Pantheon Report

Generated at 2018-09-05 03:01:27 (UTC).

Data path: AWS India 2 on `ens5` (*local*) →Saudi Arabia on `enp2s0` (*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.

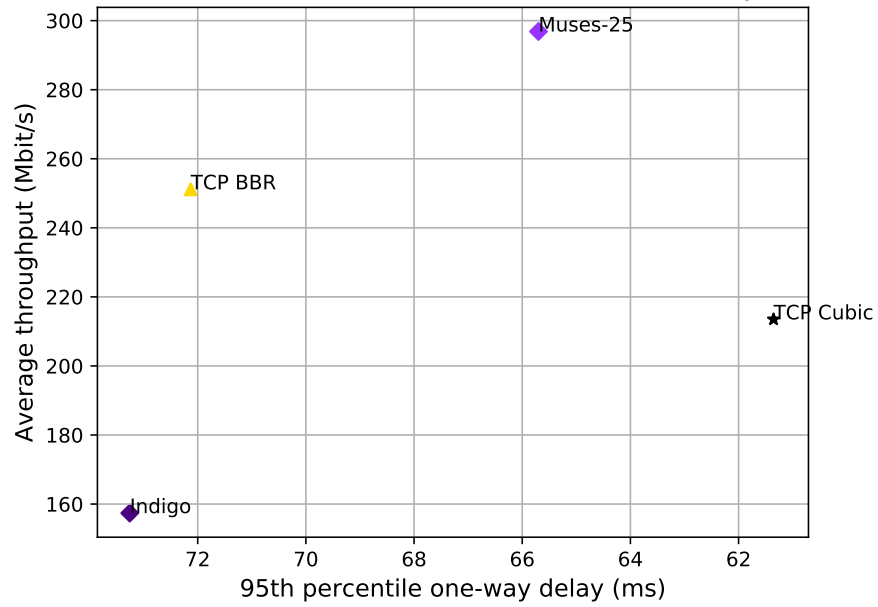NTP offsets were measured against `nets.org.sg` and have been applied to correct the timestamps in logs.

```
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
net.ipv4.tcp_mem = 536870912 536870912 536870912
```
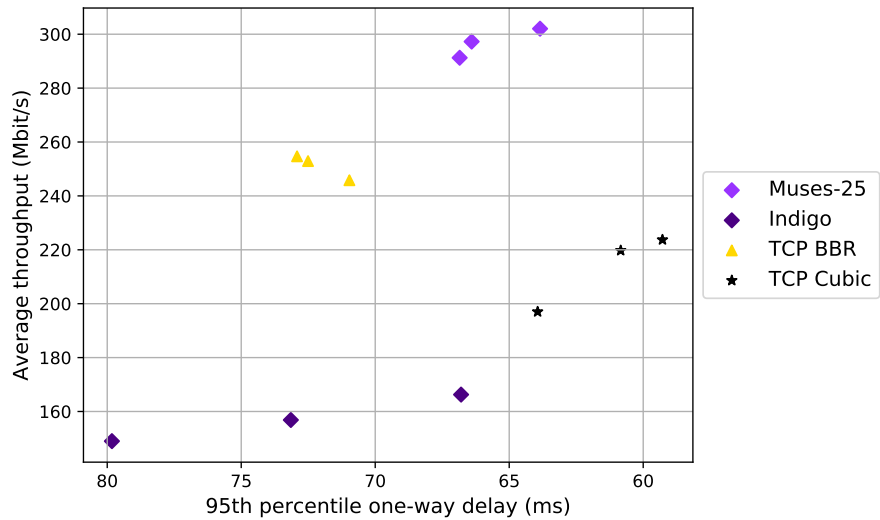
```
Git summary:
branch: muses @ 71e71e9a55b945431a7dea72180c1c9381097db9
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/muses @ 96fbc95fb38373d71fbc80c5a105e62e7636623b
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 India 2 to Saudi Arabia, 3 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

test from AWS India 2 to Saudi Arabia, 3 runs of 30s each per scheme
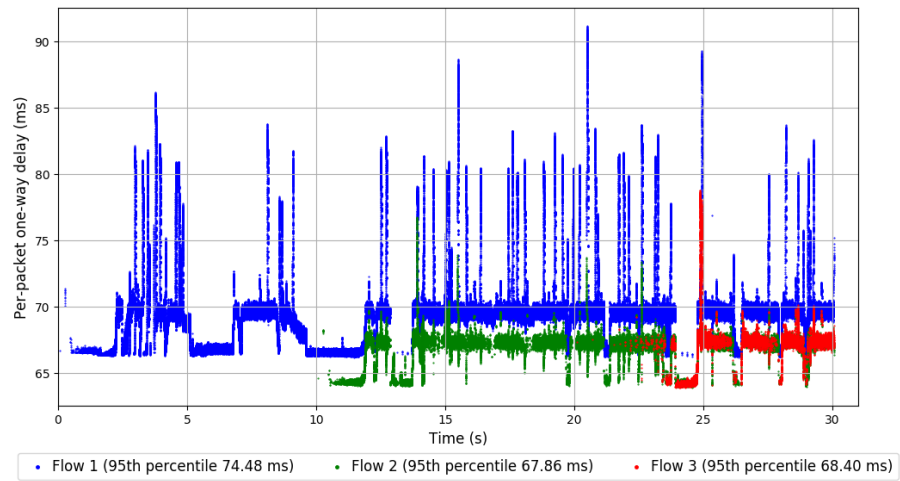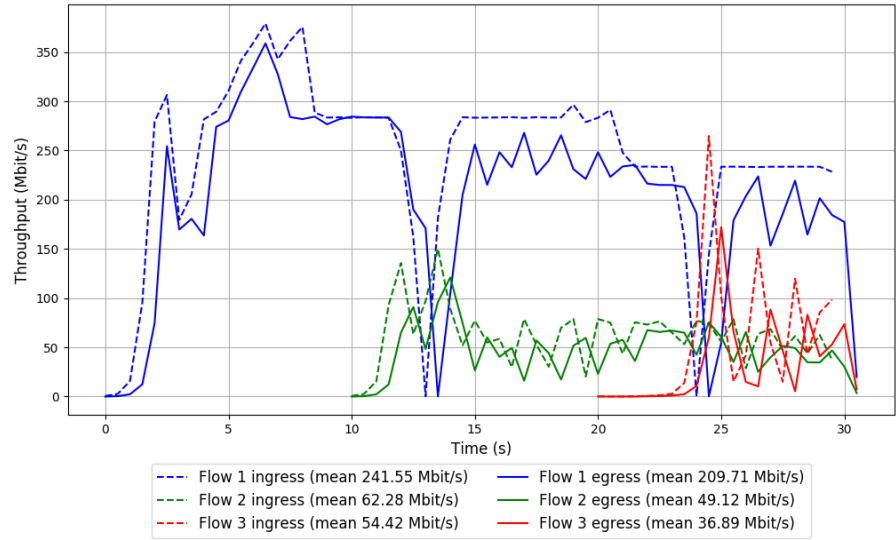3 flows with 10s interval between flows

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	210.33	47.20	28.15	73.26	67.70	67.60	13.27	22.85	21.62
TCP Cubic	3	124.38	102.30	63.05	60.97	61.69	60.64	1.73	1.49	1.49
Indigo	3	82.80	69.16	89.89	75.35	72.18	72.98	8.03	12.46	23.93
Muses-25	3	196.09	119.18	67.37	67.15	63.36	64.64	8.00	10.91	14.95

```
Run 1: Statistics of TCP BBR

Start at: 2018-09-05 02:36:19
End at: 2018-09-05 02:36:49
Local clock offset: -2.635 ms
Remote clock offset: -29.068 ms


# Below is generated by plot.py at 2018-09-05 03:00:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 254.69 Mbit/s
95th percentile per-packet one-way delay: 72.917 ms
Loss rate: 15.41%
-- Flow 1:
Average throughput: 209.71 Mbit/s
95th percentile per-packet one-way delay: 74.481 ms
Loss rate: 13.18%
-- Flow 2:
Average throughput: 49.12 Mbit/s
95th percentile per-packet one-way delay: 67.856 ms
Loss rate: 21.12%
-- Flow 3:
Average throughput: 36.89 Mbit/s
95th percentile per-packet one-way delay: 68.401 ms
Loss rate: 32.20%
```

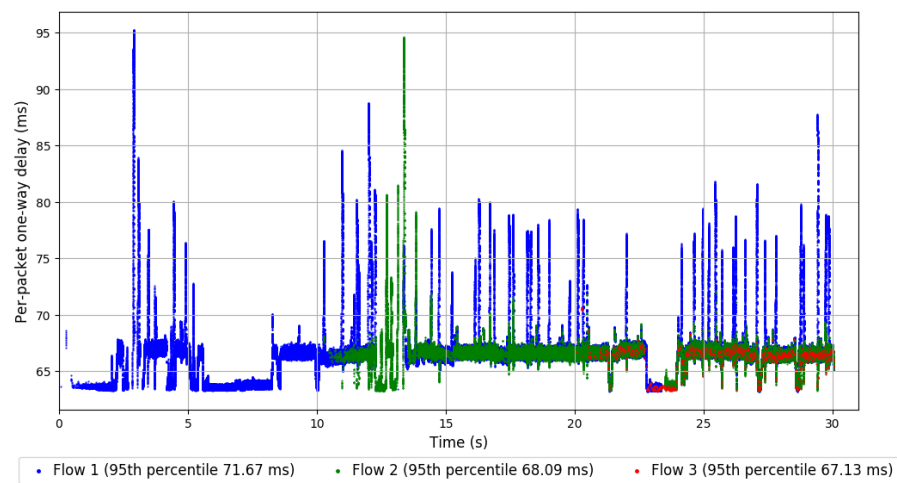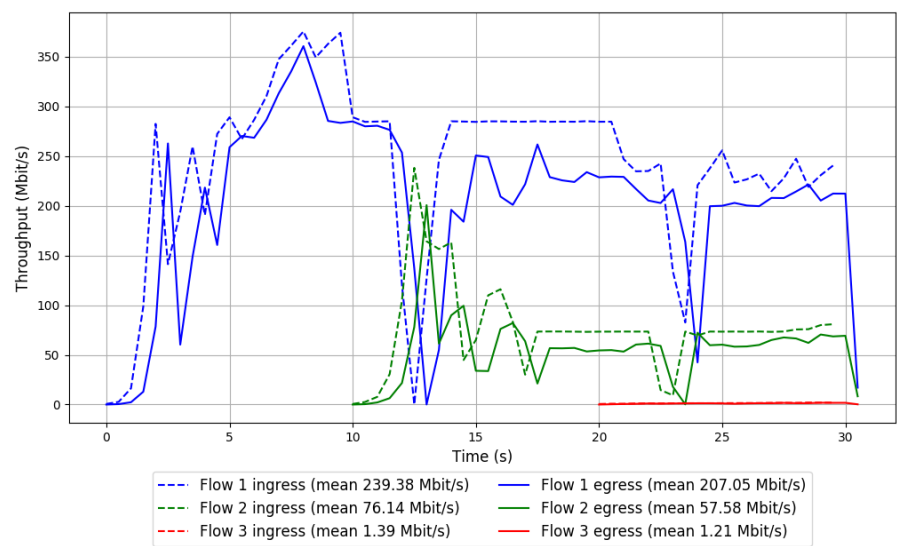Run 1: Report of TCP BBR — Data Link

```
Run 2: Statistics of TCP BBR

Start at: 2018-09-05 02:42:27
End at: 2018-09-05 02:42:57
Local clock offset: -1.948 ms
Remote clock offset: -28.048 ms


# Below is generated by plot.py at 2018-09-05 03:00:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 245.81 Mbit/s
95th percentile per-packet one-way delay: 70.963 ms
Loss rate: 15.40%
-- Flow 1:
Average throughput: 207.05 Mbit/s
95th percentile per-packet one-way delay: 71.675 ms
Loss rate: 13.50%
-- Flow 2:
Average throughput: 57.58 Mbit/s
95th percentile per-packet one-way delay: 68.092 ms
Loss rate: 24.38%
-- Flow 3:
Average throughput: 1.21 Mbit/s
95th percentile per-packet one-way delay: 67.133 ms
Loss rate: 13.19%
```
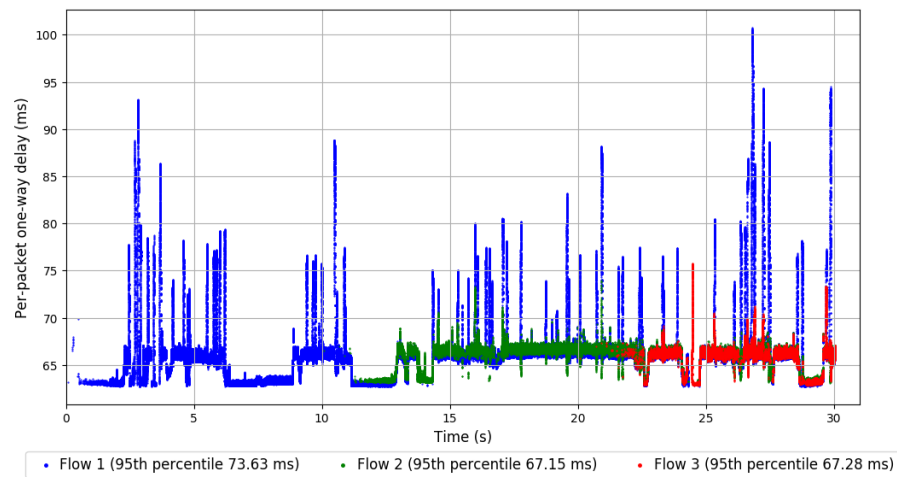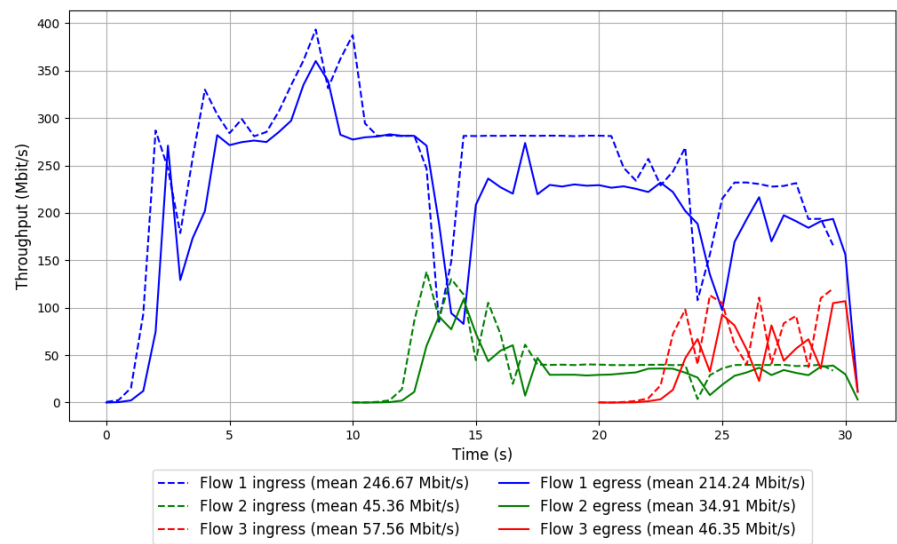
Run 2: Report of TCP BBR — Data Link

```
Run 3: Statistics of TCP BBR

Start at: 2018-09-05 02:54:10
End at: 2018-09-05 02:54:40
Local clock offset: -0.93 ms
Remote clock offset: -28.812 ms


# Below is generated by plot.py at 2018-09-05 03:00:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 252.93 Mbit/s
95th percentile per-packet one-way delay: 72.507 ms
Loss rate: 14.56%
-- Flow 1:
Average throughput: 214.24 Mbit/s
95th percentile per-packet one-way delay: 73.632 ms
Loss rate: 13.14%
-- Flow 2:
Average throughput: 34.91 Mbit/s
95th percentile per-packet one-way delay: 67.150 ms
Loss rate: 23.04%
-- Flow 3:
Average throughput: 46.35 Mbit/s
95th percentile per-packet one-way delay: 67.280 ms
Loss rate: 19.47%
```
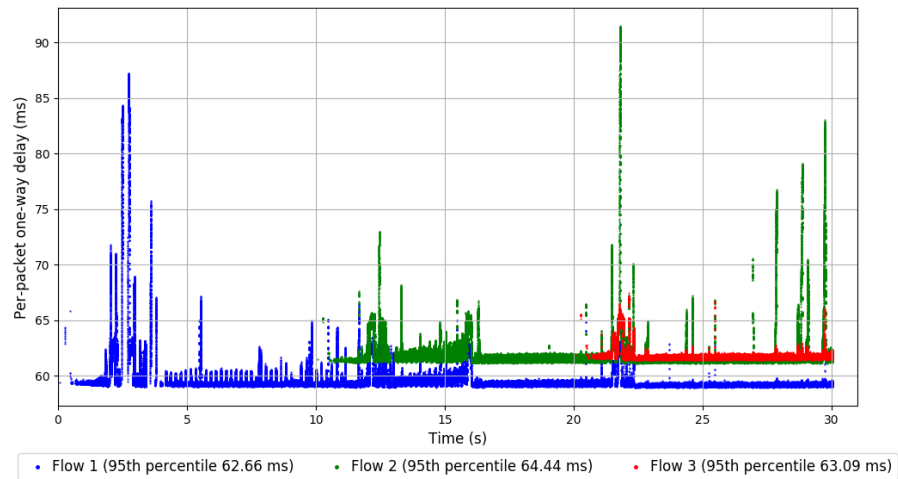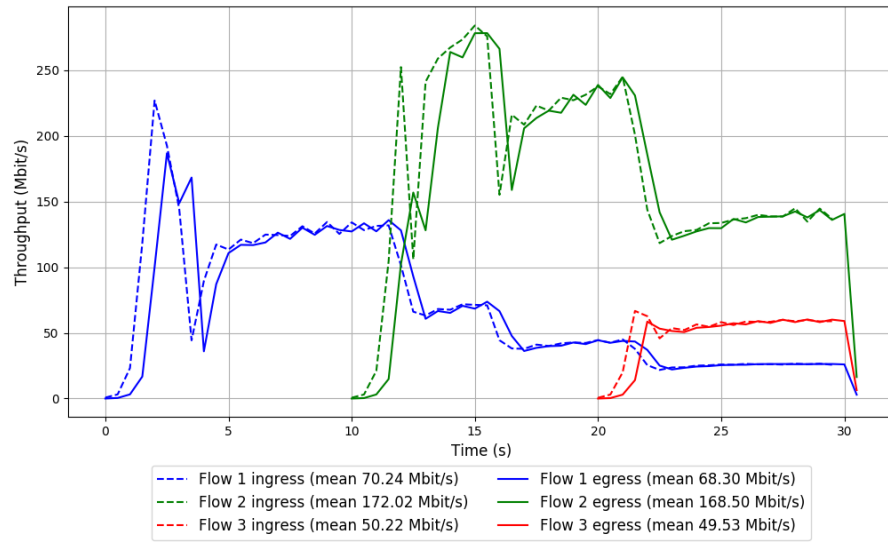
Run 3: Report of TCP BBR — Data Link

```
Run 1: Statistics of TCP Cubic

Start at: 2018-09-05 02:33:17
End at: 2018-09-05 02:33:47
Local clock offset: -2.865 ms
Remote clock offset: -34.586 ms


# Below is generated by plot.py at 2018-09-05 03:00:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 197.00 Mbit/s
95th percentile per-packet one-way delay: 63.940 ms
Loss rate: 2.25%
-- Flow 1:
Average throughput: 68.30 Mbit/s
95th percentile per-packet one-way delay: 62.663 ms
Loss rate: 2.77%
-- Flow 2:
Average throughput: 168.50 Mbit/s
95th percentile per-packet one-way delay: 64.441 ms
Loss rate: 2.05%
-- Flow 3:
Average throughput: 49.53 Mbit/s
95th percentile per-packet one-way delay: 63.085 ms
Loss rate: 1.40%
```

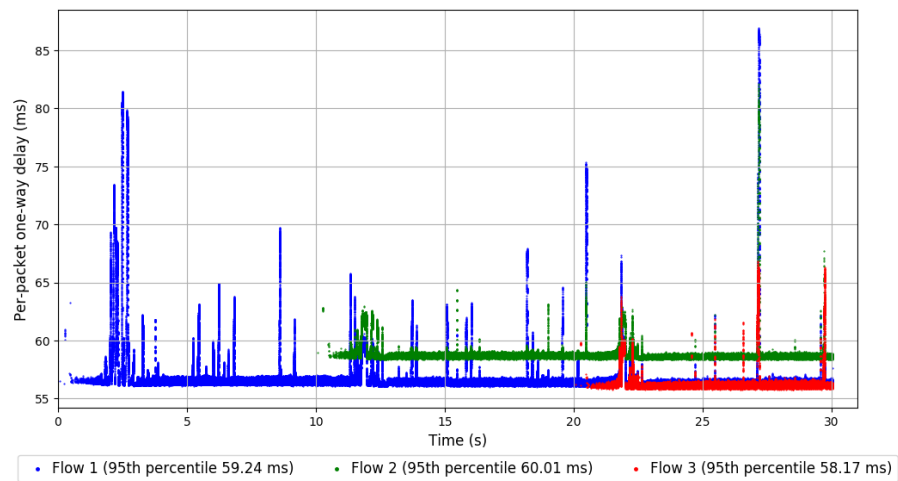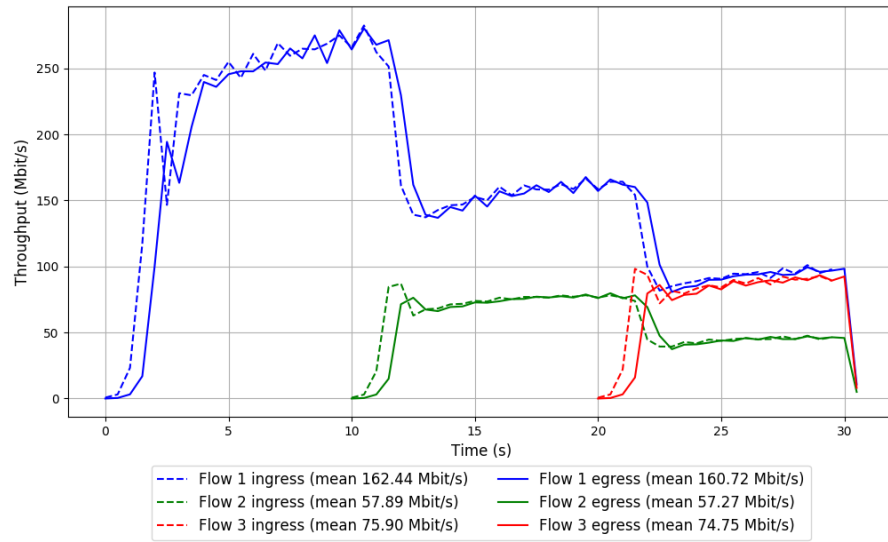Run 1: Report of TCP Cubic — Data Link

```
Run 2: Statistics of TCP Cubic

Start at: 2018-09-05 02:39:23
End at: 2018-09-05 02:39:53
Local clock offset: -1.171 ms
Remote clock offset: -35.111 ms


# Below is generated by plot.py at 2018-09-05 03:00:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 223.72 Mbit/s
95th percentile per-packet one-way delay: 59.281 ms
Loss rate: 1.11%
-- Flow 1:
Average throughput: 160.72 Mbit/s
95th percentile per-packet one-way delay: 59.245 ms
Loss rate: 1.06%
-- Flow 2:
Average throughput: 57.27 Mbit/s
95th percentile per-packet one-way delay: 60.010 ms
Loss rate: 1.09%
-- Flow 3:
Average throughput: 74.75 Mbit/s
95th percentile per-packet one-way delay: 58.170 ms
Loss rate: 1.52%
```

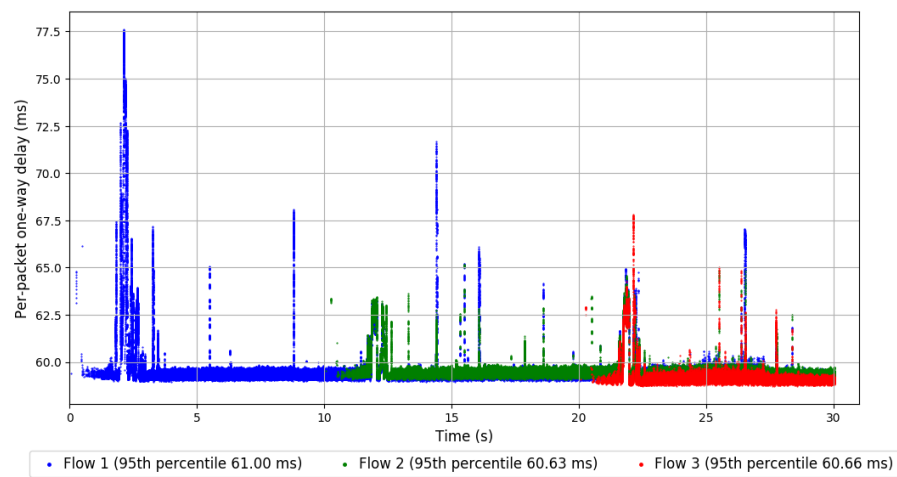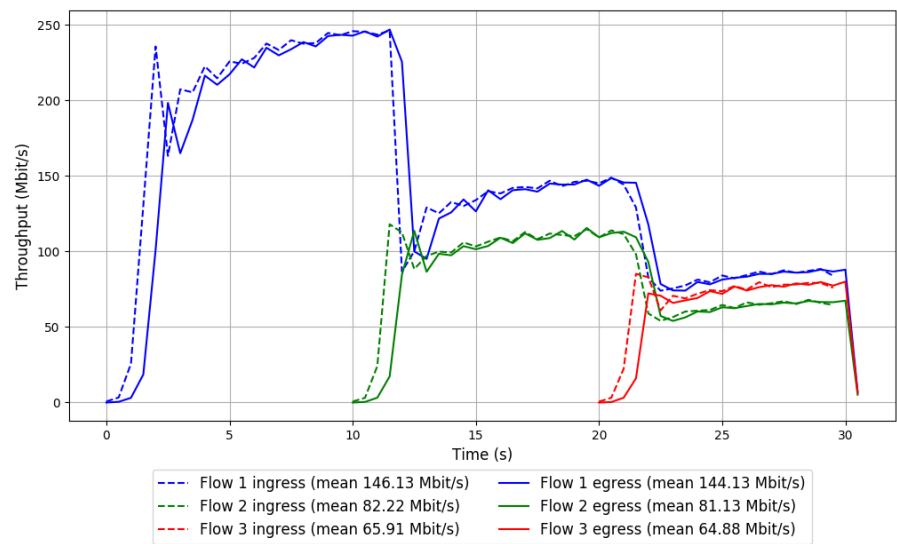Run 2: Report of TCP Cubic — Data Link

```
Run 3: Statistics of TCP Cubic

Start at: 2018-09-05 02:50:56
End at: 2018-09-05 02:51:26
Local clock offset: -3.072 ms
Remote clock offset: -34.436 ms


# Below is generated by plot.py at 2018-09-05 03:00:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 219.73 Mbit/s
95th percentile per-packet one-way delay: 60.840 ms
Loss rate: 1.38%
-- Flow 1:
Average throughput: 144.13 Mbit/s
95th percentile per-packet one-way delay: 61.000 ms
Loss rate: 1.37%
-- Flow 2:
Average throughput: 81.13 Mbit/s
95th percentile per-packet one-way delay: 60.626 ms
Loss rate: 1.33%
-- Flow 3:
Average throughput: 64.88 Mbit/s
95th percentile per-packet one-way delay: 60.665 ms
Loss rate: 1.56%
```

Run 3: Report of TCP Cubic — Data Link

- - - - Flow 1 ingress (mean 146.13 Mbit/s) ——— Flow 1 egress (mean 144.13 Mbit/s)
- - - - Flow 2 ingress (mean 82.22 Mbit/s) ——— Flow 2 egress (mean 81.13 Mbit/s)
- - - - Flow 3 ingress (mean 65.91 Mbit/s) ——— Flow 3 egress (mean 64.88 Mbit/s)

• Flow 1 (95th percentile 61.00 ms)   • Flow 2 (95th percentile 60.63 ms)   • Flow 3 (95th percentile 60.66 ms)
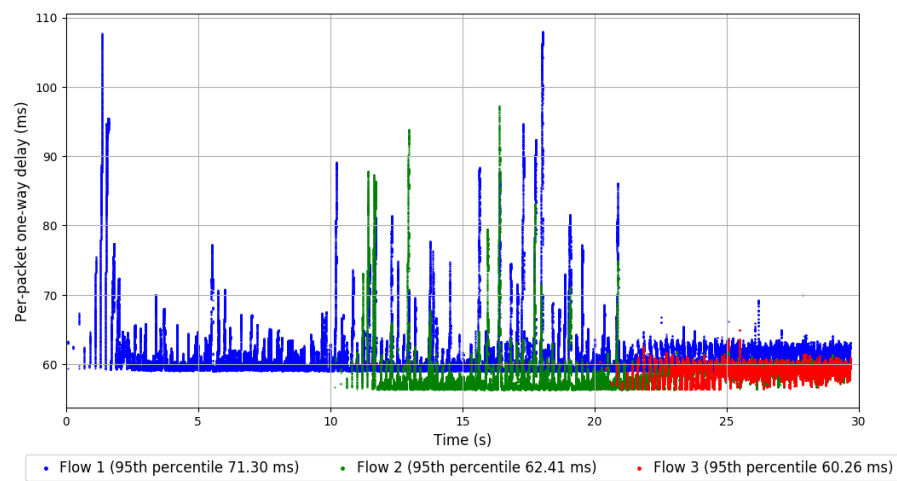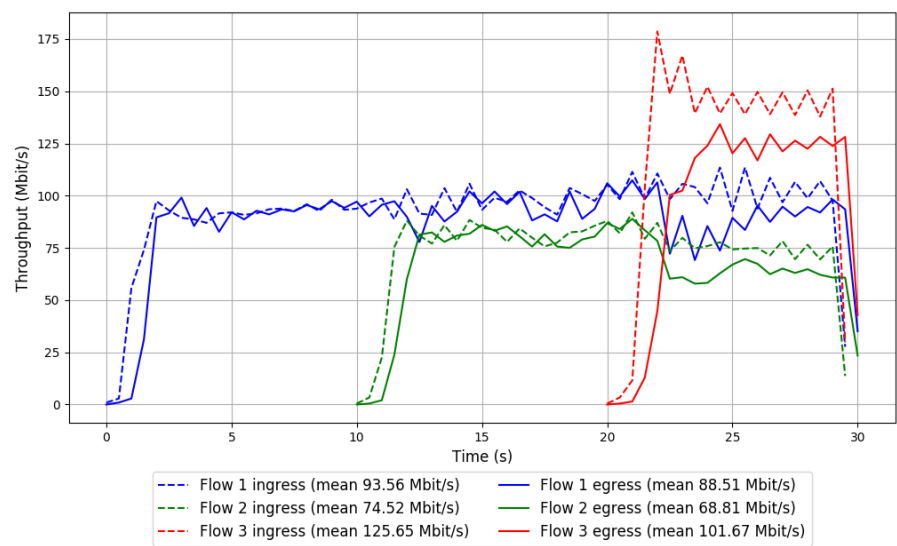
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```
Run 1: Statistics of Indigo

Start at: 2018-09-05 02:37:54
End at: 2018-09-05 02:38:24
Local clock offset: -1.807 ms
Remote clock offset: -35.563 ms


# Below is generated by plot.py at 2018-09-05 03:00:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 166.27 Mbit/s
95th percentile per-packet one-way delay: 66.796 ms
Loss rate: 9.00%
-- Flow 1:
Average throughput: 88.51 Mbit/s
95th percentile per-packet one-way delay: 71.303 ms
Loss rate: 5.40%
-- Flow 2:
Average throughput: 68.81 Mbit/s
95th percentile per-packet one-way delay: 62.405 ms
Loss rate: 7.65%
-- Flow 3:
Average throughput: 101.67 Mbit/s
95th percentile per-packet one-way delay: 60.257 ms
Loss rate: 19.06%
```
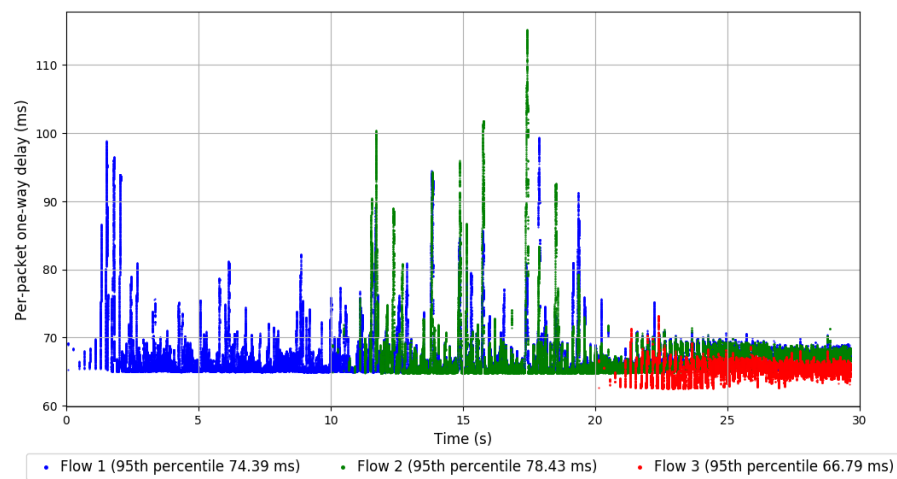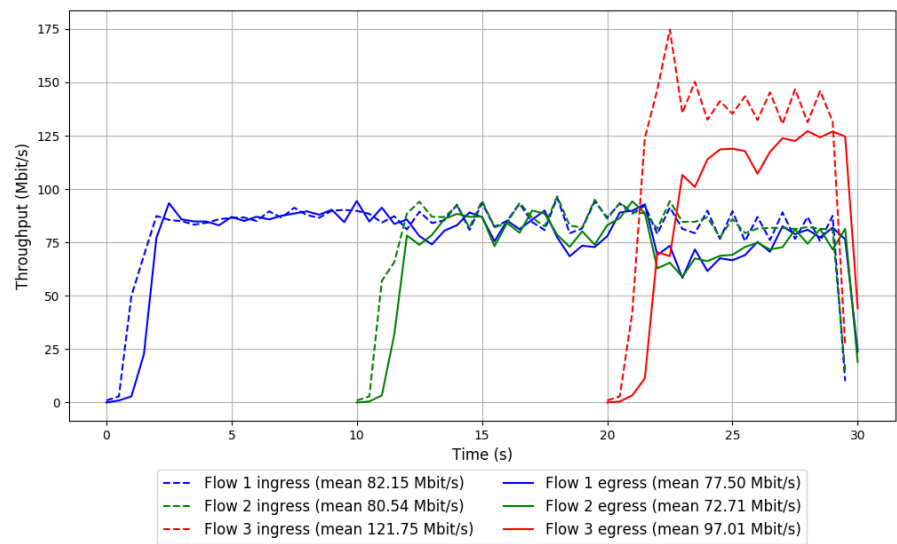
Run 1: Report of Indigo — Data Link

```
Run 2: Statistics of Indigo

Start at: 2018-09-05 02:44:00
End at: 2018-09-05 02:44:30
Local clock offset: -3.338 ms
Remote clock offset: -29.959 ms


# Below is generated by plot.py at 2018-09-05 03:00:19
# Datalink statistics
-- Total of 3 flows:
Average throughput: 156.85 Mbit/s
95th percentile per-packet one-way delay: 73.148 ms
Loss rate: 10.18%
-- Flow 1:
Average throughput: 77.50 Mbit/s
95th percentile per-packet one-way delay: 74.391 ms
Loss rate: 5.66%
-- Flow 2:
Average throughput: 72.71 Mbit/s
95th percentile per-packet one-way delay: 78.426 ms
Loss rate: 9.71%
-- Flow 3:
Average throughput: 97.01 Mbit/s
95th percentile per-packet one-way delay: 66.787 ms
Loss rate: 20.29%
```

Run 2: Report of Indigo — Data Link

Flow 1 ingress (mean 82.15 Mbit/s) Flow 1 egress (mean 77.50 Mbit/s)
Flow 2 ingress (mean 80.54 Mbit/s) Flow 2 egress (mean 72.71 Mbit/s)
Flow 3 ingress (mean 121.75 Mbit/s) Flow 3 egress (mean 97.01 Mbit/s)

Flow 1 (95th percentile 74.39 ms) Flow 2 (95th percentile 78.43 ms) Flow 3 (95th percentile 66.79 ms)
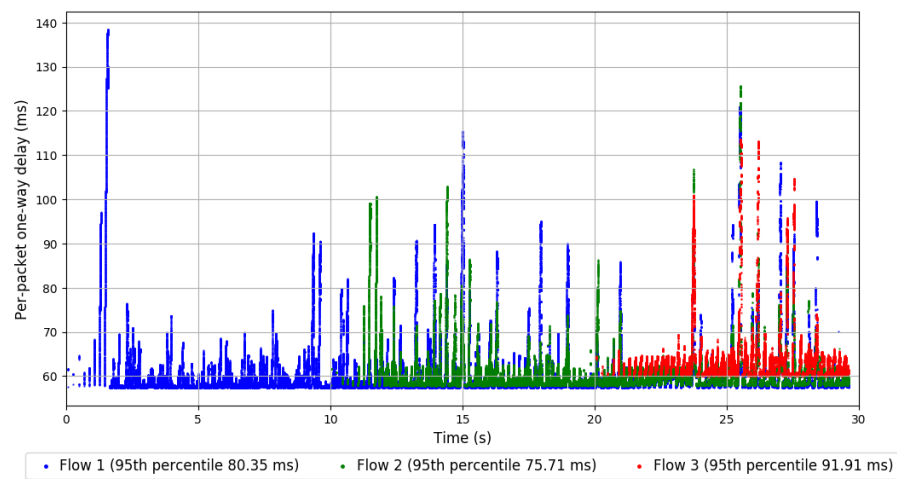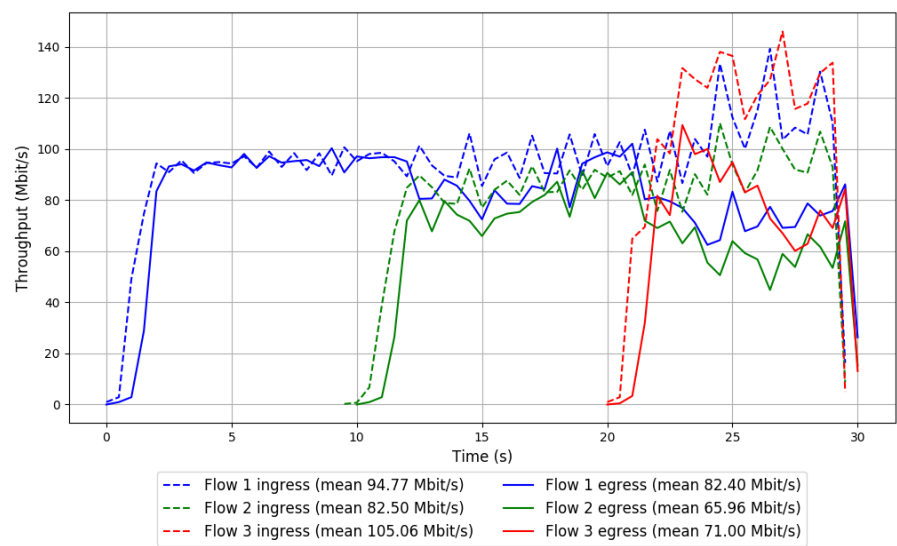
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```
Run 3: Statistics of Indigo

Start at: 2018-09-05 02:55:44
End at: 2018-09-05 02:56:14
Local clock offset: -1.598 ms
Remote clock offset: -34.607 ms


# Below is generated by plot.py at 2018-09-05 03:00:36
# Datalink statistics
-- Total of 3 flows:
Average throughput: 149.00 Mbit/s
95th percentile per-packet one-way delay: 79.825 ms
Loss rate: 18.72%
-- Flow 1:
Average throughput: 82.40 Mbit/s
95th percentile per-packet one-way delay: 80.346 ms
Loss rate: 13.04%
-- Flow 2:
Average throughput: 65.96 Mbit/s
95th percentile per-packet one-way delay: 75.711 ms
Loss rate: 20.03%
-- Flow 3:
Average throughput: 71.00 Mbit/s
95th percentile per-packet one-way delay: 91.911 ms
Loss rate: 32.44%
```
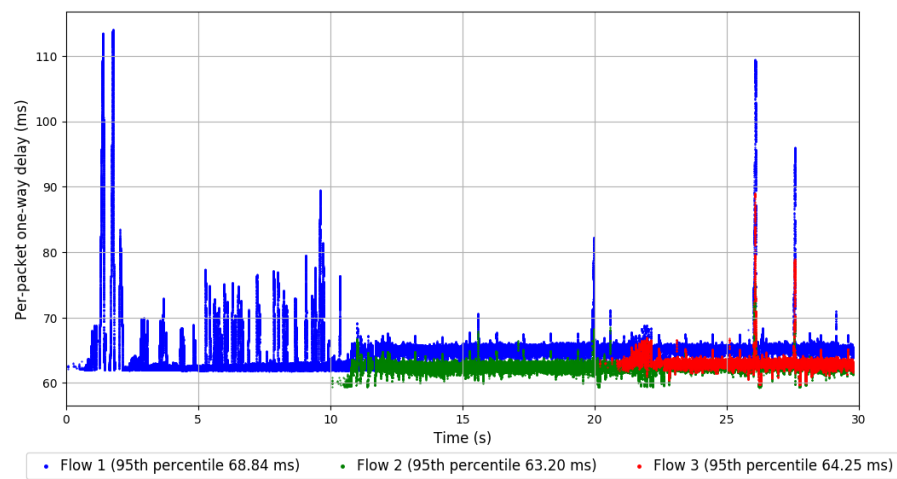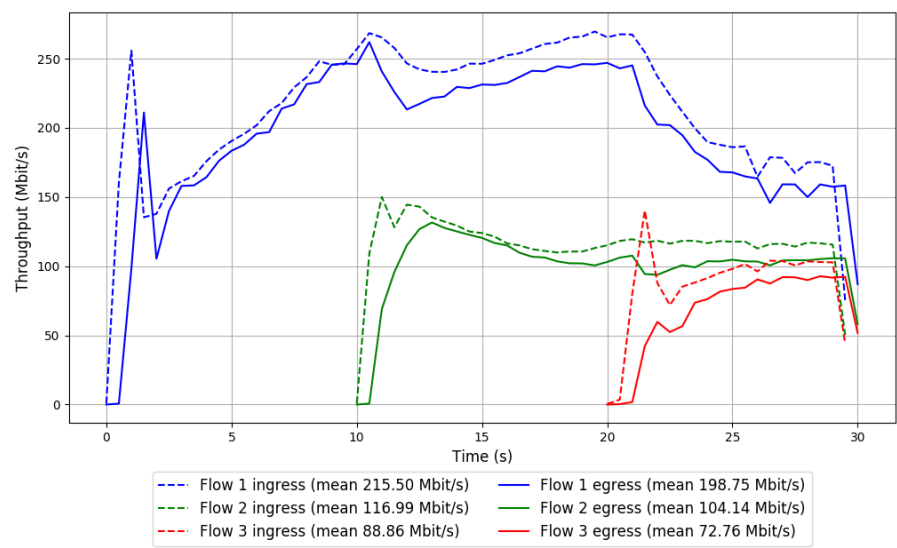
Run 3: Report of Indigo — Data Link

```
Run 1: Statistics of Muses-25

Start at: 2018-09-05 02:34:46
End at: 2018-09-05 02:35:16
Local clock offset: -1.341 ms
Remote clock offset: -32.215 ms

# Below is generated by plot.py at 2018-09-05 03:01:17
# Datalink statistics
-- Total of 3 flows:
Average throughput: 291.26 Mbit/s
95th percentile per-packet one-way delay: 66.849 ms
Loss rate: 9.46%
-- Flow 1:
Average throughput: 198.75 Mbit/s
95th percentile per-packet one-way delay: 68.836 ms
Loss rate: 7.77%
-- Flow 2:
Average throughput: 104.14 Mbit/s
95th percentile per-packet one-way delay: 63.196 ms
Loss rate: 10.97%
-- Flow 3:
Average throughput: 72.76 Mbit/s
95th percentile per-packet one-way delay: 64.254 ms
Loss rate: 18.13%
```

Run 1: Report of Muses-25 — Data Link

Flow 1 ingress (mean 215.50 Mbit/s) ---- Flow 1 egress (mean 198.75 Mbit/s)
Flow 2 ingress (mean 116.99 Mbit/s) ---- Flow 2 egress (mean 104.14 Mbit/s)
Flow 3 ingress (mean 88.86 Mbit/s) ---- Flow 3 egress (mean 72.76 Mbit/s)

Flow 1 (95th percentile 68.84 ms) • Flow 2 (95th percentile 63.20 ms) • Flow 3 (95th percentile 64.25 ms)
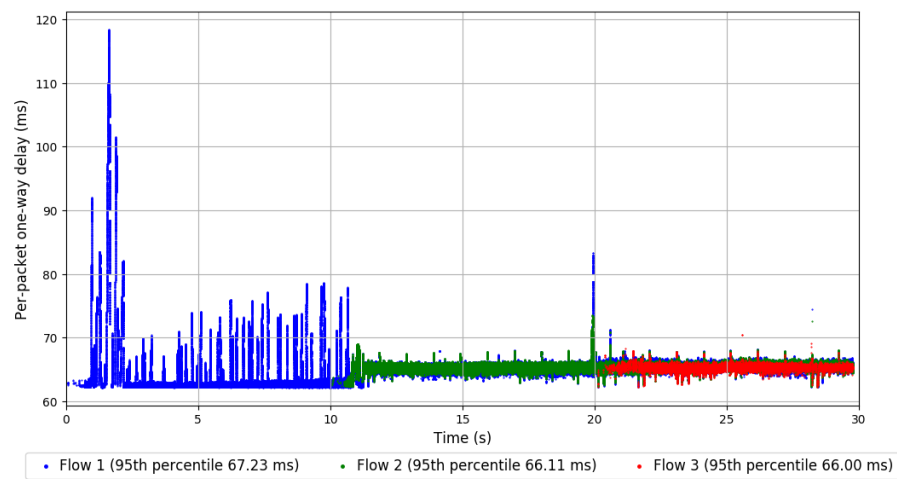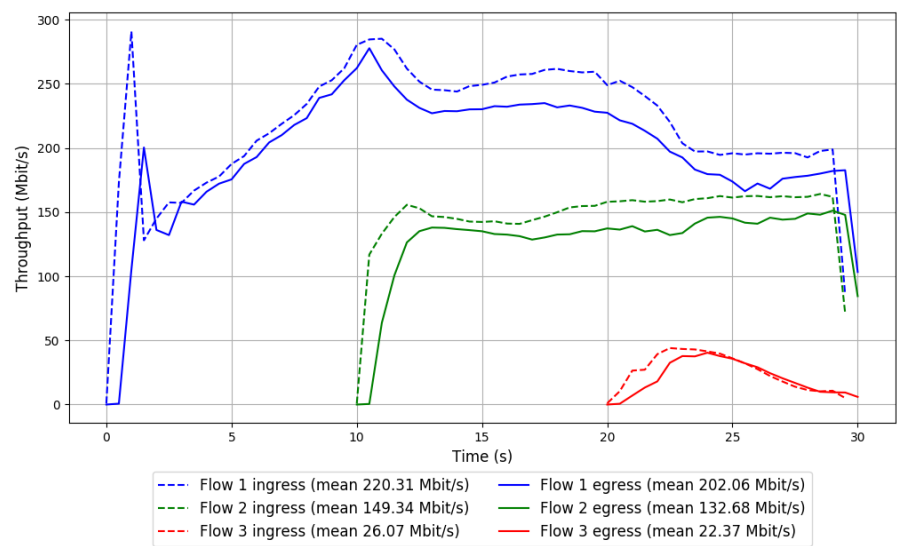
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```
Run 2: Statistics of Muses-25

Start at: 2018-09-05 02:40:53
End at: 2018-09-05 02:41:23
Local clock offset: -4.122 ms
Remote clock offset: -31.46 ms


# Below is generated by plot.py at 2018-09-05 03:01:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 297.27 Mbit/s
95th percentile per-packet one-way delay: 66.402 ms
Loss rate: 9.29%
-- Flow 1:
Average throughput: 202.06 Mbit/s
95th percentile per-packet one-way delay: 67.233 ms
Loss rate: 8.27%
-- Flow 2:
Average throughput: 132.68 Mbit/s
95th percentile per-packet one-way delay: 66.112 ms
Loss rate: 11.14%
-- Flow 3:
Average throughput: 22.37 Mbit/s
95th percentile per-packet one-way delay: 66.002 ms
Loss rate: 14.17%
```

Run 2: Report of Muses-25 — Data Link

Flow 1 ingress (mean 220.31 Mbit/s) --- Flow 1 egress (mean 202.06 Mbit/s)
Flow 2 ingress (mean 149.34 Mbit/s) --- Flow 2 egress (mean 132.68 Mbit/s)
Flow 3 ingress (mean 26.07 Mbit/s) --- Flow 3 egress (mean 22.37 Mbit/s)

Flow 1 (95th percentile 67.23 ms)   Flow 2 (95th percentile 66.11 ms)   Flow 3 (95th percentile 66.00 ms)

```
Run 3: Statistics of Muses-25

Start at: 2018-09-05 02:52:35
End at: 2018-09-05 02:53:06
Local clock offset: -1.146 ms
Remote clock offset: -34.534 ms

# Below is generated by plot.py at 2018-09-05 03:01:26
# Datalink statistics
-- Total of 3 flows:
Average throughput: 302.05 Mbit/s
95th percentile per-packet one-way delay: 63.849 ms
Loss rate: 9.22%
-- Flow 1:
Average throughput: 187.47 Mbit/s
95th percentile per-packet one-way delay: 65.383 ms
Loss rate: 7.96%
-- Flow 2:
Average throughput: 120.73 Mbit/s
95th percentile per-packet one-way delay: 60.765 ms
Loss rate: 10.62%
-- Flow 3:
Average throughput: 106.99 Mbit/s
95th percentile per-packet one-way delay: 63.664 ms
Loss rate: 12.54%
```

Run 3: Report of Muses-25 — Data Link