# Dynamic Routing:
# Exploiting HiperSockets and Real Network Devices

## Session 8447

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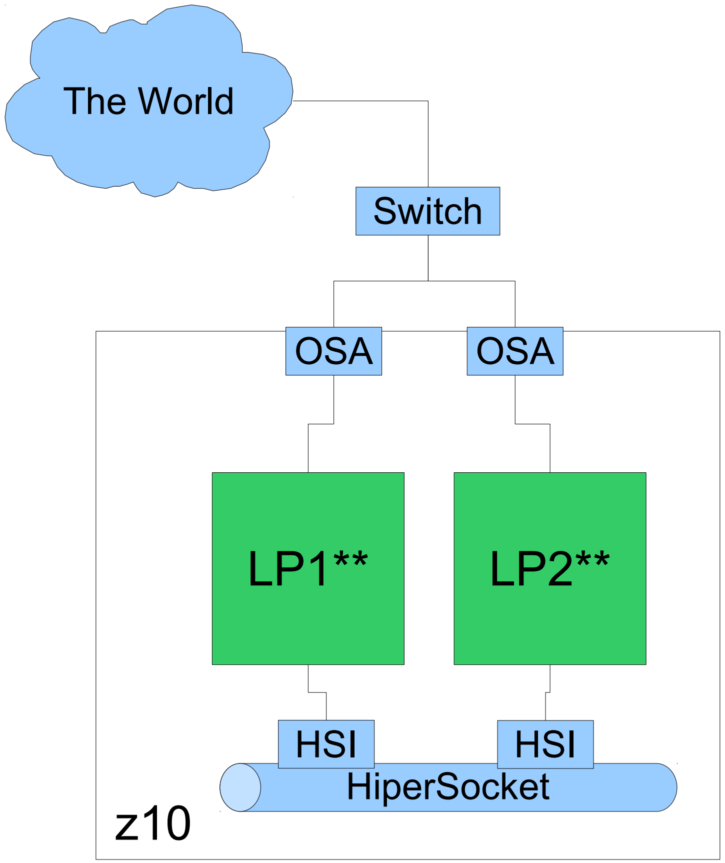
# Agenda

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

# The Problem:

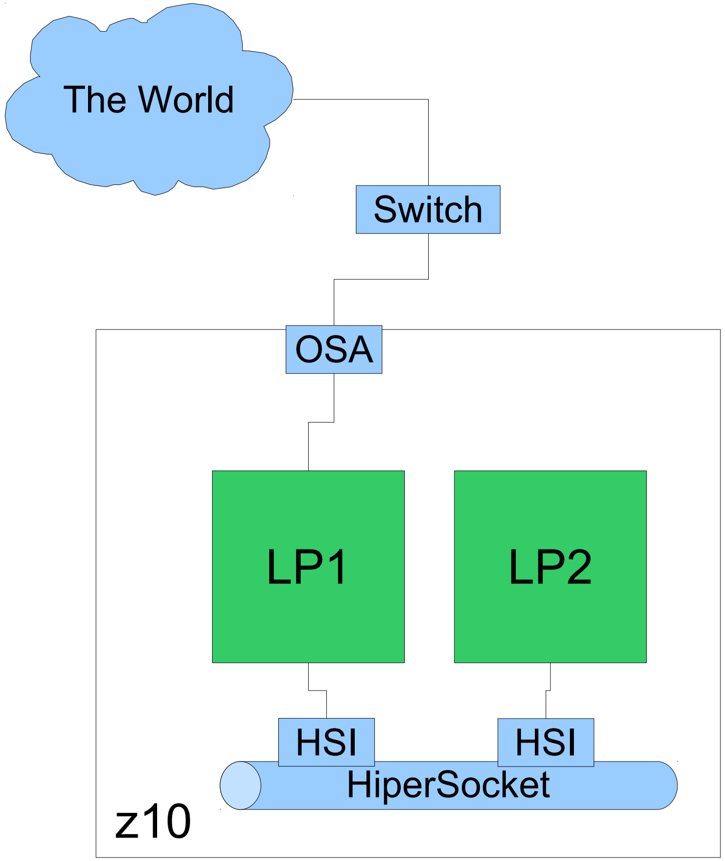


**The diagrams are drawn as LPARs, but these patterns also apply equally to z/VM Guests.

- 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?

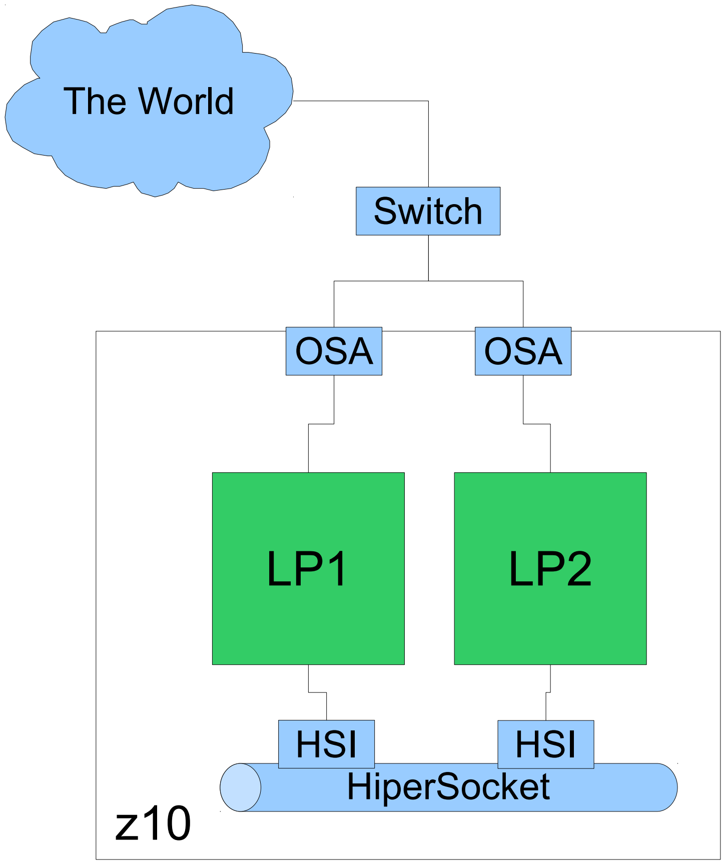
*CEC = Central Electronics Complex
Also Known As: The processor, The CPU, The machine, The big black refrigerator

# The Original Solution:



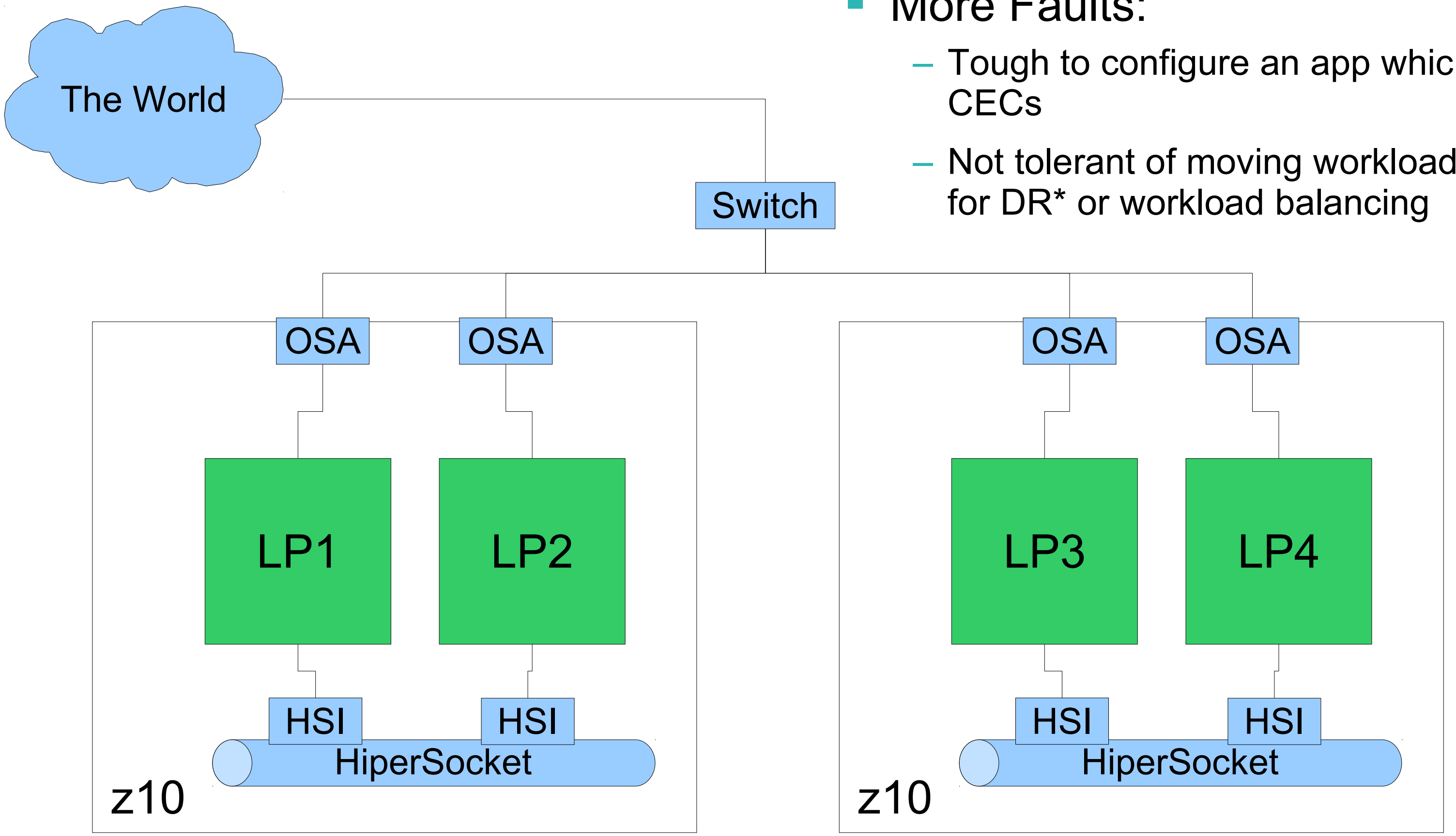
- LP1 becomes a router and forwards packets to and from the HiperSocket Network
- Faults:
  - Pretty expensive for a router: even cheap IFL mips are not really cheap enough to do this
  - LP1 is a Single Point of Failure ( SPoF )
- LP1 is a great place to put a software firewall – so this is still a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

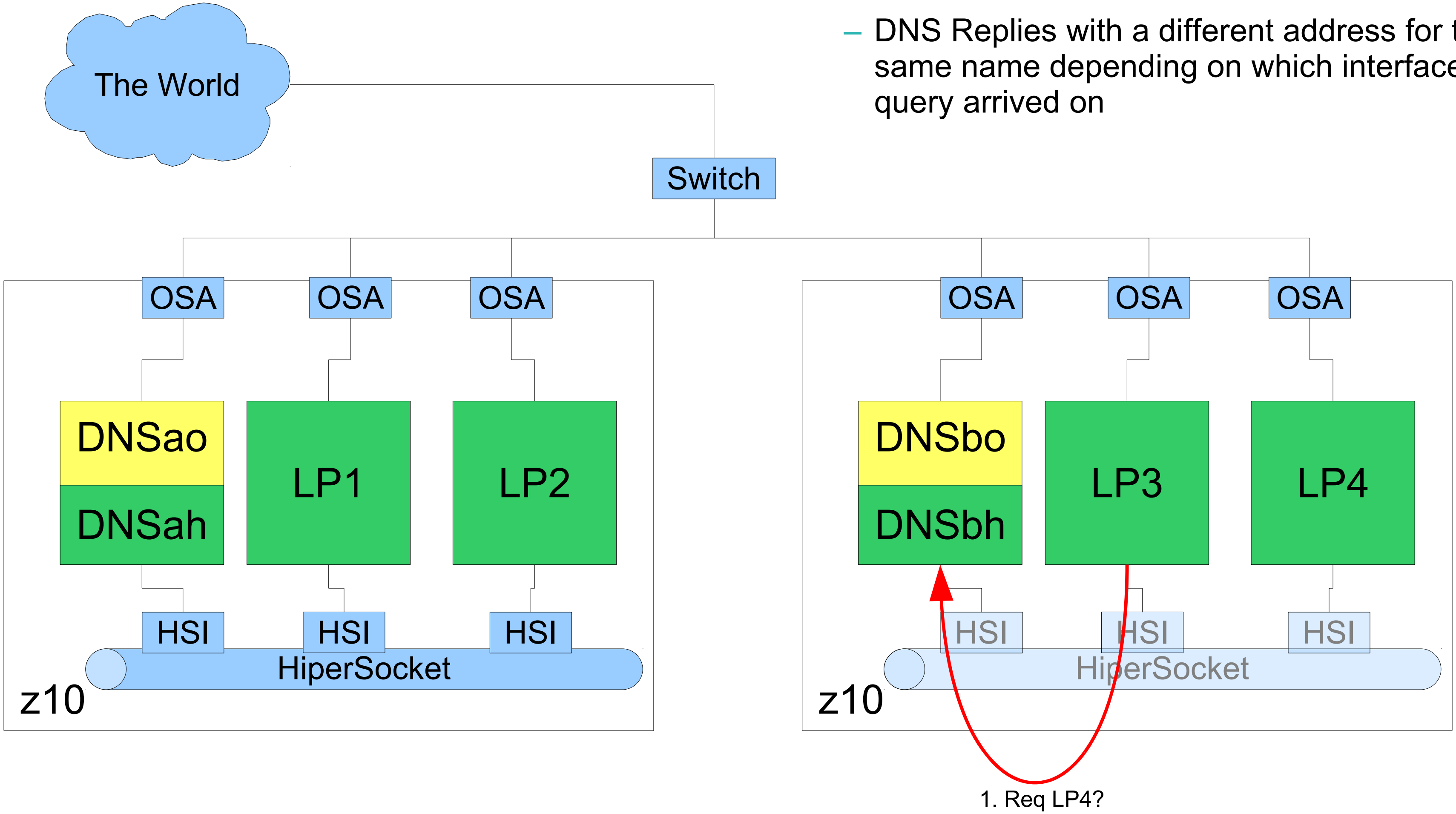


- More Faults:
  - Tough to configure an app which spans multiple CECs
  - Not tolerant of moving workload across CECs for DR* or workload balancing

*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



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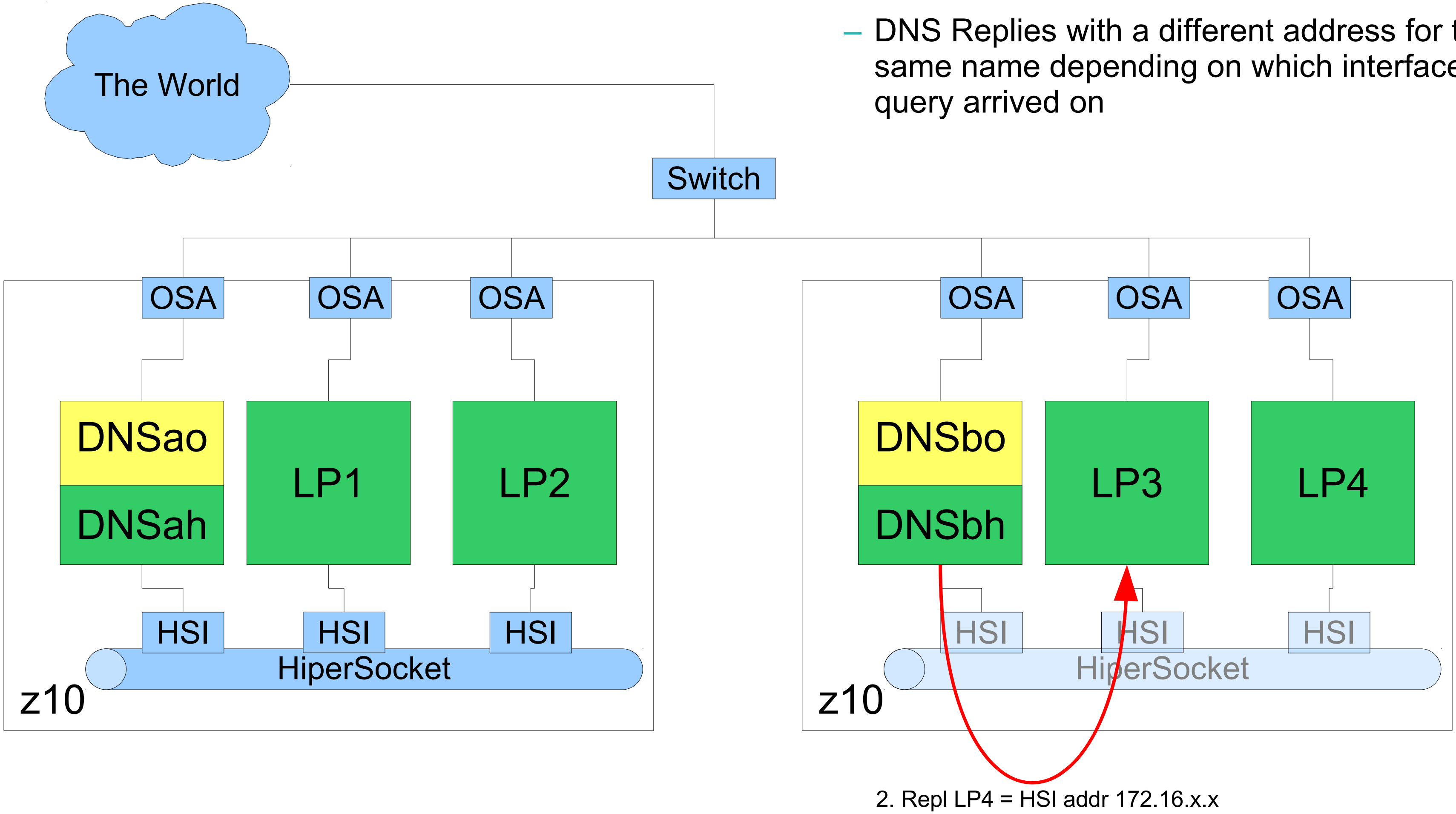

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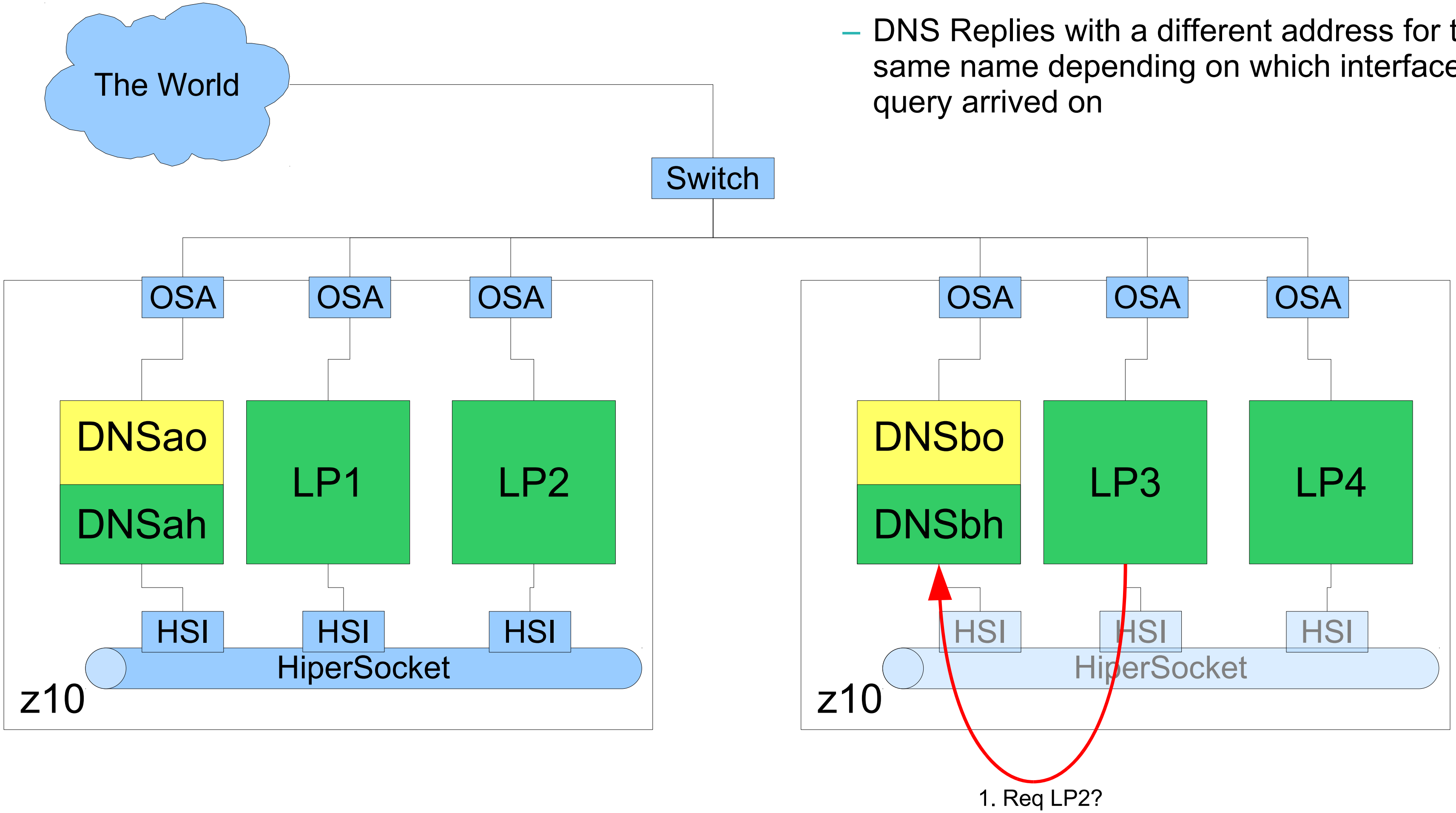

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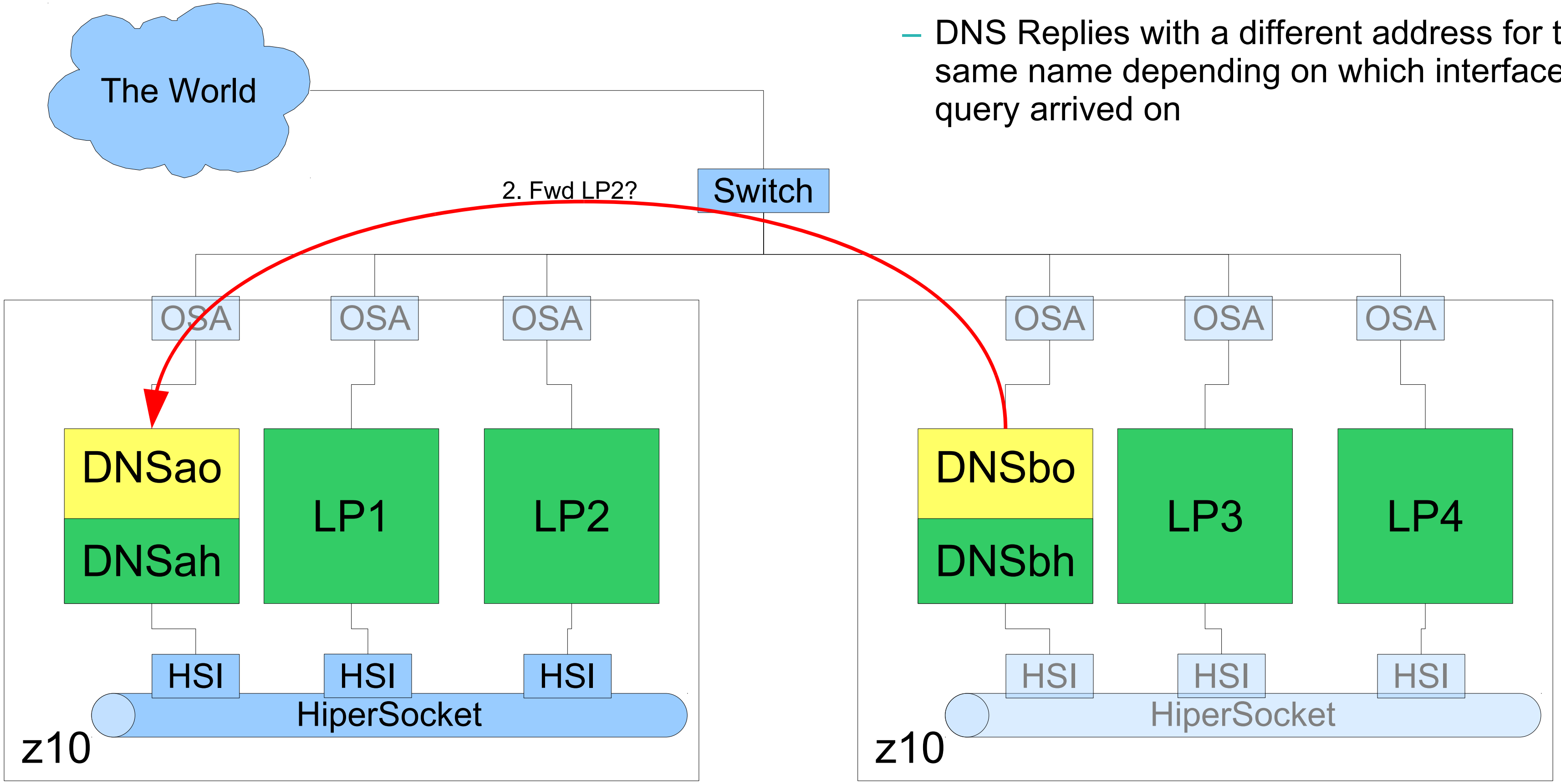

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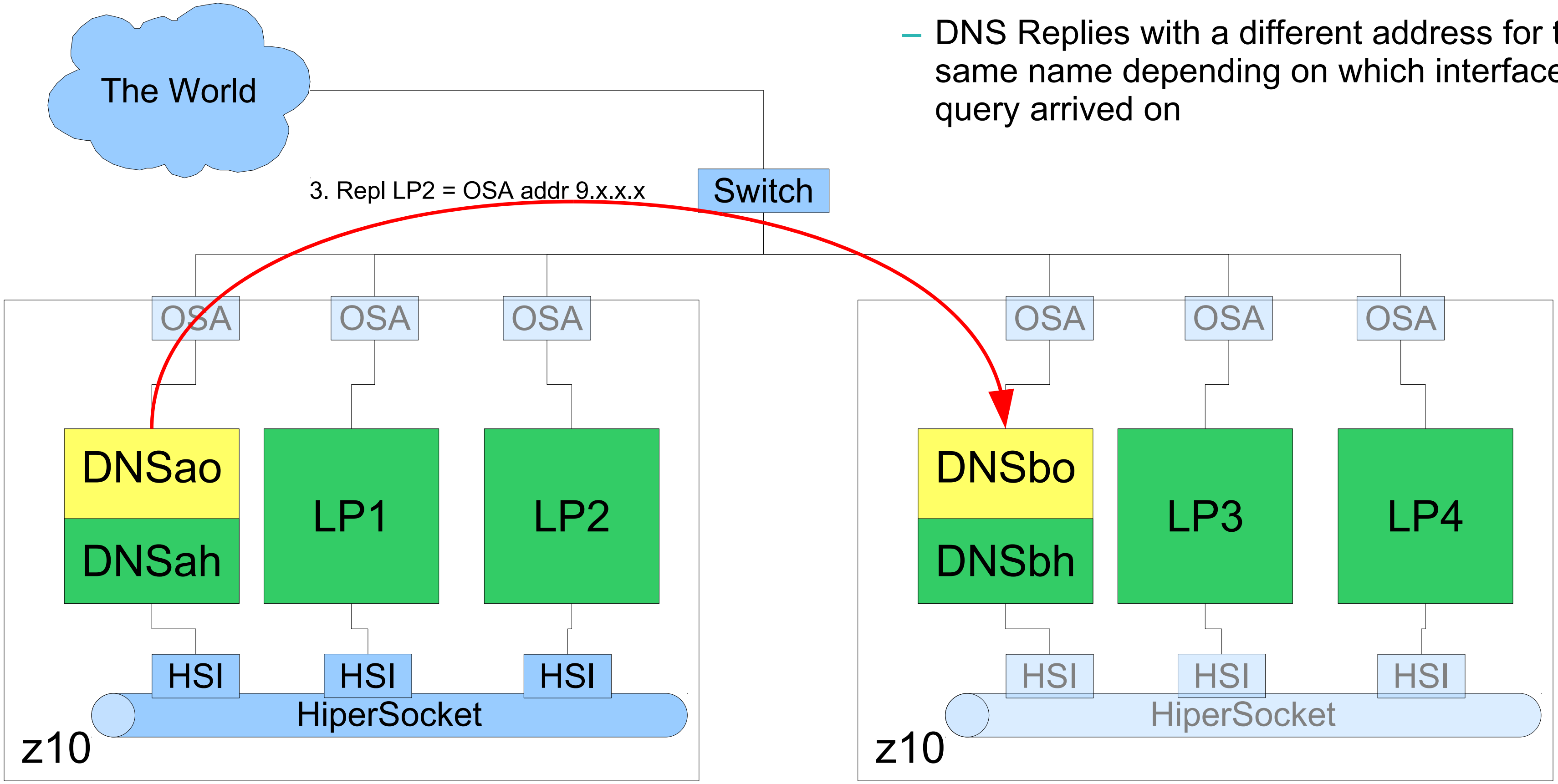

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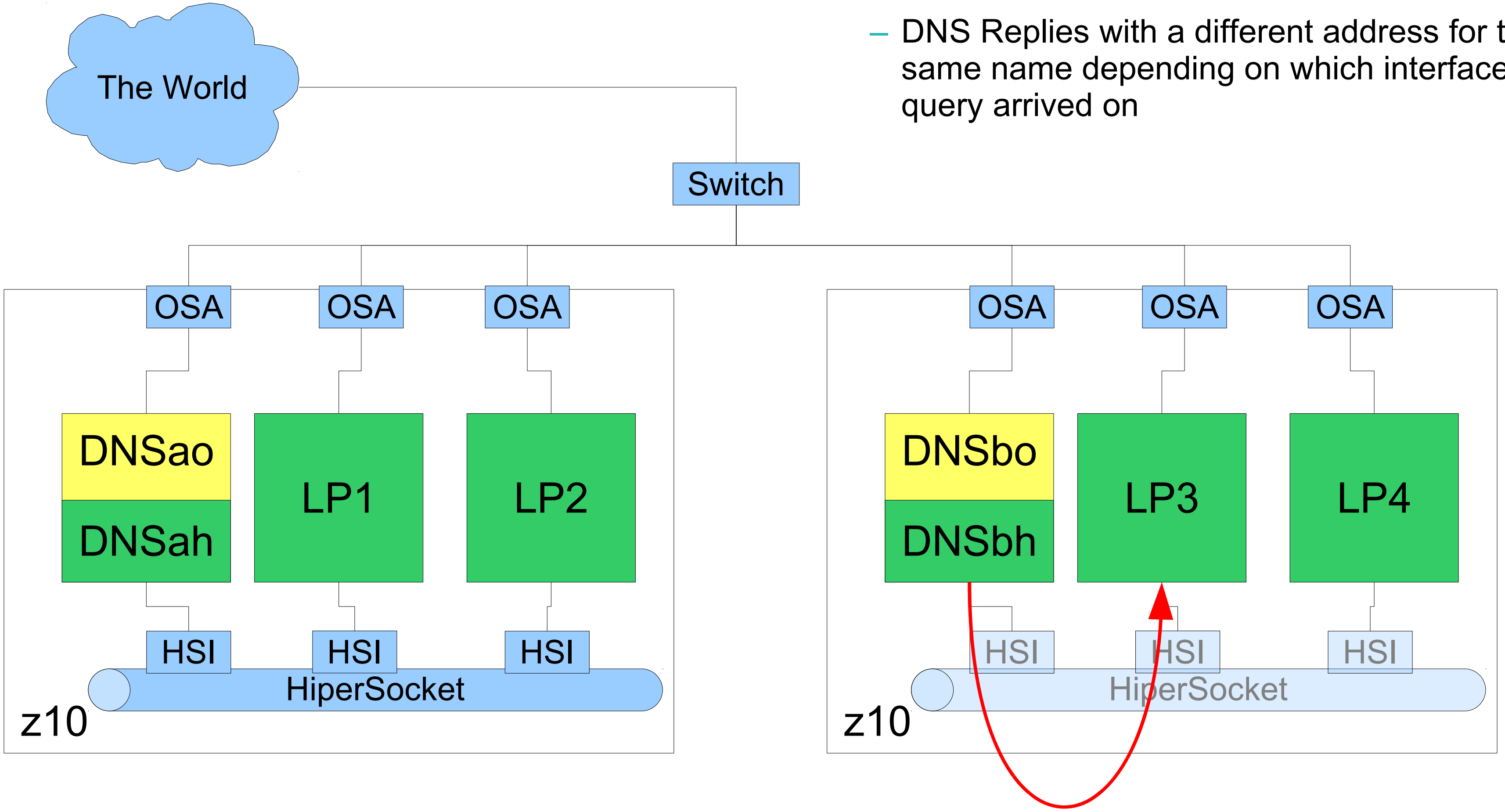
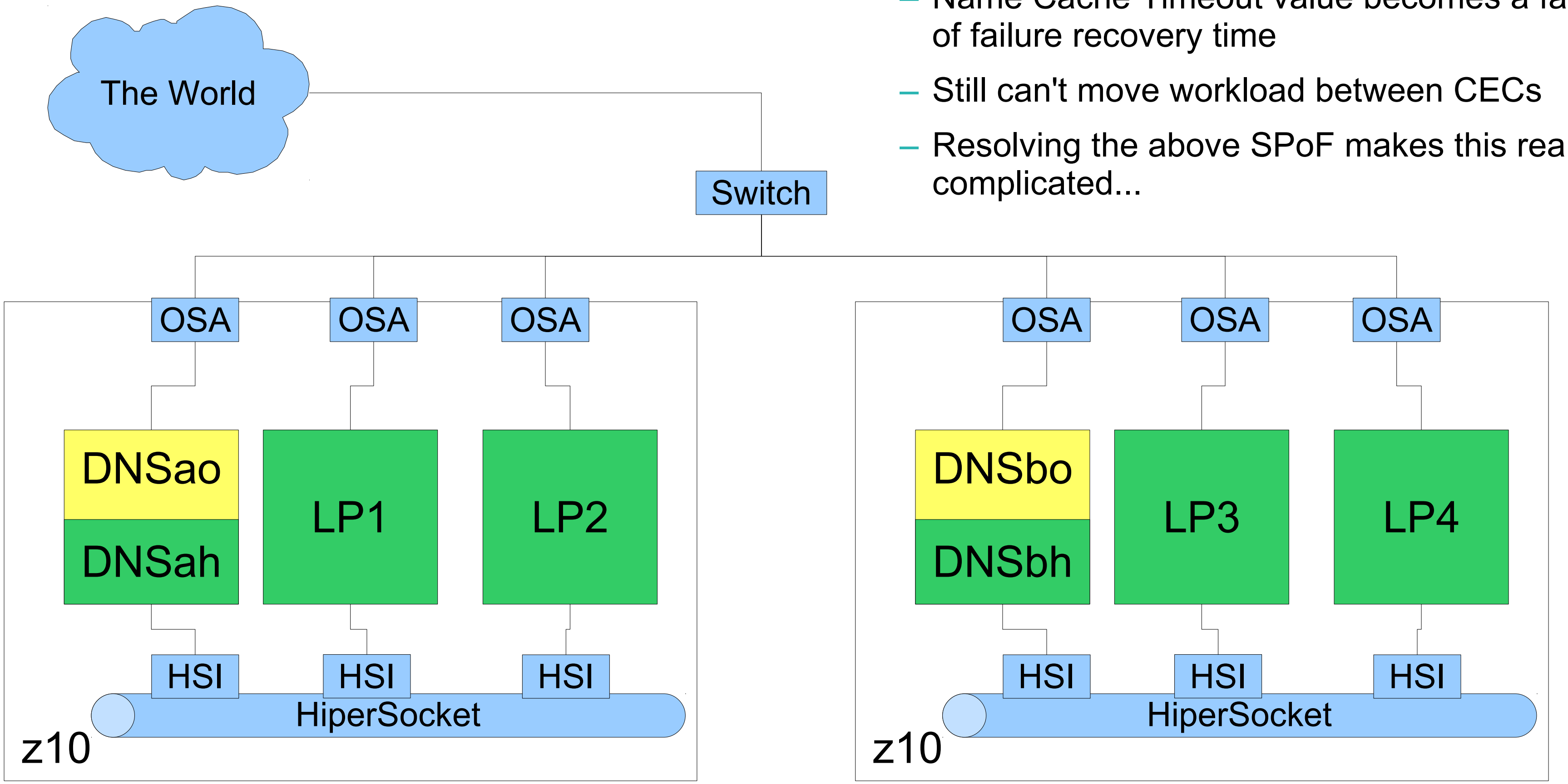


4. Repl & Cache LP2 = OSA addr 9.x.x.x

# 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...

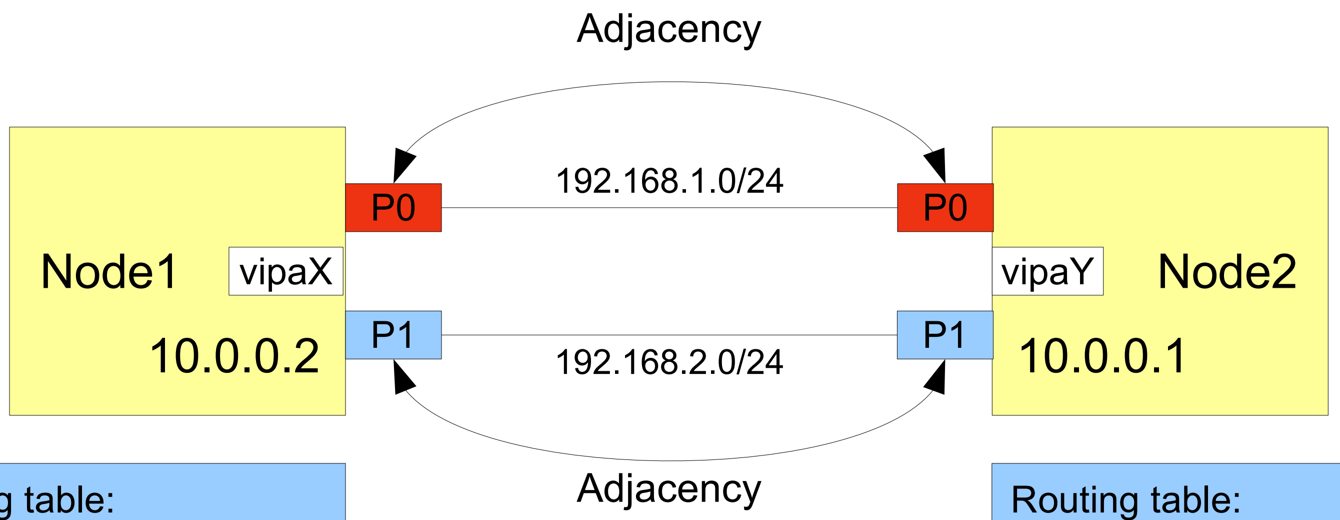
# The Problem ( again )

- 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 : getting to know your neighbors

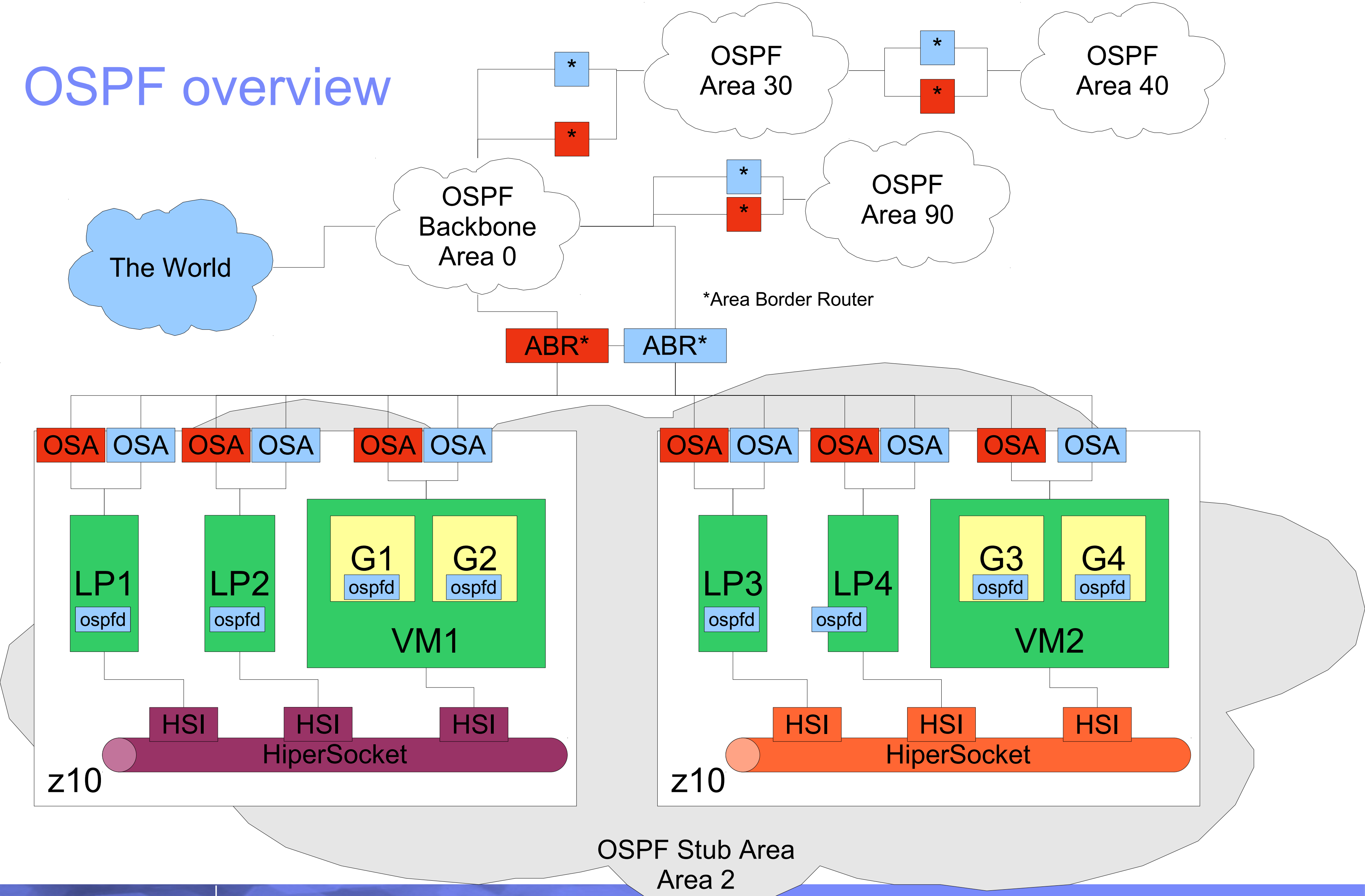


| Routing table: | |
|---|---|
| 192.168.1.0/24: | P0 |
| 192.168.2.0/24: | P1 |
| 10.0.0.1/32: | P0 |

| Routing table: | |
|---|---|
| 192.168.1.0/24: | P0 |
| 192.168.2.0/24: | P1 |
| 10.0.0.2/32: | P0 |

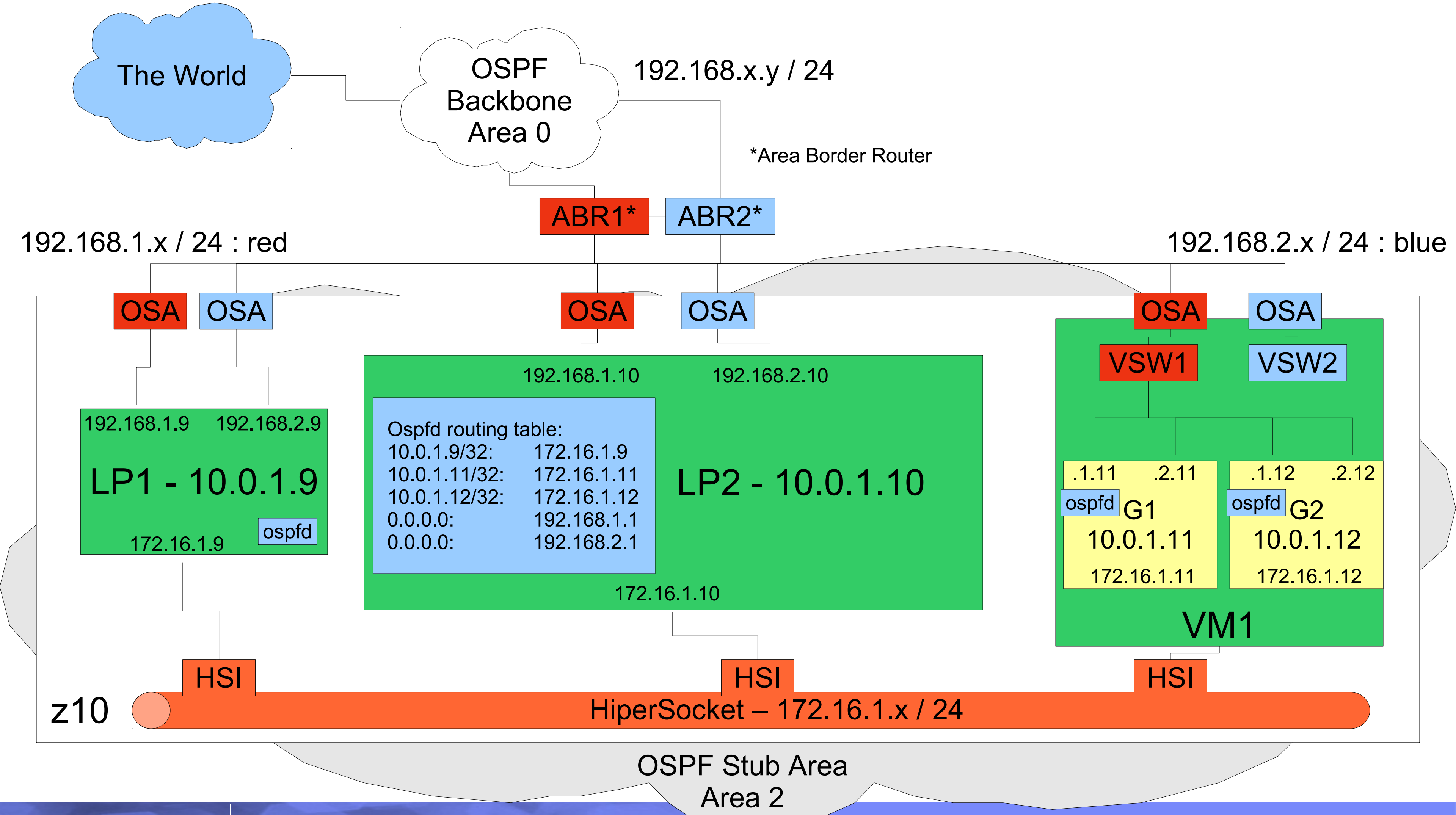
- Form Adjacency with your neighbors
- Advertise all networks you know about to your neighbors
  - Your VIPA!!
- Build routes based on the networks your neighbors advertise to you
- Maintain routes over time

# OSPF overview



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

# OSPF: zooming in



Ospfd routing table:

| | |
|---|---|
| 10.0.1.9/32: | 172.16.1.9 |
| 10.0.1.11/32: | 172.16.1.11 |
| 10.0.1.12/32: | 172.16.1.12 |
| 0.0.0.0: | 192.168.1.1 |
| 0.0.0.0: | 192.168.2.1 |

# 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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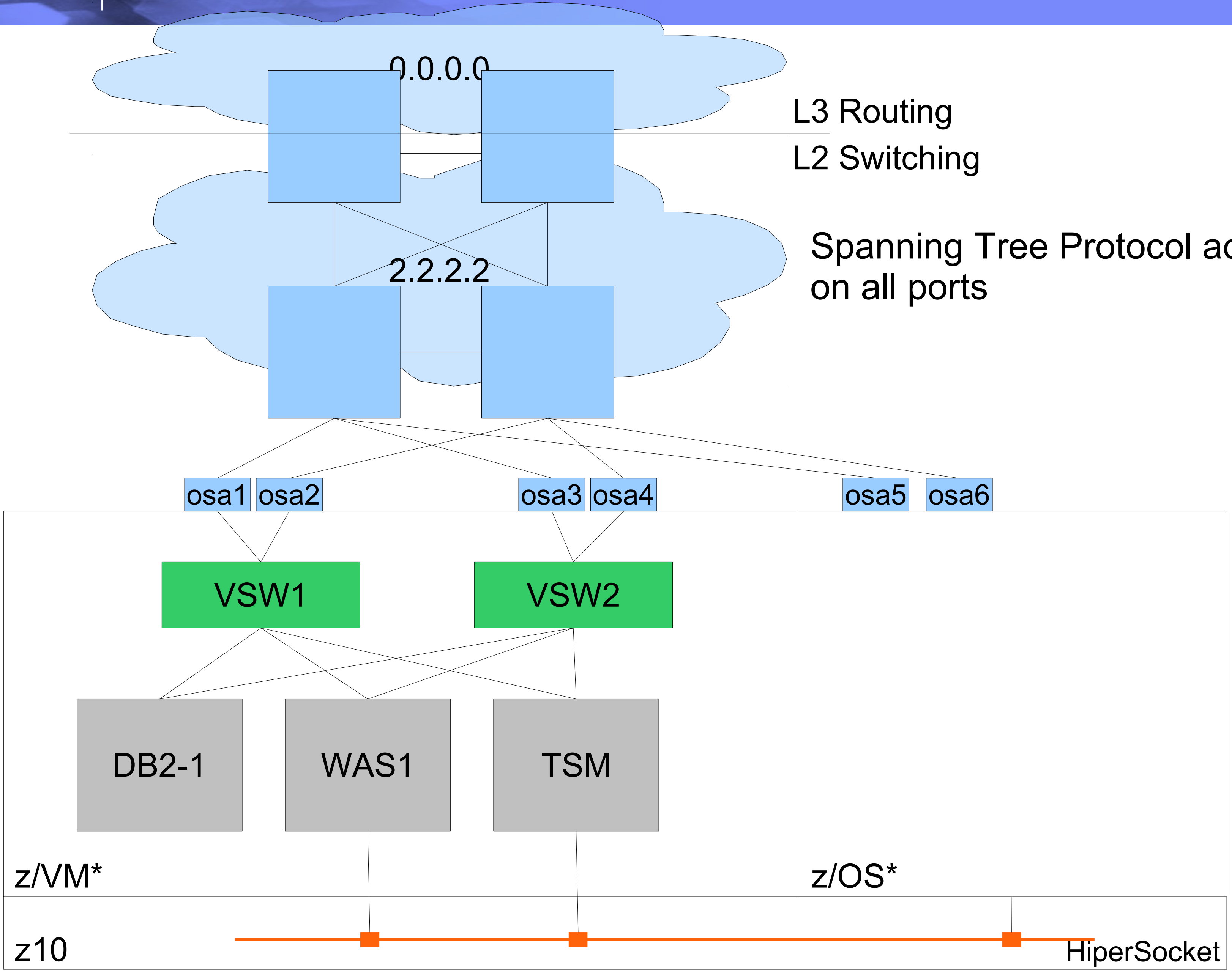
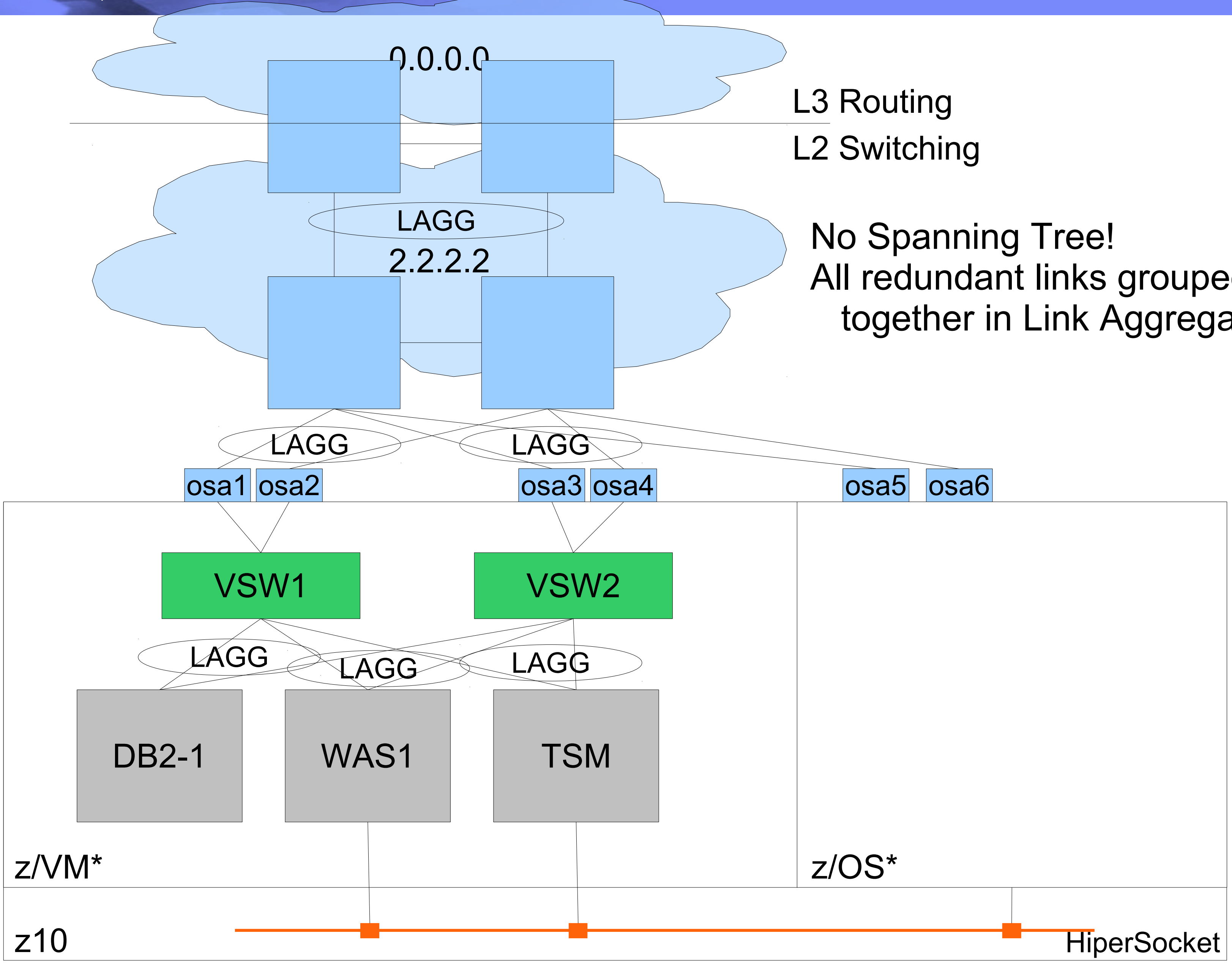
# Old vs New ?

- Does Link Aggregation make OSPF solutions obsolete?



Spanning Tree Protocol active on all ports

*Not to scale



L3 Routing

L2 Switching

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

*Not to scale