

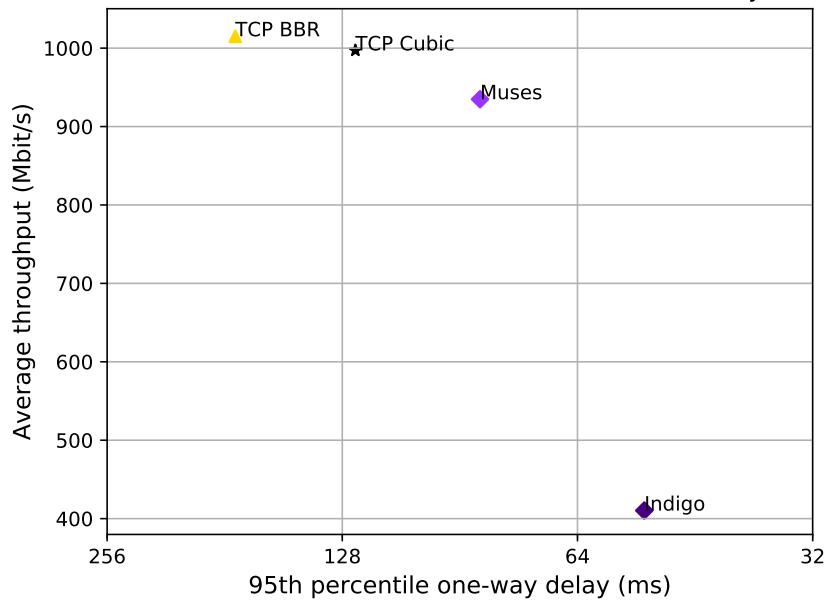
## Pantheon Report

Generated at 2018-08-28 11:41:52 (UTC).  
Data path: GCE London on `ens4 (local)` → GCE Iowa on `ens4 (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.google.com` and have been applied to correct the timestamps in logs.

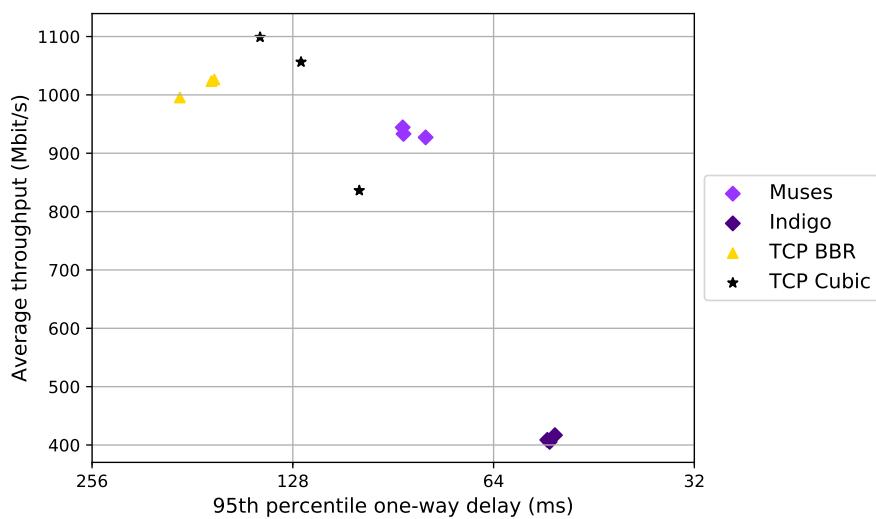
System info:  
Linux 4.15.0-1017-gcp  
net.core.default\_qdisc = fq  
net.core.rmem\_default = 16777216  
net.core.rmem\_max = 536870912  
net.core.wmem\_default = 16777216  
net.core.wmem\_max = 536870912  
net.ipv4.tcp\_rmem = 4096 16777216 536870912  
net.ipv4.tcp\_wmem = 4096 16777216 536870912

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 GCE London to GCE Iowa, 3 runs of 30s each per scheme  
3 flows with 10s interval between flows (mean of all runs by scheme)



test from GCE London to GCE Iowa, 3 runs of 30s each per scheme  
3 flows with 10s interval between flows



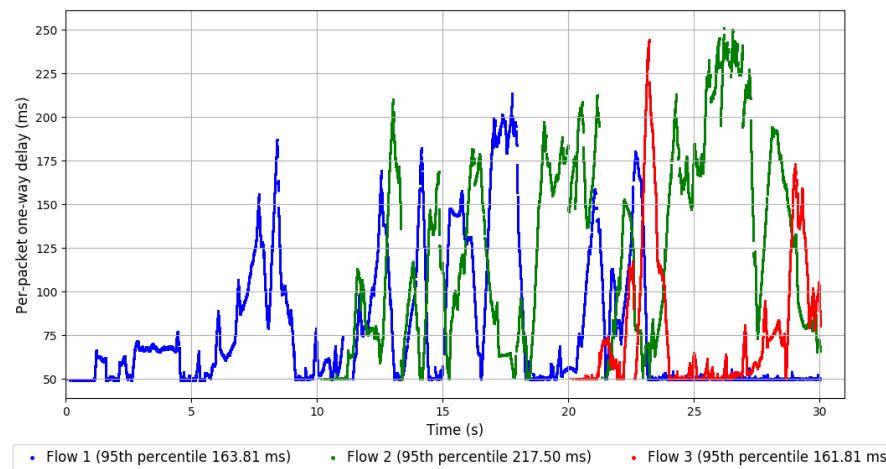
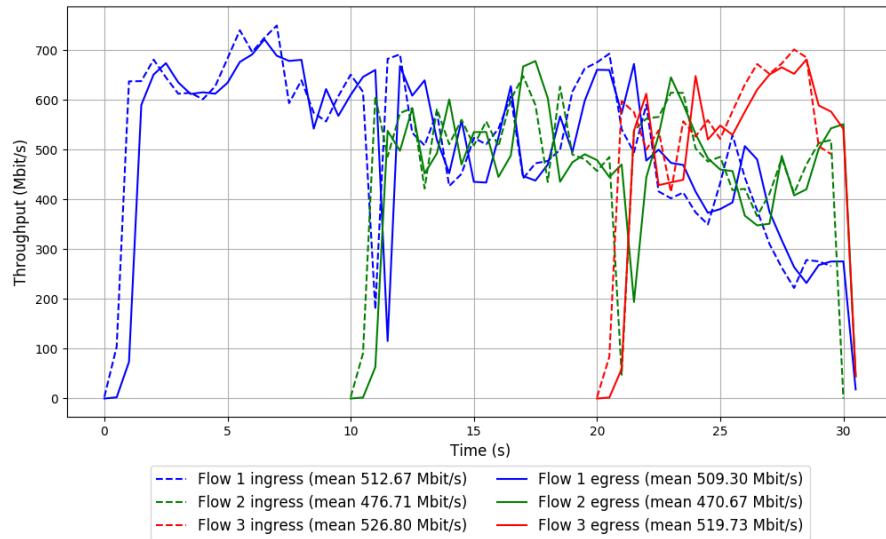
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	3	528.83	496.91	467.04	168.43	173.72	173.76	0.83	1.06	0.97
TCP Cubic	3	576.30	382.24	499.79	125.15	92.58	123.56	0.08	0.03	0.20
Indigo	3	218.17	201.93	180.70	52.52	52.03	53.11	0.00	0.00	0.00
Muses	3	522.69	455.72	336.63	84.91	84.36	86.57	0.07	0.11	0.18

Run 1: Statistics of TCP BBR

```
Start at: 2018-08-28 10:51:58
End at: 2018-08-28 10:52:28
Local clock offset: -0.556 ms
Remote clock offset: -0.522 ms

# Below is generated by plot.py at 2018-08-28 11:33:58
# Datalink statistics
-- Total of 3 flows:
Average throughput: 995.47 Mbit/s
95th percentile per-packet one-way delay: 189.063 ms
Loss rate: 1.21%
-- Flow 1:
Average throughput: 509.30 Mbit/s
95th percentile per-packet one-way delay: 163.811 ms
Loss rate: 0.66%
-- Flow 2:
Average throughput: 470.67 Mbit/s
95th percentile per-packet one-way delay: 217.504 ms
Loss rate: 2.19%
-- Flow 3:
Average throughput: 519.73 Mbit/s
95th percentile per-packet one-way delay: 161.815 ms
Loss rate: 1.04%
```

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

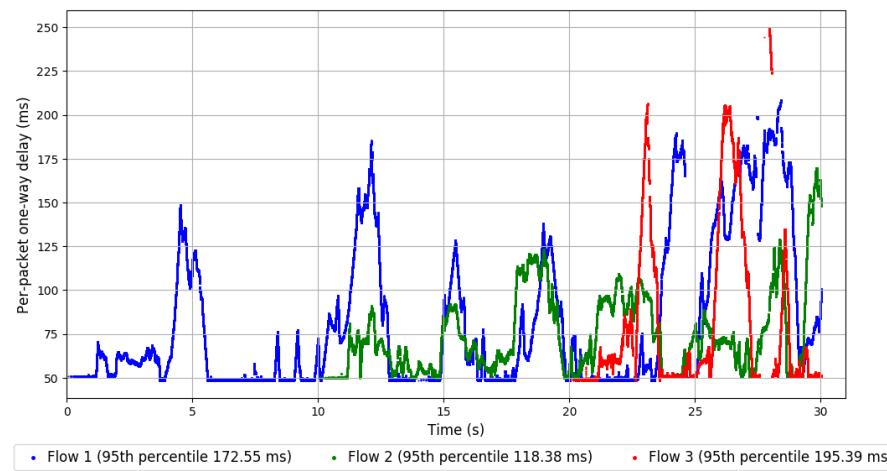
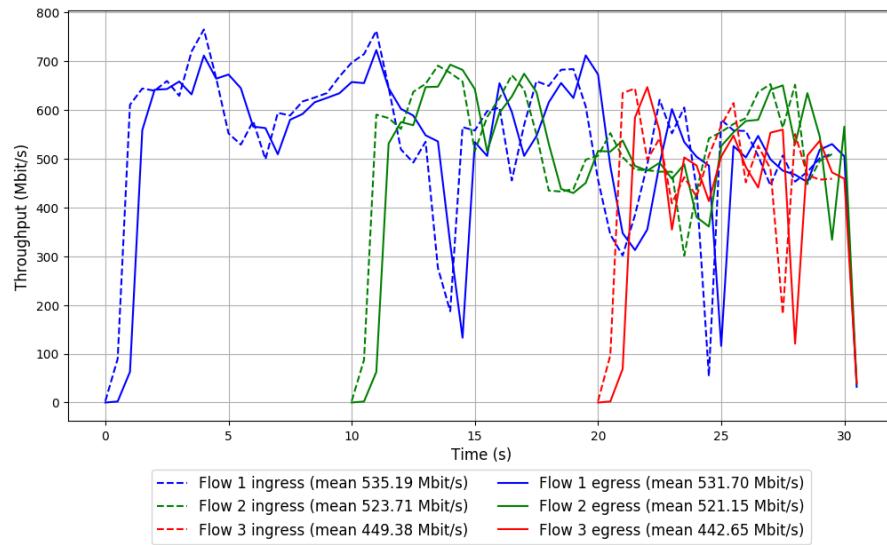


Run 2: Statistics of TCP BBR

```
Start at: 2018-08-28 10:59:42
End at: 2018-08-28 11:00:12
Local clock offset: 0.148 ms
Remote clock offset: -0.592 ms

# Below is generated by plot.py at 2018-08-28 11:34:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1026.34 Mbit/s
95th percentile per-packet one-way delay: 167.824 ms
Loss rate: 0.72%
-- Flow 1:
Average throughput: 531.70 Mbit/s
95th percentile per-packet one-way delay: 172.549 ms
Loss rate: 0.65%
-- Flow 2:
Average throughput: 521.15 Mbit/s
95th percentile per-packet one-way delay: 118.383 ms
Loss rate: 0.49%
-- Flow 3:
Average throughput: 442.65 Mbit/s
95th percentile per-packet one-way delay: 195.388 ms
Loss rate: 1.48%
```

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

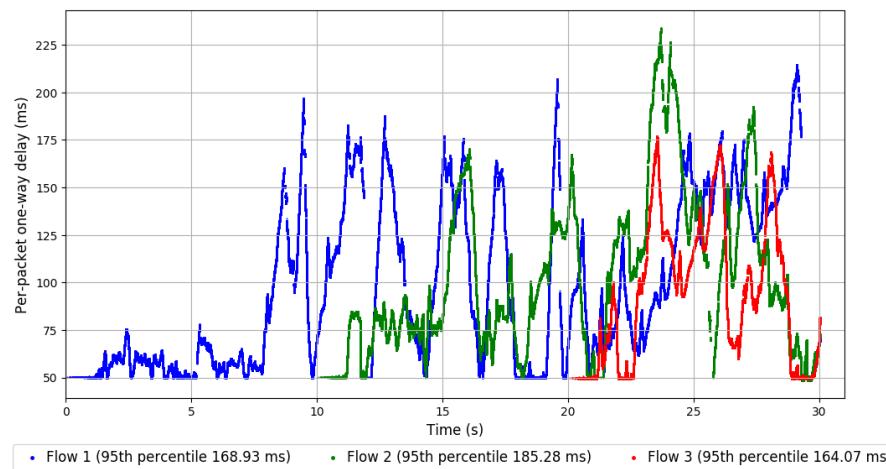
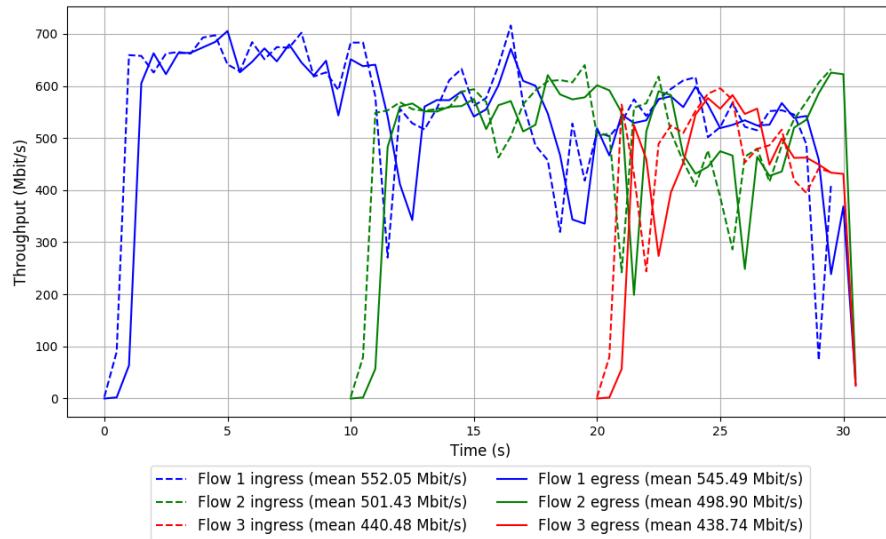


Run 3: Statistics of TCP BBR

```
Start at: 2018-08-28 11:07:27
End at: 2018-08-28 11:07:57
Local clock offset: 0.084 ms
Remote clock offset: -0.621 ms

# Below is generated by plot.py at 2018-08-28 11:34:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1023.57 Mbit/s
95th percentile per-packet one-way delay: 169.551 ms
Loss rate: 0.85%
-- Flow 1:
Average throughput: 545.49 Mbit/s
95th percentile per-packet one-way delay: 168.932 ms
Loss rate: 1.19%
-- Flow 2:
Average throughput: 498.90 Mbit/s
95th percentile per-packet one-way delay: 185.275 ms
Loss rate: 0.51%
-- Flow 3:
Average throughput: 438.74 Mbit/s
95th percentile per-packet one-way delay: 164.072 ms
Loss rate: 0.39%
```

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

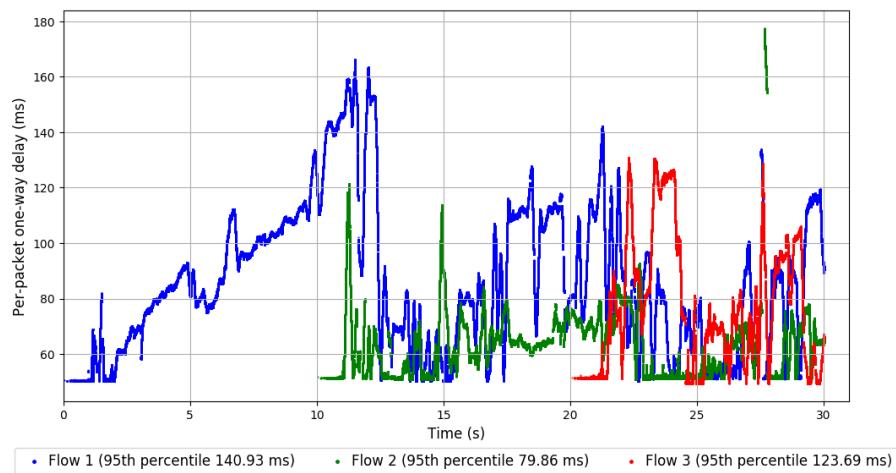
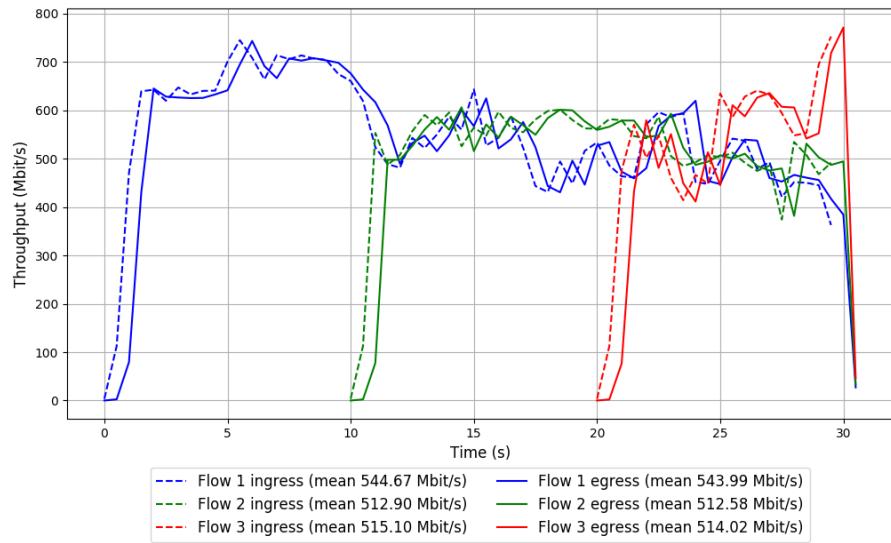


```
Run 1: Statistics of TCP Cubic
```

```
Start at: 2018-08-28 10:57:43
End at: 2018-08-28 10:58:13
Local clock offset: -0.729 ms
Remote clock offset: -0.524 ms

# Below is generated by plot.py at 2018-08-28 11:34:40
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1056.39 Mbit/s
95th percentile per-packet one-way delay: 124.415 ms
Loss rate: 0.12%
-- Flow 1:
Average throughput: 543.99 Mbit/s
95th percentile per-packet one-way delay: 140.925 ms
Loss rate: 0.12%
-- Flow 2:
Average throughput: 512.58 Mbit/s
95th percentile per-packet one-way delay: 79.862 ms
Loss rate: 0.06%
-- Flow 3:
Average throughput: 514.02 Mbit/s
95th percentile per-packet one-way delay: 123.691 ms
Loss rate: 0.21%
```

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

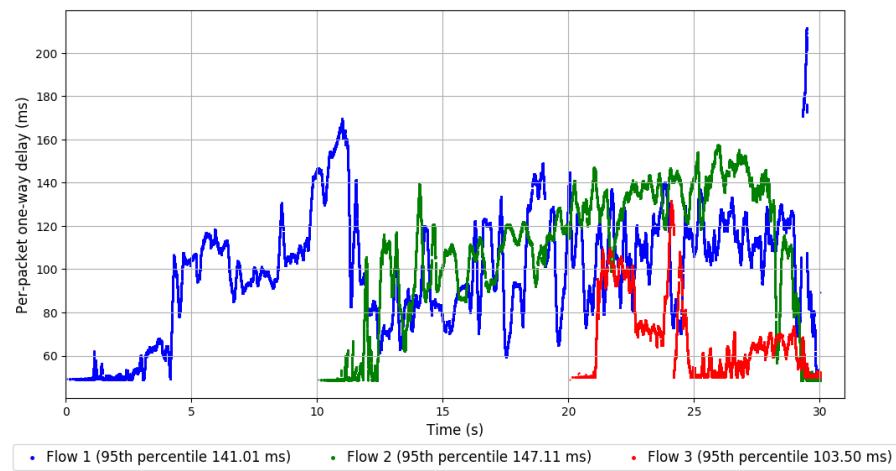
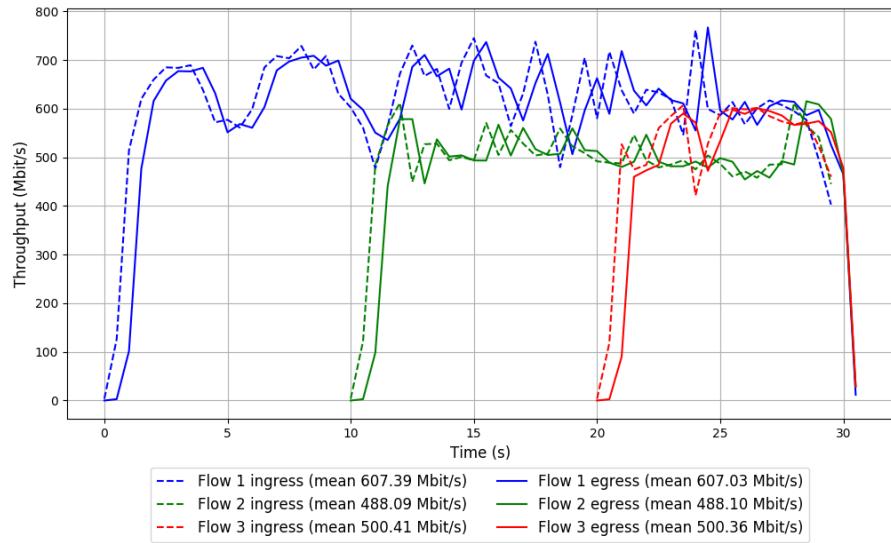


Run 2: Statistics of TCP Cubic

```
Start at: 2018-08-28 11:05:26
End at: 2018-08-28 11:05:56
Local clock offset: -0.071 ms
Remote clock offset: -0.634 ms

# Below is generated by plot.py at 2018-08-28 11:35:09
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1098.80 Mbit/s
95th percentile per-packet one-way delay: 143.320 ms
Loss rate: 0.03%
-- Flow 1:
Average throughput: 607.03 Mbit/s
95th percentile per-packet one-way delay: 141.010 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 488.10 Mbit/s
95th percentile per-packet one-way delay: 147.108 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 500.36 Mbit/s
95th percentile per-packet one-way delay: 103.499 ms
Loss rate: 0.00%
```

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

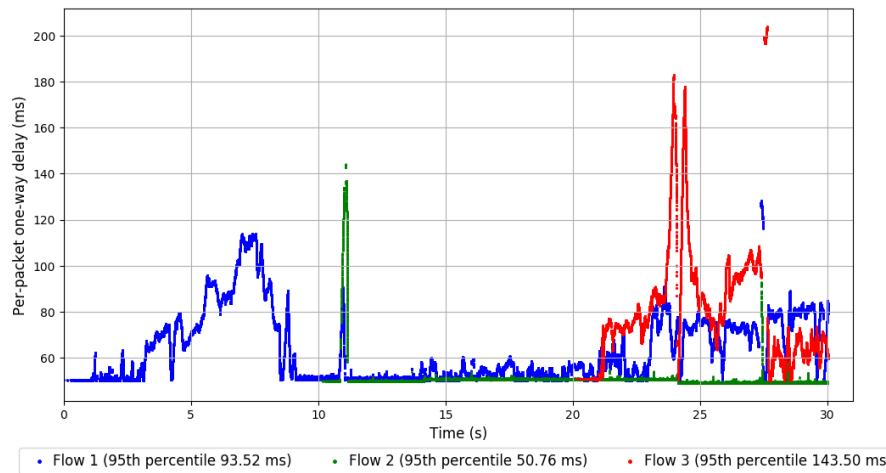
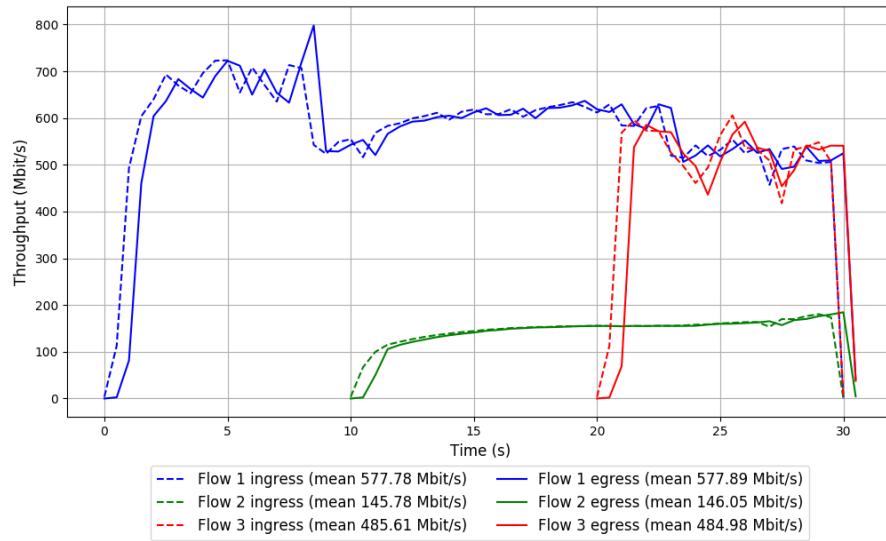


Run 3: Statistics of TCP Cubic

```
Start at: 2018-08-28 11:13:12
End at: 2018-08-28 11:13:42
Local clock offset: -0.007 ms
Remote clock offset: -0.694 ms

# Below is generated by plot.py at 2018-08-28 11:35:09
# Datalink statistics
-- Total of 3 flows:
Average throughput: 836.12 Mbit/s
95th percentile per-packet one-way delay: 101.751 ms
Loss rate: 0.11%
-- Flow 1:
Average throughput: 577.89 Mbit/s
95th percentile per-packet one-way delay: 93.518 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 146.05 Mbit/s
95th percentile per-packet one-way delay: 50.756 ms
Loss rate: 0.02%
-- Flow 3:
Average throughput: 484.98 Mbit/s
95th percentile per-packet one-way delay: 143.504 ms
Loss rate: 0.38%
```

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

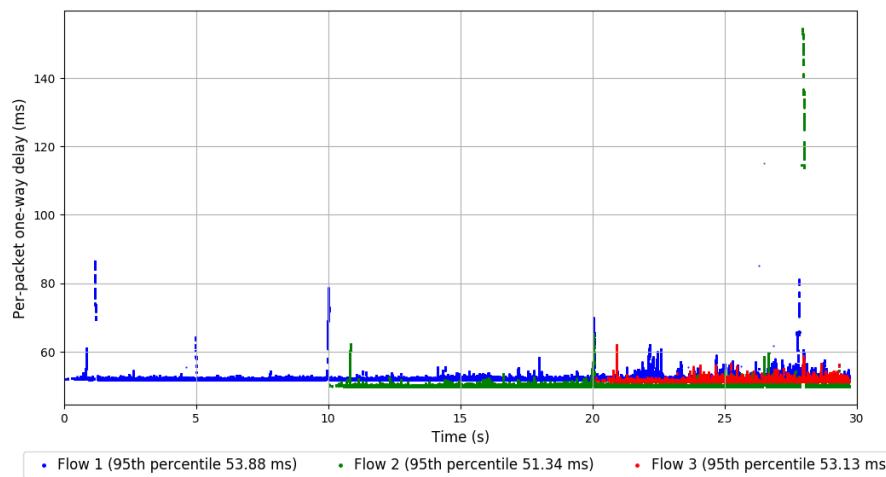
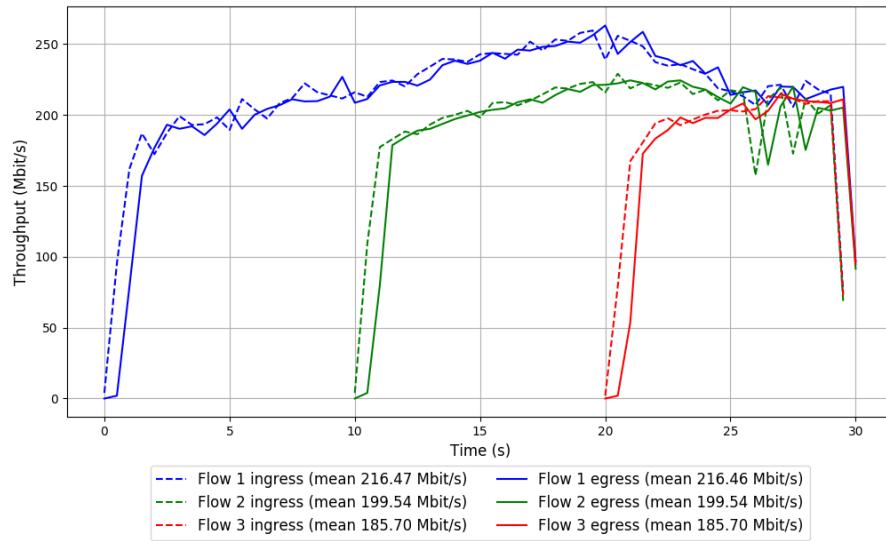


Run 1: Statistics of Indigo

```
Start at: 2018-08-28 10:54:02
End at: 2018-08-28 10:54:32
Local clock offset: -1.163 ms
Remote clock offset: -0.545 ms

# Below is generated by plot.py at 2018-08-28 11:35:09
# Datalink statistics
-- Total of 3 flows:
Average throughput: 408.71 Mbit/s
95th percentile per-packet one-way delay: 53.168 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 216.46 Mbit/s
95th percentile per-packet one-way delay: 53.884 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 199.54 Mbit/s
95th percentile per-packet one-way delay: 51.337 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 185.70 Mbit/s
95th percentile per-packet one-way delay: 53.132 ms
Loss rate: 0.00%
```

Run 1: Report of Indigo — Data Link

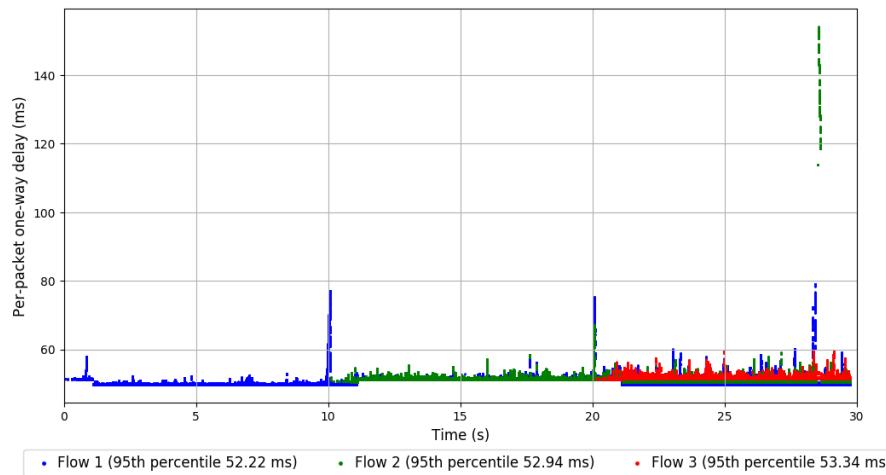
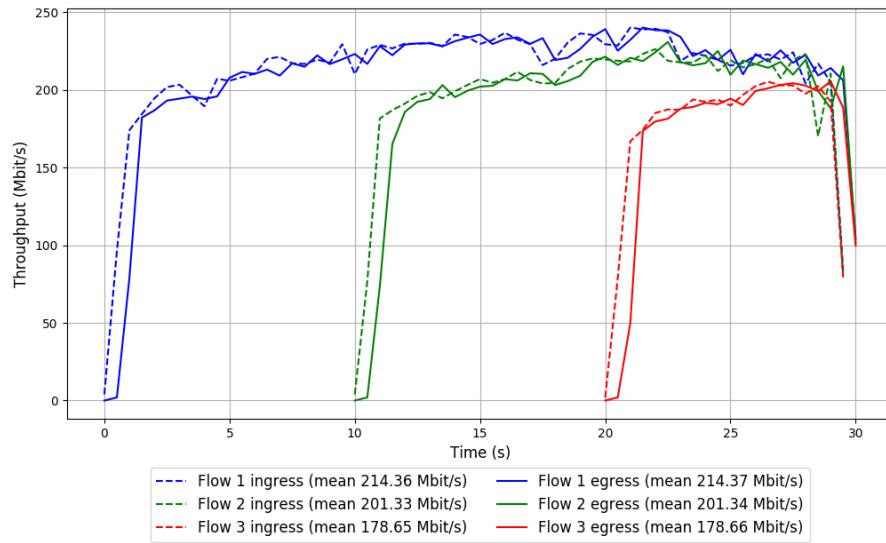


Run 2: Statistics of Indigo

```
Start at: 2018-08-28 11:01:45
End at: 2018-08-28 11:02:15
Local clock offset: -1.139 ms
Remote clock offset: -0.565 ms

# Below is generated by plot.py at 2018-08-28 11:35:09
# Datalink statistics
-- Total of 3 flows:
Average throughput: 405.37 Mbit/s
95th percentile per-packet one-way delay: 52.741 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 214.37 Mbit/s
95th percentile per-packet one-way delay: 52.219 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 201.34 Mbit/s
95th percentile per-packet one-way delay: 52.944 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 178.66 Mbit/s
95th percentile per-packet one-way delay: 53.341 ms
Loss rate: 0.00%
```

## Run 2: Report of Indigo — Data Link

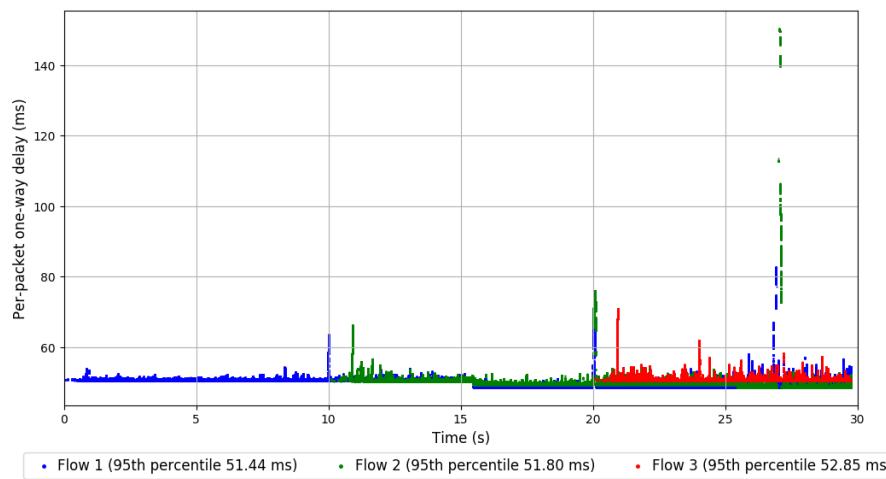
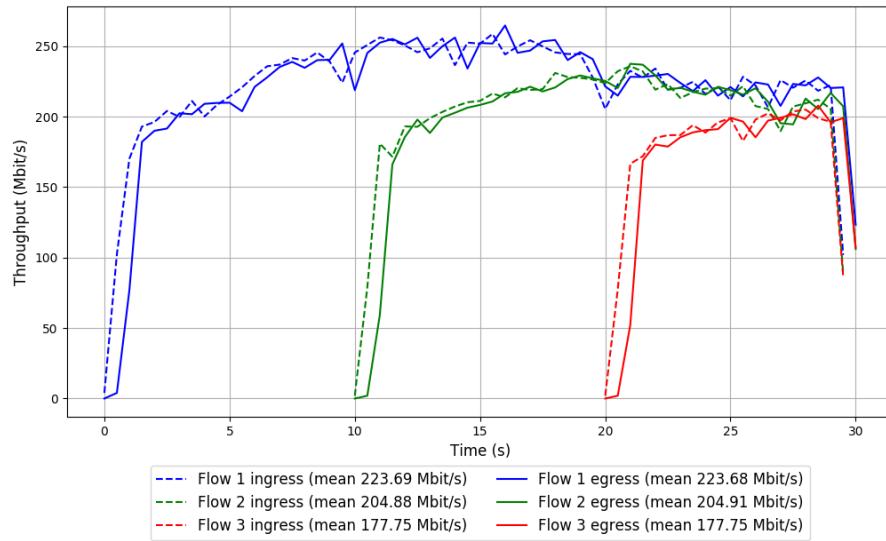


Run 3: Statistics of Indigo

```
Start at: 2018-08-28 11:09:30
End at: 2018-08-28 11:10:00
Local clock offset: 0.017 ms
Remote clock offset: -0.67 ms

# Below is generated by plot.py at 2018-08-28 11:37:53
# Datalink statistics
-- Total of 3 flows:
Average throughput: 416.83 Mbit/s
95th percentile per-packet one-way delay: 51.784 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 223.68 Mbit/s
95th percentile per-packet one-way delay: 51.443 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 204.91 Mbit/s
95th percentile per-packet one-way delay: 51.796 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 177.75 Mbit/s
95th percentile per-packet one-way delay: 52.846 ms
Loss rate: 0.00%
```

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

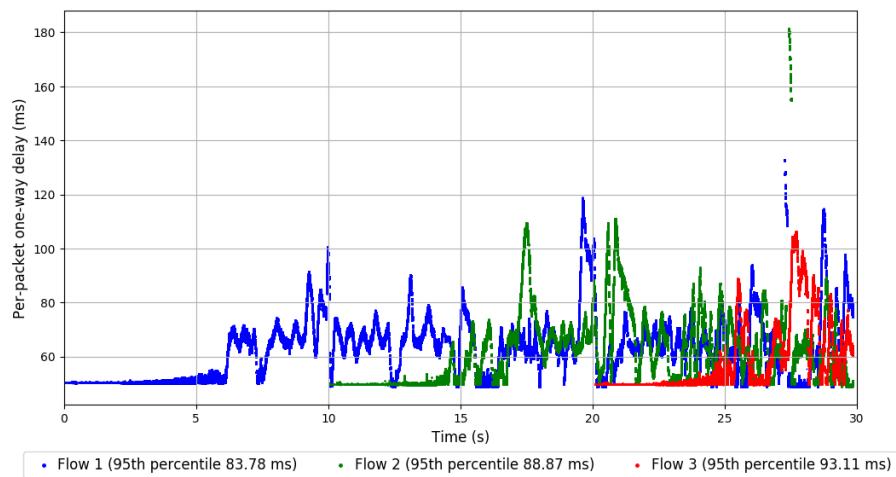
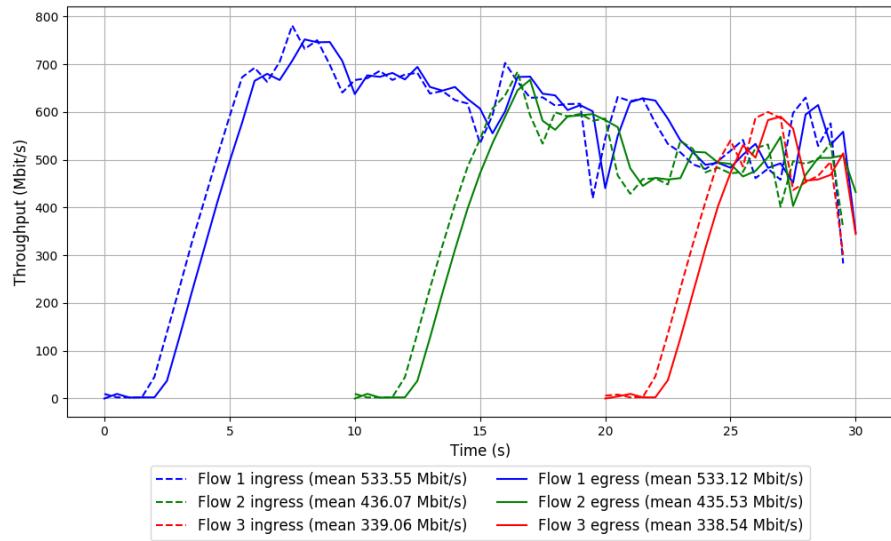


Run 1: Statistics of Muses

```
Start at: 2018-08-28 10:55:47
End at: 2018-08-28 10:56:17
Local clock offset: -0.178 ms
Remote clock offset: -0.528 ms

# Below is generated by plot.py at 2018-08-28 11:41:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 933.09 Mbit/s
95th percentile per-packet one-way delay: 87.345 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 533.12 Mbit/s
95th percentile per-packet one-way delay: 83.781 ms
Loss rate: 0.07%
-- Flow 2:
Average throughput: 435.53 Mbit/s
95th percentile per-packet one-way delay: 88.866 ms
Loss rate: 0.13%
-- Flow 3:
Average throughput: 338.54 Mbit/s
95th percentile per-packet one-way delay: 93.109 ms
Loss rate: 0.12%
```

## Run 1: Report of Muses — Data Link

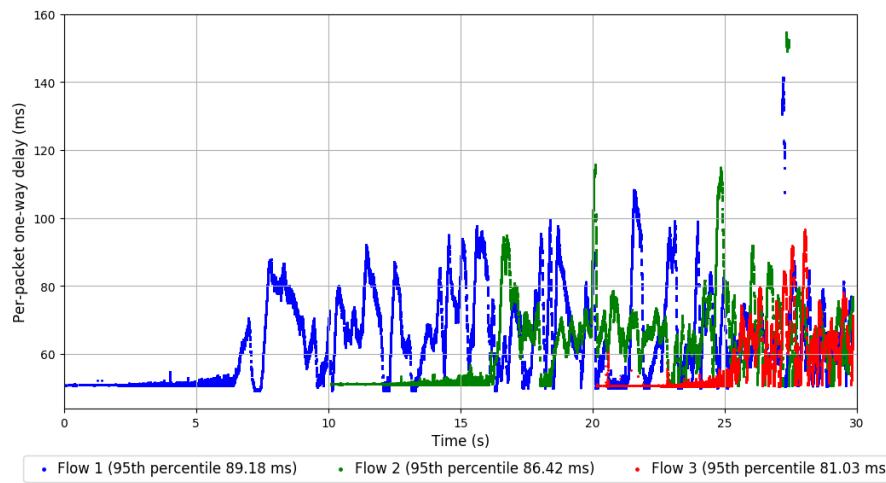
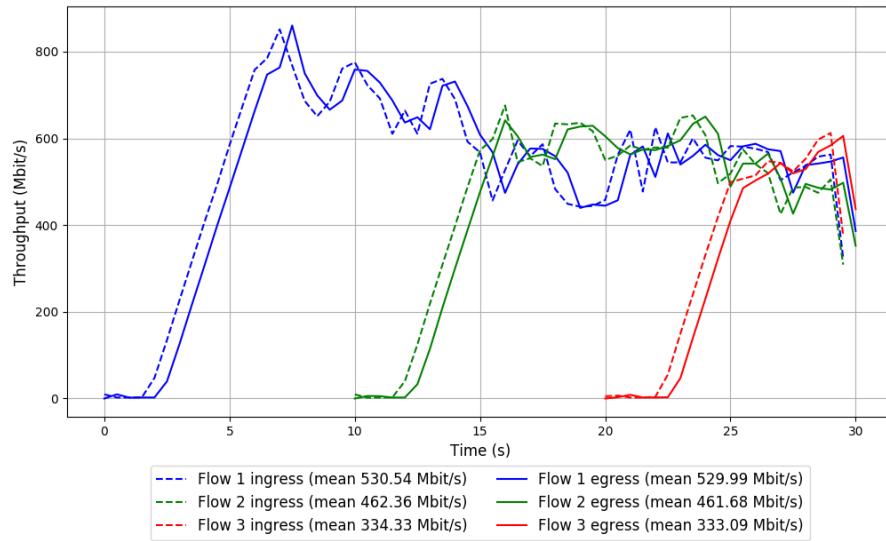


Run 2: Statistics of Muses

```
Start at: 2018-08-28 11:03:29
End at: 2018-08-28 11:03:59
Local clock offset: -0.555 ms
Remote clock offset: -0.612 ms

# Below is generated by plot.py at 2018-08-28 11:41:31
# Datalink statistics
-- Total of 3 flows:
Average throughput: 944.34 Mbit/s
95th percentile per-packet one-way delay: 87.598 ms
Loss rate: 0.15%
-- Flow 1:
Average throughput: 529.99 Mbit/s
95th percentile per-packet one-way delay: 89.184 ms
Loss rate: 0.10%
-- Flow 2:
Average throughput: 461.68 Mbit/s
95th percentile per-packet one-way delay: 86.417 ms
Loss rate: 0.14%
-- Flow 3:
Average throughput: 333.09 Mbit/s
95th percentile per-packet one-way delay: 81.033 ms
Loss rate: 0.43%
```

## Run 2: Report of Muses — Data Link



Run 3: Statistics of Muses

```
Start at: 2018-08-28 11:11:15
End at: 2018-08-28 11:11:45
Local clock offset: -1.215 ms
Remote clock offset: -0.627 ms

# Below is generated by plot.py at 2018-08-28 11:41:50
# Datalink statistics
-- Total of 3 flows:
Average throughput: 927.18 Mbit/s
95th percentile per-packet one-way delay: 80.926 ms
Loss rate: 0.05%
-- Flow 1:
Average throughput: 504.95 Mbit/s
95th percentile per-packet one-way delay: 81.750 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 469.94 Mbit/s
95th percentile per-packet one-way delay: 77.797 ms
Loss rate: 0.07%
-- Flow 3:
Average throughput: 338.26 Mbit/s
95th percentile per-packet one-way delay: 85.580 ms
Loss rate: 0.00%
```

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

