Pantheon Report

Generated at 2017-09-19 02:25:46 (UTC).

Data path: AWS Korea Ethernet (*local*) →China ppp0 (*remote*).

Repeated the test of 10 congestion control schemes 3 times.

Each test lasted for 30 seconds running 1 flow.

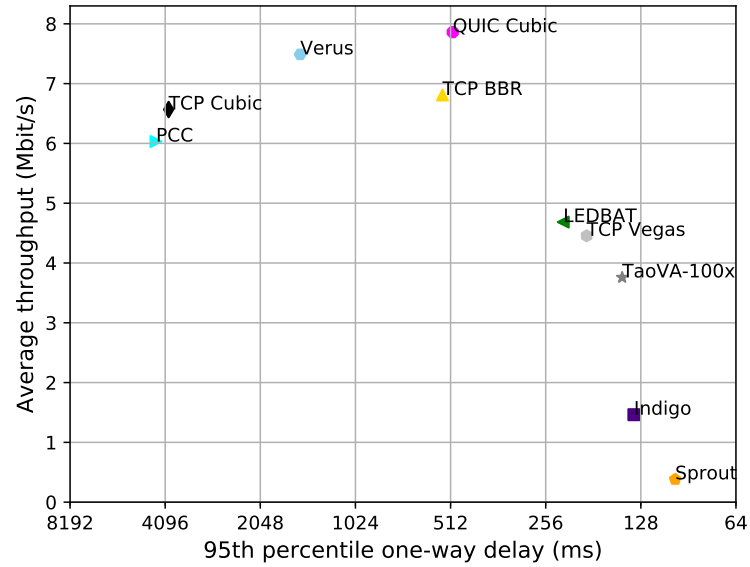Increased UDP receive buffer to 16 MB (default) and 32 MB (max).

Tested BBR with qdisc of Fair Queuing (`fq`), and other schemes with the default Linux qdisc (`pfifo_fast`).

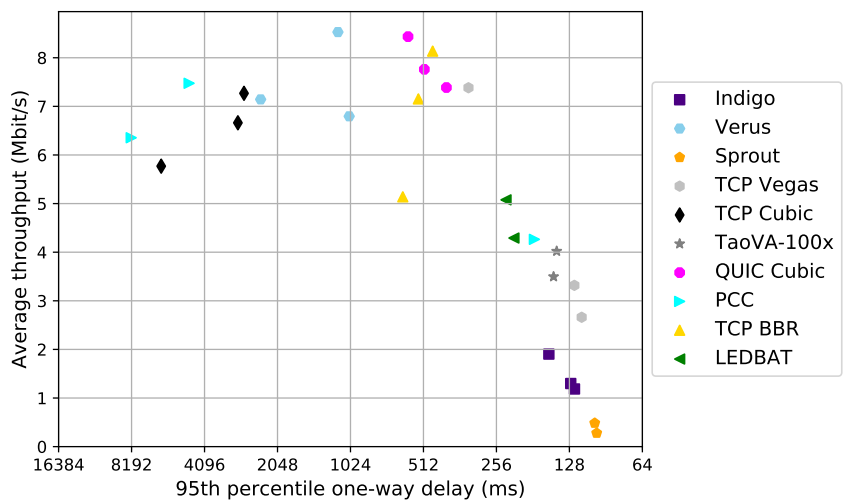NTP offsets were measured against `ntp.nict.jp` and have been applied to correct the timestamps in logs.

```
Git summary:
branch: master @ 57453dc11f8da93a2e03eea75289fea01b816298
third_party/calibrated_koho @ 3cb73c0d1c0322cdfae446ea37a522e53227db50
 M datagrump/sender.cc
third_party/genericCC @ f7ca42f251bf49b432bb71de6d13fa903515c366
third_party/indigo @ b19f3730105f9aa95452552af924e3719b03cc55
third_party/koho_cc @ f0f2e693303aee82ea808e6928eac4f1083a6681
 M datagrump/sender.cc
third_party/libutp @ b3465b942e2826f2b179eaab4a906ce6bb7cf3cf
third_party/pantheon-tunnel @ baf443516dea3eeddeccaf9b916cc313273ca4f4
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/proto-quic @ 77961f1a82733a86b42f1bc8143ebc978f3cff42
third_party/scream @ c3370fd7bd17265a79aeb34e4016ad23f5965885
third_party/sourdough @ f1a14bffe749737437f61b1eaeeb30b267cde681
third_party/sprout @ 6f2efe6e088d91066a9f023df375eee2665089ce
 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/webrtc @ a488197ddd041ace68a42849b2540ad834825f42
```

test from AWS Korea Ethernet to China ppp0, 3 runs of 30s each per scheme
(mean of all runs by scheme)

test from AWS Korea Ethernet to China ppp0, 3 runs of 30s each per scheme

scheme	# runs	mean avg tput (Mbit/s) flow 1	mean 95th-%ile delay (ms) flow 1	mean loss rate (%) flow 1
TCP BBR	3	6.81	543.15	0.89
TCP Cubic	3	6.57	3993.90	5.66
Indigo	3	1.46	134.65	0.18
LEDBAT	2	4.69	225.34	0.71
PCC	3	6.03	4379.42	13.83
QUIC Cubic	3	7.86	504.08	1.58
Sprout	2	0.38	99.70	0.74
TaoVA-100x	2	3.76	146.65	0.14
TCP Vegas	3	4.45	189.96	0.16
Verus	3	7.49	1531.38	2.64

```
Run 1: Statistics of TCP BBR

Start at: 2017-09-19 01:52:45
End at: 2017-09-19 01:53:15
Local clock offset: -0.243 ms
Remote clock offset: -1.375 ms

# Below is generated by plot.py at 2017-09-19 02:25:17
# Datalink statistics
-- Total of 1 flow:
Average throughput: 5.14 Mbit/s
95th percentile per-packet one-way delay: 623.031 ms
Loss rate: 1.00%
-- Flow 1:
Average throughput: 5.14 Mbit/s
95th percentile per-packet one-way delay: 623.031 ms
Loss rate: 1.00%
```
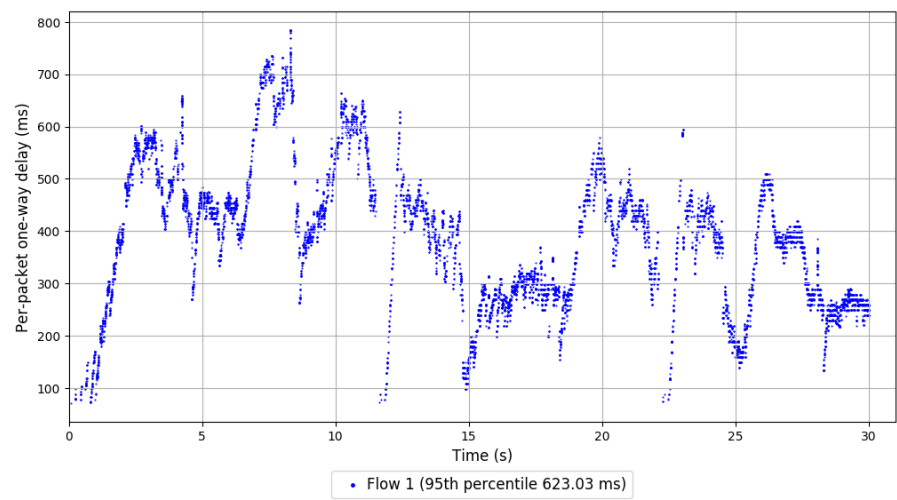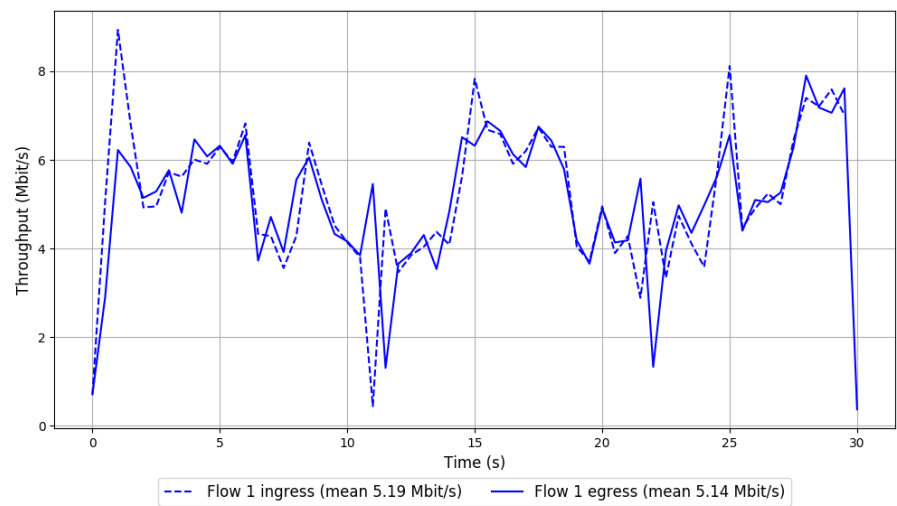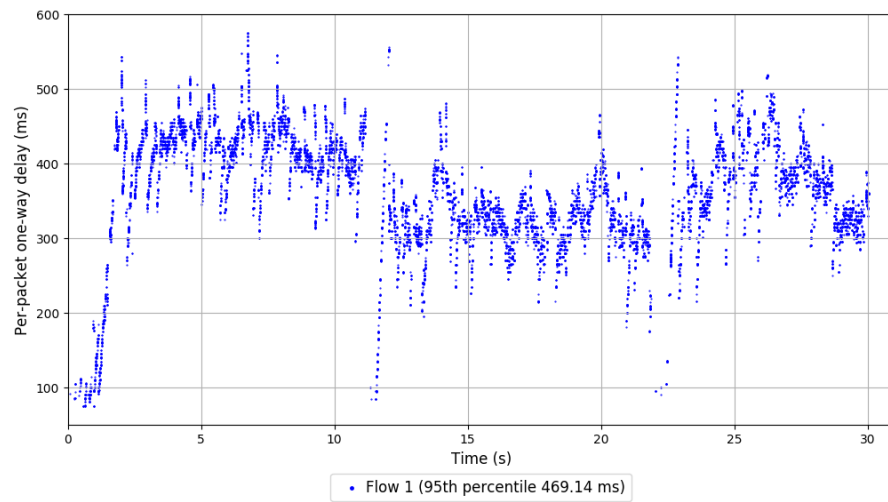
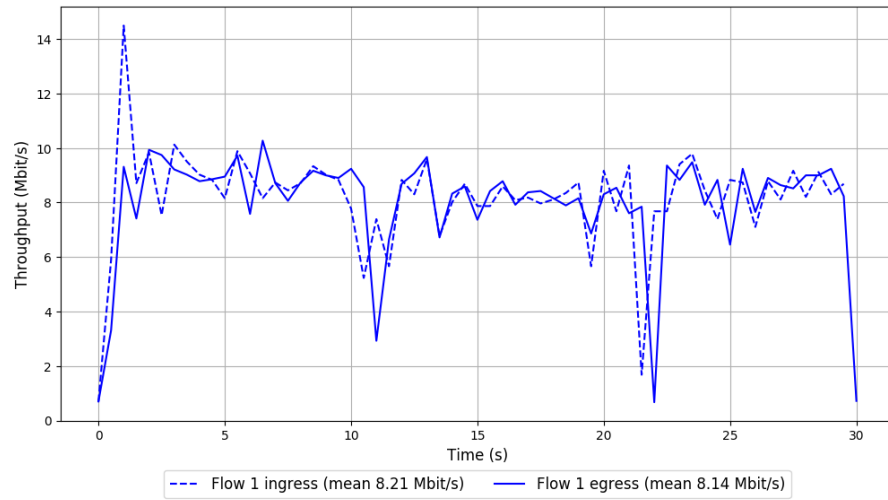Run 1: Report of TCP BBR — Data Link

```
Run 2: Statistics of TCP BBR

Start at: 2017-09-19 02:04:21
End at: 2017-09-19 02:04:51
Local clock offset: -0.884 ms
Remote clock offset: -1.126 ms


# Below is generated by plot.py at 2017-09-19 02:25:22
# Datalink statistics
-- Total of 1 flow:
Average throughput: 8.14 Mbit/s
95th percentile per-packet one-way delay: 469.145 ms
Loss rate: 0.99%
-- Flow 1:
Average throughput: 8.14 Mbit/s
95th percentile per-packet one-way delay: 469.145 ms
Loss rate: 0.99%
```

Run 2: Report of TCP BBR — Data Link

Flow 1 ingress (mean 8.21 Mbit/s)   Flow 1 egress (mean 8.14 Mbit/s)

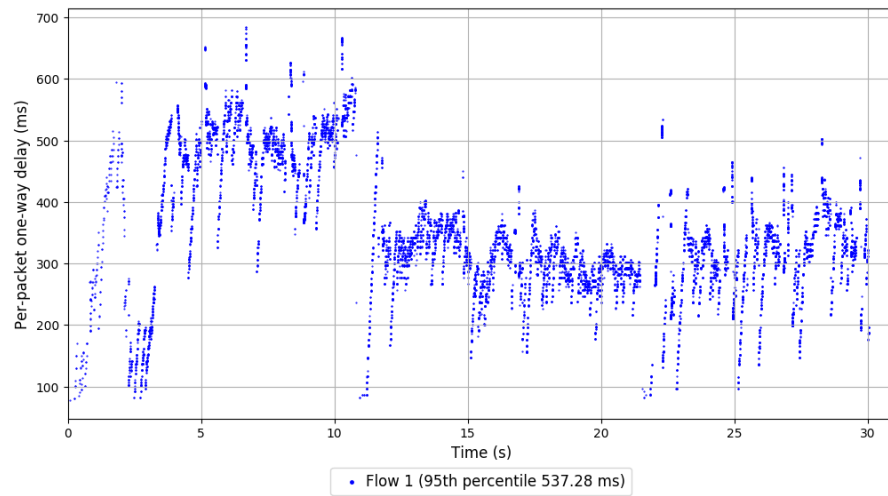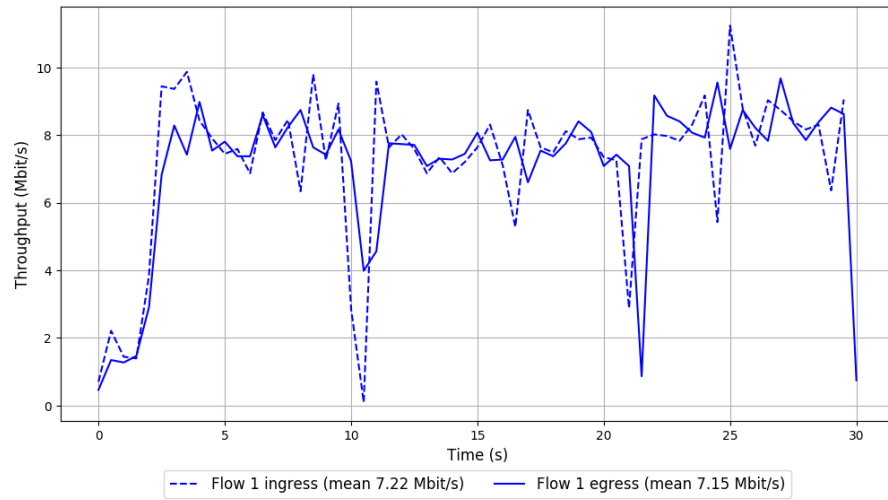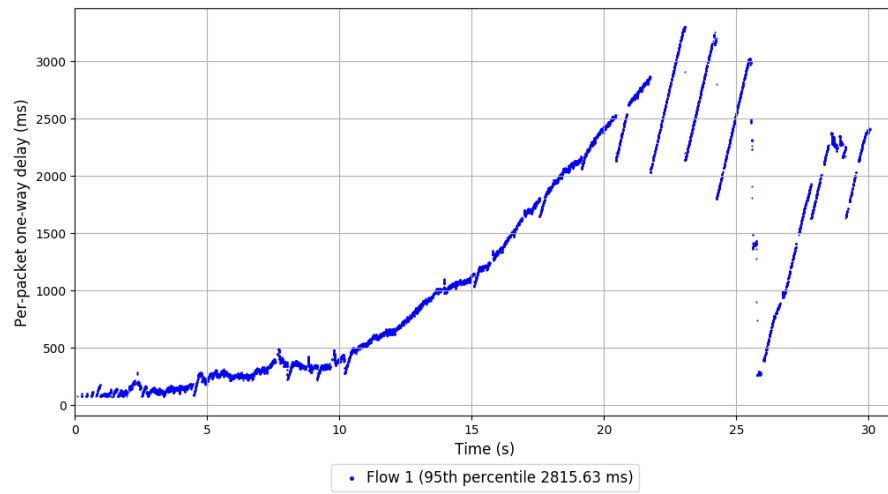- Flow 1 (95th percentile 469.14 ms)

```
Run 3: Statistics of TCP BBR

Start at: 2017-09-19 02:16:37
End at: 2017-09-19 02:17:07
Local clock offset: -1.525 ms
Remote clock offset: -1.073 ms


# Below is generated by plot.py at 2017-09-19 02:25:22
# Datalink statistics
-- Total of 1 flow:
Average throughput: 7.15 Mbit/s
95th percentile per-packet one-way delay: 537.278 ms
Loss rate: 0.69%
-- Flow 1:
Average throughput: 7.15 Mbit/s
95th percentile per-packet one-way delay: 537.278 ms
Loss rate: 0.69%
```

Run 3: Report of TCP BBR — Data Link

Flow 1 ingress (mean 7.22 Mbit/s)   Flow 1 egress (mean 7.15 Mbit/s)

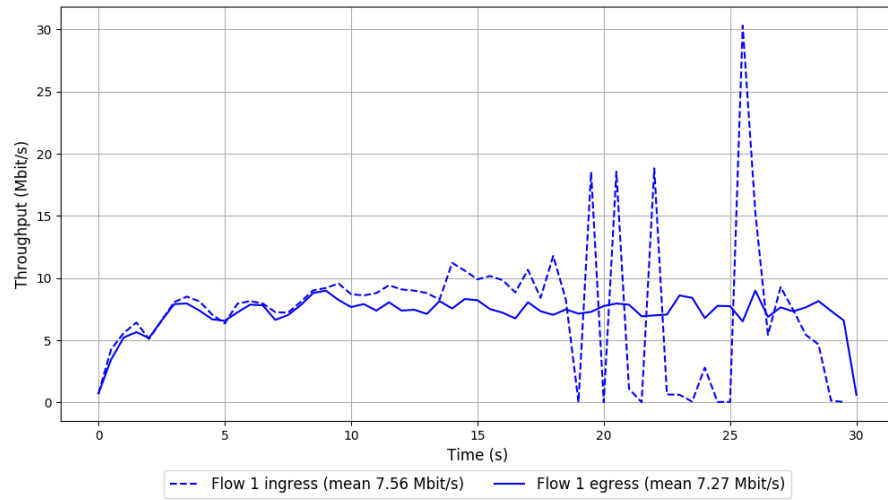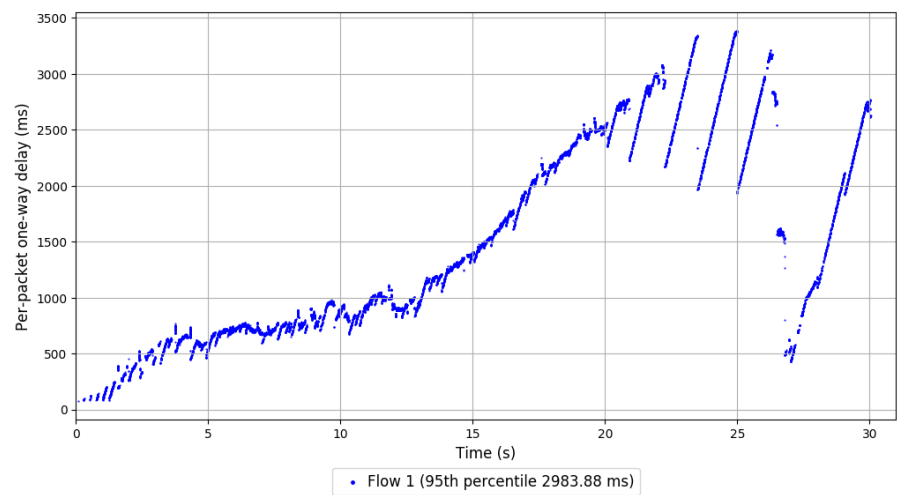Flow 1 (95th percentile 537.28 ms)

```
Run 1: Statistics of TCP Cubic

Start at: 2017-09-19 01:58:33
End at: 2017-09-19 01:59:03
Local clock offset: -0.634 ms
Remote clock offset: -1.261 ms


# Below is generated by plot.py at 2017-09-19 02:25:22
# Datalink statistics
-- Total of 1 flow:
Average throughput: 7.27 Mbit/s
95th percentile per-packet one-way delay: 2815.629 ms
Loss rate: 3.22%
-- Flow 1:
Average throughput: 7.27 Mbit/s
95th percentile per-packet one-way delay: 2815.629 ms
Loss rate: 3.22%
```
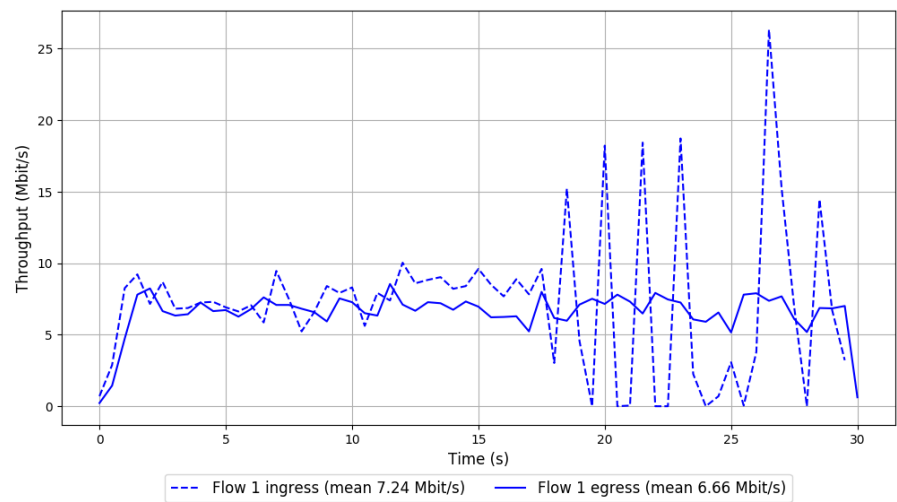
Run 1: Report of TCP Cubic — Data Link

```
Run 2: Statistics of TCP Cubic

Start at: 2017-09-19 02:10:19
End at: 2017-09-19 02:10:49
Local clock offset: -1.159 ms
Remote clock offset: -1.065 ms


# Below is generated by plot.py at 2017-09-19 02:25:22
# Datalink statistics
-- Total of 1 flow:
Average throughput: 6.66 Mbit/s
95th percentile per-packet one-way delay: 2983.882 ms
Loss rate: 7.58%
-- Flow 1:
Average throughput: 6.66 Mbit/s
95th percentile per-packet one-way delay: 2983.882 ms
Loss rate: 7.58%
```
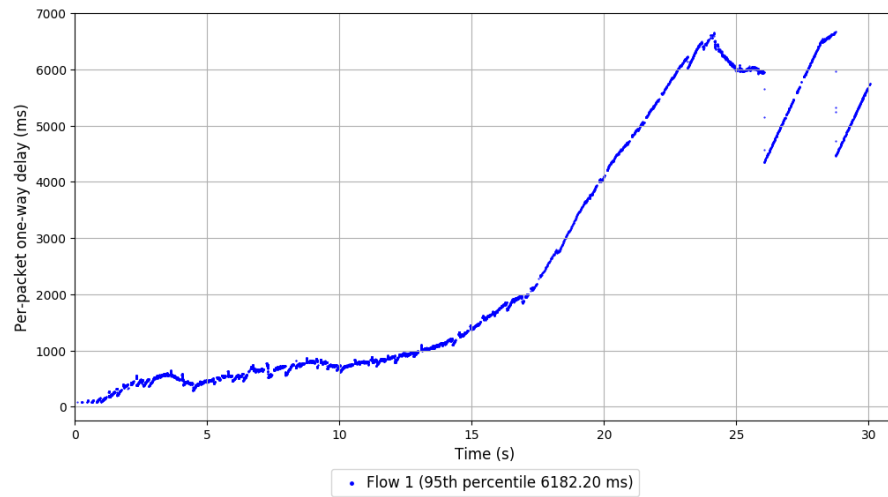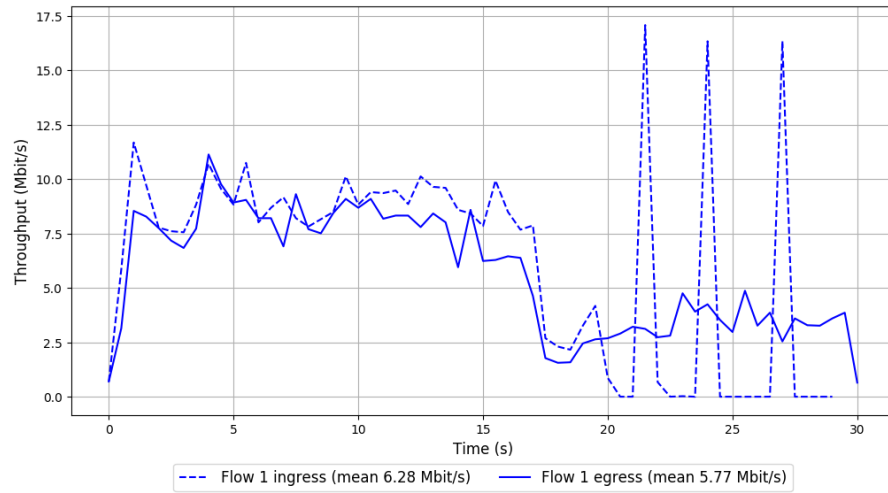
Run 2: Report of TCP Cubic — Data Link

```
Run 3: Statistics of TCP Cubic

Start at: 2017-09-19 02:22:33
End at: 2017-09-19 02:23:03
Local clock offset: -1.457 ms
Remote clock offset: -0.922 ms


# Below is generated by plot.py at 2017-09-19 02:25:22
# Datalink statistics
-- Total of 1 flow:
Average throughput: 5.77 Mbit/s
95th percentile per-packet one-way delay: 6182.198 ms
Loss rate: 6.19%
-- Flow 1:
Average throughput: 5.77 Mbit/s
95th percentile per-packet one-way delay: 6182.198 ms
Loss rate: 6.19%
```

Run 3: Report of TCP Cubic — Data Link

Flow 1 ingress (mean 6.28 Mbit/s) --- Flow 1 egress (mean 5.77 Mbit/s)

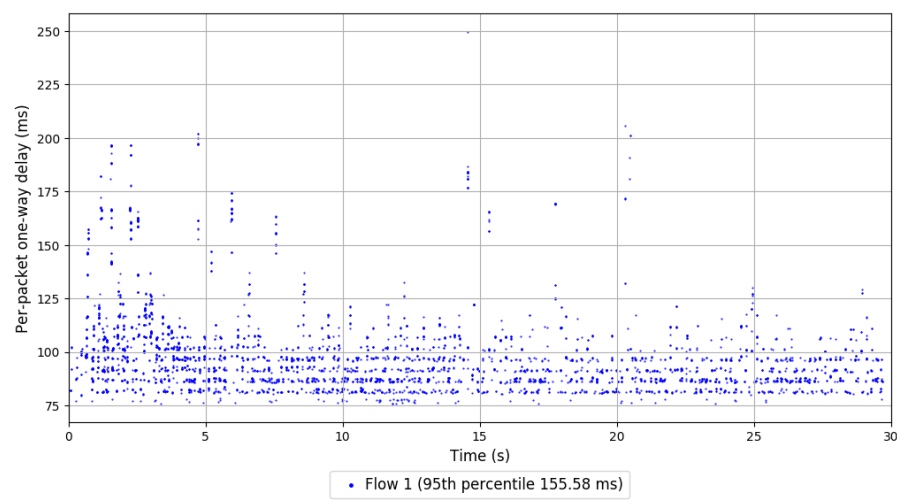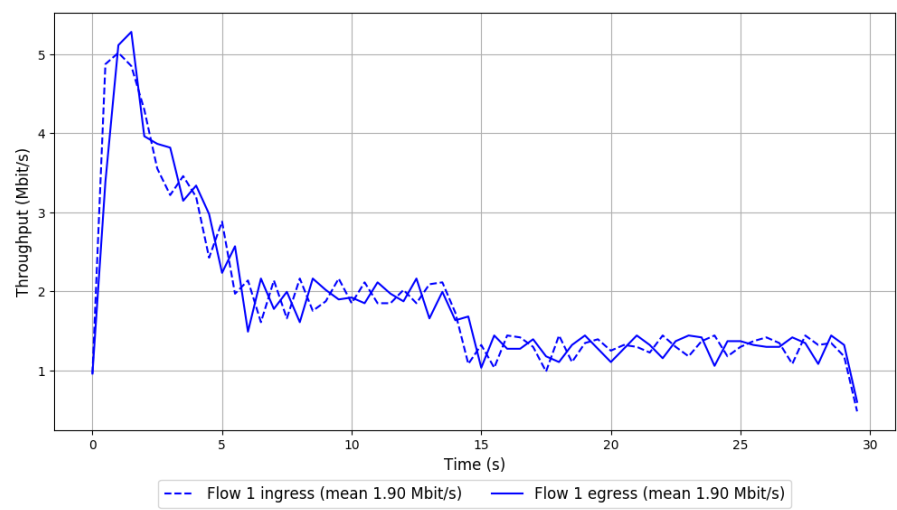
Flow 1 (95th percentile 6182.20 ms)

```
Run 1: Statistics of Indigo

Start at: 2017-09-19 01:51:36
End at: 2017-09-19 01:52:06
Local clock offset: 0.968 ms
Remote clock offset: -1.391 ms


# Below is generated by plot.py at 2017-09-19 02:25:22
# Datalink statistics
-- Total of 1 flow:
Average throughput: 1.90 Mbit/s
95th percentile per-packet one-way delay: 155.577 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 1.90 Mbit/s
95th percentile per-packet one-way delay: 155.577 ms
Loss rate: 0.00%
```

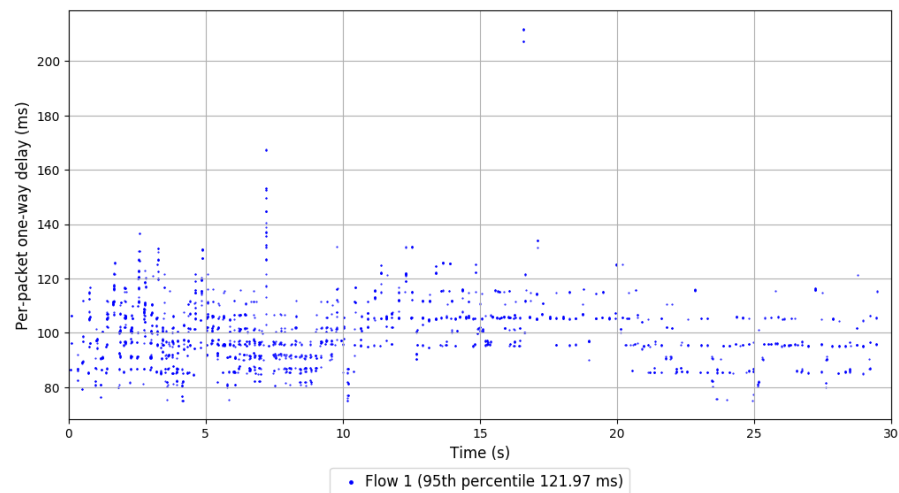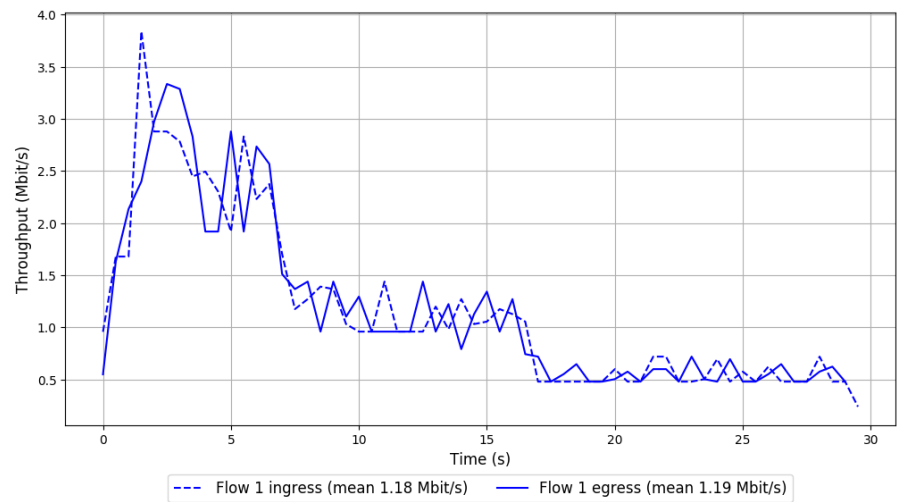# Run 1: Report of Indigo — Data Link

```
Run 2: Statistics of Indigo

Start at: 2017-09-19 02:03:11
End at: 2017-09-19 02:03:41
Local clock offset: 0.183 ms
Remote clock offset: -1.169 ms


# Below is generated by plot.py at 2017-09-19 02:25:22
# Datalink statistics
-- Total of 1 flow:
Average throughput: 1.19 Mbit/s
95th percentile per-packet one-way delay: 121.972 ms
Loss rate: 0.34%
-- Flow 1:
Average throughput: 1.19 Mbit/s
95th percentile per-packet one-way delay: 121.972 ms
Loss rate: 0.34%
```

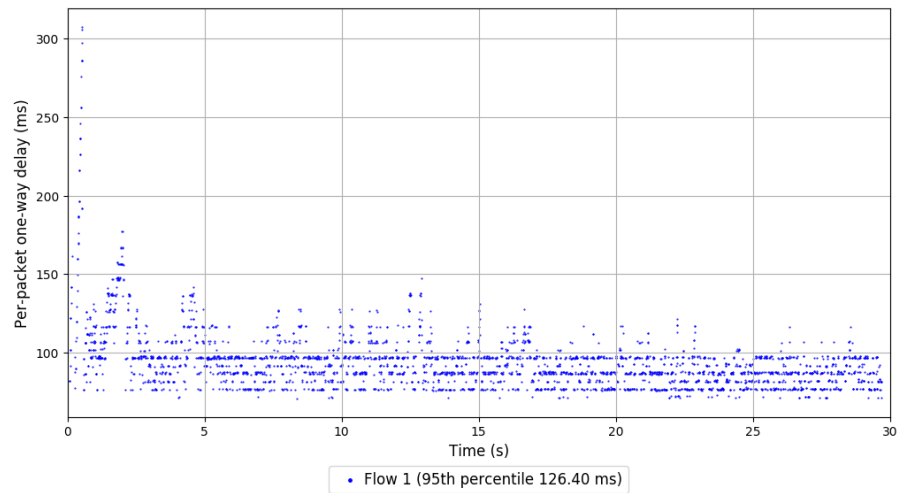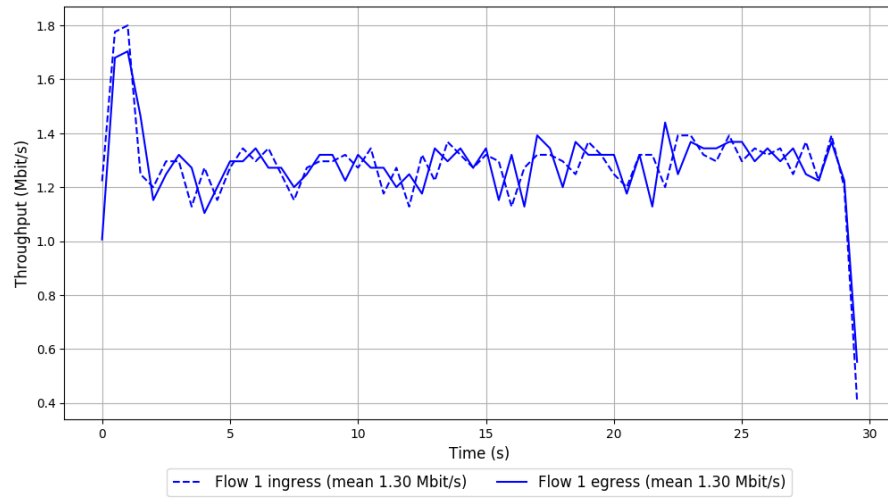Run 2: Report of Indigo — Data Link

```
Run 3: Statistics of Indigo

Start at: 2017-09-19 02:15:27
End at: 2017-09-19 02:15:57
Local clock offset: -1.409 ms
Remote clock offset: -0.857 ms

# Below is generated by plot.py at 2017-09-19 02:25:22
# Datalink statistics
-- Total of 1 flow:
Average throughput: 1.30 Mbit/s
95th percentile per-packet one-way delay: 126.399 ms
Loss rate: 0.19%
-- Flow 1:
Average throughput: 1.30 Mbit/s
95th percentile per-packet one-way delay: 126.399 ms
Loss rate: 0.19%
```

Run 3: Report of Indigo — Data Link

Flow 1 ingress (mean 1.30 Mbit/s) --- Flow 1 egress (mean 1.30 Mbit/s)

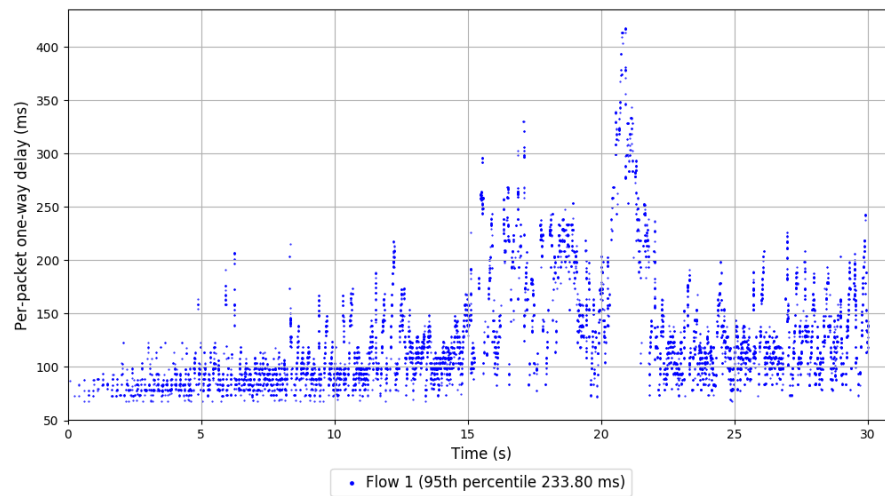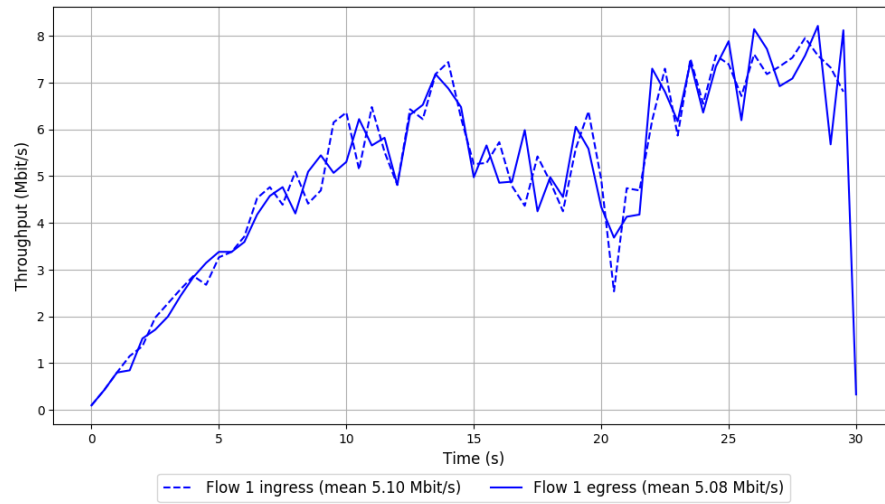• Flow 1 (95th percentile 126.40 ms)

```
Run 1: Statistics of LEDBAT

Start at: 2017-09-19 01:56:14
End at: 2017-09-19 01:56:44
Local clock offset: 0.605 ms
Remote clock offset: -1.29 ms


# Below is generated by plot.py at 2017-09-19 02:25:22
# Datalink statistics
-- Total of 1 flow:
Average throughput: 5.08 Mbit/s
95th percentile per-packet one-way delay: 233.804 ms
Loss rate: 0.51%
-- Flow 1:
Average throughput: 5.08 Mbit/s
95th percentile per-packet one-way delay: 233.804 ms
Loss rate: 0.51%
```

Run 1: Report of LEDBAT — Data Link

Run 2: Statistics of LEDBAT
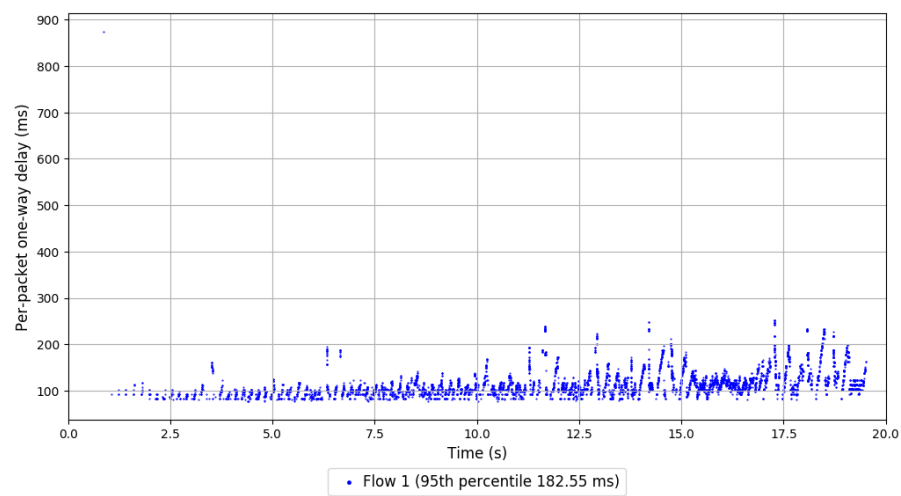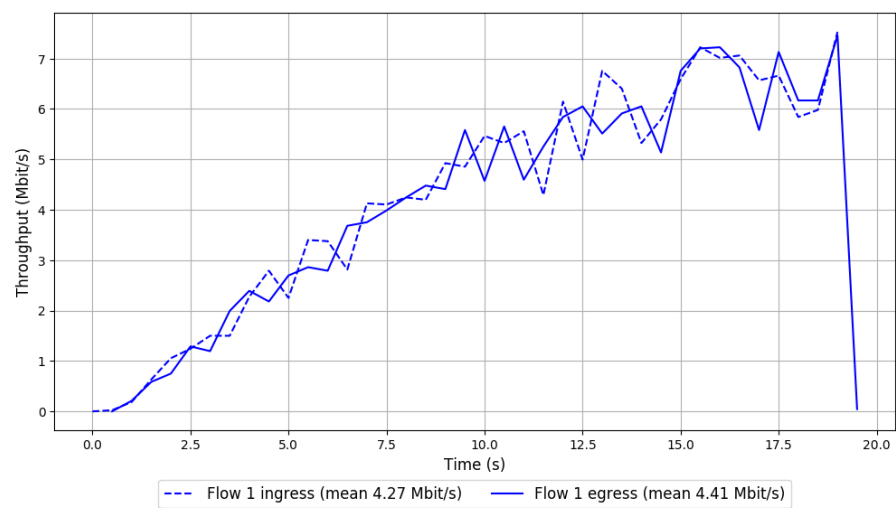
Start at: 2017-09-19 02:07:54
End at: 2017-09-19 02:08:24
Local clock offset: -0.071 ms
Remote clock offset: -1.154 ms

Run 2: Report of LEDBAT — Data Link

Flow 1 ingress (mean 4.27 Mbit/s)   —— Flow 1 egress (mean 4.41 Mbit/s)
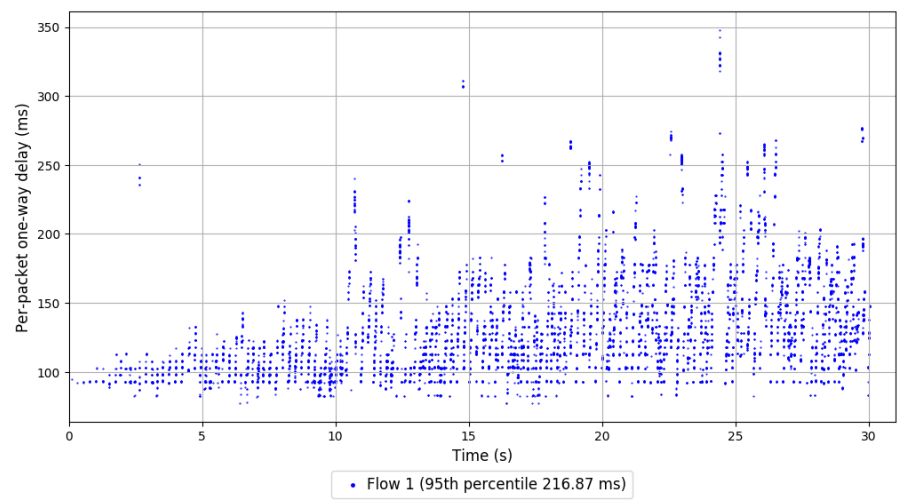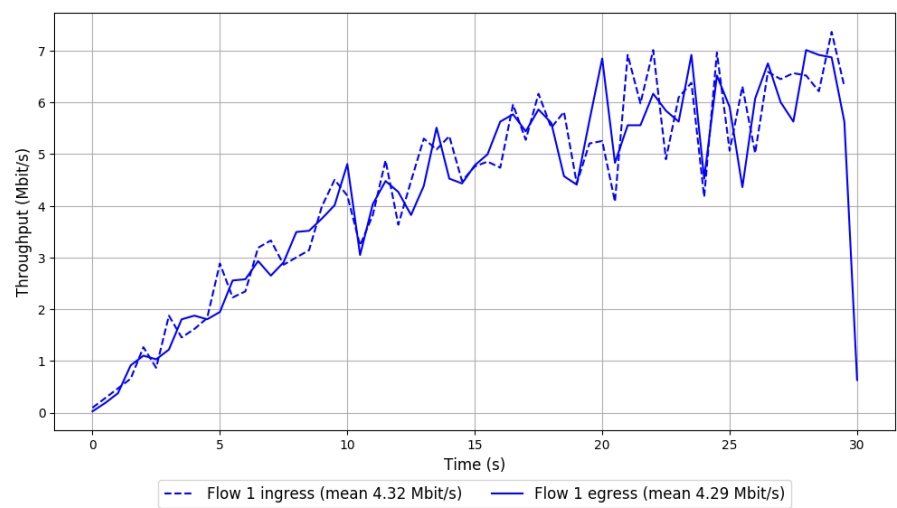

• Flow 1 (95th percentile 182.55 ms)

```
Run 3: Statistics of LEDBAT

Start at: 2017-09-19 02:20:13
End at: 2017-09-19 02:20:43
Local clock offset: -1.503 ms
Remote clock offset: -0.905 ms

# Below is generated by plot.py at 2017-09-19 02:25:25
# Datalink statistics
-- Total of 1 flow:
Average throughput: 4.29 Mbit/s
95th percentile per-packet one-way delay: 216.873 ms
Loss rate: 0.90%
-- Flow 1:
Average throughput: 4.29 Mbit/s
95th percentile per-packet one-way delay: 216.873 ms
Loss rate: 0.90%
```

Run 3: Report of LEDBAT — Data Link

Flow 1 ingress (mean 4.32 Mbit/s)   Flow 1 egress (mean 4.29 Mbit/s)

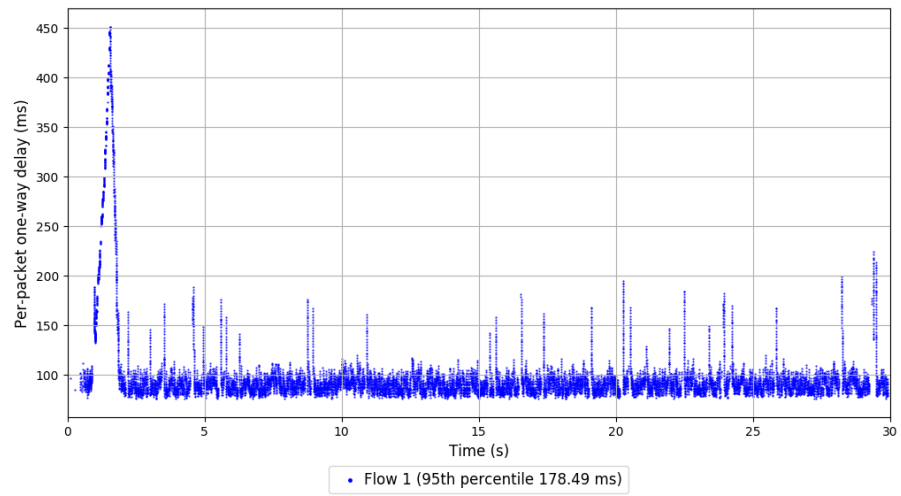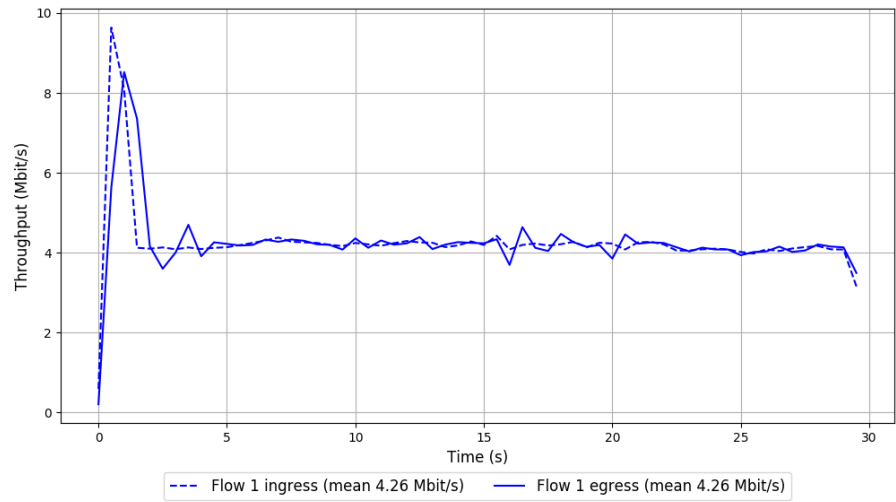Flow 1 (95th percentile 216.87 ms)

```
Run 1: Statistics of PCC

Start at: 2017-09-19 01:57:23
End at: 2017-09-19 01:57:53
Local clock offset: -0.595 ms
Remote clock offset: -1.316 ms


# Below is generated by plot.py at 2017-09-19 02:25:27
# Datalink statistics
-- Total of 1 flow:
Average throughput: 4.26 Mbit/s
95th percentile per-packet one-way delay: 178.488 ms
Loss rate: 0.12%
-- Flow 1:
Average throughput: 4.26 Mbit/s
95th percentile per-packet one-way delay: 178.488 ms
Loss rate: 0.12%
```

Run 1: Report of PCC — Data Link

Flow 1 ingress (mean 4.26 Mbit/s)   Flow 1 egress (mean 4.26 Mbit/s)

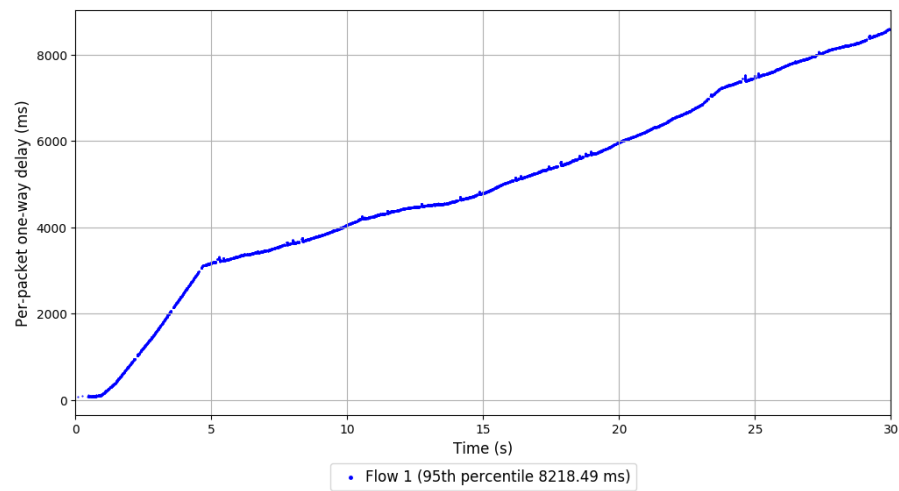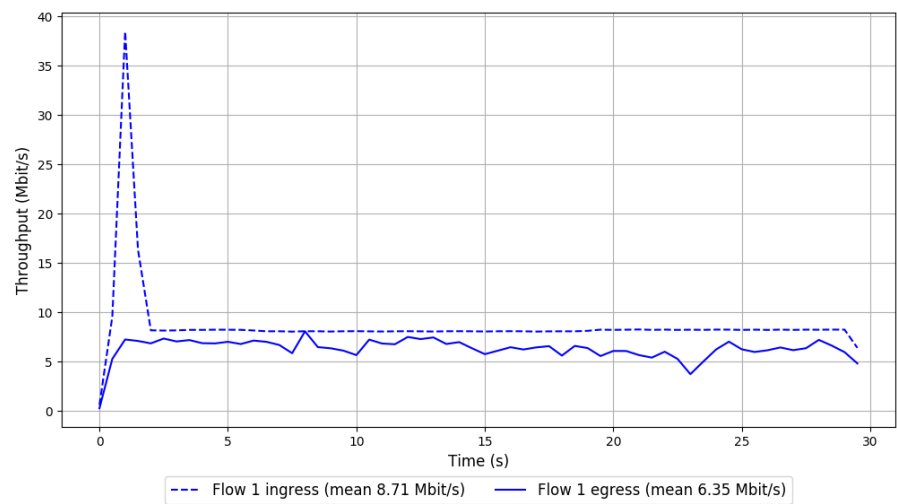Flow 1 (95th percentile 178.49 ms)

29

```
Run 2: Statistics of PCC

Start at: 2017-09-19 02:09:04
End at: 2017-09-19 02:09:34
Local clock offset: -1.146 ms
Remote clock offset: -1.142 ms


# Below is generated by plot.py at 2017-09-19 02:25:33
# Datalink statistics
-- Total of 1 flow:
Average throughput: 6.35 Mbit/s
95th percentile per-packet one-way delay: 8218.490 ms
Loss rate: 27.12%
-- Flow 1:
Average throughput: 6.35 Mbit/s
95th percentile per-packet one-way delay: 8218.490 ms
Loss rate: 27.12%
```

Run 2: Report of PCC — Data Link

Flow 1 ingress (mean 8.71 Mbit/s) --- Flow 1 egress (mean 6.35 Mbit/s)

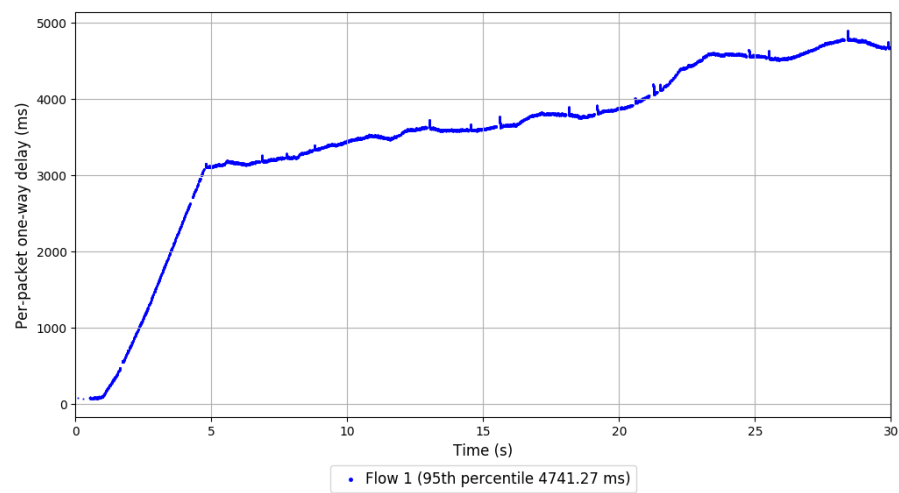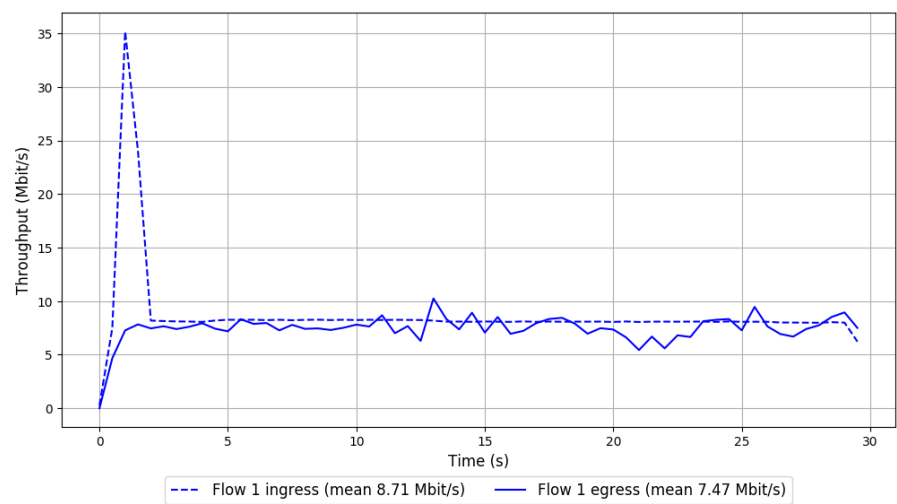Flow 1 (95th percentile 8218.49 ms)

```
Run 3: Statistics of PCC

Start at: 2017-09-19 02:21:23
End at: 2017-09-19 02:21:53
Local clock offset: -1.516 ms
Remote clock offset: -1.017 ms


# Below is generated by plot.py at 2017-09-19 02:25:35
# Datalink statistics
-- Total of 1 flow:
Average throughput: 7.47 Mbit/s
95th percentile per-packet one-way delay: 4741.268 ms
Loss rate: 14.25%
-- Flow 1:
Average throughput: 7.47 Mbit/s
95th percentile per-packet one-way delay: 4741.268 ms
Loss rate: 14.25%
```
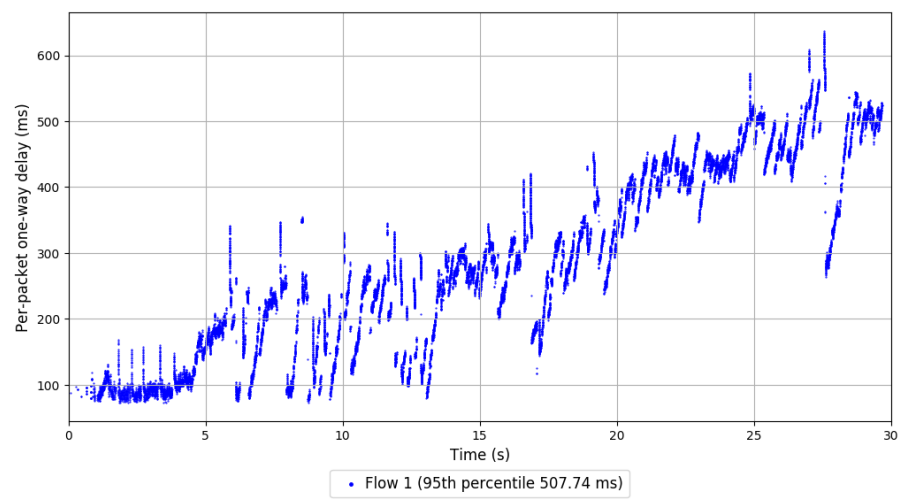
Run 3: Report of PCC — Data Link

Flow 1 ingress (mean 8.71 Mbit/s) --- Flow 1 egress (mean 7.47 Mbit/s)

• Flow 1 (95th percentile 4741.27 ms)

```
Run 1: Statistics of QUIC Cubic

Start at: 2017-09-19 01:53:54
End at: 2017-09-19 01:54:24
Local clock offset: 0.736 ms
Remote clock offset: -1.351 ms


# Below is generated by plot.py at 2017-09-19 02:25:35
# Datalink statistics
-- Total of 1 flow:
Average throughput: 7.76 Mbit/s
95th percentile per-packet one-way delay: 507.736 ms
Loss rate: 1.73%
-- Flow 1:
Average throughput: 7.76 Mbit/s
95th percentile per-packet one-way delay: 507.736 ms
Loss rate: 1.73%
```
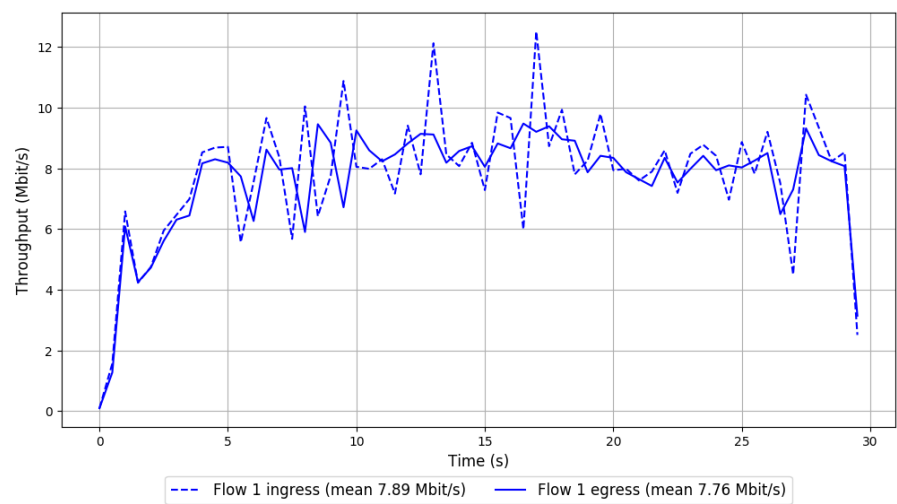
Run 1: Report of QUIC Cubic — Data Link

```
Run 2: Statistics of QUIC Cubic

Start at: 2017-09-19 02:05:30
End at: 2017-09-19 02:06:00
Local clock offset: -1.045 ms
Remote clock offset: -1.217 ms


# Below is generated by plot.py at 2017-09-19 02:25:36
# Datalink statistics
-- Total of 1 flow:
Average throughput: 8.43 Mbit/s
95th percentile per-packet one-way delay: 592.780 ms
Loss rate: 1.89%
-- Flow 1:
Average throughput: 8.43 Mbit/s
95th percentile per-packet one-way delay: 592.780 ms
Loss rate: 1.89%
```
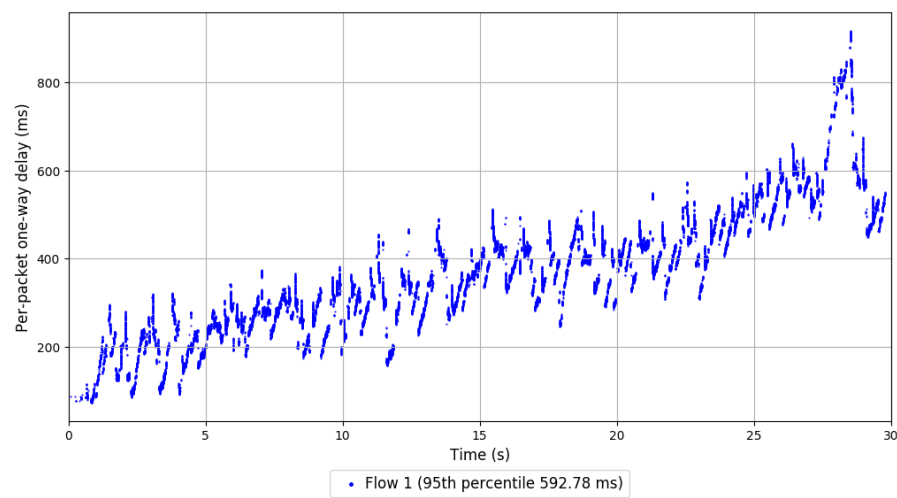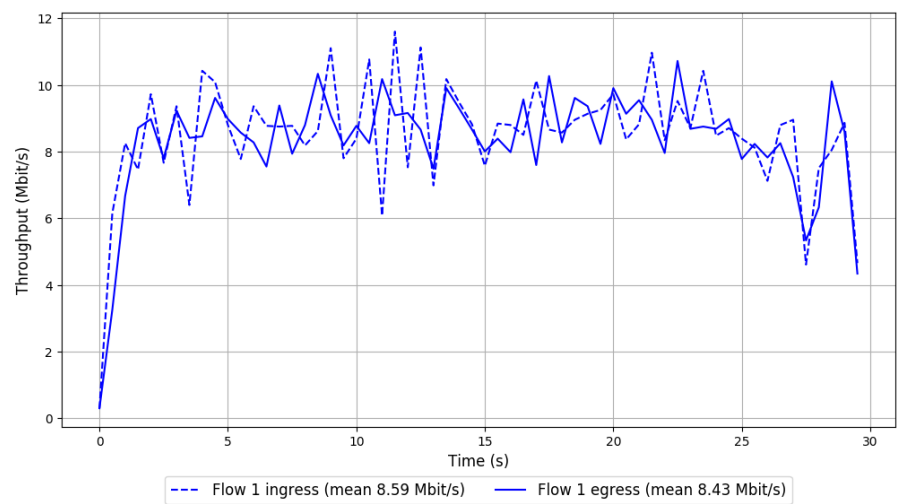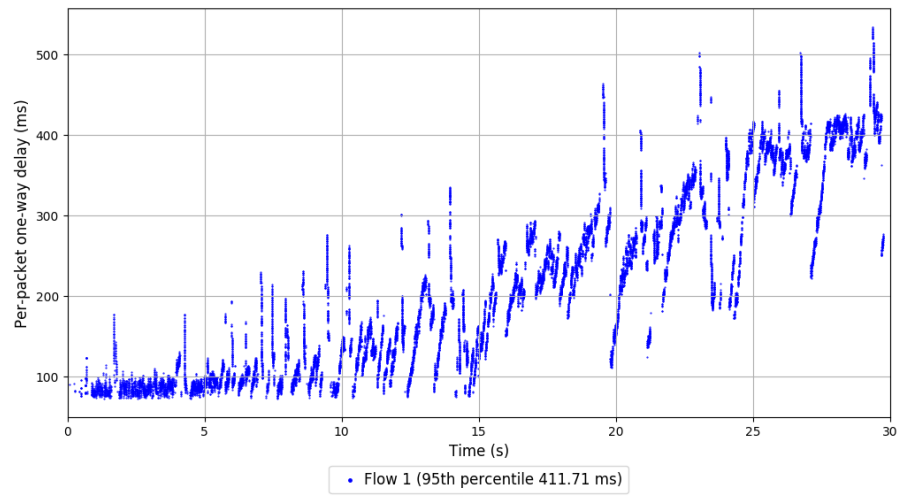
Run 2: Report of QUIC Cubic — Data Link

Flow 1 ingress (mean 8.59 Mbit/s) --- Flow 1 egress (mean 8.43 Mbit/s)

Flow 1 (95th percentile 592.78 ms)

```
Run 3: Statistics of QUIC Cubic

Start at: 2017-09-19 02:17:48
End at: 2017-09-19 02:18:18
Local clock offset: -1.431 ms
Remote clock offset: -1.031 ms


# Below is generated by plot.py at 2017-09-19 02:25:36
# Datalink statistics
-- Total of 1 flow:
Average throughput: 7.39 Mbit/s
95th percentile per-packet one-way delay: 411.709 ms
Loss rate: 1.12%
-- Flow 1:
Average throughput: 7.39 Mbit/s
95th percentile per-packet one-way delay: 411.709 ms
Loss rate: 1.12%
```
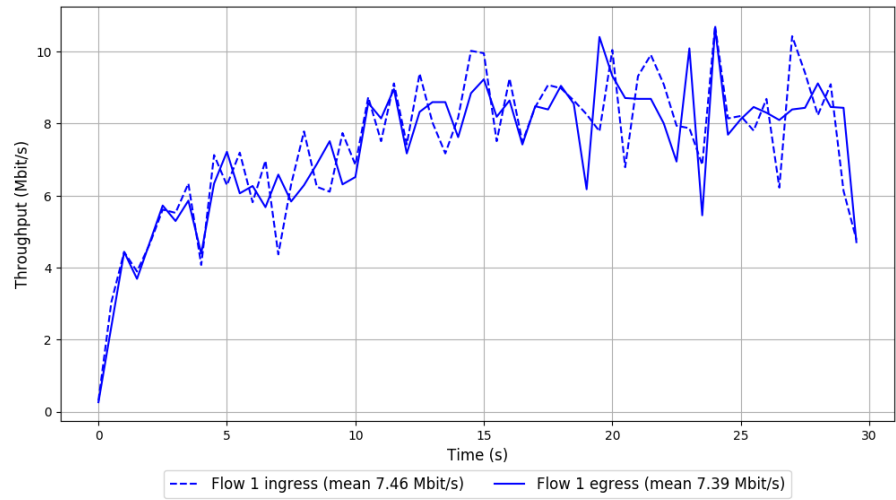
Run 3: Report of QUIC Cubic — Data Link

Flow 1 ingress (mean 7.46 Mbit/s) --- Flow 1 egress (mean 7.39 Mbit/s)

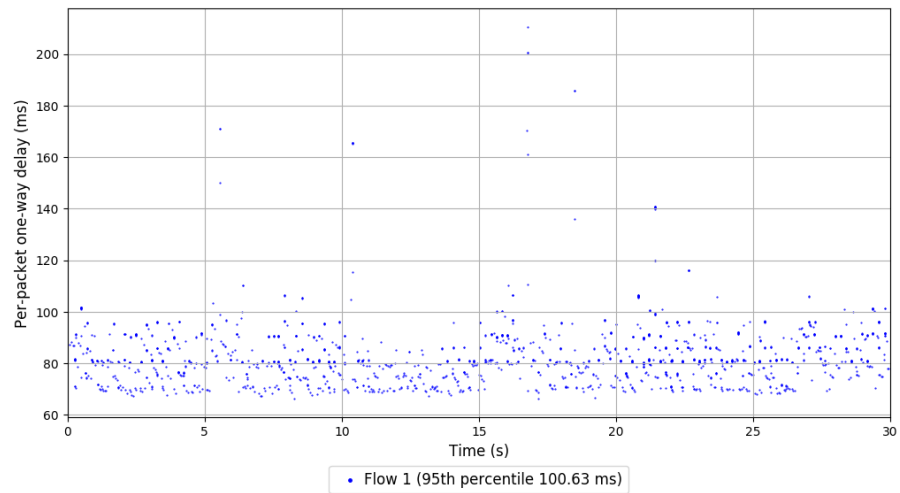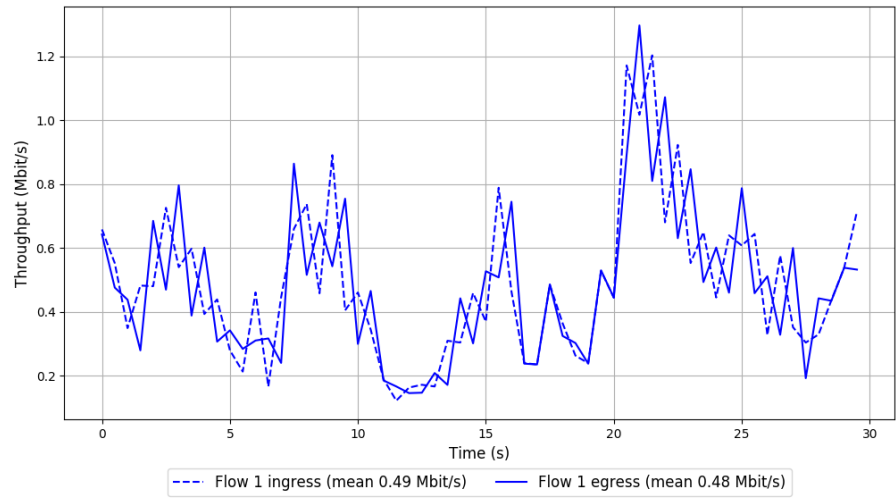
• Flow 1 (95th percentile 411.71 ms)

```
Run 1: Statistics of Sprout

Start at: 2017-09-19 01:50:27
End at: 2017-09-19 01:50:57
Local clock offset: 0.746 ms
Remote clock offset: -1.451 ms


# Below is generated by plot.py at 2017-09-19 02:25:36
# Datalink statistics
-- Total of 1 flow:
Average throughput: 0.48 Mbit/s
95th percentile per-packet one-way delay: 100.626 ms
Loss rate: 0.64%
-- Flow 1:
Average throughput: 0.48 Mbit/s
95th percentile per-packet one-way delay: 100.626 ms
Loss rate: 0.64%
```

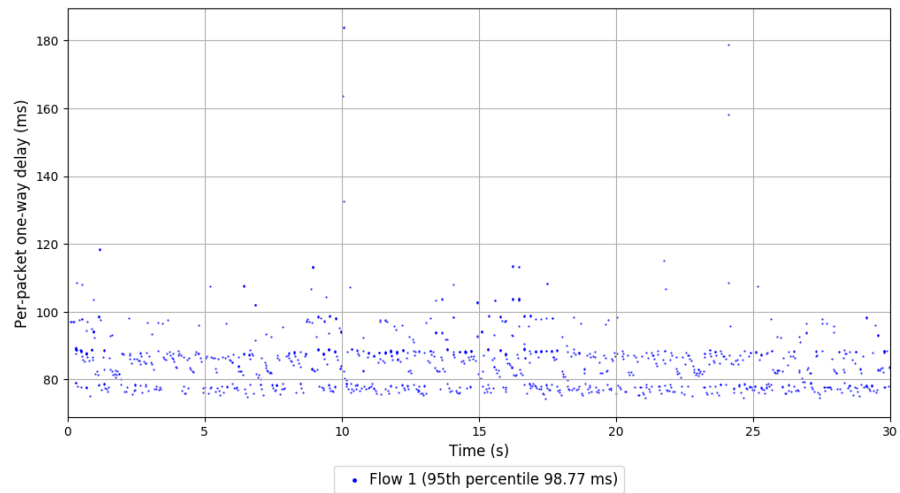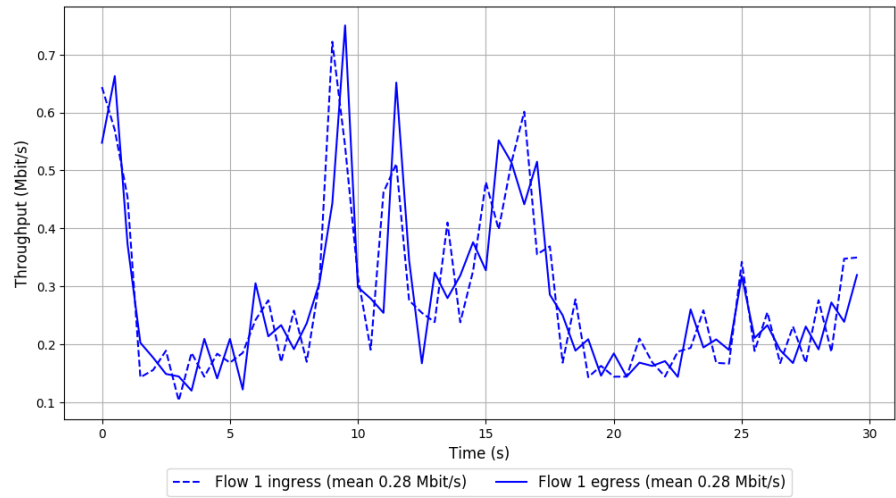Run 1: Report of Sprout — Data Link

```
Run 2: Statistics of Sprout

Start at: 2017-09-19 02:02:02
End at: 2017-09-19 02:02:32
Local clock offset: -0.729 ms
Remote clock offset: -1.149 ms


# Below is generated by plot.py at 2017-09-19 02:25:36
# Datalink statistics
-- Total of 1 flow:
Average throughput: 0.28 Mbit/s
95th percentile per-packet one-way delay: 98.773 ms
Loss rate: 0.85%
-- Flow 1:
Average throughput: 0.28 Mbit/s
95th percentile per-packet one-way delay: 98.773 ms
Loss rate: 0.85%
```

Run 2: Report of Sprout — Data Link
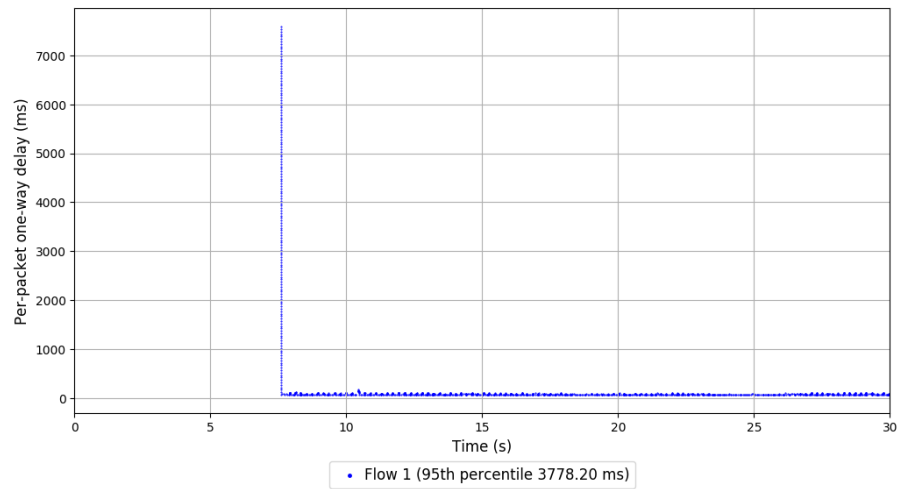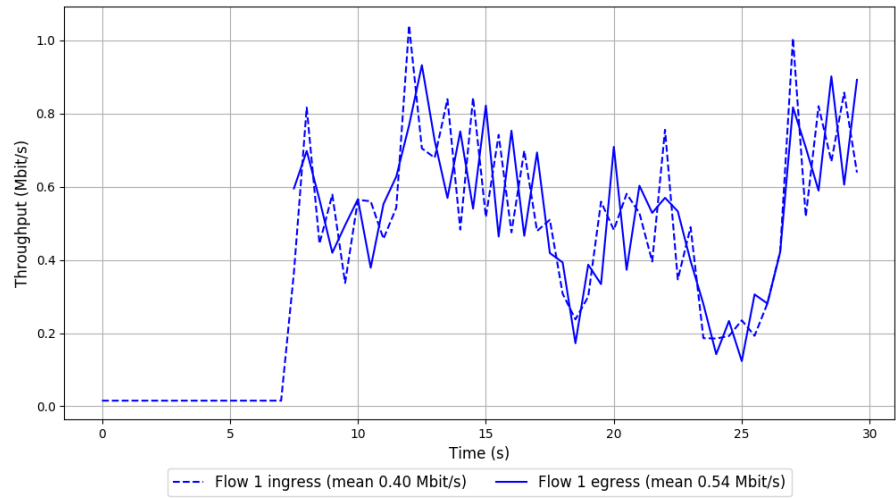
```
Run 3: Statistics of Sprout

Start at: 2017-09-19 02:13:48
End at: 2017-09-19 02:14:18
Local clock offset: -1.233 ms
Remote clock offset: -1.064 ms
```

Run 3: Report of Sprout — Data Link

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

Start at: 2017-09-19 01:49:18
End at: 2017-09-19 01:49:48
Local clock offset: 0.889 ms
Remote clock offset: -1.456 ms
```
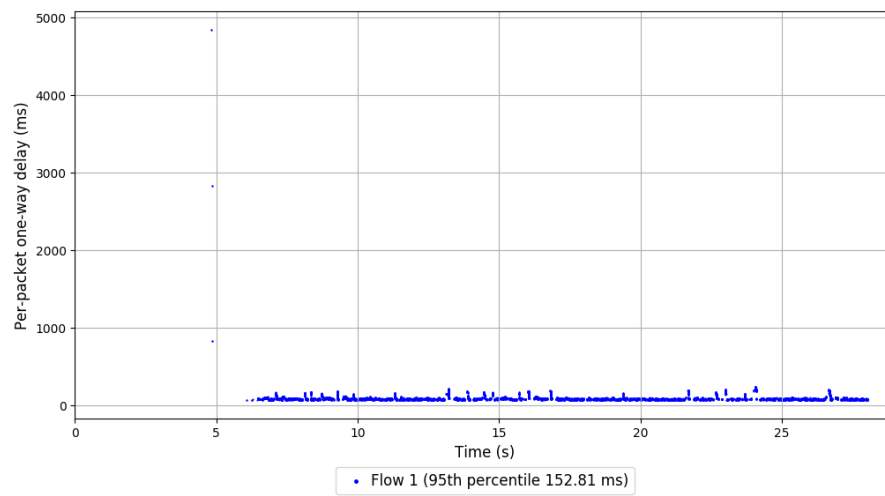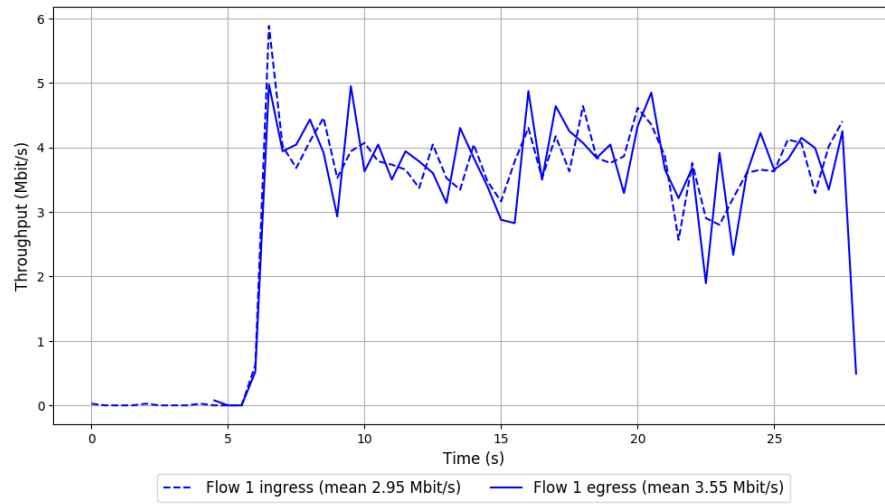
Run 1: Report of TaoVA-100x — Data Link

Flow 1 ingress (mean 2.95 Mbit/s) --- Flow 1 egress (mean 3.55 Mbit/s)

Flow 1 (95th percentile 152.81 ms)

```
Run 2: Statistics of TaoVA-100x

Start at: 2017-09-19 02:00:53
End at: 2017-09-19 02:01:23
Local clock offset: -0.865 ms
Remote clock offset: -1.257 ms


# Below is generated by plot.py at 2017-09-19 02:25:38
# Datalink statistics
-- Total of 1 flow:
Average throughput: 3.50 Mbit/s
95th percentile per-packet one-way delay: 148.805 ms
Loss rate: 0.13%
-- Flow 1:
Average throughput: 3.50 Mbit/s
95th percentile per-packet one-way delay: 148.805 ms
Loss rate: 0.13%
```
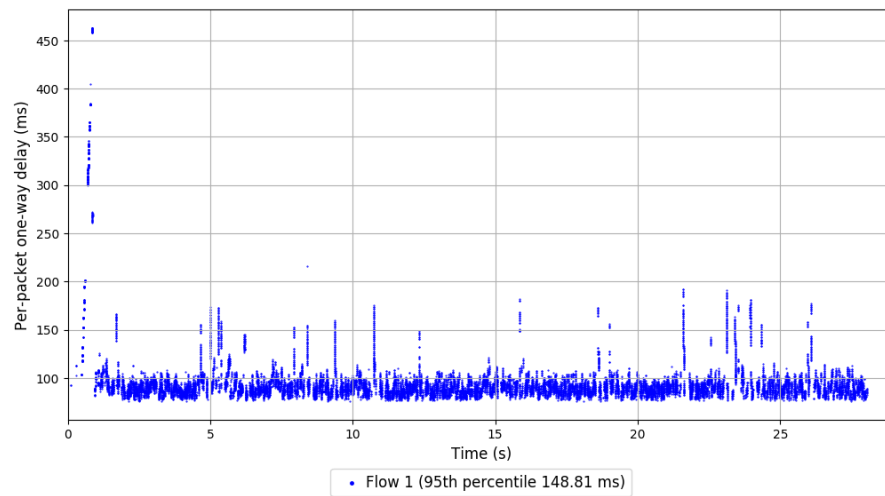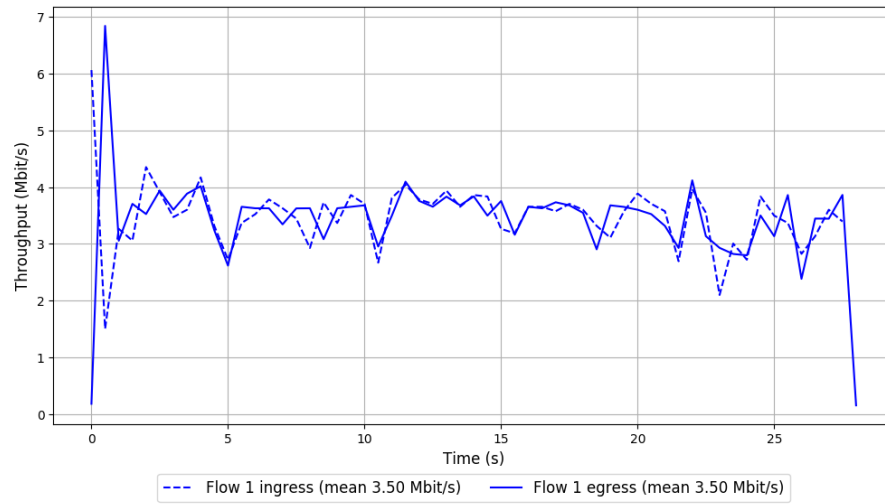
Run 2: Report of TaoVA-100x — Data Link

```
Run 3: Statistics of TaoVA-100x

Start at: 2017-09-19 02:12:38
End at: 2017-09-19 02:13:08
Local clock offset: -1.219 ms
Remote clock offset: -1.12 ms


# Below is generated by plot.py at 2017-09-19 02:25:39
# Datalink statistics
-- Total of 1 flow:
Average throughput: 4.02 Mbit/s
95th percentile per-packet one-way delay: 144.494 ms
Loss rate: 0.14%
-- Flow 1:
Average throughput: 4.02 Mbit/s
95th percentile per-packet one-way delay: 144.494 ms
Loss rate: 0.14%
```
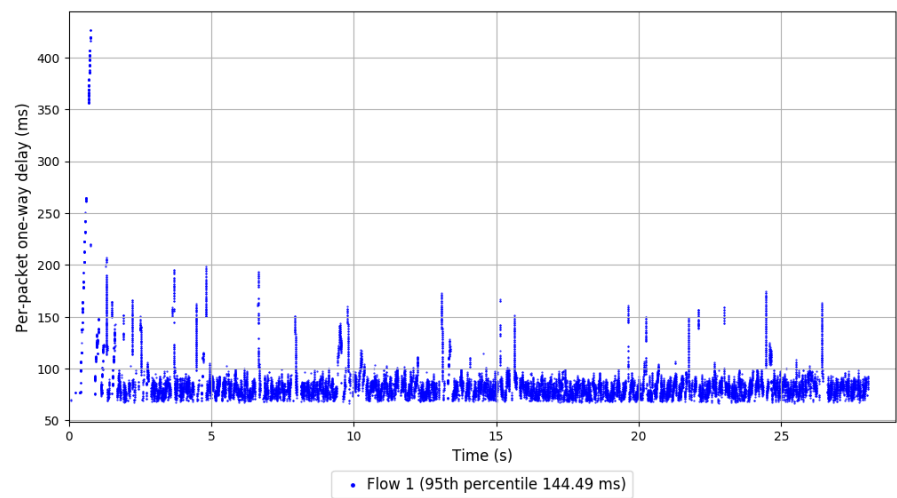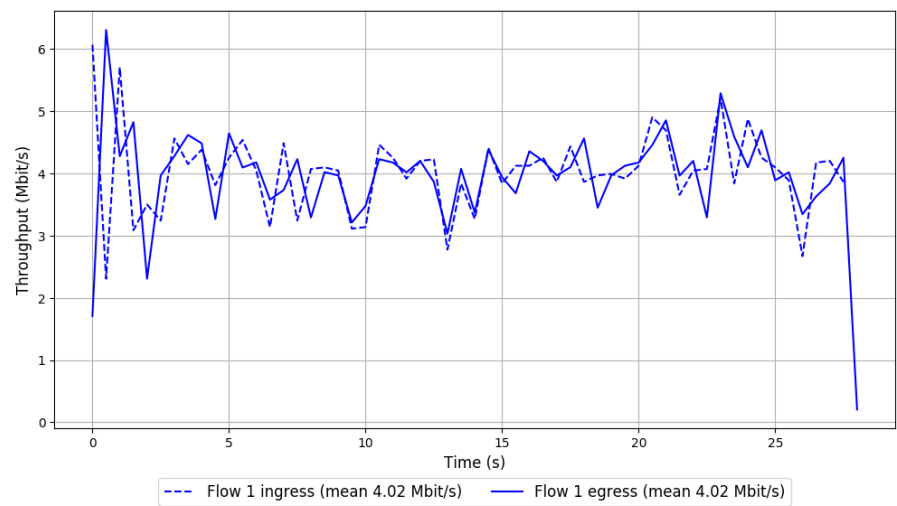
Run 3: Report of TaoVA-100x — Data Link

```
Run 1: Statistics of TCP Vegas

Start at: 2017-09-19 01:59:42
End at: 2017-09-19 02:00:12
Local clock offset: -0.665 ms
Remote clock offset: -1.31 ms


# Below is generated by plot.py at 2017-09-19 02:25:39
# Datalink statistics
-- Total of 1 flow:
Average throughput: 3.32 Mbit/s
95th percentile per-packet one-way delay: 122.098 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 3.32 Mbit/s
95th percentile per-packet one-way delay: 122.098 ms
Loss rate: 0.00%
```
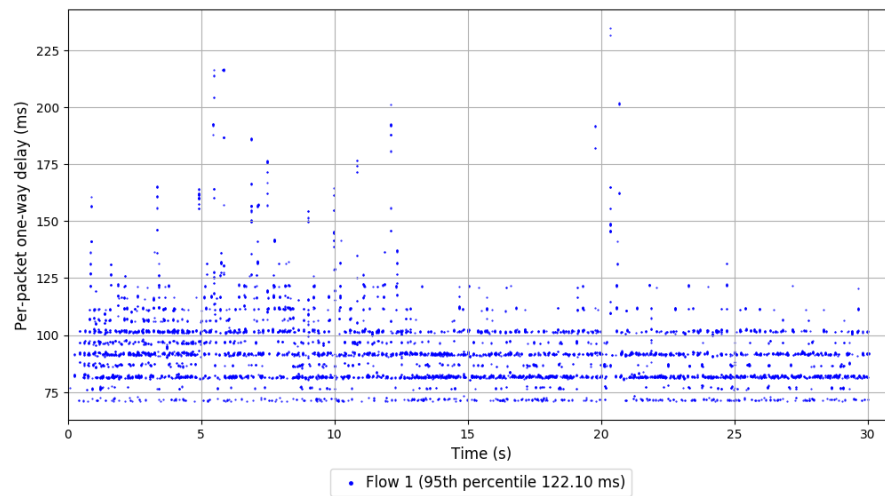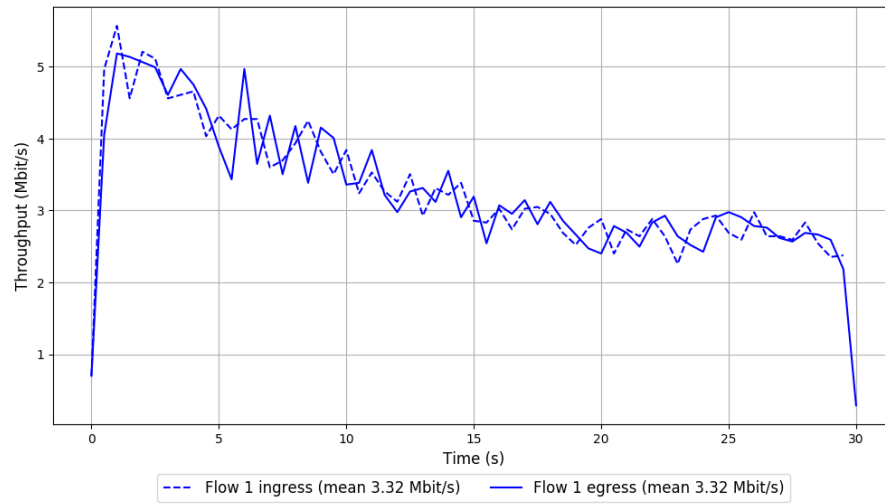
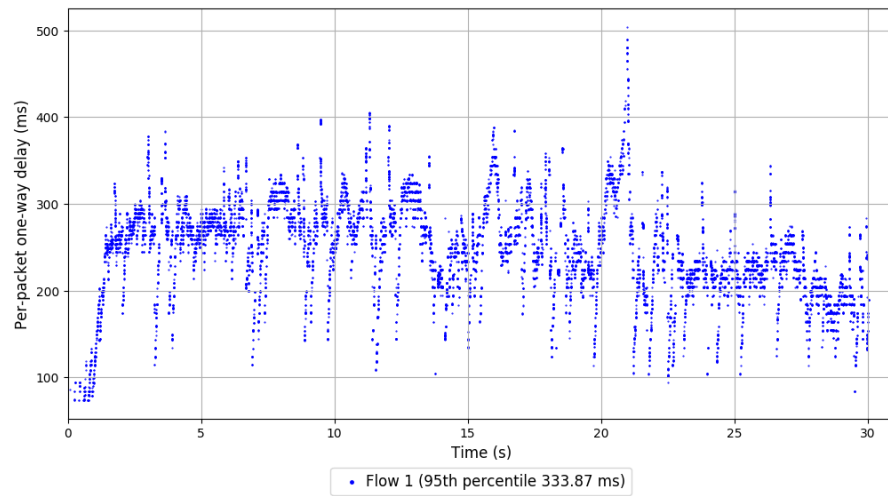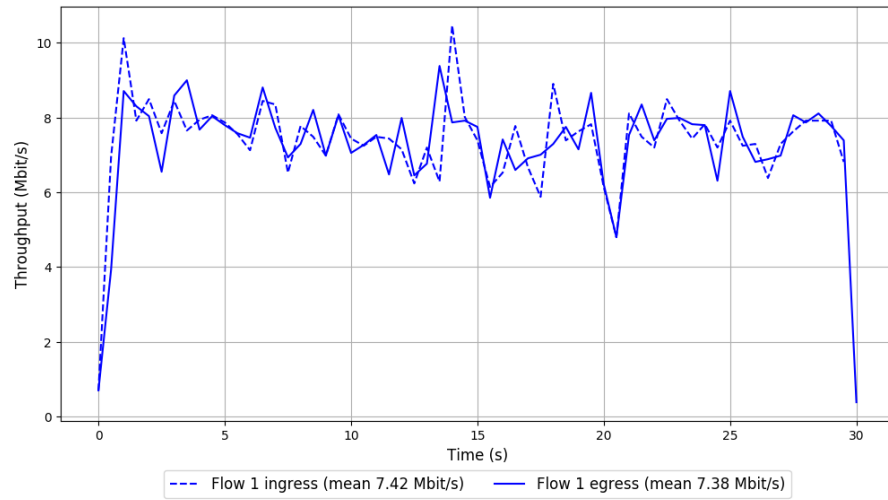Run 1: Report of TCP Vegas — Data Link

```
Run 2: Statistics of TCP Vegas

Start at: 2017-09-19 02:11:29
End at: 2017-09-19 02:11:59
Local clock offset: -0.068 ms
Remote clock offset: -1.061 ms


# Below is generated by plot.py at 2017-09-19 02:25:43
# Datalink statistics
-- Total of 1 flow:
Average throughput: 7.38 Mbit/s
95th percentile per-packet one-way delay: 333.871 ms
Loss rate: 0.44%
-- Flow 1:
Average throughput: 7.38 Mbit/s
95th percentile per-packet one-way delay: 333.871 ms
Loss rate: 0.44%
```

Run 2: Report of TCP Vegas — Data Link

```
Run 3: Statistics of TCP Vegas

Start at: 2017-09-19 02:23:44
End at: 2017-09-19 02:24:14
Local clock offset: -0.288 ms
Remote clock offset: -1.01 ms


# Below is generated by plot.py at 2017-09-19 02:25:43
# Datalink statistics
-- Total of 1 flow:
Average throughput: 2.66 Mbit/s
95th percentile per-packet one-way delay: 113.921 ms
Loss rate: 0.05%
-- Flow 1:
Average throughput: 2.66 Mbit/s
95th percentile per-packet one-way delay: 113.921 ms
Loss rate: 0.05%
```
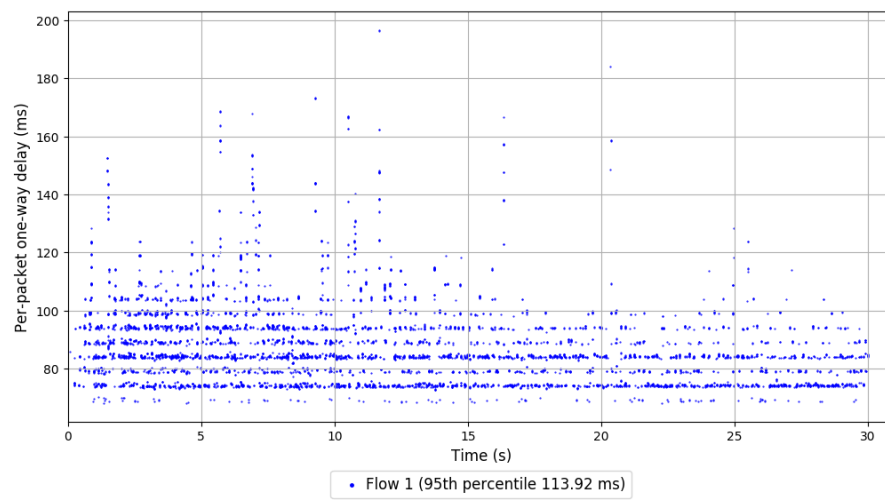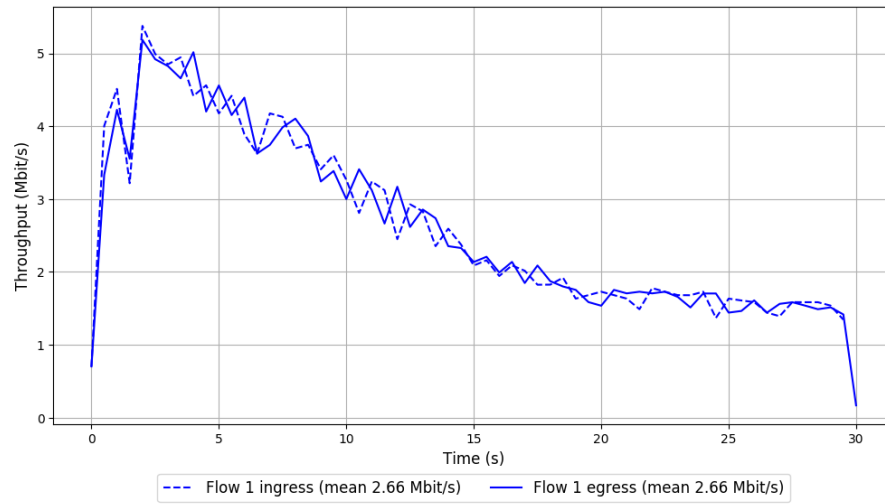
Run 3: Report of TCP Vegas — Data Link

```
Run 1: Statistics of Verus

Start at: 2017-09-19 01:55:04
End at: 2017-09-19 01:55:34
Local clock offset: 0.6 ms
Remote clock offset: -1.325 ms


# Below is generated by plot.py at 2017-09-19 02:25:44
# Datalink statistics
-- Total of 1 flow:
Average throughput: 8.53 Mbit/s
95th percentile per-packet one-way delay: 1153.639 ms
Loss rate: 2.98%
-- Flow 1:
Average throughput: 8.53 Mbit/s
95th percentile per-packet one-way delay: 1153.639 ms
Loss rate: 2.98%
```
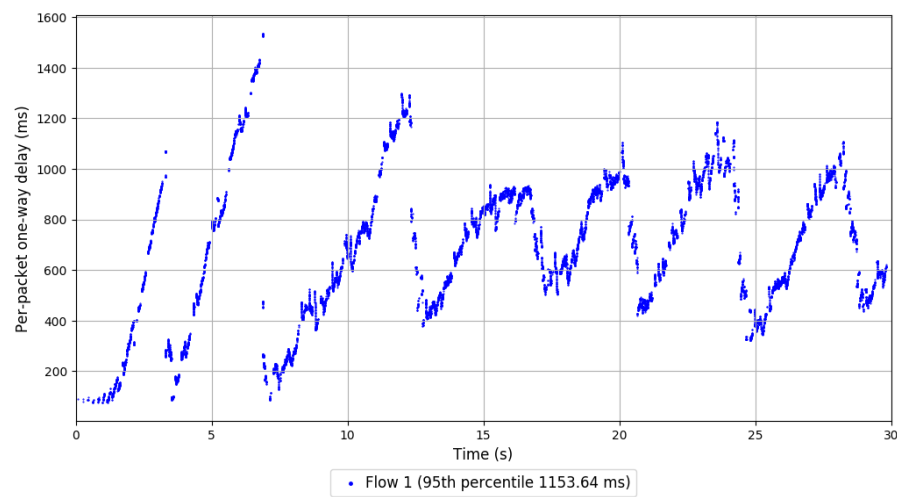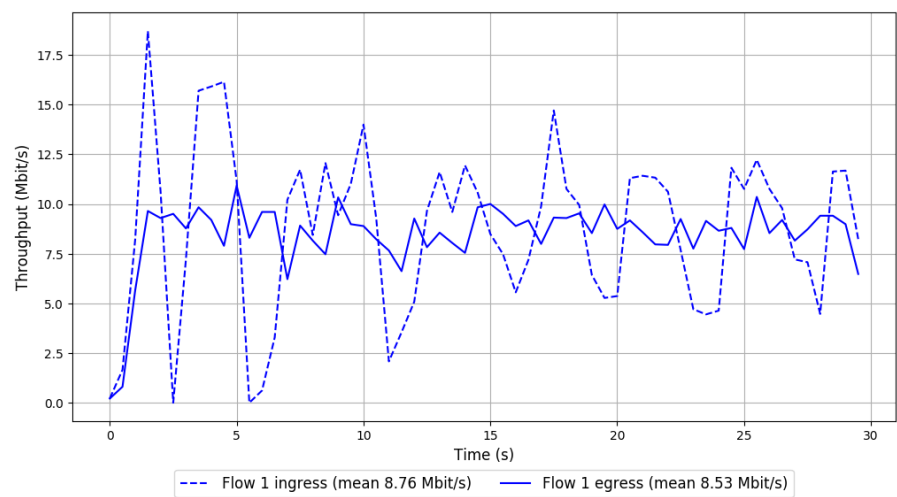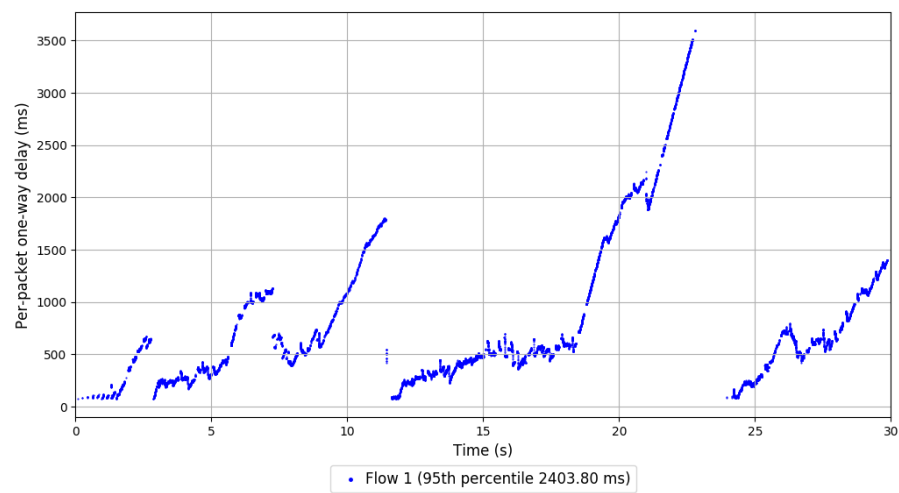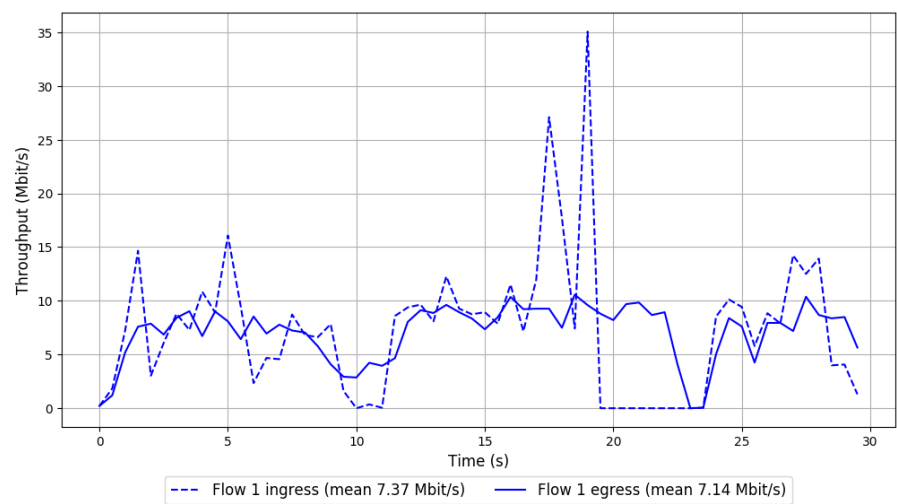
Run 1: Report of Verus — Data Link

```
Run 2: Statistics of Verus

Start at: 2017-09-19 02:06:40
End at: 2017-09-19 02:07:10
Local clock offset: -0.947 ms
Remote clock offset: -1.113 ms


# Below is generated by plot.py at 2017-09-19 02:25:44
# Datalink statistics
-- Total of 1 flow:
Average throughput: 7.14 Mbit/s
95th percentile per-packet one-way delay: 2403.801 ms
Loss rate: 3.20%
-- Flow 1:
Average throughput: 7.14 Mbit/s
95th percentile per-packet one-way delay: 2403.801 ms
Loss rate: 3.20%
```

Run 2: Report of Verus — Data Link

Flow 1 ingress (mean 7.37 Mbit/s) Flow 1 egress (mean 7.14 Mbit/s)

Flow 1 (95th percentile 2403.80 ms)

```
Run 3: Statistics of Verus

Start at: 2017-09-19 02:18:58
End at: 2017-09-19 02:19:28
Local clock offset: -1.48 ms
Remote clock offset: -0.935 ms


# Below is generated by plot.py at 2017-09-19 02:25:44
# Datalink statistics
-- Total of 1 flow:
Average throughput: 6.80 Mbit/s
95th percentile per-packet one-way delay: 1036.708 ms
Loss rate: 1.74%
-- Flow 1:
Average throughput: 6.80 Mbit/s
95th percentile per-packet one-way delay: 1036.708 ms
Loss rate: 1.74%
```

Run 3: Report of Verus — Data Link

Flow 1 ingress (mean 6.91 Mbit/s) ——— Flow 1 egress (mean 6.80 Mbit/s)

• Flow 1 (95th percentile 1036.71 ms)