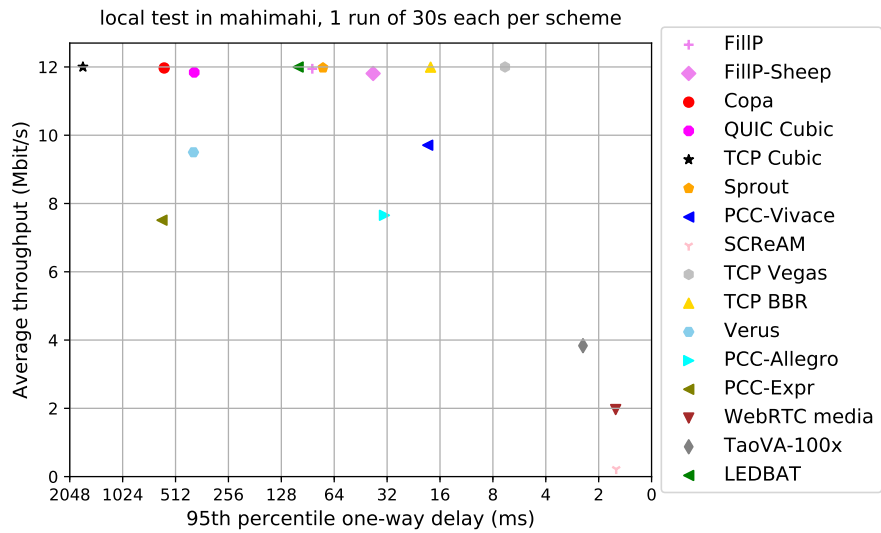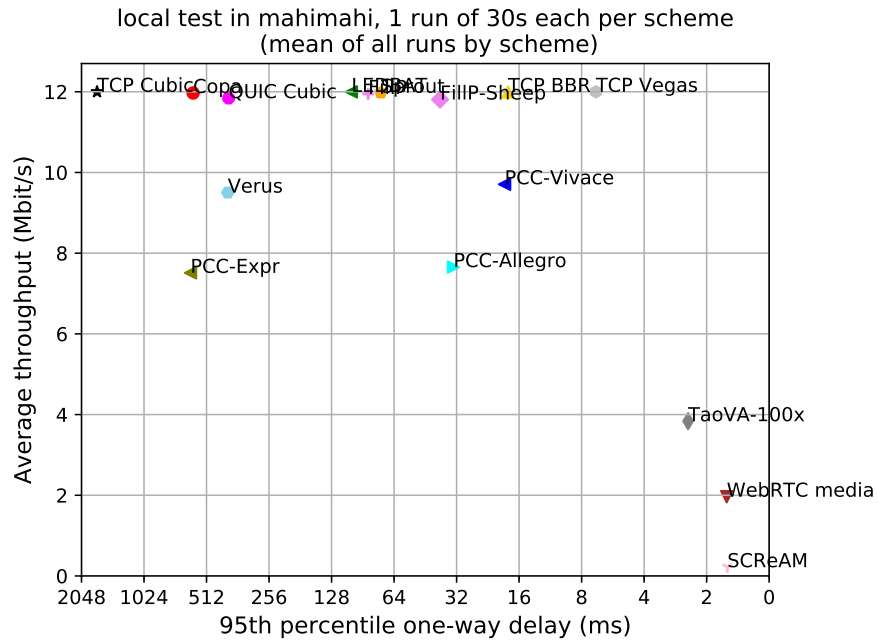# Pantheon Report

Generated at 2022-03-04 03:54:51 (UTC).
Tested in mahimahi: `mm-link 12mbps.trace 12mbps.trace`
Repeated the test of 17 congestion control schemes once.
Each test lasted for 30 seconds running 1 flow.

```
System info:
Linux 4.15.0-159-generic
net.core.default_qdisc = fq_codel
net.core.rmem_default = 212992
net.core.rmem_max = 212992
net.core.wmem_default = 212992
net.core.wmem_max = 212992
net.ipv4.tcp_rmem = 4096 131072 6291456
net.ipv4.tcp_wmem = 4096 16384 4194304

Git summary:
branch: master @ 48b2df337a5c6c4f976b79fa7960bf7dec170372
third_party/fillp @ d6da1459332fcee56963885d7eba17e6a32d4519
third_party/fillp-sheep @ 0e5bb722943babcd2b090d2c64fcd45e12e923f9
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdfe58e562f4
third_party/indigo @ 463d89b09699a57bfdfbae351646df6a60040b90
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/pantheon-tunnel @ f866d3f58d27afd942717625ee3a354cc2e802bd
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
 M src/examples/cellsim.cc
 M src/examples/sproutbt2.cc
 M src/network/sproutconn.cc
third_party/verus @ d4b447ea74c6c60a261149af2629562939f9a494
 M src/verus.hpp
 M tools/plot.py
third_party/vivace @ 2baf86211435ae071a32f96b7d8c504587f5d7f4
third_party/webrtc @ 3f0cc2a9061a41b6f9dde4735770d143a1fa2851
```

local test in mahimahi, 1 run of 30s each per scheme
(mean of all runs by scheme)

Plot axes: Average throughput (Mbit/s) vs 95th percentile one-way delay (ms)

Labels: TCP Cubic, Copa, QUIC Cubic, LEDBAT, Sprout, FillP-Sheep, TCP BBR, TCP Vegas, Verus, PCC-Vivace, PCC-Expr, PCC-Allegro, TaoVA-100x, WebRTC media, SCReAM

local test in mahimahi, 1 run of 30s each per scheme

Legend:
- FillP
- FillP-Sheep
- Copa
- QUIC Cubic
- TCP Cubic
- Sprout
- PCC-Vivace
- SCReAM
- TCP Vegas
- TCP BBR
- Verus
- PCC-Allegro
- PCC-Expr
- WebRTC media
- TaoVA-100x
- LEDBAT

2

scheme	# runs	mean avg tput (Mbit/s) flow 1	mean 95th-%ile delay (ms) flow 1	mean loss rate (%) flow 1
TCP BBR	1	11.99	18.10	0.05
Copa	1	11.97	594.13	2.18
TCP Cubic	1	12.00	1723.52	3.06
FillP	1	11.95	85.30	0.28
FillP-Sheep	1	11.81	38.43	0.10
Indigo	0	N/A	N/A	N/A
LEDBAT	1	12.00	102.73	0.34
PCC-Allegro	1	7.65	33.13	0.04
PCC-Expr	1	7.51	611.75	0.01
QUIC Cubic	1	11.84	400.81	1.47
SCReAM	1	0.22	1.34	0.00
Sprout	1	11.98	74.14	0.22
TaoVA-100x	1	3.84	2.46	0.00
TCP Vegas	1	12.00	6.83	0.02
Verus	1	9.50	404.74	0.01
PCC-Vivace	1	9.71	18.79	0.00
WebRTC media	1	1.96	1.36	0.00

```
Run 1: Statistics of TCP BBR

Start at: 2022-03-04 03:47:07
End at: 2022-03-04 03:47:37

# Below is generated by plot.py at 2022-03-04 03:54:46
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 11.99 Mbit/s (100.0% utilization)
95th percentile per-packet one-way delay: 18.100 ms
Loss rate: 0.05%
-- Flow 1:
Average throughput: 11.99 Mbit/s
95th percentile per-packet one-way delay: 18.100 ms
Loss rate: 0.05%
```
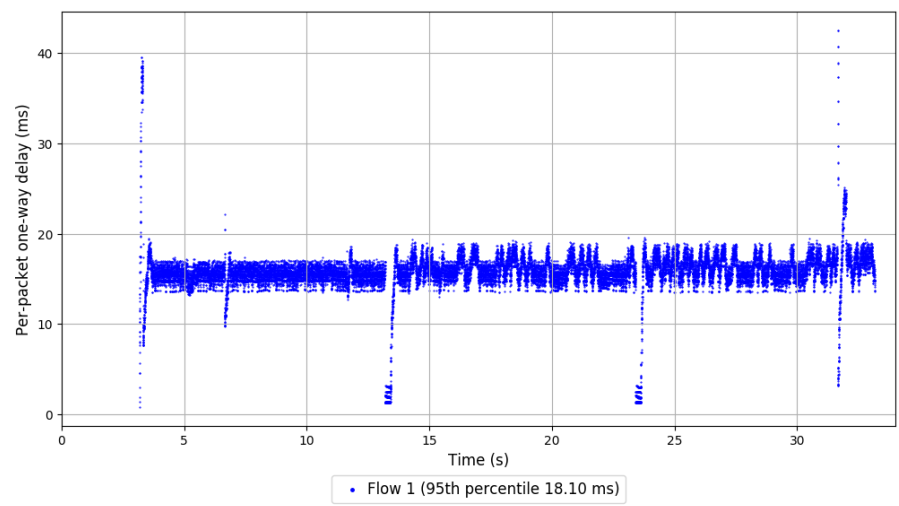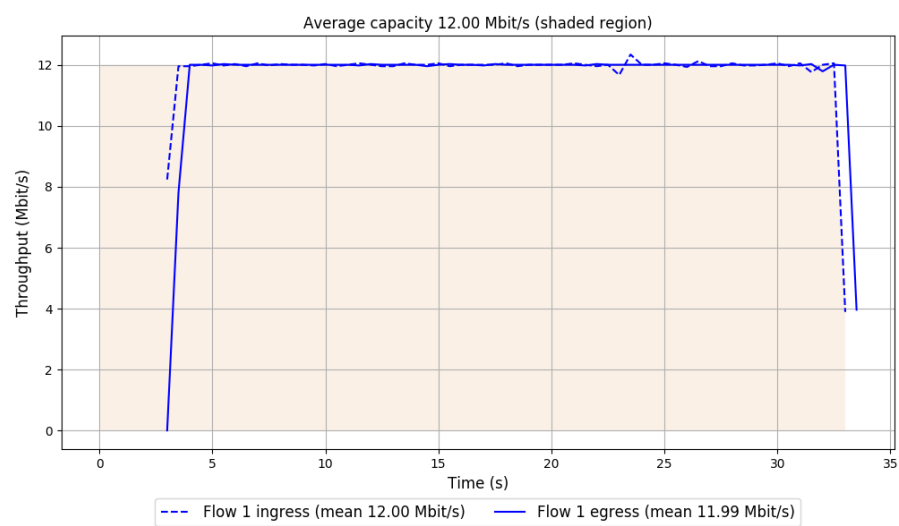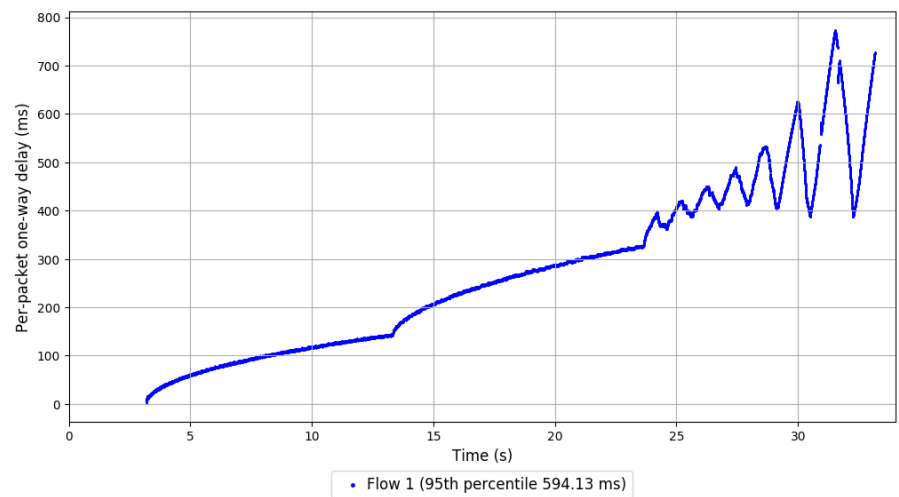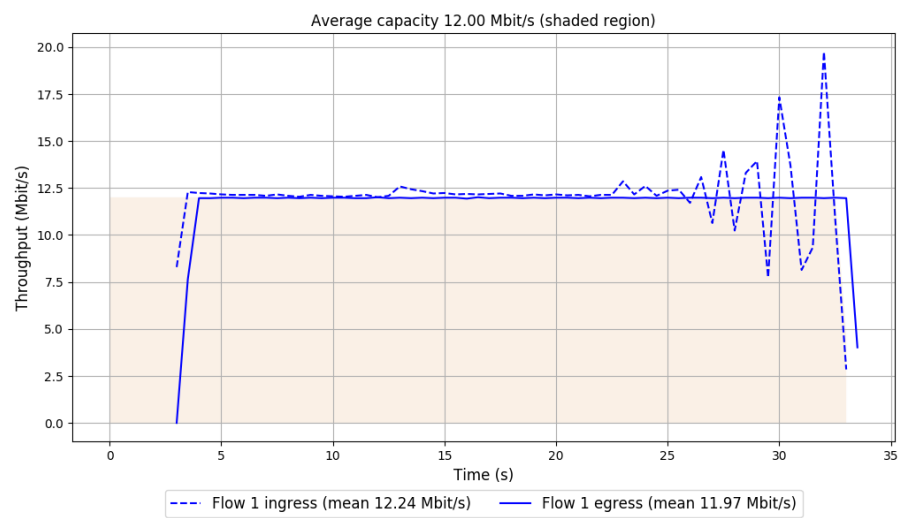
Run 1: Report of TCP BBR — Data Link

Average capacity 12.00 Mbit/s (shaded region)

- - - Flow 1 ingress (mean 12.00 Mbit/s) ⎯⎯ Flow 1 egress (mean 11.99 Mbit/s)

• Flow 1 (95th percentile 18.10 ms)

5

```
Run 1: Statistics of Copa

Start at: 2022-03-04 03:43:07
End at: 2022-03-04 03:43:37

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 11.97 Mbit/s (99.7% utilization)
95th percentile per-packet one-way delay: 594.135 ms
Loss rate: 2.18%
-- Flow 1:
Average throughput: 11.97 Mbit/s
95th percentile per-packet one-way delay: 594.135 ms
Loss rate: 2.18%
```
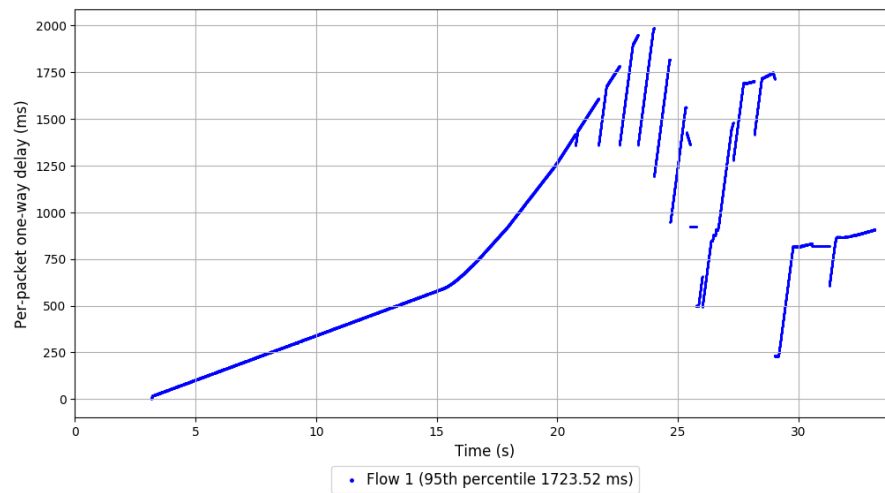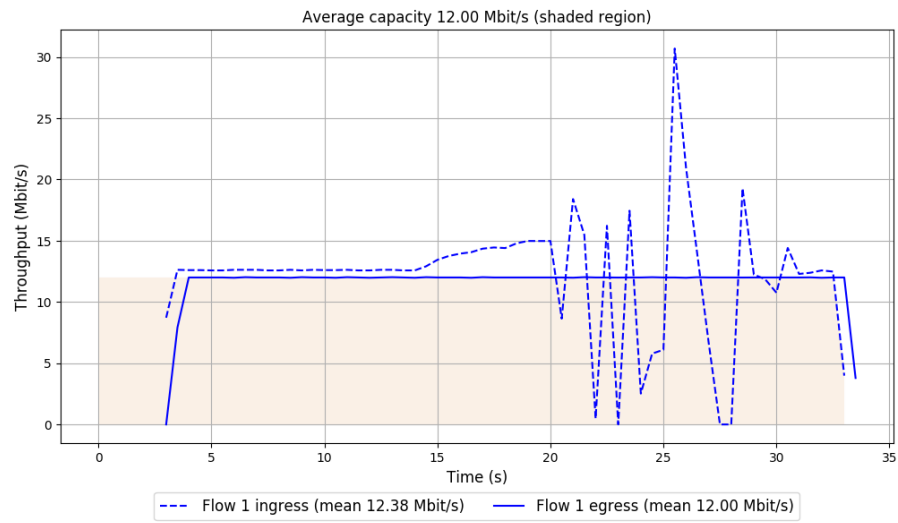
Run 1: Report of Copa — Data Link

Average capacity 12.00 Mbit/s (shaded region)

Flow 1 ingress (mean 12.24 Mbit/s)   Flow 1 egress (mean 11.97 Mbit/s)

Flow 1 (95th percentile 594.13 ms)

```
Run 1: Statistics of TCP Cubic

Start at: 2022-03-04 03:44:50
End at: 2022-03-04 03:45:20

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 12.00 Mbit/s (100.0% utilization)
95th percentile per-packet one-way delay: 1723.515 ms
Loss rate: 3.06%
-- Flow 1:
Average throughput: 12.00 Mbit/s
95th percentile per-packet one-way delay: 1723.515 ms
Loss rate: 3.06%
```

Run 1: Report of TCP Cubic — Data Link

Average capacity 12.00 Mbit/s (shaded region)

Flow 1 ingress (mean 12.38 Mbit/s)   Flow 1 egress (mean 12.00 Mbit/s)
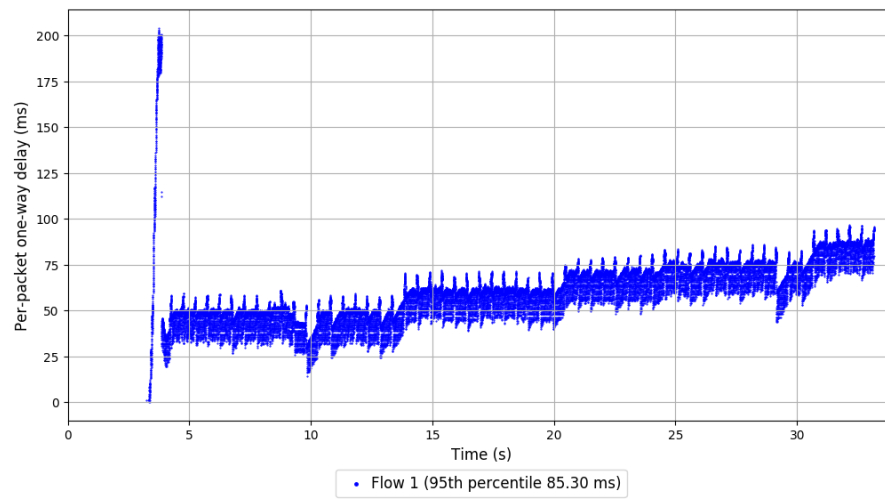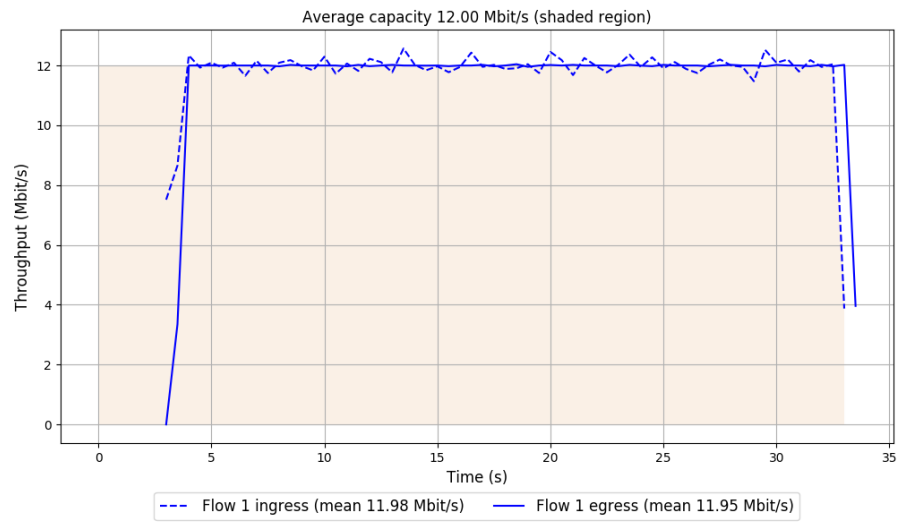

Flow 1 (95th percentile 1723.52 ms)

9

```
Run 1: Statistics of FillP

Start at: 2022-03-04 03:48:16
End at: 2022-03-04 03:48:46

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 11.95 Mbit/s (99.6% utilization)
95th percentile per-packet one-way delay: 85.297 ms
Loss rate: 0.28%
-- Flow 1:
Average throughput: 11.95 Mbit/s
95th percentile per-packet one-way delay: 85.297 ms
Loss rate: 0.28%
```
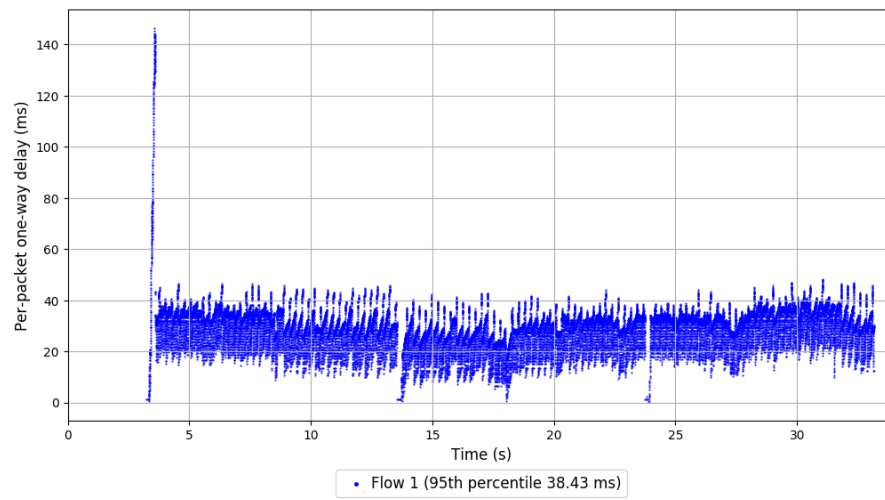
Run 1: Report of FillP — Data Link

Average capacity 12.00 Mbit/s (shaded region)

Flow 1 ingress (mean 11.98 Mbit/s)   Flow 1 egress (mean 11.95 Mbit/s)

Flow 1 (95th percentile 85.30 ms)

```
Run 1: Statistics of FillP-Sheep

Start at: 2022-03-04 03:42:33
End at: 2022-03-04 03:43:03

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 11.81 Mbit/s (98.4% utilization)
95th percentile per-packet one-way delay: 38.426 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 11.81 Mbit/s
95th percentile per-packet one-way delay: 38.426 ms
Loss rate: 0.10%
```
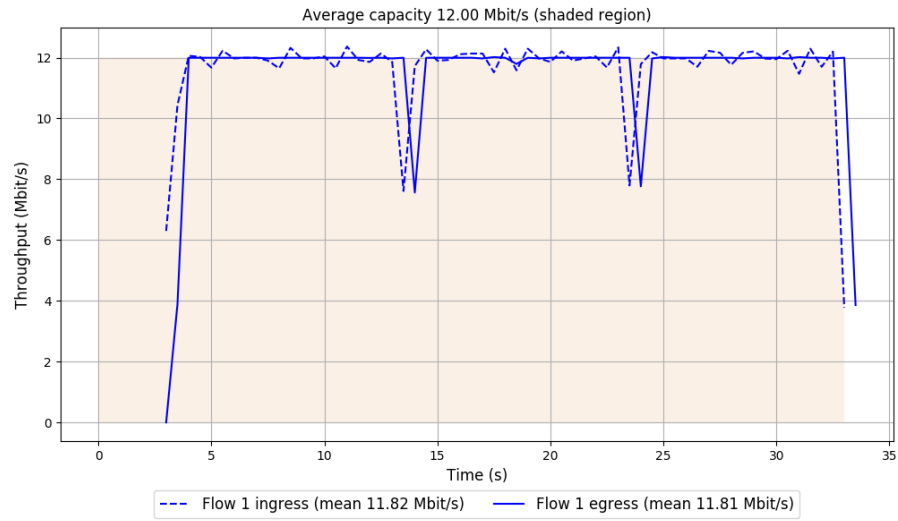
Run 1: Report of FillP-Sheep — Data Link

Average capacity 12.00 Mbit/s (shaded region)

Flow 1 ingress (mean 11.82 Mbit/s) —— Flow 1 egress (mean 11.81 Mbit/s)

• Flow 1 (95th percentile 38.43 ms)

Run 1: Statistics of Indigo

Start at: 2022-03-04 03:43:42
End at: 2022-03-04 03:44:12
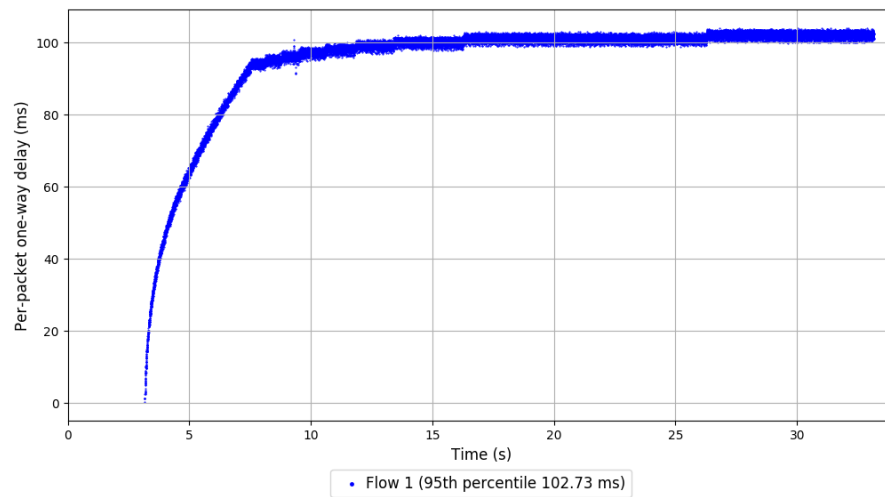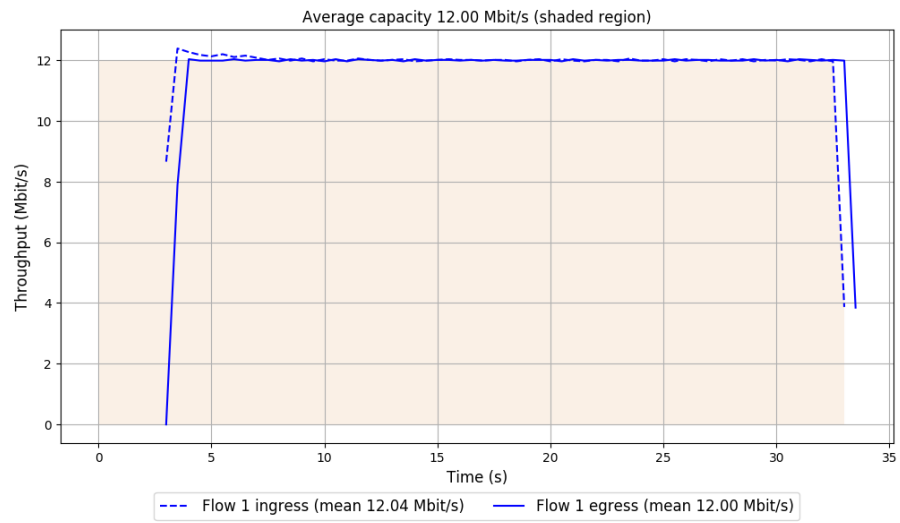
Run 1: Report of Indigo — Data Link

Figure is missing

Figure is missing

```
Run 1: Statistics of LEDBAT

Start at: 2022-03-04 03:51:07
End at: 2022-03-04 03:51:37

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 12.00 Mbit/s (100.0% utilization)
95th percentile per-packet one-way delay: 102.735 ms
Loss rate: 0.34%
-- Flow 1:
Average throughput: 12.00 Mbit/s
95th percentile per-packet one-way delay: 102.735 ms
Loss rate: 0.34%
```

Run 1: Report of LEDBAT — Data Link

Average capacity 12.00 Mbit/s (shaded region)

Flow 1 ingress (mean 12.04 Mbit/s)　　Flow 1 egress (mean 12.00 Mbit/s)
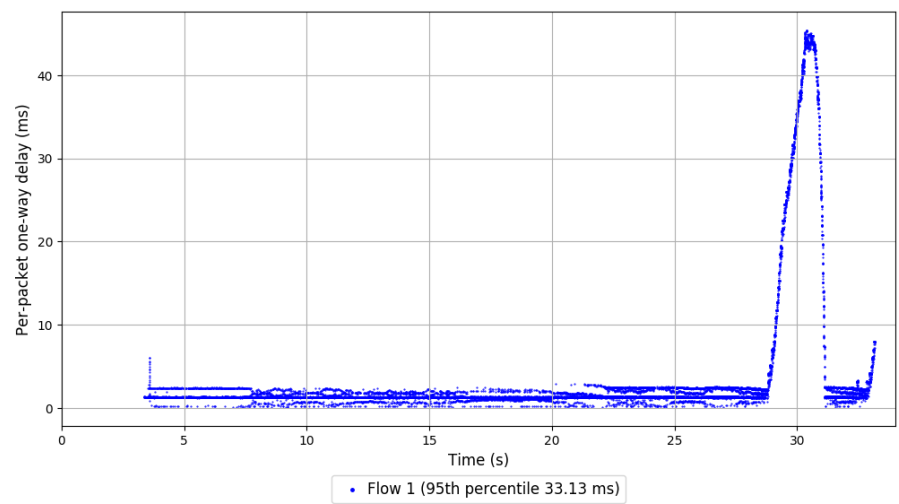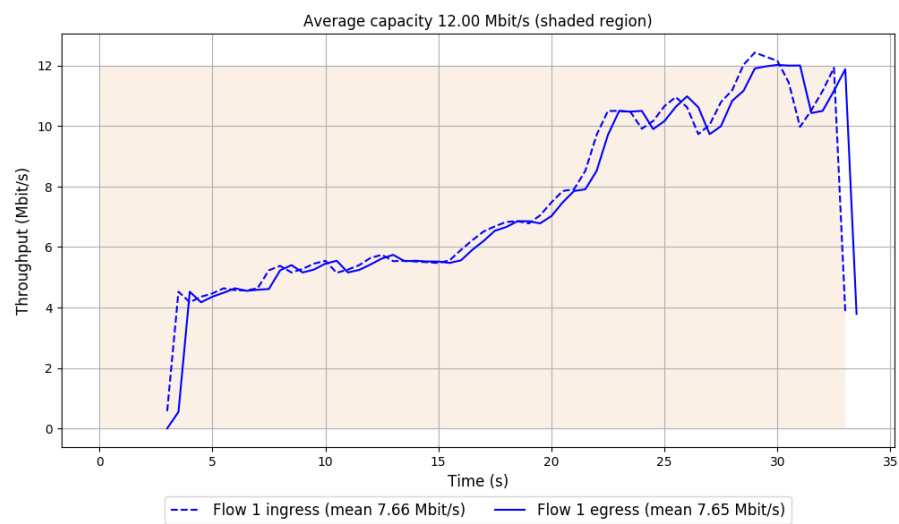

Flow 1 (95th percentile 102.73 ms)

```
Run 1: Statistics of PCC-Allegro

Start at: 2022-03-04 03:49:59
End at: 2022-03-04 03:50:29

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 7.65 Mbit/s (63.8% utilization)
95th percentile per-packet one-way delay: 33.126 ms
Loss rate: 0.04%
-- Flow 1:
Average throughput: 7.65 Mbit/s
95th percentile per-packet one-way delay: 33.126 ms
Loss rate: 0.04%
```

Run 1: Report of PCC-Allegro — Data Link

Average capacity 12.00 Mbit/s (shaded region)

--- Flow 1 ingress (mean 7.66 Mbit/s)   —— Flow 1 egress (mean 7.65 Mbit/s)
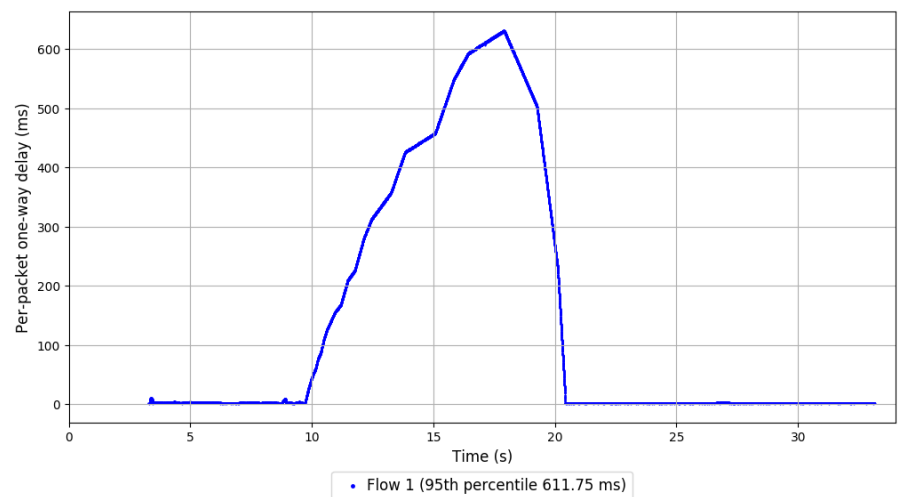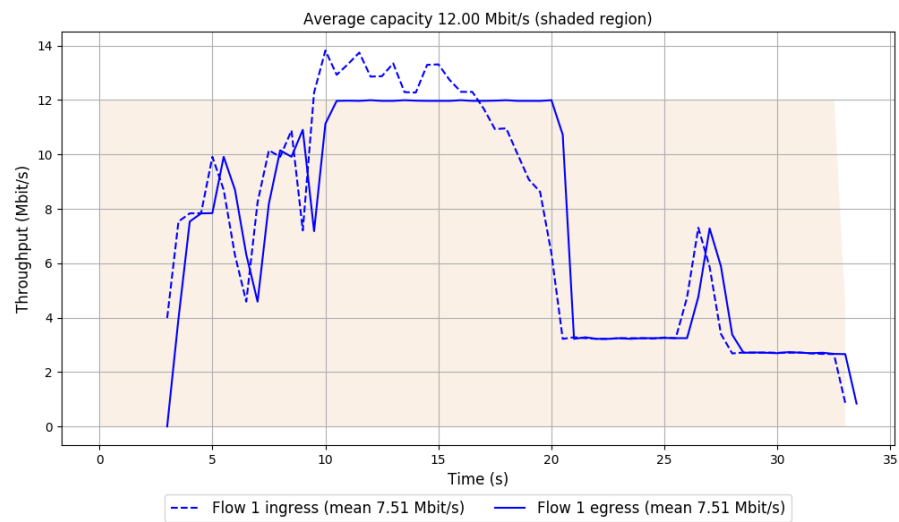

• Flow 1 (95th percentile 33.13 ms)

19

```
Run 1: Statistics of PCC-Expr

Start at: 2022-03-04 03:51:41
End at: 2022-03-04 03:52:11

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 7.51 Mbit/s (62.6% utilization)
95th percentile per-packet one-way delay: 611.748 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 7.51 Mbit/s
95th percentile per-packet one-way delay: 611.748 ms
Loss rate: 0.01%
```

Run 1: Report of PCC-Expr — Data Link

Average capacity 12.00 Mbit/s (shaded region)

--- Flow 1 ingress (mean 7.51 Mbit/s) —— Flow 1 egress (mean 7.51 Mbit/s)

• Flow 1 (95th percentile 611.75 ms)

```
Run 1: Statistics of QUIC Cubic

Start at: 2022-03-04 03:49:24
End at: 2022-03-04 03:49:54

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 11.84 Mbit/s (98.7% utilization)
95th percentile per-packet one-way delay: 400.815 ms
Loss rate: 1.47%
-- Flow 1:
Average throughput: 11.84 Mbit/s
95th percentile per-packet one-way delay: 400.815 ms
Loss rate: 1.47%
```
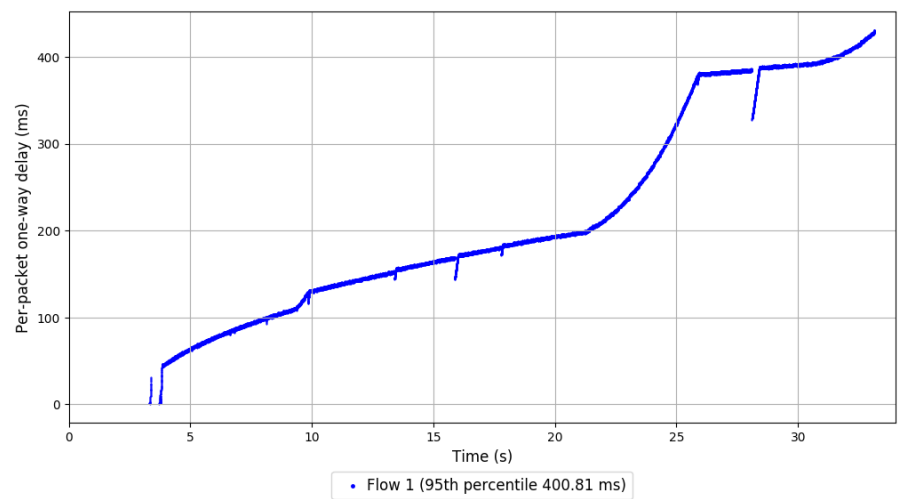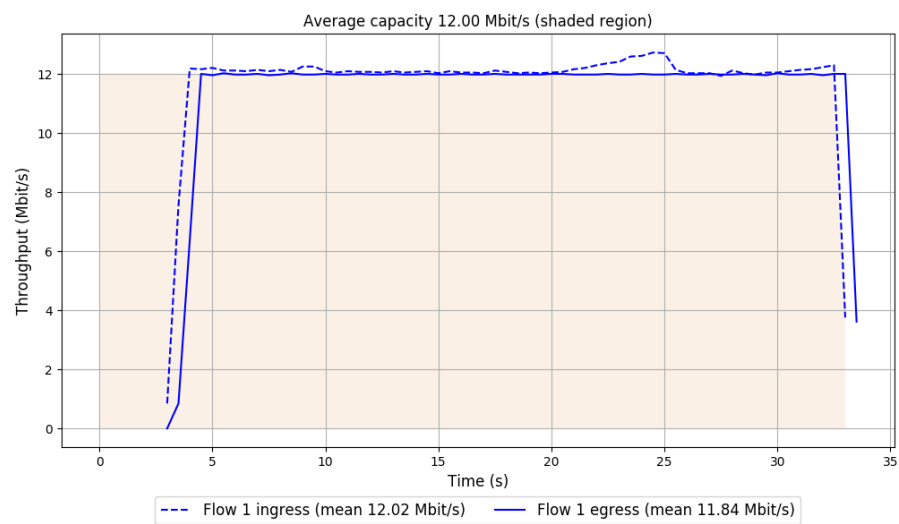
Run 1: Report of QUIC Cubic — Data Link

Average capacity 12.00 Mbit/s (shaded region)

Flow 1 ingress (mean 12.02 Mbit/s)   Flow 1 egress (mean 11.84 Mbit/s)
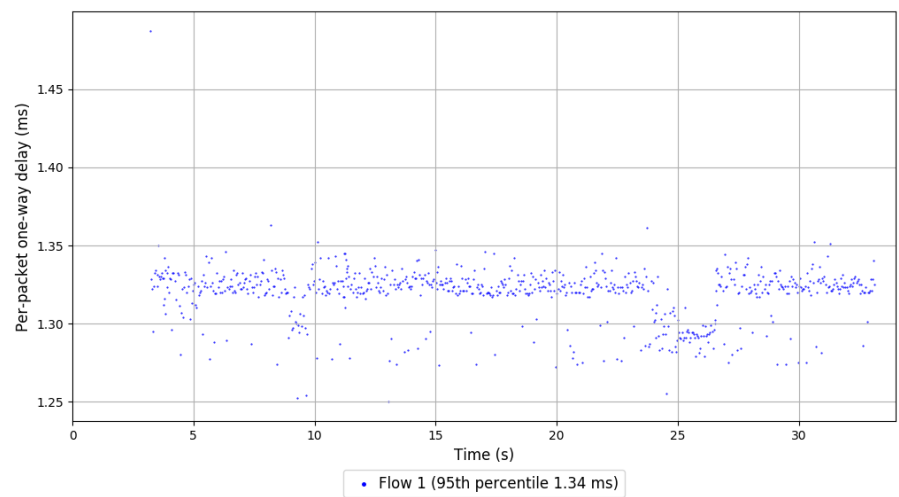

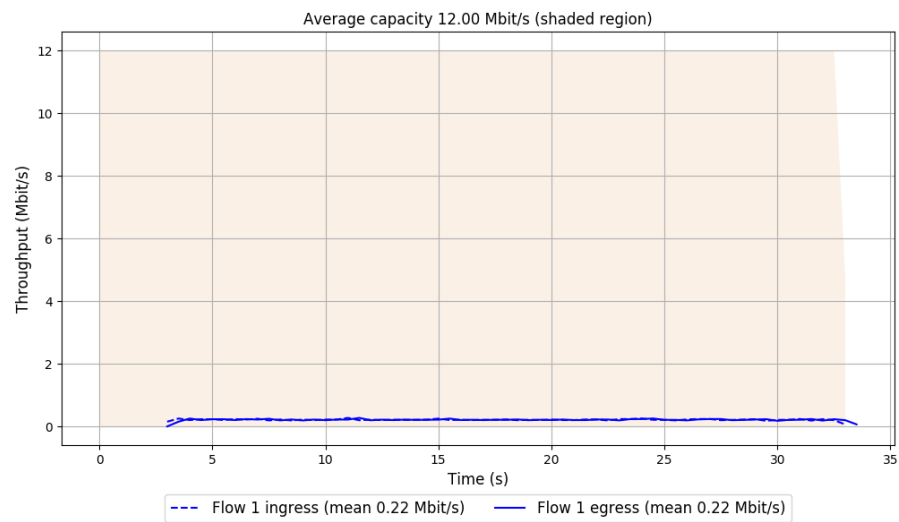Flow 1 (95th percentile 400.81 ms)

```
Run 1: Statistics of SCReAM

Start at: 2022-03-04 03:48:50
End at: 2022-03-04 03:49:20

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 0.22 Mbit/s (1.8% utilization)
95th percentile per-packet one-way delay: 1.338 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.22 Mbit/s
95th percentile per-packet one-way delay: 1.338 ms
Loss rate: 0.00%
```

Run 1: Report of SCReAM — Data Link

Average capacity 12.00 Mbit/s (shaded region)

Flow 1 ingress (mean 0.22 Mbit/s)   Flow 1 egress (mean 0.22 Mbit/s)

Flow 1 (95th percentile 1.34 ms)

```
Run 1: Statistics of Sprout

Start at: 2022-03-04 03:45:25
End at: 2022-03-04 03:45:55

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 11.98 Mbit/s (99.8% utilization)
95th percentile per-packet one-way delay: 74.145 ms
Loss rate: 0.22%
-- Flow 1:
Average throughput: 11.98 Mbit/s
95th percentile per-packet one-way delay: 74.145 ms
Loss rate: 0.22%
```
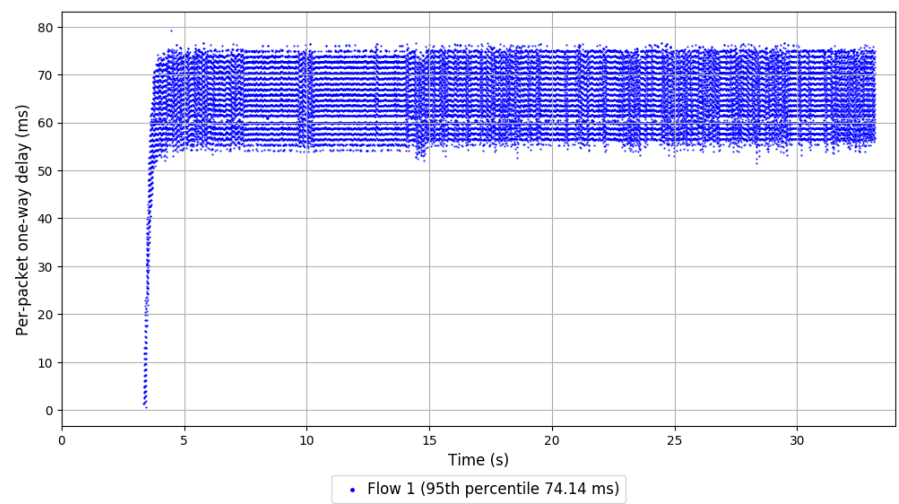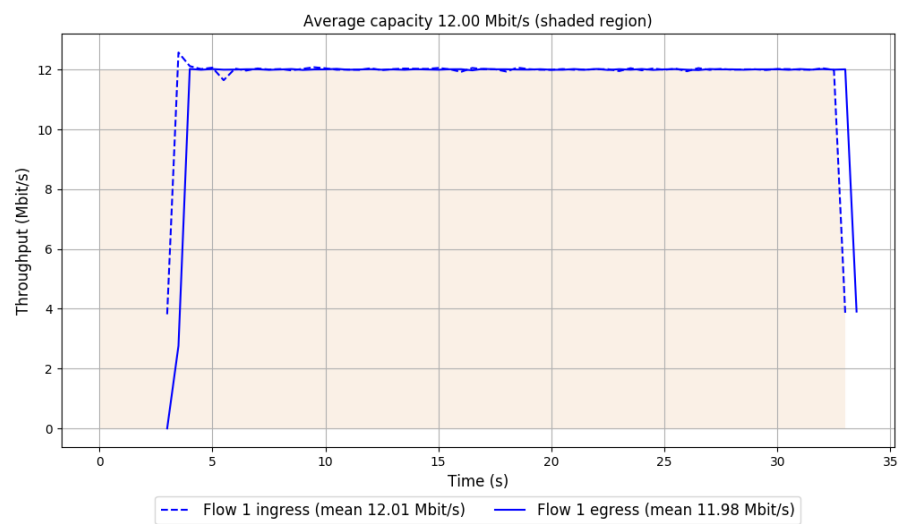
Run 1: Report of Sprout — Data Link

Average capacity 12.00 Mbit/s (shaded region)

Flow 1 ingress (mean 12.01 Mbit/s)   Flow 1 egress (mean 11.98 Mbit/s)
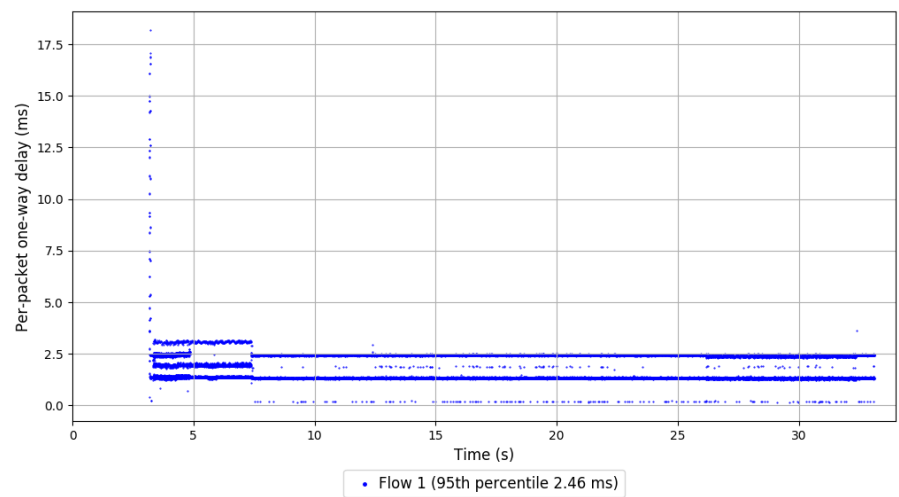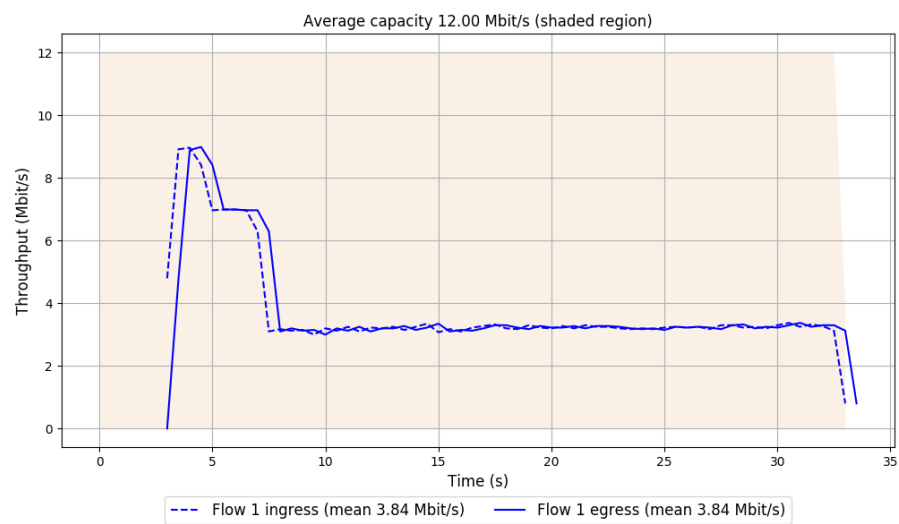

Flow 1 (95th percentile 74.14 ms)

```
Run 1: Statistics of TaoVA-100x

Start at: 2022-03-04 03:47:42
End at: 2022-03-04 03:48:12

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 3.84 Mbit/s (32.0% utilization)
95th percentile per-packet one-way delay: 2.457 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 3.84 Mbit/s
95th percentile per-packet one-way delay: 2.457 ms
Loss rate: 0.00%
```

Run 1: Report of TaoVA-100x — Data Link

Average capacity 12.00 Mbit/s (shaded region)

Flow 1 ingress (mean 3.84 Mbit/s) —— Flow 1 egress (mean 3.84 Mbit/s)

• Flow 1 (95th percentile 2.46 ms)

29

```
Run 1: Statistics of TCP Vegas

Start at: 2022-03-04 03:46:33
End at: 2022-03-04 03:47:03

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 12.00 Mbit/s (100.0% utilization)
95th percentile per-packet one-way delay: 6.825 ms
Loss rate: 0.02%
-- Flow 1:
Average throughput: 12.00 Mbit/s
95th percentile per-packet one-way delay: 6.825 ms
Loss rate: 0.02%
```
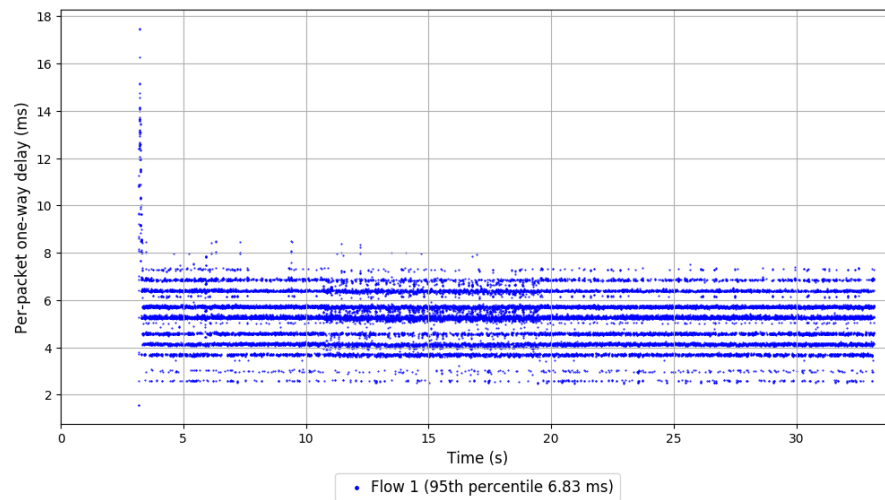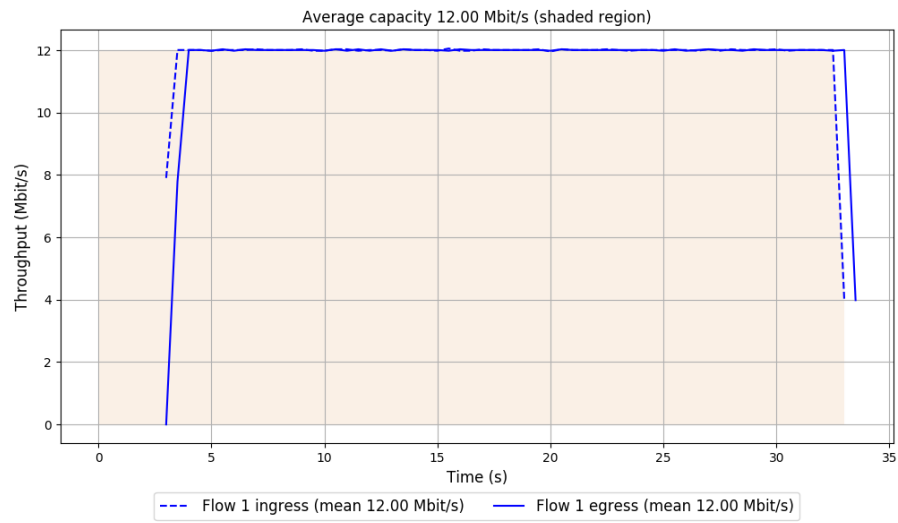
Run 1: Report of TCP Vegas — Data Link

Average capacity 12.00 Mbit/s (shaded region)

- - - Flow 1 ingress (mean 12.00 Mbit/s) ——— Flow 1 egress (mean 12.00 Mbit/s)

• Flow 1 (95th percentile 6.83 ms)

```
Run 1: Statistics of Verus

Start at: 2022-03-04 03:44:16
End at: 2022-03-04 03:44:46

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 9.50 Mbit/s (79.2% utilization)
95th percentile per-packet one-way delay: 404.735 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 9.50 Mbit/s
95th percentile per-packet one-way delay: 404.735 ms
Loss rate: 0.01%
```
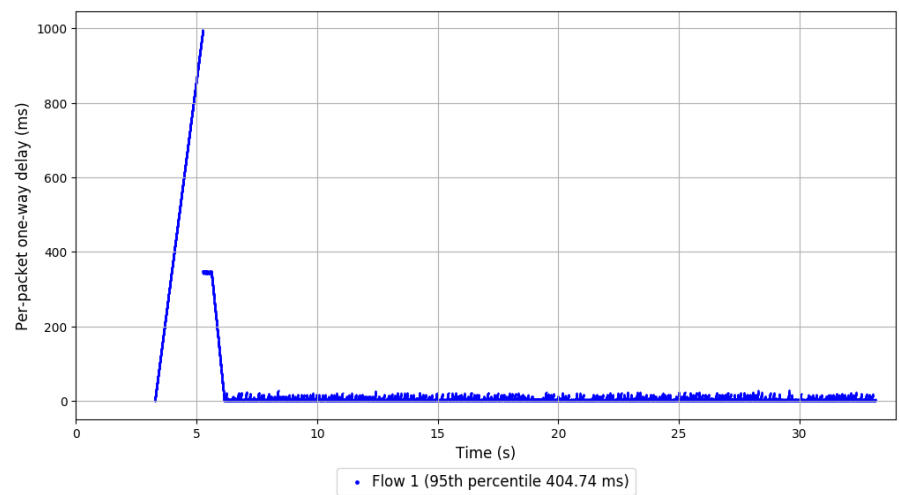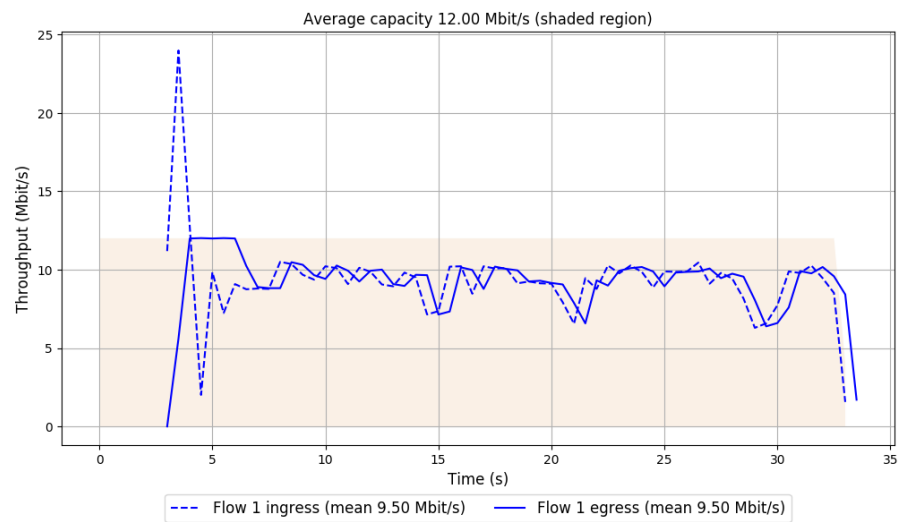
Run 1: Report of Verus — Data Link

Average capacity 12.00 Mbit/s (shaded region)

- - - Flow 1 ingress (mean 9.50 Mbit/s) —— Flow 1 egress (mean 9.50 Mbit/s)

• Flow 1 (95th percentile 404.74 ms)

```
Run 1: Statistics of PCC-Vivace

Start at: 2022-03-04 03:45:59
End at: 2022-03-04 03:46:29

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 9.71 Mbit/s (80.9% utilization)
95th percentile per-packet one-way delay: 18.794 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 9.71 Mbit/s
95th percentile per-packet one-way delay: 18.794 ms
Loss rate: 0.00%
```
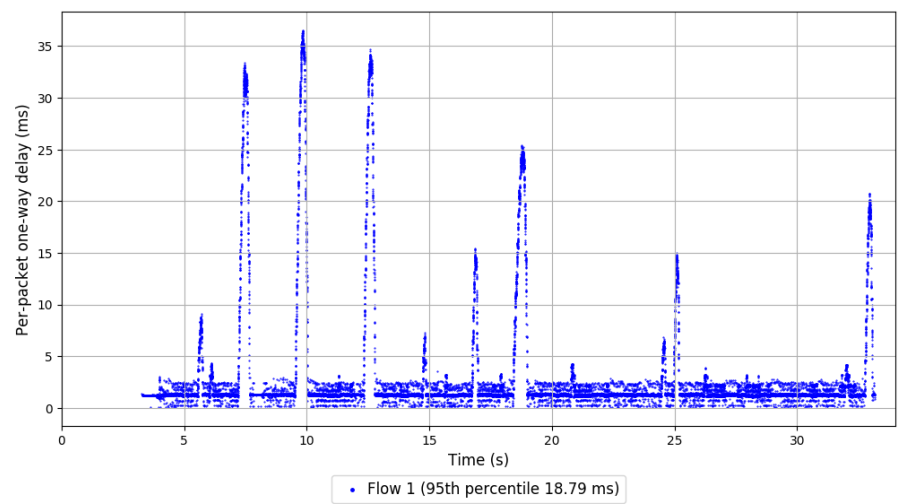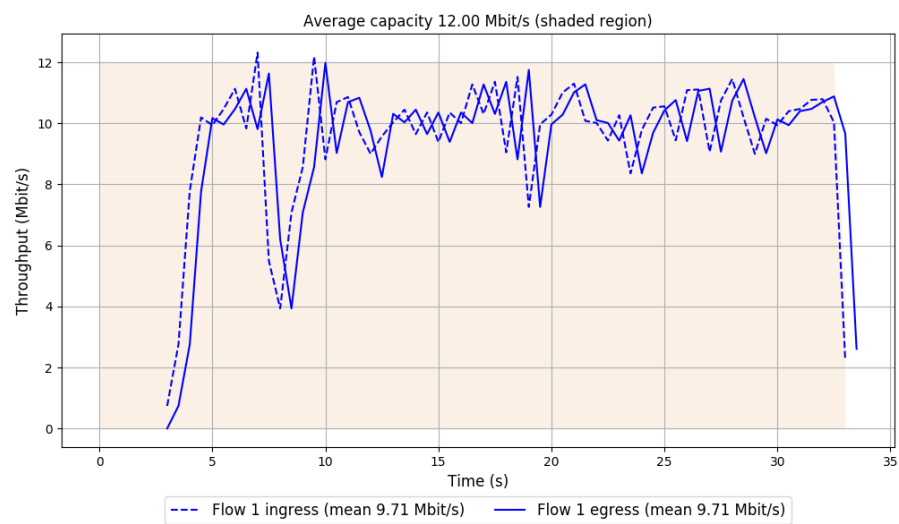
Run 1: Report of PCC-Vivace — Data Link

Average capacity 12.00 Mbit/s (shaded region)

--- Flow 1 ingress (mean 9.71 Mbit/s) ——— Flow 1 egress (mean 9.71 Mbit/s)

• Flow 1 (95th percentile 18.79 ms)

```
Run 1: Statistics of WebRTC media

Start at: 2022-03-04 03:50:33
End at: 2022-03-04 03:51:03

# Below is generated by plot.py at 2022-03-04 03:54:49
# Datalink statistics
-- Total of 1 flow:
Average capacity: 12.00 Mbit/s
Average throughput: 1.96 Mbit/s (16.4% utilization)
95th percentile per-packet one-way delay: 1.358 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 1.96 Mbit/s
95th percentile per-packet one-way delay: 1.358 ms
Loss rate: 0.00%
```

Run 1: Report of WebRTC media — Data Link

Average capacity 12.00 Mbit/s (shaded region)