

## Pantheon Report

Generated at 2019-06-26 04:16:06 (UTC).

Tested in mahimahi: mm-link 12mbps.trace 12mbps.trace

Repeated the test of 18 congestion control schemes once.

Each test lasted for 40 seconds running 3 flows with 10-second interval between two flows.

### System info:

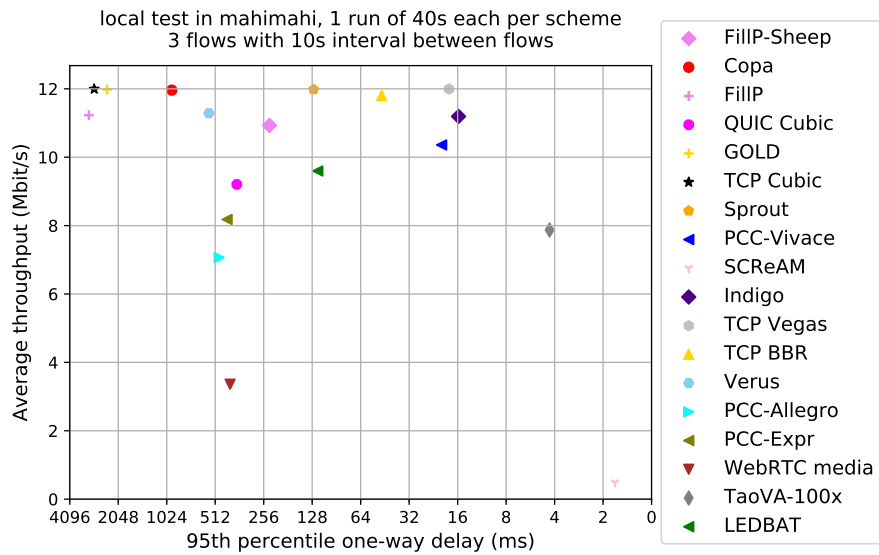
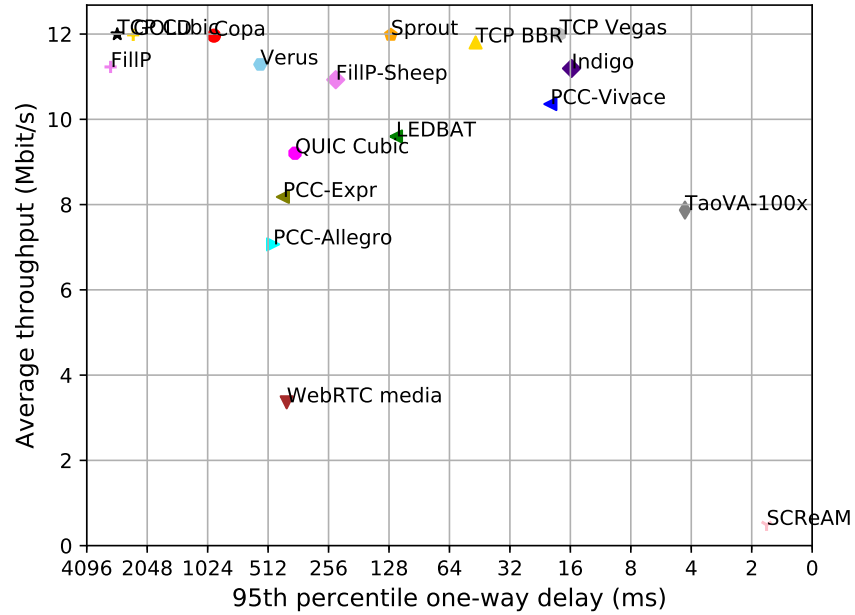
```
Linux 4.15.0-52-generic
net.core.default_qdisc = fq_codel
net.core.rmem_default = 212992
net.core.rmem_max = 212992
net.core.wmem_default = 212992
net.core.wmem_max = 212992
net.ipv4.tcp_rmem = 4096 87380 6291456
net.ipv4.tcp_wmem = 4096 16384 4194304
```

### Git summary:

```
branch: master @ e944b93d72cdefc2f7c39b55fee51f74e18543d
third_party/fillp @ d6da1459332fcee56963885d7eba17e6a32d4519
third_party/fillp-sheep @ 0e5bb722943babcd2b090d2c64fcd45e12e923f9
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdf58e562f4
third_party/gold @ b6948a72b216f2705f13bf3b588bc5ab5ff8ff9a
M dependencies.sh
M environment/__pycache__/datagram_pb2.cpython-36.opt-1.pyc
M environment/__pycache__/datagram_pb2.cpython-36.pyc
M environment/__pycache__/environment.cpython-36.opt-1.pyc
M environment/__pycache__/environment.cpython-36.pyc
M environment/__pycache__/helpers.cpython-36.opt-1.pyc
M environment/__pycache__/helpers.cpython-36.pyc
M environment/__pycache__/mahimahi.cpython-36.opt-1.pyc
M environment/__pycache__/mahimahi.cpython-36.pyc
M environment/__pycache__/project_root.cpython-36.opt-1.pyc
M environment/__pycache__/project_root.cpython-36.pyc
M environment/__pycache__/receiver.cpython-36.opt-1.pyc
M environment/__pycache__/receiver.cpython-36.pyc
M environment/environment.py
M environment/learner.py
M environment/logs.txt
M environment/receiver.py
M environment/run_receiver.py
M model
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0ecdbf90c077e64d
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-quir @ 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 40s each per scheme  
 3 flows with 10s interval between flows (mean of all runs by scheme)



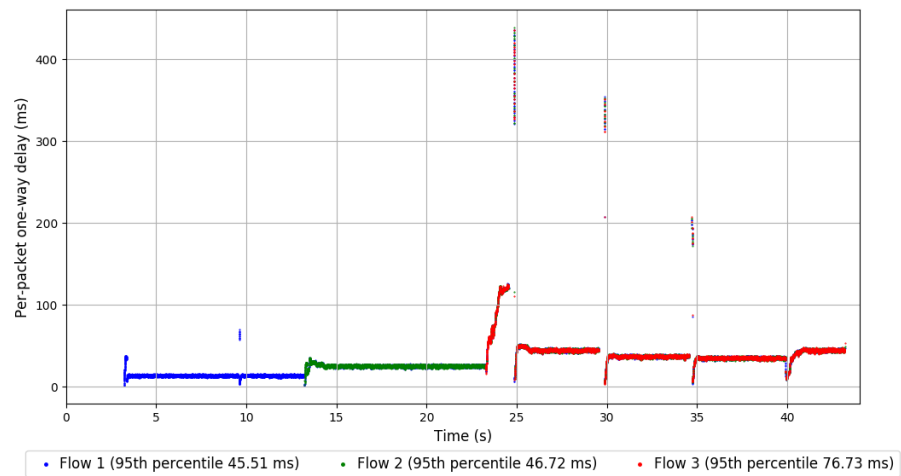
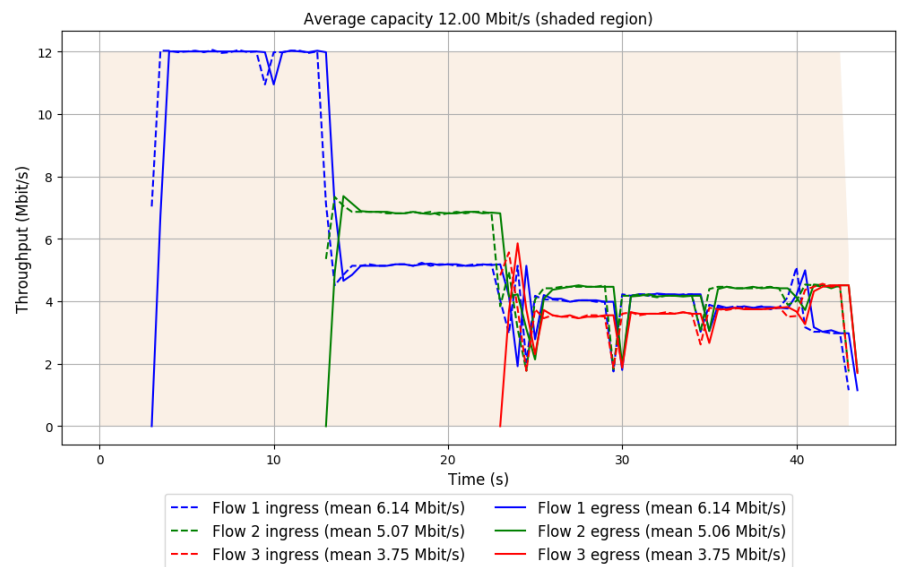
scheme	# runs	mean avg tput (Mbit/s)			mean 95th-%ile delay (ms)			mean loss rate (%)		
		flow 1	flow 2	flow 3	flow 1	flow 2	flow 3	flow 1	flow 2	flow 3
TCP BBR	1	6.14	5.06	3.75	45.51	46.72	76.73	0.05	0.13	0.27
Copa	1	10.22	1.99	0.54	951.27	975.17	1023.53	0.64	0.80	3.33
TCP Cubic	1	9.55	3.19	0.38	2804.79	2921.55	2975.32	3.15	14.72	33.92
FillP	1	5.04	5.65	3.91	2916.55	3324.27	2985.86	1.16	1.67	4.62
FillP-Sheep	1	3.54	6.26	5.43	88.00	440.68	313.38	0.06	0.21	0.58
GOLD	1	11.92	0.04	0.06	2403.97	2291.44	2406.66	4.98	3.06	19.02
Indigo	1	3.86	7.89	2.88	13.97	15.94	16.74	0.00	0.02	0.00
LEDBAT	1	6.16	2.69	2.87	110.92	120.04	120.55	0.18	0.54	0.74
PCC-Allegro	1	5.10	0.00	3.95	482.39	484.94	530.69	0.13	0.00	0.00
PCC-Expr	1	4.14	3.37	3.03	362.55	470.55	460.22	1.38	3.91	2.36
QUIC Cubic	1	0.01	8.62	4.75	1.46	370.56	386.12	0.00	1.14	2.46
SCReAM	1	0.22	0.22	0.22	1.51	1.53	1.47	0.00	0.00	0.00
Sprout	1	6.67	4.66	3.70	121.97	126.51	129.14	0.19	0.45	0.54
TaoVA-100x	1	3.86	3.26	3.13	3.95	4.41	15.56	0.01	0.01	0.02
TCP Vegas	1	6.07	4.29	5.43	17.28	18.41	18.73	0.03	0.04	0.07
Verus	1	6.21	4.82	2.99	507.73	673.75	507.38	0.44	0.56	1.23
PCC-Vivace	1	5.29	4.68	3.12	64.75	13.28	14.26	0.01	0.01	0.00
WebRTC media	1	1.92	1.12	0.32	393.76	417.78	423.73	5.63	10.17	13.60

```
Run 1: Statistics of TCP BBR

Start at: 2019-06-26 04:06:23
End at: 2019-06-26 04:07:03

# Below is generated by plot.py at 2019-06-26 04:15:26
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 11.80 Mbit/s (98.4% utilization)
95th percentile per-packet one-way delay: 47.413 ms
Loss rate: 0.11%
-- Flow 1:
Average throughput: 6.14 Mbit/s
95th percentile per-packet one-way delay: 45.508 ms
Loss rate: 0.05%
-- Flow 2:
Average throughput: 5.06 Mbit/s
95th percentile per-packet one-way delay: 46.715 ms
Loss rate: 0.13%
-- Flow 3:
Average throughput: 3.75 Mbit/s
95th percentile per-packet one-way delay: 76.732 ms
Loss rate: 0.27%
```

Run 1: Report of TCP BBR — Data Link



Run 1: Statistics of Copa

Start at: 2019-06-26 04:00:25

End at: 2019-06-26 04:01:05

# Below is generated by plot.py at 2019-06-26 04:15:33

# Datalink statistics

-- Total of 3 flows:

Average capacity: 12.00 Mbit/s

Average throughput: 11.96 Mbit/s (99.7% utilization)

95th percentile per-packet one-way delay: 952.641 ms

Loss rate: 0.72%

-- Flow 1:

Average throughput: 10.22 Mbit/s

95th percentile per-packet one-way delay: 951.274 ms

Loss rate: 0.64%

-- Flow 2:

Average throughput: 1.99 Mbit/s

95th percentile per-packet one-way delay: 975.171 ms

Loss rate: 0.80%

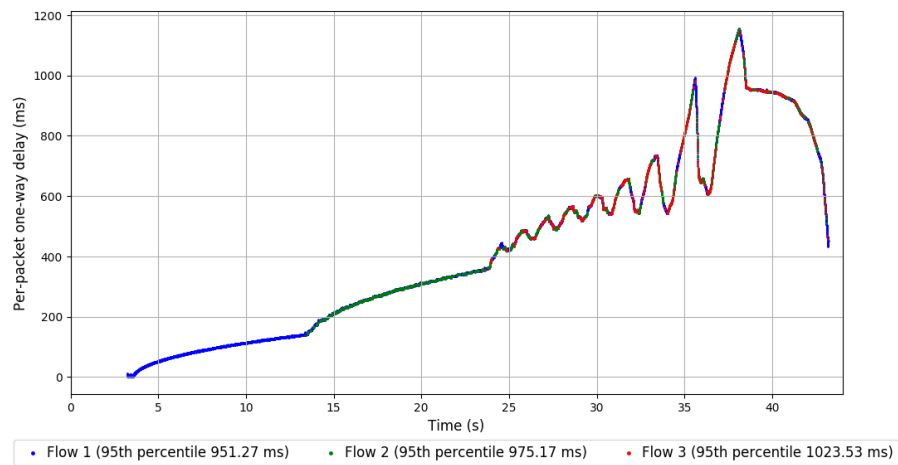
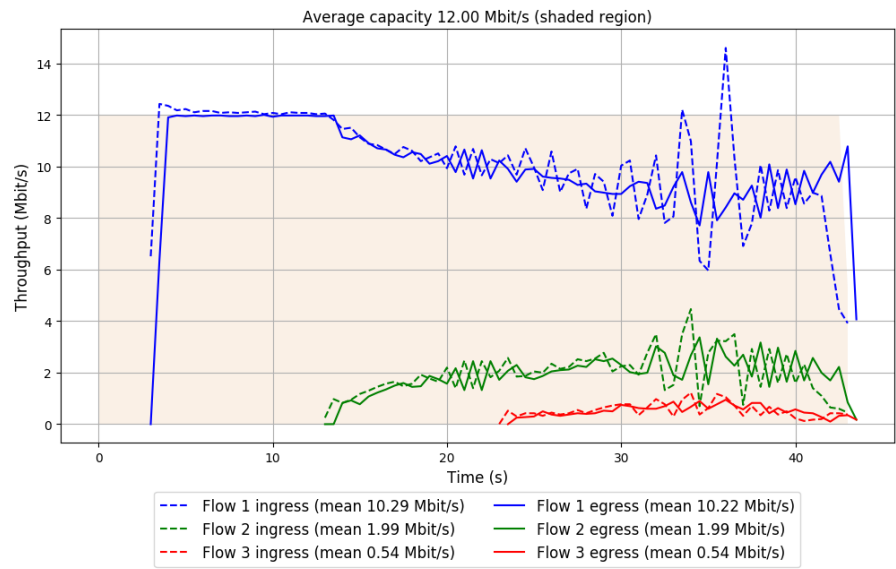
-- Flow 3:

Average throughput: 0.54 Mbit/s

95th percentile per-packet one-way delay: 1023.533 ms

Loss rate: 3.33%

## Run 1: Report of Copa — Data Link





Run 1: Statistics of TCP Cubic

Start at: 2019-06-26 04:03:24

End at: 2019-06-26 04:04:04

# Below is generated by plot.py at 2019-06-26 04:15:33

# Datalink statistics

-- Total of 3 flows:

Average capacity: 12.00 Mbit/s

Average throughput: 11.99 Mbit/s (100.0% utilization)

95th percentile per-packet one-way delay: 2887.766 ms

Loss rate: 6.24%

-- Flow 1:

Average throughput: 9.55 Mbit/s

95th percentile per-packet one-way delay: 2804.791 ms

Loss rate: 3.15%

-- Flow 2:

Average throughput: 3.19 Mbit/s

95th percentile per-packet one-way delay: 2921.549 ms

Loss rate: 14.72%

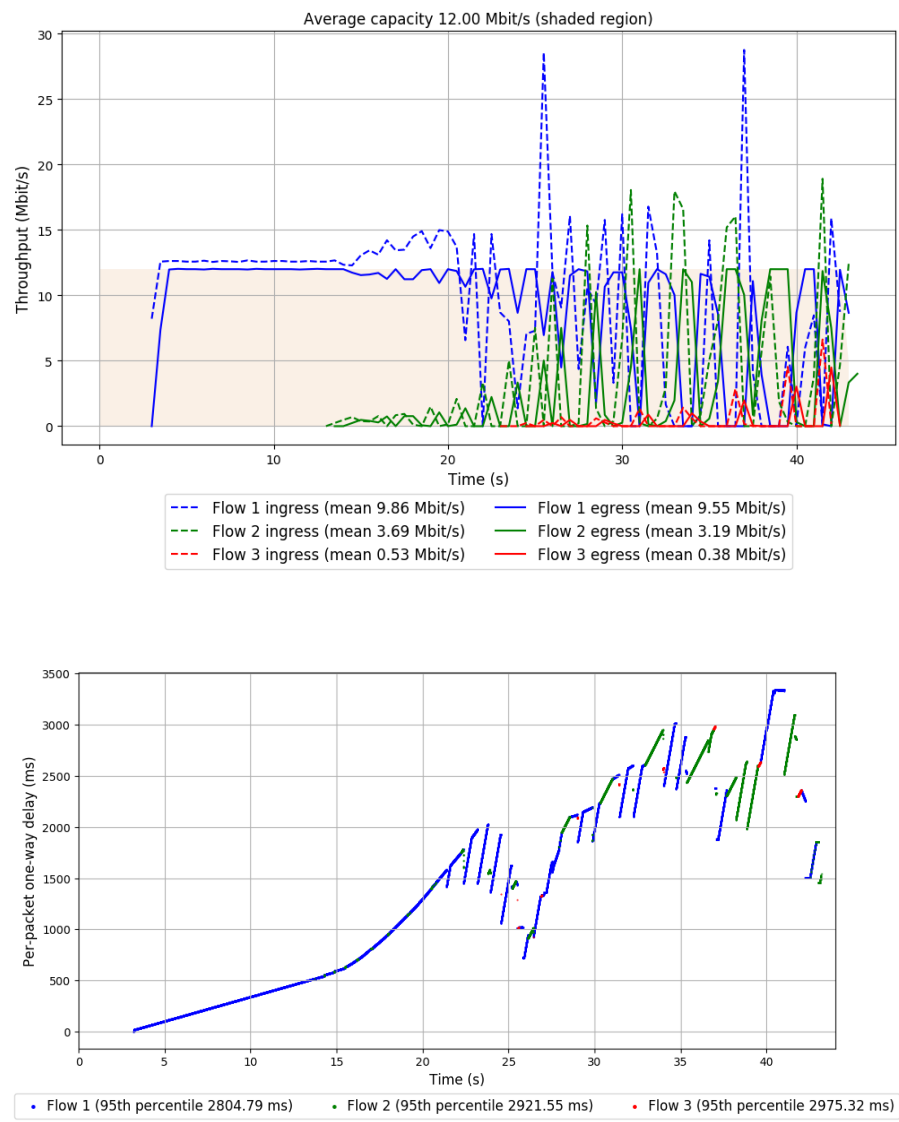
-- Flow 3:

Average throughput: 0.38 Mbit/s

95th percentile per-packet one-way delay: 2975.317 ms

Loss rate: 33.92%

Run 1: Report of TCP Cubic — Data Link

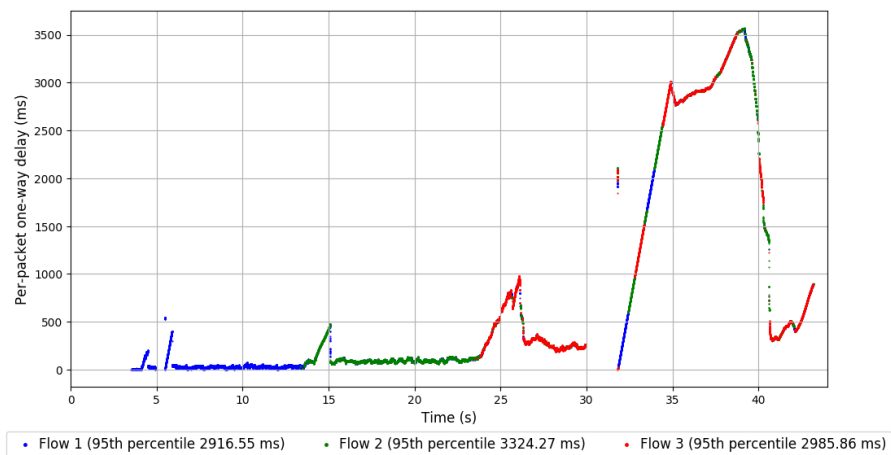
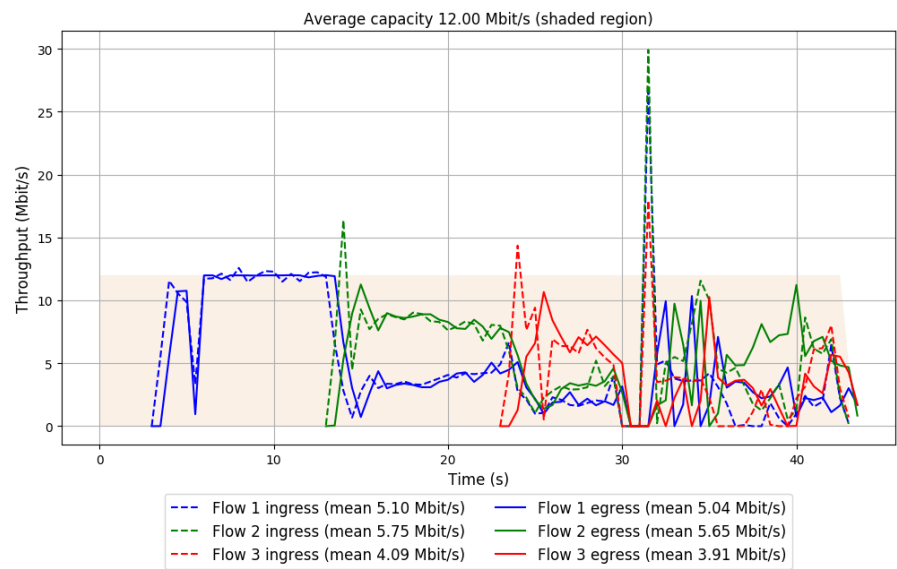


```
Run 1: Statistics of FillP

Start at: 2019-06-26 04:07:53
End at: 2019-06-26 04:08:33

# Below is generated by plot.py at 2019-06-26 04:15:33
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 11.23 Mbit/s (93.6% utilization)
95th percentile per-packet one-way delay: 3116.747 ms
Loss rate: 1.97%
-- Flow 1:
Average throughput: 5.04 Mbit/s
95th percentile per-packet one-way delay: 2916.545 ms
Loss rate: 1.16%
-- Flow 2:
Average throughput: 5.65 Mbit/s
95th percentile per-packet one-way delay: 3324.274 ms
Loss rate: 1.67%
-- Flow 3:
Average throughput: 3.91 Mbit/s
95th percentile per-packet one-way delay: 2985.865 ms
Loss rate: 4.62%
```

Run 1: Report of FillP — Data Link



Run 1: Statistics of FillP-Sheep

Start at: 2019-06-26 03:59:41

End at: 2019-06-26 04:00:21

# Below is generated by plot.py at 2019-06-26 04:15:38

# Datalink statistics

-- Total of 3 flows:

Average capacity: 12.00 Mbit/s

Average throughput: 10.93 Mbit/s (91.1% utilization)

95th percentile per-packet one-way delay: 235.775 ms

Loss rate: 0.25%

-- Flow 1:

Average throughput: 3.54 Mbit/s

95th percentile per-packet one-way delay: 87.996 ms

Loss rate: 0.06%

-- Flow 2:

Average throughput: 6.26 Mbit/s

95th percentile per-packet one-way delay: 440.676 ms

Loss rate: 0.21%

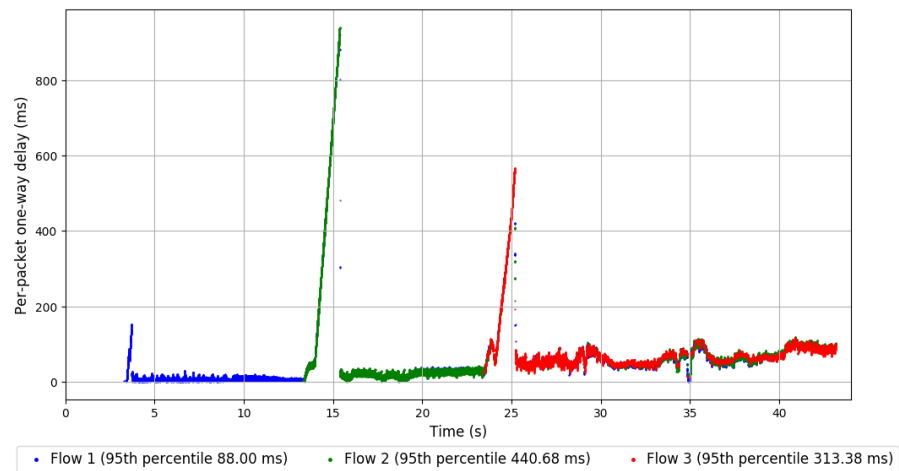
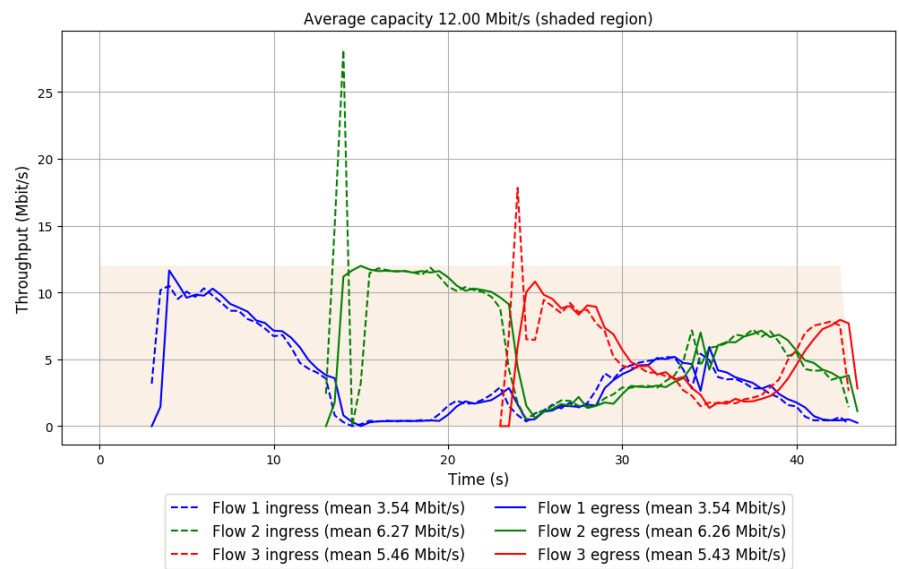
-- Flow 3:

Average throughput: 5.43 Mbit/s

95th percentile per-packet one-way delay: 313.376 ms

Loss rate: 0.58%

Run 1: Report of FillP-Sheep — Data Link

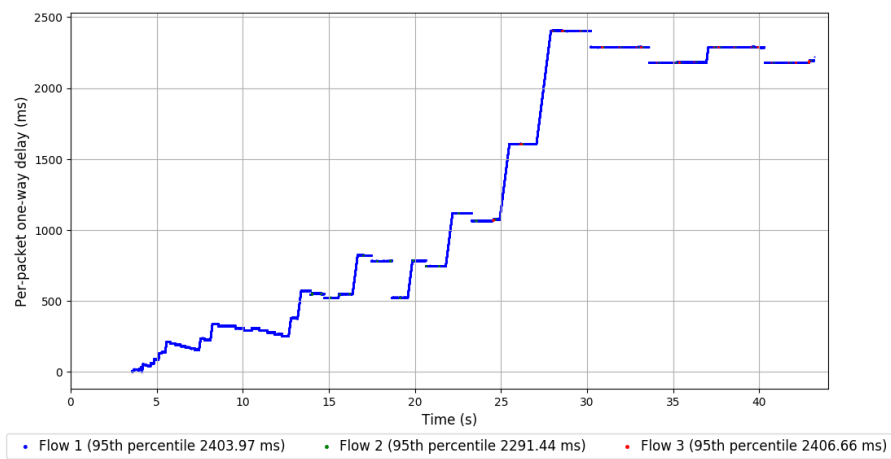
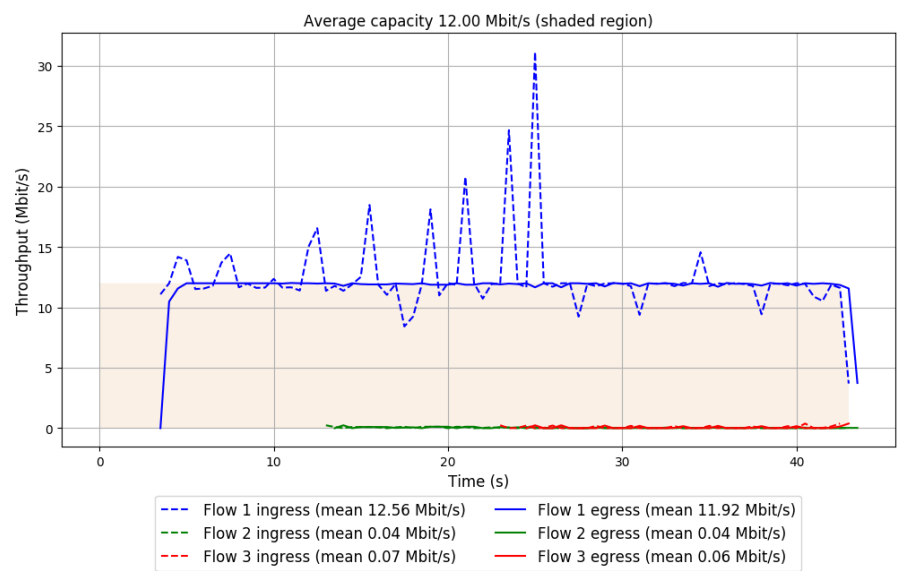


```
Run 1: Statistics of GOLD

Start at: 2019-06-26 04:02:40
End at: 2019-06-26 04:03:20

# Below is generated by plot.py at 2019-06-26 04:15:38
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 11.98 Mbit/s (99.8% utilization)
95th percentile per-packet one-way delay: 2403.972 ms
Loss rate: 5.02%
-- Flow 1:
Average throughput: 11.92 Mbit/s
95th percentile per-packet one-way delay: 2403.967 ms
Loss rate: 4.98%
-- Flow 2:
Average throughput: 0.04 Mbit/s
95th percentile per-packet one-way delay: 2291.439 ms
Loss rate: 3.06%
-- Flow 3:
Average throughput: 0.06 Mbit/s
95th percentile per-packet one-way delay: 2406.664 ms
Loss rate: 19.02%
```

Run 1: Report of GOLD — Data Link



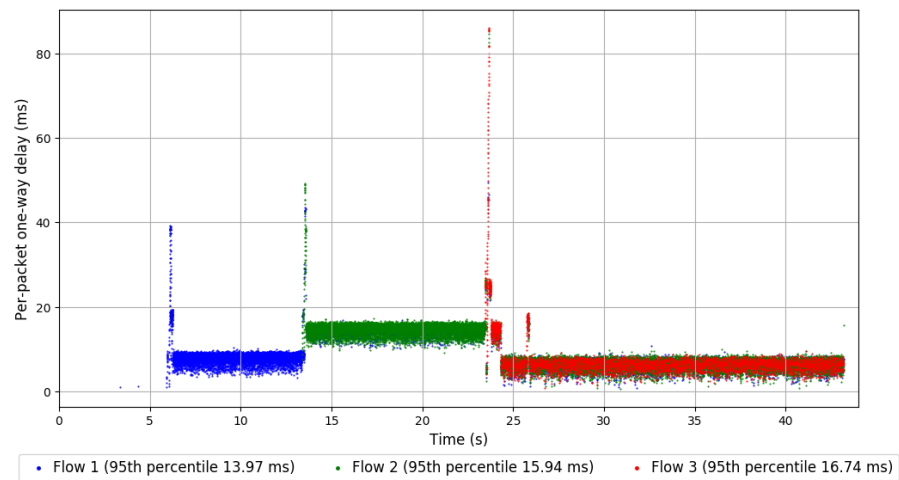
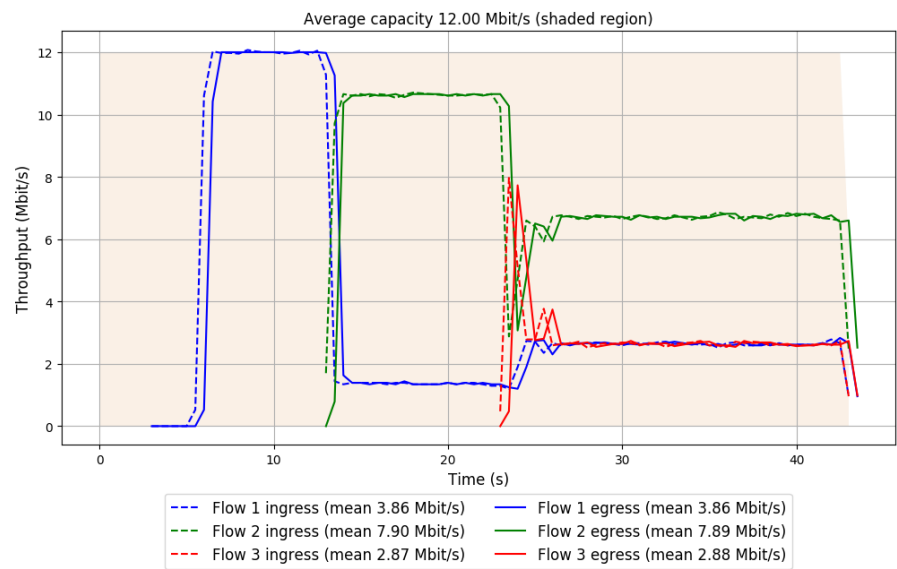


```
Run 1: Statistics of Indigo

Start at: 2019-06-26 04:01:10
End at: 2019-06-26 04:01:50

# Below is generated by plot.py at 2019-06-26 04:15:40
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 11.19 Mbit/s (93.3% utilization)
95th percentile per-packet one-way delay: 15.791 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 3.86 Mbit/s
95th percentile per-packet one-way delay: 13.974 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 7.89 Mbit/s
95th percentile per-packet one-way delay: 15.939 ms
Loss rate: 0.02%
-- Flow 3:
Average throughput: 2.88 Mbit/s
95th percentile per-packet one-way delay: 16.738 ms
Loss rate: 0.00%
```

Run 1: Report of Indigo — Data Link

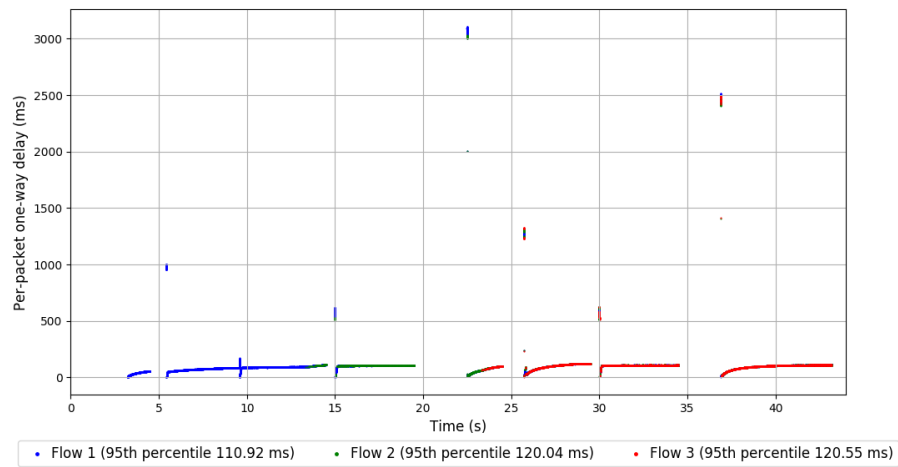
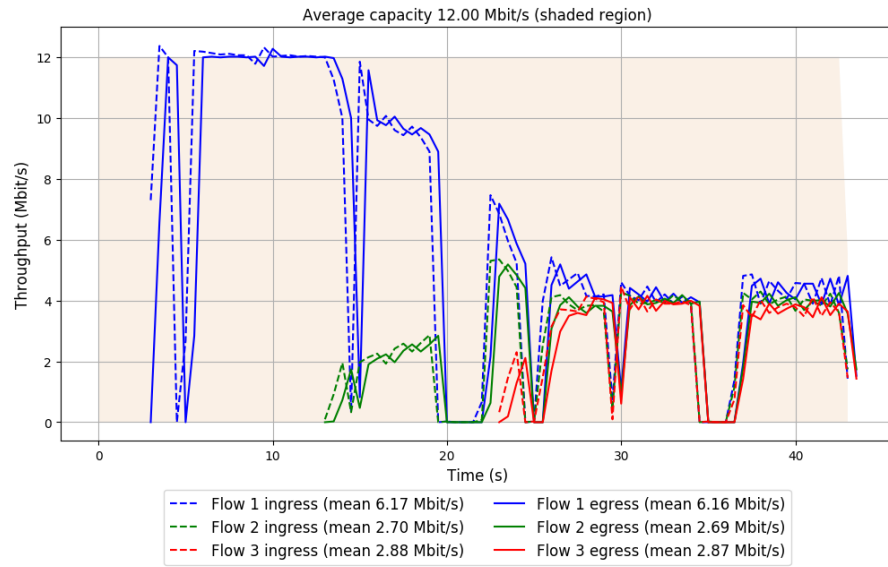


```
Run 1: Statistics of LEDBAT

Start at: 2019-06-26 04:11:36
End at: 2019-06-26 04:12:16

# Below is generated by plot.py at 2019-06-26 04:15:42
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 9.60 Mbit/s (80.0% utilization)
95th percentile per-packet one-way delay: 118.203 ms
Loss rate: 0.34%
-- Flow 1:
Average throughput: 6.16 Mbit/s
95th percentile per-packet one-way delay: 110.915 ms
Loss rate: 0.18%
-- Flow 2:
Average throughput: 2.69 Mbit/s
95th percentile per-packet one-way delay: 120.041 ms
Loss rate: 0.54%
-- Flow 3:
Average throughput: 2.87 Mbit/s
95th percentile per-packet one-way delay: 120.553 ms
Loss rate: 0.74%
```

# Run 1: Report of LEDBAT — Data Link

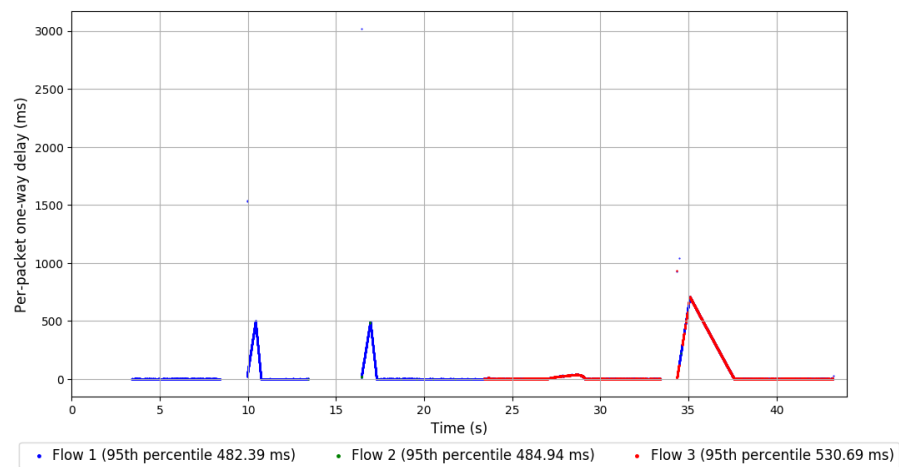
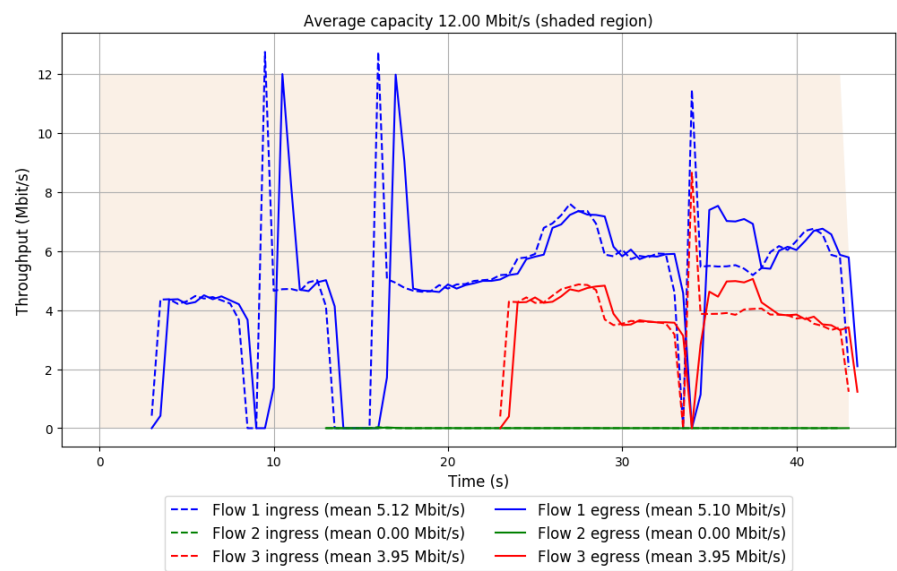


```
Run 1: Statistics of PCC-Allegro

Start at: 2019-06-26 04:10:07
End at: 2019-06-26 04:10:47

# Below is generated by plot.py at 2019-06-26 04:15:46
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 7.07 Mbit/s (58.9% utilization)
95th percentile per-packet one-way delay: 483.496 ms
Loss rate: 0.10%
-- Flow 1:
Average throughput: 5.10 Mbit/s
95th percentile per-packet one-way delay: 482.389 ms
Loss rate: 0.13%
-- Flow 2:
Average throughput: 0.00 Mbit/s
95th percentile per-packet one-way delay: 484.938 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 3.95 Mbit/s
95th percentile per-packet one-way delay: 530.691 ms
Loss rate: 0.00%
```

Run 1: Report of PCC-Allegro — Data Link

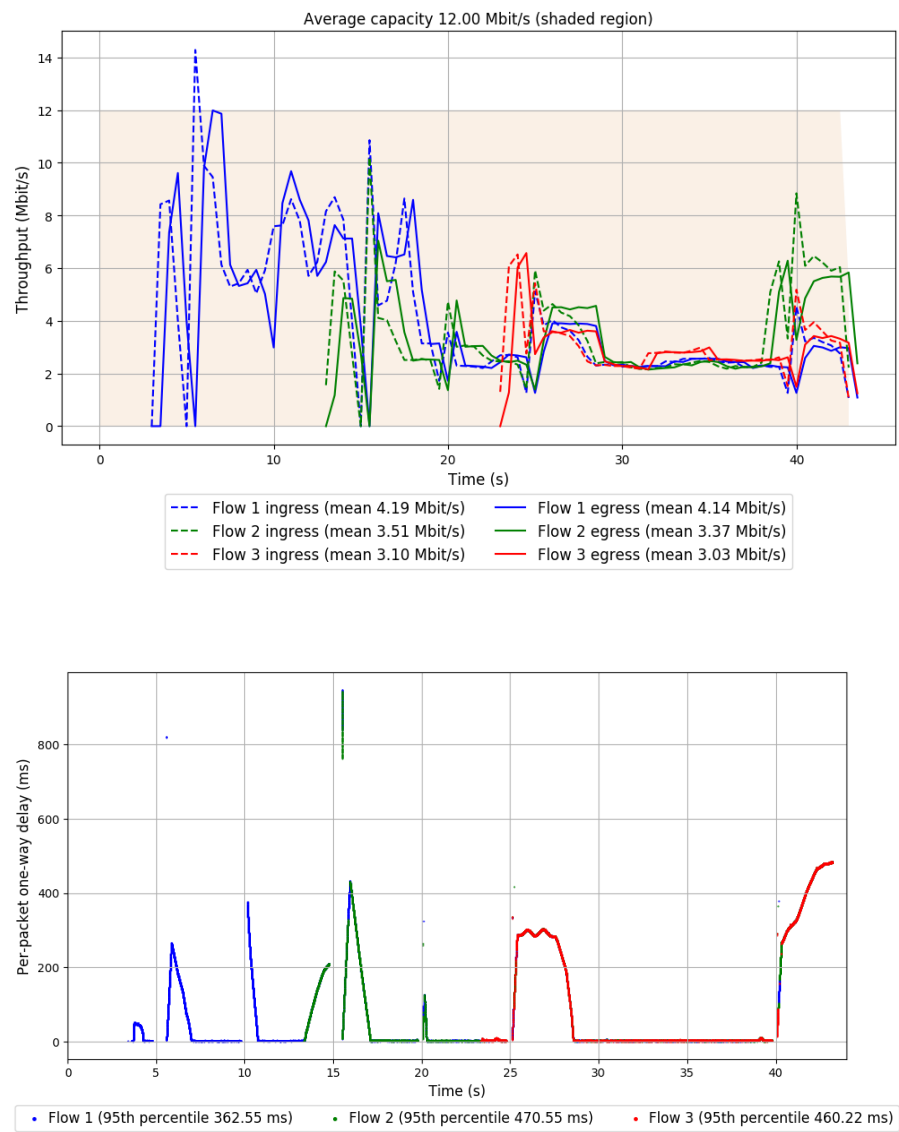


```
Run 1: Statistics of PCC-Expr

Start at: 2019-06-26 04:12:21
End at: 2019-06-26 04:13:01

# Below is generated by plot.py at 2019-06-26 04:15:51
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 8.18 Mbit/s (68.2% utilization)
95th percentile per-packet one-way delay: 432.141 ms
Loss rate: 2.36%
-- Flow 1:
Average throughput: 4.14 Mbit/s
95th percentile per-packet one-way delay: 362.545 ms
Loss rate: 1.38%
-- Flow 2:
Average throughput: 3.37 Mbit/s
95th percentile per-packet one-way delay: 470.548 ms
Loss rate: 3.91%
-- Flow 3:
Average throughput: 3.03 Mbit/s
95th percentile per-packet one-way delay: 460.219 ms
Loss rate: 2.36%
```

Run 1: Report of PCC-Expr — Data Link



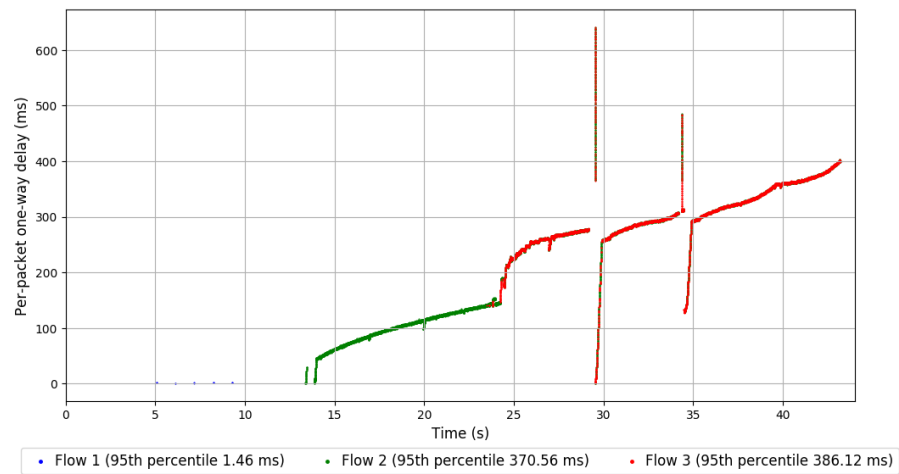
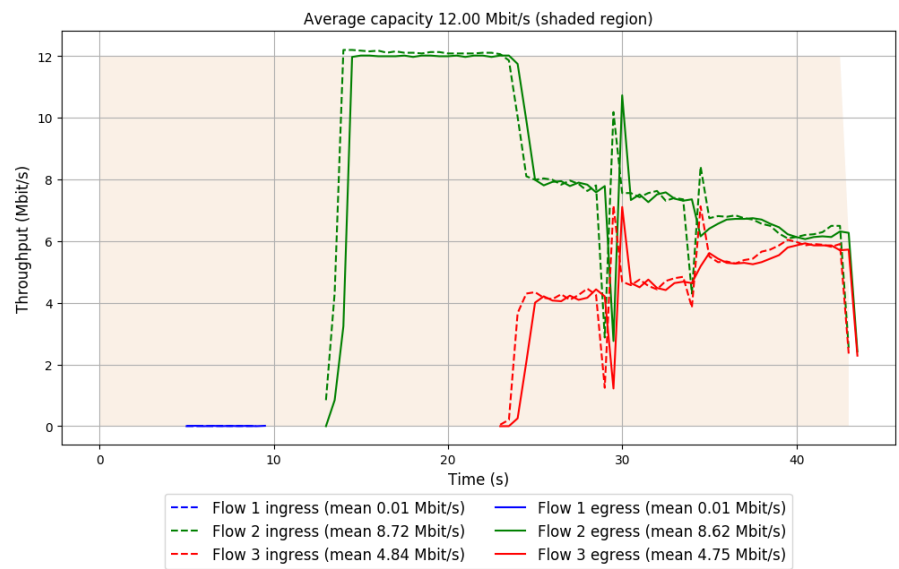


```
Run 1: Statistics of QUIC Cubic

Start at: 2019-06-26 04:09:21
End at: 2019-06-26 04:10:01

# Below is generated by plot.py at 2019-06-26 04:15:51
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 9.20 Mbit/s (76.7% utilization)
95th percentile per-packet one-way delay: 376.068 ms
Loss rate: 1.50%
-- Flow 1:
Average throughput: 0.01 Mbit/s
95th percentile per-packet one-way delay: 1.458 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 8.62 Mbit/s
95th percentile per-packet one-way delay: 370.560 ms
Loss rate: 1.14%
-- Flow 3:
Average throughput: 4.75 Mbit/s
95th percentile per-packet one-way delay: 386.119 ms
Loss rate: 2.46%
```

Run 1: Report of QUIC Cubic — Data Link

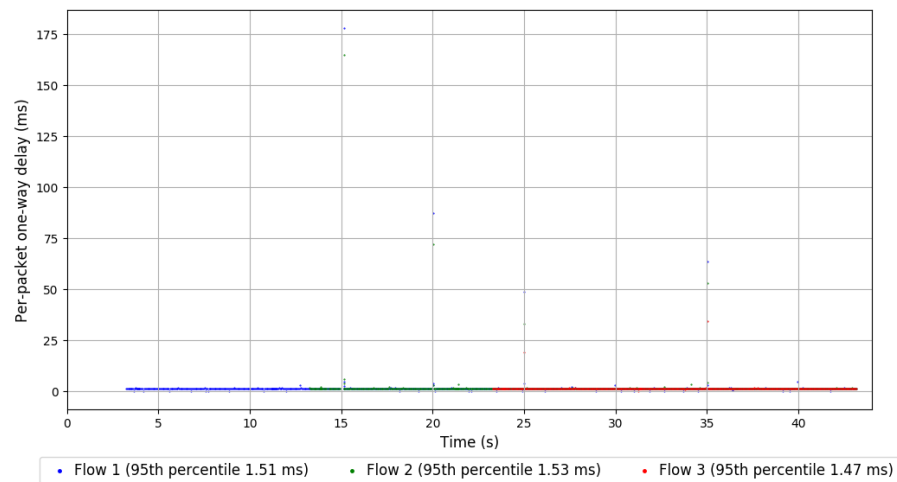
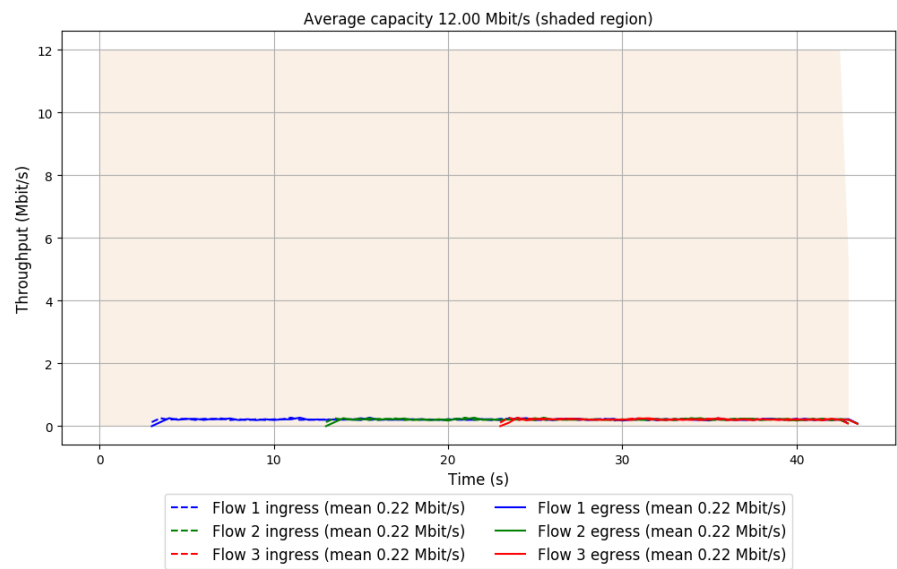


```
Run 1: Statistics of SReAM

Start at: 2019-06-26 04:08:37
End at: 2019-06-26 04:09:17

# Below is generated by plot.py at 2019-06-26 04:15:51
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 0.49 Mbit/s (4.1% utilization)
95th percentile per-packet one-way delay: 1.509 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 0.22 Mbit/s
95th percentile per-packet one-way delay: 1.511 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 0.22 Mbit/s
95th percentile per-packet one-way delay: 1.527 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 0.22 Mbit/s
95th percentile per-packet one-way delay: 1.474 ms
Loss rate: 0.00%
```

Run 1: Report of SReAM — Data Link



Run 1: Statistics of Sprout

Start at: 2019-06-26 04:04:09

End at: 2019-06-26 04:04:49

# Below is generated by plot.py at 2019-06-26 04:15:56

# Datalink statistics

-- Total of 3 flows:

Average capacity: 12.00 Mbit/s

Average throughput: 11.98 Mbit/s (99.8% utilization)

95th percentile per-packet one-way delay: 125.350 ms

Loss rate: 0.32%

-- Flow 1:

Average throughput: 6.67 Mbit/s

95th percentile per-packet one-way delay: 121.966 ms

Loss rate: 0.19%

-- Flow 2:

Average throughput: 4.66 Mbit/s

95th percentile per-packet one-way delay: 126.510 ms

Loss rate: 0.45%

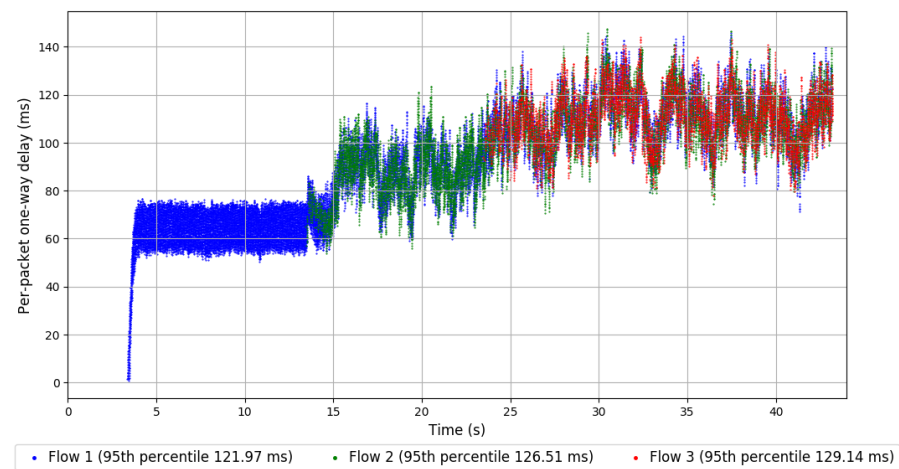
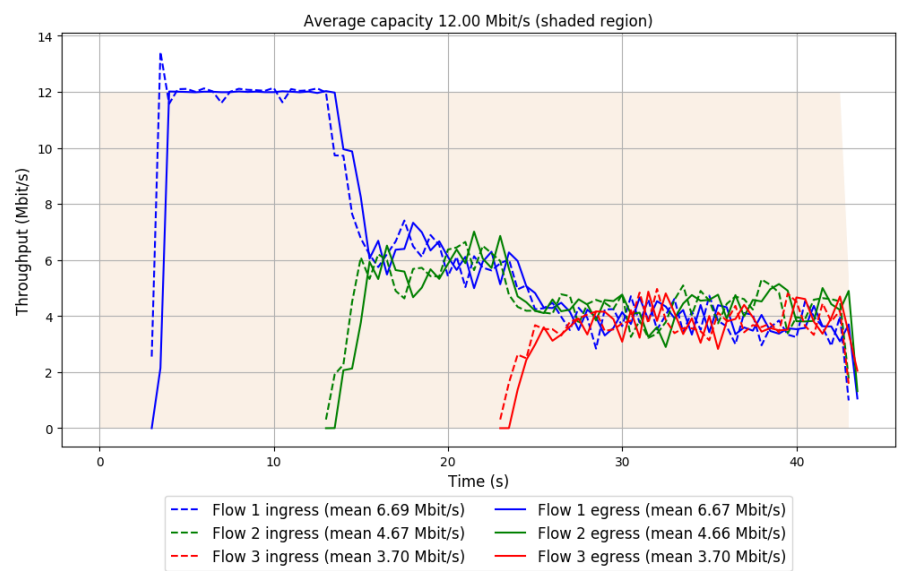
-- Flow 3:

Average throughput: 3.70 Mbit/s

95th percentile per-packet one-way delay: 129.143 ms

Loss rate: 0.54%

Run 1: Report of Sprout — Data Link

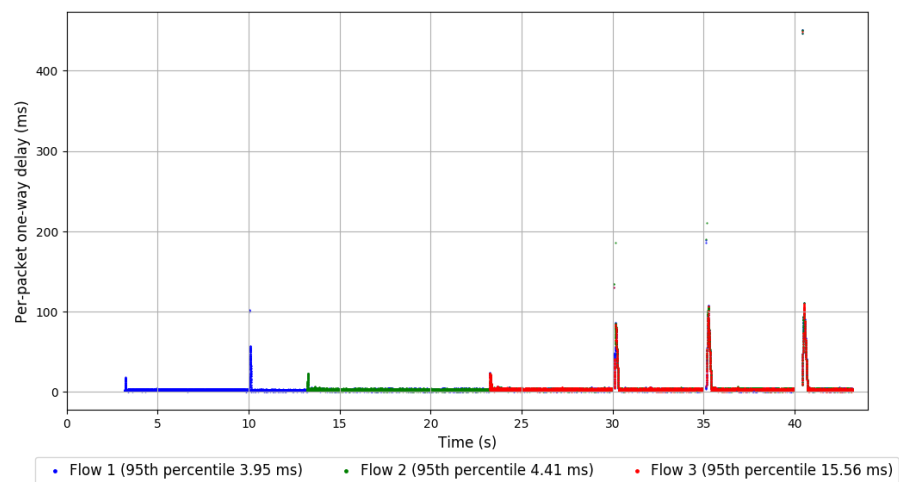
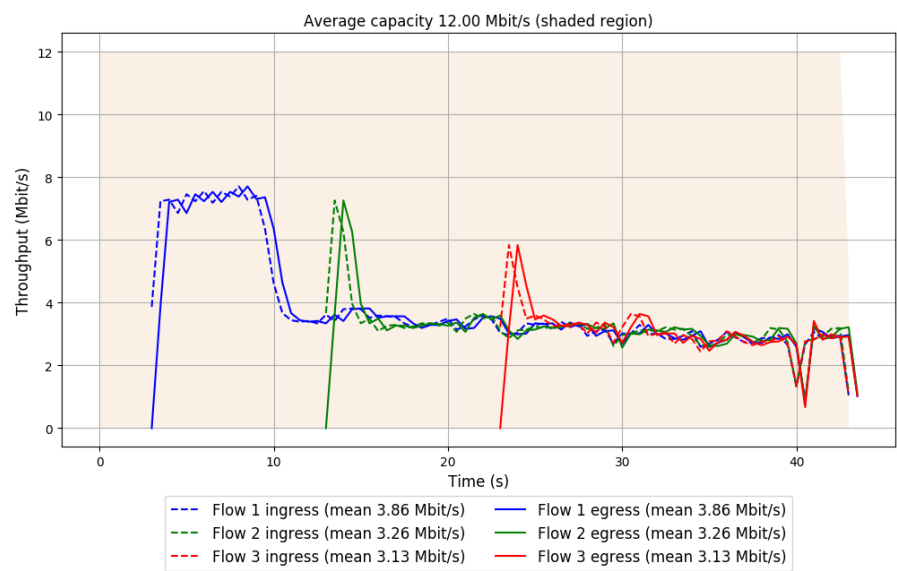


```
Run 1: Statistics of TaoVA-100x

Start at: 2019-06-26 04:07:08
End at: 2019-06-26 04:07:48

# Below is generated by plot.py at 2019-06-26 04:15:58
# Datalink statistics
-- Total of 3 flows:
Average capacity: 12.00 Mbit/s
Average throughput: 7.87 Mbit/s (65.6% utilization)
95th percentile per-packet one-way delay: 4.300 ms
Loss rate: 0.01%
-- Flow 1:
Average throughput: 3.86 Mbit/s
95th percentile per-packet one-way delay: 3.946 ms
Loss rate: 0.01%
-- Flow 2:
Average throughput: 3.26 Mbit/s
95th percentile per-packet one-way delay: 4.407 ms
Loss rate: 0.01%
-- Flow 3:
Average throughput: 3.13 Mbit/s
95th percentile per-packet one-way delay: 15.557 ms
Loss rate: 0.02%
```

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





Run 1: Statistics of TCP Vegas

Start at: 2019-06-26 04:05:39

End at: 2019-06-26 04:06:19

# Below is generated by plot.py at 2019-06-26 04:15:59

# Datalink statistics

-- Total of 3 flows:

Average capacity: 12.00 Mbit/s

Average throughput: 11.99 Mbit/s (100.0% utilization)

95th percentile per-packet one-way delay: 18.110 ms

Loss rate: 0.04%

-- Flow 1:

Average throughput: 6.07 Mbit/s

95th percentile per-packet one-way delay: 17.277 ms

Loss rate: 0.03%

-- Flow 2:

Average throughput: 4.29 Mbit/s

95th percentile per-packet one-way delay: 18.405 ms

Loss rate: 0.04%

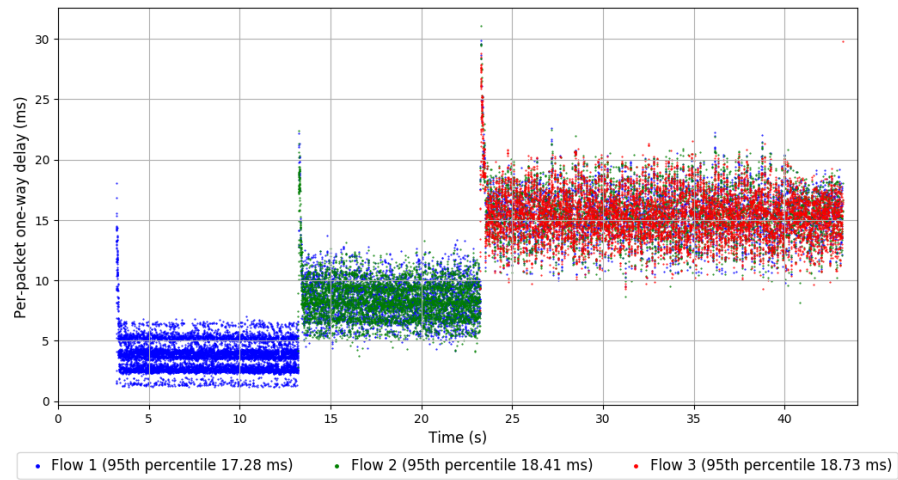
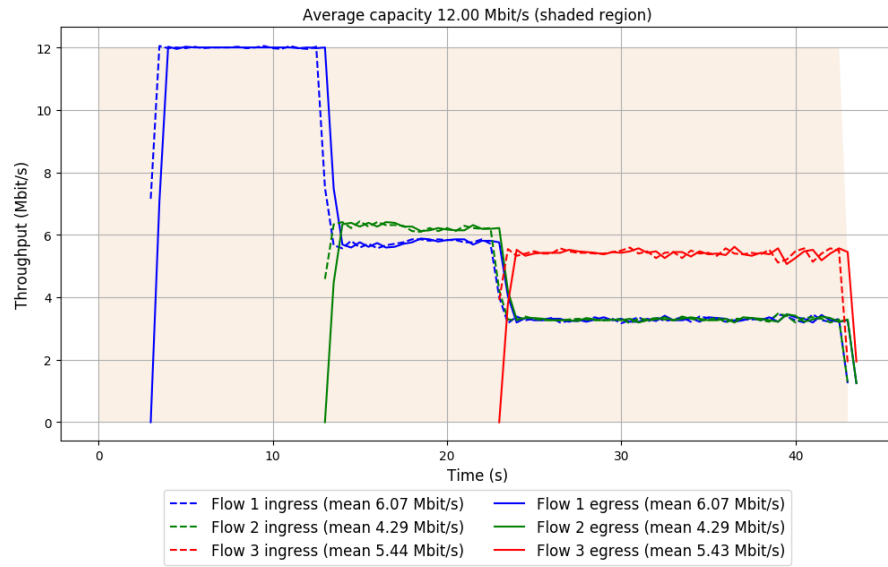
-- Flow 3:

Average throughput: 5.43 Mbit/s

95th percentile per-packet one-way delay: 18.731 ms

Loss rate: 0.07%

## Run 1: Report of TCP Vegas — Data Link



Run 1: Statistics of Verus

Start at: 2019-06-26 04:01:55

End at: 2019-06-26 04:02:35

# Below is generated by plot.py at 2019-06-26 04:16:02

# Datalink statistics

-- Total of 3 flows:

Average capacity: 12.00 Mbit/s

Average throughput: 11.29 Mbit/s (94.1% utilization)

95th percentile per-packet one-way delay: 560.315 ms

Loss rate: 0.58%

-- Flow 1:

Average throughput: 6.21 Mbit/s

95th percentile per-packet one-way delay: 507.730 ms

Loss rate: 0.44%

-- Flow 2:

Average throughput: 4.82 Mbit/s

95th percentile per-packet one-way delay: 673.745 ms

Loss rate: 0.56%

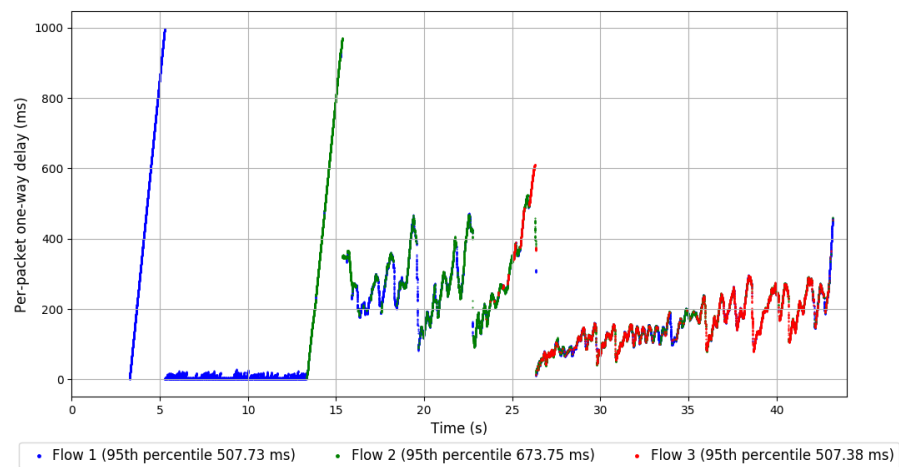
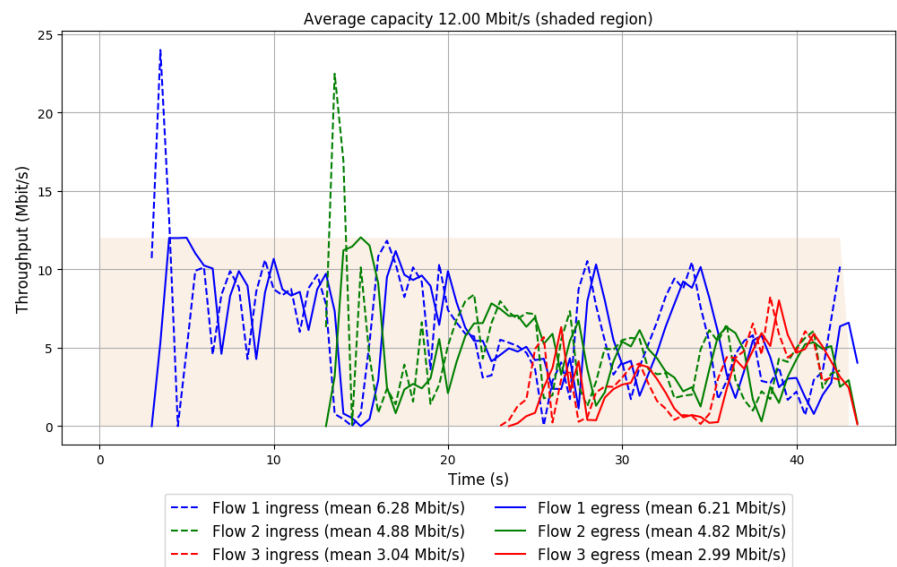
-- Flow 3:

Average throughput: 2.99 Mbit/s

95th percentile per-packet one-way delay: 507.380 ms

Loss rate: 1.23%

Run 1: Report of Verus — Data Link



Run 1: Statistics of PCC-Vivace

Start at: 2019-06-26 04:04:54

End at: 2019-06-26 04:05:34

# Below is generated by plot.py at 2019-06-26 04:16:03

# Datalink statistics

-- Total of 3 flows:

Average capacity: 12.00 Mbit/s

Average throughput: 10.36 Mbit/s (86.3% utilization)

95th percentile per-packet one-way delay: 20.127 ms

Loss rate: 0.01%

-- Flow 1:

Average throughput: 5.29 Mbit/s

95th percentile per-packet one-way delay: 64.752 ms

Loss rate: 0.01%

-- Flow 2:

Average throughput: 4.68 Mbit/s

95th percentile per-packet one-way delay: 13.279 ms

Loss rate: 0.01%

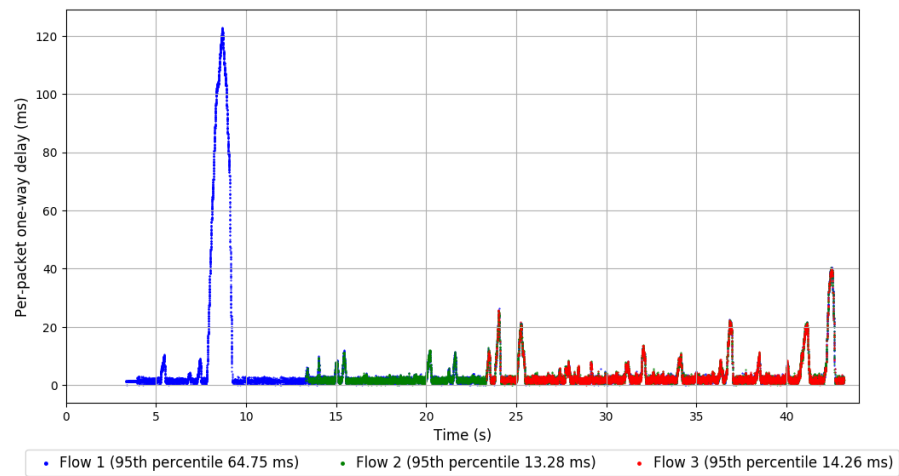
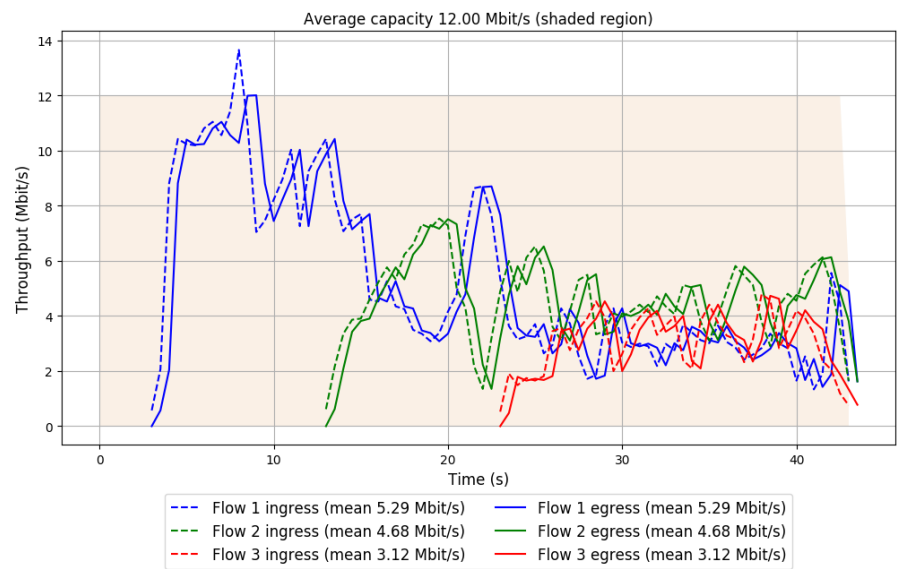
-- Flow 3:

Average throughput: 3.12 Mbit/s

95th percentile per-packet one-way delay: 14.255 ms

Loss rate: 0.00%

Run 1: Report of PCC-Vivace — Data Link



Run 1: Statistics of WebRTC media

Start at: 2019-06-26 04:10:51

End at: 2019-06-26 04:11:31

# Below is generated by plot.py at 2019-06-26 04:16:03

# Datalink statistics

-- Total of 3 flows:

Average capacity: 12.00 Mbit/s

Average throughput: 3.36 Mbit/s (28.0% utilization)

95th percentile per-packet one-way delay: 413.760 ms

Loss rate: 7.99%

-- Flow 1:

Average throughput: 1.92 Mbit/s

95th percentile per-packet one-way delay: 393.763 ms

Loss rate: 5.63%

-- Flow 2:

Average throughput: 1.12 Mbit/s

95th percentile per-packet one-way delay: 417.778 ms

Loss rate: 10.17%

-- Flow 3:

Average throughput: 0.32 Mbit/s

95th percentile per-packet one-way delay: 423.725 ms

Loss rate: 13.60%

Run 1: Report of WebRTC media — Data Link

