
UNIVERSITY OF AMSTERDAM

Container Networking Solutions

Research Project 2

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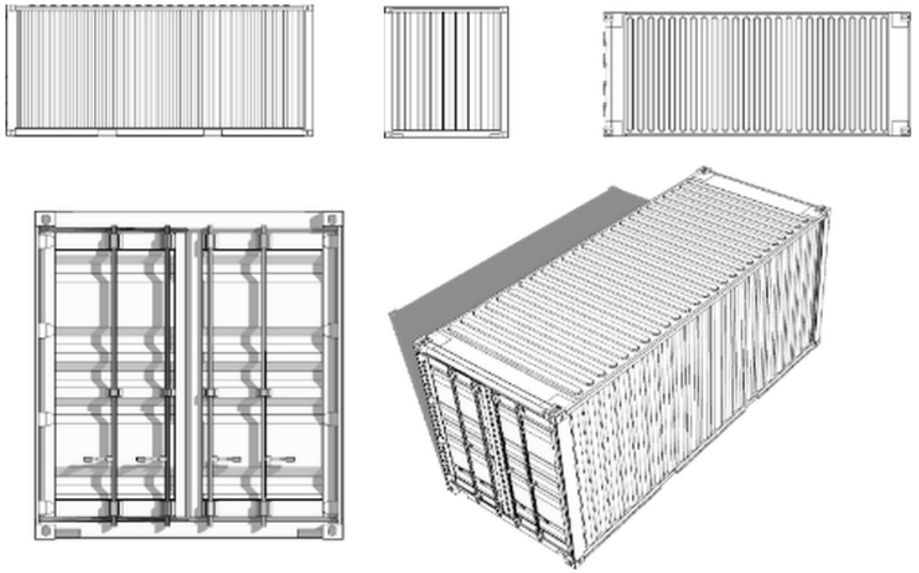
define: "container"

and whats with the buzz?

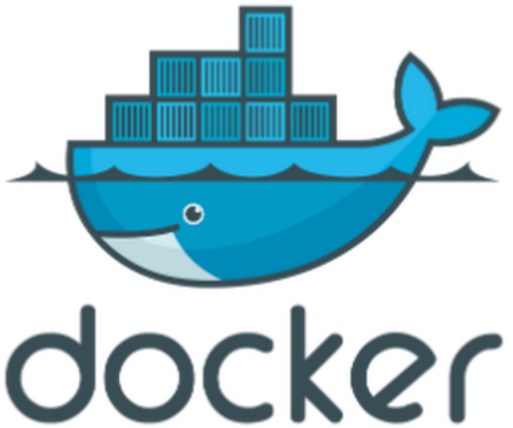
- != Virtual machine
  - Low overhead
  - Scaling
  - Use cases
    - Google
    - Spotify
- Isolation
  - Namespaces
    - NET
    - PID
  - cgroups



docker 101

containers for everyone

- De-facto standard
- LXC wrapper
  - User "friendly"
  - Extra functionality
    - Docker Hub (Repository)
    - Dockerfiles
  - Basic networking built in
- Used in my experiments



SHELL

```
core@node1 ~ $ docker run -ti ubuntu
Unable to find image 'ubuntu:latest' locally
latest: Pulling from ubuntu
428b411c28f0: Pull complete
435050075b3f: Pull complete
9fd3c8c9af32: Pull complete
6d4946999d4f: Already exists
ubuntu:latest: The image you are pulling has been verified.
Important: image verification is a tech preview feature and
should not be relied on to provide security.
Digest: sha256:45e42b43f2ff4850dcf52960ee89c21cda79ec657302d36faa
aa07d880215dd9
Status: Downloaded newer image for ubuntu:latest
root@5f10fb1c1f6c:/# lsb_release -a
No LSB modules are available.
Distributor ID: Ubuntu
Description:    Ubuntu 14.04.2 LTS
Release:        14.04
Codename:       trusty
```

research

container networking solutions

- Overlay networks
  - Literature
- Kernel modules
  - Literature
  - Performance evaluation

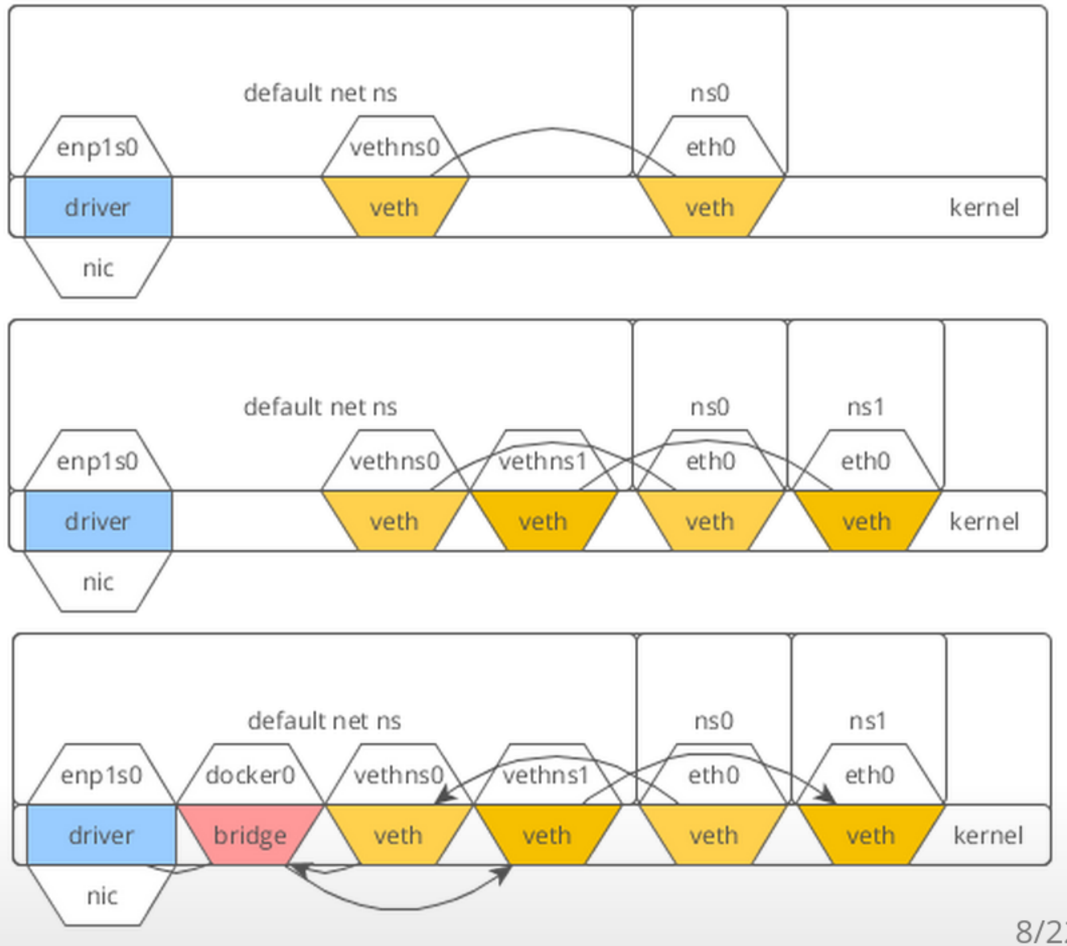
overlay networks

- Weave
  - Router on each node
  - ~30-70% performance hit(!)
- VXLAN
  - VLANs spanning other networks
  - 6-10% overhead on MTU 1500

kernel modules

veth

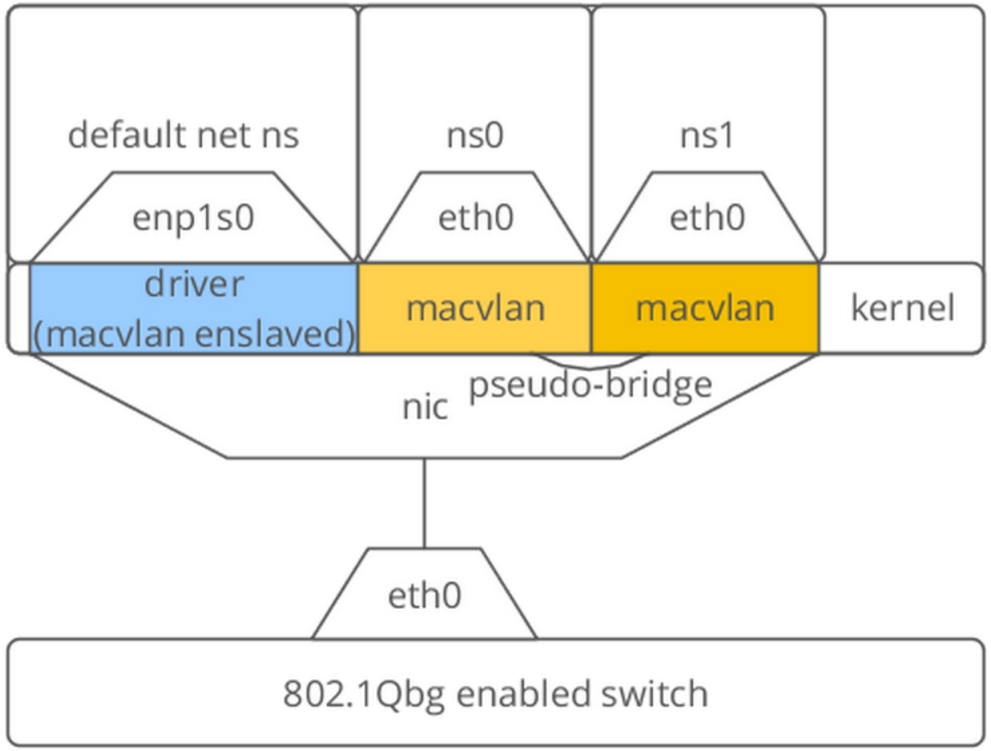
- Connected pair of ethernet devices
- Bridged mode
  - docker0
  - Can perform NAT
- Limitations
  - Efficiency



kernel modules

macvlan

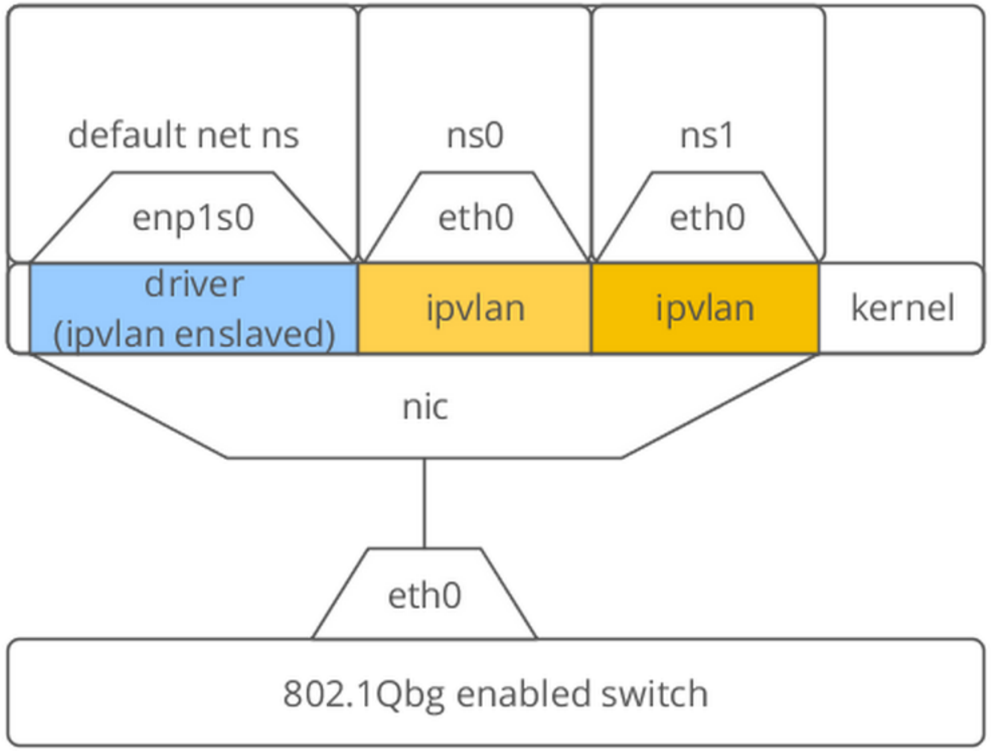
- Modes
  - Private
  - VEPA
  - Bridge
- Limitations
  - MAC access control
  - Promiscuous mode



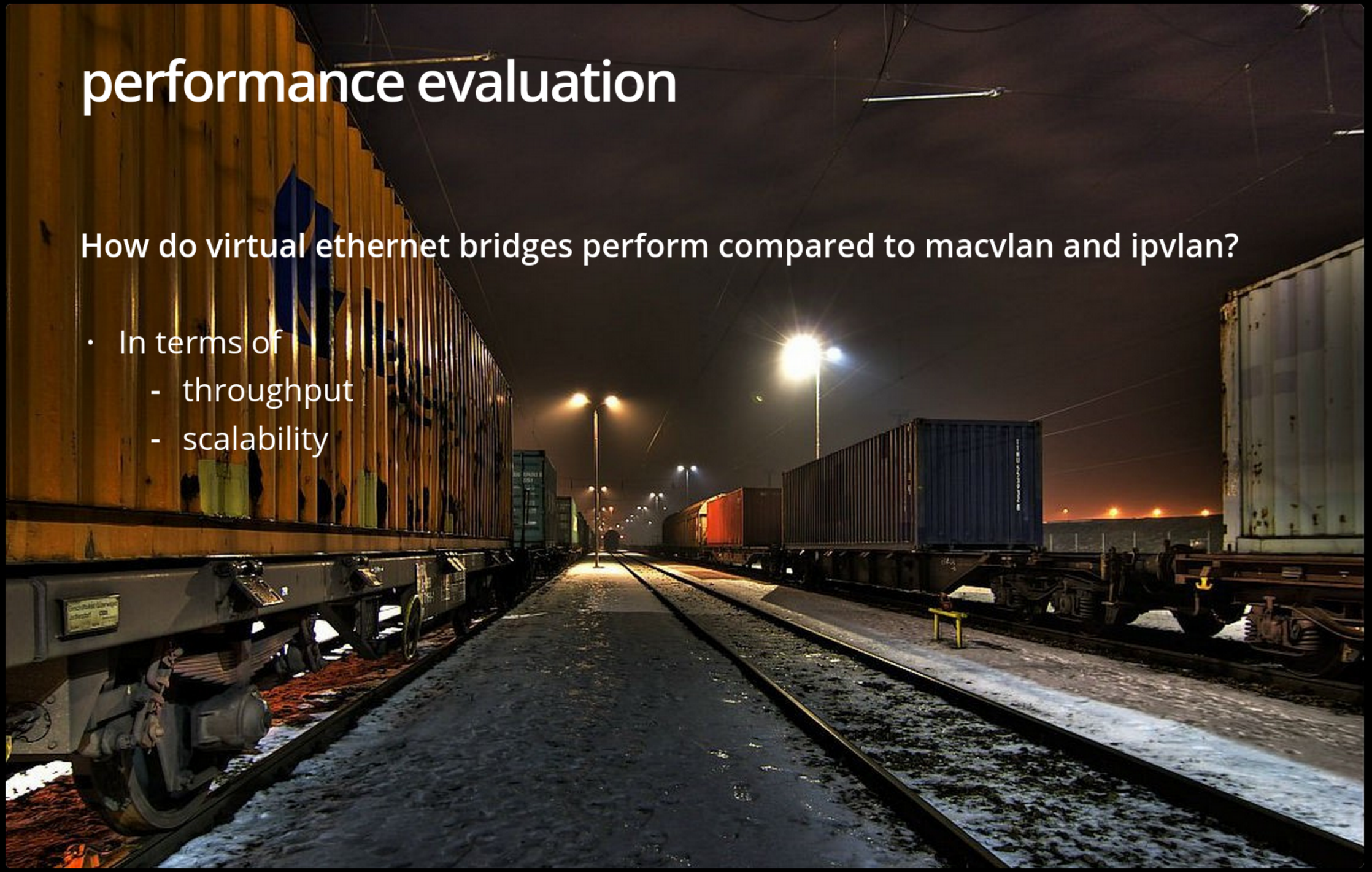
kernel modules

ipvlan

- Modes
  - L2
  - L3
- Limitations
  - Not completely stable
  - Multi- and broadcast support



performance evaluation



How do virtual ethernet bridges perform compared to macvlan and ipvlan?

- In terms of
  - throughput
  - scalability

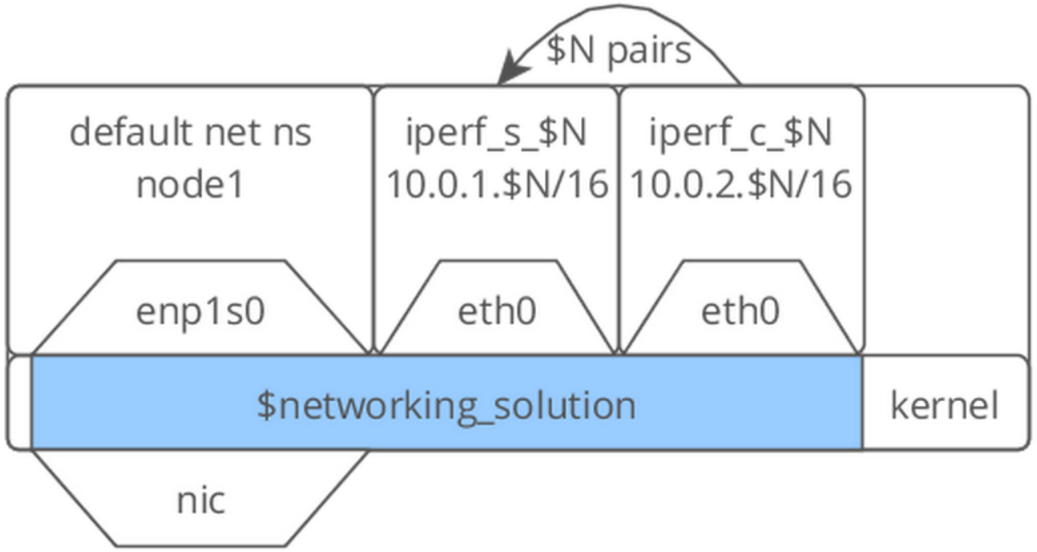
testing

hardware

- Nodes
  - CPU: 2x Intel(R) Xeon(R) CPU E5620 @ 2.40GHz
  - RAM: 24GB DDR3 1600Mhz
  - NIC: 10Gb SFP+
- Switch
  - Dell PowerConnect 6248
  - 10Gbit SFP+ modules

local testing

- iperf3
  - $N of containers exponentially increasing
  - Exponentially decreasing throughput expected

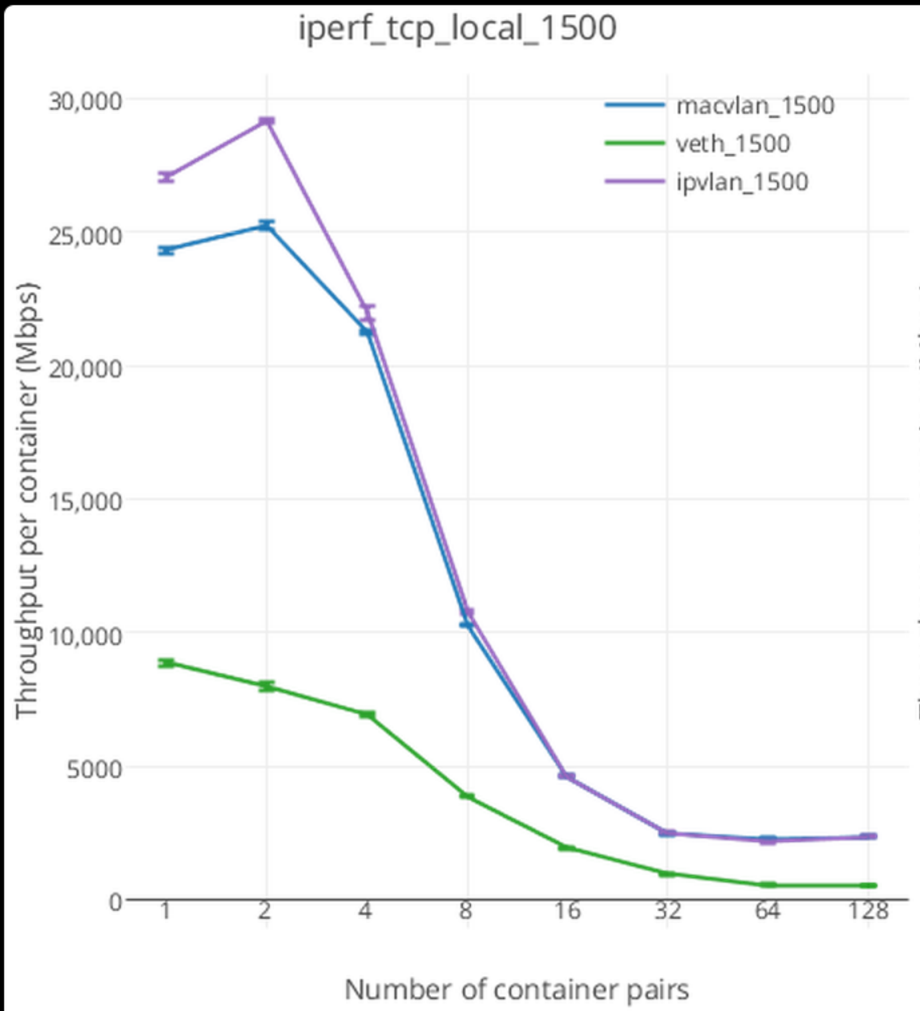


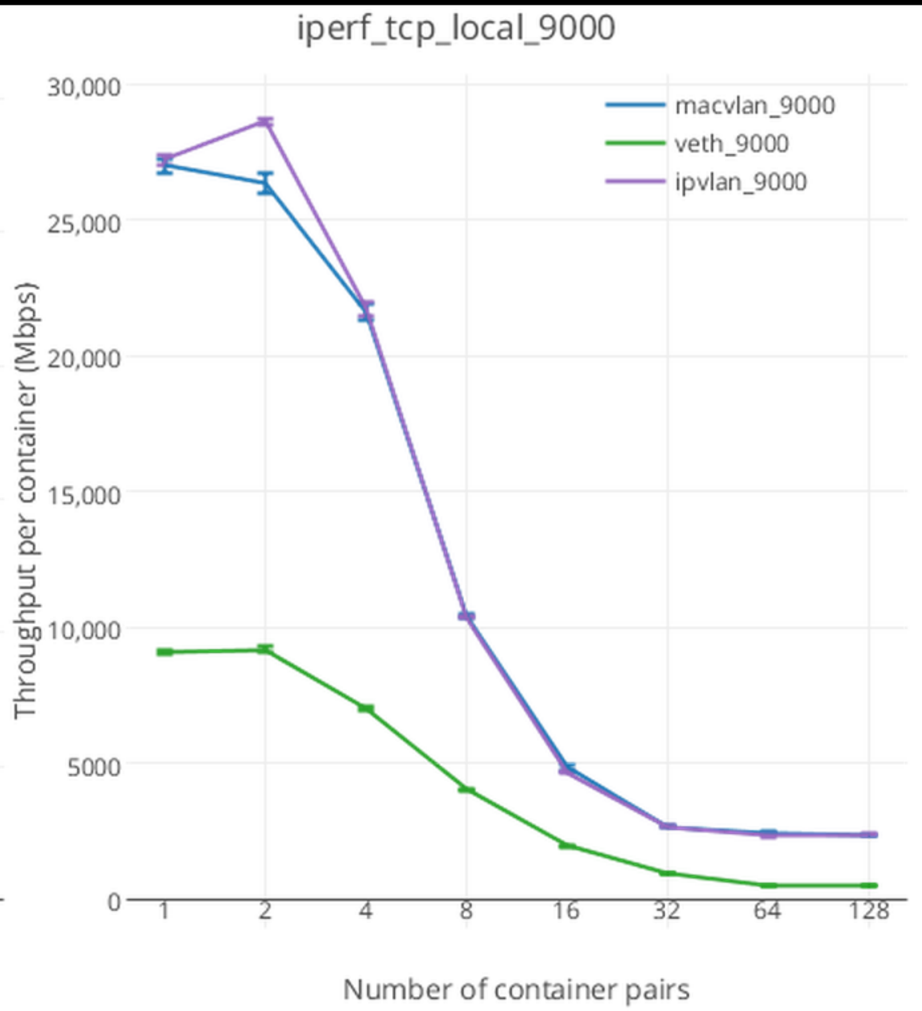
TCP - $N=1,2,4,8,16,32,64,128

UDP - $N=1,2,4,8,16

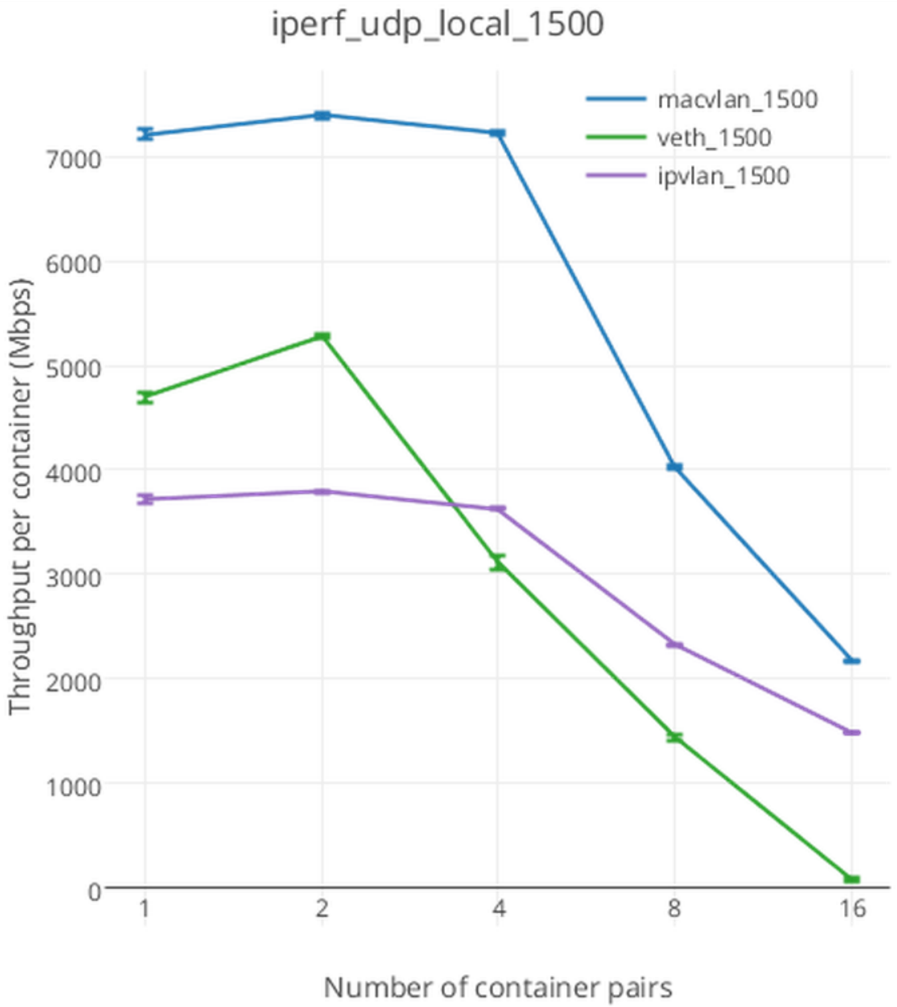
$networking_solution = veth bridge,macvlan (bridged), ipvlan (L3)

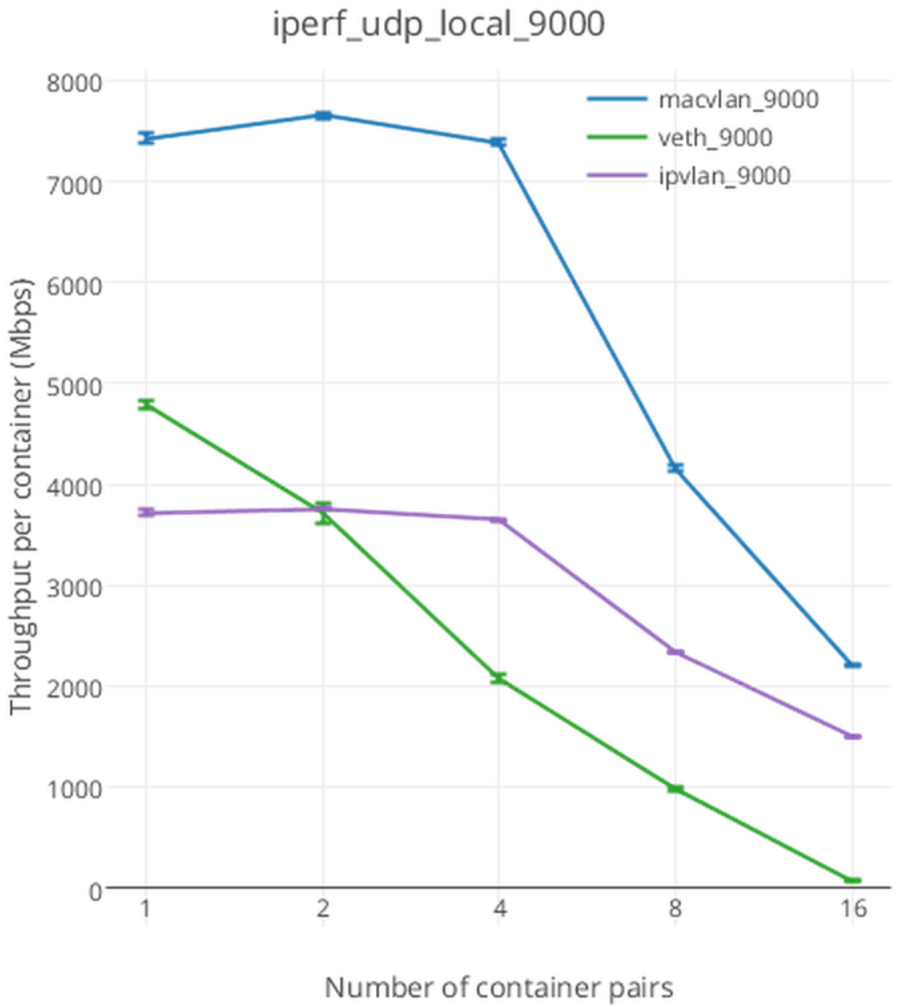
$mtu = 1500, 9000





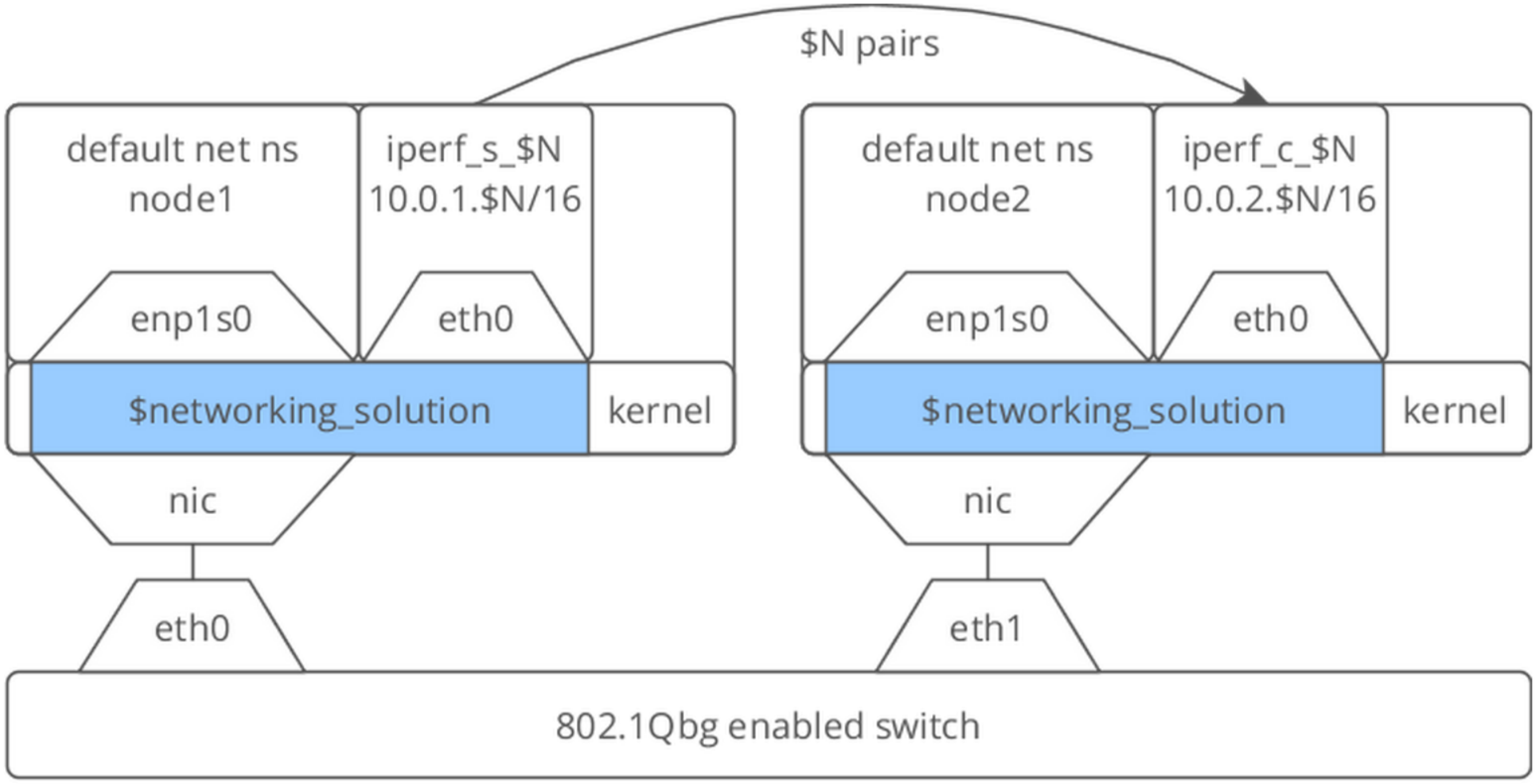
- ipvlan (L3) performs best on all number of containers pairs
  - L3; no broad- or multicast
- macvlan very close second
  - Uses of RAM as pseudo-bridge buffer
- Bridged veth pipes show their speed limitations





- performance difference with TCP
  - hypothesis: udp segment offloading in driver
- macvlan performs best
- veth performs better than ipvlan using 1 to 2 containers

switched testing



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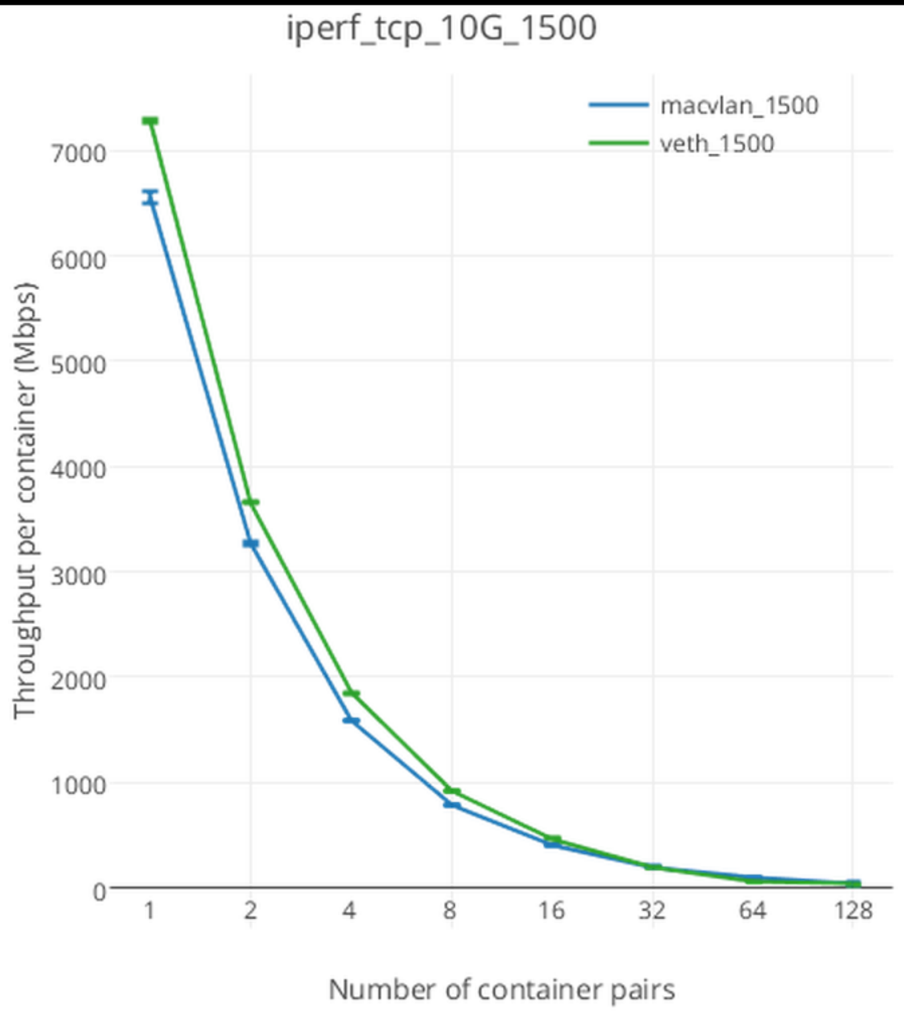
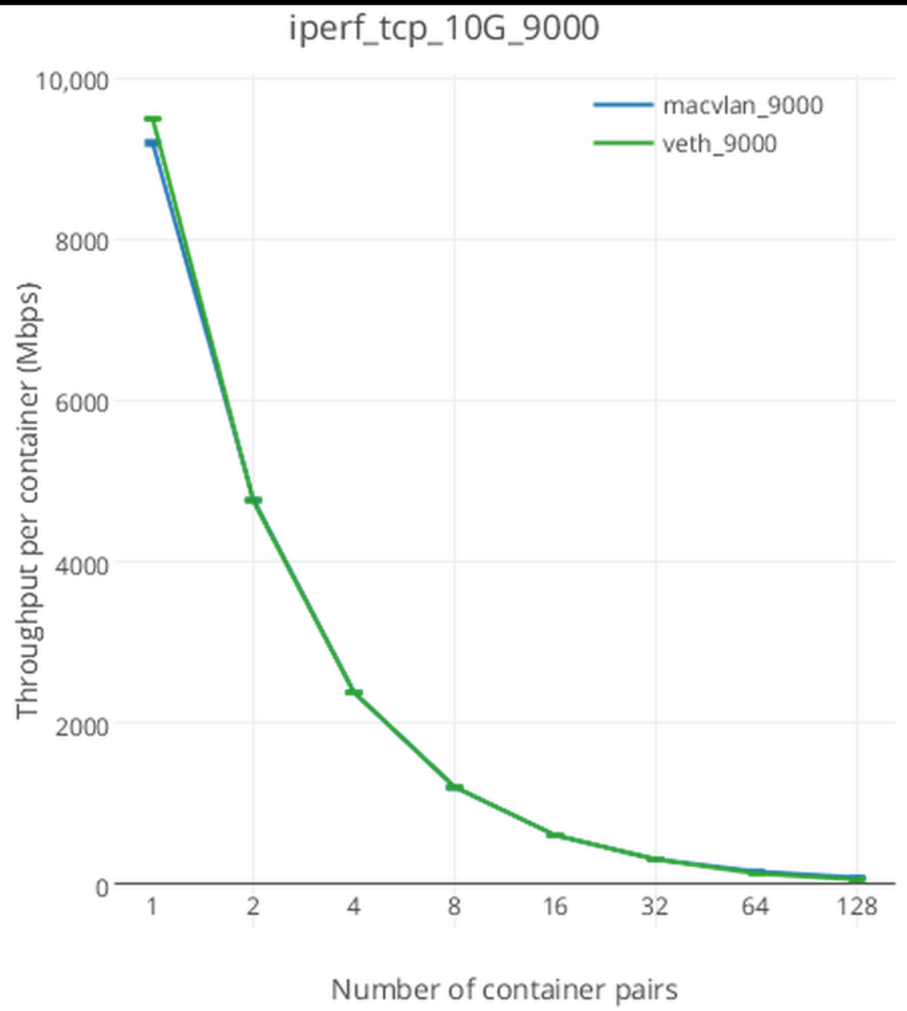
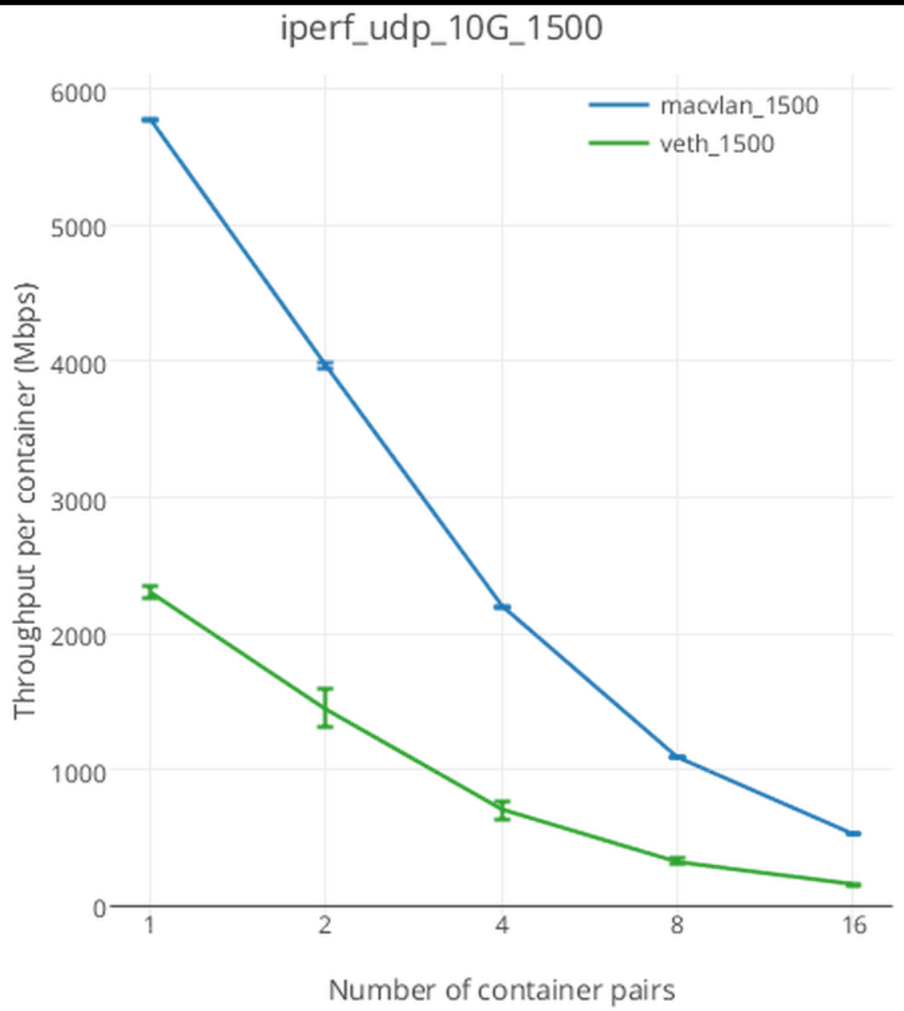
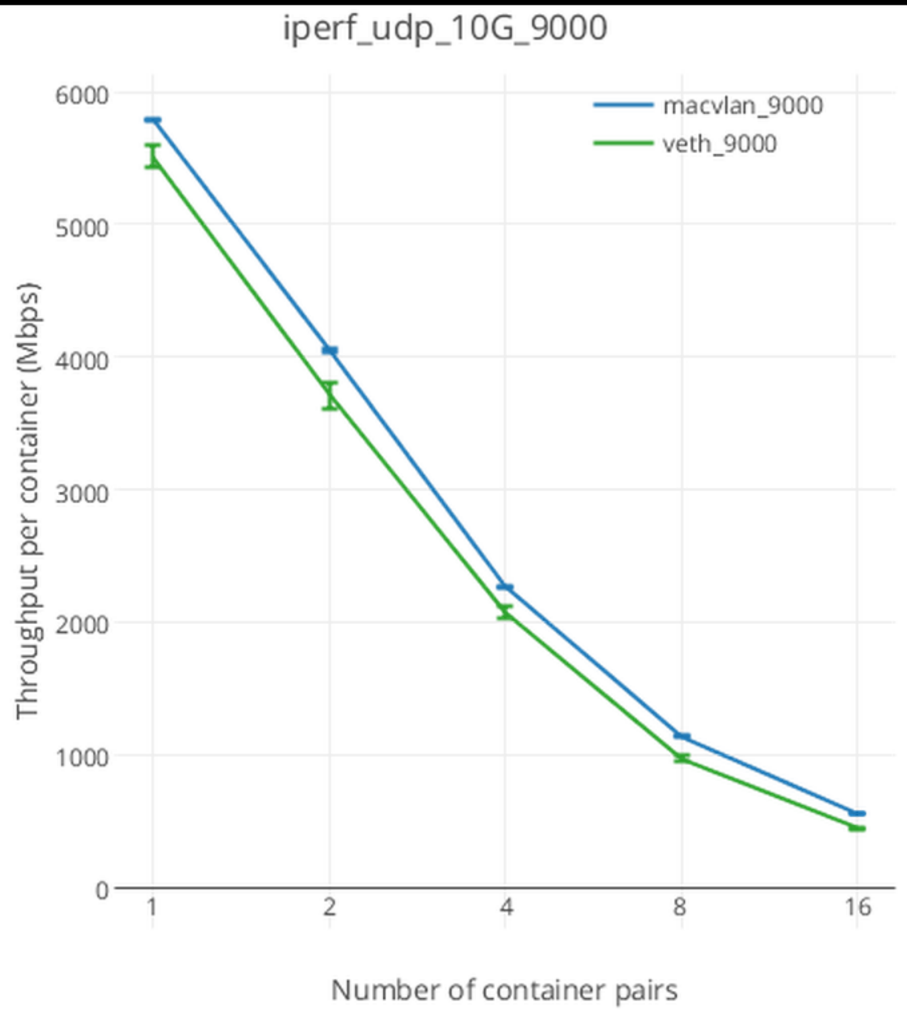




- No clear winner on 10Gbit
- Use what suits the environment





- Low bridged veth performance on MTU 1500
  - CPU bound
- Less frames sent on MTU 9000

conclusion

- Local environment:
  - ipvlan (L3) performs a bit better than macvlan (bridge mode)
    - But is still unstable when networked
  - macvlan (bridge mode) performs ~2.5 times as good as bridged veth
    - And stable as well
    - Namespace has its own MAC address
- Switched environment:
  - veth bridges and macvlan (bridge mode) on par in TCP
  - macvlan uses less CPU than veth bridges
    - Performs better using UDP

future work

- Further look into kernel modules
  - Re-evaluate ipvlan performance
  - Further UDP testing
- Test performance of new overlay networks
  - Socketplane - now Docker
    - Based on Open vSwitch and VXLAN
  - Weave with Open vSwitch backend
    - Still in development

Thank you and enjoy your lunch!

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