



Systems and Technology Group

Dynamic Routing: Exploiting HiperSockets and Real Network Devices

Session 8447

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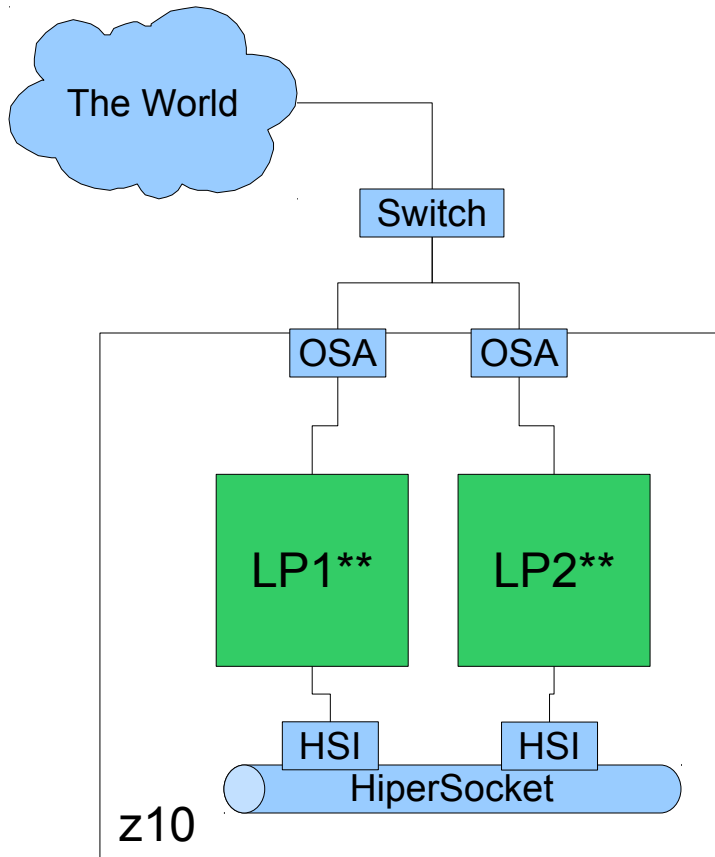
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Agenda

- What is the problem?
- Common solutions and their faults
- OSPF and its faults

The Problem:

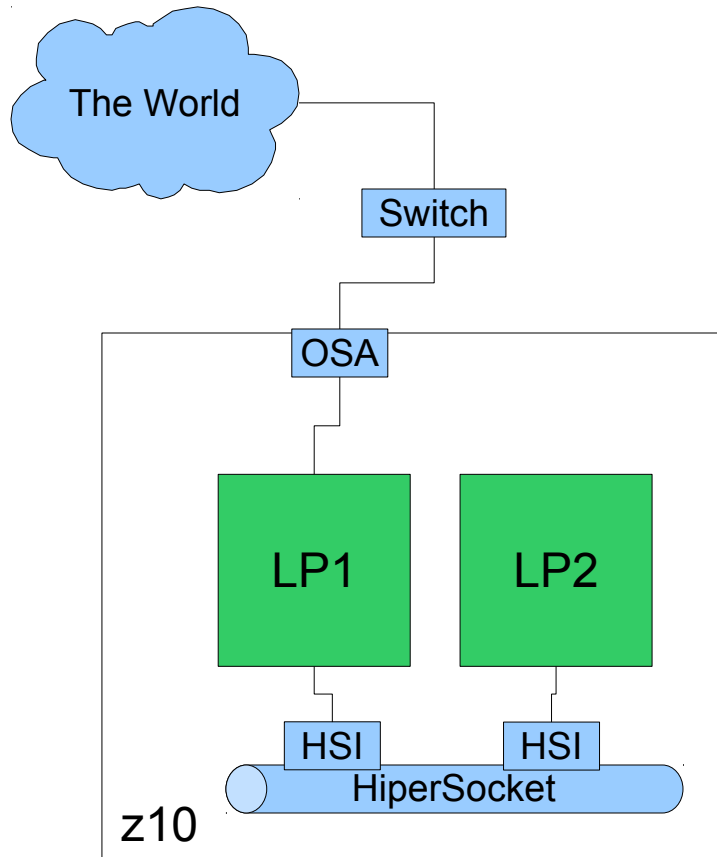


**The diagrams are drawn as LPARs, but these patterns also apply equally to z/VM Guests.

- HiperSockets are very fast, but only work within a CEC*.
- OSA is required to talk to systems outside the CEC.
- How do you exploit HiperSockets while also talking to the rest of the world?

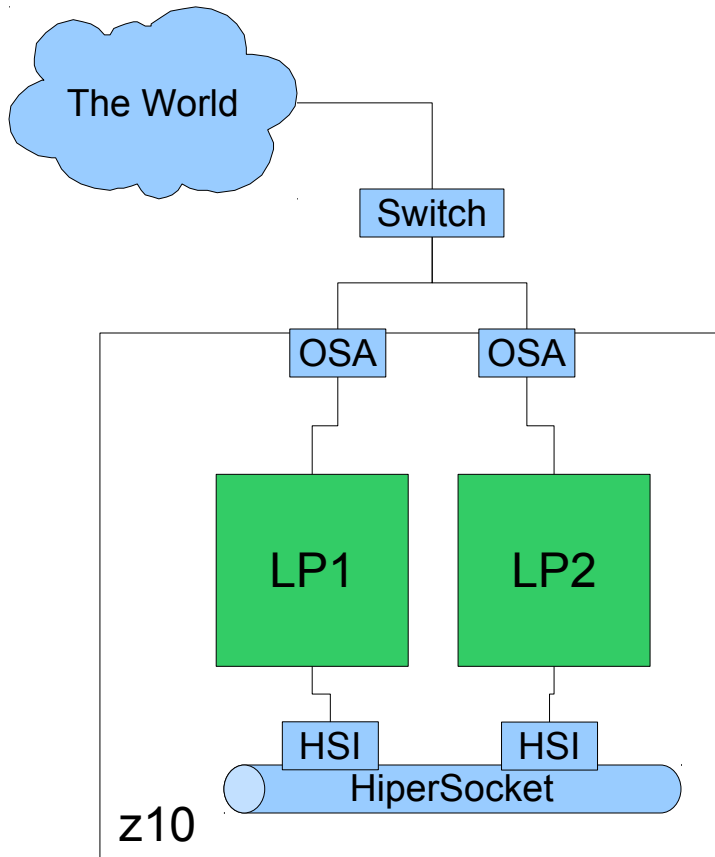
*CEC = Central Electronics Complex
Also Known As: The processor, The CPU, The machine,
The big black refrigerator

The Original Solution:



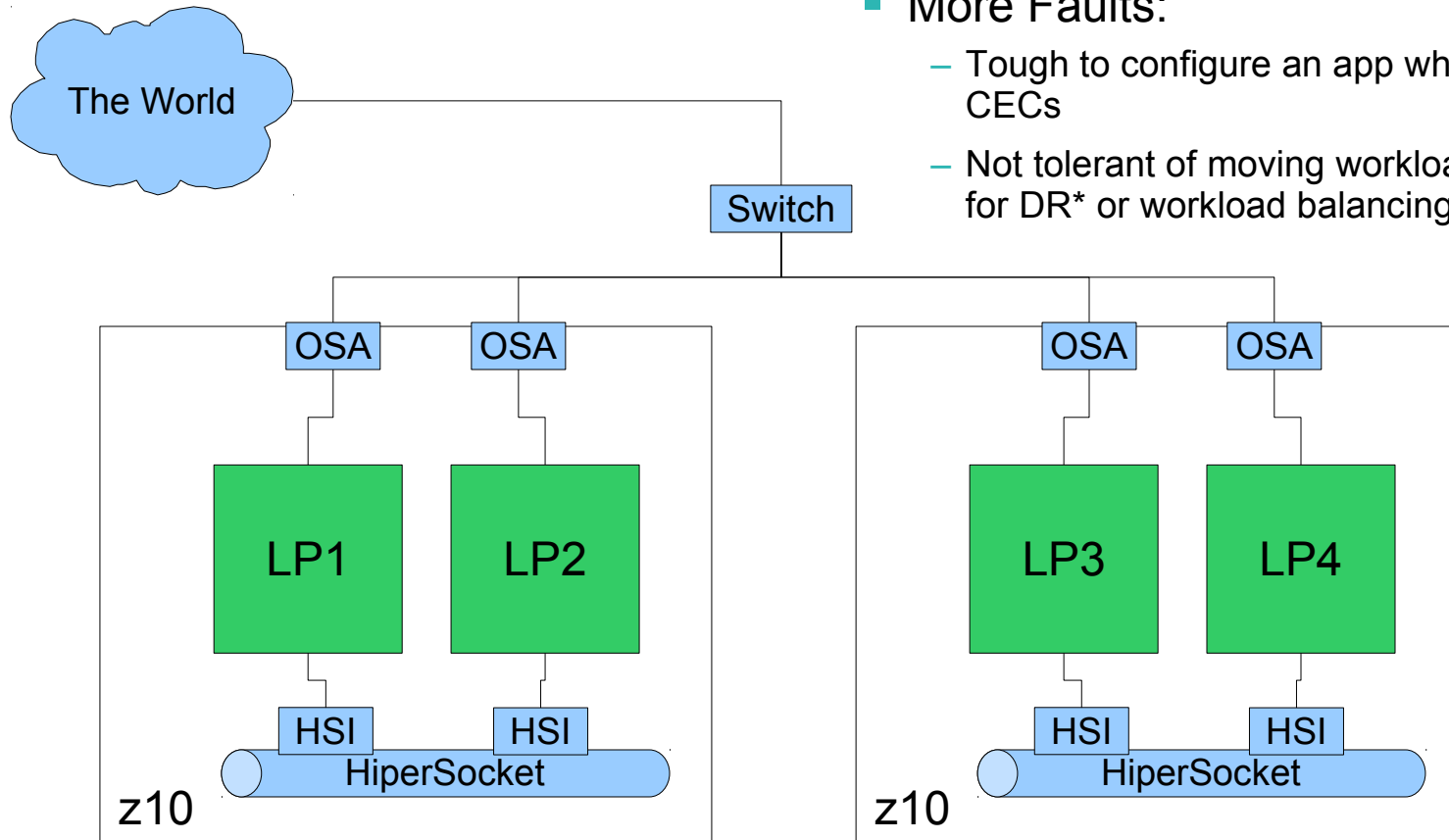
- LP1 becomes a router and forwards packets to and from the HiperSocket Network
- Faults:
 - Pretty expensive for a router: even cheap IFL mips are not really cheap enough to do this
 - LP1 is a Single Point of Failure (SPoF)
- LP1 is a great place to put a software firewall – so this is still a valid solution if you can solve the SPoF

The Common Solution:



- Use Naming to choose the interface
 - LP1o and LP2o = OSA side interfaces
 - LP1h and LP2h = HSI side interfaces
 - Both sets of names configured in DNS or hosts
- Manually configure applications to use one name or the other to choose a path
- Faults:
 - Have to pick and choose the correct path for each application in the system
 - Does not handle failures or config errors gracefully

The Common Solution part 2:

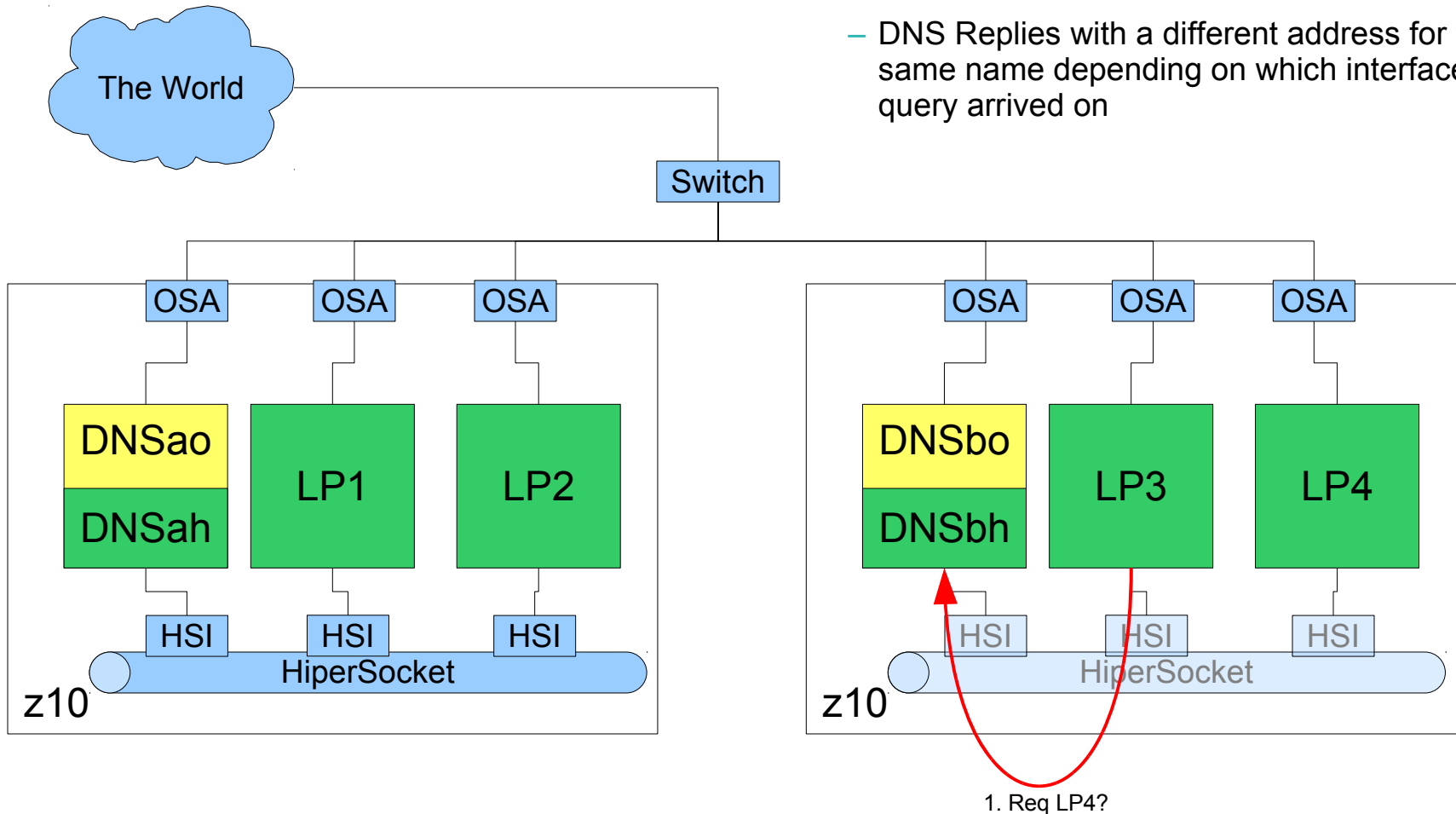


More Faults:

- Tough to configure an app which spans multiple CECs
- Not tolerant of moving workload across CECs for DR* or workload balancing

*Disaster Recovery

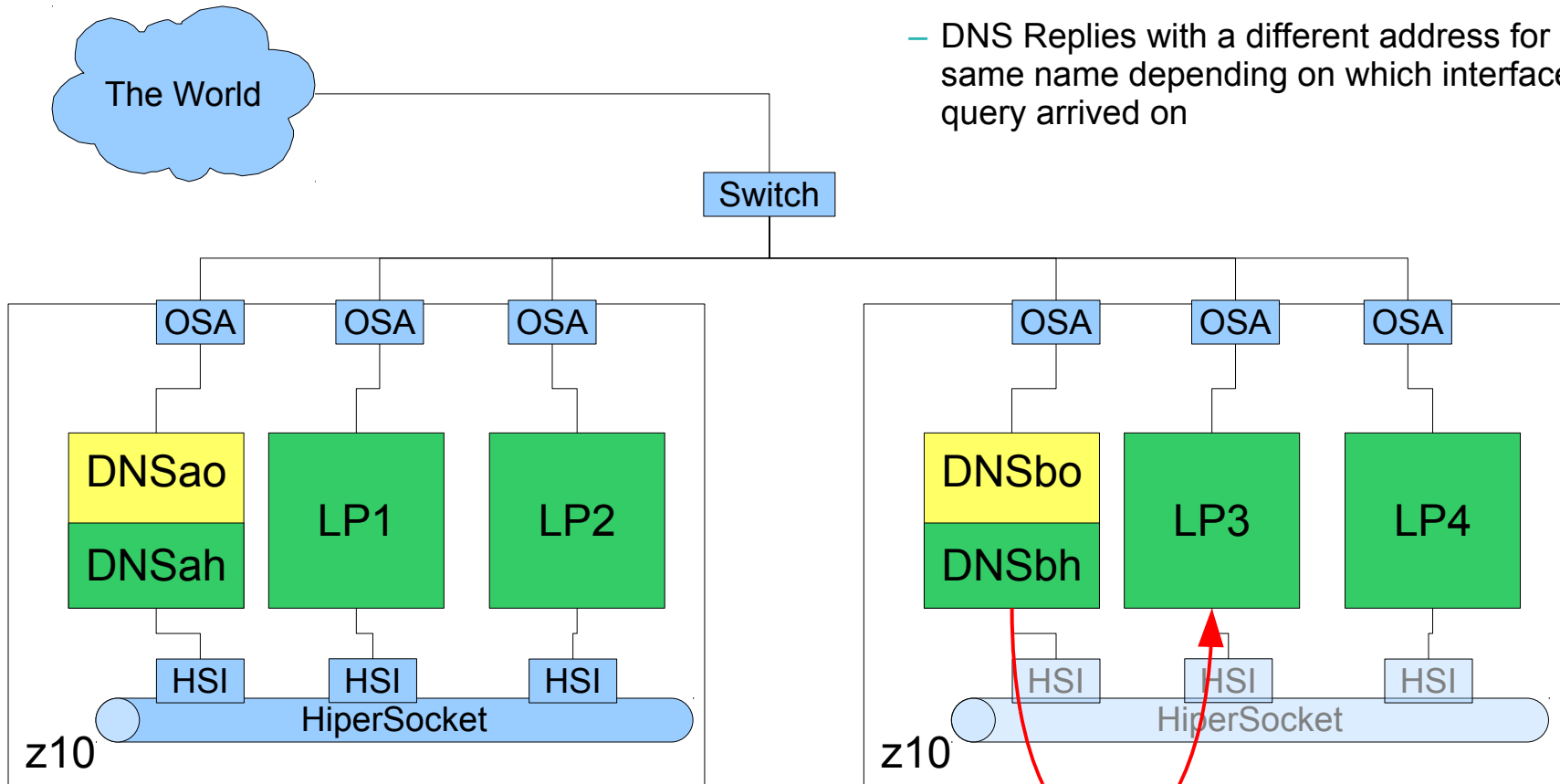
Split Horizon Solution:



Split Horizon DNS

- Single DNS has multiple zones for the same name space
- DNS Replies with a different address for the same name depending on which interface the query arrived on

Split Horizon Solution:

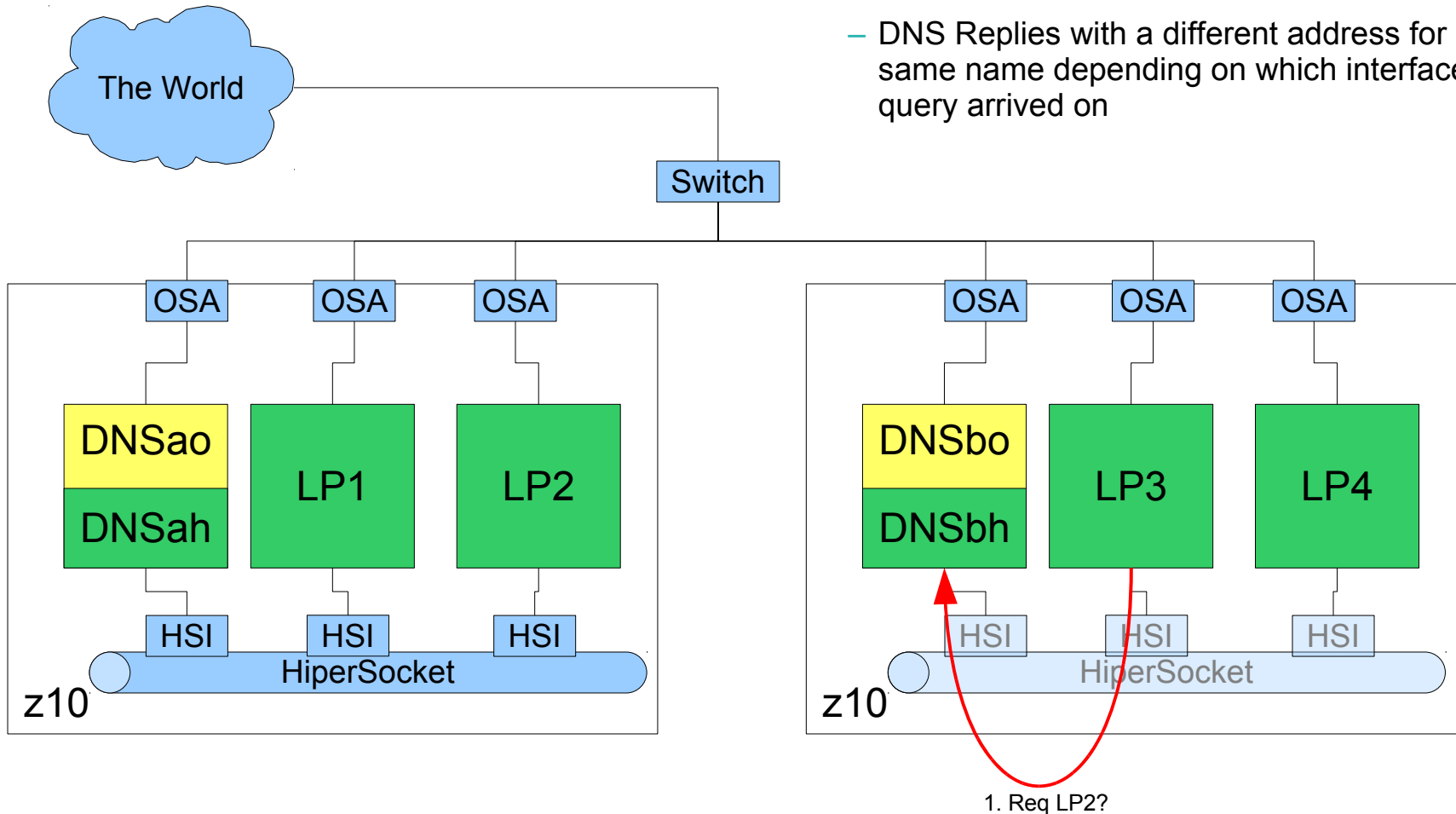


2. Repl LP4 = HSI addr 172.16.x.x

Split Horizon DNS

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- DNS Replies with a different address for the same name depending on which interface the query arrived on

Split Horizon Solution:



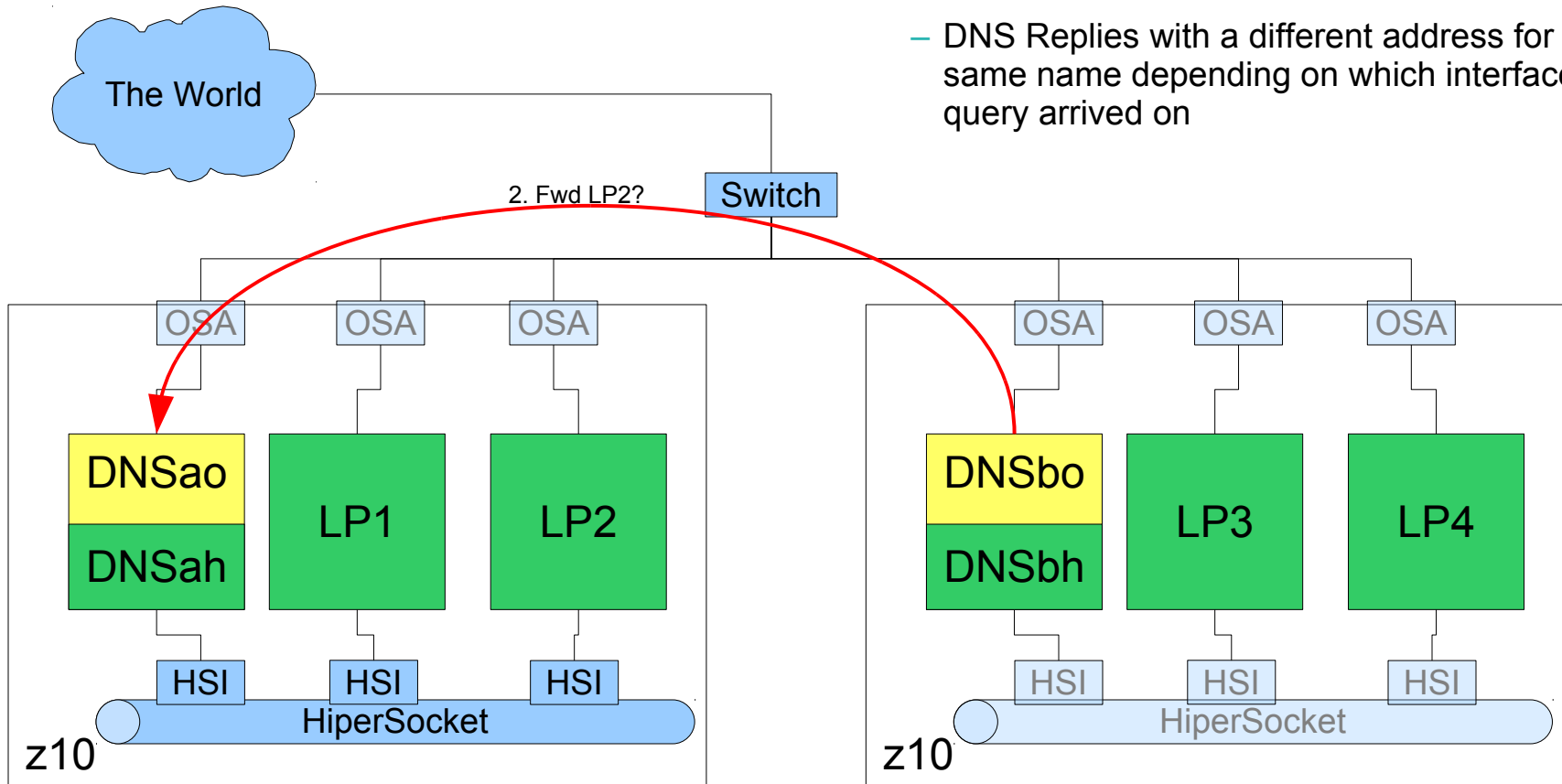
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Split Horizon Solution:

Split Horizon DNS

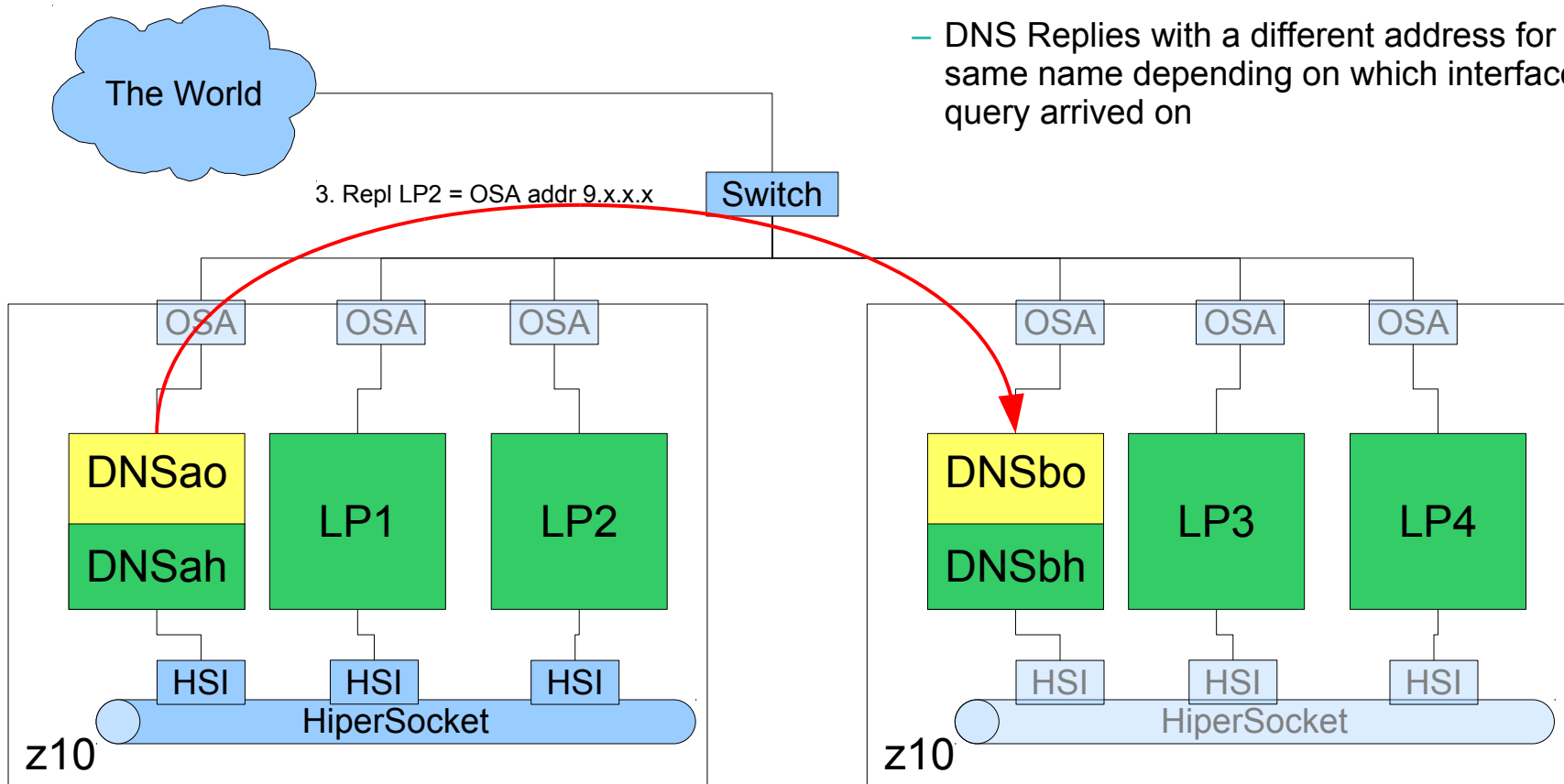
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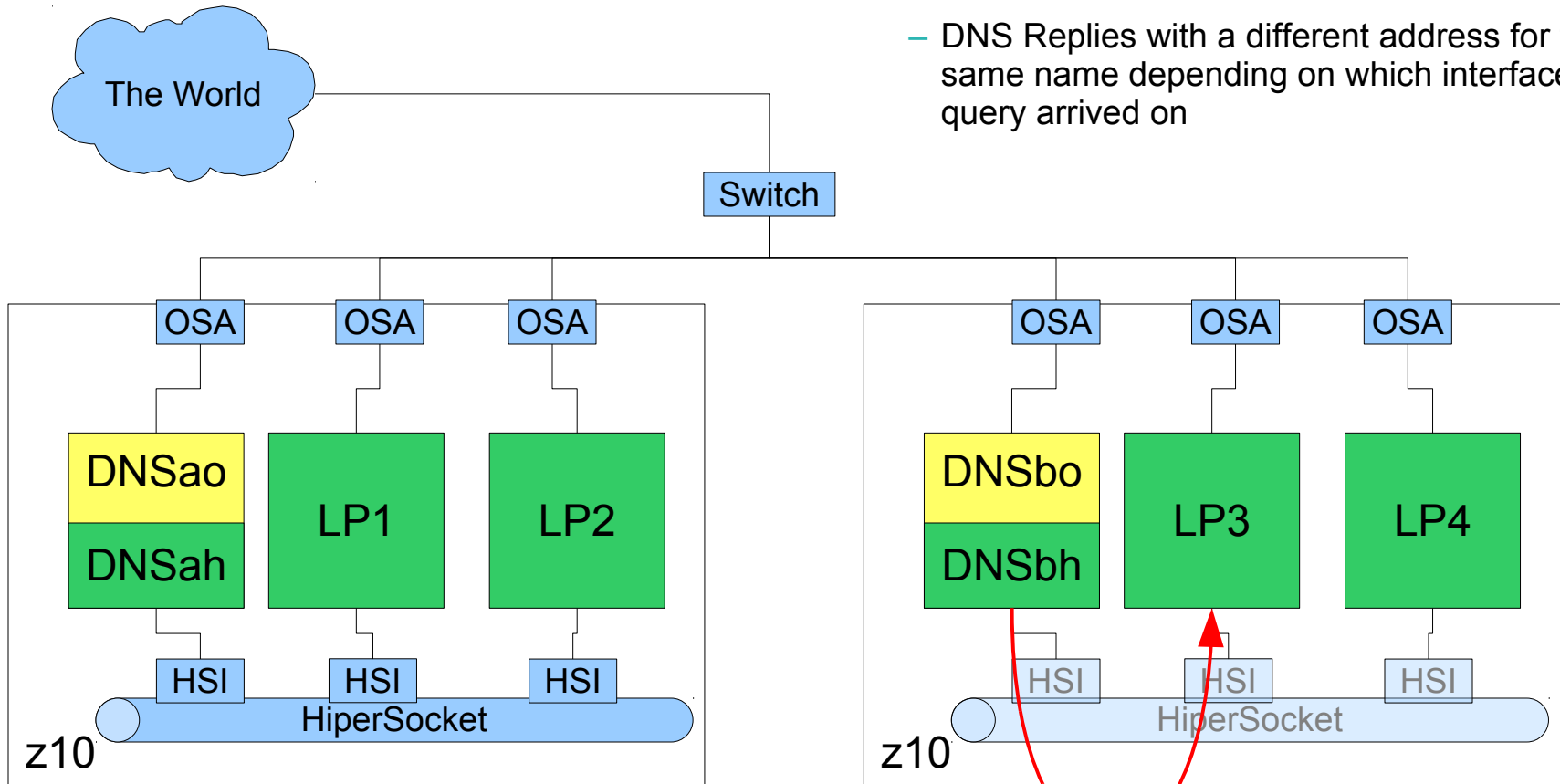
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Split Horizon Solution:

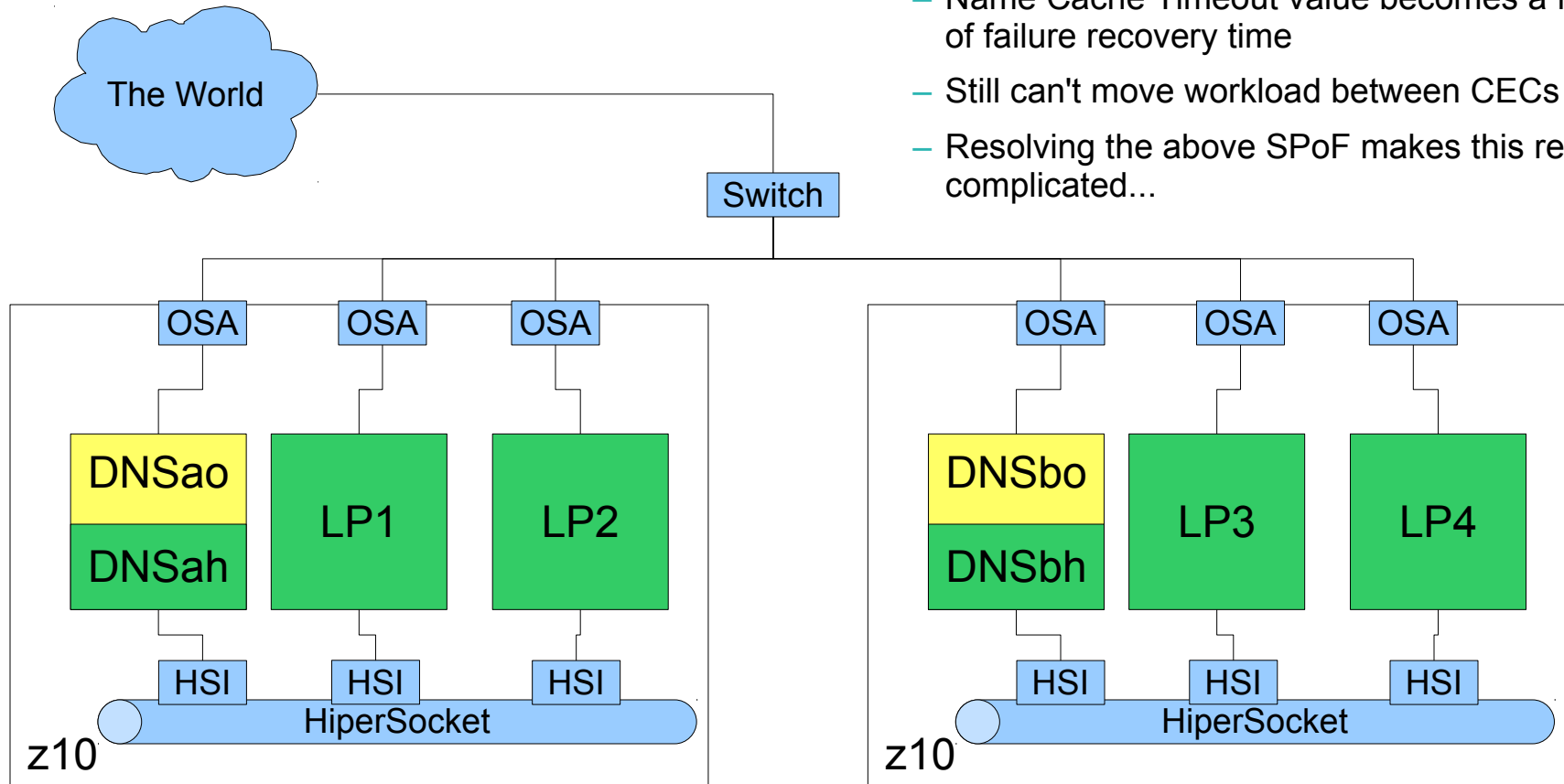


Split Horizon DNS

- Single DNS has multiple zones for the same name space
- DNS Replies with a different address for the same name depending on which interface the query arrived on

4. Repl & Cache LP2 = OSA addr 9.x.x.x

Split Horizon Solution:



■ Faults:

- The DNS in the CEC is a SPoF
- Name Cache Timeout value becomes a factor of failure recovery time
- Still can't move workload between CECs
- Resolving the above SPoF makes this really complicated...

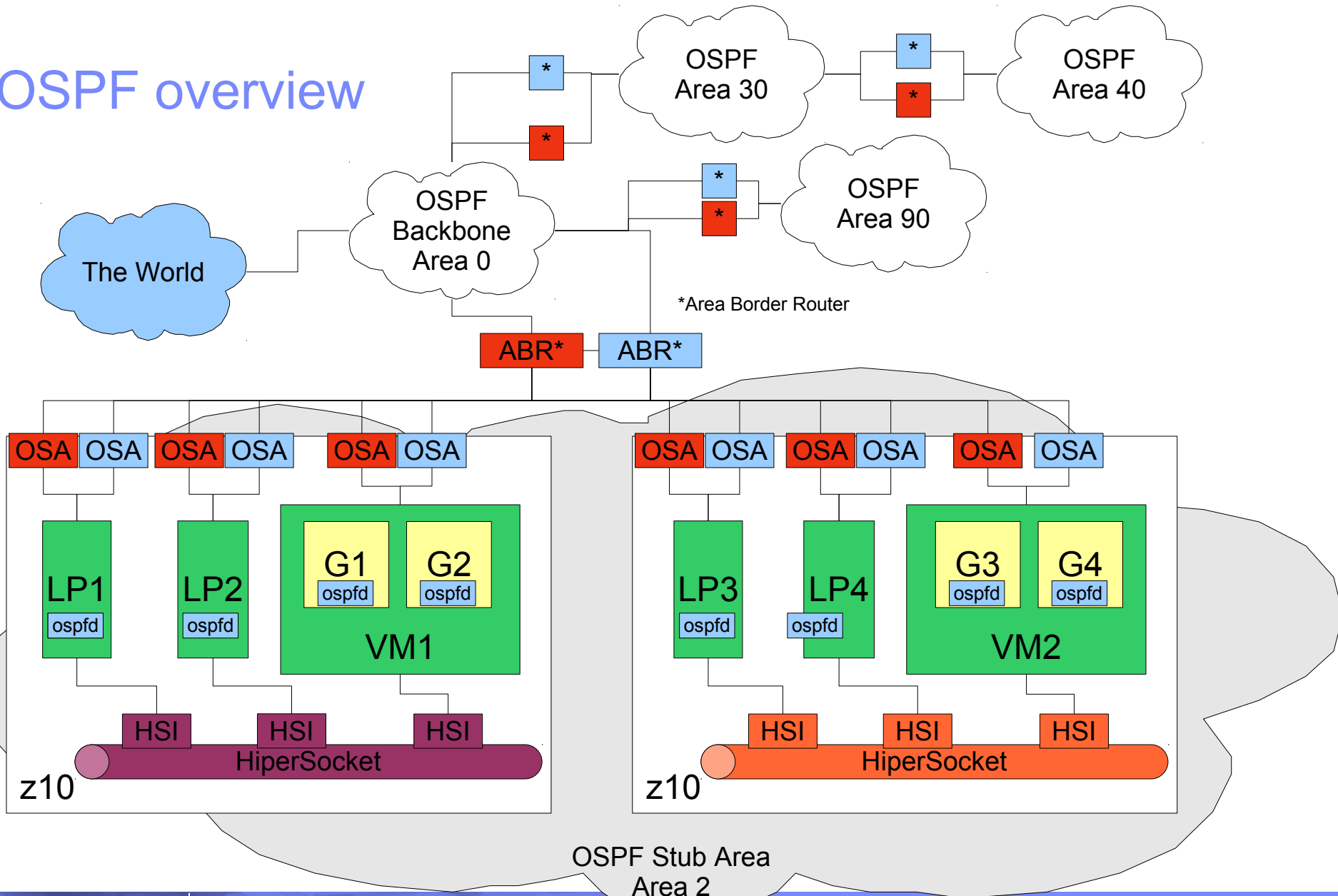
The Problem (again)

- When you get right down to it: deciding whether to use the OSA link or the HSI link to talk to a neighbor is a routing decision.
- The LPARs are not themselves routers, since they are not forwarding packets between interfaces.
- There is already a very well designed solution to this problem:

OSPF: Open Shortest Path First

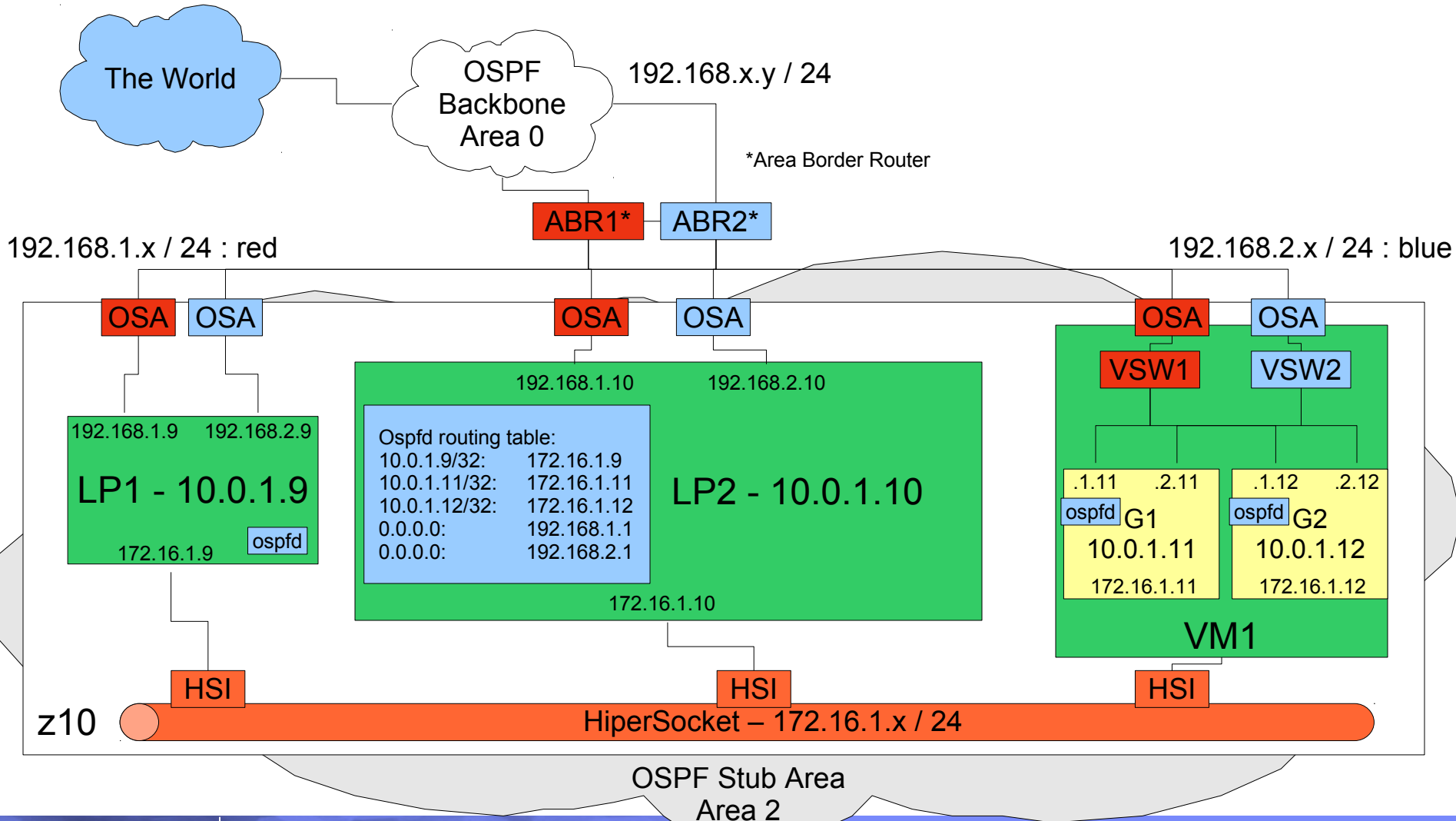
- Dynamic Routing protocol
- Nodes exchange link state notifications with adjacent nodes to maintain routing tables
 - Node is either an external router, or an LPAR / VM Guest with multiple network interfaces.
- Links have assigned weights to denote link capacity and speed
- Nodes use link state and weights to choose the correct route for packets
- In our case: systems use OSPF to choose the best link to get to the intended destination

OSPF overview



10.0.1.x/24 is the VIPA network segment
 Equal Cost MultiPathing
 also possible with this configuration

OSPF: zooming in



OSPF on Linux

- Our testing used the Quagga package
 - A fork of the zebra package

- Consists of the following components
 - Zebra daemon *
 - OSPF v2 daemon *
 - OSPF v3 (IPv6) daemon
 - Rip daemon
 - RipNG (IPv6) daemon
 - BGP daemon

- All Quagga components have an internal telnet server for interactive configuration and problem diagnosis

*these components are used in this set of examples

OSPF Config details for Linux

■ zebra.conf:

```
! Static VIPA
interface dummy0
ip address 10.0.1.10/32
ipv6 nd suppress-ra
!
interface eth1
ip address 192.168.71.10/24
ipv6 nd suppress-ra
!
! Hipersocket - 40K packet, 32K MTU
interface hsi1
ip address 172.16.1.10/16
ipv6 nd suppress-ra
!
interface lo
!
interface sit0
ipv6 nd suppress-ra
!
ip forwarding
!
line vty
exec-timeout 0 0
!
```

■ ospfd.conf:

```
! Server - Static VIPA
interface dummy0
ip ospf cost 1
ip ospf priority 0
!
interface eth1
ip ospf cost 10
ip ospf priority 0
!
interface hsi1
ip ospf cost 1
ip ospf priority 10
!
interface lo
!
interface sit0
!
router ospf
ospf router-id 172.16.1.10
network 172.16.0.0/16 area 2.2.2.2
network 172.31.0.34/32 area 2.2.2.2
network 172.31.200.1/24 area 2.2.2.2
network 192.168.71.0/24 area 2.2.2.2
area 2.2.2.2 stub
!
line vty
exec-timeout 0 0
!
```

OSPF Test Results

- As expected: no matter which interface was disabled, traffic was able to route around the dud link
- Routes re-converged quickly no matter whether the OSA or HSI side was disabled
- When OSA side links are disabled OSPF enables an eligible OS image on the CEC with a functional OSA link to become a router as in the Original Solution
- Works as Advertised!

Performance Implications

- Surprisingly – not much
- Tested 66 VM guests in the same OSPF area running on a single VM system
 - Combined CPU Utilization of the zebra & ospfd daemons was less than 1% during normal operations
 - CPU spikes up to 1.5% were noted during re-convergence after a path failure
 - Layer2 networking seems to keep VM guests in queue more so than layer3, which may contribute to the negligible overhead
 - Defining the area containing the Z systems as a Stub Area is critical to minimizing the overhead of running OSPF
 - Using a Completely Stubby Area lowers the overhead even more if your networking configuration supports it.

OSPF Faults

- Overall Complexity
 - It's not just a single default route anymore
- More customization to be done at each node during provisioning
 - But it can be handled with some creative “sed -i /old/new/” type scripting
- ... I can't think of anything else to put on this slide ...

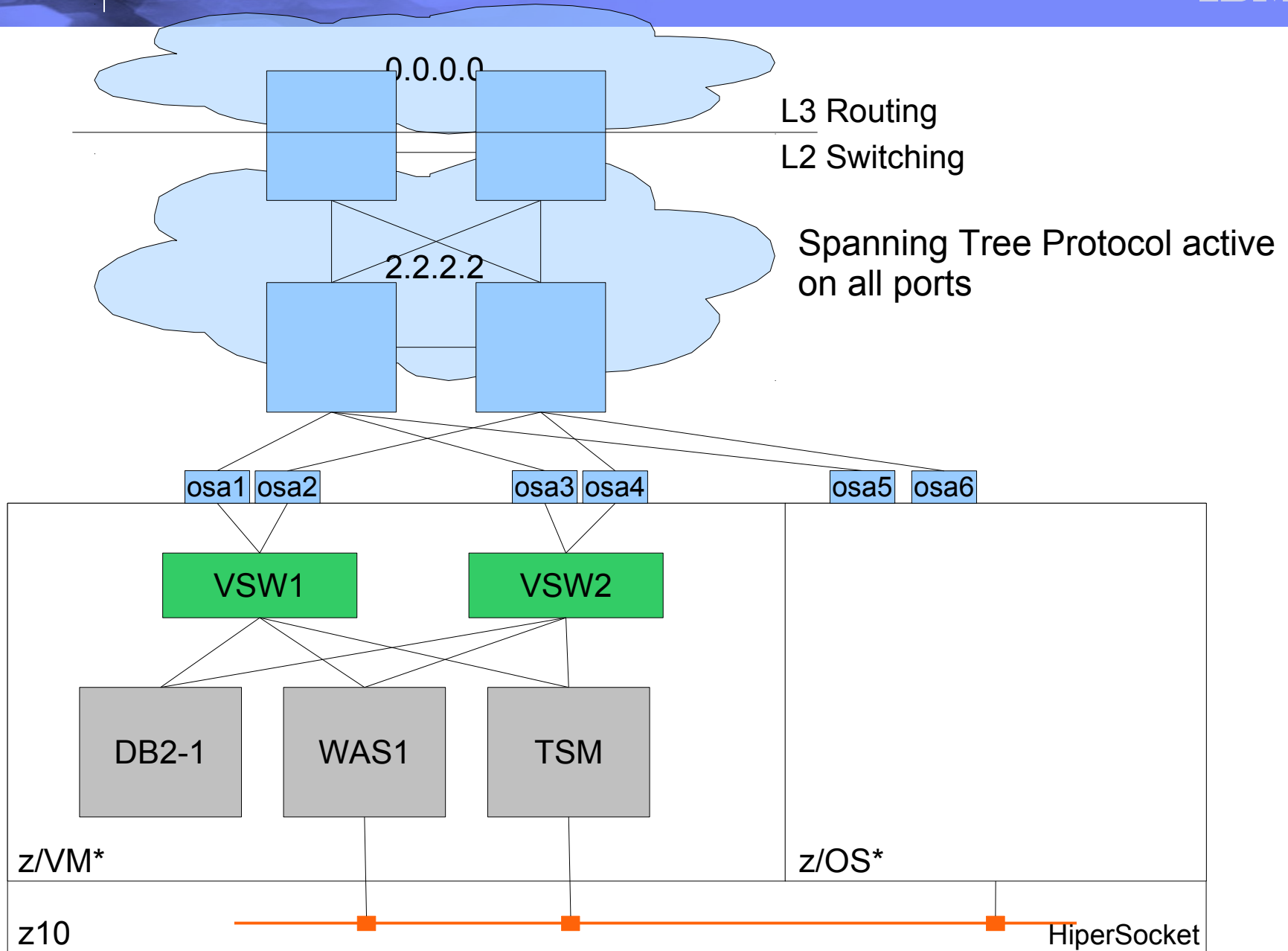
For more information

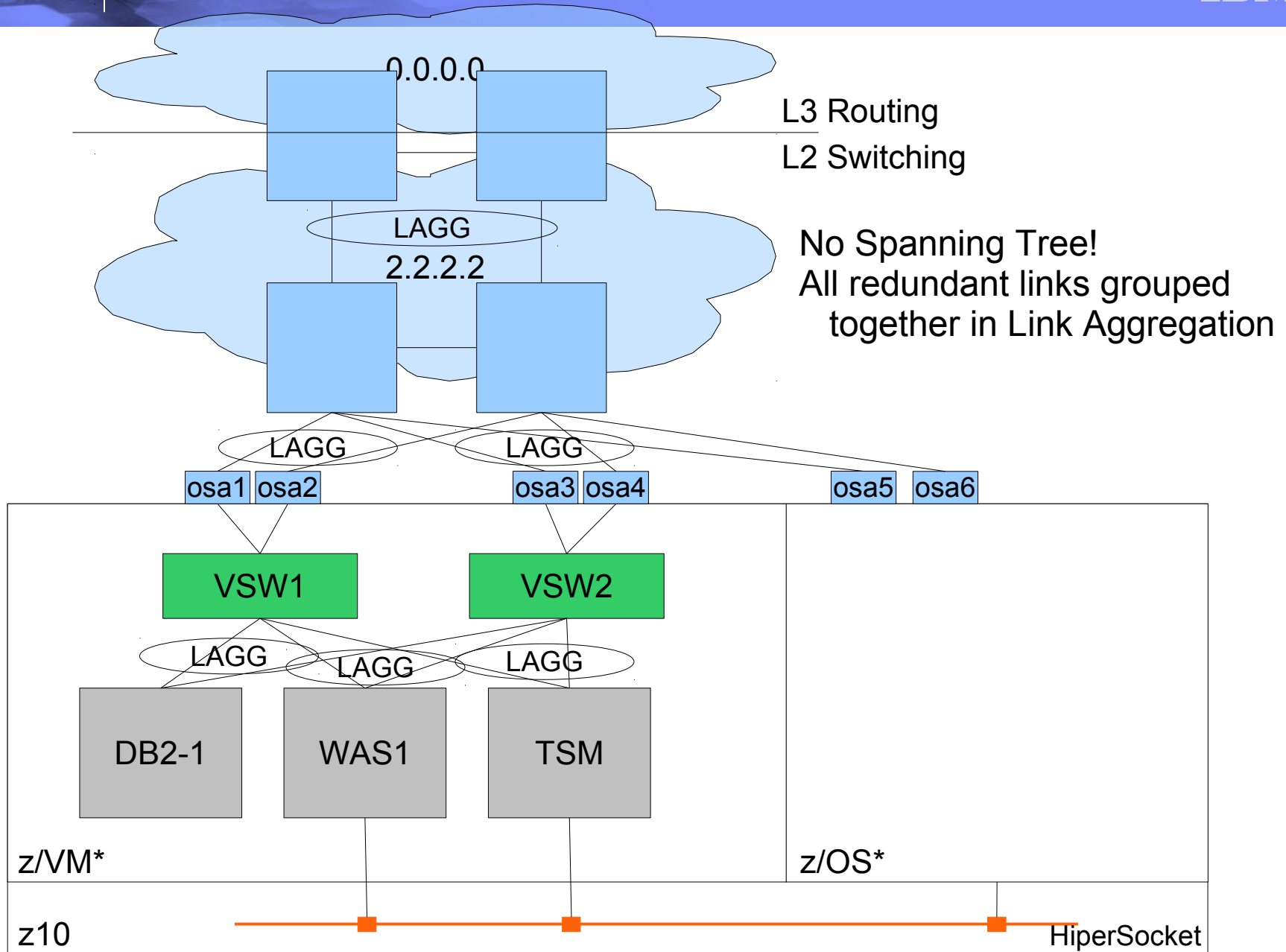
- System Z Platform Test library:
 - http://www-03.ibm.com/systems/services/platformtest/servers/systemz_library.html
- The OSPF paper this presentation is based on:
 - http://www-03.ibm.com/systems/resources/linux_ha_ospf.pdf

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Old vs New ?

- Does Link Aggregation make OSPF solutions obsolete?





L3 Routing
L2 Switching

No Spanning Tree!
All redundant links grouped together in Link Aggregation

z/VM*

z/OS*

z10

HiperSocket