IBM Linux Technology Center

Exploration of Large Scale Virtual Networks

Open Network Summit 2016

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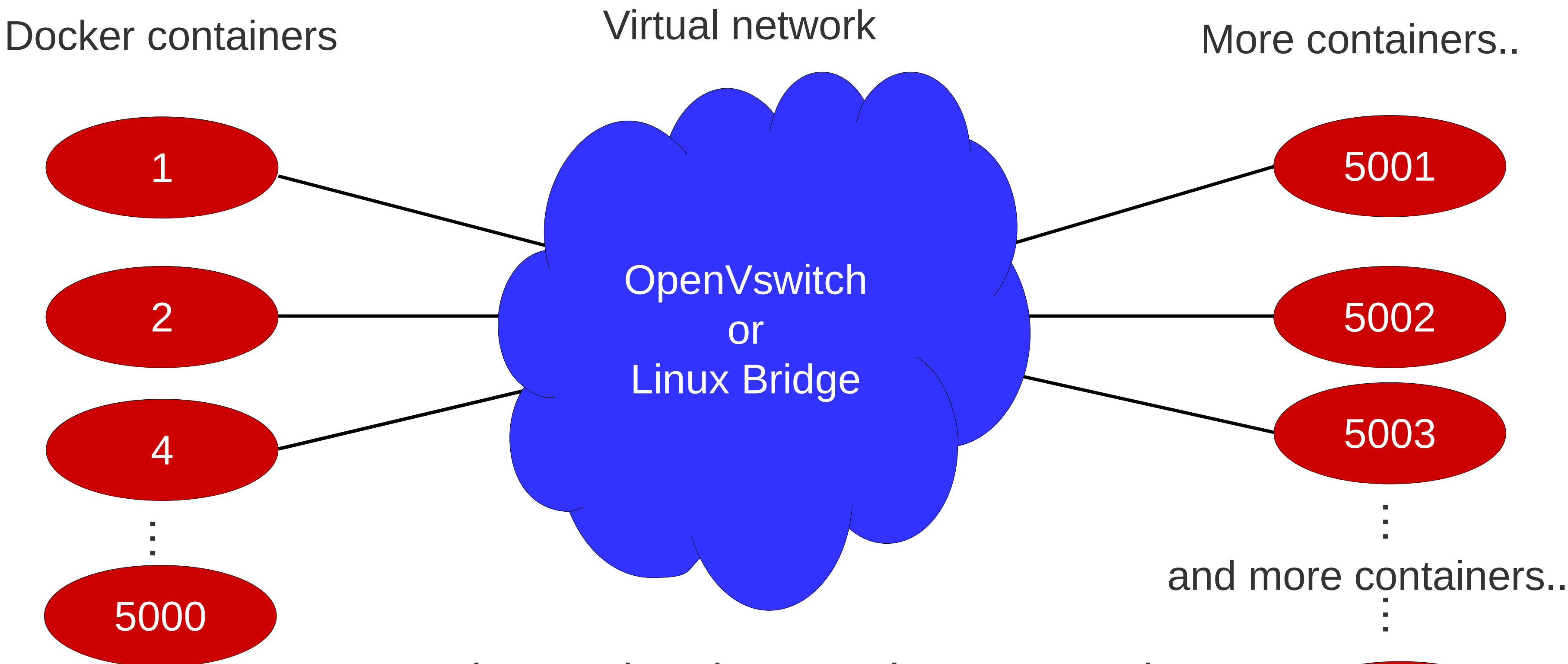
A Network of Containers



Each container has a unique “network name-space” consisting of:

- Virtual network interfaces
- Routing and arp tables
- Network statistics

Project Objectives

- Build and evaluate large virtual networks on Linux using:
  - Docker,
  - Linux Bridge,
  - OpenVswitch.

- Learn how virtual networks:
  - scale.
  - perform.
  - break.

What I Measured:

- Aggregate bandwidth
- TCP connection rate
- Latency – broadcast and unicast

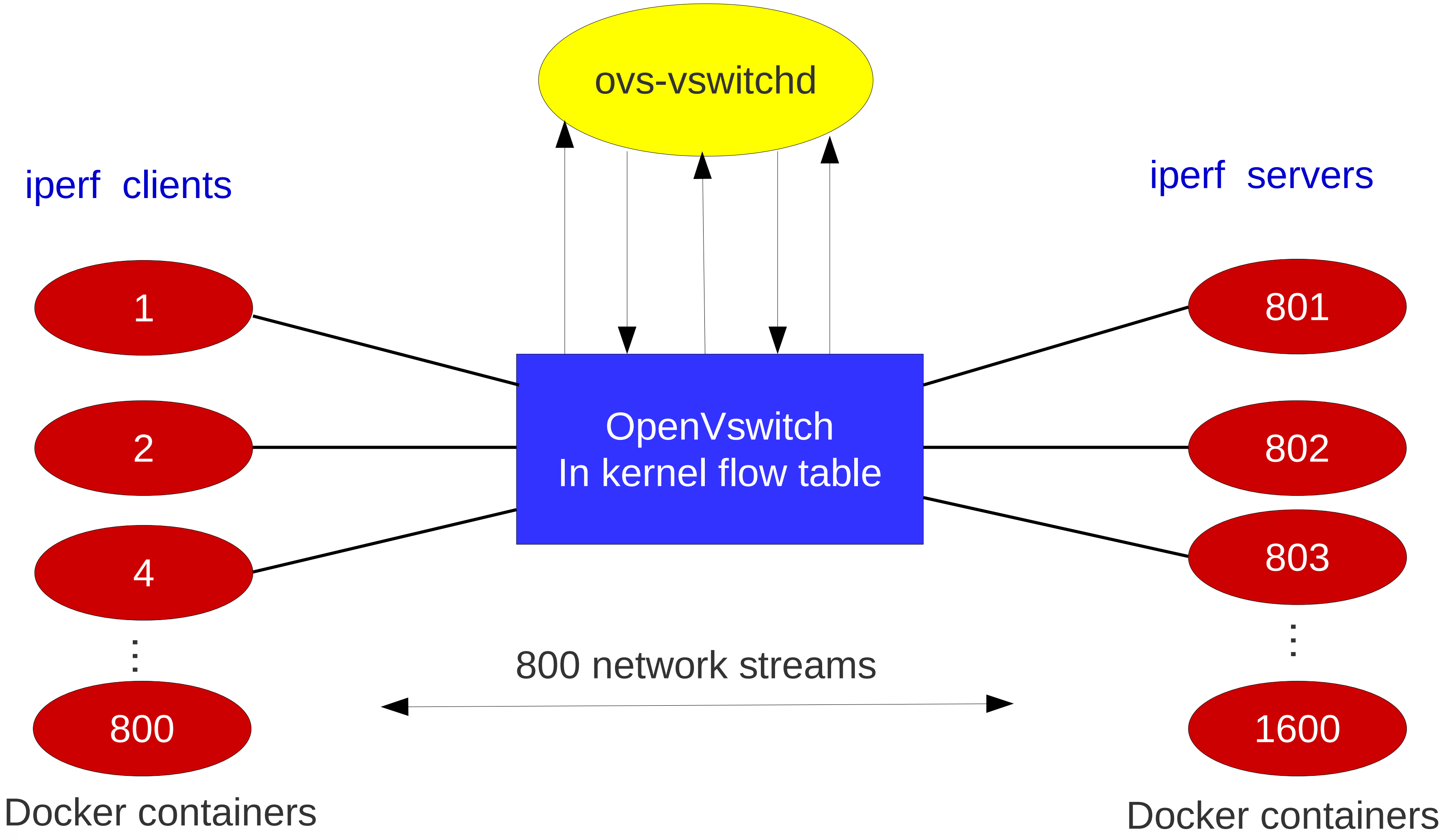
- Up to 1600 docker nodes
- IPV4

Some details..

- 80 processor power8 (SMT=8)
- 132 GB

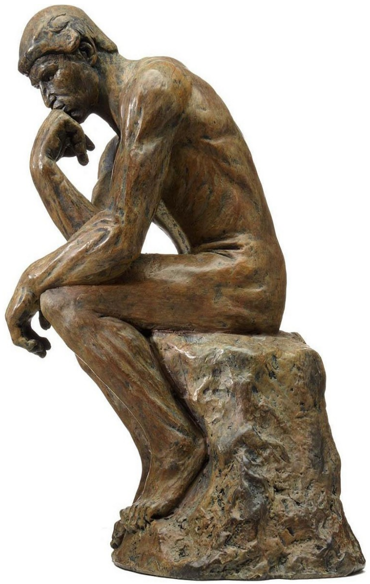
- Linux kernel version: 4.4.0 rc5+ (ppc64LE)
- OpenVswitch V2.5.90
- Docker 1.5.0

Throughput Measurements

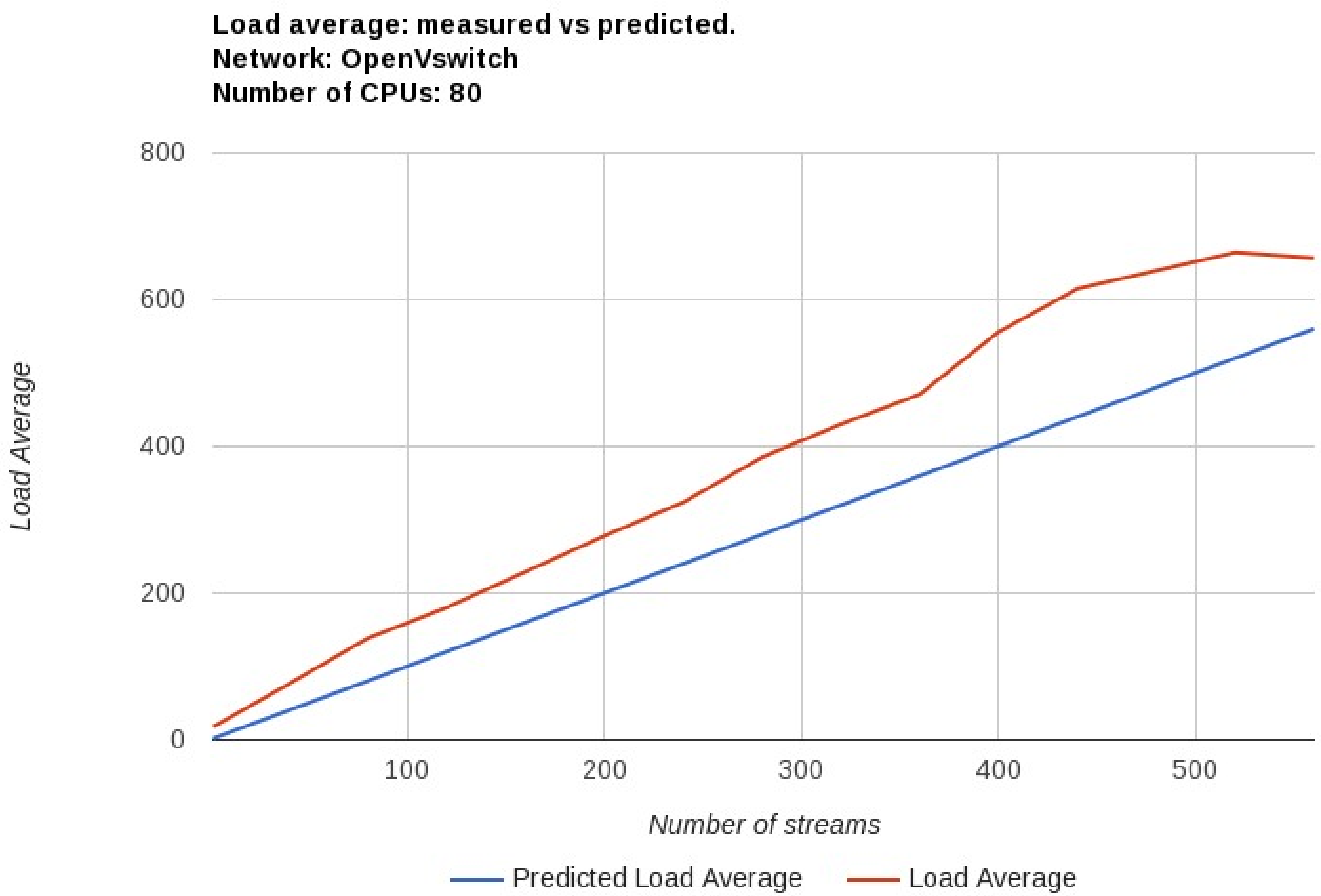


Predictions

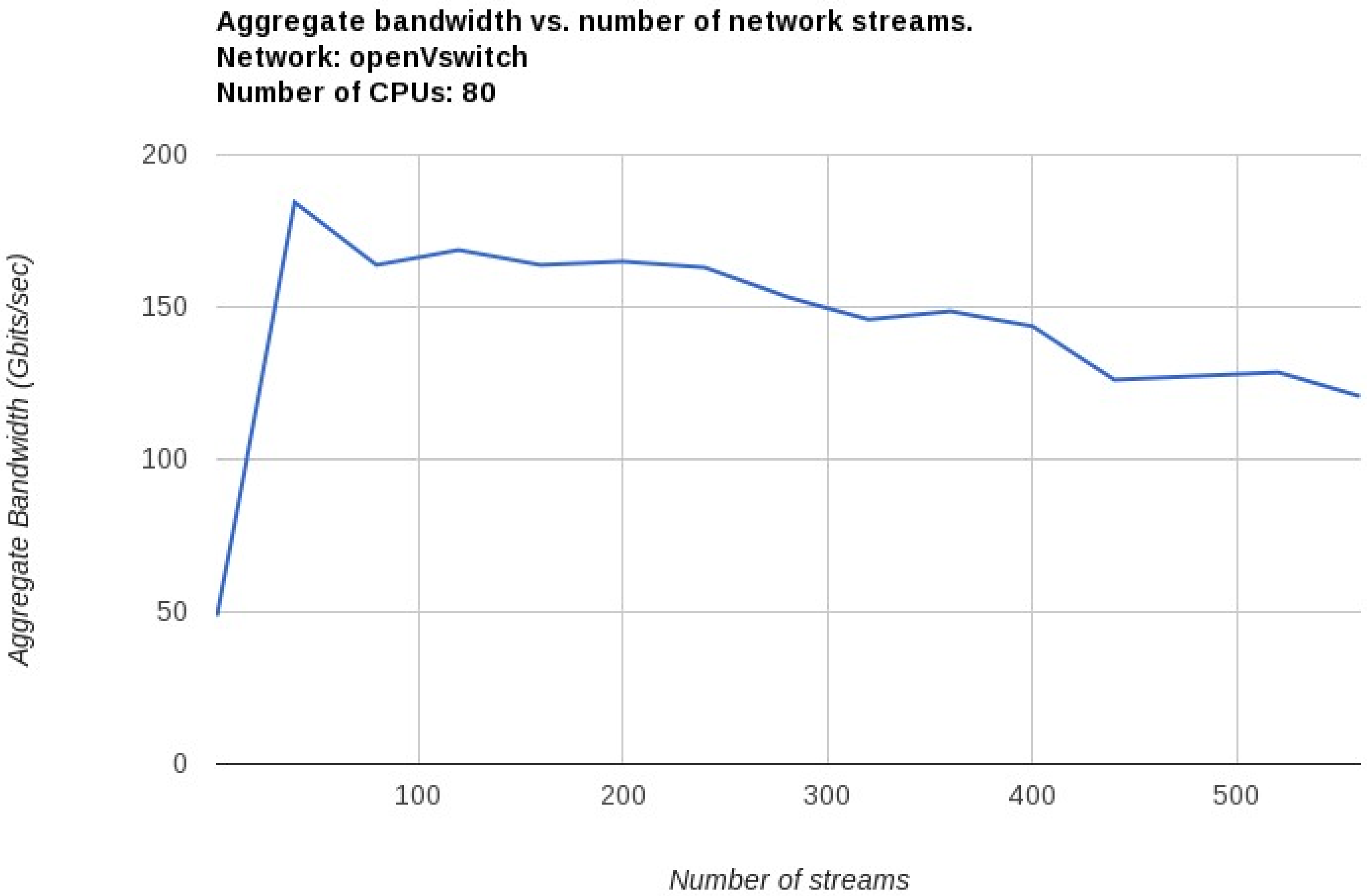
- Iperf is not performing any real I/O and will become cpu bound.
  - CPU load average ~= Number of iperf streams.
  - Throughput will level out when the number of stream equals the number of processors.



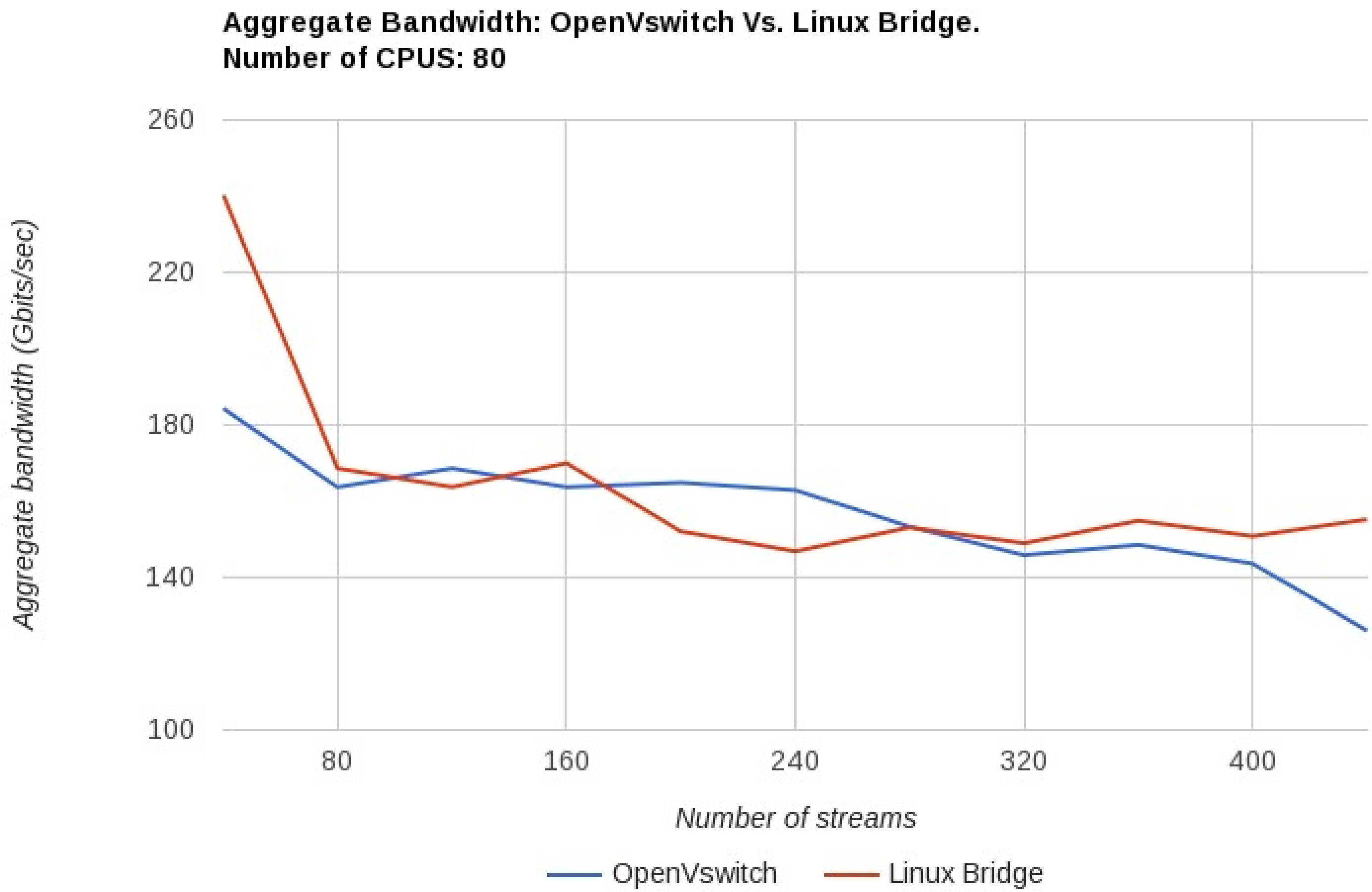
CPU Utilization:



Aggregate Bandwidth



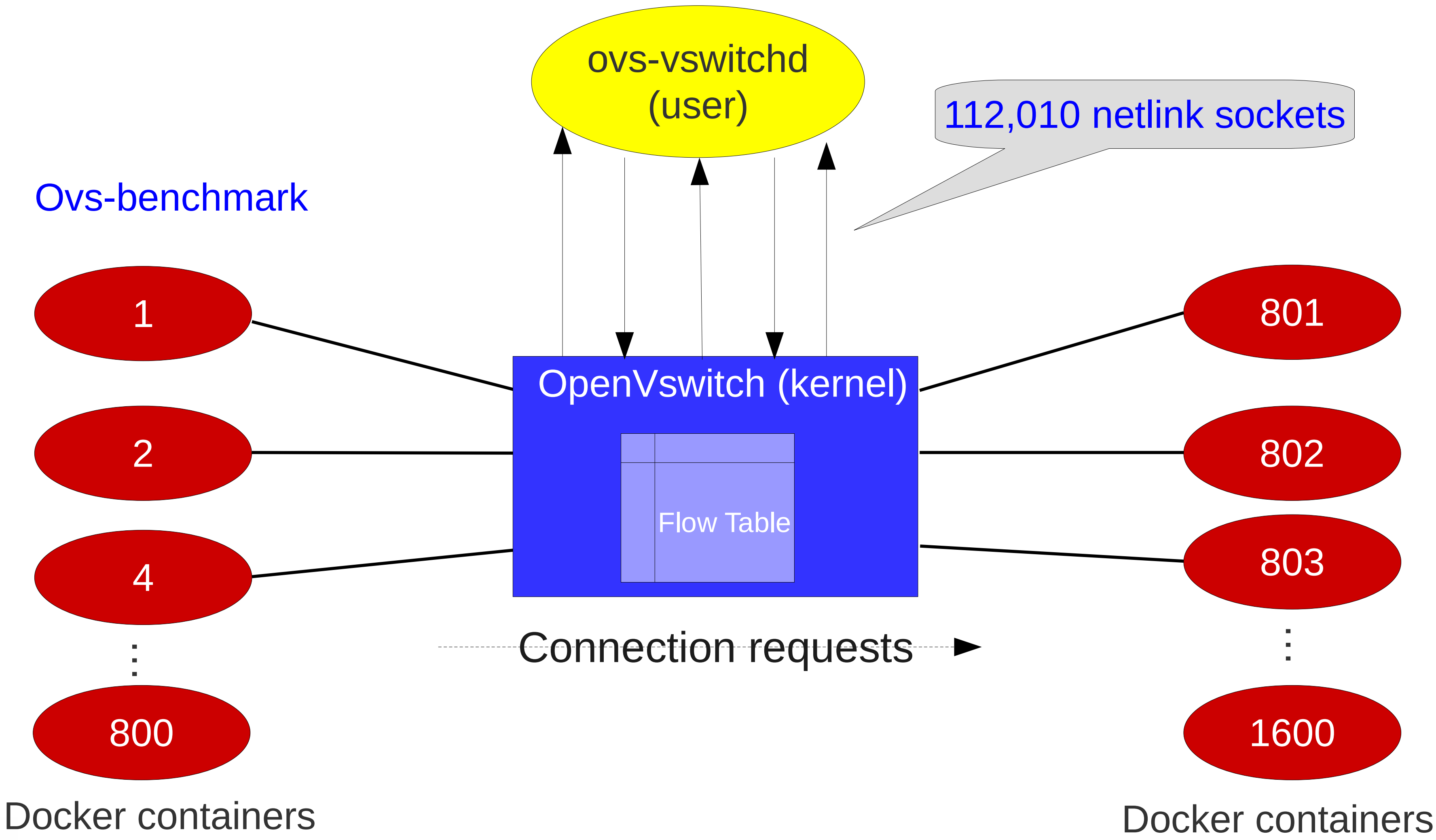
Linux Bridge compared to OpenVswitch



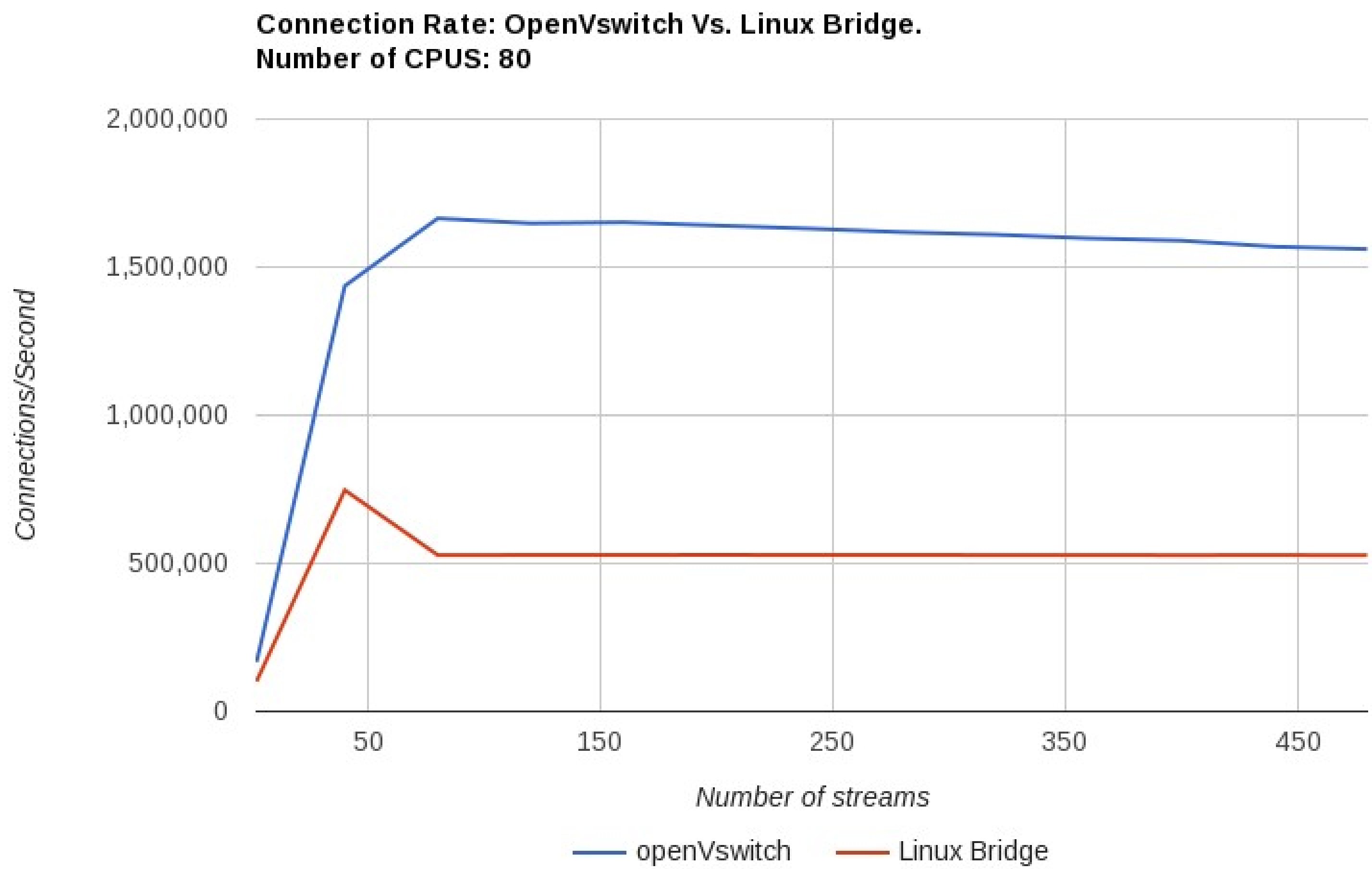
Issues

- Linux Bridge
  - Limited to a maximum of 1024 ports.
  - Linux/net/bridge/br_private.h
    - #define BR_PORT_BITS 10
    - #define BR_PORT_BITS 14 /* (16k ports) */
- OpenVswitch
  - At over 400 streams iperf sporadically failed to establish a connection returning the error "No route to host".

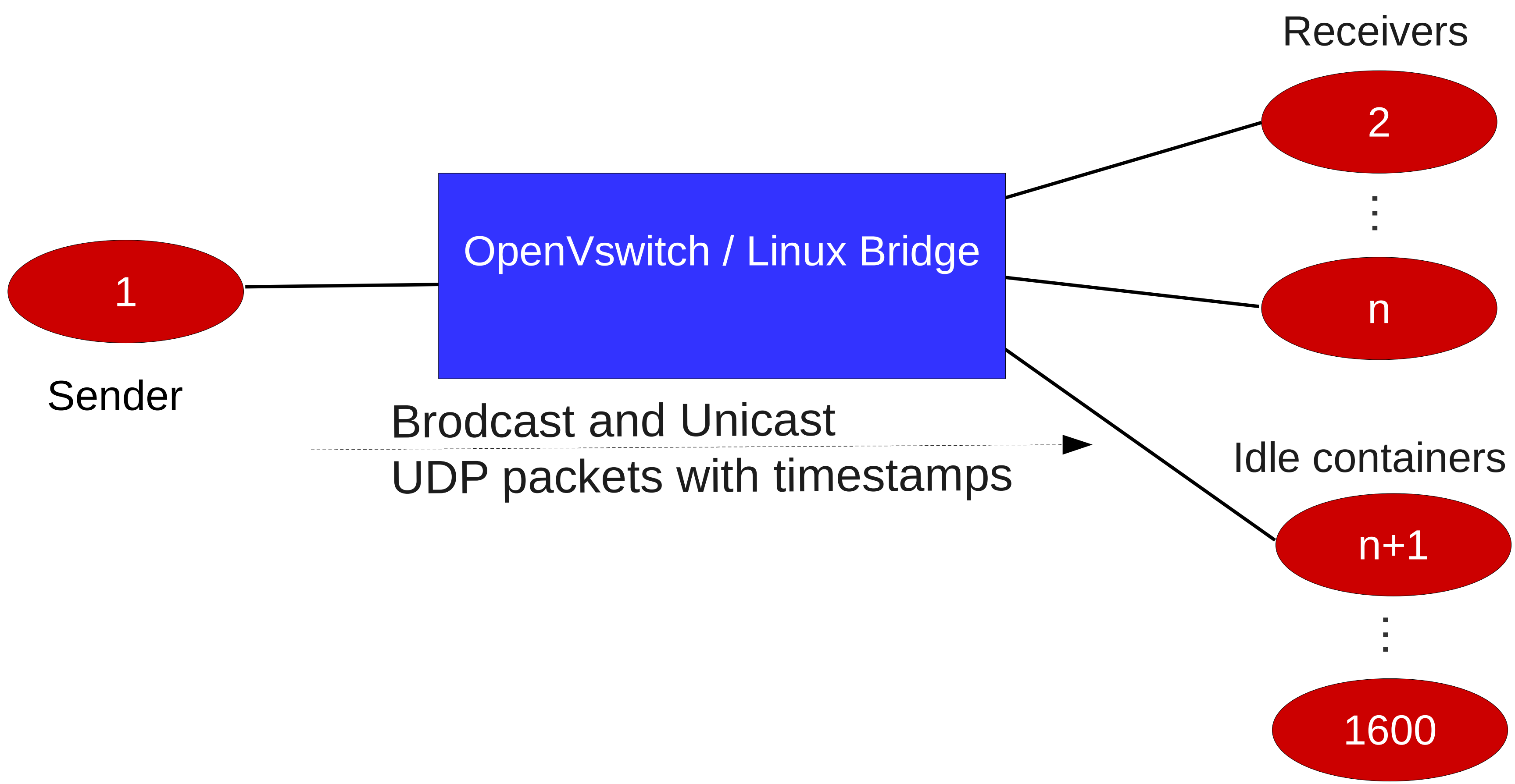
Measuring TCP Connection Rate



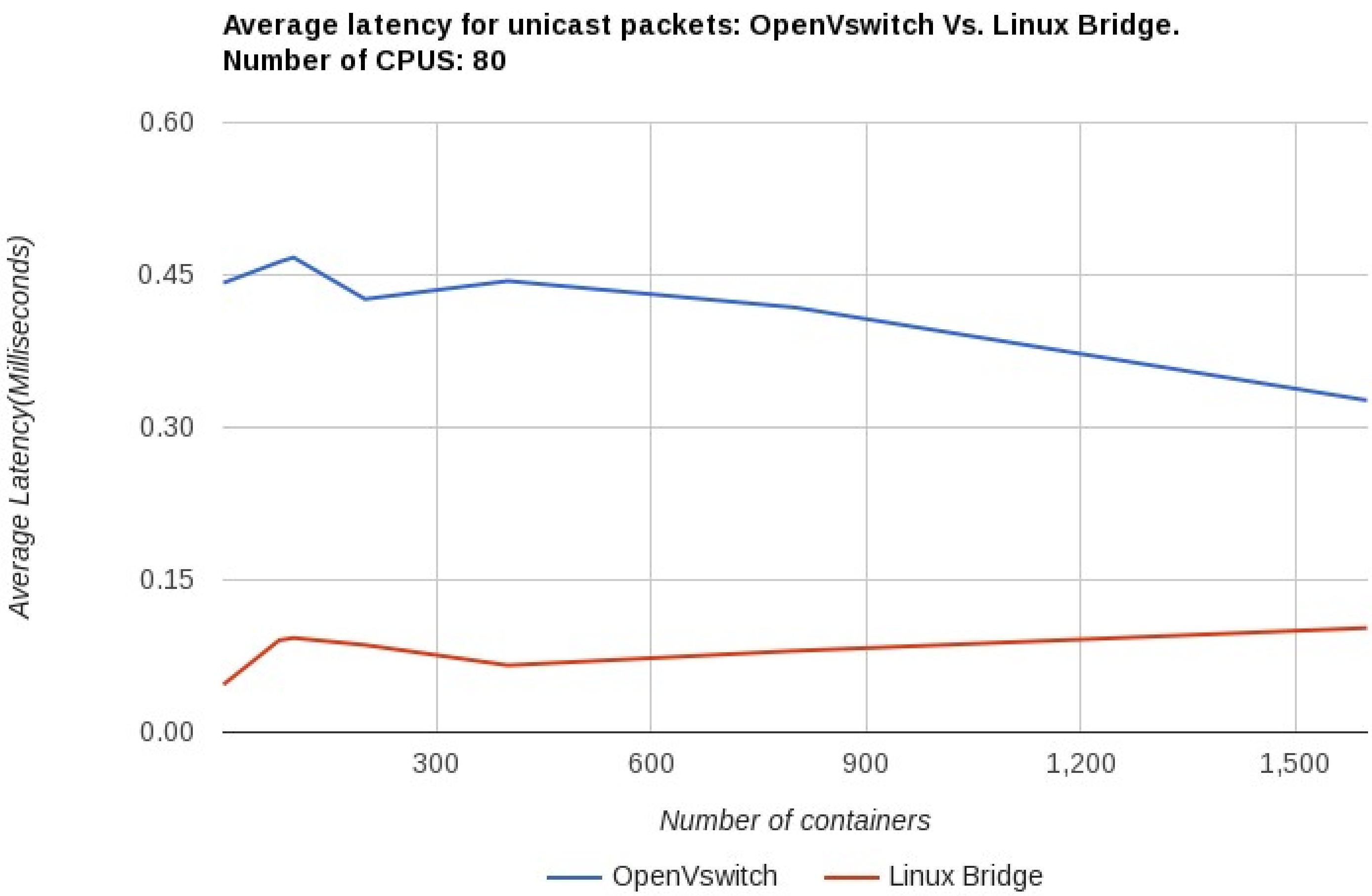
TCP Connection Rate



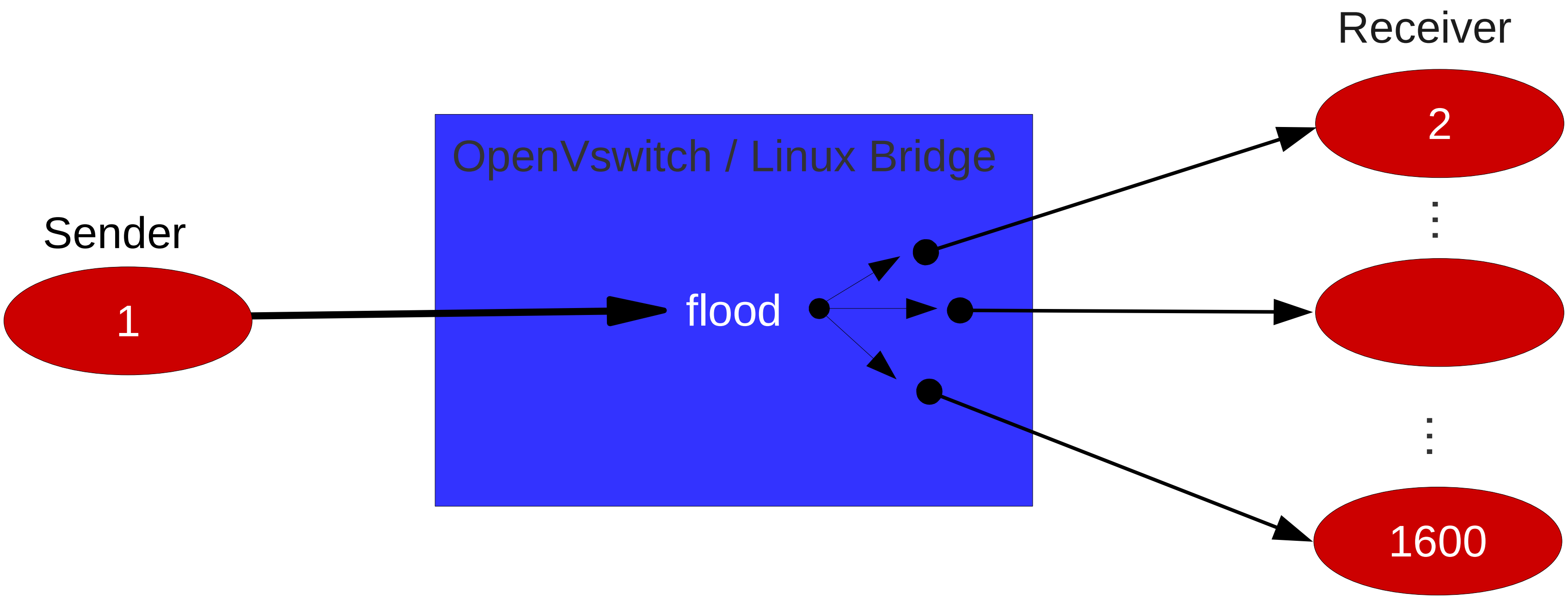
Measuring latency of unicast and brodcast packets.



Unicast Latency

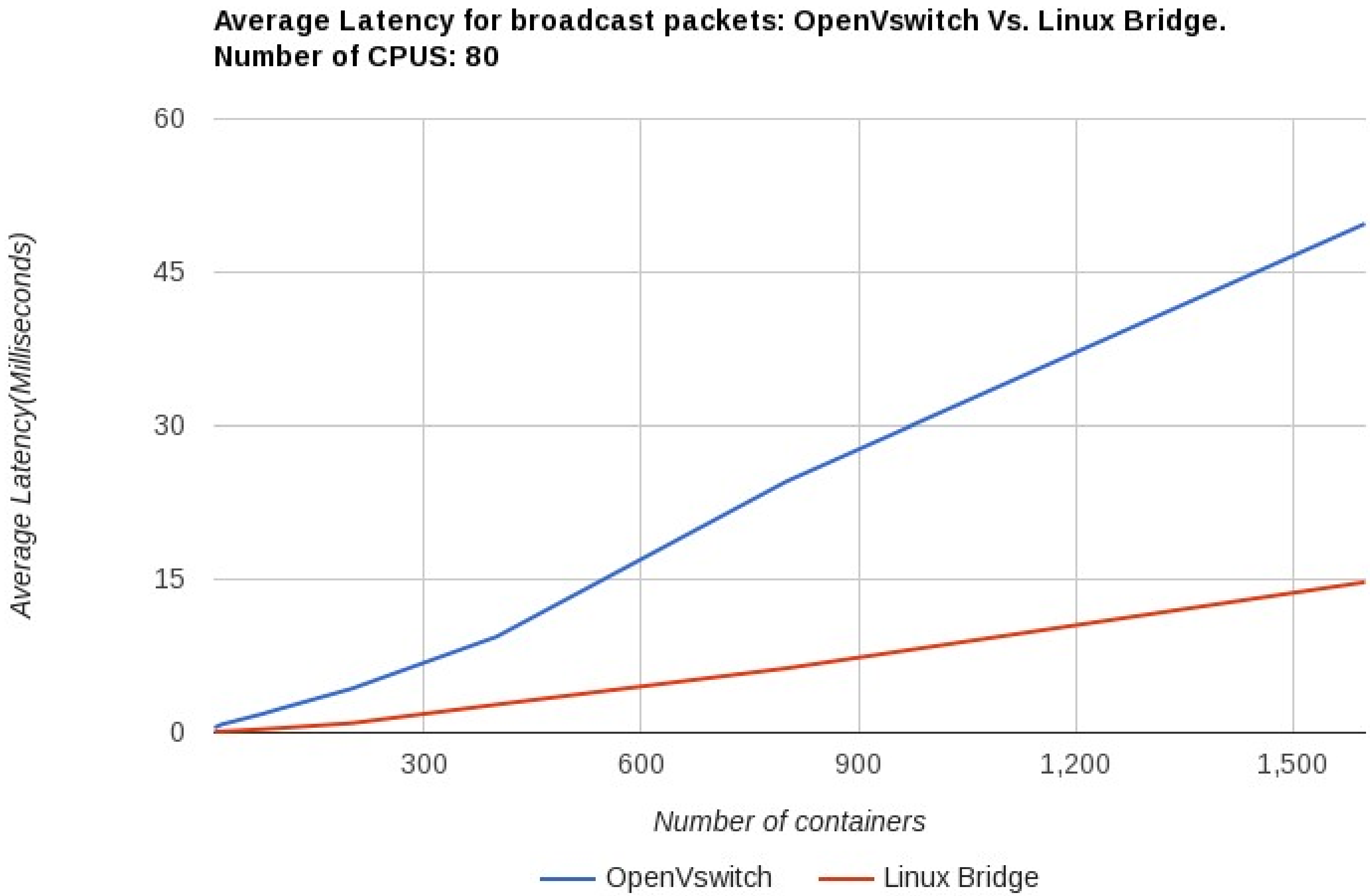


Packet Flooding.

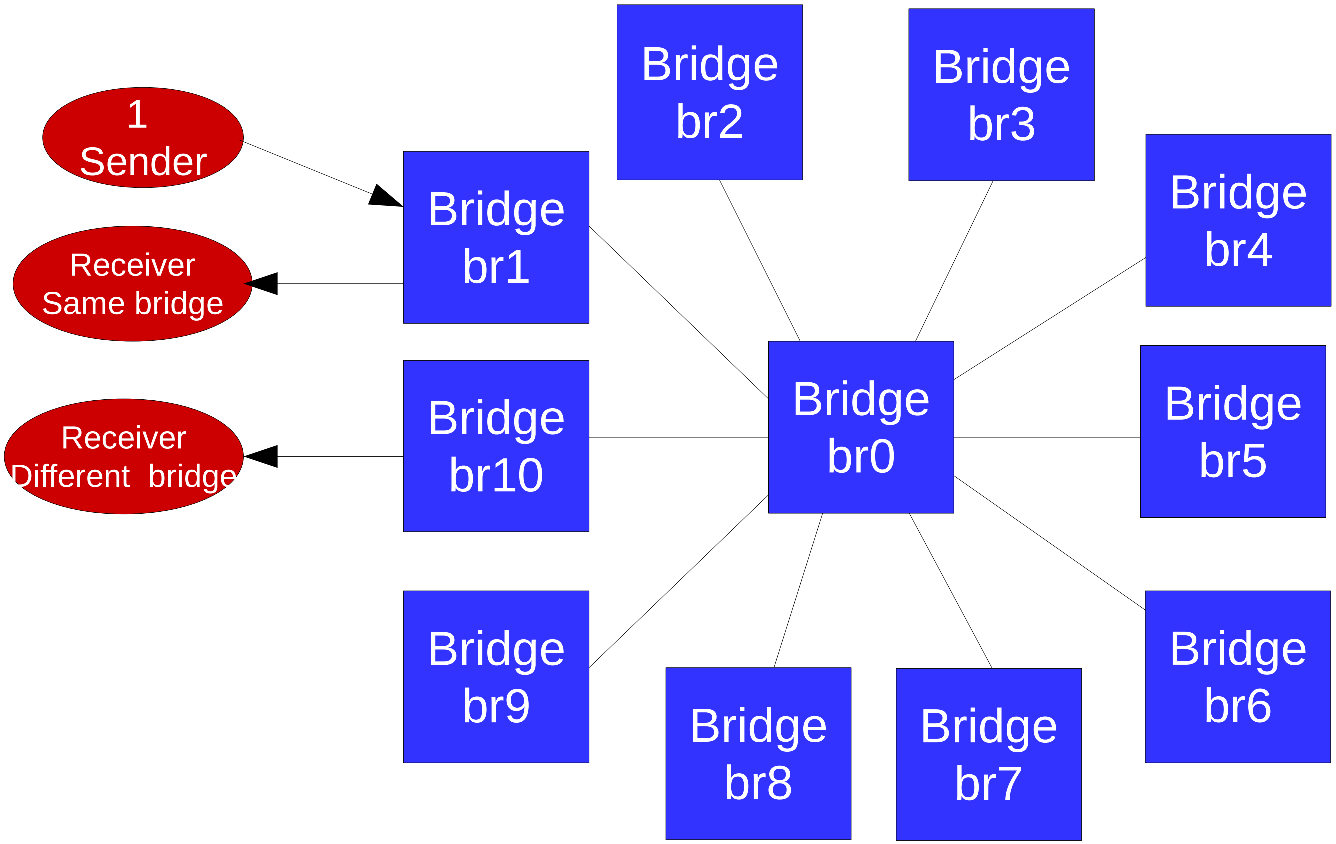


sysctl -w net.core.netdev_max_backlog=10000

Broadcast Packet Latency

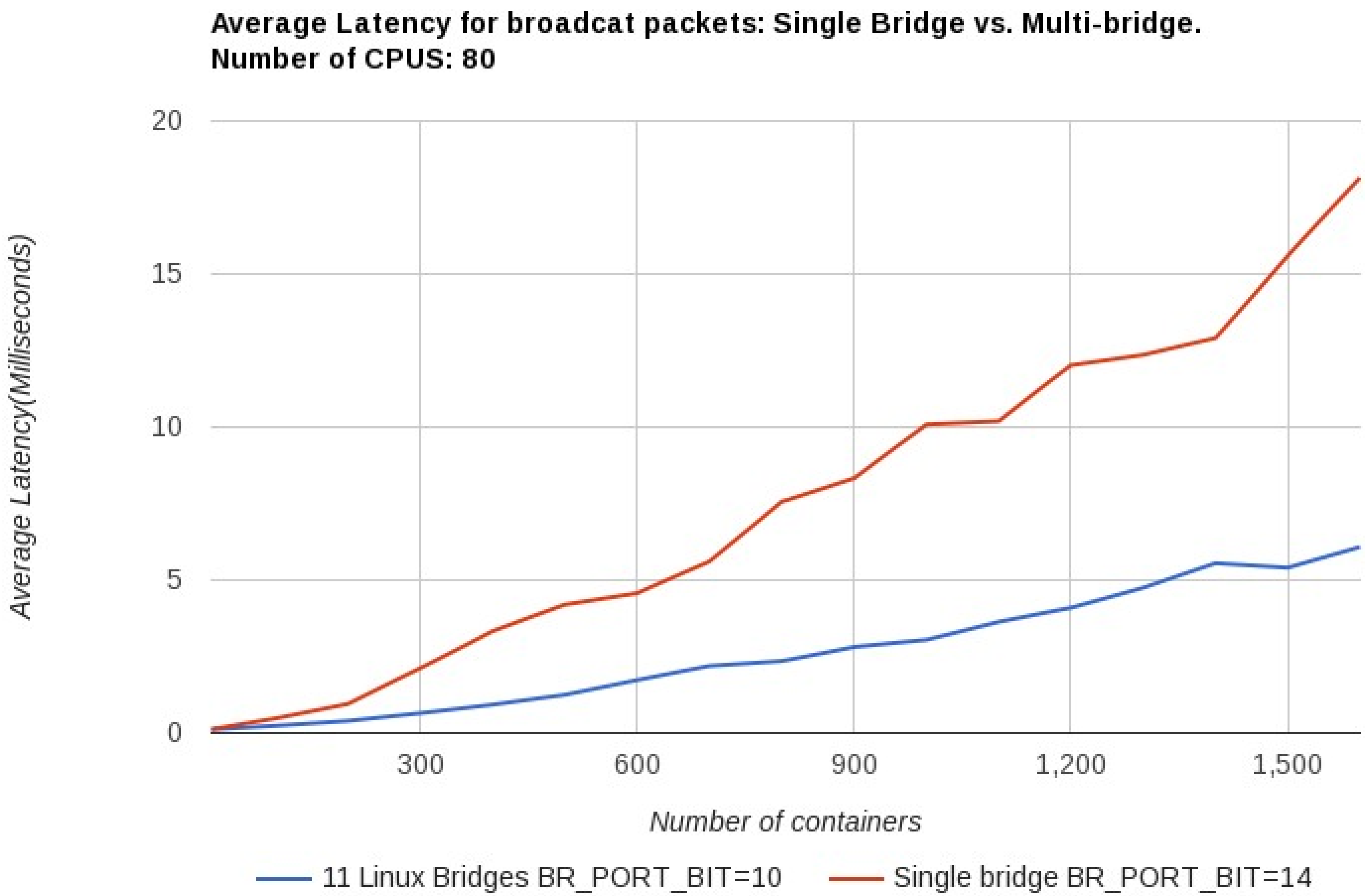


Multiple Bridge Configuration - Eleven Bridges



Up to 1600 Containers were evenly distributed between br1 through br10

Broadcast Latency – single vs. multiple bridges



Tuning

- Prevent broadcast packet loss due to overflowing per-cpu queue:

```
sysctl -w net.core.netdev_max_backlog=10000
```

- Prevent Neighbor (ARP) table overflows

```
sysctl -w net.ipv4.neigh.default.gc_thresh1=1024
sysctl -w net.ipv4.neigh.default.gc_thresh2=2048
sysctl -w net.ipv4.neigh.default.gc_thresh3=4096
```

dmesg: neighbour: arp_cache: neighbor table overflow!

Increasing the nofiles limit for ovs-vswitchd

- Ovs-vswitchd creates many netlink sockets to communicate with the kernel. 112K sockets in our set-up.
- Each netlink socket requires a file descriptor.
- The value of nofiles for the ovs-vswitchd must be at least: (Number of cpus * Number of switch ports).

```
$ prlimit -p \
 `cat /var/run/openvswitch/ovs-vswitchd.pid` \
--nofile=200000
```

In Summary.....

- Throughput becomes a function of CPU (loadaverage).
- Consider how contention for CPU will affect throughput.
- Massive layer 2 domains will have a large broadcast latency.
- I saw a decreased latency when using multiple bridges.

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