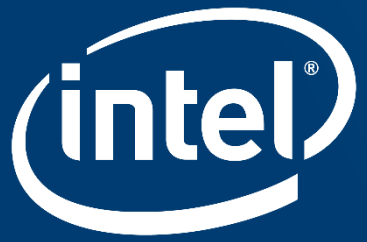

BUILDING A WHITE BOX LOAD BALANCER FOR THE CLOUD DATA CENTER

Open Networking Summit, San Jose, CA

April 2018

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Agenda

Load Balancing Options

Software Based Load Balancers

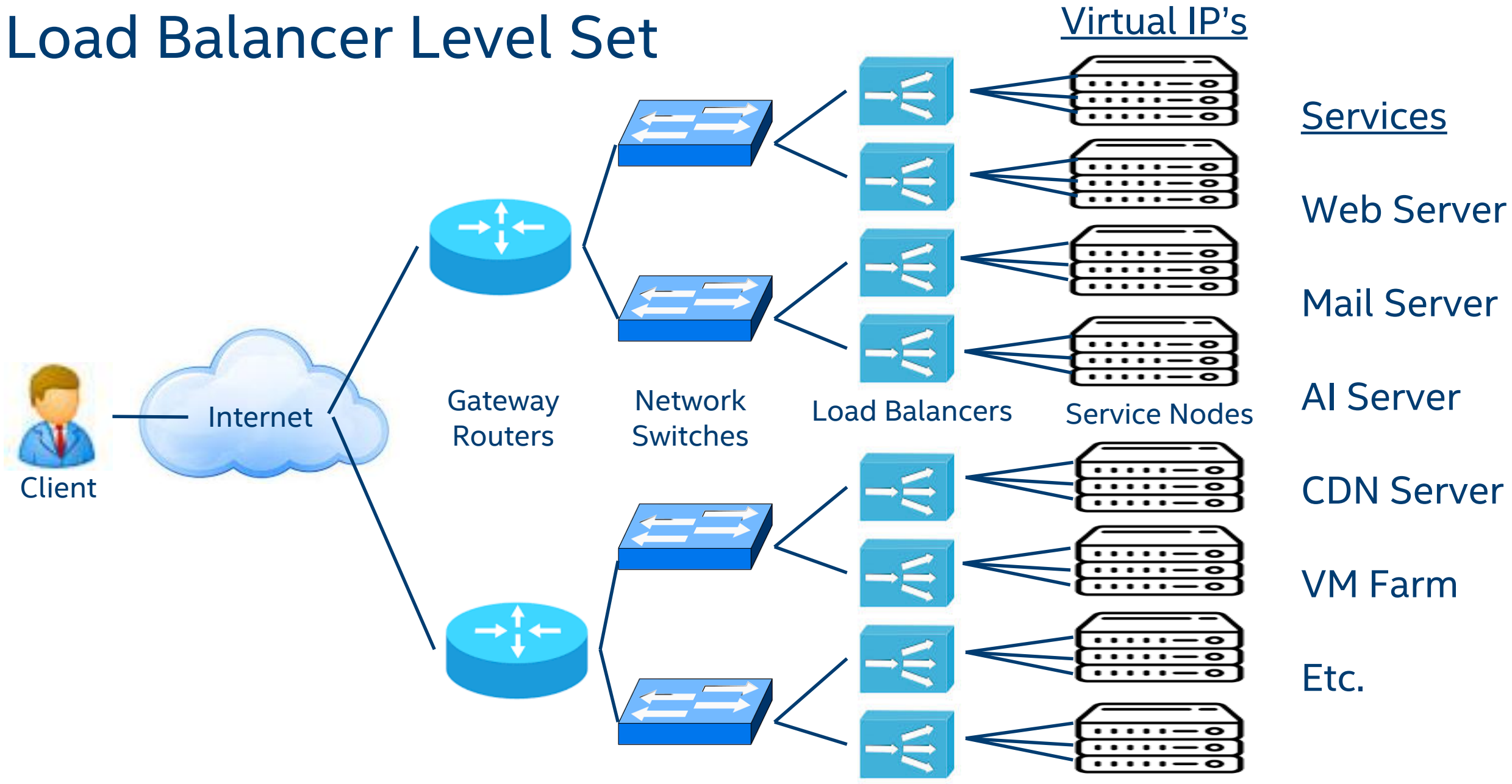
One Open Source Example

Key Performance Optimizations

Demonstration

Call to Action

Load Balancer Level Set



Load Balancer Options

Type	Advantage	Disadvantage	Cost Factors
Proprietary Physical Appliance	• Maximum Throughput • Robust Features	• Long Deployment Window • Static in Nature • Paying for stuff not used	• Large Capital Investment • Licensing and Support • Single Source Solution
Virtualized Proprietary Appliance	• Rapid Deployment • Robust Features	• Cost Increase with Scale • Paying for stuff not used	• Licensing and Support • COTS HW
Open Source Software	• Flexible • Scalable • Build what you need	• Limited Functionality	• Engineering • In House Support • COTS HW

Software Load Balancer Examples

Envoy

Maglev

Elastic Load Balancer

Jupiter

Katran

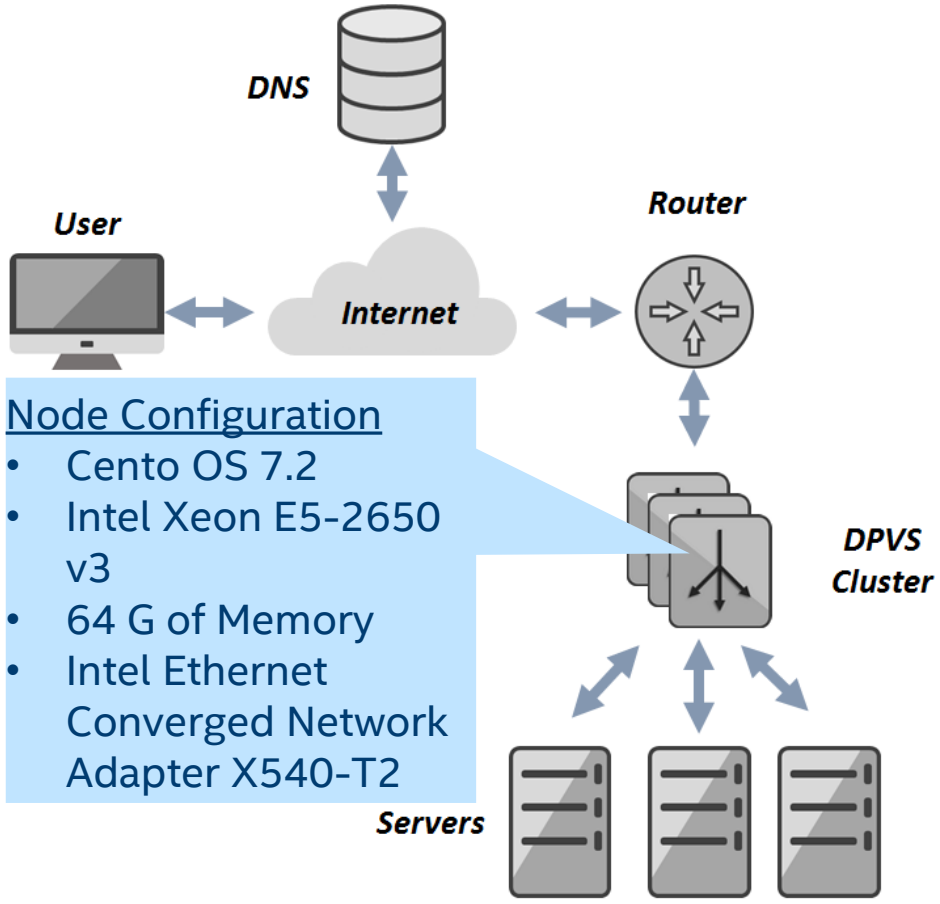
Load Balancer

FD.io VPP L3DSR

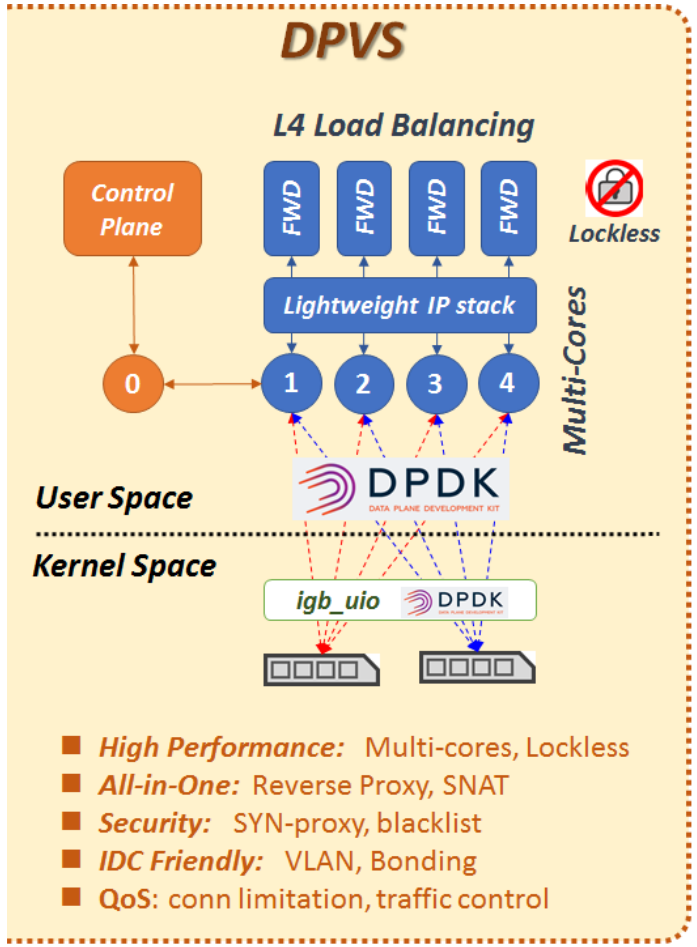
DPVS

Server Load Balancer

One Open Source Software Load Balancer



Node Configuration
- Cento OS 7.2
- Intel Xeon E5-2650 v3
- 64 G of Memory
- Intel Ethernet Converged Network Adapter X540-T2

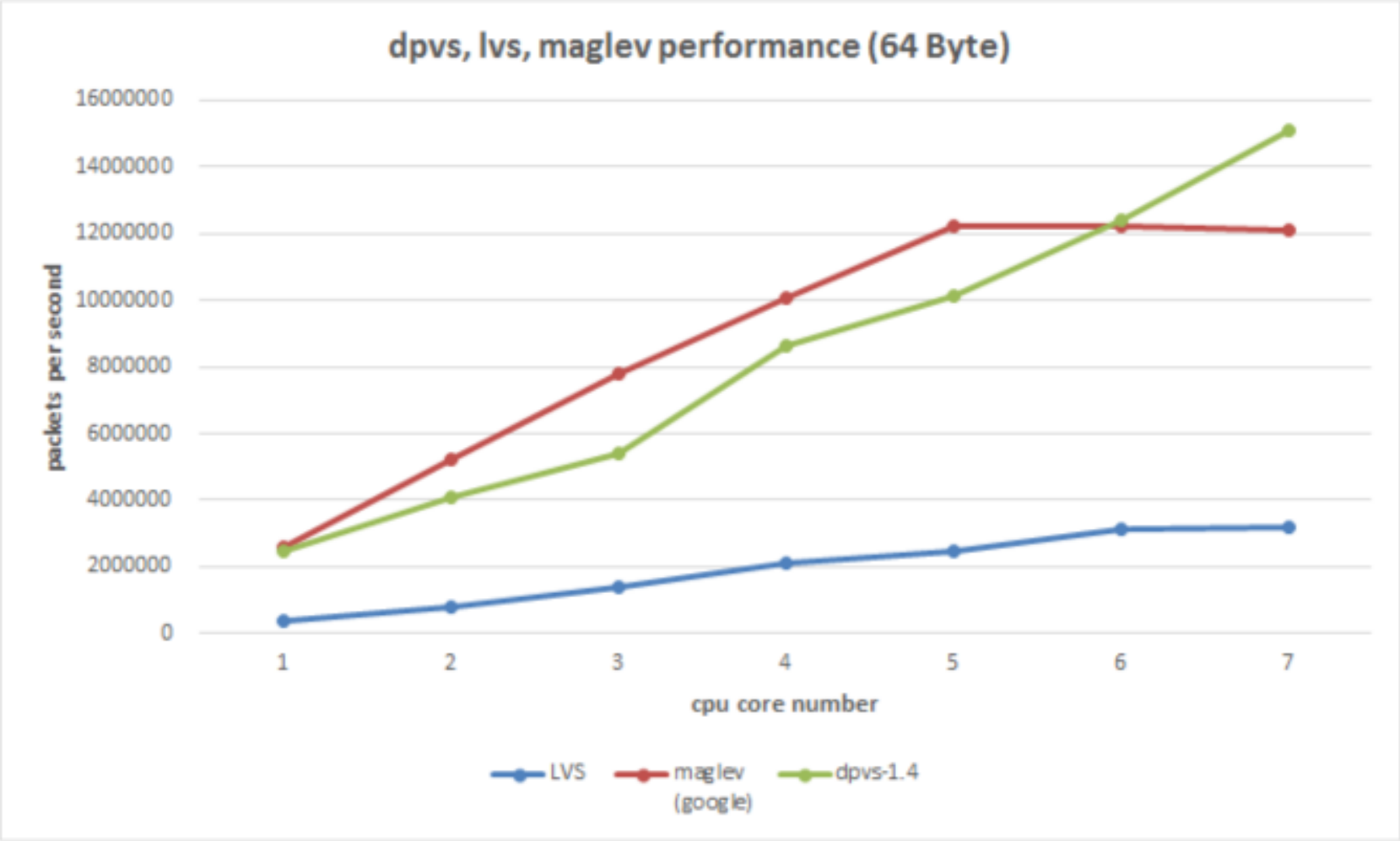


Benefits

- Consistent Hashing
- Connection tracking
- NIC Queue & CPU Bonding
- Must rapidly scale
- Equal Cost Multi-Path Routing
- Kernel Bypass using DPDK

https://github.com/**iqiyi/dpvs**

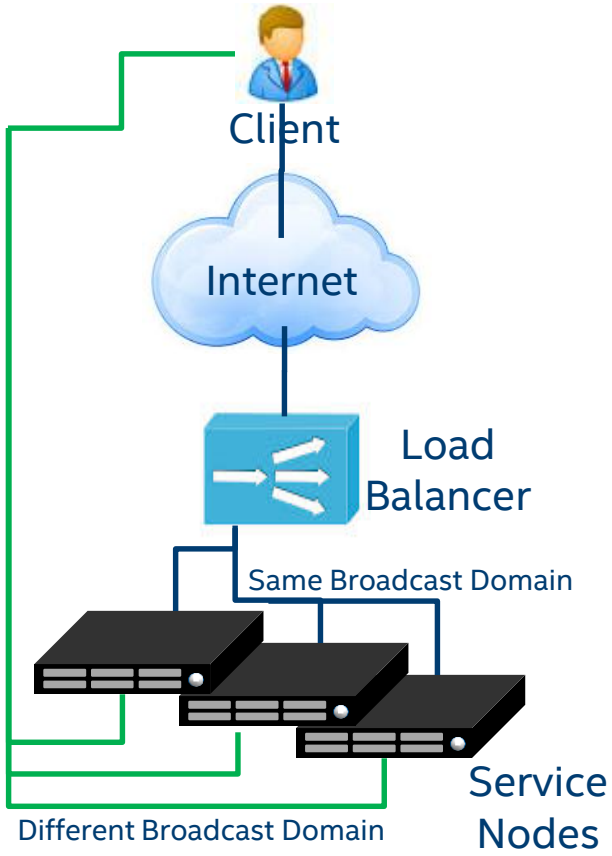
DPVS Performance



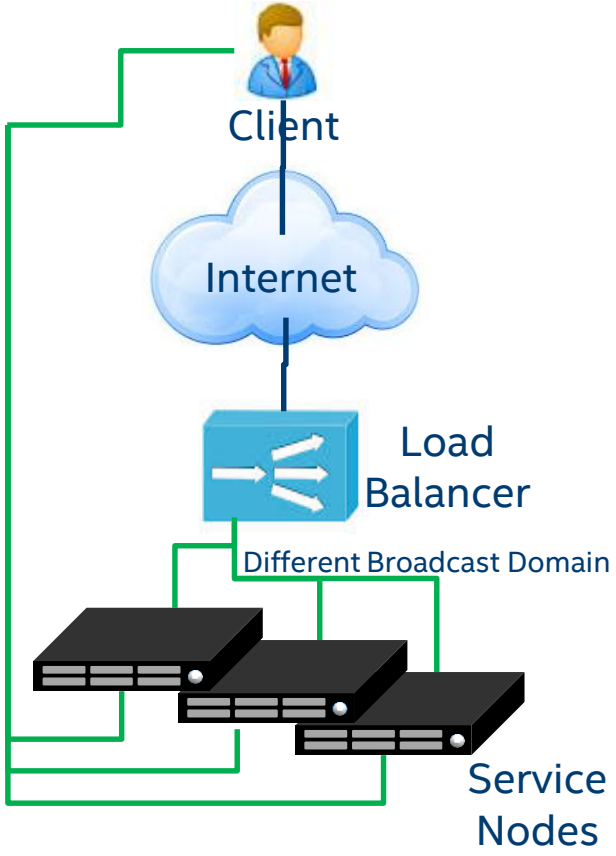
Source: https://github.com/**iqiyi/dpvs**

Three Modes of Operation

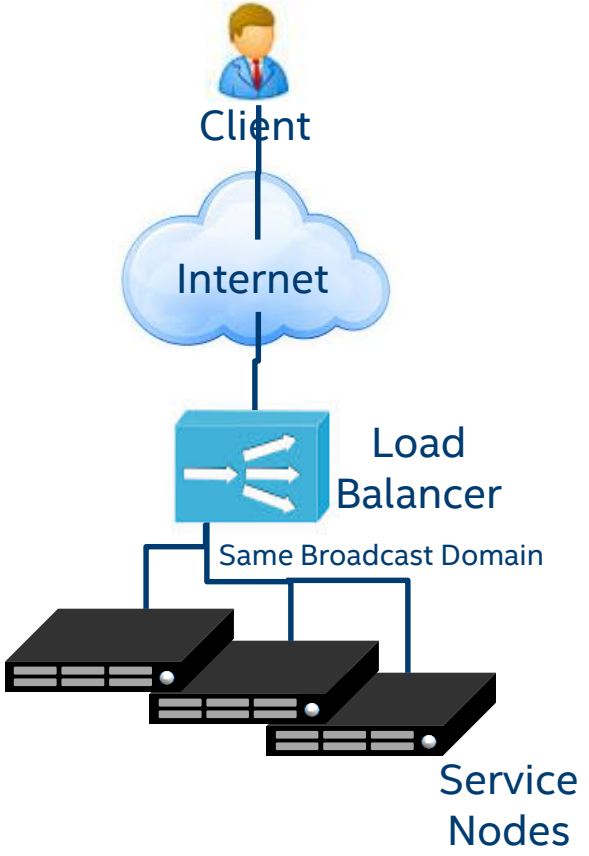
Direct Response



Tunnel



Full NAT



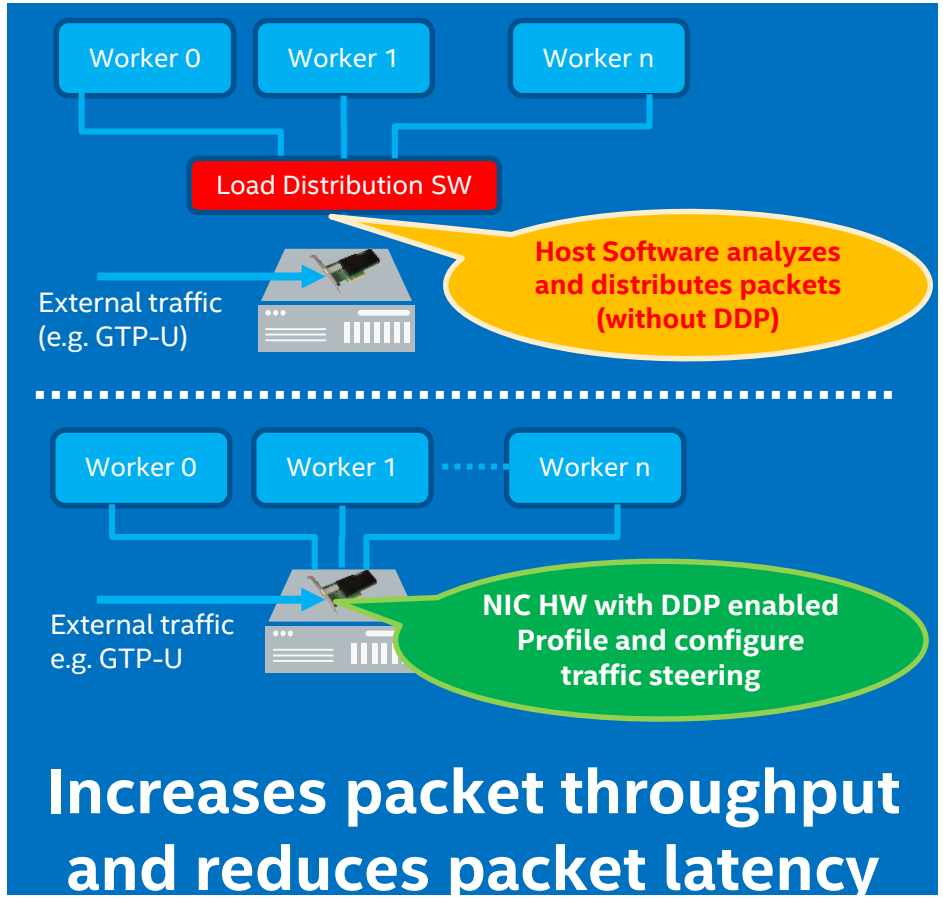
Performance Optimization

Intel Ethernet Adapters

- Dynamic Device Personalization
- Intel® Ethernet Flow Director
  - Advanced Traffic Steering

DPDK Network Acceleration

- Kernel bypass
  - Faster interface with the kernel net stack
  - Polling instead of interrupts
  - Facilitates using standard Linux* userspace net tools (tcpdump, ftp, and so on)
  - Eliminate the copy_to_user and copy_from_user operations



Demo Choices

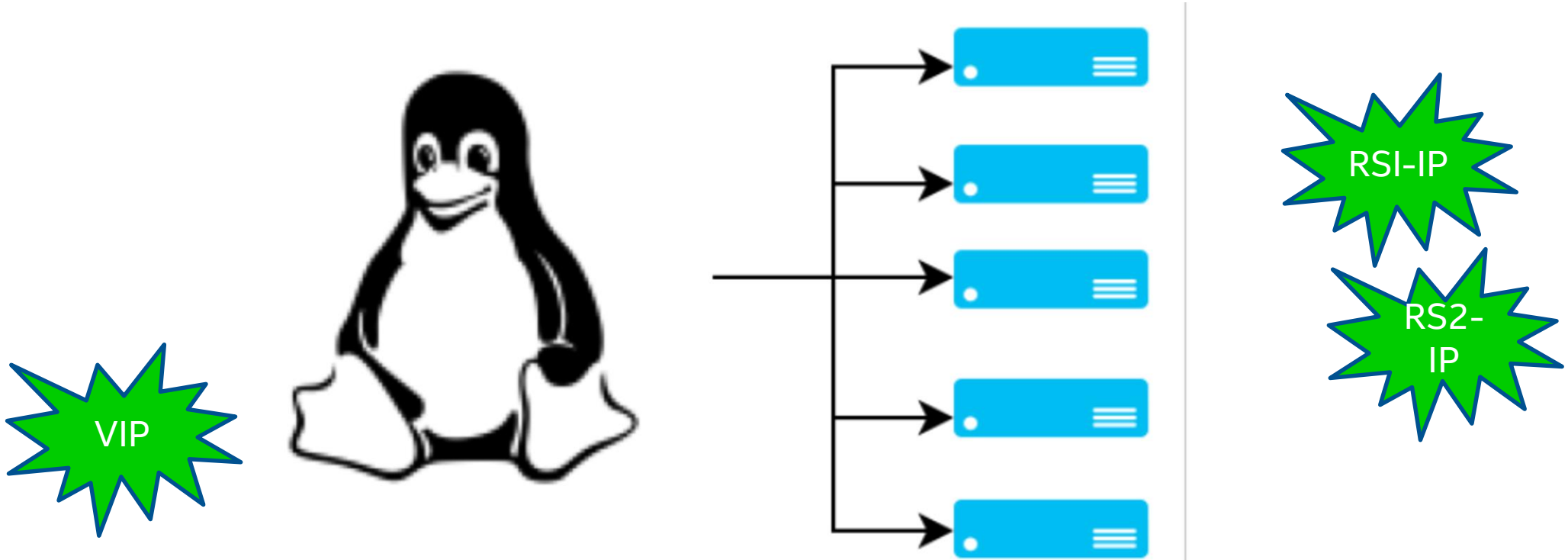
Full NAT Versus Direct Response?

Kernel Network Interface (KNI)?

Why to have man in the middle (Load Balancer) ?

Key Configuration for Demo

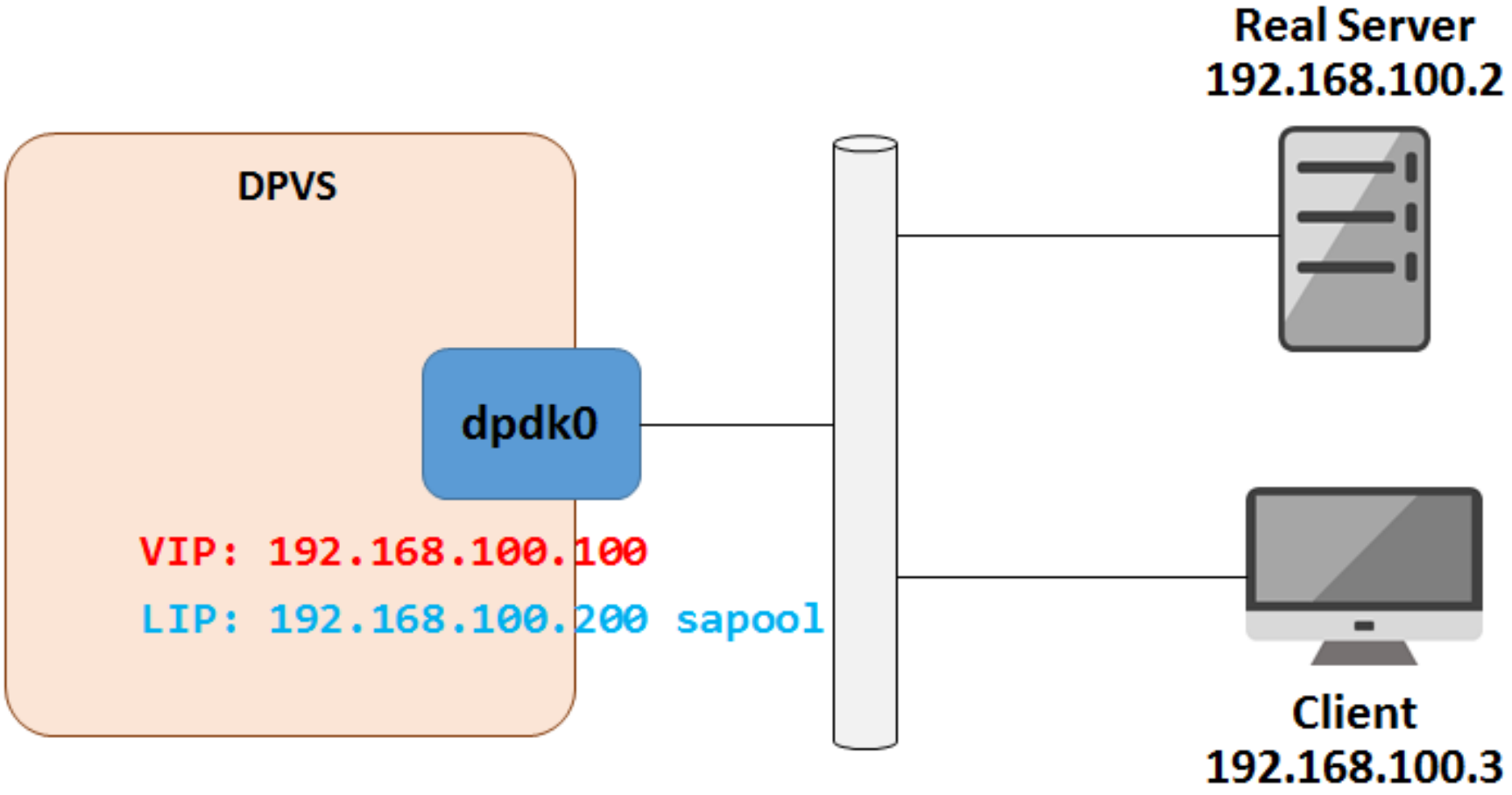
L4 Load Balancer –Full NAT



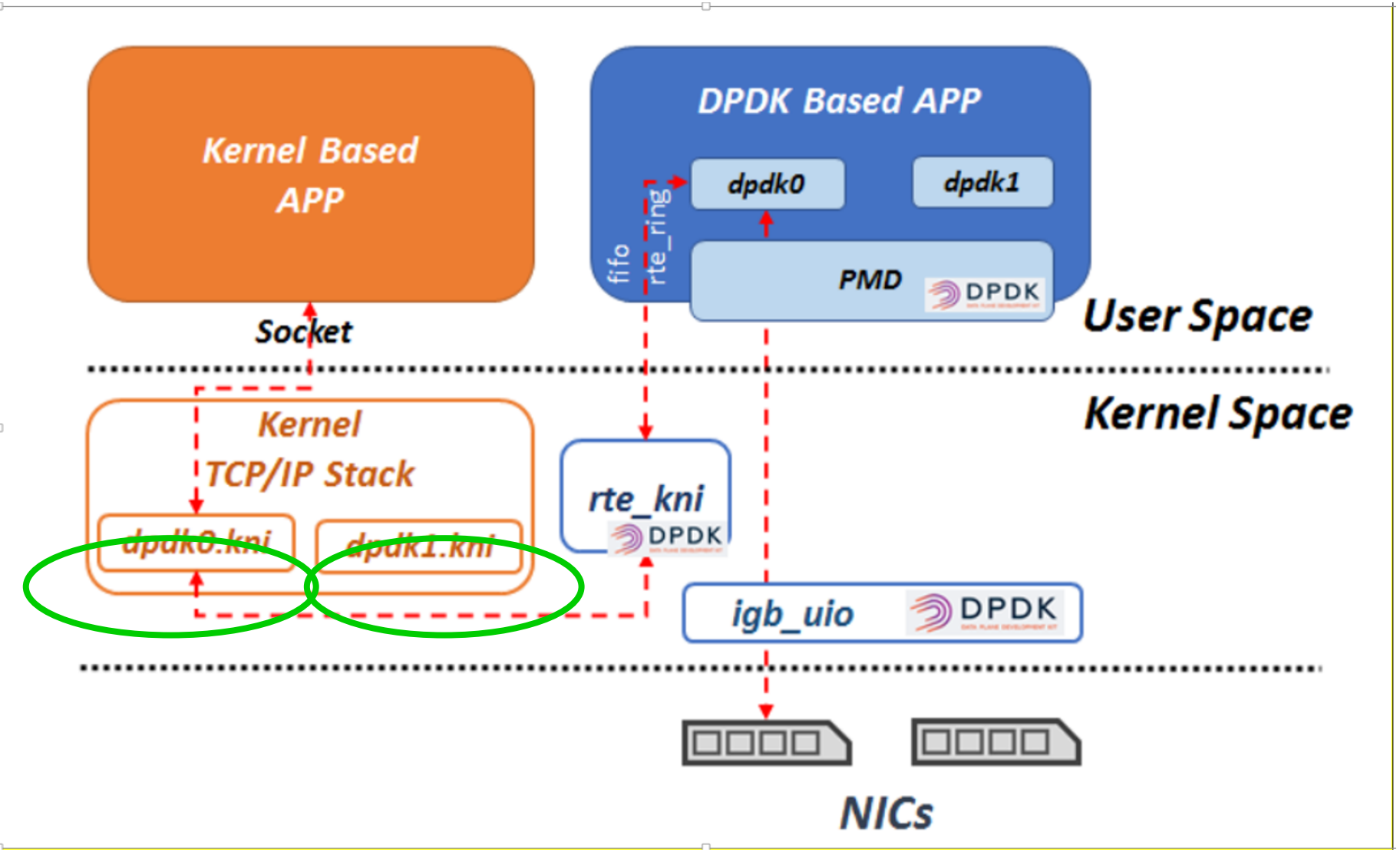
VIP – “Virtual IP” = “Service IP; ”RS1, RS2 – “Real Server IP”

The benefit of Full NAT – Servers can be used as is. No change needed

Direct Response Server Configuration



DPVS - Data Path (DPDK) + Control Path (IPVS)



Same Domain

- Both clients & Servers
  - On same side
- Dpdk0.kni alone enough

Different Domain

- Both clients & Servers
  - On same side
- Dpdk0.kni & DPDK1.kni

Spread To Servers? Or Benefit From Stickiness?

Flow Pinning has the benefit of Locality
Caching Benefits thereof.

When Spreading the Load, say for instance **Round Robin**
You trade locality for overall utilization.

What Other Scheduling Algorithms Are Out There?

Least Connected

Tagging Weight To The Server

That Is About Scheduling. What About Data Flow?

Forwarding Methods - Thin Request. Bulky Response

For Single Request, server returns multiple objects.

So Why Have Load Balancer in the path of bulky Response?

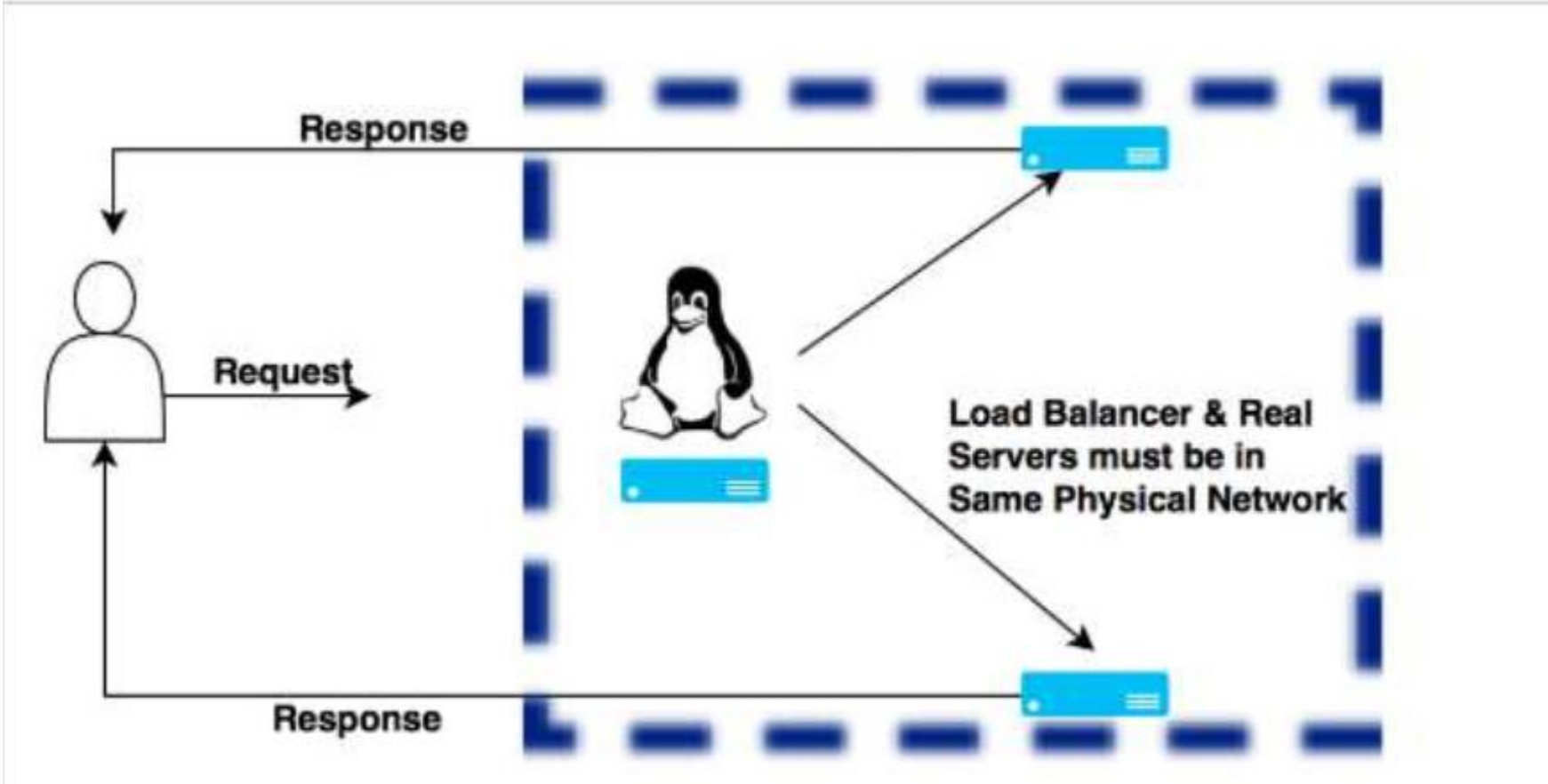
Why not Load Balancer Become Transparent During Server Response?

That is **Direct Response Server – DRS**

How?

Why To Have Man In The Middle During Response?

Request Is Served By Load Balancer But Not Response



Ready For Quiz?

Quiz

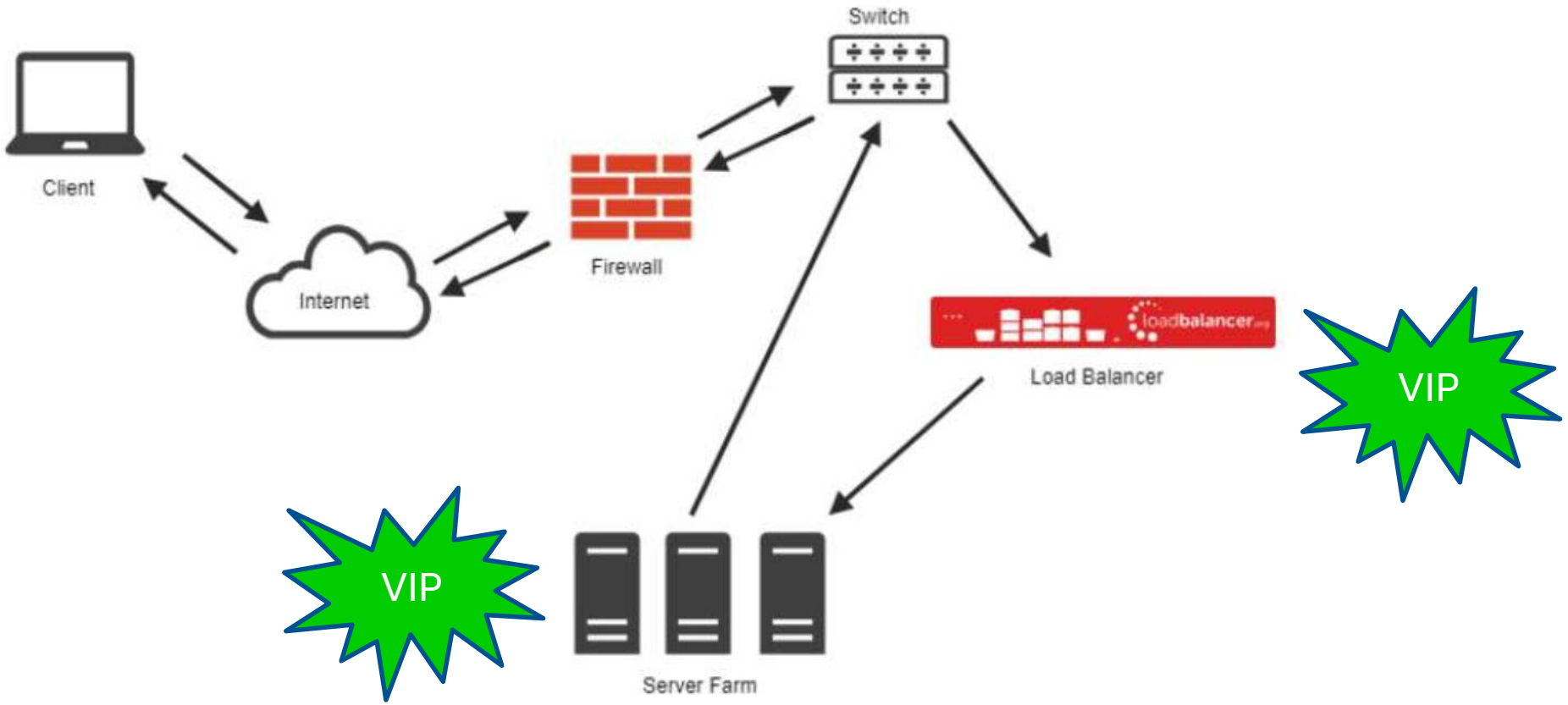
Quiz

Can you have 2 devices with same IP addresses in same subnet?

If no, Why not?

If yes, how can it?

Load Balancer & Server Farms Have Same Service IP Address



PRO: Great For Scalability

Consideration: Real Servers must host the service at VIP (rather than in RS IP)

Key Configuration for Demo

Role Of Dummy Interface In Direct Routing:

Packets from end users are forwarded directly to the real server. The IP packet is not modified

So, the real servers must be configured to accept traffic for the virtual server's IP address.

This can be done using a dummy interface or packet filtering to redirect traffic addressed to the virtual server's IP address to a local port.

The real server may send replies directly back to the end user.

Thus, the Load Balancer does not need to be in the return path.

net.ipv4.conf.lo.arp_ignore=1

net.ipv4.conf.lo.arp_ignore=1

```
[root@localhost user]# ./02_2-Machines_DRS_NGINX_Setup.sh
Kernel IP routing table
Destination     Gateway         Genmask         Flags Metric Ref    Use Iface
0.0.0.0         192.168.0.1     0.0.0.0         UG    100    0        0 enp129s0
172.16.0.0      0.0.0.0         255.255.255.0   U     100    0        0 enp59s0f0
192.168.0.0     0.0.0.0         255.255.255.0   U     100    0        0 enp129s0
192.168.122.0   0.0.0.0         255.255.255.0   U     0      0        0 virbr0
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
    inet 127.0.0.1/8 scope host lo
       valid_lft forever preferred_lft forever
    inet 172.16.0.10/32 scope global lo
       valid_lft forever preferred_lft forever
    inet6 ::1/128 scope host
       valid_lft forever preferred_lft forever
net.ipv4.conf.lo.arp_ignore = 1
Kernel IP routing table
```

Call to Actions

1. Start evaluating Open Source Software Load Balancers, we can help
2. Looking for collaborators to develop and refine scalable solutions
3. Next Steps - Explore a micro-services implementation

Contacts

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M Jay - Muthurajan.Jayakumar@intel.com

References

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http://www.linuxvirtualserver.org/software/ipvs.html#kernel-2.6
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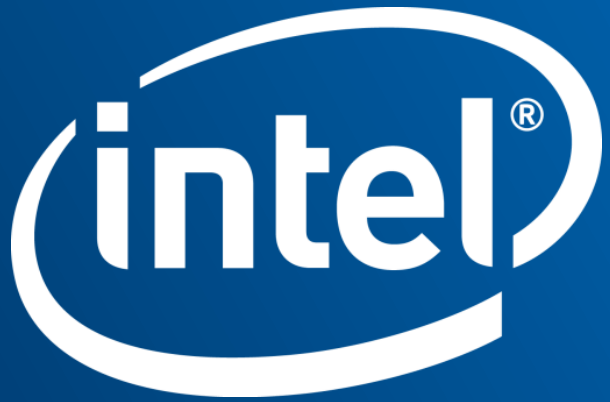
Additional Sessions

- Friday 1:50 – Accelerated Container Networking using DPDK – Sujata Tibewala & M. Jayakumar, Intel
- Friday 2:30 – VPP Accelerated High Performance & Scalable L3DSR L4 Load Balancer on Top Clos – Yusuke Tatsumi, Yahoo Japan Corp & Naoyuki Mori, Intel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Demo Block Diagram - DPVS With IPVS