

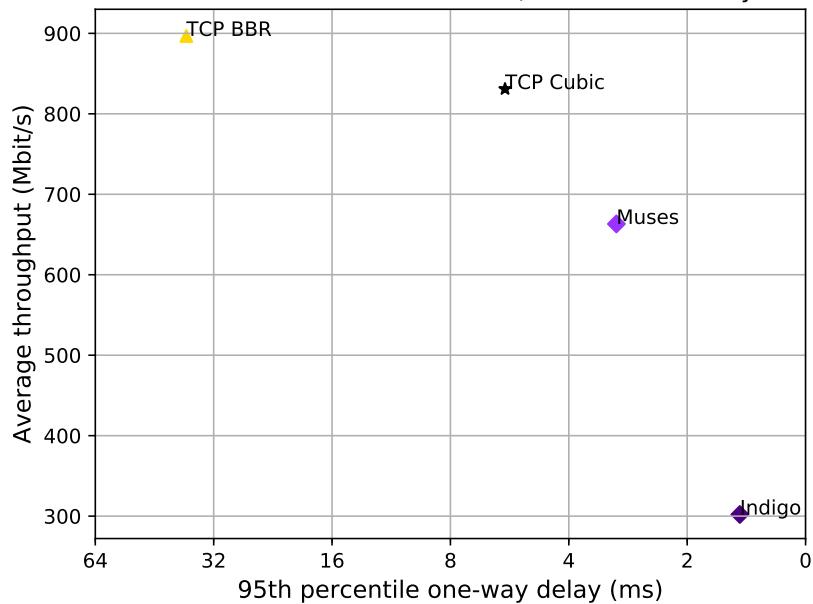
## Pantheon Report

Generated at 2018-08-28 06:45:11 (UTC).  
Data path: Stanford on `eno1` (*remote*) → AWS California 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 `time.stanford.edu` and have been applied to correct the timestamps in logs.

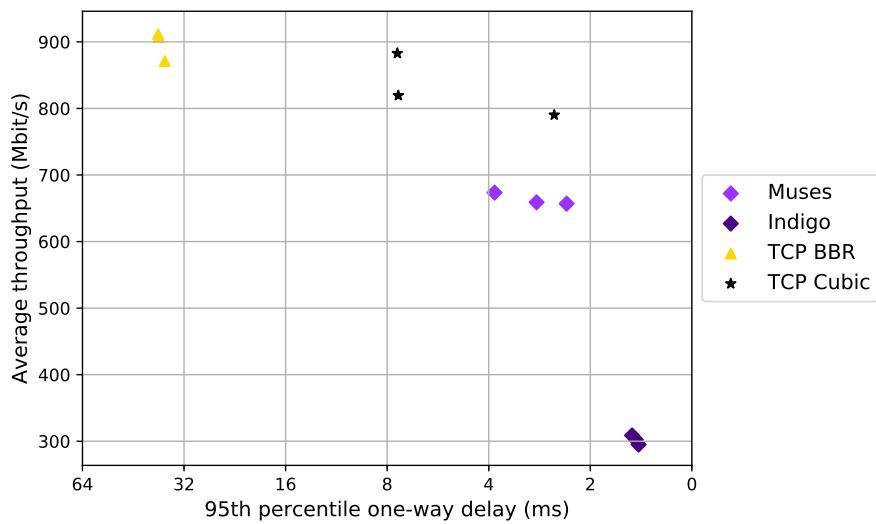
System info:  
Linux 4.15.0-1019-aws  
`net.core.default_qdisc = fq`  
`net.core.rmem_default = 16777216`  
`net.core.rmem_max = 536870912`  
`net.core.wmem_default = 16777216`  
`net.core.wmem_max = 536870912`  
`net.ipv4.tcp_rmem = 4096 16777216 536870912`  
`net.ipv4.tcp_wmem = 4096 16777216 536870912`

Git summary:  
branch: `muses` @ `86ef433b09b2f4ecae1186d6940af93bcf0969cd`  
`third_party/fillp` @ `d47f4fa1b454a5e3c0537115c5a28436dbd4b834`  
`third_party/fillp-sheep` @ `daed0c84f98531712514b2231f43ec6901114ffe`  
`third_party/genericCC` @ `d0153f8e594aa89e93b032143cedbfe58e562f4`  
`third_party/indigo` @ `2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d`  
`third_party/libutp` @ `b3465b942e2826f2b179eaab4a906ce6bb7cf3cf`  
`third_party/muses` @ `b261c9e99c63be452bc16f94ce0caa99a4c9d39a`  
`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 Stanford to AWS California 1, 3 runs of 30s each per scheme  
3 flows with 10s interval between flows (mean of all runs by scheme)



test from Stanford to AWS California 1, 3 runs of 30s each per scheme  
3 flows with 10s interval between flows



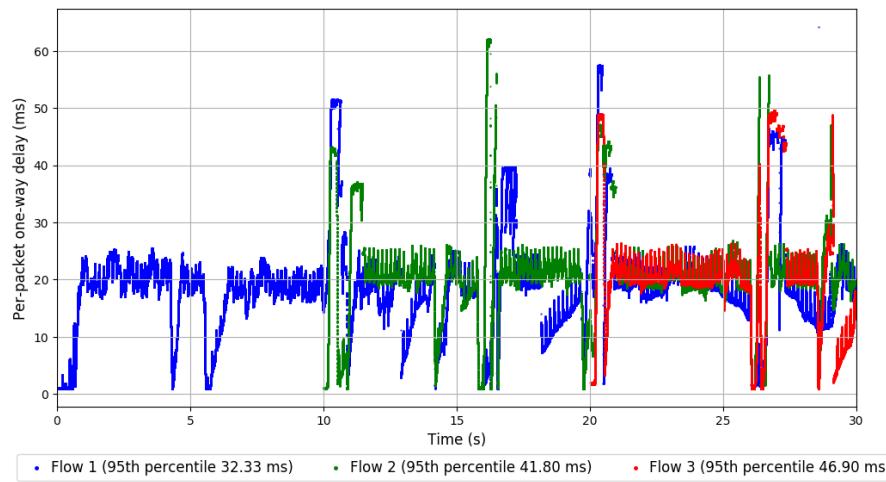
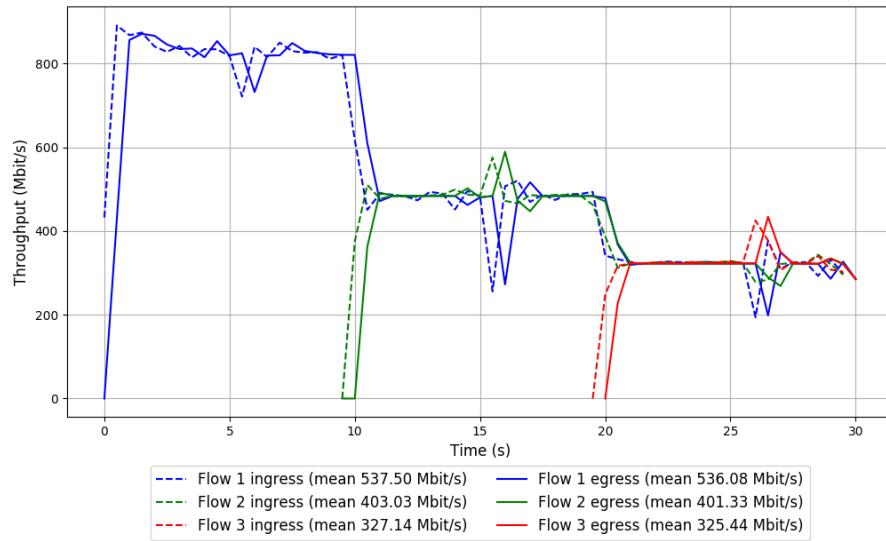
| scheme    | # runs | mean avg tput (Mbit/s) |        |        | mean 95th-%ile delay (ms) |        |        | mean loss rate (%) |        |        |
|-----------|--------|------------------------|--------|--------|---------------------------|--------|--------|--------------------|--------|--------|
|           |        | flow 1                 | flow 2 | flow 3 | flow 1                    | flow 2 | flow 3 | flow 1             | flow 2 | flow 3 |
| TCP BBR   | 3      | 522.11                 | 401.07 | 324.06 | 30.57                     | 39.10  | 51.01  | 0.34               | 0.64   | 0.92   |
| TCP Cubic | 3      | 534.41                 | 300.08 | 290.62 | 6.17                      | 5.20   | 5.13   | 0.06               | 0.12   | 0.27   |
| Indigo    | 3      | 169.39                 | 147.79 | 105.02 | 1.10                      | 1.12   | 1.15   | 0.05               | 0.10   | 0.19   |
| Muses     | 3      | 378.07                 | 337.27 | 183.40 | 2.93                      | 3.38   | 1.47   | 0.02               | 0.10   | 0.24   |

Run 1: Statistics of TCP BBR

```
Start at: 2018-08-28 06:16:54
End at: 2018-08-28 06:17:24
Local clock offset: -0.46 ms
Remote clock offset: 1.121 ms

# Below is generated by plot.py at 2018-08-28 06:42:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 911.61 Mbit/s
95th percentile per-packet one-way delay: 38.206 ms
Loss rate: 0.44%
-- Flow 1:
Average throughput: 536.08 Mbit/s
95th percentile per-packet one-way delay: 32.325 ms
Loss rate: 0.33%
-- Flow 2:
Average throughput: 401.33 Mbit/s
95th percentile per-packet one-way delay: 41.795 ms
Loss rate: 0.53%
-- Flow 3:
Average throughput: 325.44 Mbit/s
95th percentile per-packet one-way delay: 46.902 ms
Loss rate: 0.73%
```

## Run 1: Report of TCP BBR — Data Link

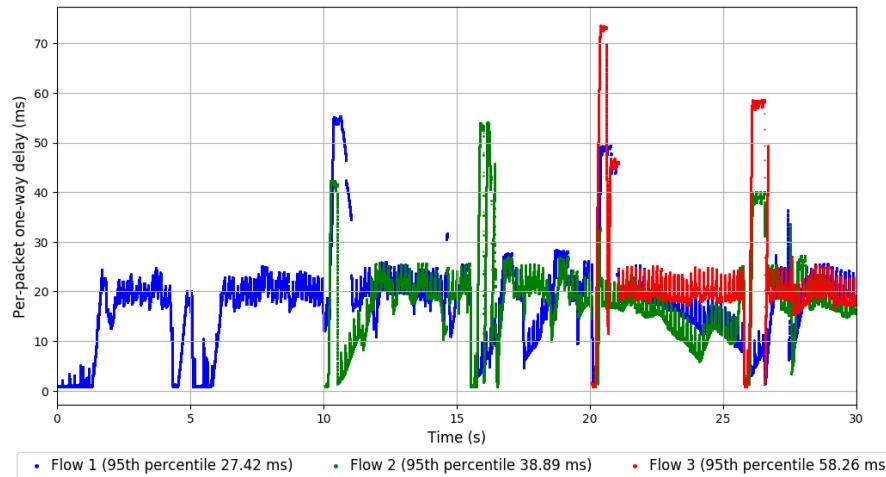
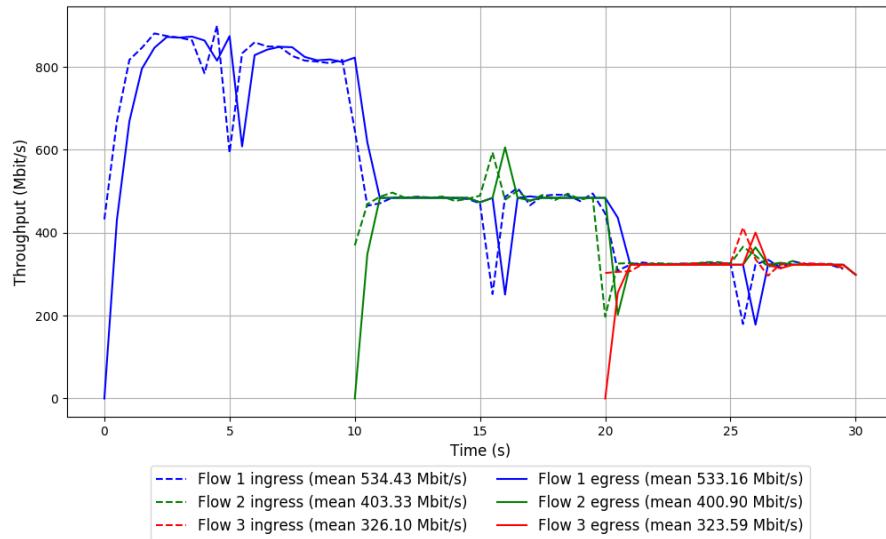


Run 2: Statistics of TCP BBR

```
Start at: 2018-08-28 06:23:45
End at: 2018-08-28 06:24:15
Local clock offset: -0.663 ms
Remote clock offset: 0.849 ms

# Below is generated by plot.py at 2018-08-28 06:42:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 907.52 Mbit/s
95th percentile per-packet one-way delay: 37.981 ms
Loss rate: 0.50%
-- Flow 1:
Average throughput: 533.16 Mbit/s
95th percentile per-packet one-way delay: 27.422 ms
Loss rate: 0.30%
-- Flow 2:
Average throughput: 400.90 Mbit/s
95th percentile per-packet one-way delay: 38.892 ms
Loss rate: 0.70%
-- Flow 3:
Average throughput: 323.59 Mbit/s
95th percentile per-packet one-way delay: 58.263 ms
Loss rate: 0.97%
```

## Run 2: Report of TCP BBR — Data Link

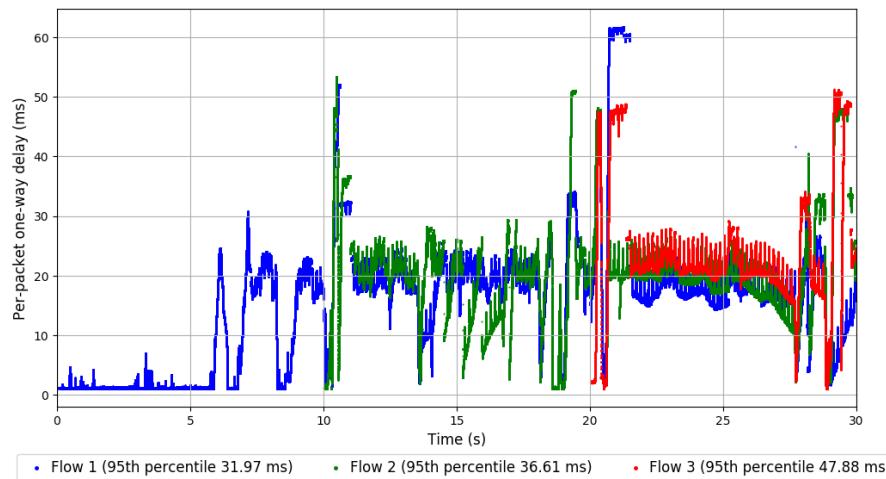
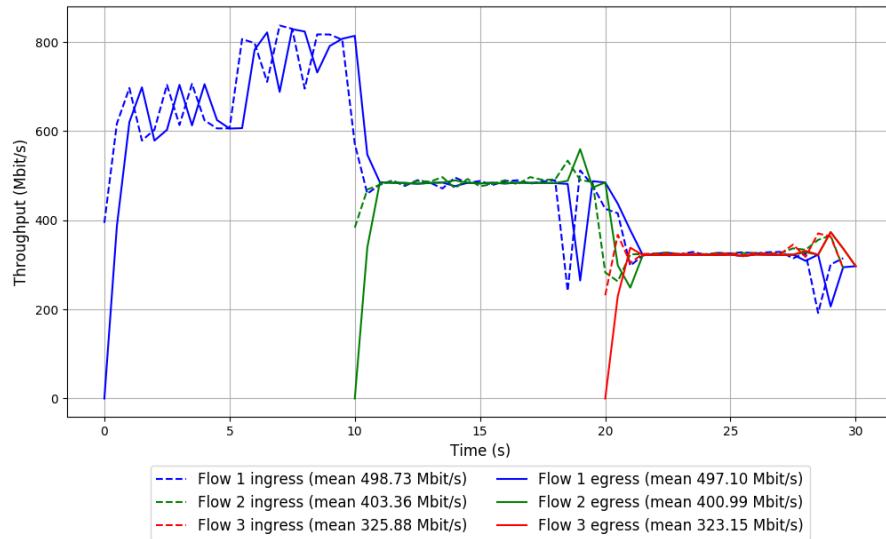


Run 3: Statistics of TCP BBR

```
Start at: 2018-08-28 06:30:39
End at: 2018-08-28 06:31:09
Local clock offset: -0.677 ms
Remote clock offset: 0.34 ms

# Below is generated by plot.py at 2018-08-28 06:42:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 871.29 Mbit/s
95th percentile per-packet one-way delay: 36.483 ms
Loss rate: 0.57%
-- Flow 1:
Average throughput: 497.10 Mbit/s
95th percentile per-packet one-way delay: 31.972 ms
Loss rate: 0.39%
-- Flow 2:
Average throughput: 400.99 Mbit/s
95th percentile per-packet one-way delay: 36.613 ms
Loss rate: 0.69%
-- Flow 3:
Average throughput: 323.15 Mbit/s
95th percentile per-packet one-way delay: 47.879 ms
Loss rate: 1.07%
```

### Run 3: Report of TCP BBR — Data Link

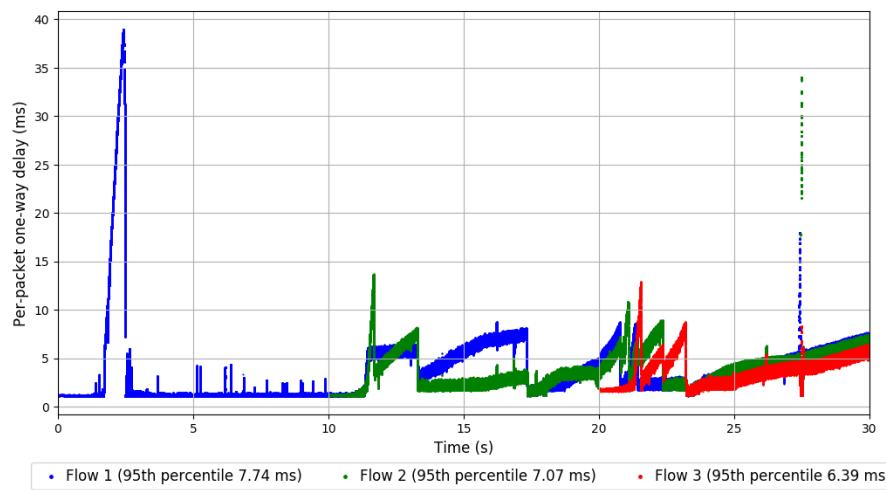
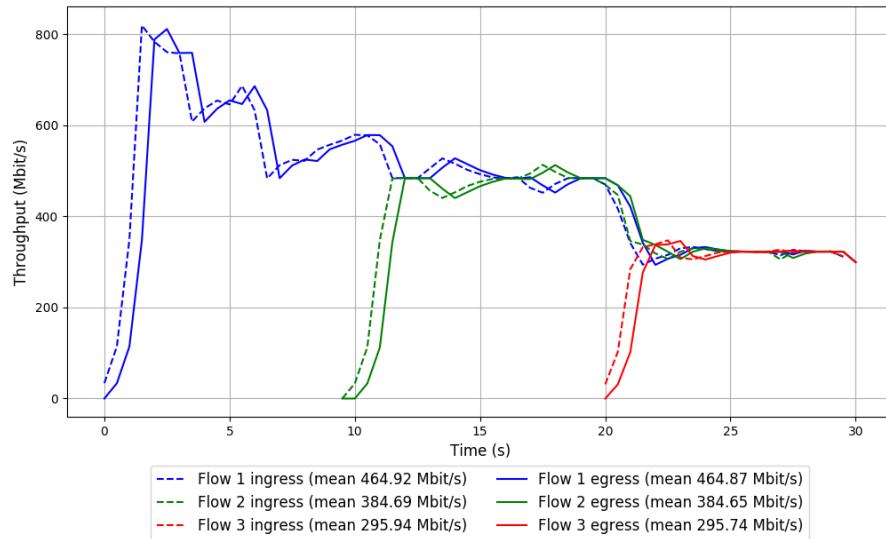


```
Run 1: Statistics of TCP Cubic
```

```
Start at: 2018-08-28 06:11:56
End at: 2018-08-28 06:12:26
Local clock offset: -0.155 ms
Remote clock offset: 0.99 ms

# Below is generated by plot.py at 2018-08-28 06:42:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 819.40 Mbit/s
95th percentile per-packet one-way delay: 7.414 ms
Loss rate: 0.11%
-- Flow 1:
Average throughput: 464.87 Mbit/s
95th percentile per-packet one-way delay: 7.735 ms
Loss rate: 0.07%
-- Flow 2:
Average throughput: 384.65 Mbit/s
95th percentile per-packet one-way delay: 7.067 ms
Loss rate: 0.11%
-- Flow 3:
Average throughput: 295.74 Mbit/s
95th percentile per-packet one-way delay: 6.392 ms
Loss rate: 0.27%
```

## Run 1: Report of TCP Cubic — Data Link

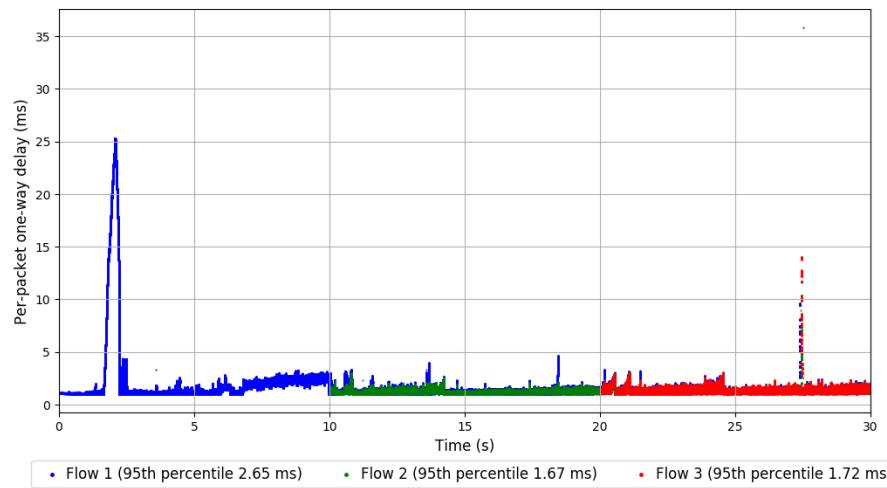
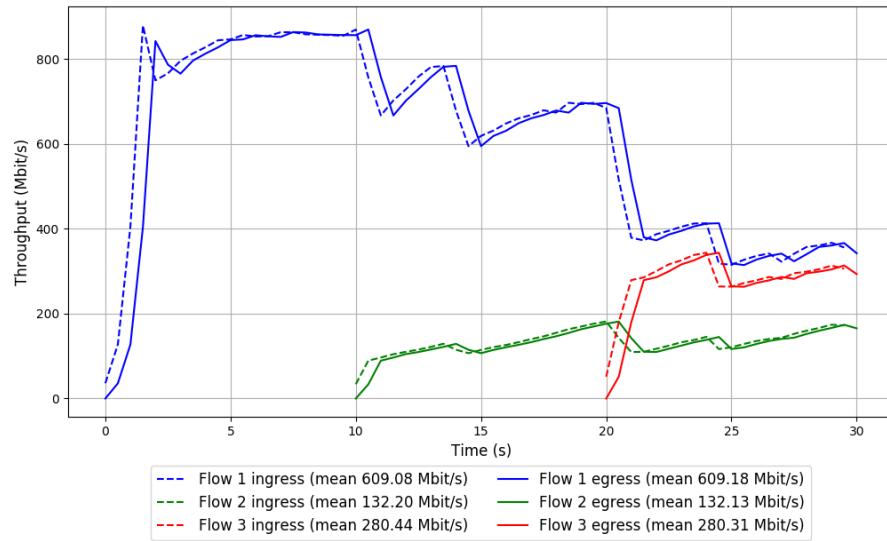


Run 2: Statistics of TCP Cubic

```
Start at: 2018-08-28 06:18:48
End at: 2018-08-28 06:19:18
Local clock offset: -0.527 ms
Remote clock offset: 1.149 ms

# Below is generated by plot.py at 2018-08-28 06:42:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 790.22 Mbit/s
95th percentile per-packet one-way delay: 2.558 ms
Loss rate: 0.08%
-- Flow 1:
Average throughput: 609.18 Mbit/s
95th percentile per-packet one-way delay: 2.645 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 132.13 Mbit/s
95th percentile per-packet one-way delay: 1.674 ms
Loss rate: 0.15%
-- Flow 3:
Average throughput: 280.31 Mbit/s
95th percentile per-packet one-way delay: 1.719 ms
Loss rate: 0.25%
```

## Run 2: Report of TCP Cubic — Data Link

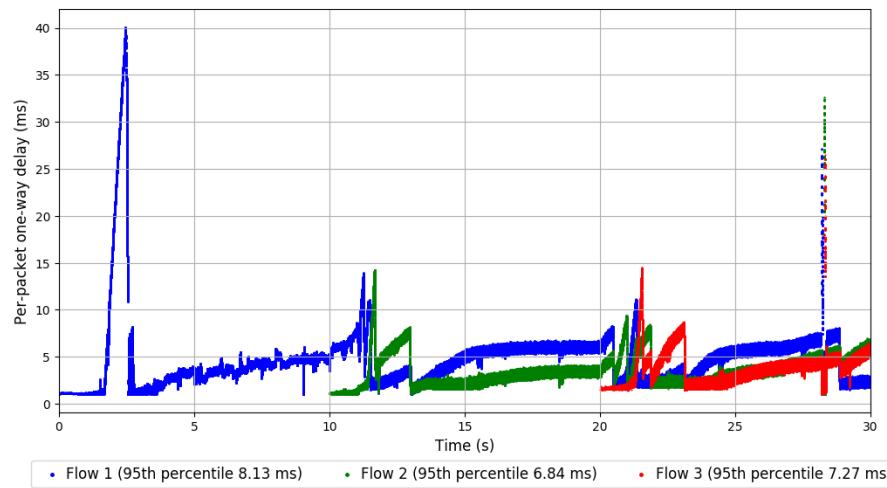
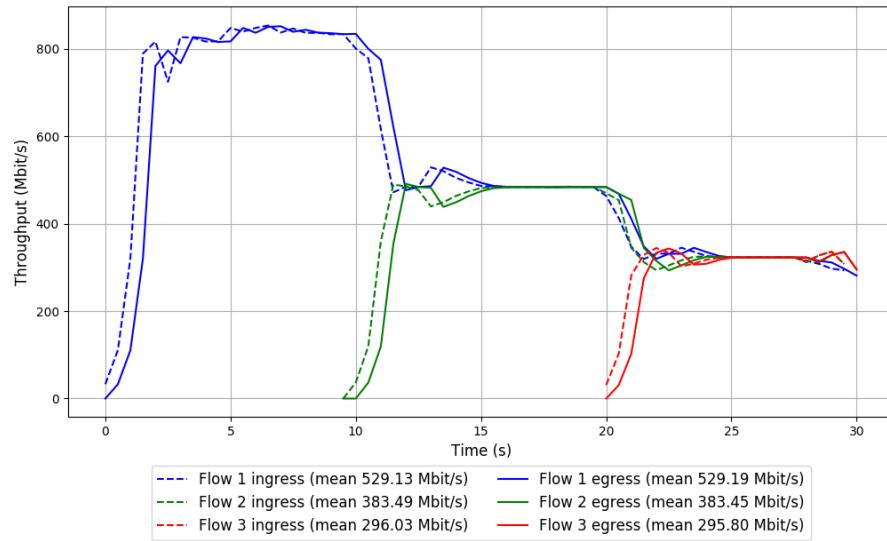


Run 3: Statistics of TCP Cubic

```
Start at: 2018-08-28 06:25:39
End at: 2018-08-28 06:26:09
Local clock offset: -0.6 ms
Remote clock offset: 0.591 ms

# Below is generated by plot.py at 2018-08-28 06:42:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 882.86 Mbit/s
95th percentile per-packet one-way delay: 7.462 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 529.19 Mbit/s
95th percentile per-packet one-way delay: 8.128 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 383.45 Mbit/s
95th percentile per-packet one-way delay: 6.844 ms
Loss rate: 0.11%
-- Flow 3:
Average throughput: 295.80 Mbit/s
95th percentile per-packet one-way delay: 7.270 ms
Loss rate: 0.28%
```

### Run 3: Report of TCP Cubic — Data Link

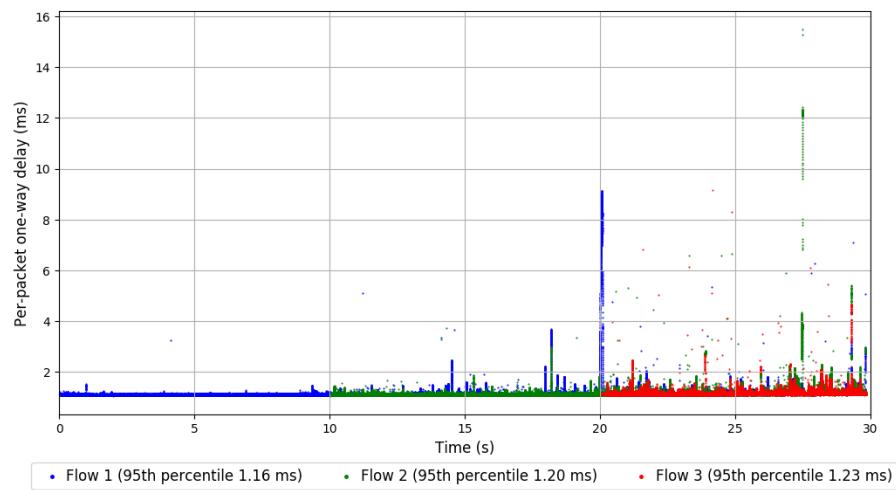
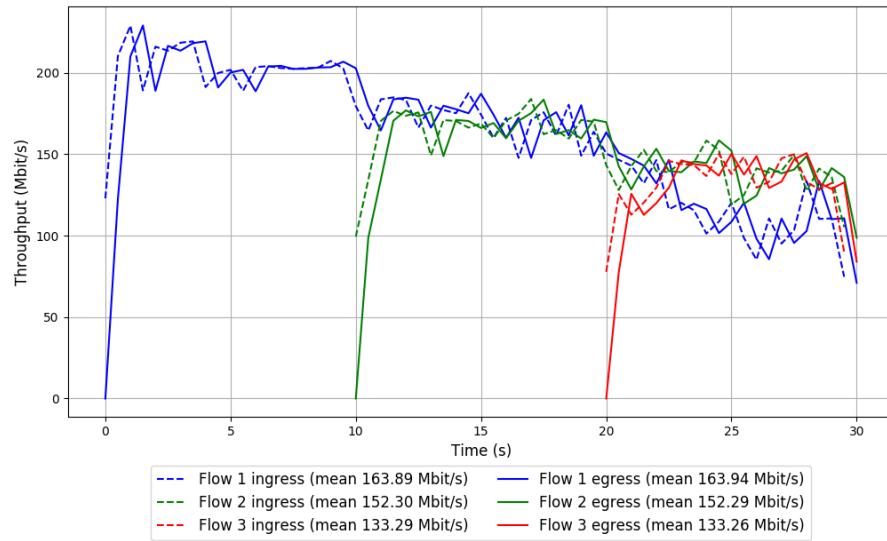


Run 1: Statistics of Indigo

```
Start at: 2018-08-28 06:15:23
End at: 2018-08-28 06:15:53
Local clock offset: -0.325 ms
Remote clock offset: 1.07 ms

# Below is generated by plot.py at 2018-08-28 06:42:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 308.78 Mbit/s
95th percentile per-packet one-way delay: 1.178 ms
Loss rate: 0.09%
-- Flow 1:
Average throughput: 163.94 Mbit/s
95th percentile per-packet one-way delay: 1.159 ms
Loss rate: 0.04%
-- Flow 2:
Average throughput: 152.29 Mbit/s
95th percentile per-packet one-way delay: 1.196 ms
Loss rate: 0.11%
-- Flow 3:
Average throughput: 133.26 Mbit/s
95th percentile per-packet one-way delay: 1.228 ms
Loss rate: 0.23%
```

Run 1: Report of Indigo — Data Link

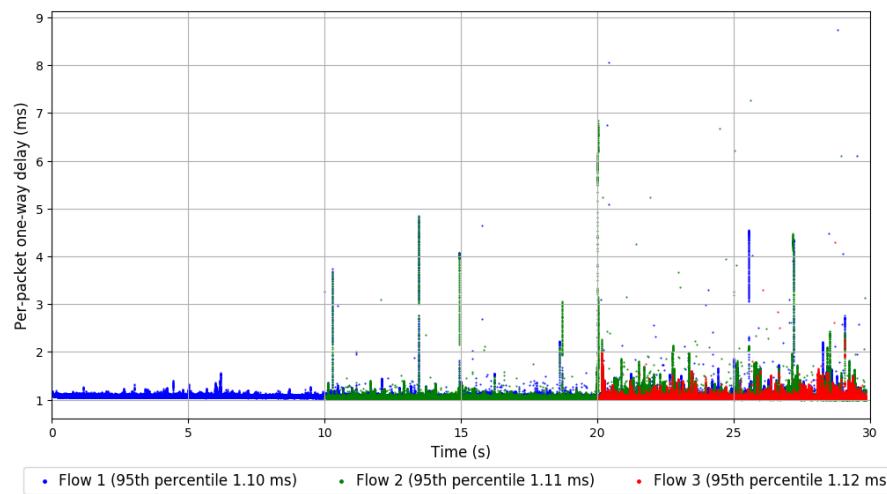
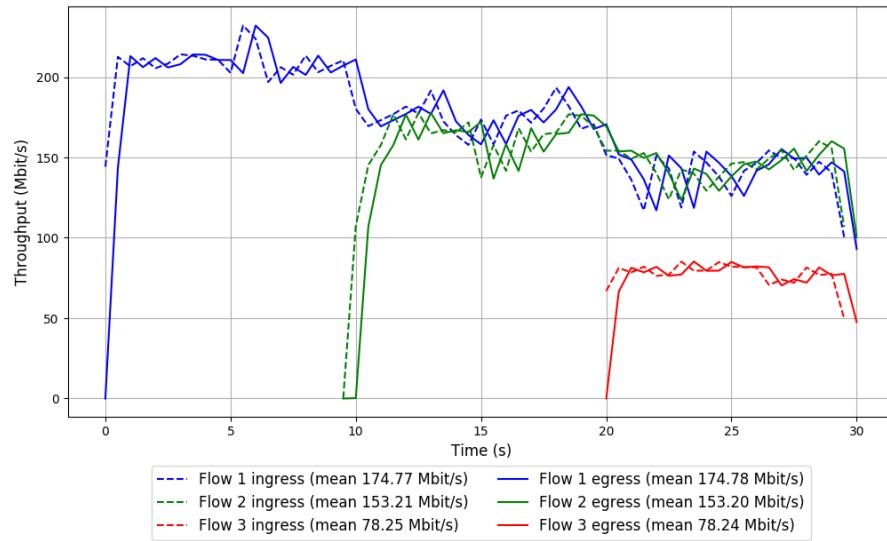


Run 2: Statistics of Indigo

```
Start at: 2018-08-28 06:22:14
End at: 2018-08-28 06:22:44
Local clock offset: -0.531 ms
Remote clock offset: 0.914 ms

# Below is generated by plot.py at 2018-08-28 06:42:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 302.41 Mbit/s
95th percentile per-packet one-way delay: 1.104 ms
Loss rate: 0.09%
-- Flow 1:
Average throughput: 174.78 Mbit/s
95th percentile per-packet one-way delay: 1.102 ms
Loss rate: 0.07%
-- Flow 2:
Average throughput: 153.20 Mbit/s
95th percentile per-packet one-way delay: 1.115 ms
Loss rate: 0.11%
-- Flow 3:
Average throughput: 78.24 Mbit/s
95th percentile per-packet one-way delay: 1.123 ms
Loss rate: 0.15%
```

Run 2: Report of Indigo — Data Link

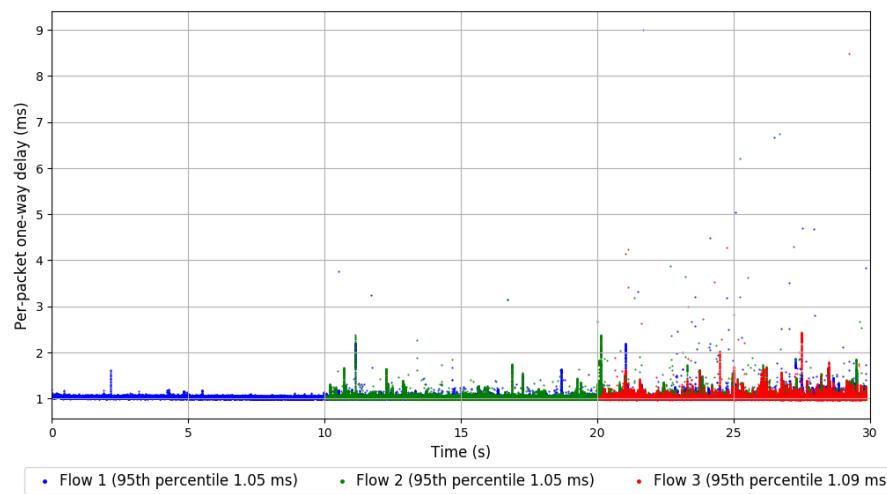
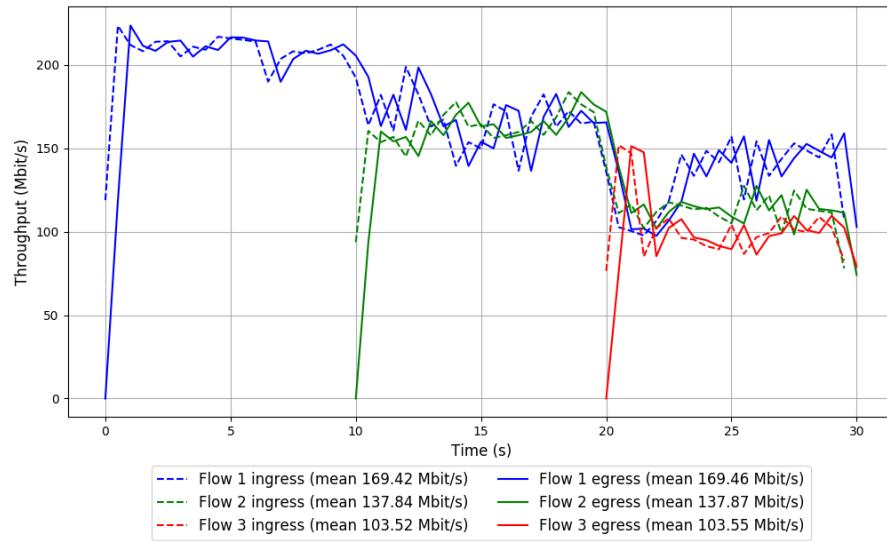


Run 3: Statistics of Indigo

```
Start at: 2018-08-28 06:29:08
End at: 2018-08-28 06:29:38
Local clock offset: -0.75 ms
Remote clock offset: 0.384 ms

# Below is generated by plot.py at 2018-08-28 06:42:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 294.94 Mbit/s
95th percentile per-packet one-way delay: 1.049 ms
Loss rate: 0.07%
-- Flow 1:
Average throughput: 169.46 Mbit/s
95th percentile per-packet one-way delay: 1.046 ms
Loss rate: 0.04%
-- Flow 2:
Average throughput: 137.87 Mbit/s
95th percentile per-packet one-way delay: 1.054 ms
Loss rate: 0.08%
-- Flow 3:
Average throughput: 103.55 Mbit/s
95th percentile per-packet one-way delay: 1.087 ms
Loss rate: 0.20%
```

### Run 3: Report of Indigo — Data Link

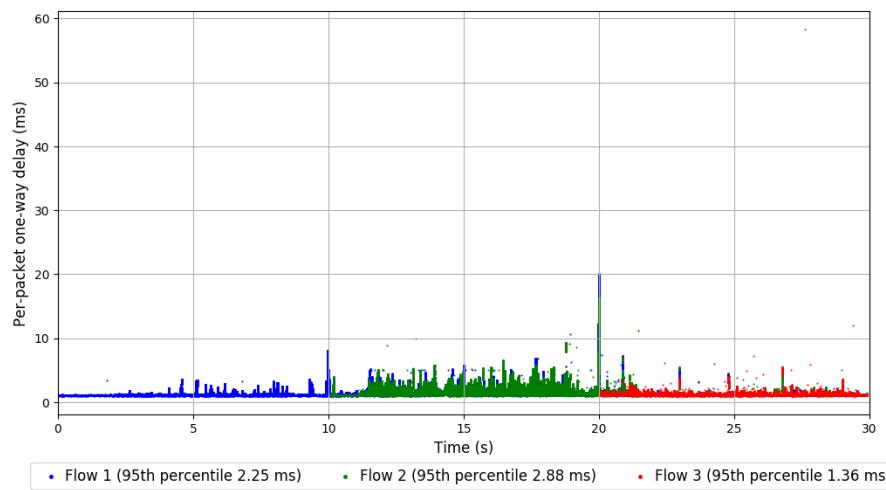
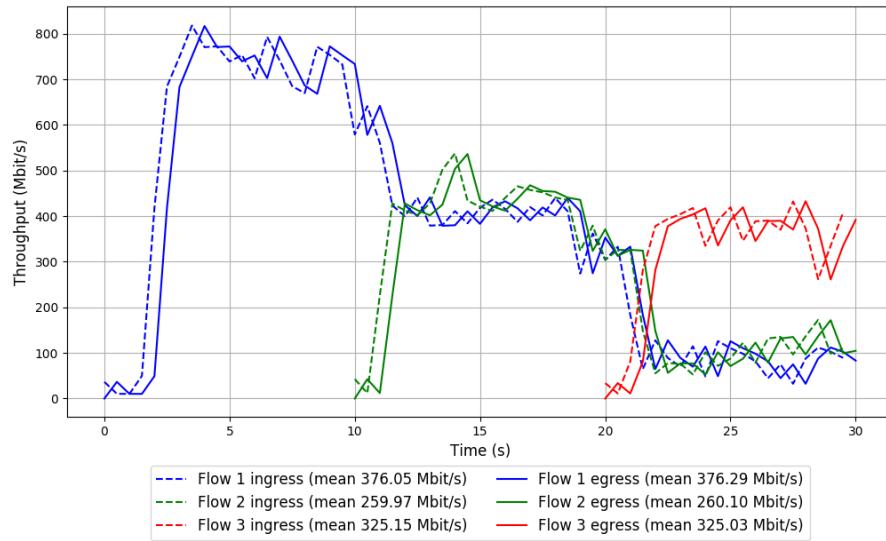


```
Run 1: Statistics of Muses
```

```
Start at: 2018-08-28 06:13:41
End at: 2018-08-28 06:14:11
Local clock offset: -0.322 ms
Remote clock offset: 1.022 ms

# Below is generated by plot.py at 2018-08-28 06:44:02
# Datalink statistics
-- Total of 3 flows:
Average throughput: 656.90 Mbit/s
95th percentile per-packet one-way delay: 2.351 ms
Loss rate: 0.07%
-- Flow 1:
Average throughput: 376.29 Mbit/s
95th percentile per-packet one-way delay: 2.255 ms
Loss rate: 0.03%
-- Flow 2:
Average throughput: 260.10 Mbit/s
95th percentile per-packet one-way delay: 2.877 ms
Loss rate: 0.05%
-- Flow 3:
Average throughput: 325.03 Mbit/s
95th percentile per-packet one-way delay: 1.356 ms
Loss rate: 0.26%
```

## Run 1: Report of Muses — Data Link

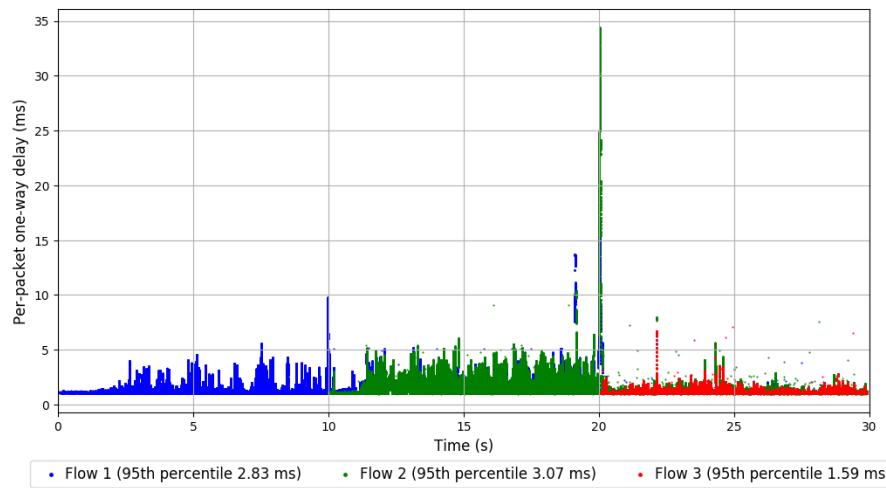
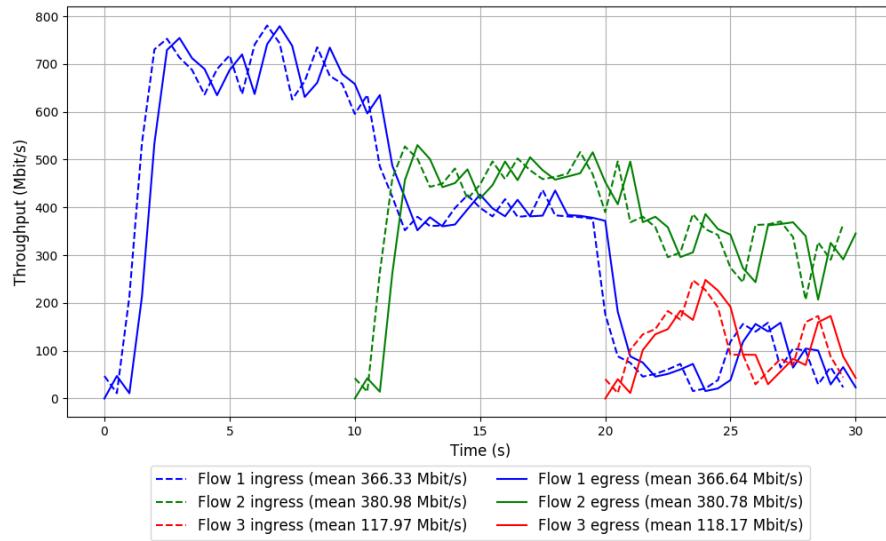


Run 2: Statistics of Muses

```
Start at: 2018-08-28 06:20:32
End at: 2018-08-28 06:21:02
Local clock offset: -0.489 ms
Remote clock offset: 1.091 ms

# Below is generated by plot.py at 2018-08-28 06:44:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 658.99 Mbit/s
95th percentile per-packet one-way delay: 2.886 ms
Loss rate: 0.07%
-- Flow 1:
Average throughput: 366.64 Mbit/s
95th percentile per-packet one-way delay: 2.825 ms
Loss rate: 0.02%
-- Flow 2:
Average throughput: 380.78 Mbit/s
95th percentile per-packet one-way delay: 3.070 ms
Loss rate: 0.15%
-- Flow 3:
Average throughput: 118.17 Mbit/s
95th percentile per-packet one-way delay: 1.586 ms
Loss rate: 0.05%
```

## Run 2: Report of Muses — Data Link



Run 3: Statistics of Muses

```
Start at: 2018-08-28 06:27:25
End at: 2018-08-28 06:27:55
Local clock offset: -0.729 ms
Remote clock offset: 0.482 ms

# Below is generated by plot.py at 2018-08-28 06:45:09
# Datalink statistics
-- Total of 3 flows:
Average throughput: 673.56 Mbit/s
95th percentile per-packet one-way delay: 3.844 ms
Loss rate: 0.06%
-- Flow 1:
Average throughput: 391.27 Mbit/s
95th percentile per-packet one-way delay: 3.699 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 370.93 Mbit/s
95th percentile per-packet one-way delay: 4.207 ms
Loss rate: 0.11%
-- Flow 3:
Average throughput: 106.99 Mbit/s
95th percentile per-packet one-way delay: 1.455 ms
Loss rate: 0.41%
```

### Run 3: Report of Muses — Data Link

