Pantheon Report

Generated at 2018-08-28 10:21:58 (UTC).

Data path: India on em1 (*remote*) →AWS India 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.

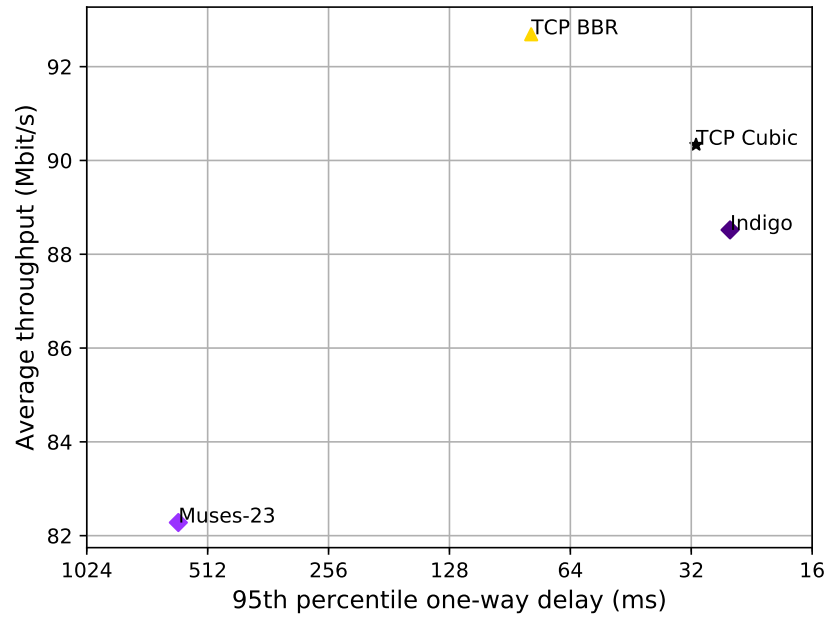NTP offsets were measured against nets.org.sg and have been applied to correct the timestamps in logs.

```
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

Git summary:
branch: muses-23 @ 88af05c5b0b7531637ca401951507a2fde628df6
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
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
```
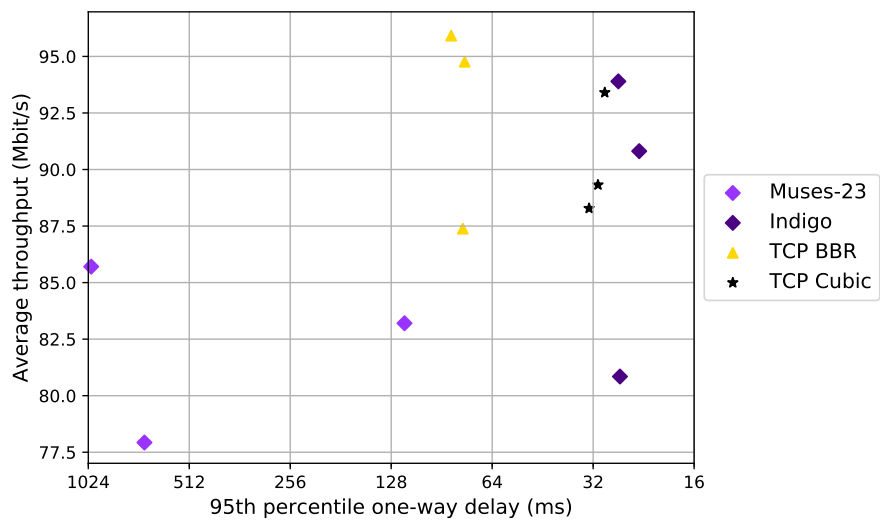
test from India to AWS India 1, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

test from India to AWS India 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	54.27	40.58	34.40	60.00	91.74	129.19	3.85	4.59	4.72
TCP Cubic	3	53.11	40.25	31.45	29.70	31.98	46.11	0.08	0.16	0.61
Indigo	3	52.46	36.38	36.21	24.38	26.89	29.44	0.05	0.14	0.35
Muses-23	3	48.90	36.29	28.66	107.92	114.99	1289.02	0.16	0.34	1.55

```
Run 1: Statistics of TCP BBR

Start at: 2018-08-28 10:06:45
End at: 2018-08-28 10:07:15
Local clock offset: -0.872 ms
Remote clock offset: -1.93 ms


# Below is generated by plot.py at 2018-08-28 10:21:15
# Datalink statistics
-- Total of 3 flows:
Average throughput: 87.39 Mbit/s
95th percentile per-packet one-way delay: 78.286 ms
Loss rate: 4.82%
-- Flow 1:
Average throughput: 52.56 Mbit/s
95th percentile per-packet one-way delay: 61.943 ms
Loss rate: 4.29%
-- Flow 2:
Average throughput: 37.40 Mbit/s
95th percentile per-packet one-way delay: 101.135 ms
Loss rate: 5.59%
-- Flow 3:
Average throughput: 29.95 Mbit/s
95th percentile per-packet one-way delay: 102.480 ms
Loss rate: 5.71%
```
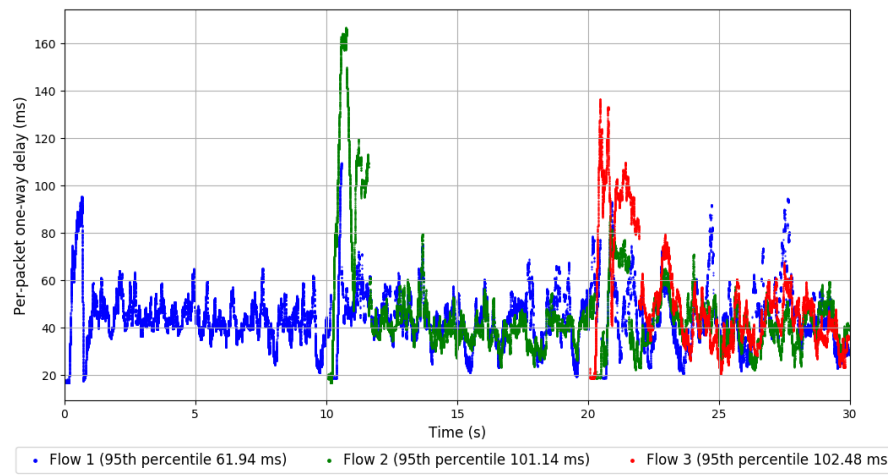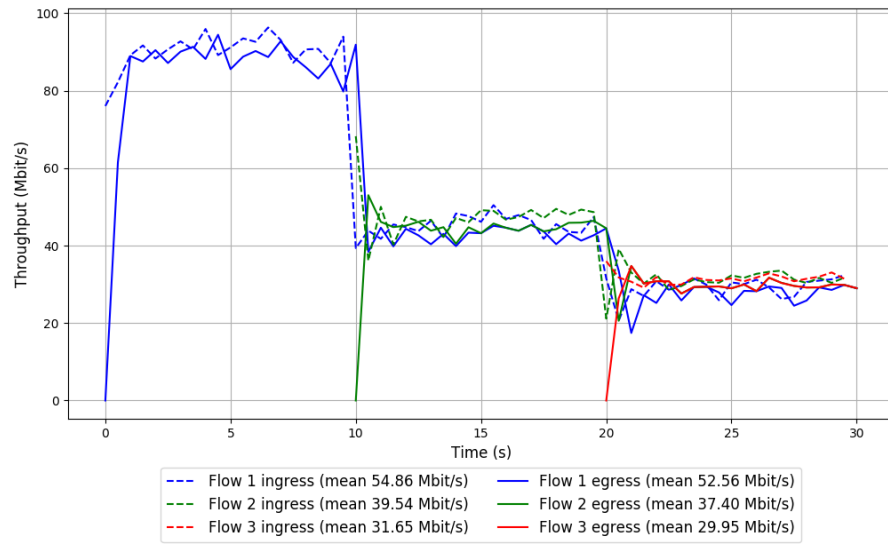
Run 1: Report of TCP BBR — Data Link

- - - - Flow 1 ingress (mean 54.86 Mbit/s)   ——— Flow 1 egress (mean 52.56 Mbit/s)
- - - - Flow 2 ingress (mean 39.54 Mbit/s)   ——— Flow 2 egress (mean 37.40 Mbit/s)
- - - - Flow 3 ingress (mean 31.65 Mbit/s)   ——— Flow 3 egress (mean 29.95 Mbit/s)

• Flow 1 (95th percentile 61.94 ms)   • Flow 2 (95th percentile 101.14 ms)   • Flow 3 (95th percentile 102.48 ms)
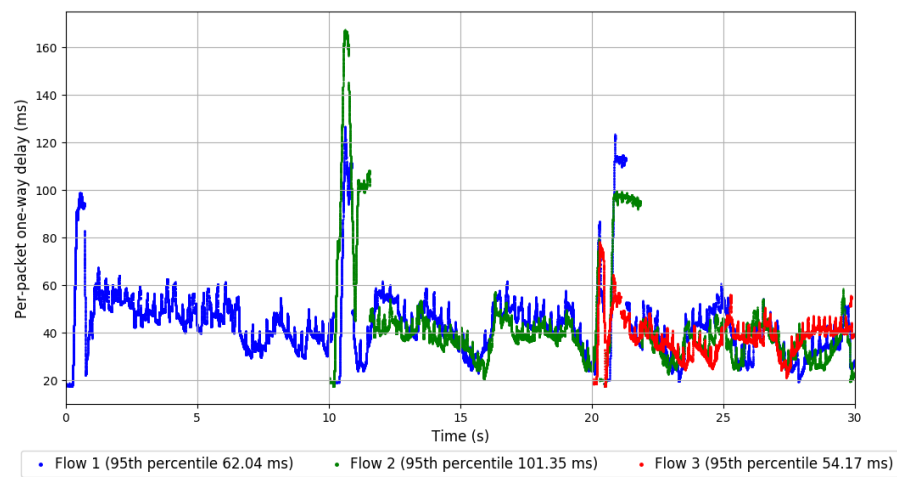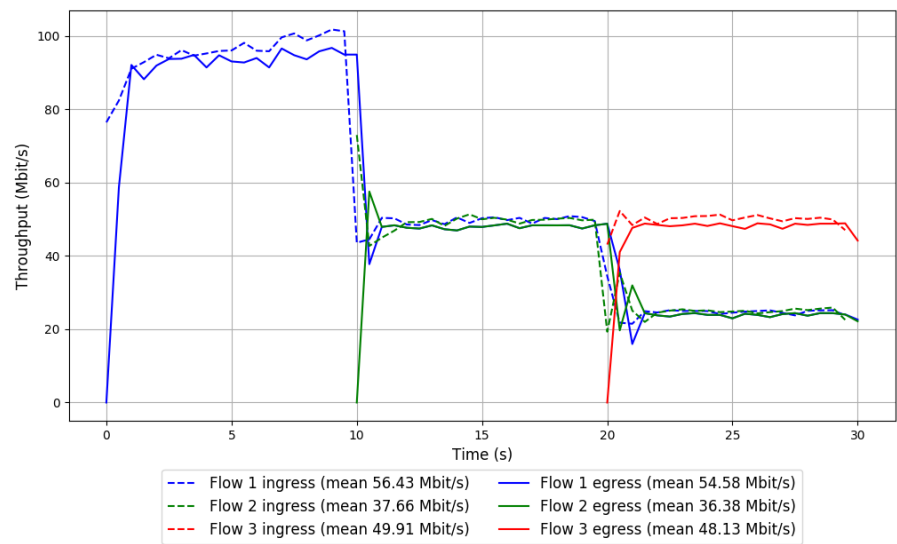
```
Run 2: Statistics of TCP BBR

Start at: 2018-08-28 10:11:44
End at: 2018-08-28 10:12:14
Local clock offset: 0.126 ms
Remote clock offset: -2.091 ms


# Below is generated by plot.py at 2018-08-28 10:21:21
# Datalink statistics
-- Total of 3 flows:
Average throughput: 94.76 Mbit/s
95th percentile per-packet one-way delay: 77.271 ms
Loss rate: 3.52%
-- Flow 1:
Average throughput: 54.58 Mbit/s
95th percentile per-packet one-way delay: 62.038 ms
Loss rate: 3.38%
-- Flow 2:
Average throughput: 36.38 Mbit/s
95th percentile per-packet one-way delay: 101.351 ms
Loss rate: 3.57%
-- Flow 3:
Average throughput: 48.13 Mbit/s
95th percentile per-packet one-way delay: 54.167 ms
Loss rate: 3.90%
```

Run 2: Report of TCP BBR — Data Link

- - - Flow 1 ingress (mean 56.43 Mbit/s)   —— Flow 1 egress (mean 54.58 Mbit/s)
- - - Flow 2 ingress (mean 37.66 Mbit/s)   —— Flow 2 egress (mean 36.38 Mbit/s)
- - - Flow 3 ingress (mean 49.91 Mbit/s)   —— Flow 3 egress (mean 48.13 Mbit/s)

• Flow 1 (95th percentile 62.04 ms)   • Flow 2 (95th percentile 101.35 ms)   • Flow 3 (95th percentile 54.17 ms)
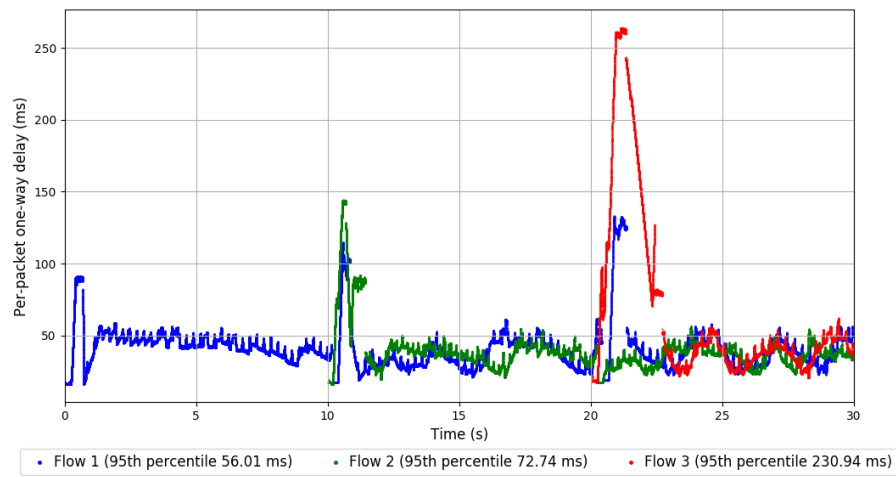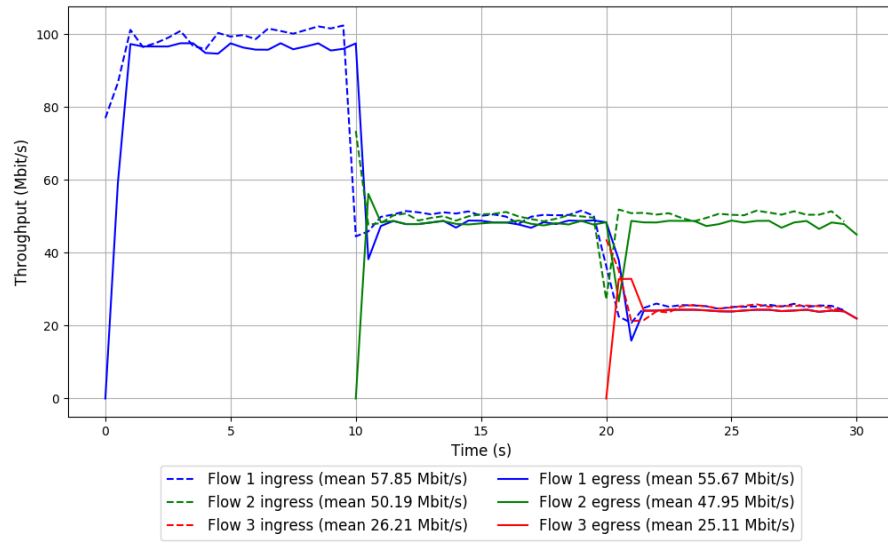
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```
Run 3: Statistics of TCP BBR

Start at: 2018-08-28 10:16:43
End at: 2018-08-28 10:17:13
Local clock offset: -0.402 ms
Remote clock offset: -1.442 ms


# Below is generated by plot.py at 2018-08-28 10:21:22
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.92 Mbit/s
95th percentile per-packet one-way delay: 84.788 ms
Loss rate: 4.18%
-- Flow 1:
Average throughput: 55.67 Mbit/s
95th percentile per-packet one-way delay: 56.007 ms
Loss rate: 3.87%
-- Flow 2:
Average throughput: 47.95 Mbit/s
95th percentile per-packet one-way delay: 72.744 ms
Loss rate: 4.62%
-- Flow 3:
Average throughput: 25.11 Mbit/s
95th percentile per-packet one-way delay: 230.936 ms
Loss rate: 4.55%
```

Run 3: Report of TCP BBR — Data Link

- - - Flow 1 ingress (mean 57.85 Mbit/s) —— Flow 1 egress (mean 55.67 Mbit/s)
- - - Flow 2 ingress (mean 50.19 Mbit/s) —— Flow 2 egress (mean 47.95 Mbit/s)
- - - Flow 3 ingress (mean 26.21 Mbit/s) —— Flow 3 egress (mean 25.11 Mbit/s)

• Flow 1 (95th percentile 56.01 ms)   • Flow 2 (95th percentile 72.74 ms)   • Flow 3 (95th percentile 230.94 ms)
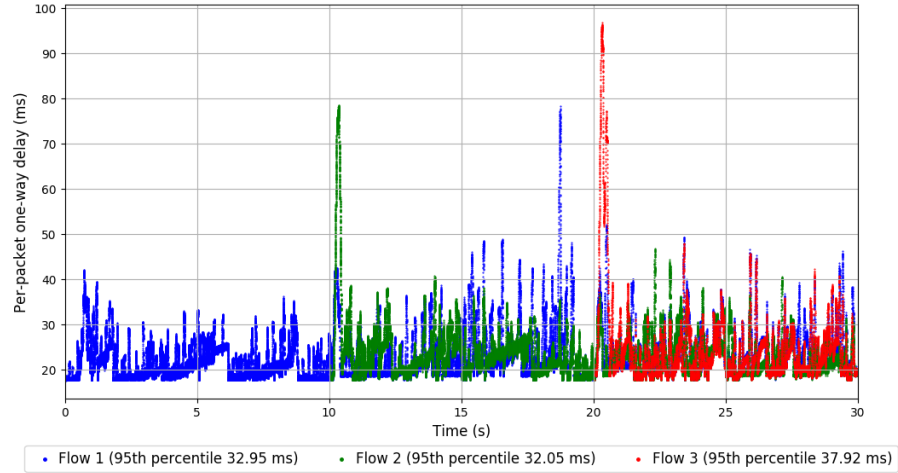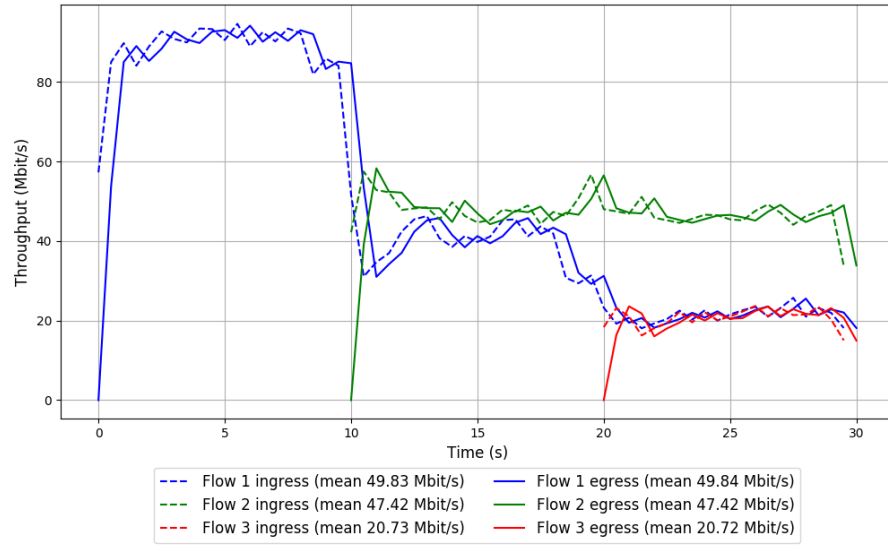
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```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-28 10:05:31
End at: 2018-08-28 10:06:01
Local clock offset: 0.21 ms
Remote clock offset: -1.745 ms


# Below is generated by plot.py at 2018-08-28 10:21:22
# Datalink statistics
-- Total of 3 flows:
Average throughput: 88.28 Mbit/s
95th percentile per-packet one-way delay: 32.895 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 49.84 Mbit/s
95th percentile per-packet one-way delay: 32.948 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 47.42 Mbit/s
95th percentile per-packet one-way delay: 32.053 ms
Loss rate: 0.13%
-- Flow 3:
Average throughput: 20.72 Mbit/s
95th percentile per-packet one-way delay: 37.923 ms
Loss rate: 0.32%
```

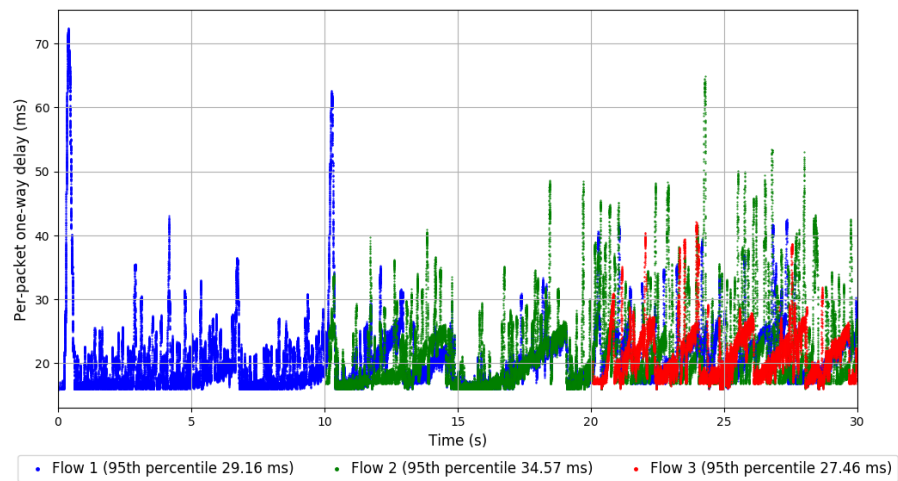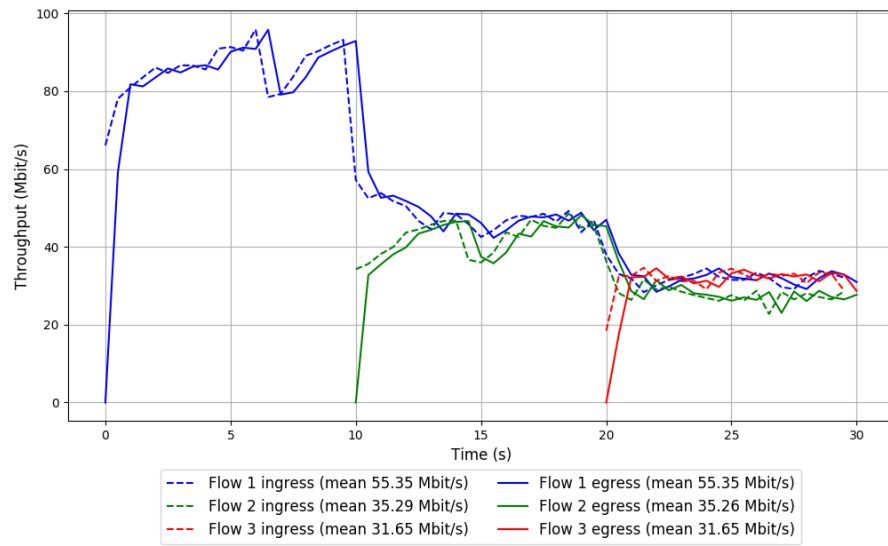Run 1: Report of TCP Cubic — Data Link

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Run 2: Statistics of TCP Cubic

Start at: 2018-08-28 10:10:32
End at: 2018-08-28 10:11:02
Local clock offset: -0.371 ms
Remote clock offset: -0.839 ms


# Below is generated by plot.py at 2018-08-28 10:21:22
# Datalink statistics
-- Total of 3 flows:
Average throughput: 89.32 Mbit/s
95th percentile per-packet one-way delay: 30.959 ms
Loss rate: 0.15%
-- Flow 1:
Average throughput: 55.35 Mbit/s
95th percentile per-packet one-way delay: 29.156 ms
Loss rate: 0.10%
-- Flow 2:
Average throughput: 35.26 Mbit/s
95th percentile per-packet one-way delay: 34.570 ms
Loss rate: 0.21%
-- Flow 3:
Average throughput: 31.65 Mbit/s
95th percentile per-packet one-way delay: 27.457 ms
Loss rate: 0.29%
```

Run 2: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 55.35 Mbit/s) --- Flow 1 egress (mean 55.35 Mbit/s) ---
Flow 2 ingress (mean 35.29 Mbit/s) --- Flow 2 egress (mean 35.26 Mbit/s) ---
Flow 3 ingress (mean 31.65 Mbit/s) --- Flow 3 egress (mean 31.65 Mbit/s) ---

Flow 1 (95th percentile 29.16 ms) • Flow 2 (95th percentile 34.57 ms) • Flow 3 (95th percentile 27.46 ms)

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```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-28 10:15:31
End at: 2018-08-28 10:16:01
Local clock offset: 0.23 ms
Remote clock offset: -1.51 ms


# Below is generated by plot.py at 2018-08-28 10:21:22
# Datalink statistics
-- Total of 3 flows:
Average throughput: 93.40 Mbit/s
95th percentile per-packet one-way delay: 29.546 ms
Loss rate: 0.26%
-- Flow 1:
Average throughput: 54.13 Mbit/s
95th percentile per-packet one-way delay: 26.993 ms
Loss rate: 0.08%
-- Flow 2:
Average throughput: 38.08 Mbit/s
95th percentile per-packet one-way delay: 29.324 ms
Loss rate: 0.14%
-- Flow 3:
Average throughput: 41.97 Mbit/s
95th percentile per-packet one-way delay: 72.951 ms
Loss rate: 1.21%
```
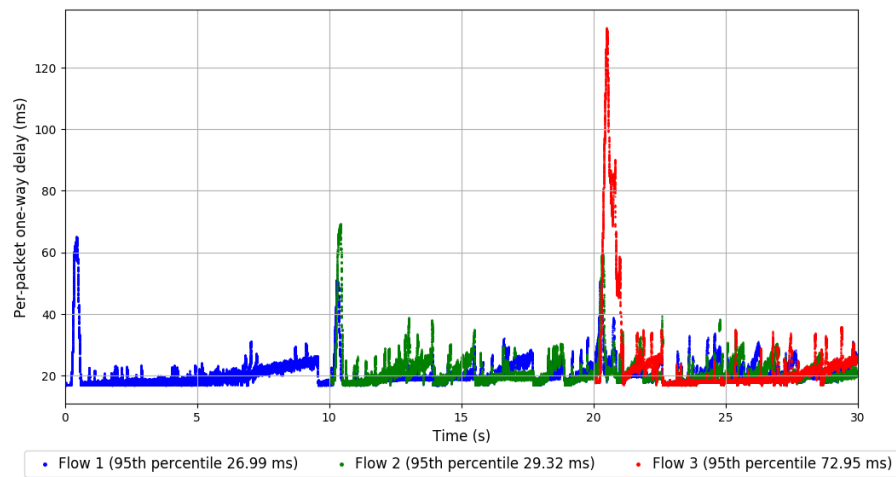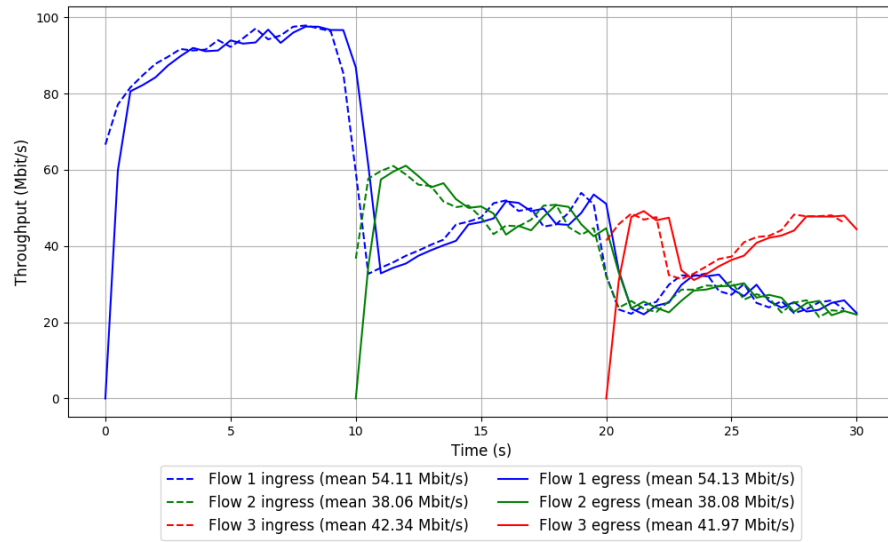
Run 3: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 54.11 Mbit/s) --- Flow 1 egress (mean 54.13 Mbit/s)
Flow 2 ingress (mean 38.06 Mbit/s) --- Flow 2 egress (mean 38.08 Mbit/s)
Flow 3 ingress (mean 42.34 Mbit/s) --- Flow 3 egress (mean 41.97 Mbit/s)

Flow 1 (95th percentile 26.99 ms)   Flow 2 (95th percentile 29.32 ms)   Flow 3 (95th percentile 72.95 ms)
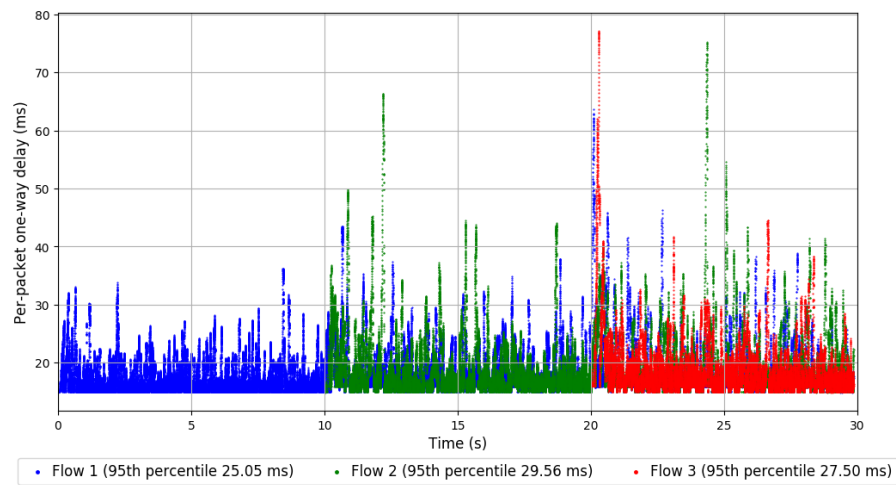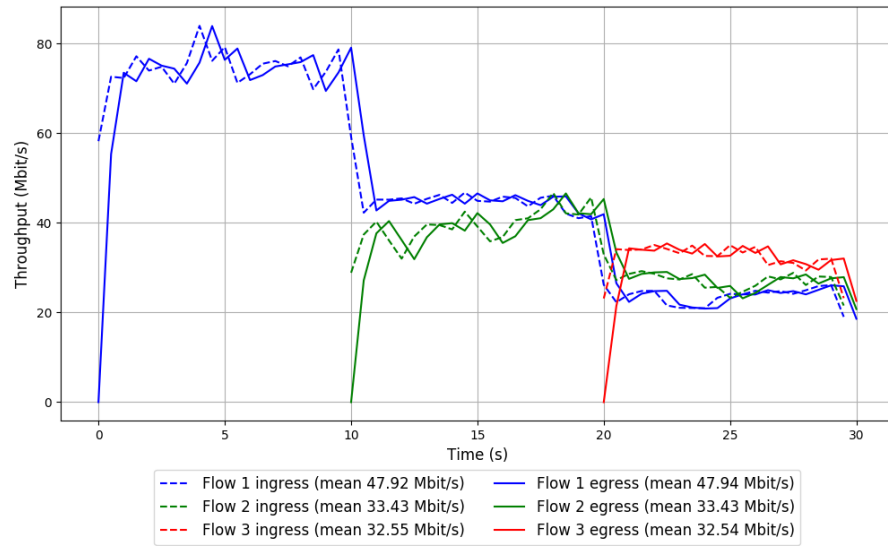
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```
Run 1: Statistics of Indigo

Start at: 2018-08-28 10:08:00
End at: 2018-08-28 10:08:30
Local clock offset: -1.423 ms
Remote clock offset: -0.502 ms


# Below is generated by plot.py at 2018-08-28 10:21:22
# Datalink statistics
-- Total of 3 flows:
Average throughput: 80.85 Mbit/s
95th percentile per-packet one-way delay: 26.618 ms
Loss rate: 0.11%
-- Flow 1:
Average throughput: 47.94 Mbit/s
95th percentile per-packet one-way delay: 25.049 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 33.43 Mbit/s
95th percentile per-packet one-way delay: 29.556 ms
Loss rate: 0.16%
-- Flow 3:
Average throughput: 32.54 Mbit/s
95th percentile per-packet one-way delay: 27.505 ms
Loss rate: 0.28%
```
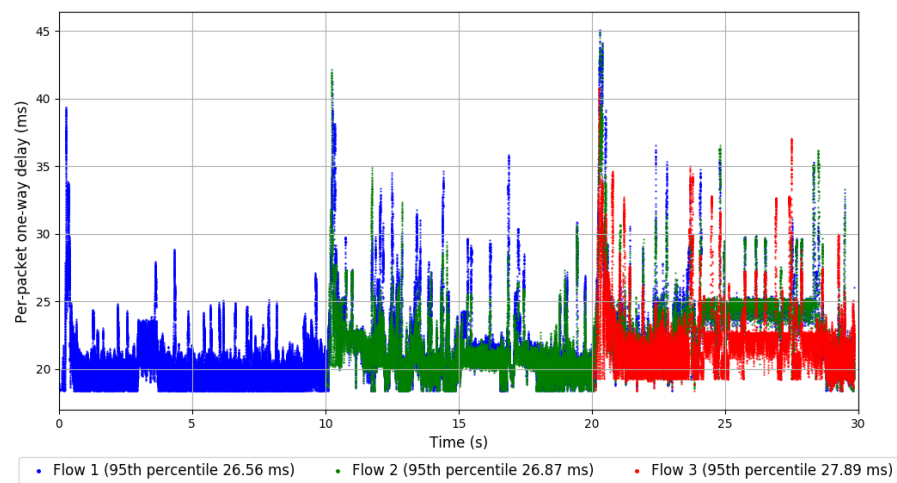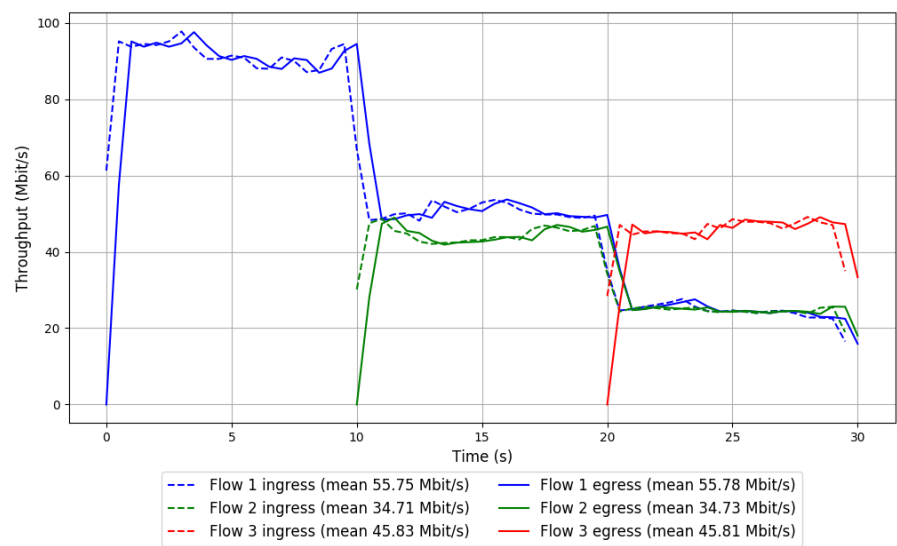
Run 1: Report of Indigo — Data Link

```
Run 2: Statistics of Indigo

Start at: 2018-08-28 10:12:59
End at: 2018-08-28 10:13:29
Local clock offset: 1.498 ms
Remote clock offset: -1.586 ms


# Below is generated by plot.py at 2018-08-28 10:21:22
# Datalink statistics
-- Total of 3 flows:
Average throughput: 93.90 Mbit/s
95th percentile per-packet one-way delay: 26.914 ms
Loss rate: 0.13%
-- Flow 1:
Average throughput: 55.78 Mbit/s
95th percentile per-packet one-way delay: 26.558 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 34.73 Mbit/s
95th percentile per-packet one-way delay: 26.872 ms
Loss rate: 0.14%
-- Flow 3:
Average throughput: 45.81 Mbit/s
95th percentile per-packet one-way delay: 27.892 ms
Loss rate: 0.40%
```

Run 2: Report of Indigo — Data Link

Flow 1 ingress (mean 55.75 Mbit/s) — — — Flow 1 egress (mean 55.78 Mbit/s)
Flow 2 ingress (mean 34.71 Mbit/s) — — — Flow 2 egress (mean 34.73 Mbit/s)
Flow 3 ingress (mean 45.83 Mbit/s) — — — Flow 3 egress (mean 45.81 Mbit/s)

Flow 1 (95th percentile 26.56 ms)   Flow 2 (95th percentile 26.87 ms)   Flow 3 (95th percentile 27.89 ms)
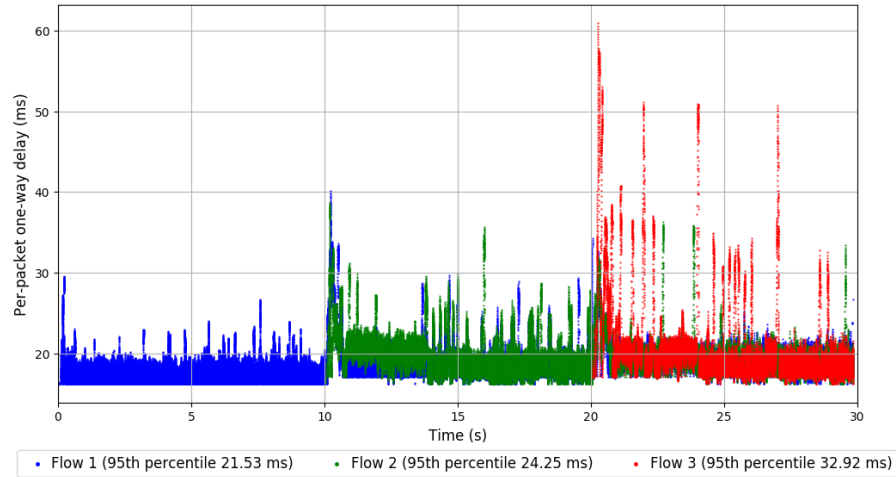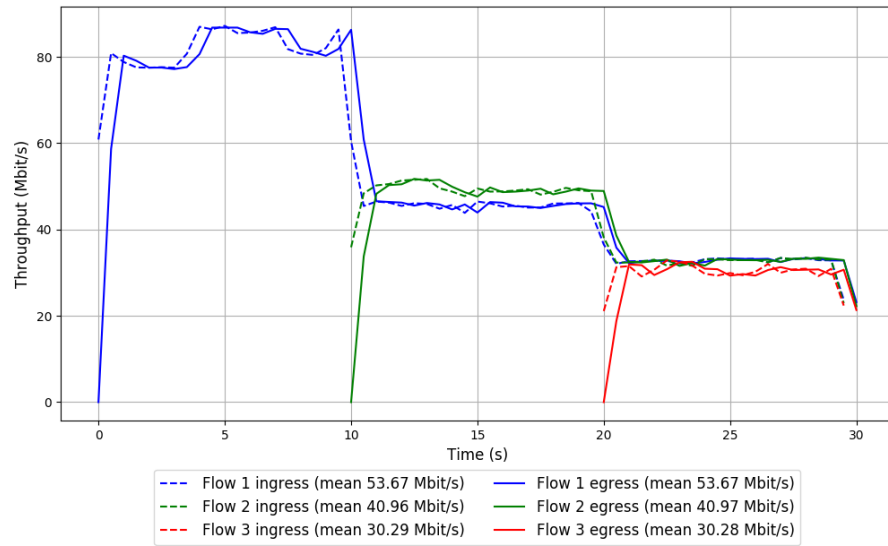
```
Run 3: Statistics of Indigo

Start at: 2018-08-28 10:17:59
End at: 2018-08-28 10:18:29
Local clock offset: -0.559 ms
Remote clock offset: -1.753 ms


# Below is generated by plot.py at 2018-08-28 10:21:46
# Datalink statistics
-- Total of 3 flows:
Average throughput: 90.81 Mbit/s
95th percentile per-packet one-way delay: 23.325 ms
Loss rate: 0.11%
-- Flow 1:
Average throughput: 53.67 Mbit/s
95th percentile per-packet one-way delay: 21.531 ms
Loss rate: 0.06%
-- Flow 2:
Average throughput: 40.97 Mbit/s
95th percentile per-packet one-way delay: 24.245 ms
Loss rate: 0.12%
-- Flow 3:
Average throughput: 30.28 Mbit/s
95th percentile per-packet one-way delay: 32.925 ms
Loss rate: 0.38%
```

Run 3: Report of Indigo — Data Link

Flow 1 ingress (mean 53.67 Mbit/s) --- Flow 1 egress (mean 53.67 Mbit/s)
Flow 2 ingress (mean 40.96 Mbit/s) --- Flow 2 egress (mean 40.97 Mbit/s)
Flow 3 ingress (mean 30.29 Mbit/s) --- Flow 3 egress (mean 30.28 Mbit/s)

Flow 1 (95th percentile 21.53 ms)   Flow 2 (95th percentile 24.25 ms)   Flow 3 (95th percentile 32.92 ms)
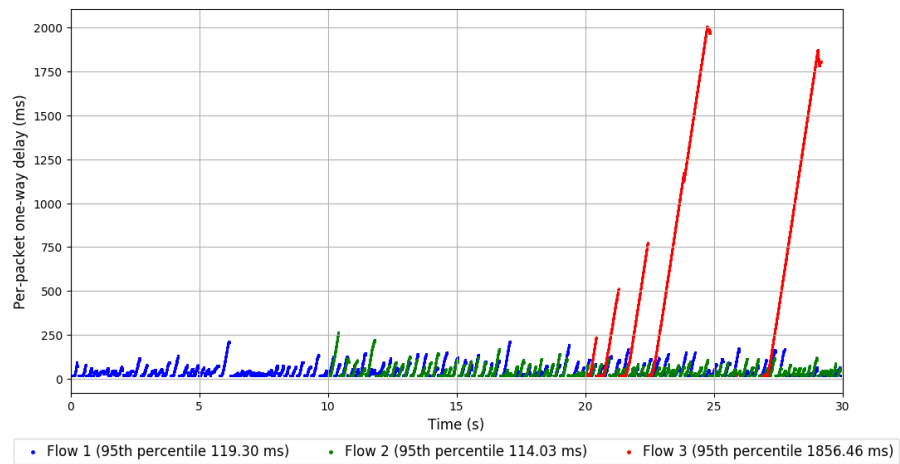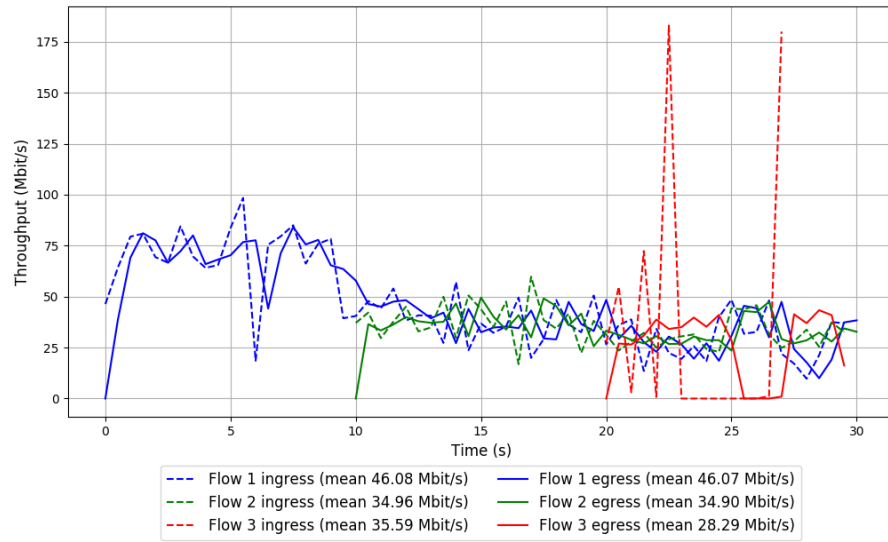
```
Run 1: Statistics of Muses-23

Start at: 2018-08-28 10:09:15
End at: 2018-08-28 10:09:45
Local clock offset: 0.818 ms
Remote clock offset: -1.365 ms

# Below is generated by plot.py at 2018-08-28 10:21:54
# Datalink statistics
-- Total of 3 flows:
Average throughput: 77.93 Mbit/s
95th percentile per-packet one-way delay: 696.514 ms
Loss rate: 0.27%
-- Flow 1:
Average throughput: 46.07 Mbit/s
95th percentile per-packet one-way delay: 119.303 ms
Loss rate: 0.09%
-- Flow 2:
Average throughput: 34.90 Mbit/s
95th percentile per-packet one-way delay: 114.031 ms
Loss rate: 0.30%
-- Flow 3:
Average throughput: 28.29 Mbit/s
95th percentile per-packet one-way delay: 1856.463 ms
Loss rate: 1.13%
```

Run 1: Report of Muses-23 — Data Link

Flow 1 ingress (mean 46.08 Mbit/s) --- Flow 1 egress (mean 46.07 Mbit/s) ---
Flow 2 ingress (mean 34.96 Mbit/s) --- Flow 2 egress (mean 34.90 Mbit/s) ---
Flow 3 ingress (mean 35.59 Mbit/s) --- Flow 3 egress (mean 28.29 Mbit/s) ---

Flow 1 (95th percentile 119.30 ms) • Flow 2 (95th percentile 114.03 ms) • Flow 3 (95th percentile 1856.46 ms)

```
Run 2: Statistics of Muses-23

Start at: 2018-08-28 10:14:16
End at: 2018-08-28 10:14:46
Local clock offset: 0.129 ms
Remote clock offset: -1.27 ms


# Below is generated by plot.py at 2018-08-28 10:21:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 85.71 Mbit/s
95th percentile per-packet one-way delay: 1003.810 ms
Loss rate: 0.39%
-- Flow 1:
Average throughput: 51.14 Mbit/s
95th percentile per-packet one-way delay: 93.214 ms
Loss rate: 0.13%
-- Flow 2:
Average throughput: 37.20 Mbit/s
95th percentile per-packet one-way delay: 123.670 ms
Loss rate: 0.22%
-- Flow 3:
Average throughput: 29.69 Mbit/s
95th percentile per-packet one-way delay: 1858.842 ms
Loss rate: 2.16%
```
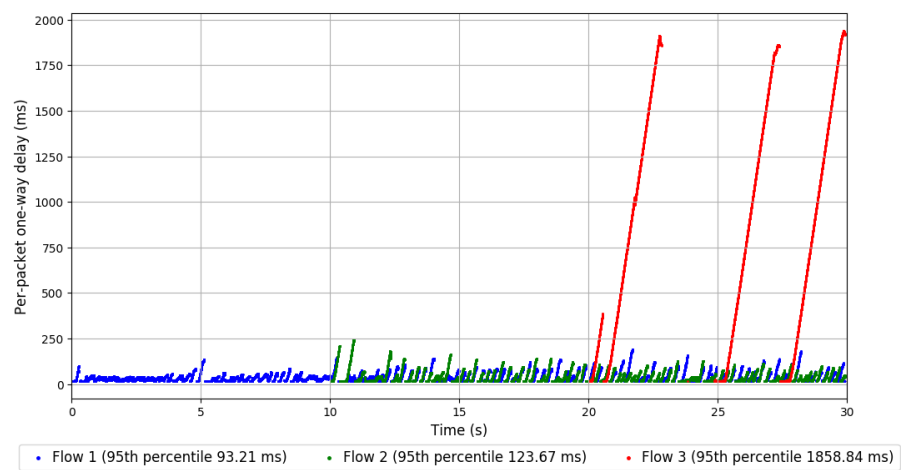
Run 2: Report of Muses-23 — Data Link

Flow 1 ingress (mean 51.15 Mbit/s) --- Flow 1 egress (mean 51.14 Mbit/s)
Flow 2 ingress (mean 37.24 Mbit/s) --- Flow 2 egress (mean 37.20 Mbit/s)
Flow 3 ingress (mean 37.28 Mbit/s) --- Flow 3 egress (mean 29.69 Mbit/s)

Flow 1 (95th percentile 93.21 ms)   Flow 2 (95th percentile 123.67 ms)   Flow 3 (95th percentile 1858.84 ms)

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```
Run 3: Statistics of Muses-23

Start at: 2018-08-28 10:19:13
End at: 2018-08-28 10:19:43
Local clock offset: 0.904 ms
Remote clock offset: -1.651 ms


# Below is generated by plot.py at 2018-08-28 10:21:56
# Datalink statistics
-- Total of 3 flows:
Average throughput: 83.20 Mbit/s
95th percentile per-packet one-way delay: 116.824 ms
Loss rate: 0.45%
-- Flow 1:
Average throughput: 49.48 Mbit/s
95th percentile per-packet one-way delay: 111.228 ms
Loss rate: 0.25%
-- Flow 2:
Average throughput: 36.78 Mbit/s
95th percentile per-packet one-way delay: 107.279 ms
Loss rate: 0.50%
-- Flow 3:
Average throughput: 28.00 Mbit/s
95th percentile per-packet one-way delay: 151.747 ms
Loss rate: 1.37%
```
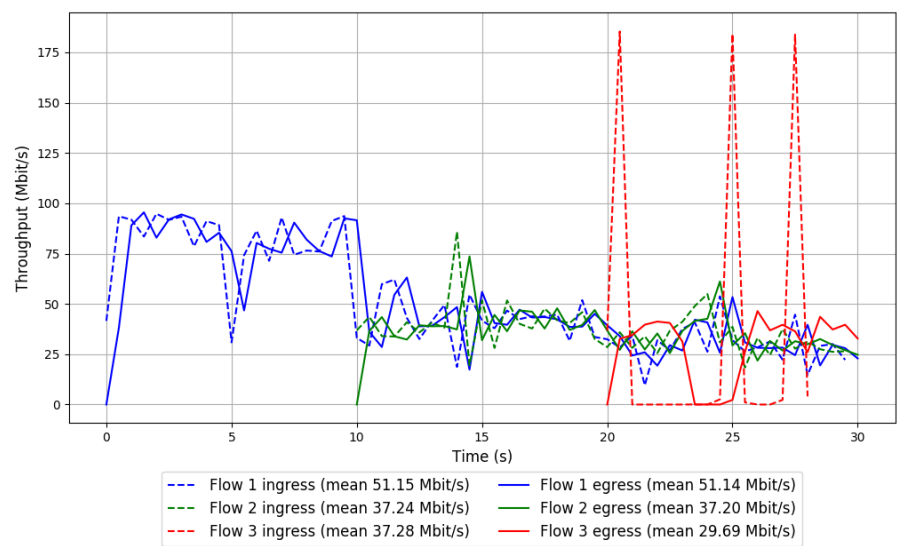
Run 3: Report of Muses-23 — Data Link

Flow 1 ingress (mean 49.54 Mbit/s) — Flow 1 egress (mean 49.48 Mbit/s)
Flow 2 ingress (mean 36.92 Mbit/s) — Flow 2 egress (mean 36.78 Mbit/s)
Flow 3 ingress (mean 28.30 Mbit/s) — Flow 3 egress (mean 28.00 Mbit/s)

Flow 1 (95th percentile 111.23 ms)   Flow 2 (95th percentile 107.28 ms)   Flow 3 (95th percentile 151.75 ms)