Pantheon Report

Generated at 2018-08-31 12:18:44 (UTC).
Data path: GCE Tokyo on ens4 (remote) → GCE Iowa on ens4 (local).
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 @ e3c5aa19ca94c3066828f83f16a8fb6b2731e7a
third_party/fillp @ daed0c84f98531712514b2231f43ec6901114ffe
third_party/genericCC @ d0153f8e594aa89e93b032143cedbdf5e8e562f4
third_party/indigo @ 2601c92e4aa9d58d38dc4dfe0edbf90c077e64d
third_party/libutp @ b3465b94e2826f2b179eaab4a906ce6bb7bf3cf
third_party/muses @ b59e0d118c50af3579569c462d33045741c85981
third_party/pantheon-tunnel @ cb1f813adb5d46339e1952
third_party/pcc @ 1af958e0a66d18b623c091a55fdec872b4981e1
M receiver/src/buffer.h
M receiver/src/core.cpp
M sender/src/buffer.h
M sender/src/core.cpp
third_party/pcc-experimental @ cd4e34e3f5f5613e8ac0d8fab92c4eb24f974ab
third_party/proto-quic @ 77961f1a82733a86b42f1bc814edc978f3cfc42
third_party/scream-reproduce @ f099118d1420a3131bflff1964974e1da3db2
M src/ScreamClient
M src/ScreamServer
third_party/sprout @ 366e35c6178b01e31d4a46ad18c74f9415f192a26
third_party/verus @ d4b447ea74c6c60a261149af2629562939f9a494
M src/verus.hpp
M tools/plot.py
third_party/vivace @ 2baf86211435ae071a32f96b7d8c504587f5d7f4
third_party/webrtc @ 3f0cc2a9061a41b6f9add475777d143a1fa2851
test from GCE Tokyo to GCE Iowa, 2 runs of 30s each per scheme
3 flows with 10s interval between flows (mean of all runs by scheme)

Average throughput (Mbit/s)

TCP BBR
TCP Cubic
Muses-25
Indigo

95th percentile one-way delay (ms)
<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>545.05</td>
<td>495.83</td>
<td>463.93</td>
</tr>
<tr>
<td>TCP Cubic</td>
<td>2</td>
<td>566.86</td>
<td>520.45</td>
<td>467.84</td>
</tr>
<tr>
<td>Indigo</td>
<td>2</td>
<td>221.16</td>
<td>211.14</td>
<td>184.38</td>
</tr>
<tr>
<td>Muses-25</td>
<td>2</td>
<td>497.18</td>
<td>424.30</td>
<td>392.36</td>
</tr>
</tbody>
</table>
Run 1: Statistics of TCP BBR

Start at: 2018-08-31 11:47:02
End at: 2018-08-31 11:47:32
Local clock offset: -6.835 ms
Remote clock offset: 0.62 ms

# Below is generated by plot.py at 2018-08-31 12:17:32
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1017.19 Mbit/s
95th percentile per-packet one-way delay: 127.029 ms
Loss rate: 1.18%
-- Flow 1:
Average throughput: 547.52 Mbit/s
95th percentile per-packet one-way delay: 136.457 ms
Loss rate: 0.94%
-- Flow 2:
Average throughput: 479.58 Mbit/s
95th percentile per-packet one-way delay: 108.890 ms
Loss rate: 1.30%
-- Flow 3:
Average throughput: 458.33 Mbit/s
95th percentile per-packet one-way delay: 126.042 ms
Loss rate: 1.81%
Run 1: Report of TCP BBR — Data Link
Run 2: Statistics of TCP BBR

Start at: 2018-08-31 11:54:50
End at: 2018-08-31 11:55:20
Local clock offset: -4.242 ms
Remote clock offset: -2.492 ms

# Below is generated by plot.py at 2018-08-31 12:17:39
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1037.52 Mbit/s
95th percentile per-packet one-way delay: 166.460 ms
Loss rate: 2.21%
-- Flow 1:
Average throughput: 542.58 Mbit/s
95th percentile per-packet one-way delay: 169.050 ms
Loss rate: 2.36%
-- Flow 2:
Average throughput: 512.08 Mbit/s
95th percentile per-packet one-way delay: 169.938 ms
Loss rate: 1.91%
-- Flow 3:
Average throughput: 469.53 Mbit/s
95th percentile per-packet one-way delay: 122.307 ms
Loss rate: 2.36%
Run 2: Report of TCP BBR — Data Link

![Graph showing throughput and per-packet one-way delay over time for different flows.]
Run 1: Statistics of TCP Cubic

Start at: 2018-08-31 11:50:54
End at: 2018-08-31 11:51:24
Local clock offset: -6.03 ms
Remote clock offset: -2.326 ms

# Below is generated by plot.py at 2018-08-31 12:17:39
# Datalink statistics
-- Total of 3 flows:
Average throughput: 1014.16 Mbit/s
95th percentile per-packet one-way delay: 135.788 ms
Loss rate: 0.74%
-- Flow 1:
Average throughput: 534.56 Mbit/s
95th percentile per-packet one-way delay: 163.112 ms
Loss rate: 0.41%
-- Flow 2:
Average throughput: 489.11 Mbit/s
95th percentile per-packet one-way delay: 97.020 ms
Loss rate: 0.76%
-- Flow 3:
Average throughput: 468.85 Mbit/s
95th percentile per-packet one-way delay: 129.671 ms
Loss rate: 1.81%
Run 1: Report of TCP Cubic — Data Link

![Graph showing throughput and per-packet one-way delay over time for different flow types and mean values.]

**Throughput (Mbps):**
- Flow 1 ingress (mean 534.56 Mbps)
- Flow 1 egress (mean 534.56 Mbps)
- Flow 2 ingress (mean 489.69 Mbps)
- Flow 2 egress (mean 489.11 Mbps)
- Flow 3 ingress (mean 471.63 Mbps)
- Flow 3 egress (mean 466.85 Mbps)

**Per-packet one-way delay (ms):**
- Flow 1 (95th percentile 163.11 ms)
- Flow 2 (95th percentile 97.02 ms)
- Flow 3 (95th percentile 129.67 ms)
Run 2: Statistics of TCP Cubic

Start at: 2018-08-31 11:58:47
End at: 2018-08-31 11:59:17
Local clock offset: -3.199 ms
Remote clock offset: 0.323 ms

# Below is generated by plot.py at 2018-08-31 12:18:08
# Datalink statistics
-- Total of 3 flows:
  Average throughput: 1119.81 Mbit/s
  95th percentile per-packet one-way delay: 105.173 ms
  Loss rate: 0.72%
-- Flow 1:
  Average throughput: 599.16 Mbit/s
  95th percentile per-packet one-way delay: 108.480 ms
  Loss rate: 0.39%
-- Flow 2:
  Average throughput: 551.80 Mbit/s
  95th percentile per-packet one-way delay: 102.177 ms
  Loss rate: 0.84%
-- Flow 3:
  Average throughput: 466.82 Mbit/s
  95th percentile per-packet one-way delay: 83.257 ms
  Loss rate: 1.71%
Run 2: Report of TCP Cubic — Data Link
Run 1: Statistics of Indigo

Start at: 2018-08-31 11:49:06
End at: 2018-08-31 11:49:36
Local clock offset: -7.182 ms
Remote clock offset: 0.596 ms

# Below is generated by plot.py at 2018-08-31 12:18:08
# Datalink statistics
-- Total of 3 flows:
  Average throughput: 412.57 Mbit/s
  95th percentile per-packet one-way delay: 66.642 ms
  Loss rate: 0.63%
-- Flow 1:
  Average throughput: 219.02 Mbit/s
  95th percentile per-packet one-way delay: 62.002 ms
  Loss rate: 0.40%
-- Flow 2:
  Average throughput: 208.04 Mbit/s
  95th percentile per-packet one-way delay: 62.223 ms
  Loss rate: 0.61%
-- Flow 3:
  Average throughput: 171.40 Mbit/s
  95th percentile per-packet one-way delay: 69.227 ms
  Loss rate: 1.56%
Run 2: Statistics of Indigo

Start at: 2018-08-31 11:56:58
End at: 2018-08-31 11:57:28
Local clock offset: -3.616 ms
Remote clock offset: -2.43 ms

# Below is generated by plot.py at 2018-08-31 12:18:08
# Datalink statistics
-- Total of 3 flows:
Average throughput: 429.04 Mbit/s
95th percentile per-packet one-way delay: 69.980 ms
Loss rate: 0.64%
-- Flow 1:
Average throughput: 223.30 Mbit/s
95th percentile per-packet one-way delay: 65.107 ms
Loss rate: 0.39%
-- Flow 2:
Average throughput: 214.24 Mbit/s
95th percentile per-packet one-way delay: 71.039 ms
Loss rate: 0.67%
-- Flow 3:
Average throughput: 197.35 Mbit/s
95th percentile per-packet one-way delay: 65.072 ms
Loss rate: 1.42%
Run 2: Report of Indigo — Data Link

![Network throughput and delay over time](image)

**Throughput (Mbps)**

- **Flow 1 ingress (mean 223.20 Mbps)**
- **Flow 1 egress (mean 223.30 Mbps)**
- **Flow 2 ingress (mean 214.21 Mbps)**
- **Flow 2 egress (mean 214.24 Mbps)**
- **Flow 3 ingress (mean 197.55 Mbps)**
- **Flow 3 egress (mean 197.35 Mbps)**

**Per-packet one-way delay (ms)**

- **Flow 1 (95th percentile 65.11 ms)**
- **Flow 2 (95th percentile 71.04 ms)**
- **Flow 3 (95th percentile 65.07 ms)**
Run 1: Statistics of Muses-25

Start at: 2018-08-31 11:45:02
End at: 2018-08-31 11:45:32
Local clock offset: -6.382 ms
Remote clock offset: -2.133 ms

# Below is generated by plot.py at 2018-08-31 12:18:43
# Datalink statistics
-- Total of 3 flows:
  Average throughput: 955.94 Mbit/s
  95th percentile per-packet one-way delay: 82.361 ms
  Loss rate: 0.63%
-- Flow 1:
  Average throughput: 532.83 Mbit/s
  95th percentile per-packet one-way delay: 82.935 ms
  Loss rate: 0.19%
-- Flow 2:
  Average throughput: 432.90 Mbit/s
  95th percentile per-packet one-way delay: 82.501 ms
  Loss rate: 0.95%
-- Flow 3:
  Average throughput: 417.01 Mbit/s
  95th percentile per-packet one-way delay: 75.884 ms
  Loss rate: 1.65%
Run 1: Report of Muses-25 — Data Link

[Detailed diagrams and graphs showing network throughput and packet delay over time]
Run 2: Statistics of Muses-25

Start at: 2018-08-31 11:52:54
End at: 2018-08-31 11:53:24
Local clock offset: ~4.911 ms
Remote clock offset: 0.48 ms

# Below is generated by plot.py at 2018-08-31 12:18:43
# Datalink statistics
-- Total of 3 flows:
Average throughput: 857.97 Mbit/s
95th percentile per-packet one-way delay: 77.745 ms
Loss rate: 0.58%
-- Flow 1:
Average throughput: 461.53 Mbit/s
95th percentile per-packet one-way delay: 76.436 ms
Loss rate: 0.49%
-- Flow 2:
Average throughput: 415.71 Mbit/s
95th percentile per-packet one-way delay: 78.944 ms
Loss rate: 0.27%
-- Flow 3:
Average throughput: 367.71 Mbit/s
95th percentile per-packet one-way delay: 81.169 ms
Loss rate: 1.61%
Run 2: Report of Muses-25 — Data Link

---

**Throughput (Mbps)**

- **Flow 1 ingress** (mean 461.96 Mbps)
- **Flow 1 egress** (mean 461.53 Mbps)
- **Flow 2 ingress** (mean 414.25 Mbps)
- **Flow 2 egress** (mean 415.71 Mbps)
- **Flow 3 ingress** (mean 368.81 Mbps)
- **Flow 3 egress** (mean 367.71 Mbps)

**Per-packet one way delay (ms)**

- **Flow 1 (95th percentile 76.44 ms)**
- **Flow 2 (95th percentile 78.94 ms)**
- **Flow 3 (95th percentile 81.17 ms)**

---

19