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# Evaluating switch buffers for high BDP flows (10G x 50ms)


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# What is BDP?

Bandwidth-Delay Product (BDP) = “bits on the wire”

Or data sent that is not yet received

| Bandwidth x RTT = | BDP |
|---|---|
| 100Mbps x 100ms = | $10^7$ bits |
| 1Gbps x 10ms = | $10^7$ bits |
| 10Gbps x 1ms = | $10^7$ bits |
| **10Gbps x 50ms =** | **$5x10^8$ bits** |
| 40Gbps x 100ms = | $4x10^9$ bits |
| 100Gbps x 100ms = | $10^{10}$ bits |

“Low”

**Our Tests**

“High”

BDP Calculator: https://www.switch.ch/network/tools/tcp_throughput/



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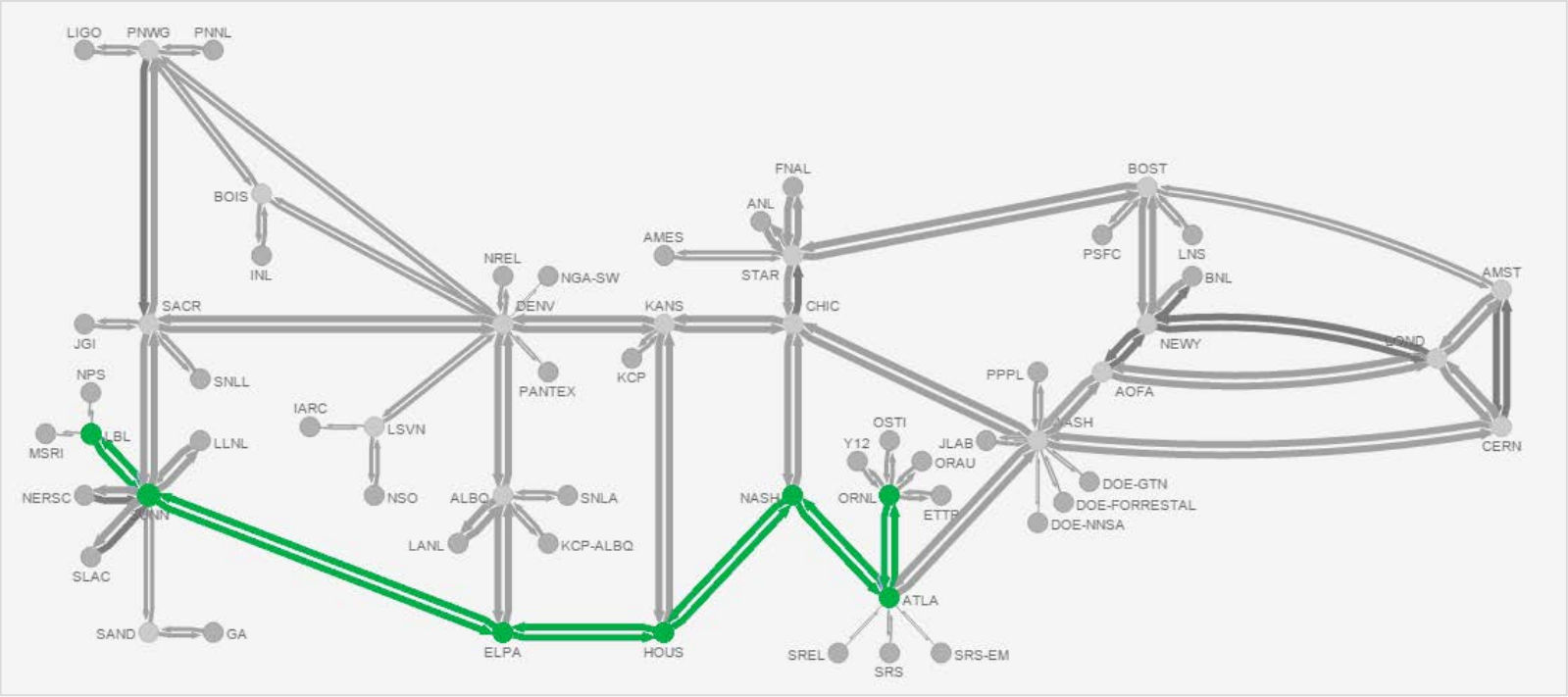
# What are “High BDP Flows”?

- Data flows over “LFNs” or “Long, Fat Networks”
- “High” BDP = $10^8$ bits or higher
- Scientific Data Transfers




LBNL’s Detector → ORNL’s Titan

Image courtesy of MyESnet, http://my.es.net



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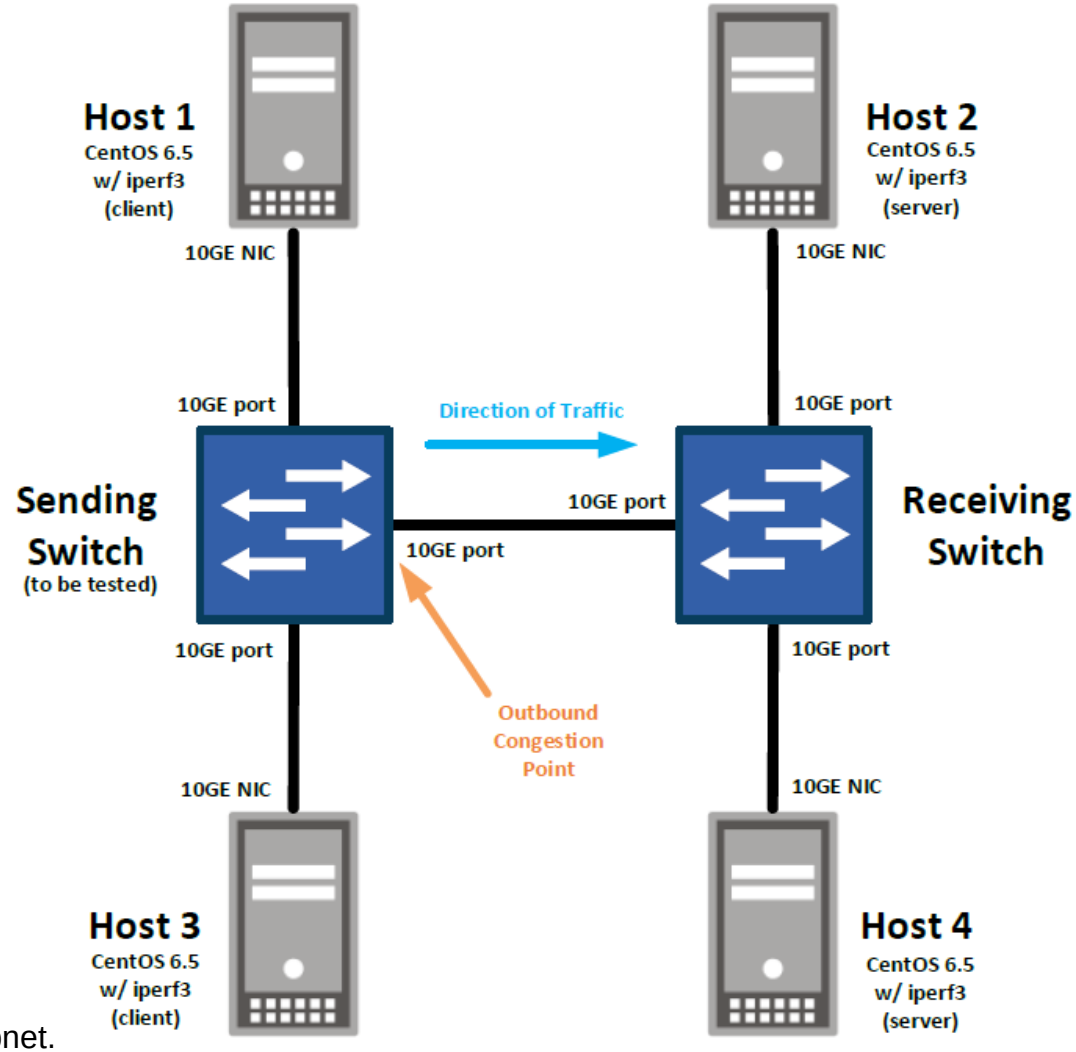
# Why do switch buffers matter here?

- Packet loss = significantly lower transfer rate
- More than just the lost packet(s), multiplication factor
- Why? TCP scales back its window size when packets are lost (congestion avoidance).
- It'll recover and scale back up, but if this happens a lot, total performance is impacted.
- Keep TCP window high to keep bandwidth up.
- Minimize packet loss by ensuring all network switches in the path have deep buffers.[1]

[1] FasterData – http://fasterdata.es.net

# Experiment Setup

Minimum Equipment:
4x Linux servers with 1x 10GE NIC each
1x Sending switch (to be tested) with 3x 10GE ports
1x Receiving switch with 3x 10GE ports
6x 10GE SX optics
5x OM3 or OM4 LC/LC cables




All four hosts in the same subnet.
Switches only doing Layer 2.
Sending Switch is the device of concern.
Buffering occurs at the Outbound Congestion Point.



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# What are we testing?

- **Test 1 – iperf3**: Does a switch have deep buffers? How deep is “deep”? May not be clear from manufacturer documentation, so we need a way to test for this.

- **Test 2 – nuttcp**: Is there a small buffer switch in the path? End users, or even network operators, may not know the details of all devices in the path.

# Test 1: iperf3 Overview

- Servers ran on hosts **2** & **4** (on receiving switch).
- Clients ran on hosts **1** & **3** (on sending switch).
- Simulating WAN connectivity (50ms RTT) and adding congestion (2Gbps UDP background traffic).
- Tests will include 15 iterations per configuration to smooth and average out variations due to network emulation.
- Tests will last a total of 35 seconds but will omit the first 5 seconds to account for TCP ramp-up. Only the last 30 seconds of data will be displayed in results.

# Test 1: iperf3
## Simulated WAN connectivity with congestion

Add a 25ms delay to each of hosts **1** and **2**:

```
host1# tc qdisc add dev eth1 root netem delay 25ms
host2# tc qdisc add dev eth1 root netem delay 25ms
```

Start the iperf3 server on hosts **2** and **4**:

```
host2# iperf3 -s
host4# iperf3 -s
```

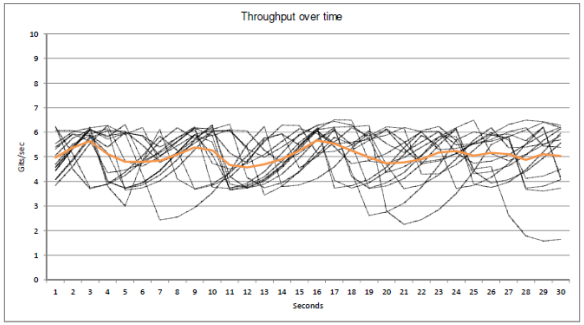
On host 3, begin a 2Gbps UDP transfer to host **4** to add congestion:

```
host3# iperf3 -c host4 -u -b2G -t3000
```

On host **1**, begin a 10Gbps TCP transfer, 2 parallel streams for 30 seconds (first 5s omitted from results):

```
host1# iperf3 -c host2 -P2 -t30 -O5
```

# Cisco 6704 (14MB[1])




TCP Throughput

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 5.39 | 5.54 | 6.07 | 6.21 | 6.24 | 4.42 | 4.45 | 3.84 | 4.56 | 5.32 | 4.07 | 5.06 | 4.08 | 4.58 | 4.69 | 4.97 |
| 2 sec | 5.93 | 6.02 | 6.07 | 5.12 | 4.50 | 5.33 | 5.33 | 4.60 | 5.34 | 5.93 | 4.90 | 5.76 | 4.84 | 5.42 | 5.51 | 5.37 |
| 3 sec | 5.87 | 6.19 | 5.92 | 3.74 | 3.70 | 6.21 | 6.10 | 5.55 | 6.10 | 5.64 | 5.84 | 6.10 | 5.77 | 6.10 | 5.87 | 5.65 |
| 4 sec | 5.39 | 6.27 | 6.15 | 3.88 | 3.90 | 3.98 | 3.80 | 6.28 | 5.85 | 4.34 | 5.15 | 5.81 | 6.07 | 5.72 | 4.01 | 5.11 |
| 5 sec | 5.99 | 4.83 | 3.65 | 4.24 | 4.37 | 3.72 | 3.00 | 5.91 | 5.99 | 4.46 | 3.71 | 6.31 | 6.03 | 5.97 | 3.73 | 4.79 |
| 6 sec | 5.86 | 4.62 | 3.74 | 4.83 | 5.05 | 3.94 | 4.85 | 6.20 | 5.85 | 4.74 | 3.86 | 4.83 | 5.47 | 4.25 | 3.94 | 4.80 |
| 7 sec | 5.39 | 5.01 | 4.02 | 5.63 | 5.84 | 4.43 | 6.12 | 4.77 | 5.03 | 5.21 | 4.26 | 5.16 | 4.78 | 2.43 | 4.44 | 4.83 |
| 8 sec | 5.76 | 5.62 | 4.55 | 6.18 | 5.26 | 5.16 | 4.10 | 5.10 | 5.44 | 5.78 | 4.89 | 5.63 | 5.18 | 2.55 | 5.18 | 5.09 |
| 9 sec | 6.22 | 6.17 | 5.29 | 5.75 | 3.68 | 5.91 | 3.70 | 5.56 | 5.89 | 6.09 | 5.68 | 6.19 | 5.70 | 2.93 | 5.90 | 5.38 |
| 10 sec | 3.77 | 5.86 | 6.03 | 6.21 | 3.84 | 6.07 | 3.90 | 6.04 | 5.60 | 4.73 | 5.88 | 6.12 | 6.30 | 3.53 | 5.08 | 5.26 |
| 11 sec | 3.71 | 6.10 | 5.16 | 4.21 | 4.17 | 6.05 | 4.35 | 6.08 | 3.66 | 4.50 | 3.66 | 6.32 | 3.90 | 4.40 | 3.74 | 4.67 |
| 12 sec | 3.92 | 5.33 | 4.76 | 3.72 | 4.82 | 5.39 | 5.03 | 6.05 | 3.73 | 4.72 | 3.80 | 4.17 | 3.75 | 5.49 | 3.84 | 4.57 |
| 13 sec | 4.40 | 4.98 | 5.69 | 3.90 | 5.62 | 3.44 | 5.77 | 5.26 | 4.06 | 5.10 | 4.10 | 3.74 | 4.01 | 6.23 | 4.19 | 4.70 |
| 14 sec | 5.15 | 5.39 | 5.95 | 4.30 | 6.29 | 3.80 | 5.93 | 4.76 | 4.62 | 5.63 | 4.65 | 3.94 | 4.55 | 3.79 | 4.82 | 4.90 |
| 15 sec | 5.91 | 5.87 | 4.54 | 4.95 | 6.27 | 4.41 | 5.47 | 5.15 | 5.39 | 6.15 | 5.45 | 4.38 | 5.30 | 3.86 | 5.59 | 5.25 |
| 16 sec | 6.28 | 6.28 | 5.00 | 5.71 | 5.16 | 5.26 | 6.06 | 5.66 | 6.11 | 5.95 | 6.16 | 5.09 | 6.07 | 4.11 | 6.12 | 5.67 |
| 17 sec | 6.44 | 3.72 | 5.60 | 6.07 | 5.23 | 6.13 | 5.56 | 6.20 | 6.21 | 5.54 | 4.05 | 5.79 | 5.41 | 4.59 | 6.51 | 5.54 |
| 18 sec | 6.29 | 3.83 | 6.19 | 5.50 | 5.47 | 4.37 | 5.26 | 4.21 | 6.22 | 5.59 | 3.73 | 5.51 | 4.72 | 5.34 | 6.50 | 5.25 |
| 19 sec | 5.74 | 4.09 | 5.85 | 6.06 | 5.77 | 2.61 | 5.66 | 3.72 | 6.28 | 5.71 | 3.94 | 3.71 | 4.85 | 5.98 | 4.83 | 4.99 |
| 20 sec | 4.36 | 4.58 | 6.22 | 5.54 | 6.13 | 2.76 | 6.10 | 3.95 | 2.80 | 5.88 | 4.40 | 3.81 | 5.14 | 4.67 | 4.74 | 4.74 |
| 21 sec | 4.59 | 5.37 | 6.16 | 5.18 | 5.61 | 3.12 | 5.33 | 4.36 | 2.25 | 6.20 | 5.10 | 4.12 | 5.58 | 3.70 | 4.97 | 4.78 |
| 22 sec | 5.04 | 6.05 | 4.29 | 5.60 | 4.79 | 3.77 | 4.72 | 5.06 | 2.44 | 6.01 | 5.87 | 4.71 | 6.01 | 3.86 | 5.40 | 4.91 |
| 23 sec | 5.68 | 6.23 | 4.31 | 6.03 | 4.88 | 4.64 | 4.83 | 5.81 | 2.84 | 5.29 | 5.45 | 5.47 | 6.03 | 4.26 | 5.79 | 5.17 |
| 24 sec | 6.13 | 5.67 | 4.68 | 5.16 | 5.14 | 5.68 | 5.12 | 5.82 | 3.51 | 5.34 | 3.71 | 6.15 | 5.48 | 4.91 | 6.18 | 5.25 |
| 25 sec | 3.89 | 4.31 | 5.26 | 4.73 | 5.54 | 6.01 | 5.56 | 4.50 | 4.41 | 5.52 | 3.84 | 4.43 | 5.53 | 5.68 | 6.49 | 5.05 |
| 26 sec | 3.75 | 4.40 | 5.89 | 4.82 | 5.92 | 5.89 | 5.98 | 4.60 | 5.50 | 5.71 | 4.17 | 3.93 | 5.64 | 6.18 | 5.13 | 5.17 |
| 27 sec | 3.97 | 4.63 | 5.93 | 5.09 | 6.31 | 5.77 | 5.68 | 2.63 | 5.83 | 6.01 | 4.72 | 4.07 | 5.82 | 5.37 | 4.84 | 5.11 |
| 28 sec | 4.47 | 5.07 | 5.65 | 5.50 | 6.50 | 3.68 | 4.13 | 1.79 | 3.73 | 6.18 | 5.52 | 4.40 | 6.09 | 5.40 | 5.10 | 4.88 |
| 29 sec | 5.20 | 5.66 | 6.21 | 5.91 | 6.43 | 3.61 | 4.22 | 1.58 | 3.80 | 5.45 | 6.21 | 4.95 | 6.41 | 5.53 | 5.49 | 5.11 |
| 30 sec | 5.96 | 6.14 | 4.16 | 6.21 | 6.27 | 3.73 | 4.50 | 1.64 | 4.07 | 5.38 | 4.07 | 5.56 | 6.19 | 5.71 | 5.86 | 5.03 |
| Avg | 5.22 | 5.33 | 5.30 | 5.20 | 5.29 | 4.64 | 5.02 | 4.76 | 4.77 | 5.47 | 4.69 | 5.04 | 5.36 | 4.75 | 5.15 | **5.07 Gbits per sec (avg)** |

| Scale |
|---|
| 10.00 |
| 9.50 |
| 9.00 |
| 8.50 |
| 8.00 |
| 7.50 |
| 7.00 |
| 6.50 |
| 6.00 |
| 5.50 |
| 5.00 |
| 4.50 |
| 4.00 |
| 3.50 |
| 3.00 |
| 2.50 |
| 2.00 |
| 1.50 |
| 1.00 |
| 0.50 |
| 0.00 |

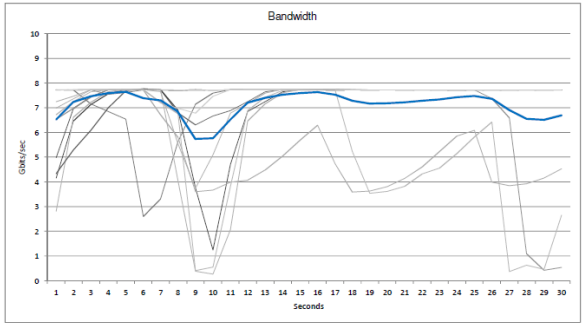
Retransmissions

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 sec | 0 | 0 | 1 | 29 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 sec | 38 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 0 | 9 | 0 | 0 | 5 |
| 4 sec | 0 | 0 | 27 | 0 | 0 | 32 | 35 | 34 | 22 | 0 | 31 | 0 | 2 | 41 | 0 |
| 5 sec | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 32 | 0 | 0 | 0 |
| 6 sec | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 2 | 0 | 0 | 0 | 33 | 14 | 0 |
| 7 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 sec | 0 | 0 | 0 | 35 | 29 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | 0 | 0 | 0 |
| 10 sec | 7 | 50 | 0 | 0 | 0 | 31 | 0 | 0 | 10 | 0 | 26 | 17 | 0 | 0 | 27 |
| 11 sec | 0 | 0 | 17 | 36 | 0 | 0 | 0 | 31 | 0 | 0 | 0 | 0 | 31 | 0 | 0 |
| 12 sec | 0 | 36 | 0 | 0 | 0 | 33 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| 13 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 39 | 0 |
| 14 sec | 0 | 0 | 36 | 0 | 13 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 sec | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 sec | 2 | 41 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 34 |
| 17 sec | 28 | 0 | 0 | 16 | 0 | 0 | 24 | 0 | 12 | 0 | 28 | 0 | 68 | 0 | 0 |
| 18 sec | 13 | 0 | 0 | 0 | 0 | 32 | 0 | 25 | 7 | 0 | 0 | 27 | 0 | 0 | 19 |
| 19 sec | 16 | 0 | 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 20 sec | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 22 | 0 |
| 21 sec | 0 | 0 | 29 | 0 | 18 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 | 0 | 0 | 0 |
| 23 sec | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 7 | 0 | 0 |
| 24 sec | 13 | 24 | 0 | 9 | 0 | 0 | 0 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 4 |
| 25 sec | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | 31 | 0 | 0 | 0 |
| 26 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 33 | 6 |
| 27 sec | 0 | 0 | 30 | 0 | 12 | 20 | 12 | 4 | 23 | 0 | 0 | 0 | 0 | 0 | 0 |
| 28 sec | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 11 | 0 | 0 | 0 | 0 | 0 |
| 29 sec | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 1 | 0 | 136 | 0 | 0 | 1 | 0 | 0 |
| 30 sec | 0 | 0 | 8 | 37 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 38 | 0 | 0 | 0 |
| Total | 140 | 190 | 188 | 177 | 124 | 158 | 97 | 143 | 100 | 223 | 136 | 121 | 142 | 149 | 99 |

**146 retrans per test (avg)**

| Scale |
|---|
| 0 |
| 1-49 |
| 50-99 |
| 100+ |

# Cisco 6716 (90MB[2])




TCP Throughput

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 4.98 | 6.54 | 7.72 | 4.16 | 7.72 | 2.81 | 4.34 | 6.99 | 7.72 | 7.72 | 7.72 | 7.73 | 7.25 | 7.71 | 6.72 | 6.52 |
| 2 sec | 6.96 | 6.97 | 7.72 | 6.46 | 7.72 | 6.61 | 5.29 | 7.36 | 7.71 | 7.72 | 7.72 | 7.72 | 7.46 | 7.73 | 7.25 | 7.23 |
| 3 sec | 7.45 | 7.42 | 7.73 | 7.13 | 7.15 | 7.22 | 6.09 | 7.72 | 7.72 | 7.72 | 7.72 | 7.73 | 7.72 | 7.73 | 7.64 | 7.46 |
| 4 sec | 7.72 | 7.74 | 7.73 | 7.57 | 6.85 | 7.65 | 7.00 | 7.74 | 7.54 | 7.72 | 7.72 | 7.73 | 7.72 | 7.73 | 7.72 | 7.59 |
| 5 sec | 7.72 | 7.75 | 7.73 | 7.74 | 6.54 | 7.75 | 7.68 | 7.73 | 7.62 | 7.72 | 7.72 | 7.72 | 7.71 | 7.73 | 7.71 | 7.64 |
| 6 sec | 7.72 | 7.73 | 7.73 | 7.76 | 2.60 | 7.74 | 7.77 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.74 | 7.72 | 7.39 |
| 7 sec | 7.72 | 7.72 | 7.73 | 7.74 | 3.30 | 7.75 | 7.72 | 7.66 | 7.71 | 7.72 | 7.72 | 7.73 | 6.72 | 7.20 | 7.22 | 7.29 |
| 8 sec | 7.72 | 7.71 | 6.79 | 6.90 | 5.62 | 4.05 | 7.72 | 5.55 | 7.71 | 7.71 | 7.71 | 7.72 | 5.80 | 6.98 | 6.75 | 6.83 |
| 9 sec | 7.72 | 7.72 | 6.31 | 3.76 | 7.14 | 0.38 | 7.71 | 3.74 | 7.72 | 7.72 | 7.71 | 3.60 | 6.78 | 0.41 | 7.73 | 5.74 |
| 10 sec | 7.72 | 7.72 | 6.67 | 1.24 | 7.59 | 0.26 | 7.72 | 5.09 | 7.72 | 7.71 | 7.71 | 7.72 | 3.66 | 7.47 | 0.55 | 5.77 |
| 11 sec | 7.72 | 7.72 | 6.88 | 4.71 | 7.73 | 2.07 | 7.72 | 6.78 | 7.72 | 7.72 | 7.73 | 7.72 | 3.99 | 7.73 | 3.82 | 6.52 |
| 12 sec | 7.72 | 7.72 | 7.24 | 6.85 | 7.74 | 6.46 | 7.72 | 7.17 | 7.72 | 7.72 | 7.72 | 7.72 | 4.07 | 7.72 | 6.88 | 7.21 |
| 13 sec | 7.72 | 7.72 | 7.64 | 7.25 | 7.74 | 7.15 | 7.72 | 7.59 | 7.72 | 7.72 | 7.72 | 7.72 | 4.48 | 7.72 | 7.42 | 7.40 |
| 14 sec | 7.72 | 7.72 | 7.73 | 7.65 | 7.74 | 7.60 | 7.72 | 7.75 | 7.72 | 7.72 | 7.72 | 7.72 | 5.04 | 7.73 | 7.70 | 7.53 |
| 15 sec | 7.72 | 7.72 | 7.74 | 7.74 | 7.74 | 7.74 | 7.72 | 7.75 | 7.72 | 7.72 | 7.72 | 7.72 | 5.69 | 7.73 | 7.71 | 7.59 |
| 16 sec | 7.72 | 7.72 | 7.74 | 7.74 | 7.72 | 7.74 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.71 | 6.29 | 7.74 | 7.72 | 7.63 |
| 17 sec | 7.71 | 7.72 | 7.75 | 7.76 | 7.72 | 7.75 | 7.72 | 7.71 | 7.72 | 7.72 | 7.71 | 7.72 | 4.73 | 7.74 | 7.72 | 7.53 |
| 18 sec | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.75 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.73 | 3.59 | 7.72 | 5.23 | 7.28 |
| 19 sec | 7.72 | 7.72 | 7.72 | 7.71 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 3.63 | 7.72 | 3.53 | 7.17 |
| 20 sec | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 3.81 | 7.72 | 3.61 | 7.19 |
| 21 sec | 7.72 | 7.72 | 7.72 | 7.71 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 4.14 | 7.72 | 3.82 | 7.22 |
| 22 sec | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.71 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 4.61 | 7.72 | 4.32 | 7.29 |
| 23 sec | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.71 | 7.72 | 7.72 | 7.71 | 5.22 | 7.72 | 4.55 | 7.34 |
| 24 sec | 7.72 | 7.71 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.71 | 7.72 | 7.72 | 5.85 | 7.72 | 5.14 | 7.42 |
| 25 sec | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.71 | 7.72 | 7.72 | 7.72 | 6.08 | 7.71 | 5.81 | 7.48 |
| 26 sec | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.71 | 7.72 | 7.72 | 7.72 | 7.37 | 7.72 | 3.98 | 7.72 | 6.42 | 7.36 |
| 27 sec | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.71 | 7.72 | 6.59 | 7.72 | 3.85 | 7.71 | 0.37 | 6.90 |
| 28 sec | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.71 | 7.72 | 7.72 | 1.09 | 7.72 | 3.92 | 7.72 | 0.63 | 6.55 |
| 29 sec | 7.72 | 7.72 | 7.71 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 0.42 | 7.72 | 4.15 | 7.72 | 0.46 | 6.51 |
| 30 sec | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 7.72 | 0.54 | 7.72 | 4.53 | 7.71 | 2.65 | 6.69 |
| Avg | 7.59 | 7.65 | 7.56 | 7.02 | 7.22 | 6.64 | 7.45 | 7.34 | 7.71 | 7.72 | 6.97 | 7.72 | 5.23 | 7.64 | 5.17 | **7.11 Gbits per sec (avg)** |

| Scale |
|---|
| 10.00 |
| 9.50 |
| 9.00 |
| 8.50 |
| 8.00 |
| 7.50 |
| 7.00 |
| 6.50 |
| 6.00 |
| 5.50 |
| 5.00 |
| 4.50 |
| 4.00 |
| 3.50 |
| 3.00 |
| 2.50 |
| 2.00 |
| 1.50 |
| 1.00 |
| 0.50 |
| 0.00 |

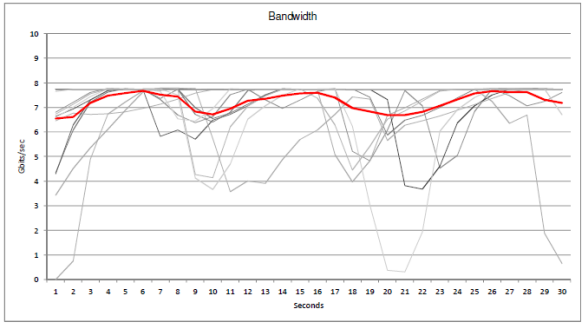
Retransmissions

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 sec | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 35 | 0 | 0 |
| 3 sec | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 sec | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 sec | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7 sec | 0 | 0 | 0 | 0 | 0 | 0 | 12 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | 1 |
| 8 sec | 0 | 0 | 1 | 2 | 0 | 4 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 1 | 3 |
| 9 sec | 0 | 0 | 0 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 10 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| 12 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| 13 sec | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 |
| 14 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| 15 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 16 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 17 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 |
| 18 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 5 |
| 19 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 |
| 20 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 1 |
| 21 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 22 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 4 |
| 23 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 6 |
| 24 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| 25 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| 26 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 1 |
| 27 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 9 | 0 | 2 |
| 28 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 7 | 0 | 10 |
| 29 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 0 | 0 |
| 30 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 0 | 0 |
| Total | 0 | 2 | 1 | 5 | 6 | 9 | 12 | 4 | 1 | 0 | 9 | 0 | 146 | 2 | 38 |

**16 retrans per test (avg)**

| Scale |
|---|
| 0 |
| 1-49 |
| 50-99 |
| 100+ |

# Cisco 6716 (200MB[3])




TCP Throughput

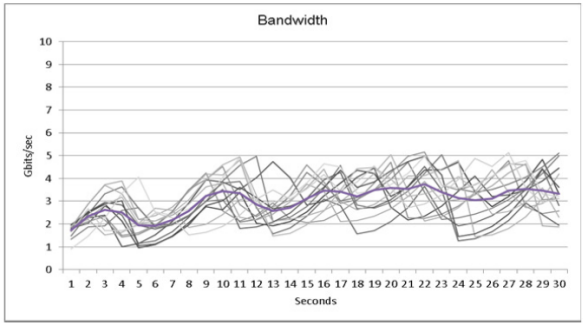
| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 6.64 | 6.80 | 7.73 | 7.74 | 4.35 | 6.46 | 4.29 | 0.09 | 7.73 | 7.73 | 7.74 | 6.58 | 3.43 | 7.65 | 6.73 | 6.11 |
| 2 sec | 6.94 | 7.20 | 7.74 | 7.73 | 6.08 | 6.76 | 6.29 | 0.76 | 7.73 | 7.73 | 7.73 | 7.00 | 4.52 | 7.74 | 7.13 | 6.61 |
| 3 sec | 7.31 | 7.61 | 7.73 | 7.73 | 7.21 | 6.72 | 7.30 | 4.89 | 7.74 | 7.73 | 7.73 | 7.44 | 5.35 | 7.74 | 7.56 | 7.19 |
| 4 sec | 7.68 | 7.77 | 7.73 | 7.73 | 7.62 | 6.74 | 7.68 | 6.73 | 7.73 | 7.73 | 7.73 | 7.76 | 6.10 | 7.74 | 7.73 | 7.48 |
| 5 sec | 7.73 | 7.75 | 7.73 | 7.73 | 7.76 | 6.82 | 7.73 | 7.22 | 7.73 | 7.73 | 7.74 | 7.74 | 6.88 | 7.74 | 7.75 | 7.59 |
| 6 sec | 7.75 | 7.73 | 7.73 | 7.73 | 7.73 | 6.96 | 7.74 | 7.67 | 7.73 | 7.74 | 7.73 | 7.74 | 7.62 | 7.75 | 7.75 | 7.67 |
| 7 sec | 7.76 | 7.32 | 7.74 | 7.73 | 7.36 | 7.13 | 5.82 | 7.76 | 7.73 | 7.73 | 7.73 | 7.64 | 7.79 | 7.75 | 7.69 | 7.51 |
| 8 sec | 7.74 | 6.69 | 7.73 | 7.73 | 7.74 | 7.34 | 6.08 | 7.75 | 7.74 | 7.73 | 7.73 | 6.53 | 7.79 | 7.50 | 7.73 | 7.44 |
| 9 sec | 7.73 | 6.38 | 7.73 | 7.73 | 6.98 | 7.58 | 5.71 | 7.77 | 6.72 | 7.73 | 7.73 | 6.44 | 7.75 | 4.13 | 4.27 | 6.83 |
| 10 sec | 7.74 | 6.62 | 7.73 | 7.74 | 6.54 | 7.72 | 6.48 | 5.73 | 6.41 | 7.73 | 7.74 | 6.95 | 7.72 | 3.66 | 4.14 | 6.71 |
| 11 sec | 7.73 | 7.51 | 7.73 | 7.73 | 6.77 | 7.74 | 6.72 | 3.57 | 6.81 | 7.73 | 7.73 | 7.76 | 7.74 | 4.69 | 6.21 | 6.94 |
| 12 sec | 7.73 | 7.74 | 7.74 | 7.73 | 7.13 | 7.73 | 7.07 | 4.01 | 7.68 | 7.73 | 7.73 | 7.73 | 7.73 | 6.52 | 7.05 | 7.27 |
| 13 sec | 7.73 | 7.31 | 7.73 | 7.73 | 7.51 | 7.73 | 7.49 | 3.91 | 7.73 | 7.73 | 7.73 | 7.72 | 7.73 | 7.07 | 7.46 | 7.35 |
| 14 sec | 7.73 | 6.96 | 7.73 | 7.74 | 7.76 | 7.74 | 7.73 | 4.88 | 7.74 | 7.73 | 7.74 | 7.74 | 7.73 | 7.49 | 7.73 | 7.48 |
| 15 sec | 7.74 | 7.30 | 7.73 | 7.73 | 7.74 | 7.72 | 7.73 | 5.69 | 7.75 | 7.74 | 7.73 | 7.74 | 7.74 | 7.75 | 7.75 | 7.57 |
| 16 sec | 7.73 | 7.65 | 7.74 | 7.73 | 7.73 | 7.74 | 7.73 | 6.08 | 7.75 | 7.73 | 7.73 | 7.73 | 7.73 | 7.75 | 7.37 | 7.59 |
| 17 sec | 7.73 | 7.77 | 7.73 | 7.73 | 7.73 | 7.73 | 7.74 | 6.72 | 7.75 | 7.73 | 7.73 | 7.72 | 5.08 | 7.76 | 6.29 | 7.40 |
| 18 sec | 7.73 | 5.21 | 7.73 | 7.73 | 7.73 | 7.73 | 7.72 | 7.42 | 7.75 | 7.73 | 7.73 | 7.73 | 3.97 | 6.23 | 4.45 | 6.97 |
| 19 sec | 7.74 | 4.83 | 7.73 | 7.74 | 7.73 | 7.73 | 7.73 | 7.33 | 7.41 | 7.74 | 7.73 | 7.73 | 4.82 | 3.03 | 5.42 | 6.83 |
| 20 sec | 7.73 | 6.07 | 7.74 | 7.32 | 7.73 | 7.74 | 7.74 | 7.73 | 5.65 | 5.87 | 7.73 | 7.73 | 7.73 | 6.67 | 0.38 | 6.52 | 6.69 |
| 21 sec | 7.73 | 7.69 | 7.73 | 3.82 | 7.73 | 7.73 | 7.74 | 6.27 | 6.48 | 7.73 | 7.73 | 7.73 | 6.98 | 0.30 | 6.86 | 6.68 |
| 22 sec | 7.73 | 7.07 | 7.73 | 3.68 | 7.74 | 7.73 | 7.73 | 6.45 | 6.68 | 7.73 | 7.73 | 7.73 | 7.33 | 1.93 | 7.26 | 6.82 |
| 23 sec | 7.74 | 4.53 | 7.73 | 4.60 | 7.73 | 7.73 | 7.73 | 6.65 | 7.00 | 7.74 | 7.73 | 7.73 | 7.69 | 6.03 | 7.66 | 7.07 |
| 24 sec | 7.73 | 5.05 | 7.73 | 6.36 | 7.73 | 7.73 | 7.73 | 6.88 | 7.39 | 7.73 | 7.73 | 7.73 | 7.74 | 6.91 | 7.74 | 7.33 |
| 25 sec | 7.73 | 6.83 | 7.74 | 7.06 | 7.73 | 7.74 | 7.74 | 7.12 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.40 | 7.75 | 7.57 |
| 26 sec | 7.73 | 7.75 | 7.73 | 7.50 | 7.73 | 7.73 | 7.73 | 7.36 | 7.76 | 7.73 | 7.73 | 7.73 | 7.25 | 7.74 | 7.76 | 7.66 |
| 27 sec | 7.74 | 7.48 | 7.73 | 7.74 | 7.74 | 7.73 | 7.73 | 7.61 | 7.77 | 7.73 | 7.74 | 7.73 | 6.35 | 7.76 | 7.74 | 7.62 |
| 28 sec | 7.73 | 7.06 | 7.73 | 7.77 | 7.73 | 7.73 | 7.73 | 7.74 | 7.77 | 7.73 | 7.73 | 7.73 | 6.69 | 7.76 | 7.74 | 7.62 |
| 29 sec | 7.73 | 7.25 | 7.74 | 7.76 | 7.73 | 7.74 | 7.73 | 7.74 | 7.72 | 7.74 | 7.73 | 7.73 | 1.87 | 7.75 | 7.73 | 7.31 |
| 30 sec | 7.73 | 7.61 | 7.72 | 7.73 | 7.73 | 7.73 | 7.73 | 7.74 | 7.73 | 7.73 | 7.73 | 7.73 | 0.65 | 6.70 | 7.73 | 7.18 |
| Avg | 7.66 | 6.95 | 7.73 | 7.28 | 7.41 | 7.50 | 7.26 | 6.11 | 7.44 | 7.73 | 7.73 | 7.55 | 6.41 | 6.28 | 7.02 | **7.20 Gbits per sec (avg)** |

| Scale |
|---|
| 10.00 |
| 9.50 |
| 9.00 |
| 8.50 |
| 8.00 |
| 7.50 |
| 7.00 |
| 6.50 |
| 6.00 |
| 5.50 |
| 5.00 |
| 4.50 |
| 4.00 |
| 3.50 |
| 3.00 |
| 2.50 |
| 2.00 |
| 1.50 |
| 1.00 |
| 0.50 |
| 0.00 |

Retransmissions

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 sec | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 4 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 sec | 0 | 0 | 0 | 0 | 0 | 0 

# Brocade MLXe (1MB)




TCP Throughput

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 1.98 | 1.67 | 1.80 | 1.83 | 1.48 | 1.93 | 1.96 | 1.85 | 1.33 | 1.92 | 1.85 | 0.91 | 1.86 | 1.69 | 1.93 | 1.73 |
| 2 sec | 2.28 | 2.56 | 2.04 | 2.55 | 2.44 | 2.19 | 2.53 | 2.88 | 1.88 | 2.49 | 2.11 | 1.47 | 2.89 | 2.67 | 2.24 | 2.35 |
| 3 sec | 2.39 | 2.17 | 2.78 | 2.87 | 3.32 | 1.51 | 2.96 | 3.71 | 1.93 | 2.88 | 2.34 | 2.25 | 3.73 | 1.71 | 2.84 | 2.63 |
| 4 sec | 1.01 | 1.43 | 2.39 | 2.12 | 3.63 | 1.64 | 2.83 | 3.32 | 2.59 | 3.03 | 1.50 | 3.36 | 3.88 | 1.71 | 3.19 | 2.51 |
| 5 sec | 1.15 | 1.54 | 1.15 | 0.97 | 2.69 | 2.01 | 1.95 | 2.19 | 2.71 | 1.04 | 1.61 | 4.05 | 2.20 | 1.94 | 2.02 | 1.95 |
| 6 sec | 1.52 | 1.90 | 1.27 | 1.10 | 1.91 | 2.69 | 1.77 | 2.36 | 1.85 | 1.12 | 1.95 | 2.52 | 2.13 | 2.48 | 2.13 | 1.91 |
| 7 sec | 2.11 | 2.54 | 1.66 | 1.47 | 2.02 | 2.60 | 1.96 | 2.74 | 1.97 | 1.44 | 2.56 | 2.40 | 2.39 | 2.28 | 2.49 | 2.18 |
| 8 sec | 2.92 | 3.50 | 2.29 | 2.07 | 2.40 | 1.86 | 2.34 | 3.41 | 2.37 | 1.97 | 3.52 | 2.67 | 2.89 | 1.51 | 3.07 | 2.59 |
| 9 sec | 3.94 | 4.24 | 3.21 | 2.76 | 3.01 | 1.98 | 3.01 | 4.19 | 3.01 | 2.80 | 3.96 | 3.18 | 3.64 | 1.63 | 3.95 | 3.23 |
| 10 sec | 3.85 | 2.58 | 3.79 | 2.63 | 3.89 | 2.41 | 3.52 | 4.16 | 3.08 | 3.03 | 4.52 | 4.02 | 3.79 | 1.90 | 4.60 | 3.45 |
| 11 sec | 3.51 | 2.13 | 3.86 | 3.40 | 4.56 | 3.08 | 1.80 | 4.80 | 2.08 | 3.62 | 2.85 | 4.93 | 2.29 | 2.38 | 4.94 | 3.35 |
| 12 sec | 4.02 | 2.39 | 2.73 | 2.04 | 4.98 | 3.16 | 1.87 | 2.66 | 2.19 | 3.16 | 2.31 | 2.93 | 2.18 | 3.10 | 3.26 | 2.87 |
| 13 sec | 4.74 | 2.93 | 1.57 | 1.91 | 2.11 | 2.14 | 2.09 | 2.75 | 2.58 | 2.68 | 2.78 | 2.95 | 2.43 | 3.49 | 1.48 | 2.58 |
| 14 sec | 4.02 | 2.22 | 1.82 | 2.11 | 2.30 | 2.19 | 2.49 | 3.05 | 3.24 | 2.79 | 3.55 | 3.22 | 2.97 | 3.09 | 1.59 | 2.71 |
| 15 sec | 2.84 | 2.06 | 2.33 | 2.54 | 2.76 | 2.36 | 3.11 | 3.58 | 4.27 | 3.08 | 4.60 | 3.79 | 3.76 | 3.55 | 1.96 | 3.11 |
| 16 sec | 3.00 | 2.15 | 3.10 | 3.24 | 3.56 | 2.61 | 3.94 | 4.41 | 3.71 | 3.62 | 3.84 | 4.64 | 3.45 | 4.18 | 2.58 | 3.47 |
| 17 sec | 3.39 | 2.53 | 2.80 | 3.80 | 4.58 | 2.98 | 4.27 | 2.99 | 3.02 | 4.37 | 2.91 | 4.51 | 2.11 | 3.44 | 3.48 | 3.41 |
| 18 sec | 4.06 | 3.05 | 1.57 | 4.35 | 2.83 | 3.53 | 2.66 | 2.63 | 3.16 | 3.61 | 3.06 | 3.36 | 2.15 | 3.85 | 4.43 | 3.22 |
| 19 sec | 4.45 | 3.80 | 1.70 | 4.21 | 2.70 | 4.22 | 2.74 | 2.85 | 3.46 | 3.85 | 3.50 | 3.46 | 2.35 | 4.55 | 4.48 | 3.49 |
| 20 sec | 2.75 | 4.71 | 2.10 | 3.21 | 2.95 | 5.03 | 3.08 | 3.36 | 3.96 | 4.34 | 4.24 | 3.72 | 2.67 | 3.59 | 3.99 | 3.58 |
| 21 sec | 2.17 | 2.28 | 2.72 | 3.63 | 3.45 | 3.46 | 3.66 | 4.11 | 4.70 | 4.73 | 4.96 | 4.23 | 3.21 | 2.72 | 3.21 | 3.55 |
| 22 sec | 2.34 | 2.25 | 3.66 | 4.35 | 4.23 | 2.14 | 4.52 | 4.13 | 3.39 | 4.98 | 5.16 | 4.96 | 3.86 | 2.88 | 3.33 | 3.75 |
| 23 sec | 2.78 | 2.44 | 2.42 | 4.39 | 5.05 | 2.31 | 3.49 | 4.41 | 2.19 | 4.14 | 3.70 | 3.70 | 3.01 | 3.29 | 3.58 | 3.39 |
| 24 sec | 3.45 | 2.78 | 1.92 | 4.72 | 3.55 | 2.71 | 1.27 | 4.78 | 2.26 | 1.46 | 3.50 | 3.59 | 3.06 | 3.96 | 4.08 | 3.14 |
| 25 sec | 4.10 | 3.31 | 2.05 | 3.43 | 3.40 | 3.39 | 1.35 | 1.44 | 2.43 | 1.56 | 3.72 | 3.71 | 3.28 | 4.88 | 3.48 | 3.04 |
| 26 sec | 3.20 | 4.03 | 2.36 | 2.76 | 3.52 | 4.38 | 1.65 | 1.52 | 2.70 | 1.89 | 4.07 | 4.07 | 3.68 | 4.52 | 2.43 | 3.12 |
| 27 sec | 3.27 | 4.78 | 2.84 | 3.20 | 3.74 | 3.39 | 2.16 | 1.80 | 3.06 | 2.44 | 4.65 | 4.60 | 4.25 | 5.13 | 2.55 | 3.46 |
| 28 sec | 3.48 | 2.77 | 3.52 | 3.88 | 4.06 | 2.72 | 2.92 | 2.32 | 3.58 | 3.29 | 4.60 | 4.78 | 4.63 | 3.58 | 2.96 | 3.54 |
| 29 sec | 3.88 | 2.45 | 4.42 | 4.82 | 4.50 | 2.90 | 2.41 | 3.11 | 4.23 | 4.40 | 3.08 | 3.32 | 1.92 | 2.95 | 3.59 | 3.47 |
| 30 sec | 4.46 | 2.57 | 2.80 | 3.33 | 5.10 | 3.33 | 1.94 | 4.20 | 5.00 | 3.62 | 3.12 | 3.20 | 1.88 | 3.12 | 2.29 | 3.33 |
| Avg | 3.10 | 2.73 | 2.49 | 2.99 | 3.36 | 2.76 | 2.61 | 3.19 | 2.93 | 2.98 | 3.34 | 3.48 | 2.95 | 3.06 | 3.07 | 3.00 Gbits per sec (avg) |

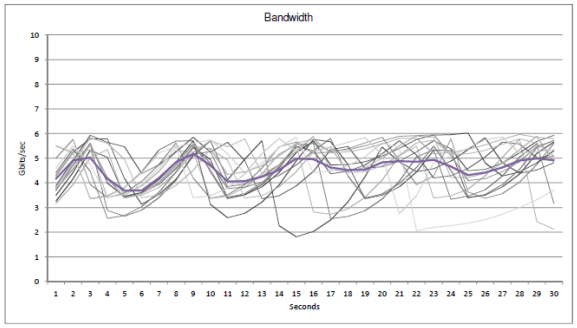
| Scale |
|---|
| 10.00 |
| 9.50 |
| 9.00 |
| 8.50 |
| 8.00 |
| 7.50 |
| 7.00 |
| 6.50 |
| 6.00 |
| 5.50 |
| 5.00 |
| 4.50 |
| 4.00 |
| 3.50 |
| 3.00 |
| 2.50 |
| 2.00 |
| 1.50 |
| 1.00 |
| 0.50 |
| 0.00 |

Retransmissions

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | |
| 2 sec | 4 | 7 | 0 | 8 | 0 | 9 | 6 | 0 | 3 | 5 | 0 | 0 | 0 | 0 | 3 | |
| 3 sec | 7 | 9 | 0 | 0 | 10 | 0 | 0 | 6 | 0 | 6 | 20 | 0 | 5 | 4 | 0 | |
| 4 sec | 50 | 0 | 31 | 35 | 3 | 0 | 15 | 2 | 0 | 6 | 0 | 0 | 4 | 0 | 14 | |
| 5 sec | 0 | 0 | 0 | 0 | 6 | 0 | 1 | 0 | 13 | 0 | 0 | 40 | 8 | 0 | 0 | |
| 6 sec | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 7 sec | 0 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | |
| 8 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 9 sec | 0 | 4 | 0 | 22 | 0 | 0 | 0 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | |
| 10 sec | 12 | 9 | 4 | 0 | 0 | 0 | 4 | 0 | 7 | 5 | 0 | 0 | 9 | 0 | 1 | |
| 11 sec | 0 | 0 | 3 | 0 | 2 | 0 | 0 | 6 | 0 | 0 | 75 | 19 | 0 | 0 | 0 | |
| 12 sec | 0 | 0 | 5 | 6 | 5 | 157 | 0 | 0 | 0 | 172 | 0 | 0 | 0 | 0 | 18 | |
| 13 sec | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | |
| 14 sec | 8 | 228 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 15 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 16 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 173 | 0 | 20 | 0 | 183 | 9 | 0 | |
| 17 sec | 0 | 0 | 6 | 10 | 4 | 0 | 14 | 17 | 0 | 3 | 0 | 64 | 1 | 0 | 0 | |
| 18 sec | 0 | 0 | 0 | 0 | 50 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 11 | |
| 19 sec | 8 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 20 sec | 8 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 125 | |
| 21 sec | 0 | 69 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 3 | 4 | 0 | 0 | 0 | 0 | |
| 22 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 112 | 0 | 34 | 0 | 10 | 0 | 0 | |
| 23 sec | 0 | 0 | 27 | 10 | 24 | 0 | 200 | 0 | 0 | 28 | 0 | 11 | 0 | 0 | 0 | |
| 24 sec | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25 sec | 9 | 0 | 0 | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | |
| 26 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | |
| 27 sec | 0 | 13 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28 sec | 0 | 196 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 42 | 189 | 60 | 48 | 0 | |
| 29 sec | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30 sec | 0 | 0 | 121 | 25 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 28 | |
| Total | 106 | 544 | 199 | 151 | 131 | 210 | 247 | 53 | 308 | 240 | 202 | 323 | 280 | 85 | 215 | 220 retrans per test (avg) |

| Scale |
|---|
| 0 |
| 1-49 |
| 50-99 |
| 100+ |

# Brocade MLXe (10MB)




TCP Throughput

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 4.28 | 5.00 | 5.50 | 3.26 | 3.68 | 4.26 | 3.88 | 3.16 | 4.40 | 3.49 | 3.75 | 4.60 | 3.76 | 5.51 | 3.81 | 4.16 |
| 2 sec | 5.24 | 5.76 | 5.22 | 4.16 | 4.72 | 5.22 | 4.91 | 3.92 | 5.37 | 4.41 | 4.55 | 5.50 | 4.57 | 5.24 | 4.82 | 4.91 |
| 3 sec | 5.78 | 3.94 | 3.36 | 5.32 | 5.57 | 5.34 | 5.92 | 5.01 | 4.47 | 5.60 | 5.56 | 4.74 | 5.55 | 3.34 | 5.82 | 5.02 |
| 4 sec | 5.78 | 3.39 | 3.48 | 5.04 | 2.88 | 3.42 | 5.64 | 5.35 | 2.56 | 3.99 | 4.22 | 3.40 | 4.18 | 3.45 | 5.60 | 4.16 |
| 5 sec | 4.17 | 3.59 | 3.81 | 3.46 | 2.65 | 3.51 | 5.46 | 3.39 | 2.68 | 3.43 | 3.38 | 3.54 | 3.40 | 3.79 | 4.94 | 3.68 |
| 6 sec | 3.12 | 4.05 | 4.44 | 3.60 | 2.89 | 3.88 | 4.38 | 3.50 | 3.03 | 3.62 | 3.57 | 3.93 | 3.57 | 4.41 | 3.39 | 3.69 |
| 7 sec | 3.52 | 4.74 | 5.33 | 3.94 | 3.40 | 4.46 | 4.72 | 3.81 | 3.61 | 4.13 | 4.01 | 4.58 | 3.96 | 5.21 | 3.50 | 4.19 |
| 8 sec | 4.15 | 5.61 | 5.69 | 4.58 | 4.11 | 5.30 | 5.26 | 4.43 | 4.44 | 4.83 | 4.72 | 5.46 | 4.62 | 5.47 | 3.90 | 4.84 |
| 9 sec | 5.10 | 4.19 | 5.71 | 5.44 | 5.16 | 5.24 | 5.85 | 5.23 | 5.51 | 5.71 | 5.60 | 5.60 | 5.49 | 3.39 | 4.50 | 5.18 |
| 10 sec | 5.70 | 3.37 | 4.44 | 4.94 | 5.27 | 3.37 | 5.24 | 5.70 | 4.79 | 3.13 | 4.50 | 5.74 | 5.38 | 3.47 | 5.38 | 4.69 |
| 11 sec | 4.12 | 3.51 | 3.36 | 3.40 | 3.85 | 3.45 | 5.64 | 5.46 | 3.77 | 2.59 | 3.41 | 5.18 | 4.34 | 3.78 | 4.92 | 4.05 |
| 12 sec | 4.96 | 3.93 | 3.51 | 3.51 | 3.95 | 3.81 | 4.90 | 5.78 | 3.82 | 2.77 | 3.57 | 4.39 | 4.44 | 4.37 | 3.38 | 4.07 |
| 13 sec | 5.71 | 4.60 | 3.92 | 3.84 | 4.25 | 4.35 | 3.36 | 4.37 | 4.03 | 3.21 | 4.00 | 4.79 | 4.69 | 5.19 | 3.48 | 4.25 |
| 14 sec | 2.26 | 5.46 | 4.61 | 4.41 | 4.73 | 5.17 | 3.48 | 4.72 | 4.30 | 3.91 | 4.66 | 5.43 | 5.10 | 5.79 | 3.83 | 4.52 |
| 15 sec | 1.81 | 5.65 | 5.46 | 5.23 | 5.45 | 5.53 | 3.88 | 5.28 | 4.73 | 4.89 | 5.55 | 5.85 | 5.60 | 5.28 | 4.46 | 4.98 |
| 16 sec | 2.03 | 5.19 | 5.31 | 5.69 | 5.61 | 2.81 | 4.47 | 5.89 | 5.31 | 5.76 | 5.59 | 4.40 | 5.77 | 5.31 | 5.27 | 4.96 |
| 17 sec | 2.49 | 5.25 | 4.36 | 4.72 | 2.55 | 2.73 | 5.34 | 4.53 | 5.79 | 5.67 | 5.29 | 4.48 | 5.21 | 5.45 | 5.45 | 4.62 |
| 18 sec | 3.22 | 5.38 | 4.47 | 4.74 | 2.63 | 2.95 | 5.47 | 4.45 | 4.28 | 4.75 | 5.35 | 4.69 | 5.26 | 5.64 | 4.41 | 4.51 |
| 19 sec | 4.25 | 5.62 | 4.72 | 4.85 | 2.87 | 3.41 | 4.59 | 4.63 | 3.38 | 3.36 | 5.50 | 5.06 | 5.38 | 5.84 | 4.46 | 4.53 |
| 20 sec | 5.45 | 5.85 | 5.17 | 5.09 | 3.34 | 4.11 | 4.65 | 4.99 | 3.55 | 3.50 | 5.69 | 5.61 | 5.58 | 5.13 | 4.69 | 4.83 |
| 21 sec | 4.86 | 4.90 | 5.70 | 5.40 | 4.07 | 5.10 | 4.88 | 5.50 | 3.97 | 3.84 | 5.89 | 5.44 | 5.79 | 2.75 | 5.11 | 4.88 |
| 22 sec | 4.45 | 3.92 | 5.13 | 5.76 | 5.05 | 5.48 | 5.25 | 5.90 | 4.62 | 4.44 | 5.91 | 2.05 | 5.79 | 3.47 | 5.61 | 4.86 |
| 23 sec | 4.57 | 4.27 | 4.19 | 5.94 | 5.34 | 3.38 | 5.71 | 5.85 | 5.49 | 5.32 | 5.95 | 2.20 | 5.18 | 4.83 | 5.73 | 4.93 |
| 24 sec | 4.88 | 5.78 | 4.29 | 5.95 | 3.33 | 3.47 | 5.38 | 4.22 | 4.51 | 5.30 | 5.11 | 2.26 | 5.23 | 5.09 | 5.15 | 4.66 |
| 25 sec | 5.34 | 3.63 | 4.58 | 6.01 | 3.46 | 3.74 | 4.49 | 4.21 | 3.38 | 3.41 | 4.09 | 2.36 | 5.36 | 5.41 | 5.17 | 4.31 |
| 26 sec | 5.82 | 3.37 | 5.05 | 4.80 | 3.72 | 4.29 | 4.55 | 4.39 | 3.52 | 3.50 | 4.17 | 2.51 | 5.54 | 5.75 | 5.32 | 4.42 |
| 27 sec | 4.81 | 3.57 | 5.66 | 4.27 | 4.27 | 5.03 | 4.80 | 4.79 | 3.93 | 3.83 | 4.46 | 2.72 | 5.77 | 5.86 | 5.56 | 4.62 |
| 28 sec | 4.39 | 4.03 | 5.58 | 4.44 | 5.05 | 5.77 | 5.22 | 5.34 | 4.54 | 4.35 | 4.85 | 2.99 | 5.96 | 5.20 | 5.78 | 4.90 |
| 29 sec | 4.52 | 4.74 | 5.02 | 4.80 | 5.57 | 2.43 | 5.68 | 5.89 | 5.42 | 5.19 | 5.47 | 3.30 | 5.85 | 5.25 | 5.62 | 4.98 |
| 30 sec | 4.82 | 5.60 | 5.07 | 5.31 | 3.16 | 2.12 | 5.93 | 4.81 | 5.72 | 5.65 | 5.71 | 3.70 | 5.78 | 5.35 | 5.08 | 4.92 |
| Avg | 4.39 | 4.60 | 4.74 | 4.73 | 4.09 | 4.10 | 4.96 | 4.82 | 4.30 | 4.25 | 4.80 | 4.22 | 5.07 | 4.80 | 4.80 | 4.58 Gbits per sec (avg) |

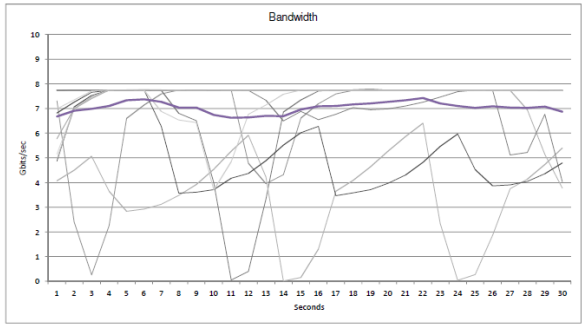
| Scale |
|---|
| 10.00 |
| 9.50 |
| 9.00 |
| 8.50 |
| 8.00 |
| 7.50 |
| 7.00 |
| 6.50 |
| 6.00 |
| 5.50 |
| 5.00 |
| 4.50 |
| 4.00 |
| 3.50 |
| 3.00 |
| 2.50 |
| 2.00 |
| 1.50 |
| 1.00 |
| 0.50 |
| 0.00 |

Retransmissions

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2 sec | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | |
| 3 sec | 45 | 24 | 0 | 0 | 11 | 29 | 59 | 0 | 20 | 0 | 34 | 0 | 0 | 0 | 10 | |
| 4 sec | 0 | 0 | 0 | 43 | 1 | 0 | 0 | 64 | 0 | 29 | 0 | 17 | 9 | 0 | 0 | |
| 5 sec | 42 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 36 | |
| 6 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 7 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 8 sec | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 48 | 0 | |
| 9 sec | 0 | 5 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | |
| 10 sec | 53 | 0 | 14 | 41 | 20 | 0 | 24 | 29 | 55 | 10 | 0 | 51 | 23 | 0 | 0 | |
| 11 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 26 | 0 | 9 | 0 | 19 | |
| 12 sec | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 13 sec | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 14 sec | 396 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | |
| 15 sec | 0 | 36 | 0 | 0 | 0 | 319 | 0 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 0 | |
| 16 sec | 0 | 0 | 58 | 21 | 131 | 0 | 0 | 0 | 0 | 20 | 0 | 16 | 8 | 0 | 0 | |
| 17 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | |
| 18 sec | 0 | 0 | 0 | 0 | 0 | 0 | 44 | 0 | 24 | 8 | 0 | 0 | 0 | 0 | 0 | |
| 19 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 20 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 0 | |
| 21 sec | 15 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | |
| 22 sec | 0 | 1 | 17 | 0 | 0 | 37 | 0 | 1 | 0 | 0 | 2 | 9 | 9 | 0 | 0 | |
| 23 sec | 0 | 0 | 0 | 9 | 5 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | |
| 24 sec | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 0 | 11 | 10 | 0 | 27 | 0 | 0 | 0 | |
| 25 sec | 0 | 21 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26 sec | 0 | 0 | 0 | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27 sec | 25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | |
| 28 sec | 0 | 0 | 46 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 0 | |
| 29 sec | 0 | 0 | 0 | 0 | 16 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | |
| 30 sec | 0 | 0 | 0 | 0 | 1 | 0 | 16 | 31 | 41 | 18 | 0 | 1 | 3 | 0 | 0 | |
| Total | 585 | 93 | 155 | 130 | 185 | 417 | 205 | 199 | 151 | 95 | 104 | 121 | 79 | 118 | 108 | 183 avg retrans per test |

| Scale |
|---|
| 0 |
| 1-49 |
| 50-99 |
| 100+ |

# Brocade MLXe (64MB)




TCP Throughput

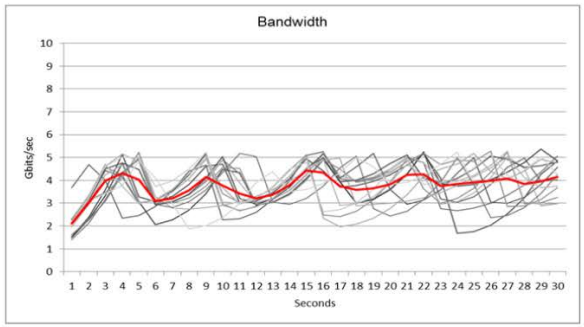
| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 4.87 | 7.31 | 7.73 | 7.73 | 7.74 | 4.07 | 7.73 | 7.74 | 7.73 | 6.82 | 7.73 | 5.15 | 5.77 | 6.98 | 4.94 | 6.67 |
| 2 sec | 7.06 | 2.41 | 7.74 | 7.73 | 7.73 | 4.50 | 7.74 | 7.73 | 7.74 | 7.26 | 7.73 | 7.00 | 6.98 | 7.35 | 6.98 | 6.91 |
| 3 sec | 7.53 | 0.26 | 7.73 | 7.73 | 7.73 | 5.06 | 7.73 | 7.73 | 7.73 | 7.66 | 7.74 | 7.47 | 7.40 | 7.71 | 7.46 | 6.98 |
| 4 sec | 7.74 | 2.25 | 7.73 | 7.73 | 7.73 | 3.64 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.74 | 7.75 | 7.74 | 7.73 | 7.10 |
| 5 sec | 7.73 | 6.60 | 7.73 | 7.74 | 7.74 | 2.84 | 7.73 | 7.74 | 7.73 | 7.74 | 7.73 | 7.76 | 7.76 | 7.74 | 7.73 | 7.34 |
| 6 sec | 7.73 | 7.14 | 7.73 | 7.73 | 7.73 | 2.93 | 7.73 | 7.73 | 7.74 | 7.75 | 7.73 | 7.77 | 7.74 | 7.73 | 7.75 | 7.38 |
| 7 sec | 7.73 | 7.59 | 7.74 | 7.73 | 7.73 | 3.12 | 7.73 | 7.73 | 7.73 | 6.27 | 7.73 | 7.76 | 7.73 | 6.88 | 7.76 | 7.26 |
| 8 sec | 7.73 | 7.74 | 7.73 | 7.73 | 6.80 | 3.48 | 7.74 | 7.73 | 7.73 | 3.57 | 7.74 | 7.75 | 7.72 | 6.53 | 7.73 | 7.03 |
| 9 sec | 7.73 | 7.73 | 7.73 | 7.74 | 6.51 | 3.92 | 7.73 | 7.73 | 7.73 | 3.61 | 7.73 | 7.73 | 7.74 | 6.43 | 7.73 | 7.03 |
| 10 sec | 7.73 | 7.76 | 7.73 | 7.73 | 4.00 | 4.54 | 7.73 | 7.74 | 7.73 | 3.71 | 7.73 | 7.74 | 7.73 | 3.70 | 7.73 | 6.74 |
| 11 sec | 7.73 | 7.75 | 7.74 | 7.73 | 0.05 | 5.27 | 7.73 | 7.73 | 7.74 | 4.17 | 7.73 | 7.73 | 7.73 | 4.84 | 7.73 | 6.63 |
| 12 sec | 7.73 | 4.78 | 7.73 | 7.73 | 0.40 | 5.91 | 7.74 | 7.73 | 7.73 | 4.37 | 7.74 | 7.73 | 7.73 | 6.77 | 7.74 | 6.64 |
| 13 sec | 7.73 | 3.95 | 7.73 | 7.73 | 3.32 | 4.23 | 7.73 | 7.73 | 7.33 | 4.88 | 7.73 | 7.73 | 7.74 | 7.14 | 7.73 | 6.70 |
| 14 sec | 7.73 | 4.31 | 7.73 | 7.74 | 6.86 | 0.01 | 7.73 | 7.73 | 6.49 | 5.51 | 7.73 | 7.73 | 7.73 | 7.58 | 7.73 | 6.69 |
| 15 sec | 7.73 | 6.61 | 7.73 | 7.73 | 7.34 | 0.16 | 7.73 | 7.74 | 6.88 | 6.02 | 7.73 | 7.74 | 7.73 | 7.74 | 7.73 | 6.96 |
| 16 sec | 7.73 | 7.19 | 7.74 | 7.73 | 7.71 | 1.30 | 7.73 | 7.73 | 6.54 | 6.28 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.09 |
| 17 sec | 7.73 | 7.59 | 7.73 | 7.73 | 7.75 | 3.65 | 7.74 | 7.73 | 6.77 | 3.47 | 7.74 | 7.73 | 7.73 | 7.74 | 7.74 | 7.10 |
| 18 sec | 7.73 | 7.73 | 7.73 | 7.74 | 7.76 | 4.08 | 7.73 | 7.73 | 7.03 | 3.58 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.17 |
| 19 sec | 7.73 | 7.74 | 7.73 | 7.73 | 7.78 | 4.64 | 7.73 | 7.74 | 6.95 | 3.71 | 7.73 | 7.74 | 7.73 | 7.73 | 7.73 | 7.21 |
| 20 sec | 7.74 | 7.75 | 7.73 | 7.73 | 7.74 | 5.27 | 7.73 | 7.73 | 6.98 | 3.97 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.27 |
| 21 sec | 7.73 | 7.74 | 7.74 | 7.73 | 7.73 | 5.86 | 7.74 | 7.73 | 7.10 | 4.30 | 7.74 | 7.73 | 7.73 | 7.73 | 7.73 | 7.34 |
| 22 sec | 7.73 | 7.75 | 7.73 | 7.73 | 7.73 | 6.41 | 7.73 | 7.73 | 7.26 | 4.82 | 7.73 | 7.73 | 7.73 | 7.74 | 7.74 | 7.42 |
| 23 sec | 7.73 | 7.73 | 7.73 | 7.74 | 7.73 | 2.35 | 7.73 | 7.73 | 7.46 | 5.46 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.20 |
| 24 sec | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 0.03 | 7.73 | 7.74 | 7.68 | 5.97 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.10 |
| 25 sec | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 0.27 | 7.73 | 7.73 | 7.74 | 4.52 | 7.73 | 7.74 | 7.73 | 7.73 | 7.73 | 7.02 |
| 26 sec | 7.73 | 7.74 | 7.73 | 7.73 | 7.73 | 1.87 | 7.73 | 7.73 | 7.73 | 3.86 | 7.73 | 7.73 | 7.73 | 7.74 | 7.74 | 7.08 |
| 27 sec | 7.73 | 7.73 | 7.73 | 7.73 | 7.74 | 3.75 | 7.73 | 7.73 | 5.11 | 3.91 | 7.73 | 7.73 | 7.74 | 7.73 | 7.73 | 7.04 |
| 28 sec | 7.73 | 7.73 | 7.73 | 7.74 | 7.73 | 4.13 | 7.73 | 6.95 | 5.22 | 4.05 | 7.73 | 7.73 | 7.73 | 7.73 | 7.73 | 7.03 |
| 29 sec | 7.74 | 7.73 | 7.73 | 7.73 | 7.73 | 4.73 | 7.73 | 5.14 | 6.77 | 4.36 | 7.73 | 7.74 | 7.73 | 7.73 | 7.73 | 7.07 |
| 30 sec | 7.73 | 7.74 | 7.72 | 7.73 | 7.73 | 5.40 | 7.73 | 3.78 | 4.03 | 4.79 | 7.73 | 7.72 | 7.73 | 7.73 | 7.73 | 6.87 |
| Avg | 7.61 | 6.65 | 7.73 | 7.73 | 6.85 | 3.58 | 7.73 | 7.49 | 7.13 | 5.14 | 7.73 | 7.62 | 7.63 | 7.29 | 7.61 | 7.03 Gbits per sec (avg) |

| Scale |
|---|
| 10.00 |
| 9.50 |
| 9.00 |
| 8.50 |
| 8.00 |
| 7.50 |
| 7.00 |
| 6.50 |
| 6.00 |
| 5.50 |
| 5.00 |
| 4.50 |
| 4.00 |
| 3.50 |
| 3.00 |
| 2.50 |
| 2.00 |
| 1.50 |
| 1.00 |
| 0.50 |
| 0.00 |

Retransmissions

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2 sec | 0 | 3 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 3 sec | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 4 sec | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 0 | 0 | 0

# Arista 7150 (~8MB[1])




TCP Throughput

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 1.51 | 2.26 | 3.67 | 1.50 | 1.61 | 2.27 | 2.18 | 1.97 | 1.41 | 2.29 | 2.12 | 2.13 | 2.08 | 2.18 | 2.32 | 2.10 |
| 2 sec | 2.38 | 3.27 | 4.68 | 2.29 | 2.28 | 3.26 | 3.14 | 2.96 | 2.12 | 3.32 | 3.15 | 3.06 | 3.02 | 3.23 | 3.33 | 3.03 |
| 3 sec | 3.59 | 4.60 | 4.01 | 3.33 | 3.09 | 4.62 | 4.43 | 3.95 | 3.16 | 4.51 | 3.47 | 3.42 | 4.24 | 4.61 | 4.72 | 3.98 |
| 4 sec | 5.14 | 4.21 | 2.33 | 4.76 | 4.26 | 5.16 | 4.16 | 4.16 | 4.36 | 4.77 | 4.10 | 3.77 | 4.68 | 5.01 | 3.75 | 4.31 |
| 5 sec | 3.27 | 3.03 | 2.46 | 3.08 | 4.98 | 4.84 | 2.99 | 5.21 | 4.92 | 4.48 | 5.23 | 4.85 | 3.03 | 4.96 | 2.98 | 4.02 |
| 6 sec | 3.08 | 3.15 | 2.85 | 2.06 | 2.98 | 2.96 | 3.14 | 3.27 | 2.96 | 2.92 | 3.06 | 4.11 | 3.14 | 3.72 | 3.16 | 3.10 |
| 7 sec | 3.31 | 3.55 | 3.53 | 2.26 | 3.10 | 3.08 | 3.54 | 2.78 | 2.80 | 3.05 | 3.00 | 2.97 | 3.48 | 3.99 | 3.60 | 3.20 |
| 8 sec | 3.82 | 4.24 | 4.40 | 2.70 | 3.38 | 3.40 | 4.24 | 2.74 | 3.08 | 3.40 | 3.23 | 1.87 | 4.08 | 4.50 | 4.30 | 3.56 |
| 9 sec | 4.61 | 5.14 | 4.66 | 3.43 | 3.97 | 4.00 | 5.19 | 2.81 | 3.58 | 4.10 | 3.76 | 2.01 | 4.93 | 5.22 | 4.97 | 4.16 |
| 10 sec | 4.72 | 3.42 | 2.28 | 4.48 | 4.91 | 4.90 | 2.94 | 2.90 | 4.33 | 5.03 | 4.57 | 2.36 | 3.69 | 3.07 | 2.91 | 3.77 |
| 11 sec | 2.99 | 3.02 | 2.31 | 4.33 | 4.28 | 3.89 | 2.68 | 3.07 | 5.19 | 3.21 | 4.52 | 3.00 | 2.97 | 2.99 | 2.69 | 3.41 |
| 12 sec | 3.09 | 3.22 | 2.60 | 2.91 | 3.03 | 2.99 | 2.86 | 3.31 | 5.03 | 2.95 | 2.94 | 3.91 | 3.15 | 3.22 | 2.84 | 3.20 |
| 13 sec | 3.44 | 3.70 | 3.16 | 3.05 | 3.18 | 3.16 | 3.21 | 3.61 | 3.04 | 3.18 | 3.03 | 4.39 | 3.52 | 3.73 | 3.22 | 3.37 |
| 14 sec | 4.07 | 4.46 | 3.99 | 3.42 | 3.56 | 3.58 | 3.75 | 3.98 | 2.95 | 3.71 | 3.38 | 3.52 | 4.20 | 4.50 | 3.77 | 3.79 |
| 15 sec | 4.94 | 5.11 | 5.09 | 4.08 | 4.24 | 4.27 | 4.50 | 4.40 | 3.22 | 4.53 | 4.00 | 3.61 | 5.07 | 4.79 | 4.54 | 4.43 |
| 16 sec | 4.41 | 2.49 | 5.25 | 4.93 | 5.21 | 5.22 | 5.16 | 4.91 | 3.75 | 4.99 | 4.90 | 3.86 | 2.35 | 2.63 | 4.89 | 4.33 |
| 17 sec | 3.71 | 2.41 | 3.96 | 3.93 | 4.08 | 4.20 | 4.11 | 4.96 | 4.55 | 3.94 | 4.51 | 4.33 | 1.96 | 2.72 | 2.90 | 3.75 |
| 18 sec | 3.77 | 2.64 | 2.99 | 3.01 | 3.95 | 4.01 | 4.59 | 2.87 | 5.06 | 4.01 | 3.91 | 4.99 | 2.08 | 3.03 | 2.98 | 3.59 |
| 19 sec | 3.95 | 3.16 | 3.16 | 3.18 | 4.10 | 4.16 | 5.19 | 2.95 | 2.77 | 4.29 | 4.05 | 4.59 | 2.34 | 3.60 | 3.29 | 3.65 |
| 20 sec | 4.24 | 3.91 | 3.59 | 3.61 | 4.44 | 4.51 | 3.61 | 3.00 | 2.44 | 4.74 | 4.34 | 3.81 | 2.76 | 4.43 | 3.89 | 3.82 |
| 21 sec | 4.67 | 4.95 | 4.26 | 4.30 | 4.96 | 5.04 | 2.94 | 3.10 | 2.65 | 5.11 | 4.82 | 3.92 | 3.37 | 4.94 | 4.70 | 4.25 |
| 22 sec | 5.15 | 3.63 | 5.24 | 5.23 | 4.78 | 4.79 | 3.15 | 3.24 | 3.17 | 4.11 | 5.17 | 4.23 | 4.17 | 3.83 | 4.19 | 4.27 |
| 23 sec | 4.09 | 3.01 | 3.19 | 3.87 | 2.76 | 3.88 | 3.59 | 3.47 | 3.92 | 3.89 | 4.69 | 4.72 | 4.49 | 3.88 | 2.94 | 3.76 |
| 24 sec | 1.69 | 3.20 | 3.05 | 3.74 | 2.67 | 3.95 | 4.31 | 3.77 | 4.99 | 4.08 | 4.91 | 5.22 | 4.71 | 4.12 | 3.07 | 3.83 |
| 25 sec | 1.76 | 3.25 | 3.29 | 3.83 | 2.78 | 4.22 | 5.00 | 4.14 | 3.81 | 4.50 | 4.83 | 3.88 | 5.19 | 4.53 | 3.45 | 3.92 |
| 26 sec | 2.03 | 4.37 | 3.81 | 4.04 | 3.01 | 4.67 | 3.04 | 4.55 | 2.36 | 5.07 | 5.27 | 3.84 | 4.38 | 5.14 | 4.12 | 3.98 |
| 27 sec | 2.54 | 5.23 | 4.58 | 4.37 | 3.34 | 5.28 | 3.00 | 5.04 | 2.47 | 4.92 | 2.85 | 4.06 | 4.07 | 4.23 | 5.02 | 4.07 |
| 28 sec | 3.24 | 2.97 | 4.98 | 4.78 | 3.80 | 3.04 | 3.25 | 4.53 | 2.81 | 4.58 | 2.88 | 4.44 | 4.41 | 3.78 | 4.13 | 3.84 |
| 29 sec | 4.27 | 3.03 | 3.95 | 5.37 | 4.35 | 2.95 | 3.81 | 2.88 | 3.43 | 4.65 | 3.16 | 5.04 | 4.92 | 3.92 | 3.67 | 3.96 |
| 30 sec | 4.86 | 3.25 | 4.03 | 4.85 | 5.06 | 3.00 | 4.56 | 2.97 | 4.26 | 4.80 | 3.68 | 4.24 | 4.77 | 4.22 | 3.75 | 4.15 |
| Avg | 3.61 | 3.61 | 3.71 | 3.69 | 3.74 | 3.98 | 3.74 | 3.58 | 3.49 | 4.10 | 3.92 | 3.81 | 3.71 | 3.96 | 3.67 | **3.75 Gbits per sec (avg)** |

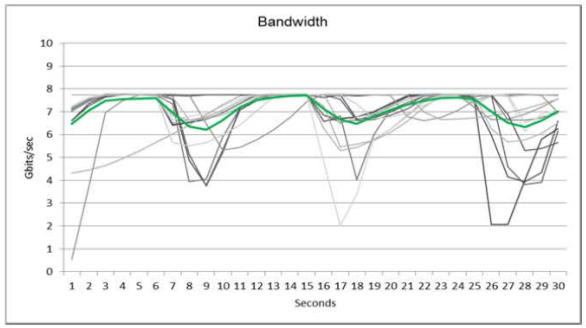
| Scale |
|---|
| 10.00 |
| 9.50 |
| 9.00 |
| 8.50 |
| 8.00 |
| 7.50 |
| 7.00 |
| 6.50 |
| 6.00 |
| 5.50 |
| 5.00 |
| 4.50 |
| 4.00 |
| 3.50 |
| 3.00 |
| 2.50 |
| 2.00 |
| 1.50 |
| 1.00 |
| 0.50 |
| 0.00 |

Retransmissions

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 3 sec | 0 | 0 | 68 | 0 | 0 | 0 | 0 | 5 | 0 | 19 | 1 | 7 | 0 | 0 | 0 | |
| 4 sec | 0 | 49 | 0 | 0 | 0 | 1 | 69 | 0 | 10 | 0 | 0 | 0 | 71 | 24 | 40 | |
| 5 sec | 132 | 0 | 0 | 116 | 38 | 57 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 10 | 0 | |
| 6 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 88 | 7 | 0 | 40 | 28 | 0 | 0 | 0 | |
| 7 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 11 | 0 | 0 | 0 | |
| 8 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 9 sec | 0 | 0 | 47 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 40 | |
| 10 sec | 103 | 18 | 2 | 0 | 0 | 0 | 27 | 0 | 0 | 0 | 0 | 0 | 22 | 21 | 1 | |
| 11 sec | 0 | 0 | 0 | 19 | 147 | 34 | 0 | 0 | 8 | 10 | 36 | 0 | 0 | 0 | 0 | |
| 12 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 13 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 10 | 0 | 0 | 0 | |
| 14 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 15 sec | 0 | 522 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 34 | 0 | |
| 16 sec | 400 | 177 | 3 | 0 | 0 | 0 | 10 | 0 | 0 | 37 | 0 | 0 | 320 | 0 | 8 | |
| 17 sec | 0 | 0 | 115 | 68 | 60 | 155 | 0 | 11 | 0 | 0 | 40 | 0 | 0 | 0 | 0 | |
| 18 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 19 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 27 | 0 | 0 | 0 | |
| 20 sec | 0 | 0 | 0 | 0 | 0 | 0 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 21 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 | 0 | 0 | 41 | 0 | |
| 22 sec | 0 | 40 | 0 | 0 | 473 | 45 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 8 | |
| 23 sec | 390 | 0 | 111 | 111 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | |
| 24 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 54 | 0 | 0 | 0 | |
| 25 sec | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 18 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 0 | 2 | 0 | 0 | |
| 27 sec | 0 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 39 | 0 | 0 | 0 | 3 | 0 | |
| 28 sec | 0 | 0 | 40 | 0 | 0 | 406 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 97 | |
| 29 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30 sec | 67 | 0 | 0 | 99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 79 | 20 | 0 | 0 | |
| Total | 1092 | 819 | 386 | 413 | 718 | 698 | 168 | 110 | 92 | 153 | 137 | 216 | 437 | 146 | 194 | **385 retrans per test (avg)** |

| Scale |
|---|
| 0 |
| 1-49 |
| 50-99 |
| 100+ |

# Arista 7504E (VOQ*)




TCP Throughput

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 6.61 | 7.09 | 7.09 | 7.12 | 7.09 | 7.08 | 7.15 | 7.18 | 7.04 | 6.62 | 0.54 | 7.25 | 4.31 | 7.23 | 7.74 | 6.48 |
| 2 sec | 7.27 | 7.48 | 7.48 | 7.52 | 7.52 | 7.48 | 7.55 | 7.58 | 7.45 | 7.36 | 3.73 | 7.62 | 4.45 | 7.62 | 7.74 | 7.06 |
| 3 sec | 7.65 | 7.75 | 7.75 | 7.74 | 7.74 | 7.74 | 7.76 | 7.75 | 7.72 | 7.70 | 6.97 | 7.72 | 4.65 | 7.74 | 7.72 | 7.47 |
| 4 sec | 7.75 | 7.77 | 7.75 | 7.76 | 7.73 | 7.75 | 7.76 | 7.77 | 7.73 | 7.76 | 7.48 | 7.74 | 4.94 | 7.74 | 7.74 | 7.54 |
| 5 sec | 7.75 | 7.75 | 7.76 | 7.77 | 7.73 | 7.76 | 7.74 | 7.77 | 7.74 | 7.75 | 7.75 | 7.73 | 5.27 | 7.75 | 7.73 | 7.58 |
| 6 sec | 7.77 | 7.74 | 7.77 | 7.76 | 7.73 | 7.76 | 7.72 | 7.73 | 7.74 | 7.75 | 7.76 | 7.73 | 5.65 | 7.77 | 7.73 | 7.61 |
| 7 sec | 7.55 | 6.44 | 6.41 | 6.42 | 7.34 | 6.82 | 7.72 | 6.52 | 7.72 | 7.72 | 7.76 | 6.65 | 6.02 | 5.65 | 7.65 | 6.96 |
| 8 sec | 4.88 | 6.52 | 6.55 | 6.55 | 3.93 | 6.63 | 5.13 | 6.64 | 7.73 | 7.69 | 7.73 | 6.80 | 6.43 | 5.51 | 6.63 | 6.36 |
| 9 sec | 3.78 | 6.67 | 6.69 | 6.68 | 4.05 | 6.72 | 3.74 | 6.78 | 7.74 | 7.74 | 6.47 | 6.94 | 6.87 | 5.65 | 6.69 | 6.21 |
| 10 sec | 5.32 | 6.96 | 6.96 | 6.97 | 5.92 | 6.95 | 5.22 | 7.09 | 7.73 | 7.73 | 5.32 | 7.24 | 7.32 | 5.97 | 6.87 | 6.64 |
| 11 sec | 7.07 | 7.36 | 7.36 | 7.37 | 7.16 | 7.34 | 7.17 | 7.49 | 7.73 | 7.74 | 5.45 | 7.58 | 7.70 | 6.43 | 7.21 | 7.21 |
| 12 sec | 7.47 | 7.73 | 7.72 | 7.72 | 7.58 | 7.70 | 7.60 | 7.75 | 7.73 | 7.73 | 5.76 | 7.73 | 7.75 | 7.03 | 7.58 | 7.51 |
| 13 sec | 7.75 | 7.75 | 7.75 | 7.76 | 7.72 | 7.75 | 7.76 | 7.76 | 7.74 | 7.75 | 6.19 | 7.74 | 7.73 | 7.61 | 7.73 | 7.63 |
| 14 sec | 7.74 | 7.77 | 7.76 | 7.76 | 7.74 | 7.75 | 7.75 | 7.76 | 7.72 | 7.74 | 6.76 | 7.73 | 7.75 | 7.75 | 7.73 | 7.68 |
| 15 sec | 7.75 | 7.74 | 7.76 | 7.77 | 7.73 | 7.76 | 7.73 | 7.75 | 7.74 | 7.73 | 7.43 | 7.73 | 7.73 | 7.75 | 7.72 | 7.72 |
| 16 sec | 7.62 | 6.84 | 6.85 | 6.60 | 6.57 | 7.25 | 7.73 | 6.29 | 7.75 | 7.74 | 7.76 | 4.81 | 7.74 | 7.74 | 7.76 | 7.14 |
| 17 sec | 7.75 | 6.54 | 6.69 | 6.70 | 6.82 | 5.46 | 7.56 | 5.29 | 7.70 | 7.73 | 7.77 | 2.01 | 7.75 | 7.74 | 6.48 | 6.67 |
| 18 sec | 6.68 | 6.63 | 6.77 | 6.78 | 4.04 | 5.59 | 6.62 | 5.43 | 7.73 | 7.70 | 7.73 | 3.40 | 7.74 | 7.35 | 6.77 | 6.46 |
| 19 sec | 6.73 | 6.87 | 7.01 | 6.99 | 6.00 | 5.74 | 6.67 | 5.76 | 7.74 | 7.73 | 7.73 | 5.81 | 7.75 | 6.71 | 6.91 | 6.81 |
| 20 sec | 6.98 | 7.26 | 7.36 | 7.34 | 7.08 | 6.09 | 6.84 | 6.23 | 7.73 | 7.73 | 7.71 | 6.23 | 7.75 | 6.78 | 7.19 | 7.09 |
| 21 sec | 7.32 | 7.64 | 7.71 | 7.68 | 7.42 | 6.59 | 7.14 | 6.84 | 7.74 | 7.74 | 6.77 | 6.81 | 7.73 | 6.95 | 7.55 | 7.31 |
| 22 sec | 7.69 | 7.76 | 7.74 | 7.74 | 7.69 | 7.19 | 7.57 | 7.51 | 7.72 | 7.74 | 6.62 | 7.41 | 6.98 | 7.27 | 7.73 | 7.49 |
| 23 sec | 7.75 | 7.77 | 7.76 | 7.77 | 7.73 | 7.70 | 7.74 | 7.77 | 7.74 | 7.74 | 6.76 | 7.72 | 6.66 | 7.63 | 7.75 | 7.60 |
| 24 sec | 7.75 | 7.74 | 7.76 | 7.77 | 7.73 | 7.74 | 7.76 | 7.76 | 7.73 | 7.75 | 7.06 | 7.73 | 6.68 | 7.75 | 7.73 | 7.63 |
| 25 sec | 7.48 | 7.20 | 7.68 | 7.59 | 7.74 | 7.34 | 7.73 | 7.76 | 7.74 | 7.73 | 7.48 | 7.74 | 6.74 | 7.75 | 7.73 | 7.56 |
| 26 sec | 5.97 | 6.66 | 7.74 | 2.07 | 7.73 | 7.70 | 7.73 | 7.73 | 7.74 | 7.74 | 7.75 | 7.73 | 6.82 | 7.75 | 6.26 | 7.01 |
| 27 sec | 4.16 | 6.69 | 7.72 | 2.06 | 7.73 | 7.75 | 4.59 | 7.68 | 6.63 | 6.89 | 7.76 | 7.68 | 6.96 | 7.75 | 5.67 | 6.51 |
| 28 sec | 3.93 | 6.89 | 7.74 | 4.01 | 7.74 | 7.74 | 3.82 | 7.73 | 6.63 | 5.29 | 7.77 | 6.14 | 7.12 | 6.53 | 5.77 | 6.32 |
| 29 sec | 4.34 | 7.21 | 7.74 | 5.79 | 7.73 | 7.73 | 3.91 | 7.73 | 6.74 | 5.39 | 7.72 | 6.91 | 7.34 | 6.79 | 6.06 | 6.61 |
| 30 sec | 6.58 | 7.58 | 7.73 | 6.25 | 7.72 | 7.74 | 6.16 | 7.73 | 7.03 | 5.66 | 6.96 | 7.06 | 7.55 | 6.92 | 6.51 | 7.01 |
| Avg | 6.76 | 7.26 | 7.42 | 6.79 | 7.07 | 7.21 | 6.84 | 7.22 | 7.57 | 7.43 | 6.81 | 6.90 | 6.80 | 7.15 | 7.20 | **7.10 Gbits per sec (avg)** |

| Scale |
|---|
| 10.00 |
| 9.50 |
| 9.00 |
| 8.50 |
| 8.00 |
| 7.50 |
| 7.00 |
| 6.50 |
| 6.00 |
| 5.50 |
| 5.00 |
| 4.50 |
| 4.00 |
| 3.50 |
| 3.00 |
| 2.50 |
| 2.00 |
| 1.50 |
| 1.00 |
| 0.50 |
| 0.00 |

Retransmissions

| | Test #1 | Test #2 | Test #3 | Test #4 | Test #5 | Test #6 | Test #7 | Test #8 | Test #9 | Test #10 | Test #11 | Test #12 | Test #13 | Test #14 | Test #15 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 sec | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 2 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 3 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 4 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 5 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 6 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 7 sec | 2 | 8 | 20 | 36 | 74 | 30 | 4 | 34 | 13 | 0 | 0 | 22 | 0 | 104 | 15 | |
| 8 sec | 2 | 0 | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 7 | 0 | 0 | 0 | 0 | 0 | |
| 9 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 66 | 0 | 0 | 0 | 0 | |
| 10 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 11 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 13 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 14 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 15 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 16 sec | 1 | 72 | 26 | 65 | 2 | 96 | 0 | 58 | 0 | 0 | 0 | 88 | 0 | 0 | 0 | |
| 17 sec | 0 | 0 | 0 | 0 | 1 | 3 | 17 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 51 | |
| 18 sec | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 11 | 0 | 0 | 0 | 25 | 0 | |
| 19 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 20 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 17 | 0 | 0 | 0 | 0 | |
| 21 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | |
| 22 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | |
| 23 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25 sec | 1 | 31 | 53 | 39 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26 sec | 2 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 0 | 0 | 0 | 36 | |
| 27 sec | 3 | 0 | 0 | 0 | 3 | 0 | 23 | 18 | 54 | 5 | 0 | 11 | 0 | 0 | 0 | |
| 28 sec | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 69 | 0 | |
| 29 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30 sec | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 56 | 0 | 0 | 0 | 0 | |
| Total | 12 | 111 | 99 | 145 | 84 | 131 | 48 | 110 | 77 | 23 | 140 | 121 | 25 | 198 | 102 | **95 retrans per test (avg)** |

| Scale |
|---|
| 0 |
| 1-49 |
| 50-99 |
| 100+ |

* PetraA chipsets may have 50MB buffer max[2]. Tested unit had Arad chipset, unclear on max buffer size.

[1] http://people.ucsc.edu/~warner/Bufs/arista_7150
[2] http://people.ucsc.edu/~warner/Bufs/arista7504



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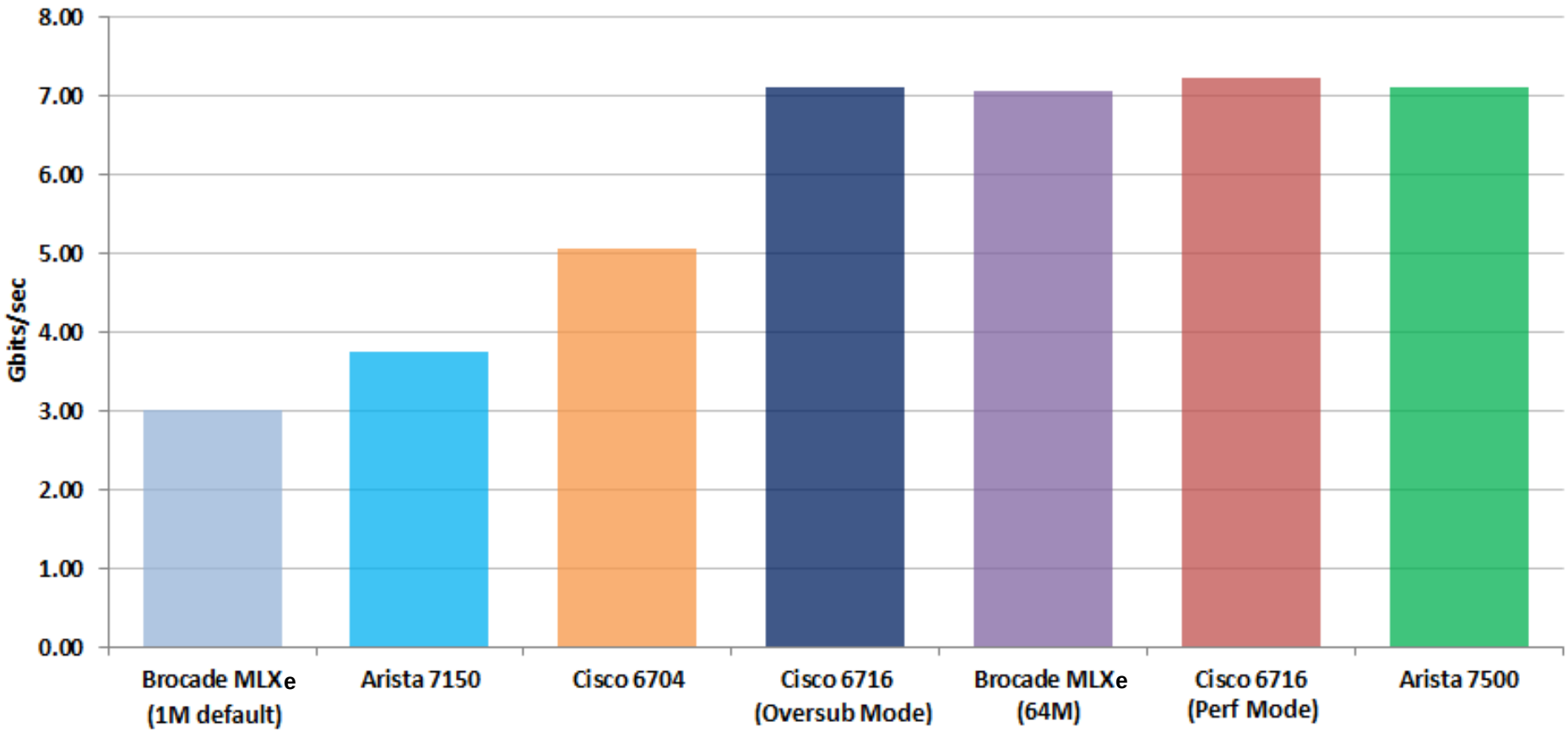
# Test 1: iperf3 overall results

How deep is “deep”? About **60MB**[1] per port.




[1] http://fasterdata.es.net/network-tuning/router-switch-buffer-size-issues/



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# Test 2: nuttcp

Same experiment setup as Test 1 (see slide 5)

Simulated WAN connectivity with congestion: 50ms RTT

```
host1# tc qdisc add dev eth1 root netem delay 25ms
host2# tc qdisc add dev eth1 root netem delay 25ms
```

Add 2Gbps UDP background traffic on link:

```
host4# iperf3 –s
host3# iperf3 -c host4 -u -b2G -t3000
```

Basic test parameters[1]:

```
host2# nuttcp -S
host1# nuttcp -l8972 -T30 -u -w4m -RiX/Y –i1 host2
```

X = Rate Limit (Mbps)
Y = Burst Size (# of packets)

[1] https://fasterdata.es.net/performance-testing/network-troubleshooting-tools/nuttcp/



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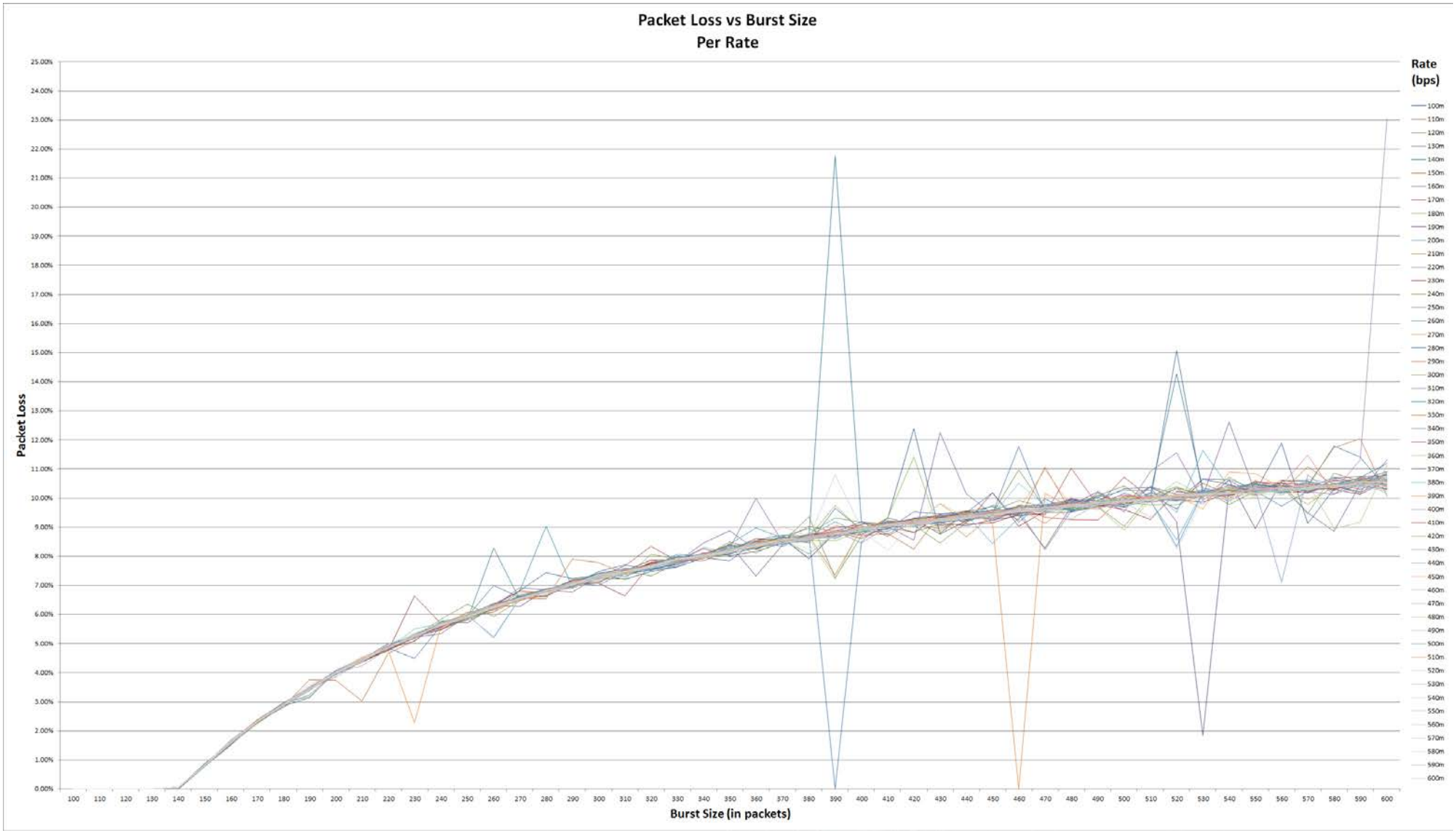
# Test 2: nuttcp

Iterate through nuttcp tests incrementing rate and burst size by 10 for each test from 100-600.

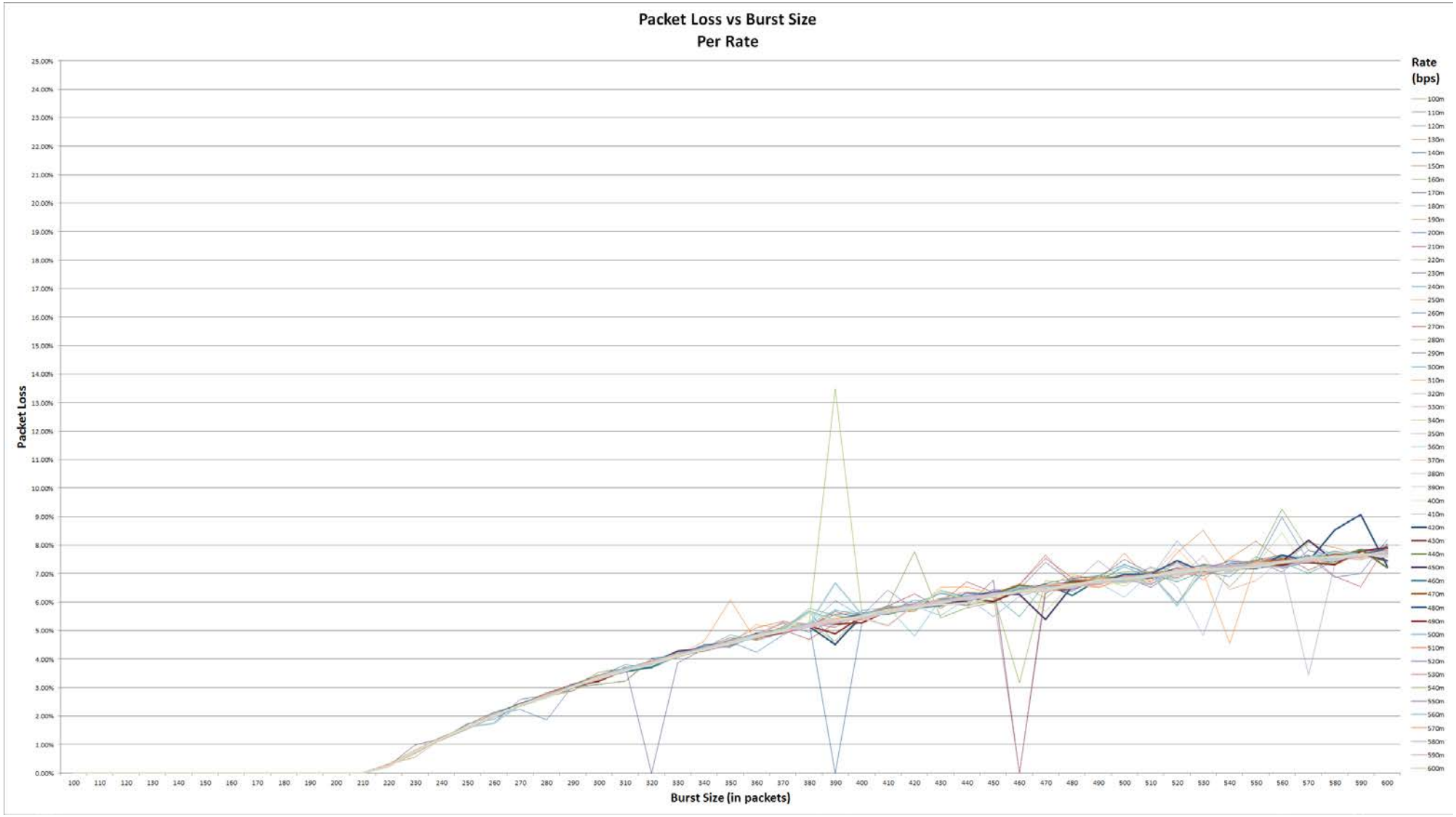
Example shell script:

```
#! /bin/sh


targetip=$1


for ((x=10; x<=60; x++))
do
  rate=$(($x*10))m
  for ((y=10; y<=60; y++))
  do
    burst=$(($y*10))
    echo "nuttcp -l8972 -T30 -u -w4m -Ri$rate/$burst -i1 $targetip" >> /var/tmp/$targetip
    nuttcp -l8972 -T30 -u -w4m -Ri$rate/$burst -i1 $targetip | grep TX >> /var/tmp/$targetip
    sleep 5
  done
done
```

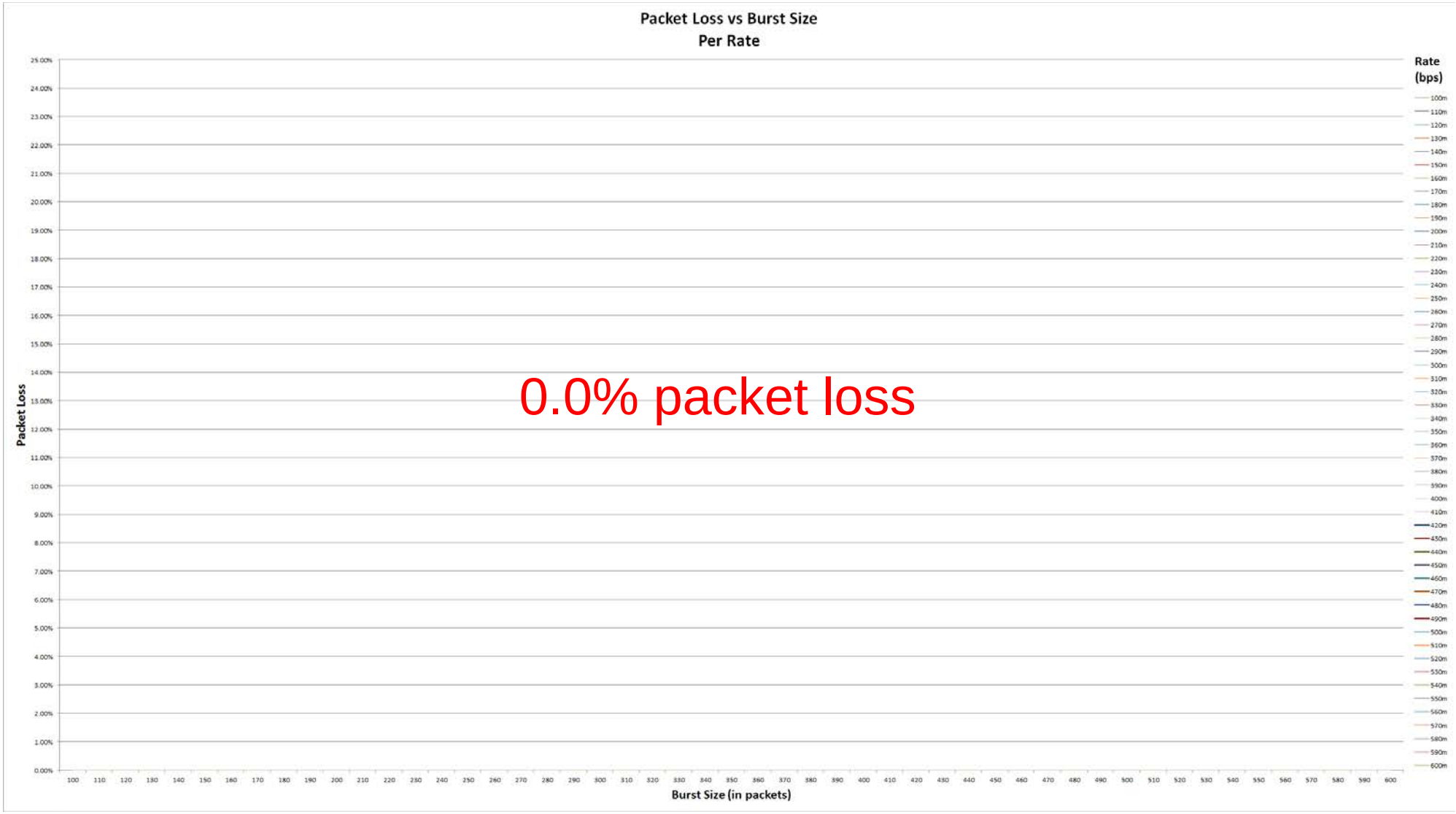
# Arista 7120 (9MB buffers)



# Juniper EX4300 (small buffers)



# Juniper MX80 (deep buffers)



# Test 2: nuttcp Conclusion

**If this is clean:**

```
nuttcp -l8972 -T30 -u -w4m -Ri300m/100 -i1
```

**And this is not:**

```
nuttcp -l8972 -T30 -u -w4m -Ri300m/300 -i1
```

**Then there is likely a switch with small buffers in the path.**



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# Additional Information

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**Brian Tierney**
bltierney@es.net

- **Higher Resolution Test Results**

  http://www.smitasin.com/switch-buffer-testing
- **Jim Warner's Packet Buffer Page**

  http://people.ucsc.edu/~warner/buffer.html
- **Faster Data @ ESnet**

  http://fasterdata.es.net
- **Cisco Buffers, Queues & Thresholds on Cat 6500 Ethernet Modules**

  http://goo.gl/gTyryX
- **SWITCH.ch BDP Calculator**

  https://www.switch.ch/network/tools/tcp_throughput/