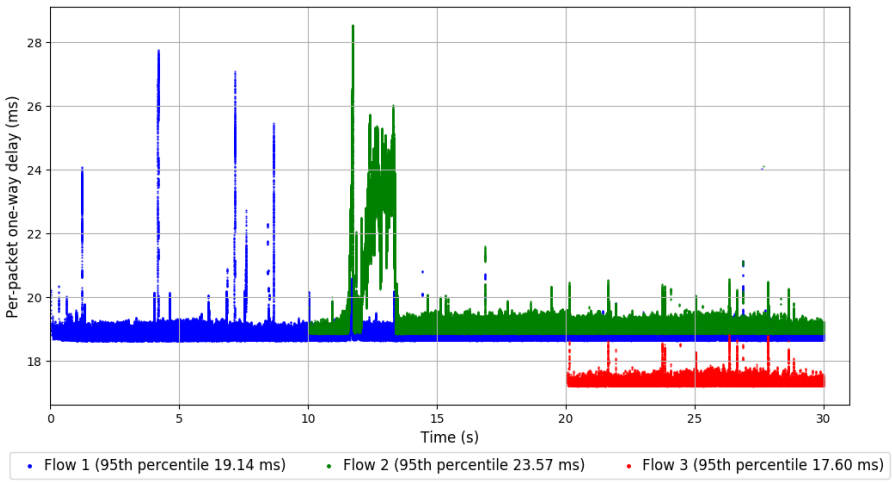
```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-31 09:02:41
End at: 2018-08-31 09:03:11
Local clock offset: -6.613 ms
Remote clock offset: -2.47 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 427.75 Mbit/s
95th percentile per-packet one-way delay: 22.115 ms
Loss rate: 0.04%
-- Flow 1:
Average throughput: 210.69 Mbit/s
95th percentile per-packet one-way delay: 19.135 ms
Loss rate: 0.03%
-- Flow 2:
Average throughput: 292.11 Mbit/s
95th percentile per-packet one-way delay: 23.565 ms
Loss rate: 0.06%
-- Flow 3:
Average throughput: 67.63 Mbit/s
95th percentile per-packet one-way delay: 17.600 ms
Loss rate: 0.02%
```

Run 3: Report of TCP Cubic — Data Link



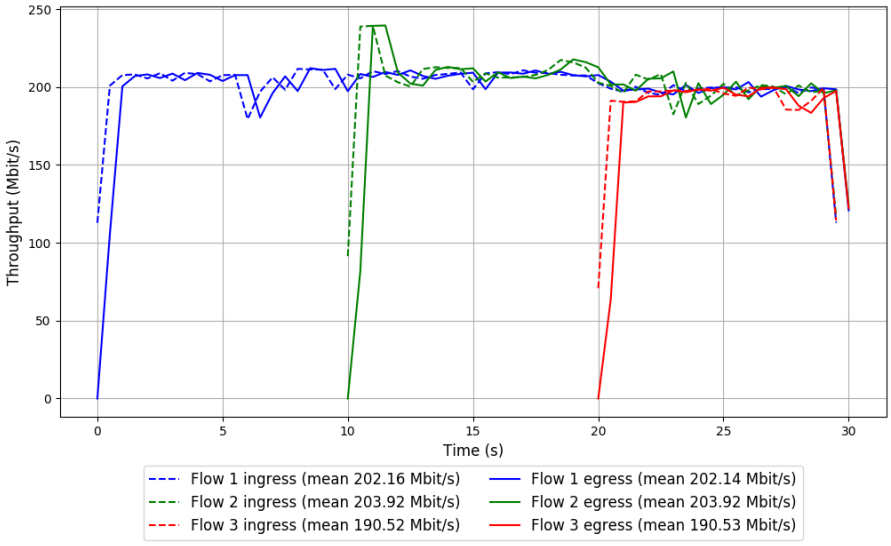


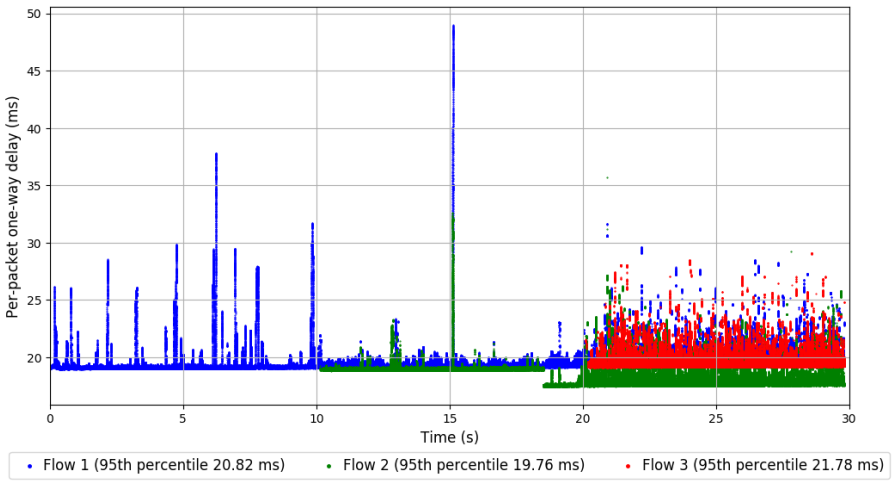
```
Run 1: Statistics of Indigo

Start at: 2018-08-31 08:54:42
End at: 2018-08-31 08:55:12
Local clock offset: -6.856 ms
Remote clock offset: -0.806 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 398.71 Mbit/s
95th percentile per-packet one-way delay: 20.754 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 202.14 Mbit/s
95th percentile per-packet one-way delay: 20.820 ms
Loss rate: 0.01%
-- Flow 2:
Average throughput: 203.92 Mbit/s
95th percentile per-packet one-way delay: 19.763 ms
Loss rate: 0.01%
-- Flow 3:
Average throughput: 190.53 Mbit/s
95th percentile per-packet one-way delay: 21.783 ms
Loss rate: 0.02%
```

Run 1: Report of Indigo — Data Link



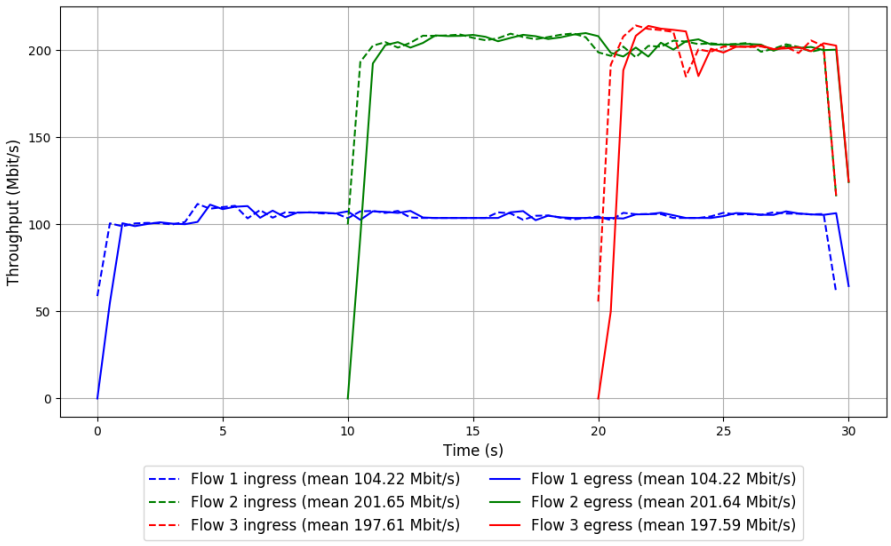


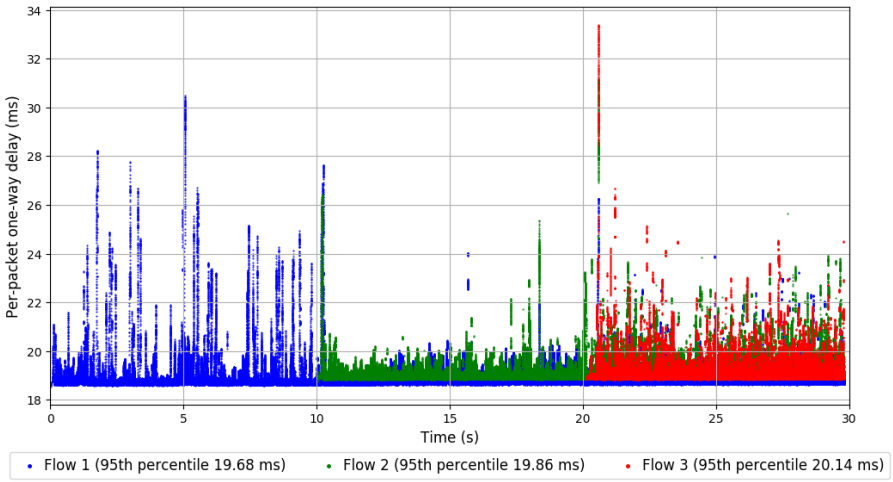
```
Run 2: Statistics of Indigo

Start at: 2018-08-31 09:01:09
End at: 2018-08-31 09:01:39
Local clock offset: -6.438 ms
Remote clock offset: -2.221 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 302.02 Mbit/s
95th percentile per-packet one-way delay: 19.859 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 104.22 Mbit/s
95th percentile per-packet one-way delay: 19.679 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 201.64 Mbit/s
95th percentile per-packet one-way delay: 19.855 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 197.59 Mbit/s
95th percentile per-packet one-way delay: 20.138 ms
Loss rate: 0.01%
```

Run 2: Report of Indigo — Data Link



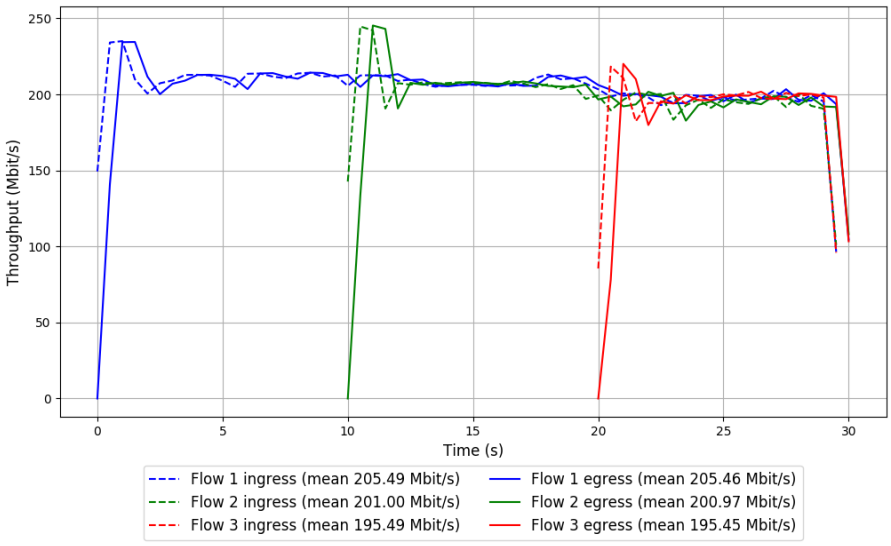


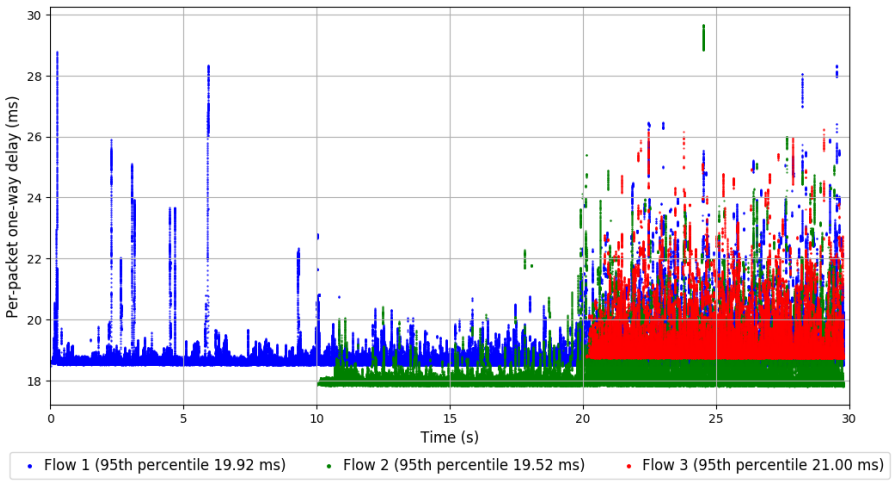
```
Run 3: Statistics of Indigo

Start at: 2018-08-31 09:07:25
End at: 2018-08-31 09:07:55
Local clock offset: -7.11 ms
Remote clock offset: -2.937 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 401.93 Mbit/s
95th percentile per-packet one-way delay: 20.074 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 205.46 Mbit/s
95th percentile per-packet one-way delay: 19.922 ms
Loss rate: 0.01%
-- Flow 2:
Average throughput: 200.97 Mbit/s
95th percentile per-packet one-way delay: 19.515 ms
Loss rate: 0.01%
-- Flow 3:
Average throughput: 195.45 Mbit/s
95th percentile per-packet one-way delay: 20.997 ms
Loss rate: 0.02%
```

Run 3: Report of Indigo — Data Link



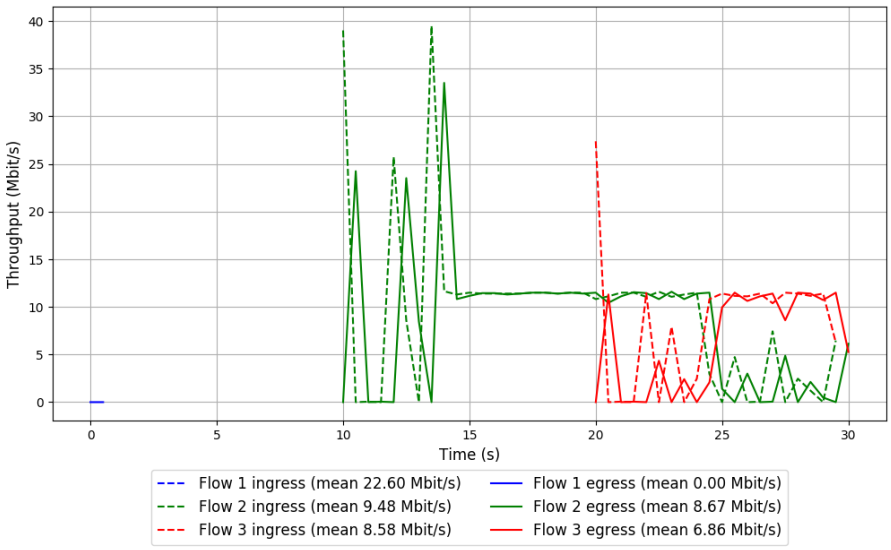


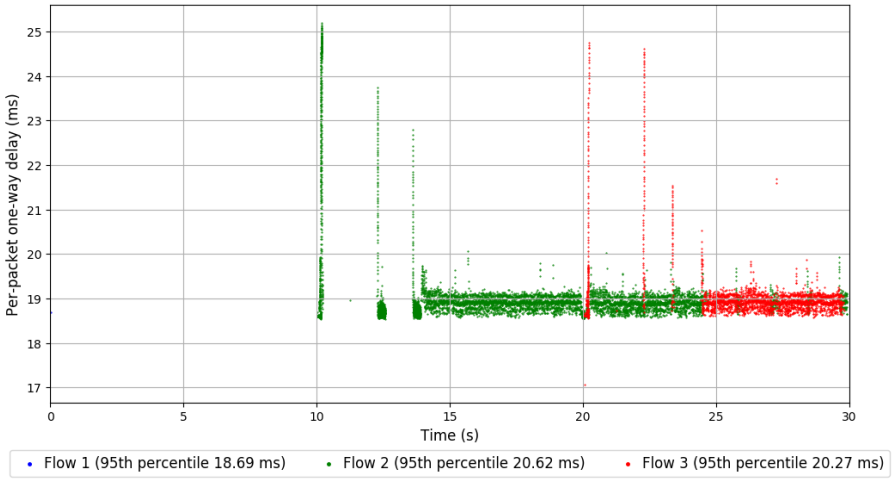
```
Run 1: Statistics of Muses-25

Start at: 2018-08-31 08:53:24
End at: 2018-08-31 08:53:54
Local clock offset: -6.507 ms
Remote clock offset: -0.294 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 8.00 Mbit/s
95th percentile per-packet one-way delay: 20.427 ms
Loss rate: 12.08%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 18.691 ms
Loss rate: 97.39%
-- Flow 2:
Average throughput: 8.67 Mbit/s
95th percentile per-packet one-way delay: 20.618 ms
Loss rate: 8.54%
-- Flow 3:
Average throughput: 6.86 Mbit/s
95th percentile per-packet one-way delay: 20.269 ms
Loss rate: 20.04%
```

Run 1: Report of Muses-25 — Data Link



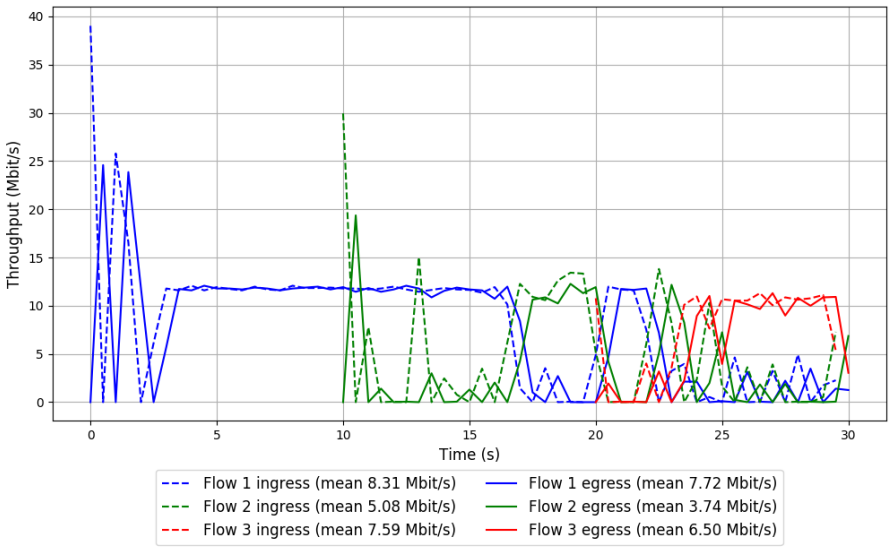


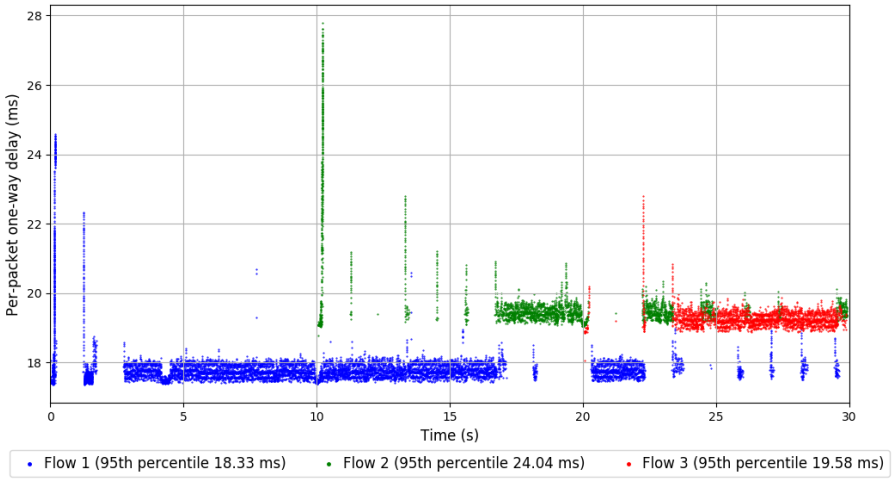
```
Run 2: Statistics of Muses-25

Start at: 2018-08-31 08:59:51
End at: 2018-08-31 09:00:21
Local clock offset: -6.472 ms
Remote clock offset: -1.936 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 12.26 Mbit/s
95th percentile per-packet one-way delay: 20.029 ms
Loss rate: 13.07%
-- Flow 1:
Average throughput: 7.72 Mbit/s
95th percentile per-packet one-way delay: 18.329 ms
Loss rate: 7.24%
-- Flow 2:
Average throughput: 3.74 Mbit/s
95th percentile per-packet one-way delay: 24.041 ms
Loss rate: 26.38%
-- Flow 3:
Average throughput: 6.50 Mbit/s
95th percentile per-packet one-way delay: 19.582 ms
Loss rate: 14.34%
```

Run 2: Report of Muses-25 — Data Link





```
Run 3: Statistics of Muses-25

Start at: 2018-08-31 09:06:07
End at: 2018-08-31 09:06:37
Local clock offset: -6.916 ms
Remote clock offset: -2.843 ms

# Below is generated by plot.py at 2018-08-31 09:17:18
# Datalink statistics
-- Total of 3 flows:
Average throughput: 8.41 Mbit/s
95th percentile per-packet one-way delay: 20.347 ms
Loss rate: 10.60%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 18.509 ms
Loss rate: 97.39%
-- Flow 2:
Average throughput: 9.55 Mbit/s
95th percentile per-packet one-way delay: 19.446 ms
Loss rate: 6.63%
-- Flow 3:
Average throughput: 6.38 Mbit/s
95th percentile per-packet one-way delay: 23.583 ms
Loss rate: 20.88%
```

Run 3: Report of Muses-25 — Data Link