Pantheon Report

Generated at 2018-08-31 05:54:18 (UTC).

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

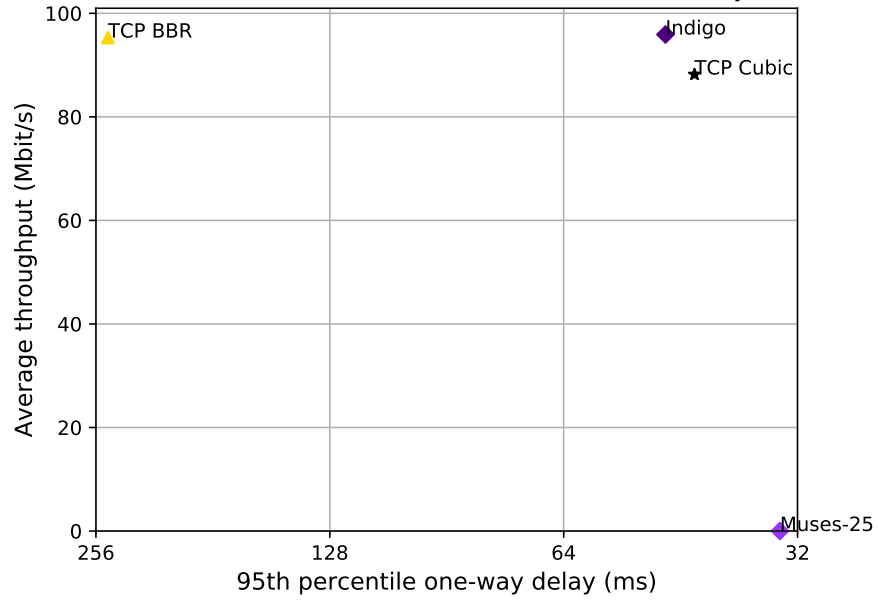NTP offsets were measured against `time.stanford.edu` and have been applied to correct the timestamps in logs.

```
System info:
Linux 4.15.0-1020-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 @ 2de97ca91a065473c29a25fffe63fb137c97a67c
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
```
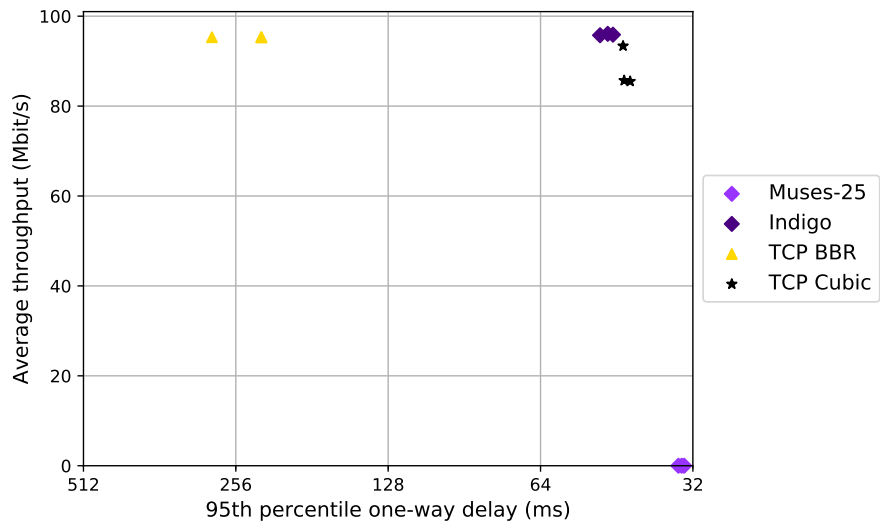
test from Mexico to AWS California 2, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

test from Mexico to AWS California 2, 3 runs of 30s each per scheme
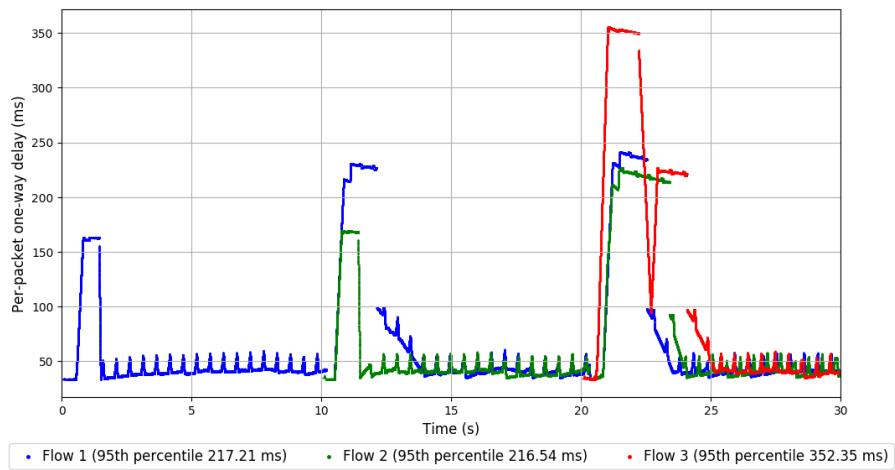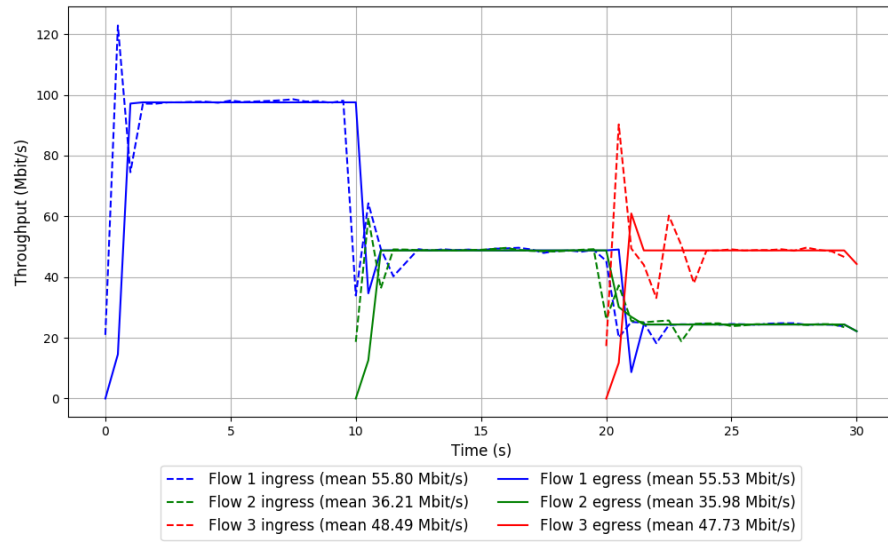3 flows with 10s interval between flows

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	56.39	37.22	42.72	207.80	195.09	415.37	0.97	1.44	2.58
TCP Cubic	3	50.92	38.15	35.89	47.33	41.27	43.66	0.15	0.32	0.66
Indigo	3	57.99	38.94	36.80	48.72	48.09	43.99	0.21	0.41	0.72
Muses-25	3	0.00	0.00	0.00	33.77	33.78	33.68	0.00	0.00	0.00

```
Run 1: Statistics of TCP BBR

Start at: 2018-08-31 05:37:27
End at: 2018-08-31 05:37:57
Local clock offset: -8.979 ms
Remote clock offset: -2.489 ms


# Below is generated by plot.py at 2018-08-31 05:54:12
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.28 Mbit/s
95th percentile per-packet one-way delay: 227.668 ms
Loss rate: 1.02%
-- Flow 1:
Average throughput: 55.53 Mbit/s
95th percentile per-packet one-way delay: 217.208 ms
Loss rate: 0.70%
-- Flow 2:
Average throughput: 35.98 Mbit/s
95th percentile per-packet one-way delay: 216.544 ms
Loss rate: 0.97%
-- Flow 3:
Average throughput: 47.73 Mbit/s
95th percentile per-packet one-way delay: 352.353 ms
Loss rate: 2.20%
```

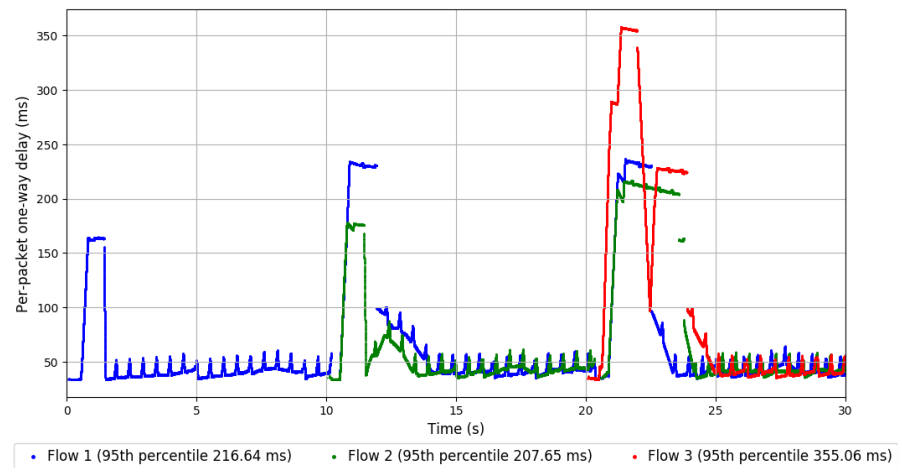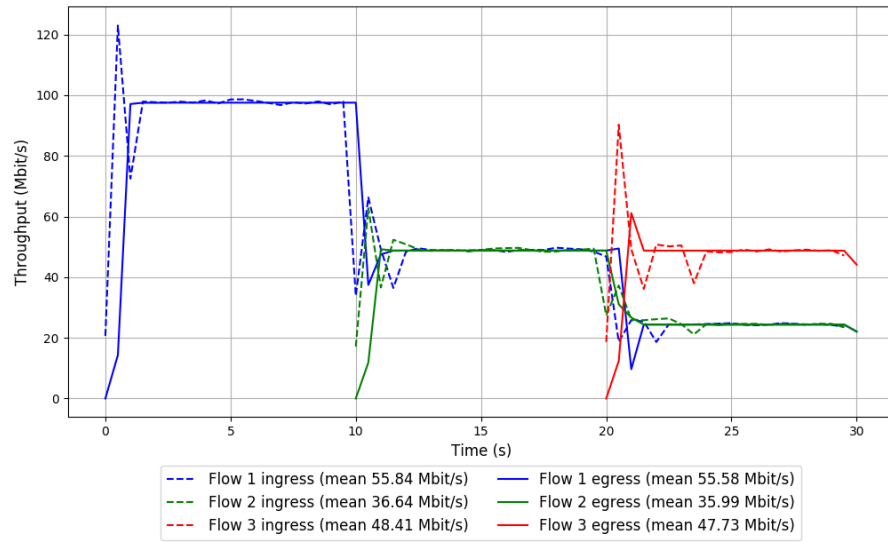Run 1: Report of TCP BBR — Data Link

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```
Run 2: Statistics of TCP BBR

Start at: 2018-08-31 05:42:47
End at: 2018-08-31 05:43:17
Local clock offset: -10.006 ms
Remote clock offset: -2.489 ms


# Below is generated by plot.py at 2018-08-31 05:54:12
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.35 Mbit/s
95th percentile per-packet one-way delay: 228.110 ms
Loss rate: 1.27%
-- Flow 1:
Average throughput: 55.58 Mbit/s
95th percentile per-packet one-way delay: 216.644 ms
Loss rate: 0.69%
-- Flow 2:
Average throughput: 35.99 Mbit/s
95th percentile per-packet one-way delay: 207.651 ms
Loss rate: 2.07%
-- Flow 3:
Average throughput: 47.73 Mbit/s
95th percentile per-packet one-way delay: 355.062 ms
Loss rate: 2.04%
```

Run 2: Report of TCP BBR — Data Link

Flow 1 ingress (mean 55.84 Mbit/s) --- Flow 1 egress (mean 55.58 Mbit/s)
Flow 2 ingress (mean 36.64 Mbit/s) --- Flow 2 egress (mean 35.99 Mbit/s)
Flow 3 ingress (mean 48.41 Mbit/s) --- Flow 3 egress (mean 47.73 Mbit/s)

Flow 1 (95th percentile 216.64 ms) Flow 2 (95th percentile 207.65 ms) Flow 3 (95th percentile 355.06 ms)
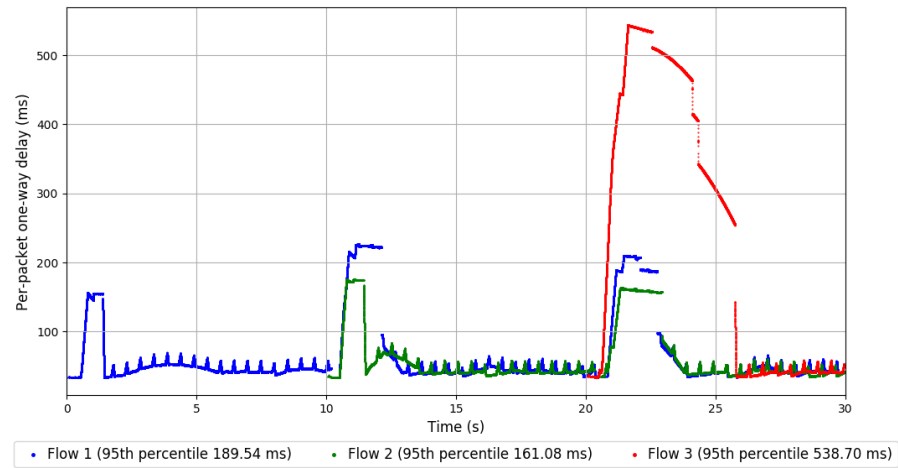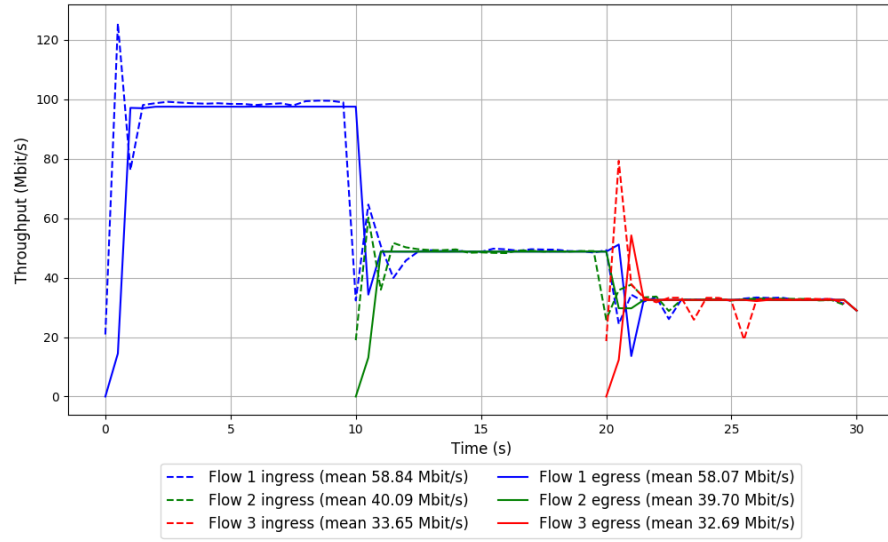
```
Run 3: Statistics of TCP BBR

Start at: 2018-08-31 05:48:09
End at: 2018-08-31 05:48:39
Local clock offset: -9.471 ms
Remote clock offset: -2.427 ms


# Below is generated by plot.py at 2018-08-31 05:54:12
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.32 Mbit/s
95th percentile per-packet one-way delay: 285.388 ms
Loss rate: 1.68%
-- Flow 1:
Average throughput: 58.07 Mbit/s
95th percentile per-packet one-way delay: 189.537 ms
Loss rate: 1.51%
-- Flow 2:
Average throughput: 39.70 Mbit/s
95th percentile per-packet one-way delay: 161.076 ms
Loss rate: 1.29%
-- Flow 3:
Average throughput: 32.69 Mbit/s
95th percentile per-packet one-way delay: 538.699 ms
Loss rate: 3.49%
```

Run 3: Report of TCP BBR — Data Link

- - - Flow 1 ingress (mean 58.84 Mbit/s) —— Flow 1 egress (mean 58.07 Mbit/s)
- - - Flow 2 ingress (mean 40.09 Mbit/s) —— Flow 2 egress (mean 39.70 Mbit/s)
- - - Flow 3 ingress (mean 33.65 Mbit/s) —— Flow 3 egress (mean 32.69 Mbit/s)

• Flow 1 (95th percentile 189.54 ms)   • Flow 2 (95th percentile 161.08 ms)   • Flow 3 (95th percentile 538.70 ms)
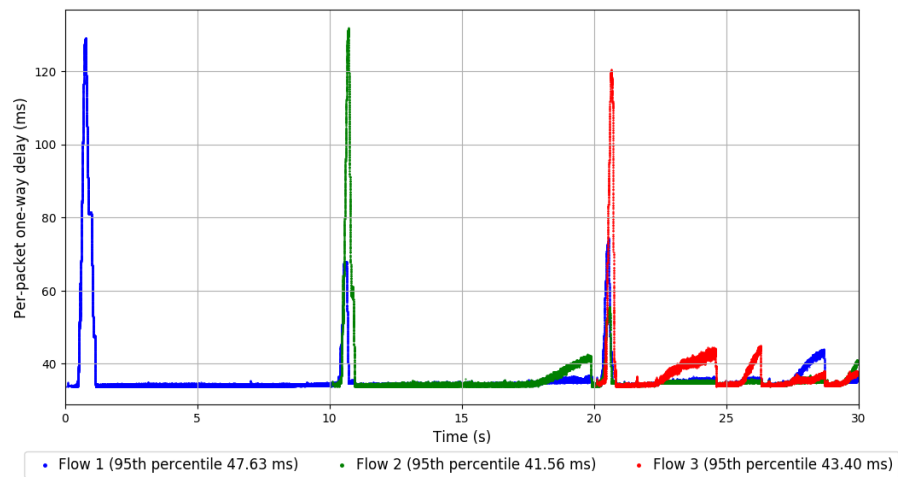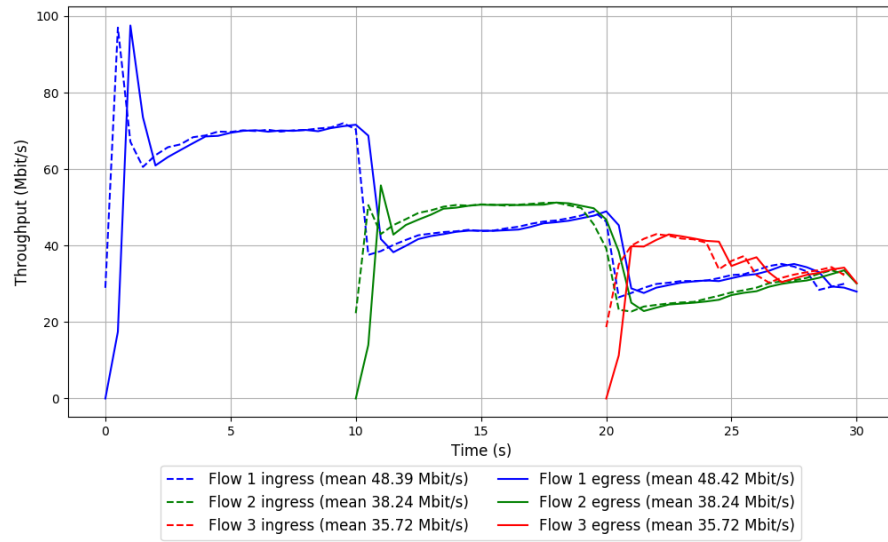
9

```
Run 1: Statistics of TCP Cubic

Start at: 2018-08-31 05:40:10
End at: 2018-08-31 05:40:40
Local clock offset: -9.397 ms
Remote clock offset: -2.614 ms


# Below is generated by plot.py at 2018-08-31 05:54:12
# Datalink statistics
-- Total of 3 flows:
Average throughput: 85.69 Mbit/s
95th percentile per-packet one-way delay: 43.747 ms
Loss rate: 0.28%
-- Flow 1:
Average throughput: 48.42 Mbit/s
95th percentile per-packet one-way delay: 47.631 ms
Loss rate: 0.16%
-- Flow 2:
Average throughput: 38.24 Mbit/s
95th percentile per-packet one-way delay: 41.558 ms
Loss rate: 0.33%
-- Flow 3:
Average throughput: 35.72 Mbit/s
95th percentile per-packet one-way delay: 43.404 ms
Loss rate: 0.65%
```

Run 1: Report of TCP Cubic — Data Link

- - - - Flow 1 ingress (mean 48.39 Mbit/s) —— Flow 1 egress (mean 48.42 Mbit/s)
- - - - Flow 2 ingress (mean 38.24 Mbit/s) —— Flow 2 egress (mean 38.24 Mbit/s)
- - - - Flow 3 ingress (mean 35.72 Mbit/s) —— Flow 3 egress (mean 35.72 Mbit/s)

• Flow 1 (95th percentile 47.63 ms)   • Flow 2 (95th percentile 41.56 ms)   • Flow 3 (95th percentile 43.40 ms)
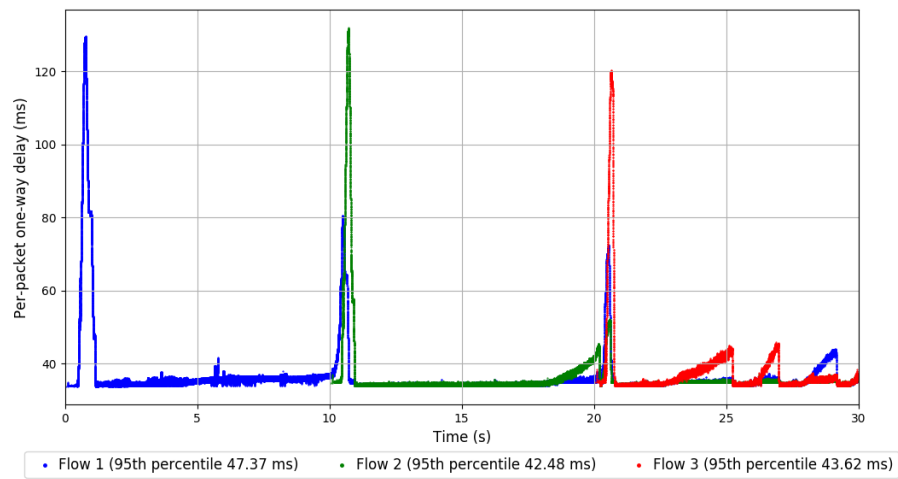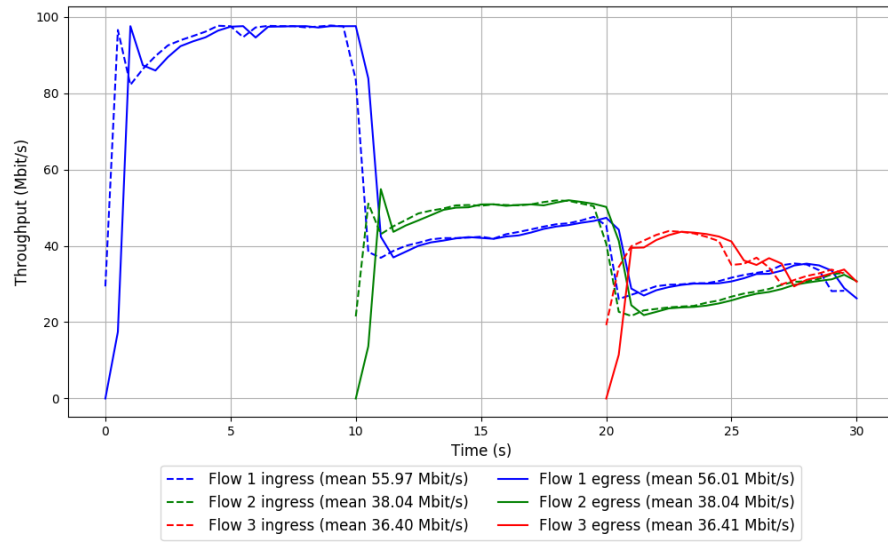
```
Run 2: Statistics of TCP Cubic

Start at: 2018-08-31 05:45:31
End at: 2018-08-31 05:46:01
Local clock offset: -10.745 ms
Remote clock offset: -2.483 ms


# Below is generated by plot.py at 2018-08-31 05:54:12
# Datalink statistics
-- Total of 3 flows:
Average throughput: 93.38 Mbit/s
95th percentile per-packet one-way delay: 43.962 ms
Loss rate: 0.25%
-- Flow 1:
Average throughput: 56.01 Mbit/s
95th percentile per-packet one-way delay: 47.367 ms
Loss rate: 0.13%
-- Flow 2:
Average throughput: 38.04 Mbit/s
95th percentile per-packet one-way delay: 42.485 ms
Loss rate: 0.32%
-- Flow 3:
Average throughput: 36.41 Mbit/s
95th percentile per-packet one-way delay: 43.621 ms
Loss rate: 0.63%
```

Run 2: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 55.97 Mbit/s) — — —   Flow 1 egress (mean 56.01 Mbit/s) ———
Flow 2 ingress (mean 38.04 Mbit/s) — — —   Flow 2 egress (mean 38.04 Mbit/s) ———
Flow 3 ingress (mean 36.40 Mbit/s) — — —   Flow 3 egress (mean 36.41 Mbit/s) ———

• Flow 1 (95th percentile 47.37 ms)   • Flow 2 (95th percentile 42.48 ms)   • Flow 3 (95th percentile 43.62 ms)
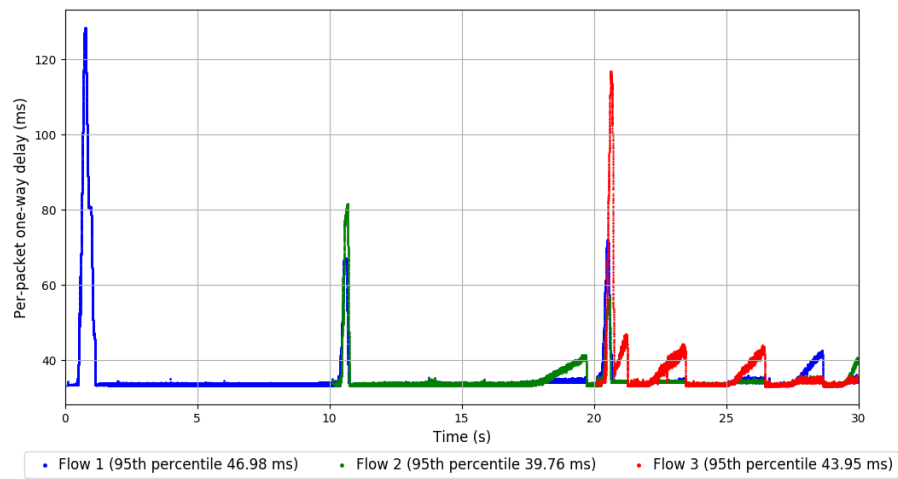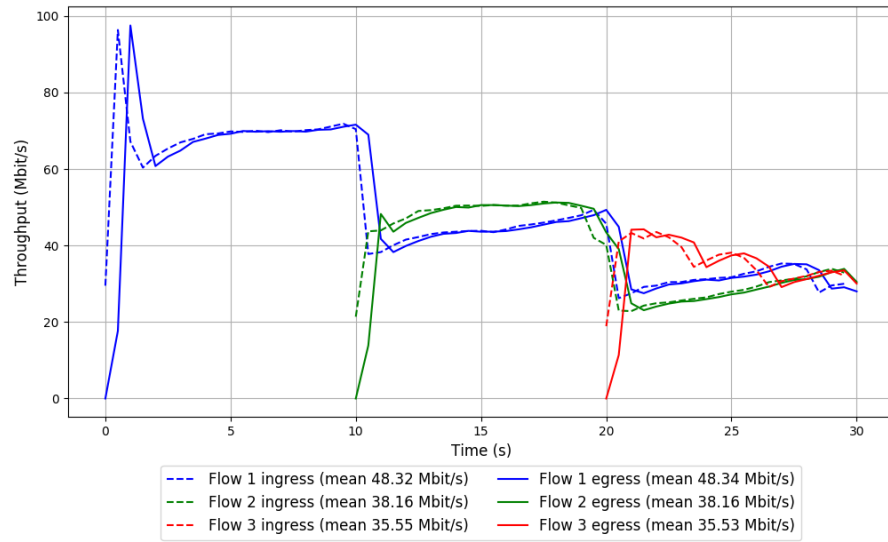
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```
Run 3: Statistics of TCP Cubic

Start at: 2018-08-31 05:50:53
End at: 2018-08-31 05:51:23
Local clock offset: -7.427 ms
Remote clock offset: -2.352 ms


# Below is generated by plot.py at 2018-08-31 05:54:12
# Datalink statistics
-- Total of 3 flows:
Average throughput: 85.50 Mbit/s
95th percentile per-packet one-way delay: 42.569 ms
Loss rate: 0.28%
-- Flow 1:
Average throughput: 48.34 Mbit/s
95th percentile per-packet one-way delay: 46.984 ms
Loss rate: 0.16%
-- Flow 2:
Average throughput: 38.16 Mbit/s
95th percentile per-packet one-way delay: 39.761 ms
Loss rate: 0.32%
-- Flow 3:
Average throughput: 35.53 Mbit/s
95th percentile per-packet one-way delay: 43.945 ms
Loss rate: 0.70%
```

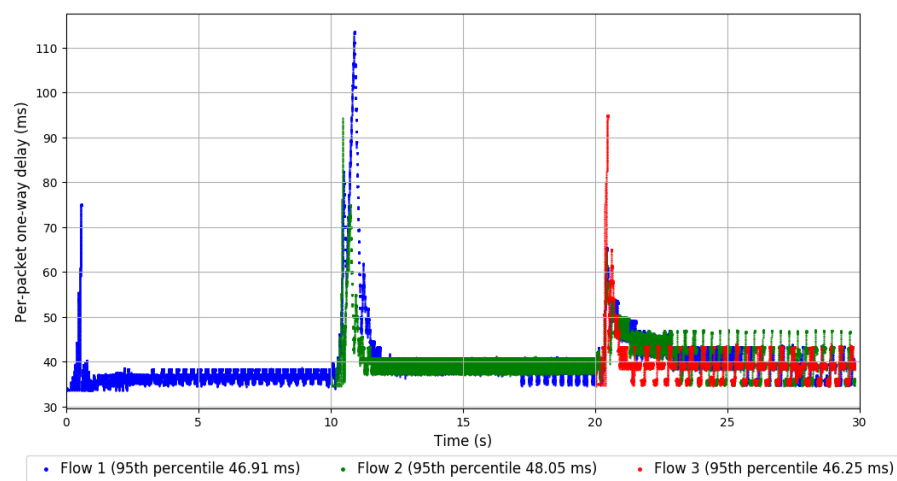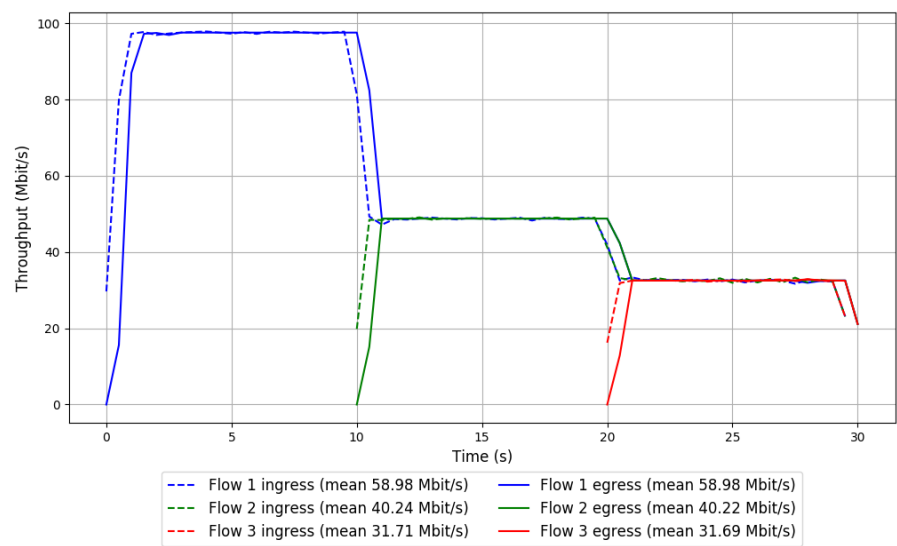Run 3: Report of TCP Cubic — Data Link

```
Run 1: Statistics of Indigo

Start at: 2018-08-31 05:38:48
End at: 2018-08-31 05:39:18
Local clock offset: -9.115 ms
Remote clock offset: -2.378 ms


# Below is generated by plot.py at 2018-08-31 05:54:13
# Datalink statistics
-- Total of 3 flows:
Average throughput: 96.07 Mbit/s
95th percentile per-packet one-way delay: 47.141 ms
Loss rate: 0.31%
-- Flow 1:
Average throughput: 58.98 Mbit/s
95th percentile per-packet one-way delay: 46.905 ms
Loss rate: 0.21%
-- Flow 2:
Average throughput: 40.22 Mbit/s
95th percentile per-packet one-way delay: 48.047 ms
Loss rate: 0.39%
-- Flow 3:
Average throughput: 31.69 Mbit/s
95th percentile per-packet one-way delay: 46.250 ms
Loss rate: 0.71%
```

Run 1: Report of Indigo — Data Link

Flow 1 ingress (mean 58.98 Mbit/s) --- Flow 1 egress (mean 58.98 Mbit/s)
Flow 2 ingress (mean 40.24 Mbit/s) --- Flow 2 egress (mean 40.22 Mbit/s)
Flow 3 ingress (mean 31.71 Mbit/s) --- Flow 3 egress (mean 31.69 Mbit/s)

Flow 1 (95th percentile 46.91 ms)   Flow 2 (95th percentile 48.05 ms)   Flow 3 (95th percentile 46.25 ms)
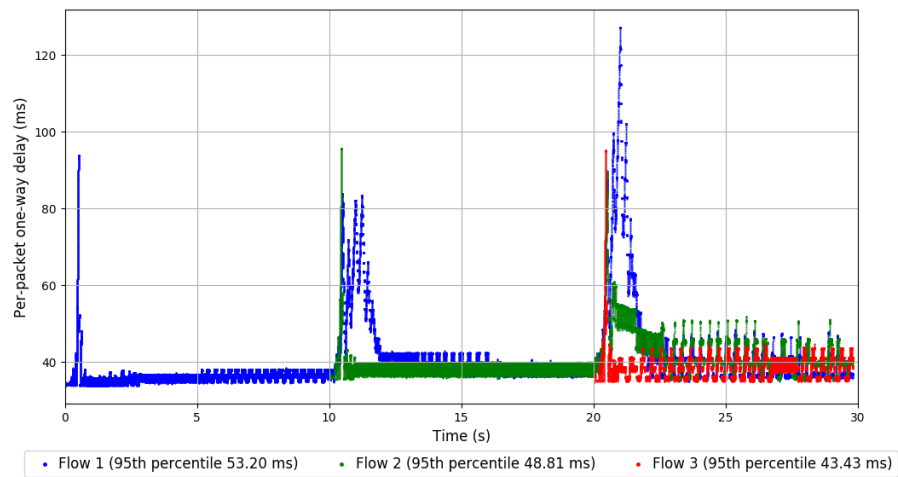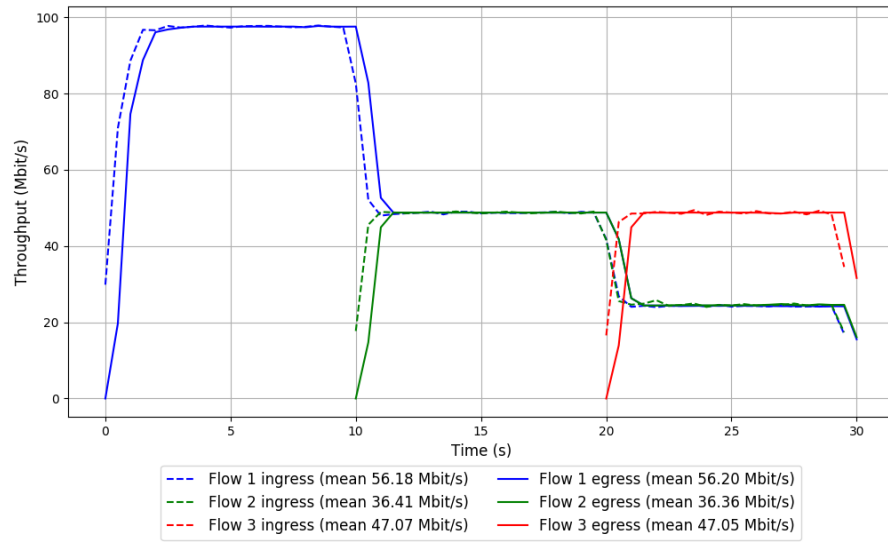
17

```
Run 2: Statistics of Indigo

Start at: 2018-08-31 05:44:09
End at: 2018-08-31 05:44:39
Local clock offset: -10.441 ms
Remote clock offset: -2.61 ms

# Below is generated by plot.py at 2018-08-31 05:54:13
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.76 Mbit/s
95th percentile per-packet one-way delay: 48.819 ms
Loss rate: 0.33%
-- Flow 1:
Average throughput: 56.20 Mbit/s
95th percentile per-packet one-way delay: 53.197 ms
Loss rate: 0.19%
-- Flow 2:
Average throughput: 36.36 Mbit/s
95th percentile per-packet one-way delay: 48.813 ms
Loss rate: 0.44%
-- Flow 3:
Average throughput: 47.05 Mbit/s
95th percentile per-packet one-way delay: 43.430 ms
Loss rate: 0.70%
```

Run 2: Report of Indigo — Data Link

Flow 1 ingress (mean 56.18 Mbit/s) — — — Flow 1 egress (mean 56.20 Mbit/s)
Flow 2 ingress (mean 36.41 Mbit/s) — — — Flow 2 egress (mean 36.36 Mbit/s)
Flow 3 ingress (mean 47.07 Mbit/s) — — — Flow 3 egress (mean 47.05 Mbit/s)

Flow 1 (95th percentile 53.20 ms)   Flow 2 (95th percentile 48.81 ms)   Flow 3 (95th percentile 43.43 ms)
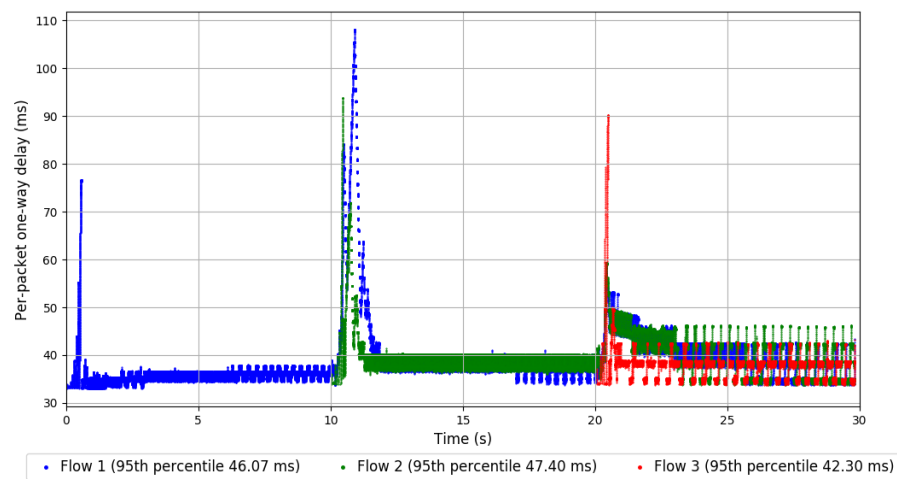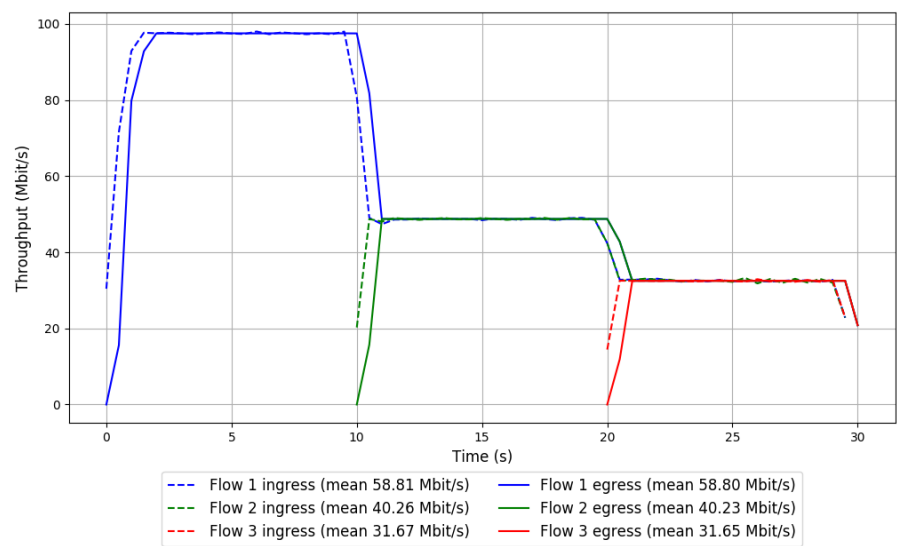
```
Run 3: Statistics of Indigo

Start at: 2018-08-31 05:49:31
End at: 2018-08-31 05:50:01
Local clock offset: -8.571 ms
Remote clock offset: -2.388 ms


# Below is generated by plot.py at 2018-08-31 05:54:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 95.88 Mbit/s
95th percentile per-packet one-way delay: 46.036 ms
Loss rate: 0.33%
-- Flow 1:
Average throughput: 58.80 Mbit/s
95th percentile per-packet one-way delay: 46.067 ms
Loss rate: 0.22%
-- Flow 2:
Average throughput: 40.23 Mbit/s
95th percentile per-packet one-way delay: 47.400 ms
Loss rate: 0.41%
-- Flow 3:
Average throughput: 31.65 Mbit/s
95th percentile per-packet one-way delay: 42.304 ms
Loss rate: 0.74%
```
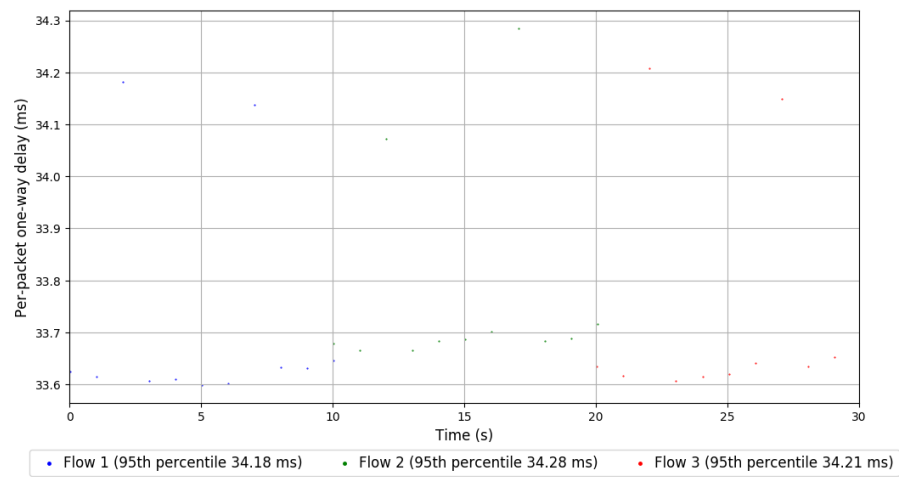
Run 3: Report of Indigo — Data Link

Flow 1 ingress (mean 58.81 Mbit/s) --- Flow 1 egress (mean 58.80 Mbit/s)
Flow 2 ingress (mean 40.26 Mbit/s) --- Flow 2 egress (mean 40.23 Mbit/s)
Flow 3 ingress (mean 31.67 Mbit/s) --- Flow 3 egress (mean 31.65 Mbit/s)

Flow 1 (95th percentile 46.07 ms)   Flow 2 (95th percentile 47.40 ms)   Flow 3 (95th percentile 42.30 ms)
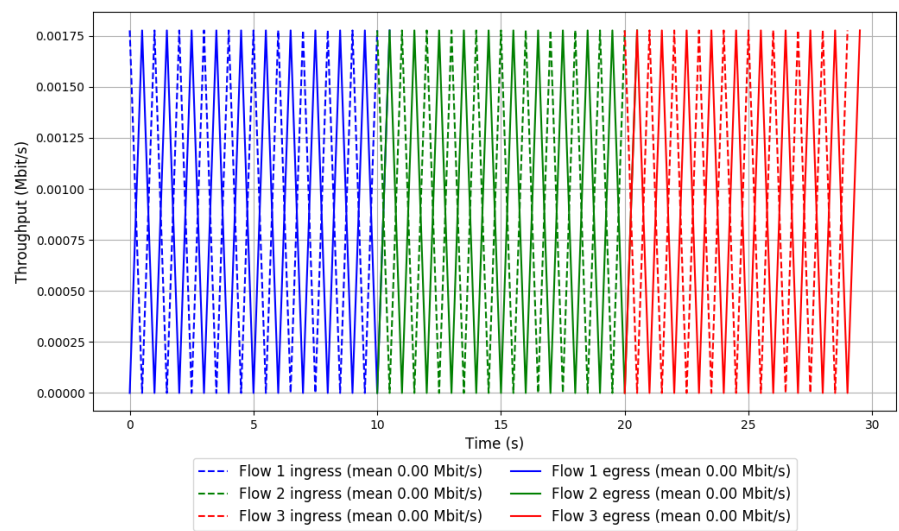
21

```
Run 1: Statistics of Muses-25

Start at: 2018-08-31 05:41:31
End at: 2018-08-31 05:42:01
Local clock offset: -9.69 ms
Remote clock offset: -2.441 ms


# Below is generated by plot.py at 2018-08-31 05:54:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 34.181 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 34.181 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 34.284 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 34.208 ms
Loss rate: 0.00%
```
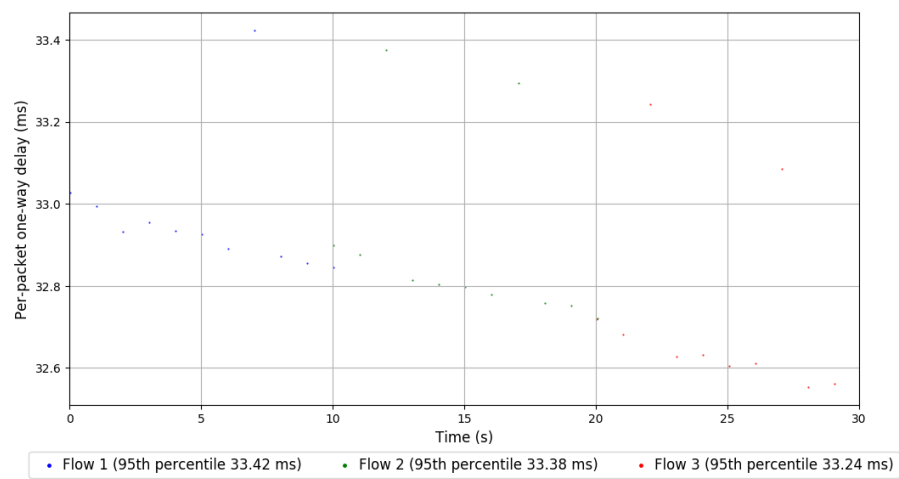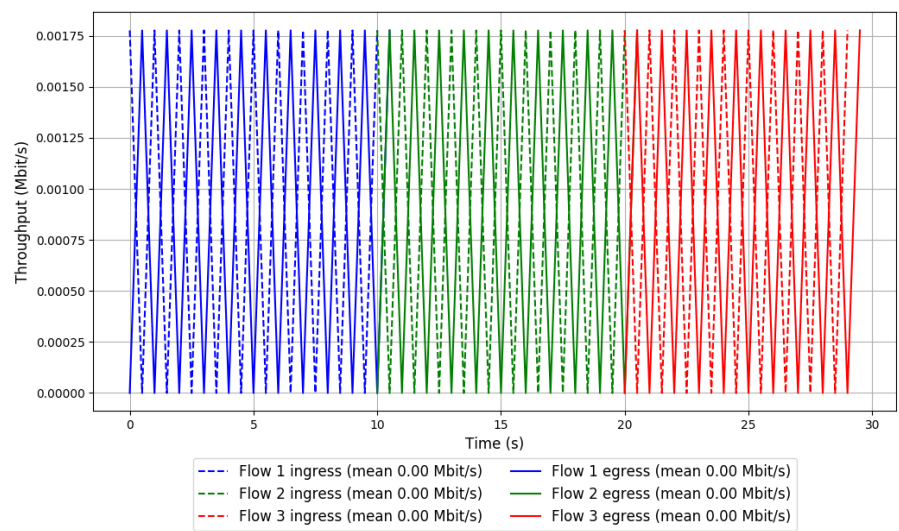
Run 1: Report of Muses-25 — Data Link

```
Run 2: Statistics of Muses-25

Start at: 2018-08-31 05:46:53
End at: 2018-08-31 05:47:23
Local clock offset: -10.844 ms
Remote clock offset: -2.577 ms


# Below is generated by plot.py at 2018-08-31 05:54:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 33.294 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 33.422 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 33.376 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 33.243 ms
Loss rate: 0.00%
```

Run 2: Report of Muses-25 — Data Link

```
Run 3: Statistics of Muses-25

Start at: 2018-08-31 05:52:14
End at: 2018-08-31 05:52:44
Local clock offset: -6.72 ms
Remote clock offset: -2.29 ms

# Below is generated by plot.py at 2018-08-31 05:54:16
# Datalink statistics
-- Total of 3 flows:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 33.678 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 33.717 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 33.678 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 33.602 ms
Loss rate: 0.00%
```

Run 3: Report of Muses-25 — Data Link