Pantheon Report


Data path: GCE London on ens4 (local) \(\rightarrow\) GCE Iowa on ens4 (remote).
Repeated the test of 4 congestion control schemes twice.
Each test lasted for 30 seconds running 3 flows with 10-second interval between two flows.
NTP offsets were measured against time.google.com and have been applied to correct the timestamps in logs.

System info:
Linux 4.15.0-1018-gcp
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 @ e3c5aa19ca94c3066828fb83f16a8fb6b2731e7a
third_party/fillp @ d47f4fa1b454a5e3c0537115c5a28436dbd4b834
third_party/fillp-sheep @ dea0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143c6edbe58e562f4
third_party/indigo @ 2601c92e4a9d5d8d36c4fde0edbf90c077e64d
third_party/libutp @ b3465b942e2826f2b179eabab4a906c66bb7cf3cf
third_party/muses @ b59e0d118c5af3579569c462d33045741c85981
third_party/pantheon-tunnel @ cbf6e6db5f5740dfe1771f813c6d646339e1952
third_party/pcc @ 1afcf9584a0d6d1b62c091a55f8c872ab4981e1
M receiver/src/buffer.h
M receiver/src/core.cpp
M sender/src/buffer.h
M sender/src/core.cpp
third_party/pcc-experimental @ cd43e34e3f5f5613e8ac0d0a92c4eb24f9744ab
third_party/proto-quic @ 77961f1a82733a86b42f1bc8143e8bc978f3cfc42
third_party/scream-reproduce @ f099118d1421aa3131bf11ff1964974e1da3b6b2
M src/ScreamClient
M src/ScreamServer
third_party/sprout @ 366e35c6178b01e31d4a6ad18c74f9415f19a26
third_party/verus @ d4b447ea74c6c60a261149af2629562939f9a494
M src/verus.hpp
M tools/plot.py
third_party/vivace @ 2abf86211435ae071a32f96b7d8c504587f5d7f4
third_party/webrtc @ 3f0cc2a9061a41b6f9d0e47357770143a1fa2851
test from GCE London to GCE Iowa, 2 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)
<table>
<thead>
<tr>
<th>scheme</th>
<th># runs</th>
<th>mean avg tput (Mbit/s)</th>
<th>mean 95th-%ile delay (ms)</th>
<th>mean loss rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>flow 1</td>
<td>flow 2</td>
<td>flow 3</td>
</tr>
<tr>
<td>TCP BBR</td>
<td>2</td>
<td>562.94</td>
<td>507.35</td>
<td>511.27</td>
</tr>
<tr>
<td>TCP Cubic</td>
<td>2</td>
<td>613.19</td>
<td>529.06</td>
<td>540.63</td>
</tr>
<tr>
<td>Indigo</td>
<td>2</td>
<td>224.50</td>
<td>212.57</td>
<td>185.99</td>
</tr>
<tr>
<td>Muses-25</td>
<td>2</td>
<td>593.97</td>
<td>497.17</td>
<td>478.09</td>
</tr>
</tbody>
</table>
Run 1: Statistics of TCP BBR

Start at: 2018-08-31 12:44:11
End at: 2018-08-31 12:44:41
Local clock offset: 0.043 ms
Remote clock offset: -1.085 ms

# Below is generated by plot.py at 2018-08-31 13:16:34
# Datalink statistics
-- Total of 3 flows:
  Average throughput: 1073.91 Mbit/s
  95th percentile per-packet one-way delay: 136.224 ms
  Loss rate: 1.08%
-- Flow 1:
  Average throughput: 571.06 Mbit/s
  95th percentile per-packet one-way delay: 127.180 ms
  Loss rate: 0.55%
-- Flow 2:
  Average throughput: 501.11 Mbit/s
  95th percentile per-packet one-way delay: 140.937 ms
  Loss rate: 0.67%
-- Flow 3:
  Average throughput: 508.17 Mbit/s
  95th percentile per-packet one-way delay: 153.189 ms
  Loss rate: 3.62%
Run 1: Report of TCP BBR — Data Link

Throughput (Mbps)

Time (s)

Flow 1 ingress (mean 574.27 Mbps)  
Flow 1 egress (mean 571.06 Mbps)
Flow 2 ingress (mean 504.48 Mbps)  
Flow 2 egress (mean 501.11 Mbps)
Flow 3 ingress (mean 527.27 Mbps)  
Flow 3 egress (mean 508.17 Mbps)

Time (s)

Per-packet one-way delay (ms)

Flow 1 (95th percentile 127.18 ms)  
Flow 2 (95th percentile 140.94 ms)  
Flow 3 (95th percentile 153.19 ms)
Run 2: Statistics of TCP BBR

Start at: 2018-08-31 12:52:10
End at: 2018-08-31 12:52:40
Local clock offset: 0.371 ms
Remote clock offset: -1.261 ms

# Below is generated by plot.py at 2018-08-31 13:16:37
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1068.03 Mbit/s
95th percentile per-packet one-way delay: 130.203 ms
Loss rate: 0.63%
-- Flow 1:
Average throughput: 554.82 Mbit/s
95th percentile per-packet one-way delay: 134.351 ms
Loss rate: 0.92%
-- Flow 2:
Average throughput: 513.59 Mbit/s
95th percentile per-packet one-way delay: 122.881 ms
Loss rate: 0.42%
-- Flow 3:
Average throughput: 514.38 Mbit/s
95th percentile per-packet one-way delay: 137.669 ms
Loss rate: 0.14%
Run 1: Statistics of TCP Cubic

Start at: 2018-08-31 12:48:20
End at: 2018-08-31 12:48:50
Local clock offset: 0.482 ms
Remote clock offset: -1.156 ms

# Below is generated by plot.py at 2018-08-31 13:18:03
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1119.34 Mbit/s
95th percentile per-packet one-way delay: 134.496 ms
Loss rate: 0.08%

-- Flow 1:
Average throughput: 617.76 Mbit/s
95th percentile per-packet one-way delay: 134.183 ms
Loss rate: 0.02%

-- Flow 2:
Average throughput: 494.19 Mbit/s
95th percentile per-packet one-way delay: 72.440 ms
Loss rate: 0.00%

-- Flow 3:
Average throughput: 518.14 Mbit/s
95th percentile per-packet one-way delay: 146.191 ms
Loss rate: 0.42%
Run 1: Report of TCP Cubic — Data Link

![Throughput Graph]

**Throughput (Mbps)**

- Flow 1 ingress (mean 617.87 Mbps)
- Flow 1 egress (mean 617.76 Mbps)
- Flow 2 ingress (mean 494.19 Mbps)
- Flow 2 egress (mean 494.19 Mbps)
- Flow 3 ingress (mean 520.42 Mbps)
- Flow 3 egress (mean 518.14 Mbps)

![End-to-End Delay Graph]

**Per-packet end-to-end delay (ms)**

- Flow 1 (95th percentile 134.18 ms)
- Flow 2 (95th percentile 72.44 ms)
- Flow 3 (95th percentile 146.19 ms)
Run 2: Statistics of TCP Cubic

Start at: 2018-08-31 12:56:17
End at: 2018-08-31 12:56:47
Local clock offset: 0.603 ms
Remote clock offset: -1.381 ms

# Below is generated by plot.py at 2018-08-31 13:18:13
# Datalink statistics
-- Total of 3 flows:
  Average throughput: 1171.45 Mbit/s
  95th percentile per-packet one-way delay: 117.123 ms
  Loss rate: 0.10%
  -- Flow 1:
    Average throughput: 608.62 Mbit/s
    95th percentile per-packet one-way delay: 125.115 ms
    Loss rate: 0.16%
  -- Flow 2:
    Average throughput: 563.93 Mbit/s
    95th percentile per-packet one-way delay: 71.857 ms
    Loss rate: 0.06%
  -- Flow 3:
    Average throughput: 563.12 Mbit/s
    95th percentile per-packet one-way delay: 107.152 ms
    Loss rate: 0.00%
Run 2: Report of TCP Cubic — Data Link

![Graph showing network performance metrics over time.](image-url)
Run 1: Statistics of Indigo

Start at: 2018-08-31 12:50:23
End at: 2018-08-31 12:50:53
Local clock offset: 0.505 ms
Remote clock offset: -1.219 ms

# Below is generated by plot.py at 2018-08-31 13:18:13
# Datalink statistics
-- Total of 3 flows:
Average throughput: 429.67 Mbit/s
95th percentile per-packet one-way delay: 51.801 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 227.33 Mbit/s
95th percentile per-packet one-way delay: 51.308 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 215.54 Mbit/s
95th percentile per-packet one-way delay: 52.334 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 182.07 Mbit/s
95th percentile per-packet one-way delay: 50.864 ms
Loss rate: 0.00%
Run 1: Report of Indigo — Data Link

![Graph showing throughput and per-packet end-to-end delay over time for different flows.]

Legend:
- Flow 1 ingress (mean 227.33 Mbit/s)
- Flow 1 egress (mean 227.33 Mbit/s)
- Flow 2 ingress (mean 215.54 Mbit/s)
- Flow 2 egress (mean 215.54 Mbit/s)
- Flow 3 ingress (mean 181.99 Mbit/s)
- Flow 3 egress (mean 182.07 Mbit/s)
Run 2: Statistics of Indigo

Start at: 2018-08-31 12:58:21
End at: 2018-08-31 12:58:51
Local clock offset: 0.465 ms
Remote clock offset: -1.217 ms

# Below is generated by plot.py at 2018-08-31 13:18:13
# Datalink statistics
-- Total of 3 flows:
Average throughput: 422.57 Mbit/s
95th percentile per-packet one-way delay: 51.268 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 221.67 Mbit/s
95th percentile per-packet one-way delay: 51.131 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 209.61 Mbit/s
95th percentile per-packet one-way delay: 51.308 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 189.91 Mbit/s
95th percentile per-packet one-way delay: 51.686 ms
Loss rate: 0.00%
Run 2: Report of Indigo — Data Link

![Graph showing throughput and per-packet end-to-end delay over time for flows 1, 2, and 3.]

- Flow 1 ingress (mean 221.67 Mbit/s)
- Flow 1 egress (mean 221.67 Mbit/s)
- Flow 2 ingress (mean 209.64 Mbit/s)
- Flow 2 egress (mean 209.61 Mbit/s)
- Flow 3 ingress (mean 189.91 Mbit/s)
- Flow 3 egress (mean 189.91 Mbit/s)
Run 1: Statistics of Muses-25

Start at: 2018-08-31 12:46:16
End at: 2018-08-31 12:46:46
Local clock offset: 0.146 ms
Remote clock offset: -1.137 ms

# Below is generated by plot.py at 2018-08-31 13:19:24
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1082.73 Mbit/s
95th percentile per-packet one-way delay: 59.143 ms
Loss rate: 0.00%
-- Flow 1:
Average throughput: 597.62 Mbit/s
95th percentile per-packet one-way delay: 60.098 ms
Loss rate: 0.00%
-- Flow 2:
Average throughput: 496.91 Mbit/s
95th percentile per-packet one-way delay: 57.576 ms
Loss rate: 0.00%
-- Flow 3:
Average throughput: 473.61 Mbit/s
95th percentile per-packet one-way delay: 58.978 ms
Loss rate: 0.00%
Run 1: Report of Muses-25 — Data Link
Run 2: Statistics of Muses-25

Start at: 2018-08-31 12:54:13
End at: 2018-08-31 12:54:43
Local clock offset: 0.814 ms
Remote clock offset: -1.314 ms

# Below is generated by plot.py at 2018-08-31 13:19:24
# Datalink statistics
-- Total of 3 flows:
  Average throughput: 1079.15 Mbit/s
  95th percentile per-packet one-way delay: 57.644 ms
  Loss rate: 0.00%
-- Flow 1:
  Average throughput: 590.32 Mbit/s
  95th percentile per-packet one-way delay: 58.680 ms
  Loss rate: 0.00%
-- Flow 2:
  Average throughput: 497.43 Mbit/s
  95th percentile per-packet one-way delay: 57.288 ms
  Loss rate: 0.00%
-- Flow 3:
  Average throughput: 482.57 Mbit/s
  95th percentile per-packet one-way delay: 55.343 ms
  Loss rate: 0.00%
Run 2: Report of Muses-25 — Data Link

![Graph showing throughput and per-packet one-way delay over time for different flows.](image-url)

- Flow 1 ingress (mean 590.33 Mbit/s)
- Flow 1 egress (mean 590.32 Mbit/s)
- Flow 2 ingress (mean 497.43 Mbit/s)
- Flow 2 egress (mean 497.43 Mbit/s)
- Flow 3 ingress (mean 482.60 Mbit/s)
- Flow 3 egress (mean 482.57 Mbit/s)