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Networking with Linux on System z

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IBM Corporation

Aug 7, 2012: 4:30 PM-5:45 PM
Grand Ballroom Salon C (Anaheim Marriott Hotel)

Session Number **11807**

SHARE in Anaheim 2012

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Session 11807
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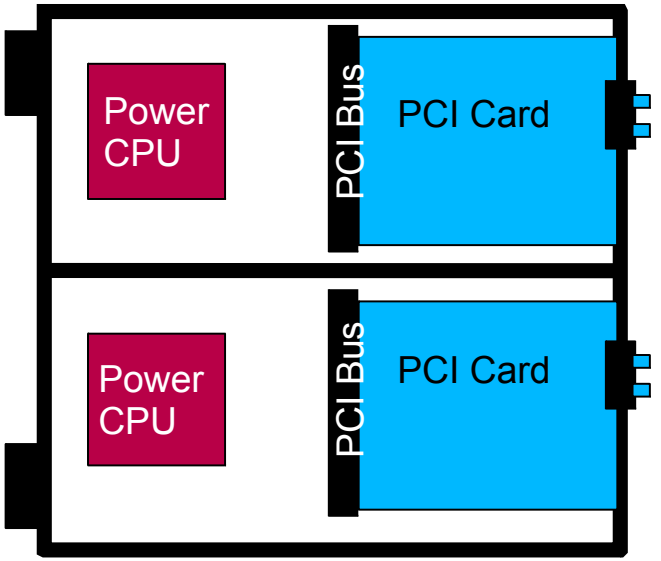
Agenda

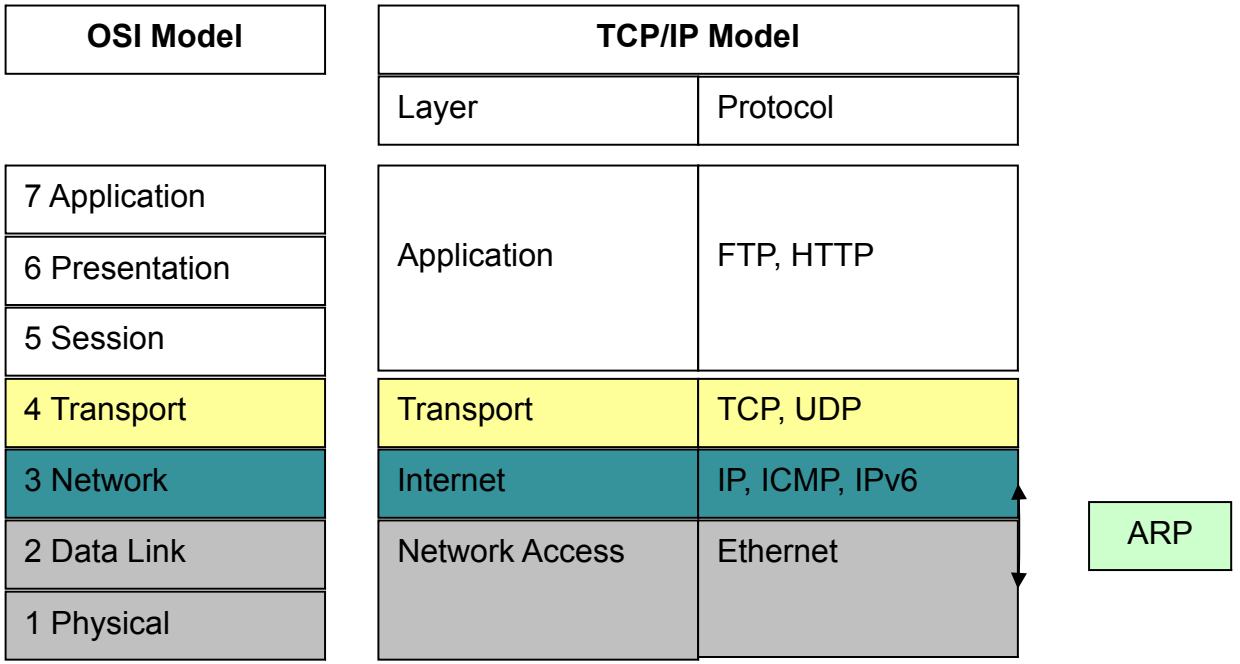
Network Connections

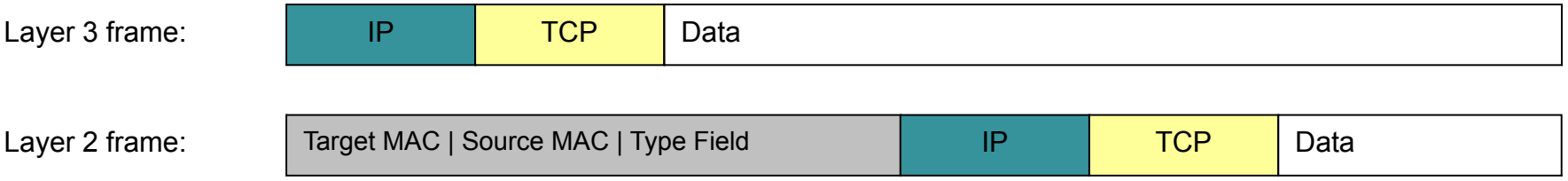
Primary Network Device: OSA Express

- Open Systems Adapter-Express (OSA-Express) provides connectivity support to the following LAN types: 1000BASE-T Ethernet (10/100/1000 Mbps), 1 Gbps Ethernet, 10 Gbps Ethernet
- 'Integrated Power computer' with network daughter card
- Shared between up to 640 OSA devices
- Three devices numbers (ccw devices) per OSA device:
  - Read device (control data ← OSA)
  - Write device (control data → OSA)
  - Data device (network traffic)
- OSA Address Table: which OS image has which IP address
- Network traffic Linux ↔ OSA, either
  - IP (layer3 mode)
    - One MAC address for all stacks
    - OSA handles ARP (Address Resolution Protocol)
  - Ethernet / data link layer level (layer2 mode)



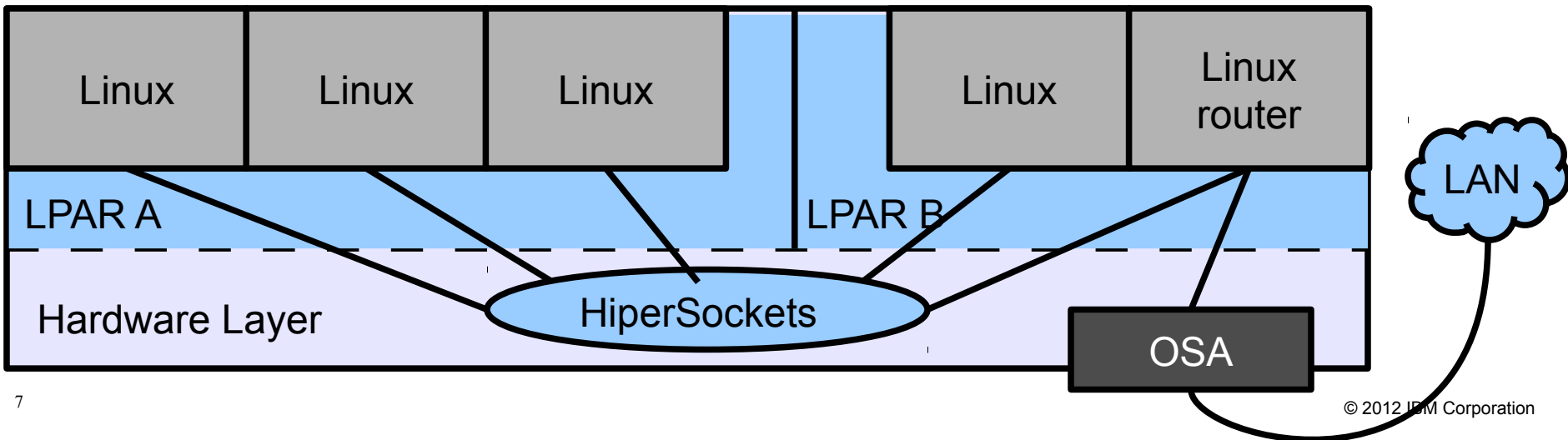
QETH Layer 3 vs Layer 2 mode





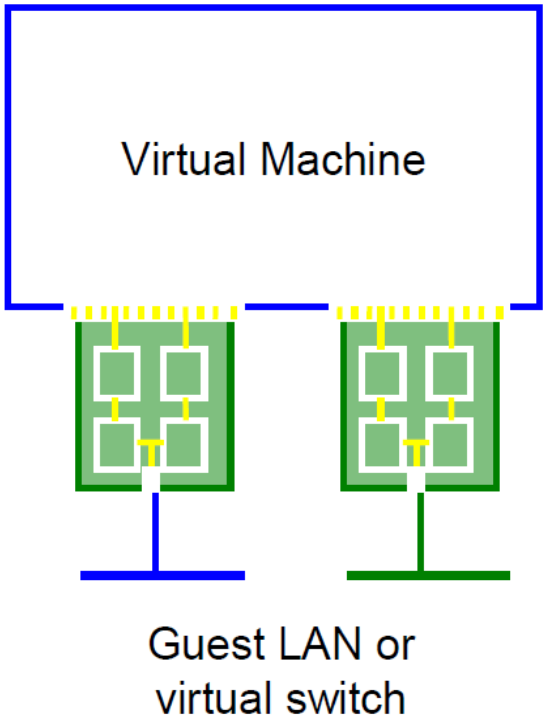
System z Hipersockets

- Connectivity within a central processor complex without physical cabling
- Internal Queued Input/Output (IQDIO) at memory speed
- Licensed Internal Code (LIC) function emulating DataLink Layer of an OSA-device (internal LAN)
- 4 different MTU sizes supported:
  - 8KB, 16KB, 32KB, 56KB
- Support of
  - Broadcast, VLAN, Ipv6, Layer2 (with z10)



Virtual Network Interface Card (NIC)

- A simulated network adapter
  - OSA-Express QDIO
  - HiperSockets
  - Must match LAN type
- Usually 3 devices per NIC
- Provides access to Guest LAN or VSWITCH
- Created by directory or *CP DEFINE NIC*



z/VM Guests (Linux, zVSE, ...)

```
DEF NIC 600 TYPE QDIO
COUPLE 600 SYSTEM VSWITCH1
```

Virtual Switch

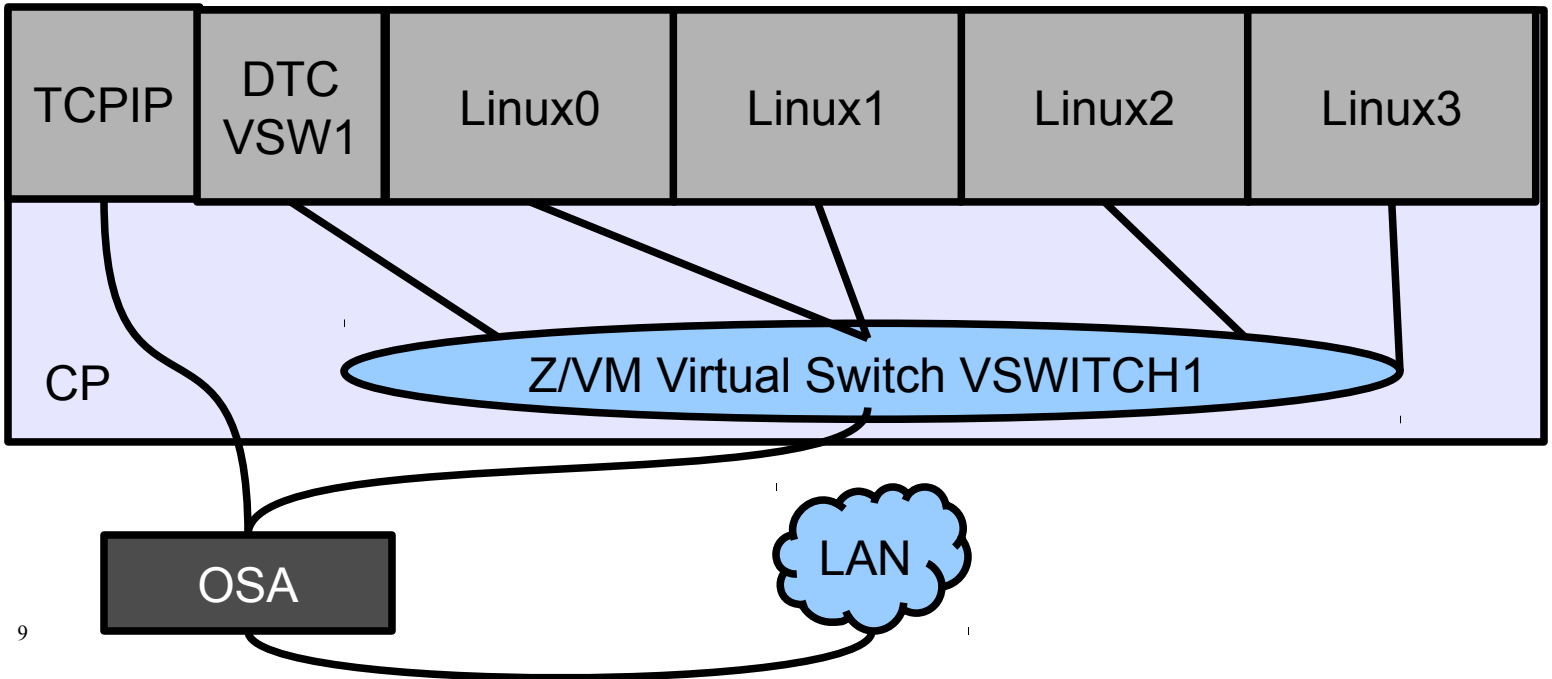
- Create simulated Layer 2 or 3 switch device
- VM access control and VLAN authorization
- Create ports
- Connect NIC to Virtual Switch (LAN Segment)
- Full MAC address management
  (generation and assignment)
- 1-n VSWITCHs per z/VM Image

Create VSWITCH from PRIVCLASS B User ID

```
DEF VSWITCH VSWITCH1 ETHERNET
SET VSWITCH VSWITCH1 GRANT {user ID}
```

From Linux Virtual Machines

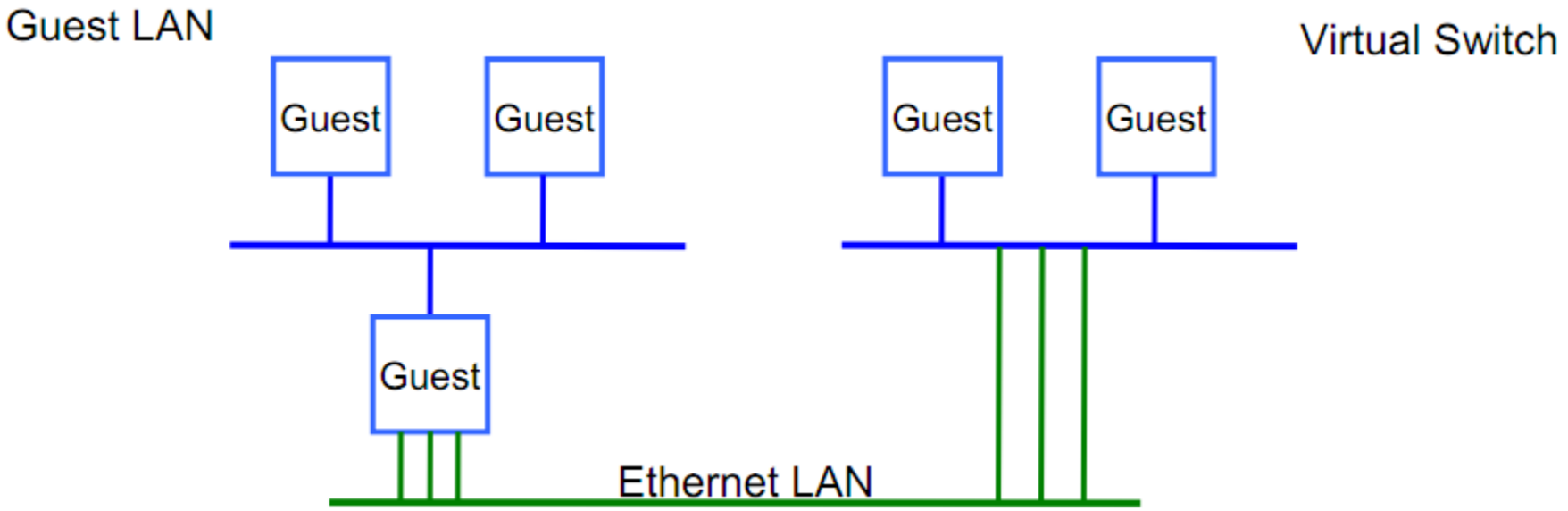
```
DEF NIC 600 TYPE QDIO
COUPLE 600 SYSTEM VSWITCH1
```



GuestLAN

- A simulated LAN
- Ethernet: IPv4 and IPv6
- HiperSockets: IPv4
- Unicast, Multicast, and Broadcast
- No built-in connection to outside network
- As many as you want
- Owned by system or individual user
- Is not a device - it is a system object
- Created in SYSTEM CONFIG, directory, or by CP
- DEFINE LAN command

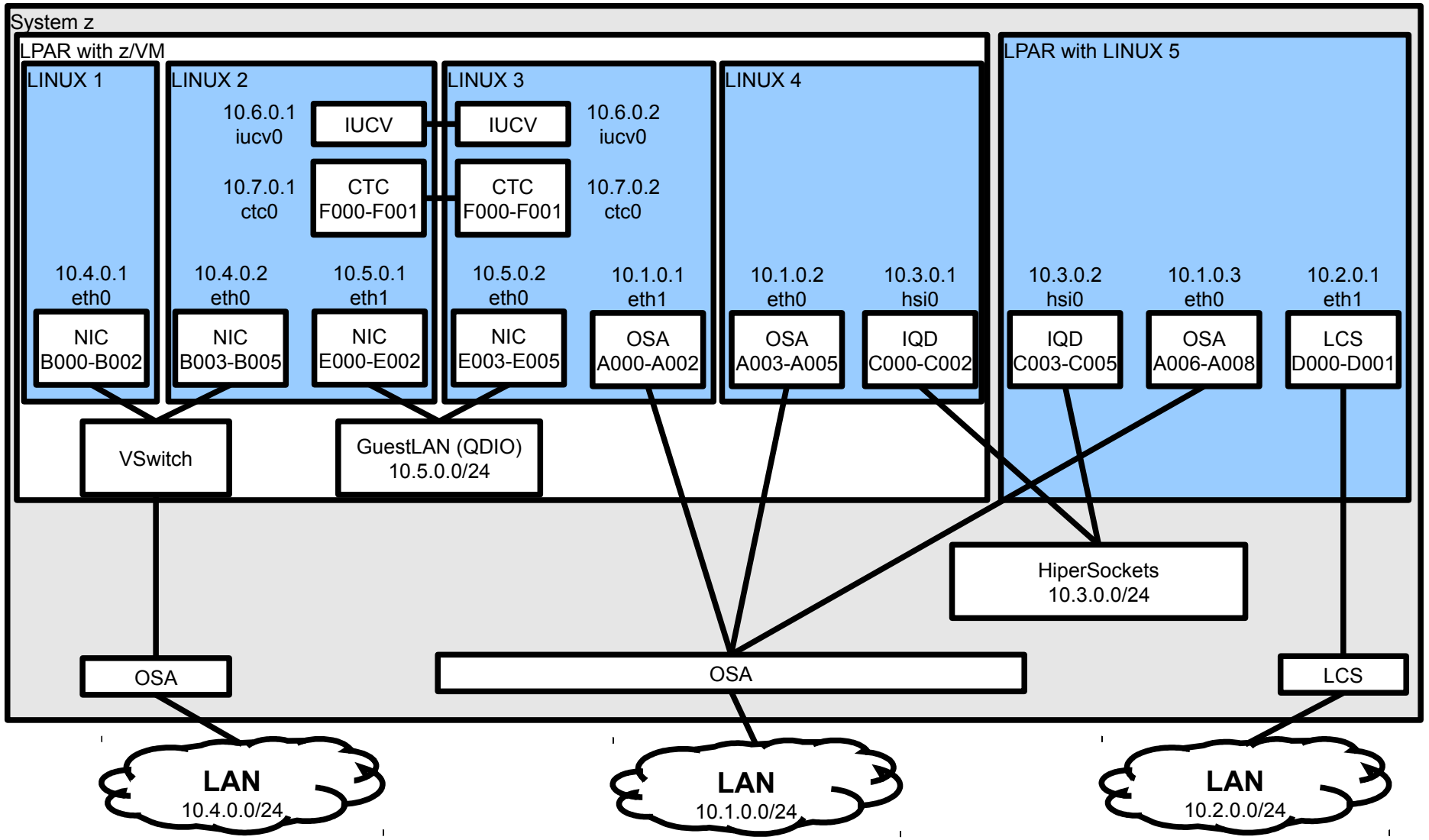
Guest LAN vs. Virtual Switch



- Virtual router is required
- Different subnets
- External router awareness
- Guest-managed failover

- No virtual router
- Same subnets
- Transparent bridge
- CP-managed failover

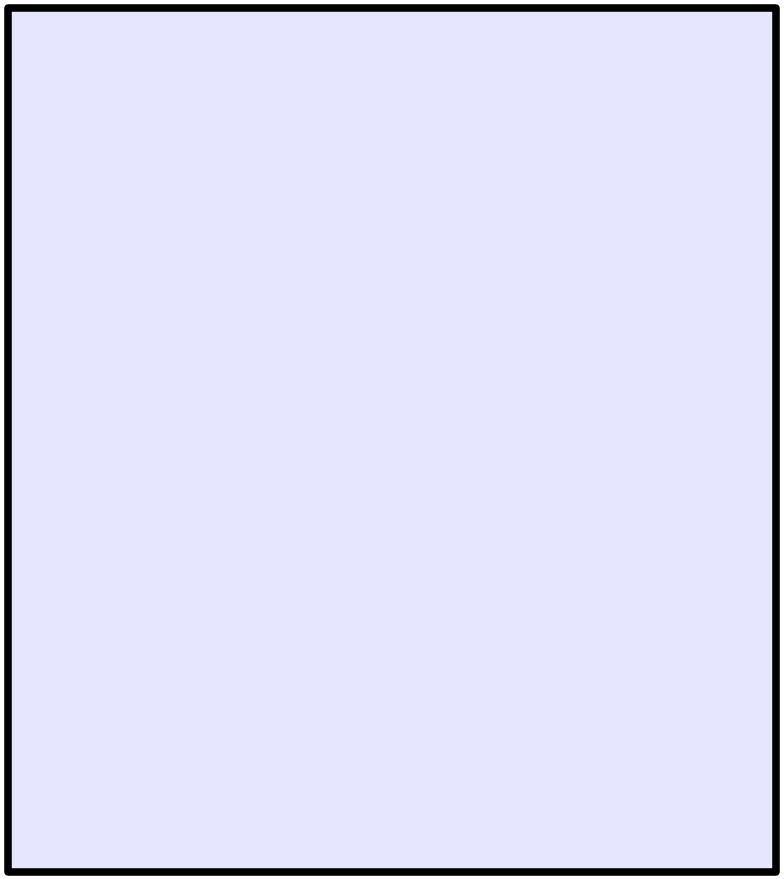
Network Example



Where is the Problem?

Where is the Problem?

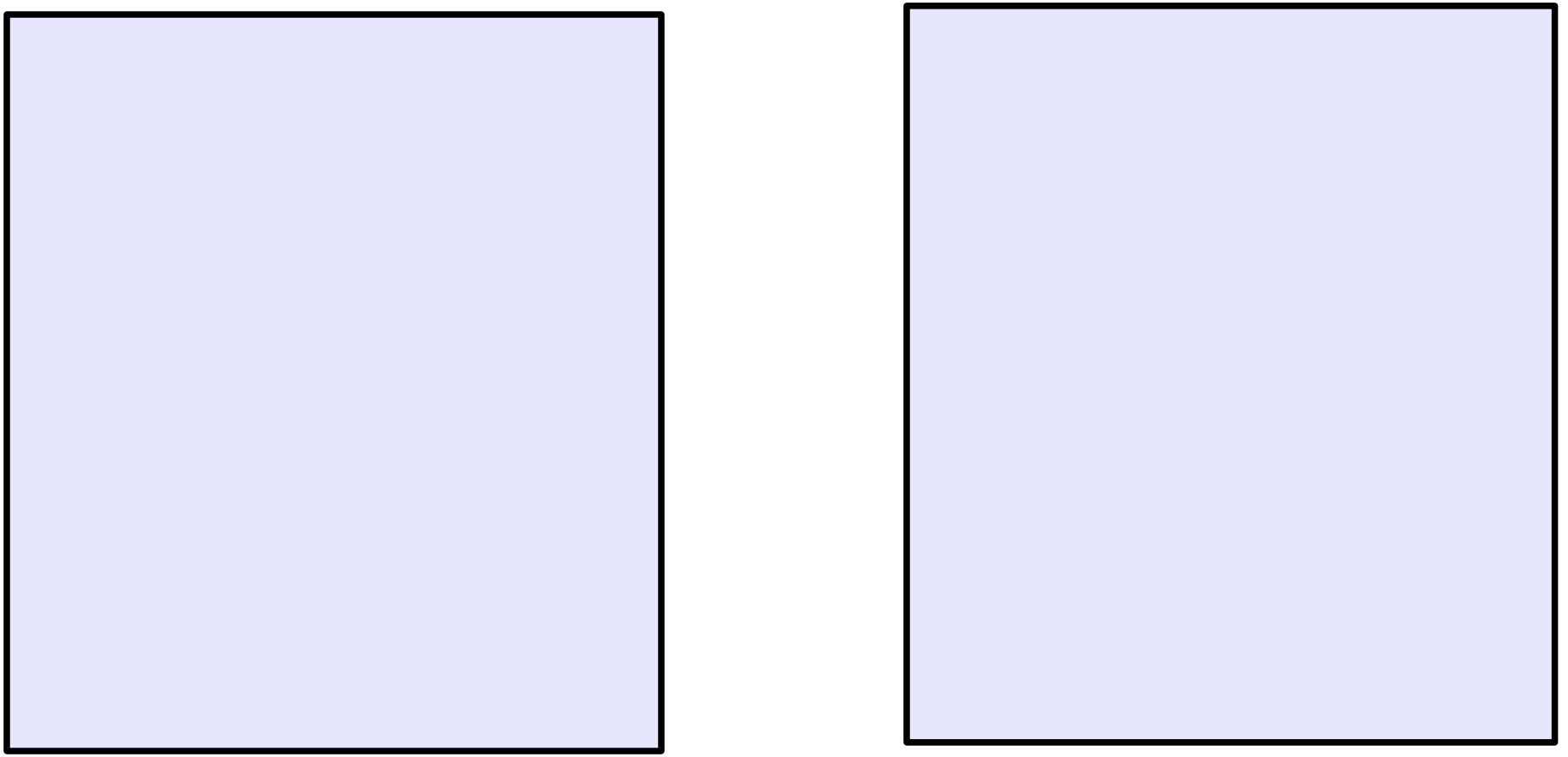
Site A



Where is the Problem?

Site A

Site B



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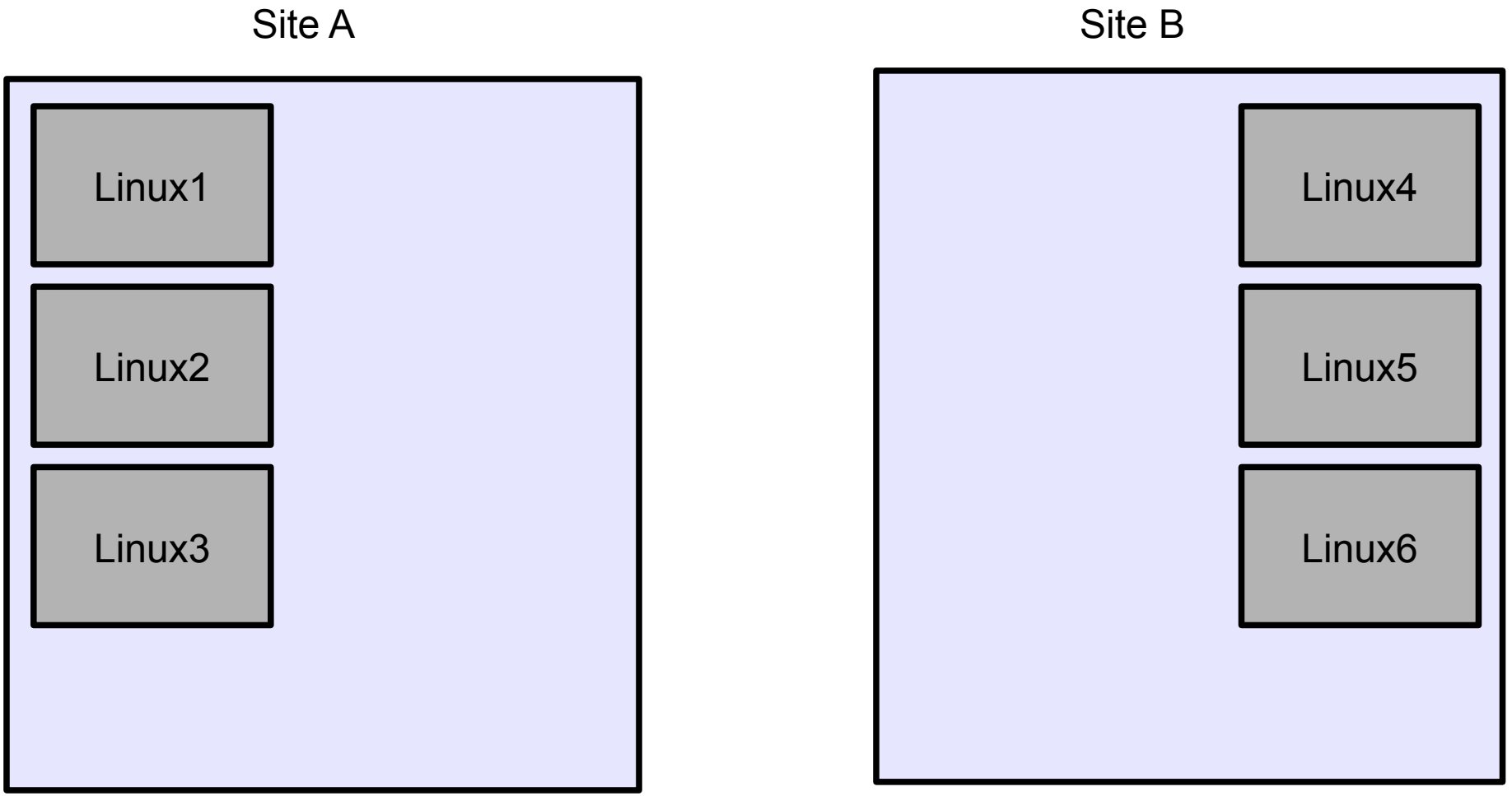

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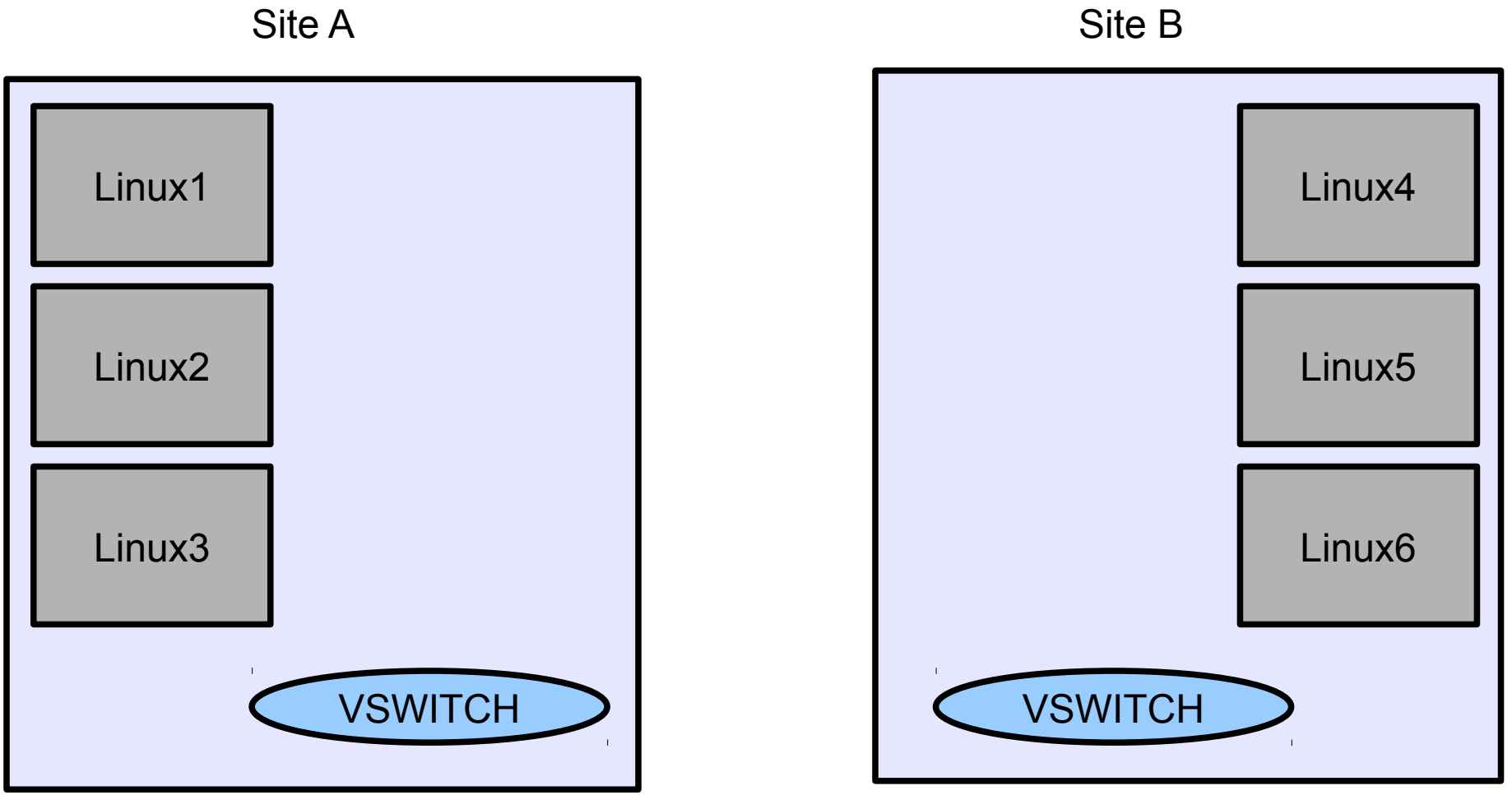

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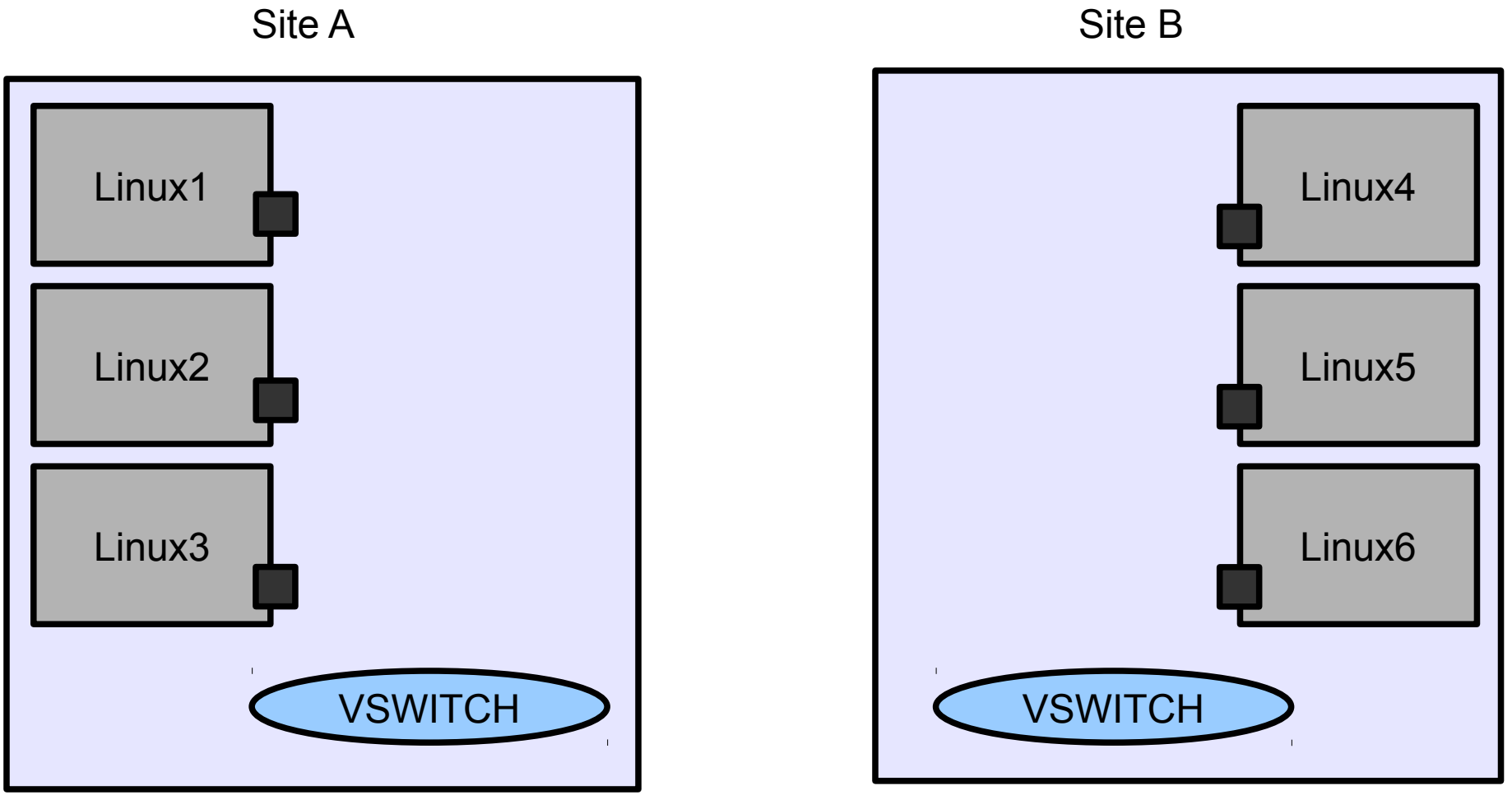

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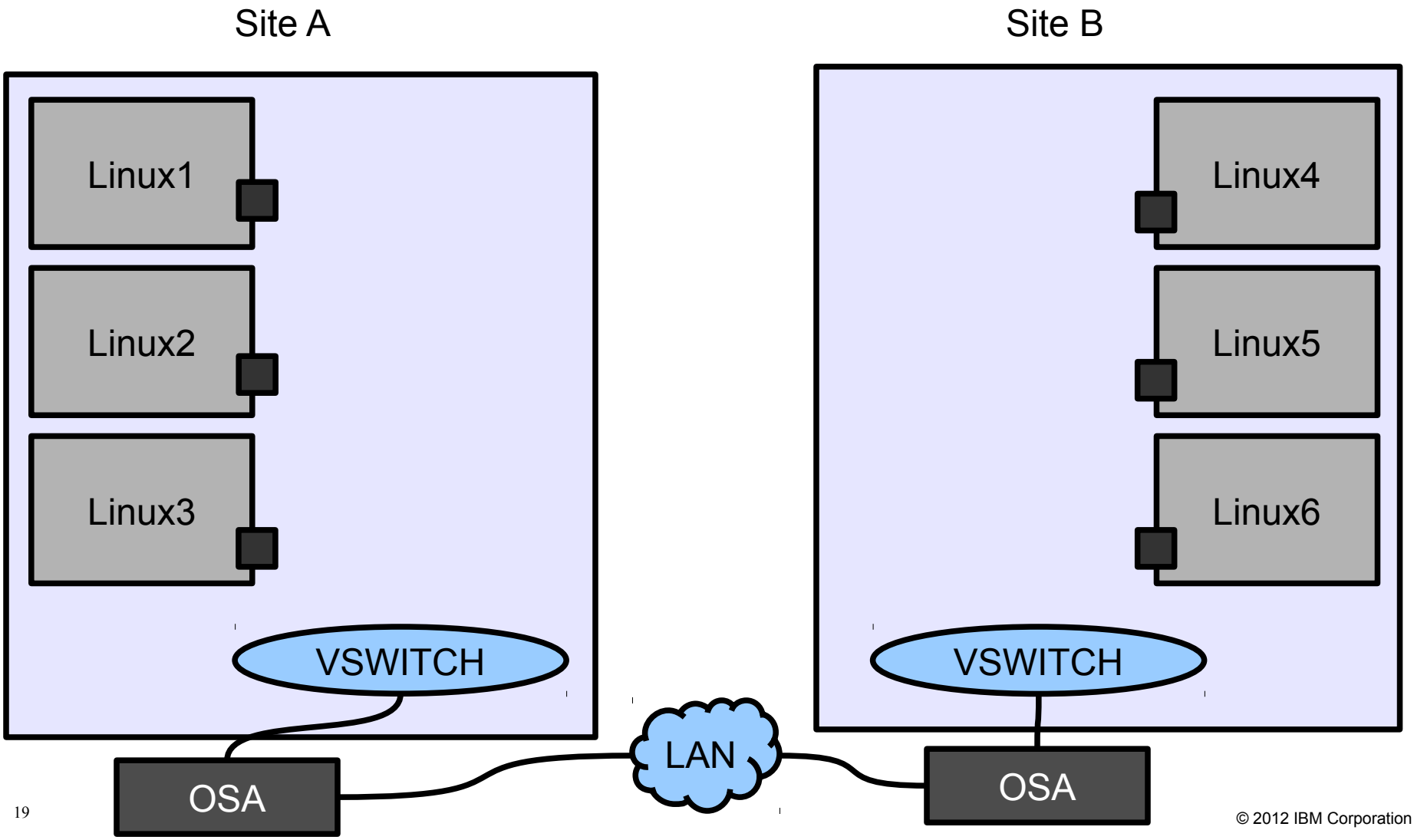

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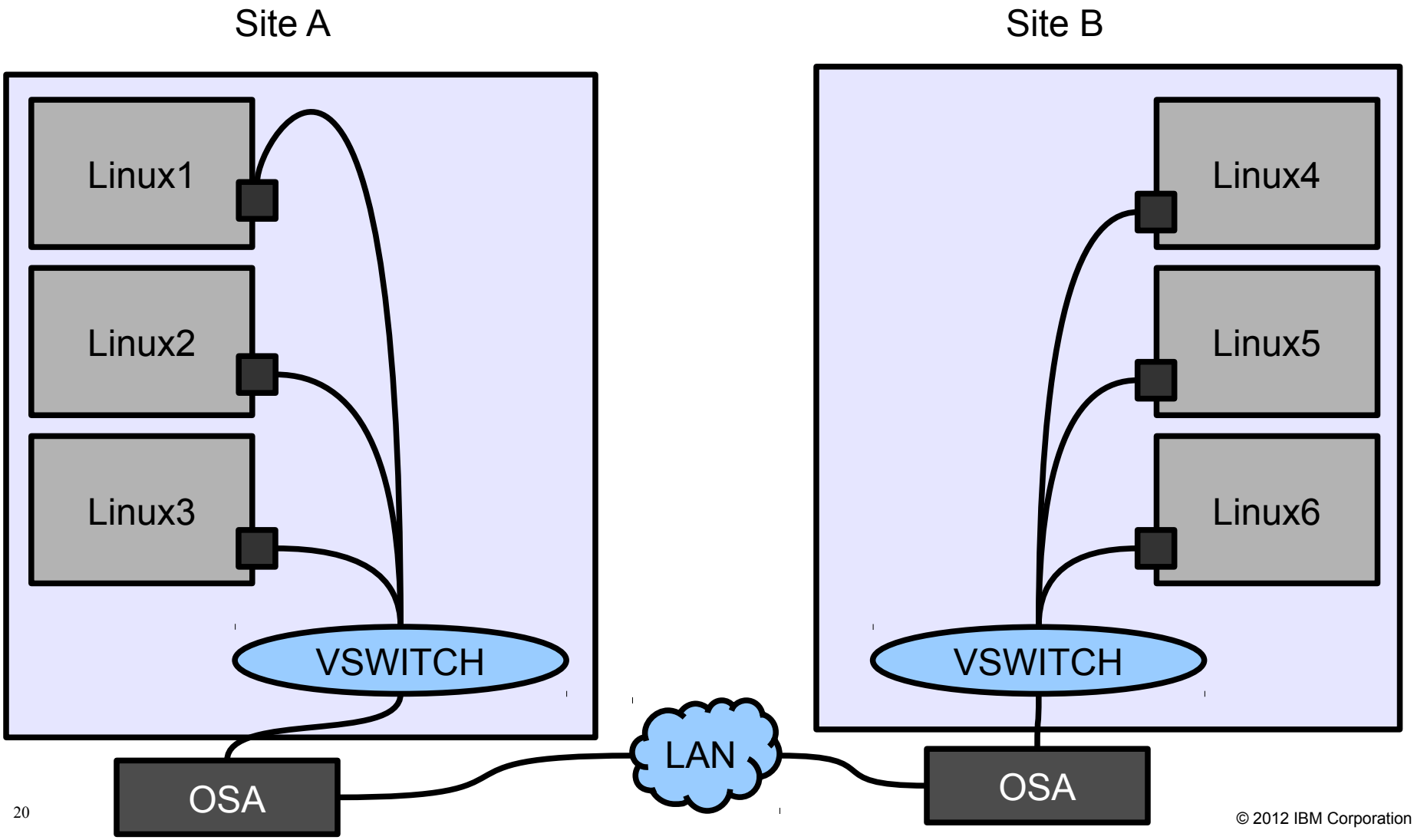
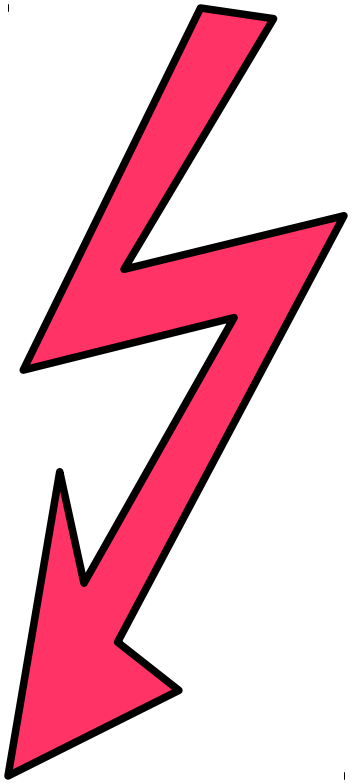
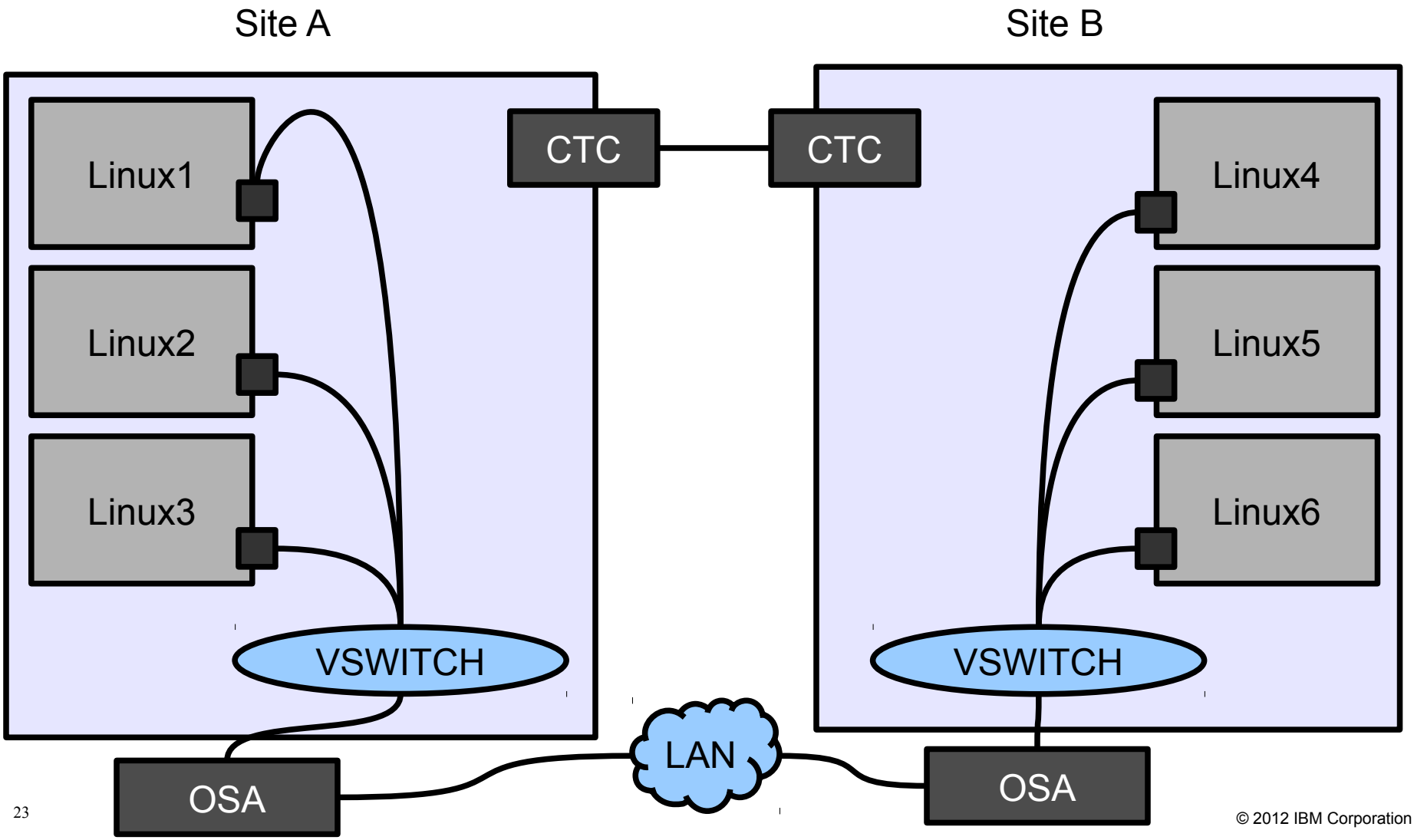




Everything is working fine...but the OSA cards are shared with the z/OS and the Linux TSM backup takes forever....

...So the Admin decides to implement a CTC connection for the backup...

Where is the Problem?



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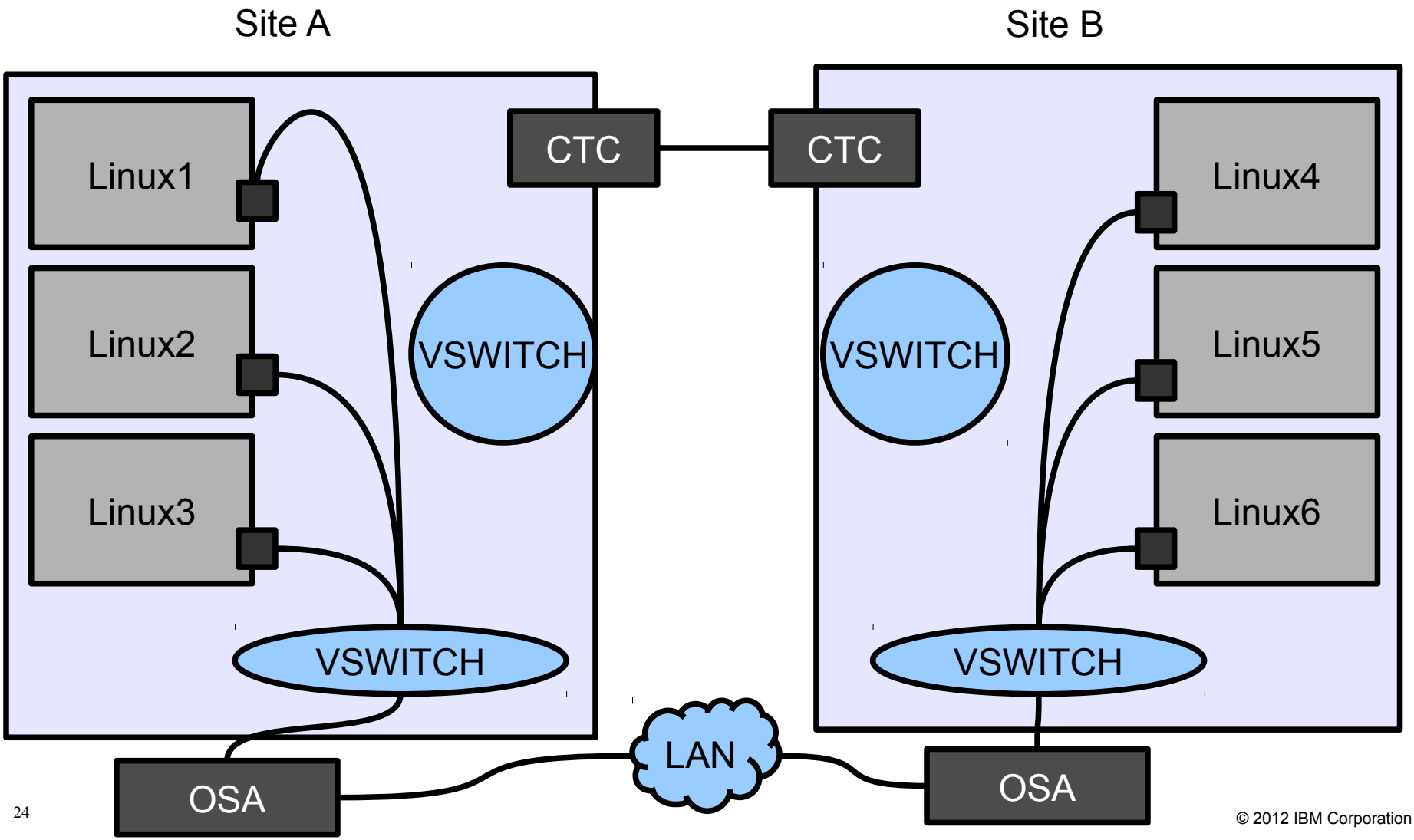

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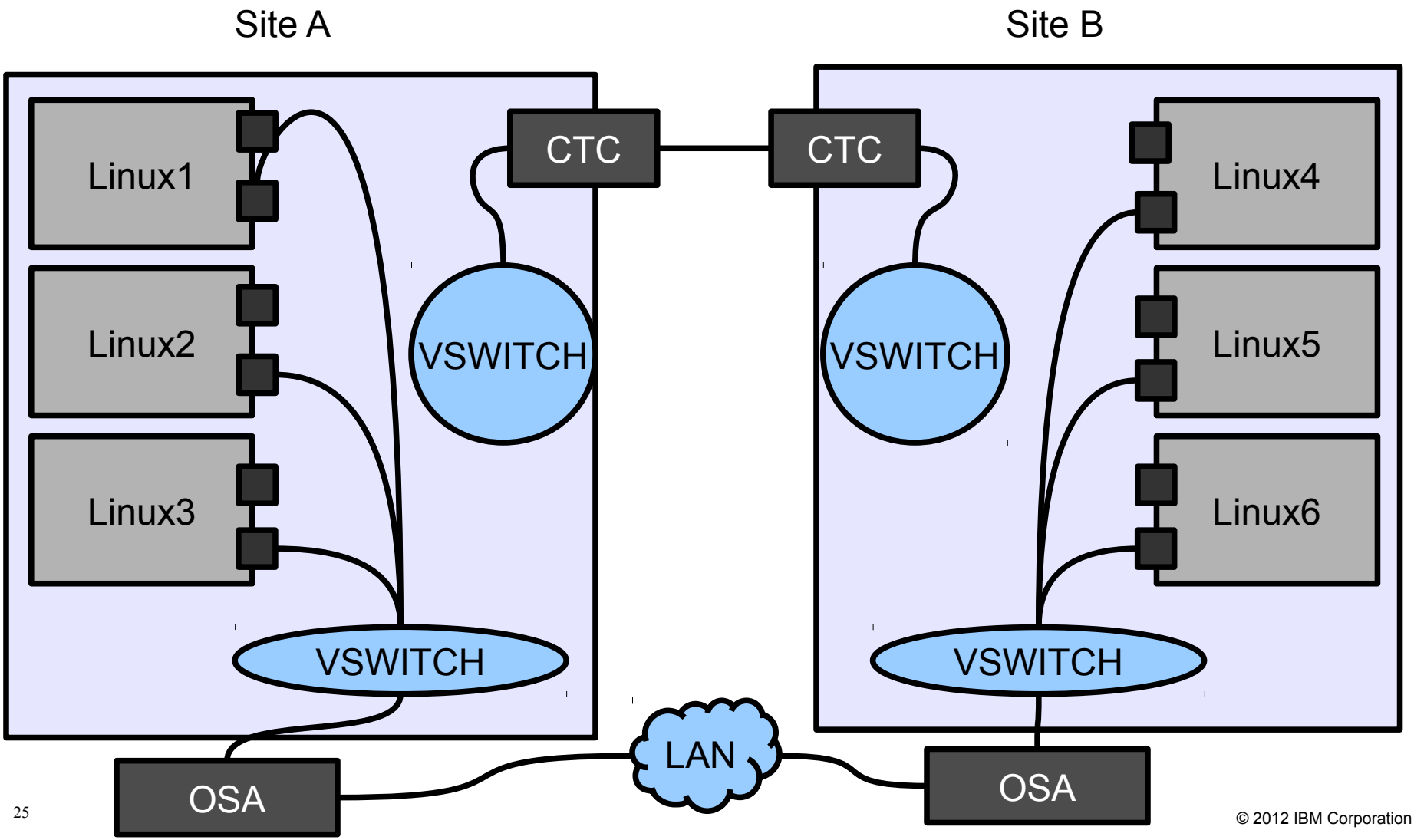

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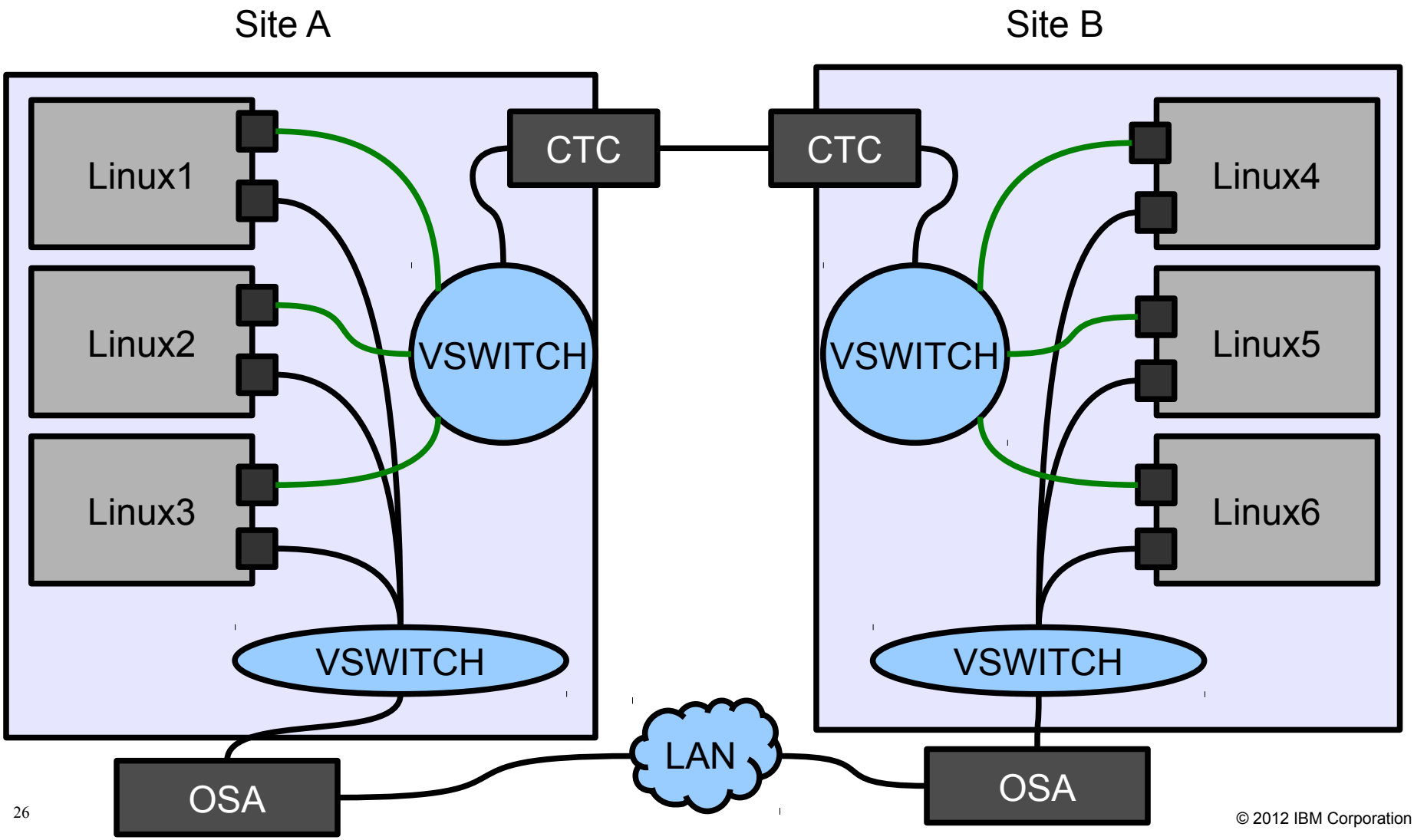

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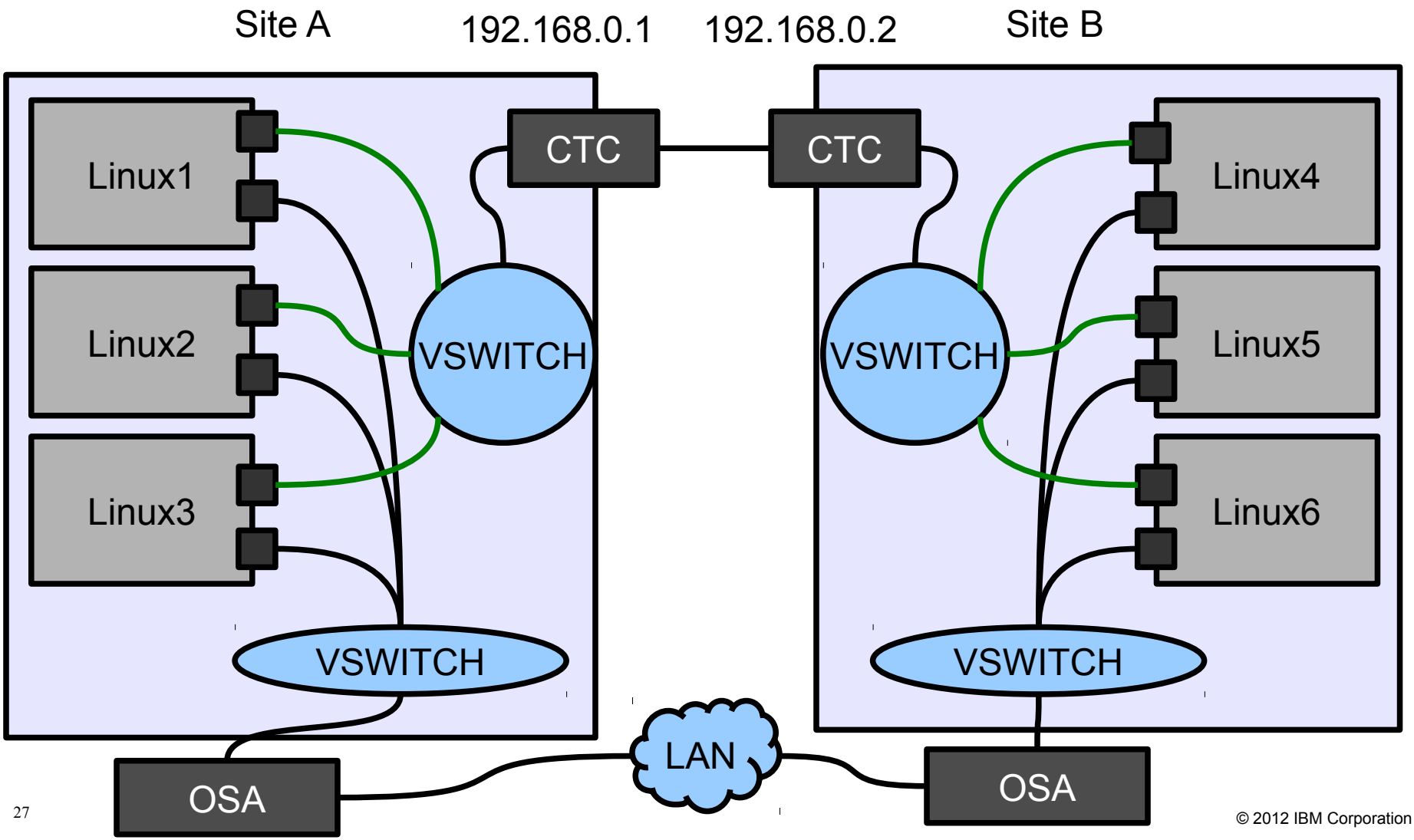

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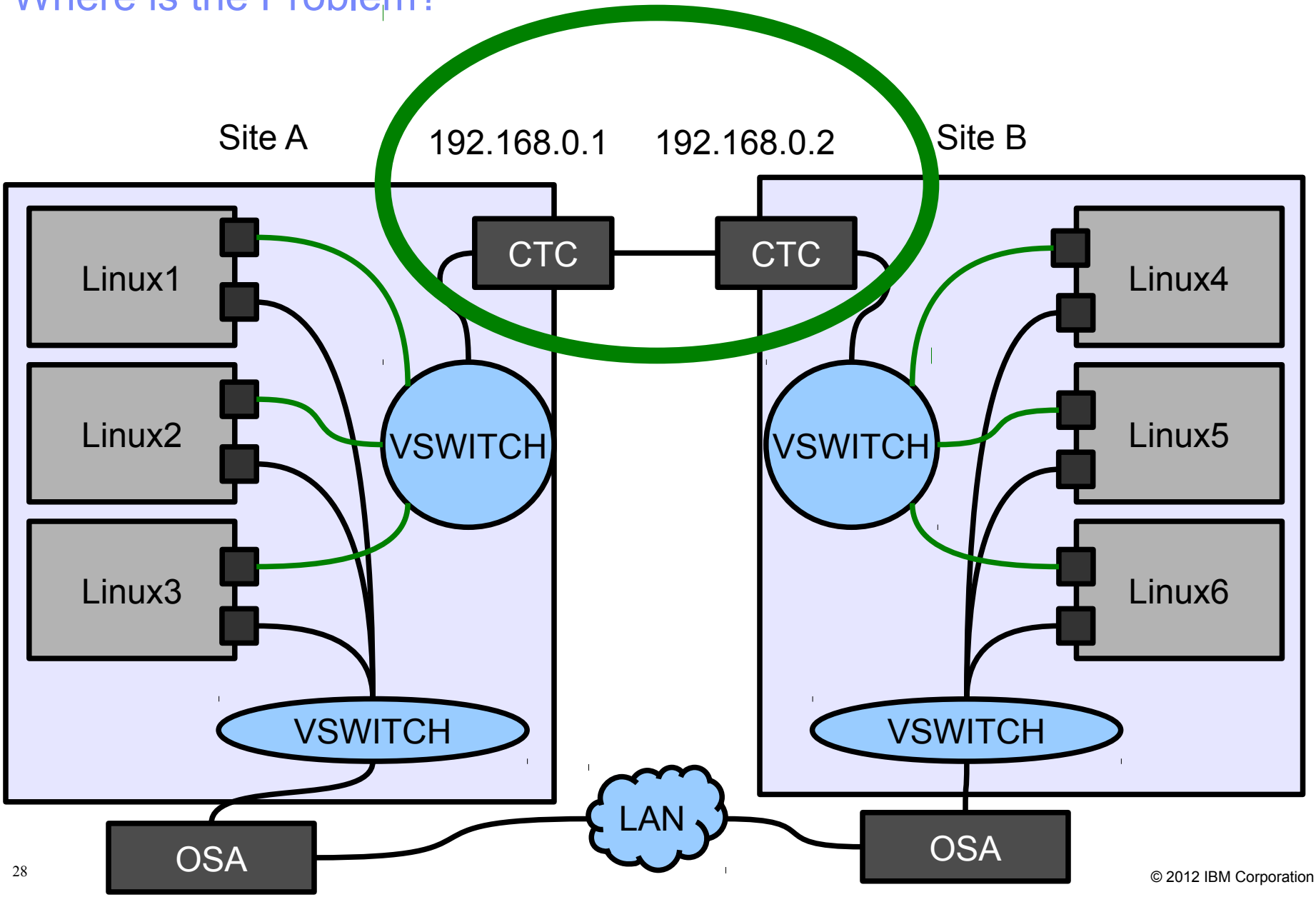

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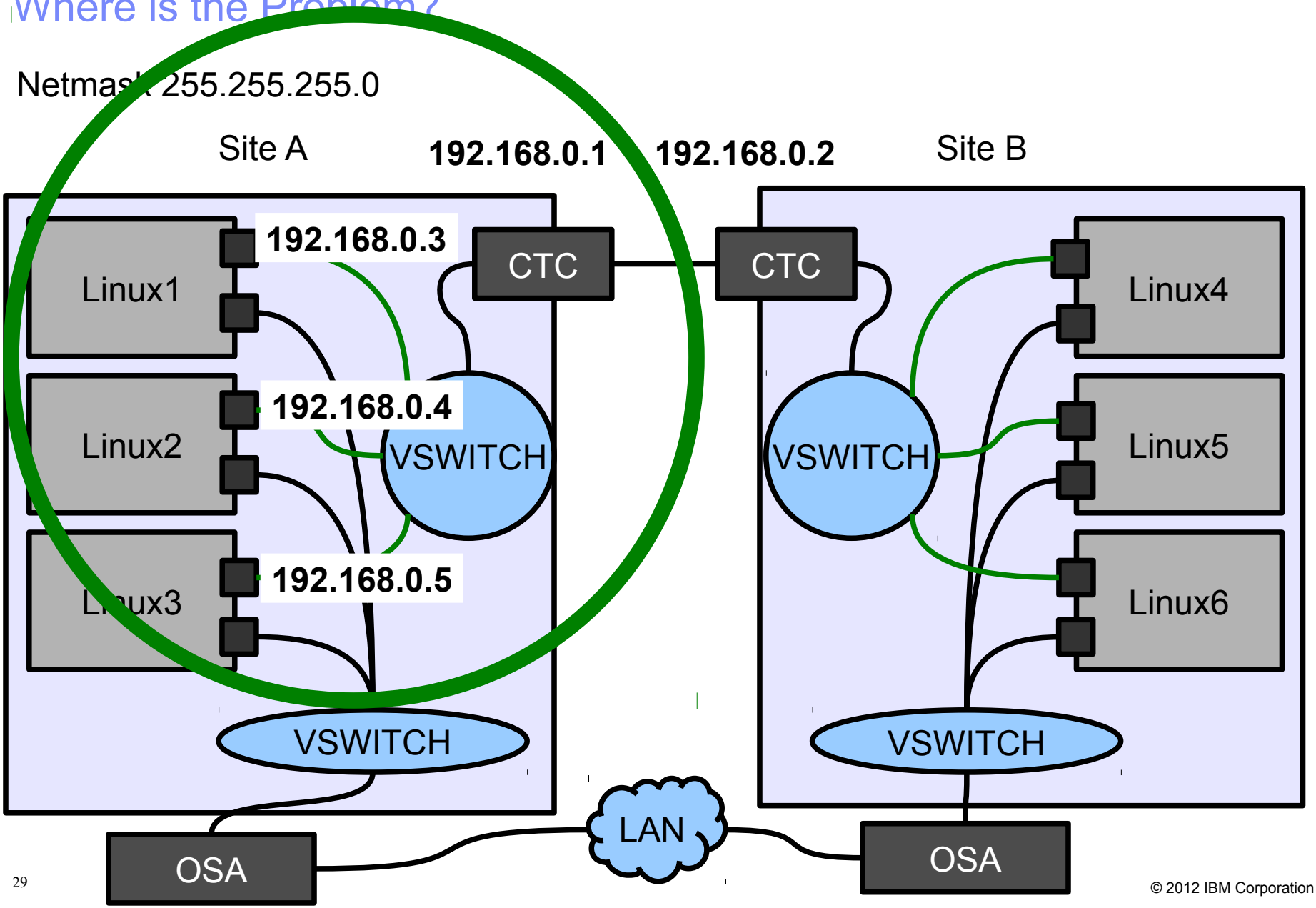
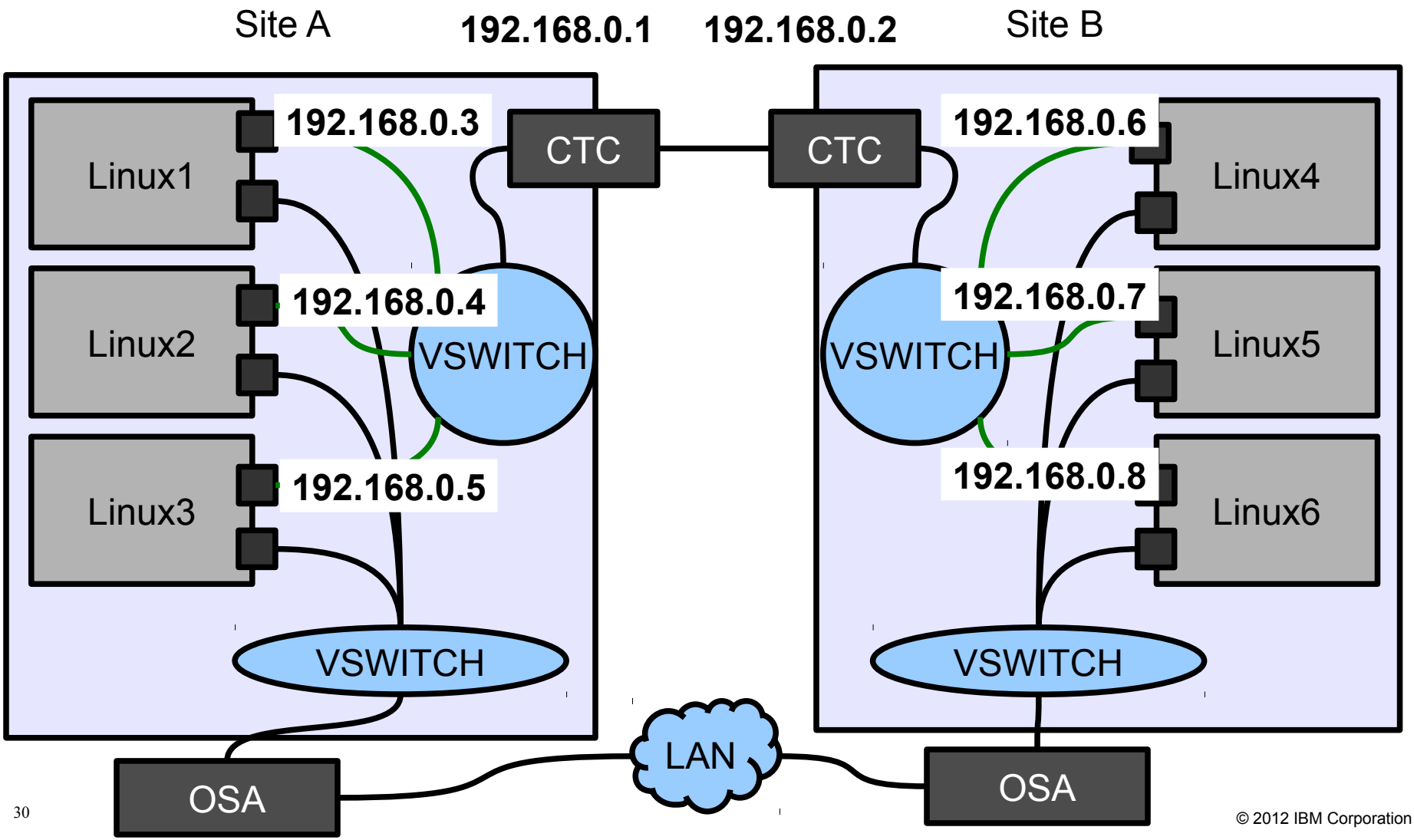


Where is the Problem?

Netmask 255.255.255.0



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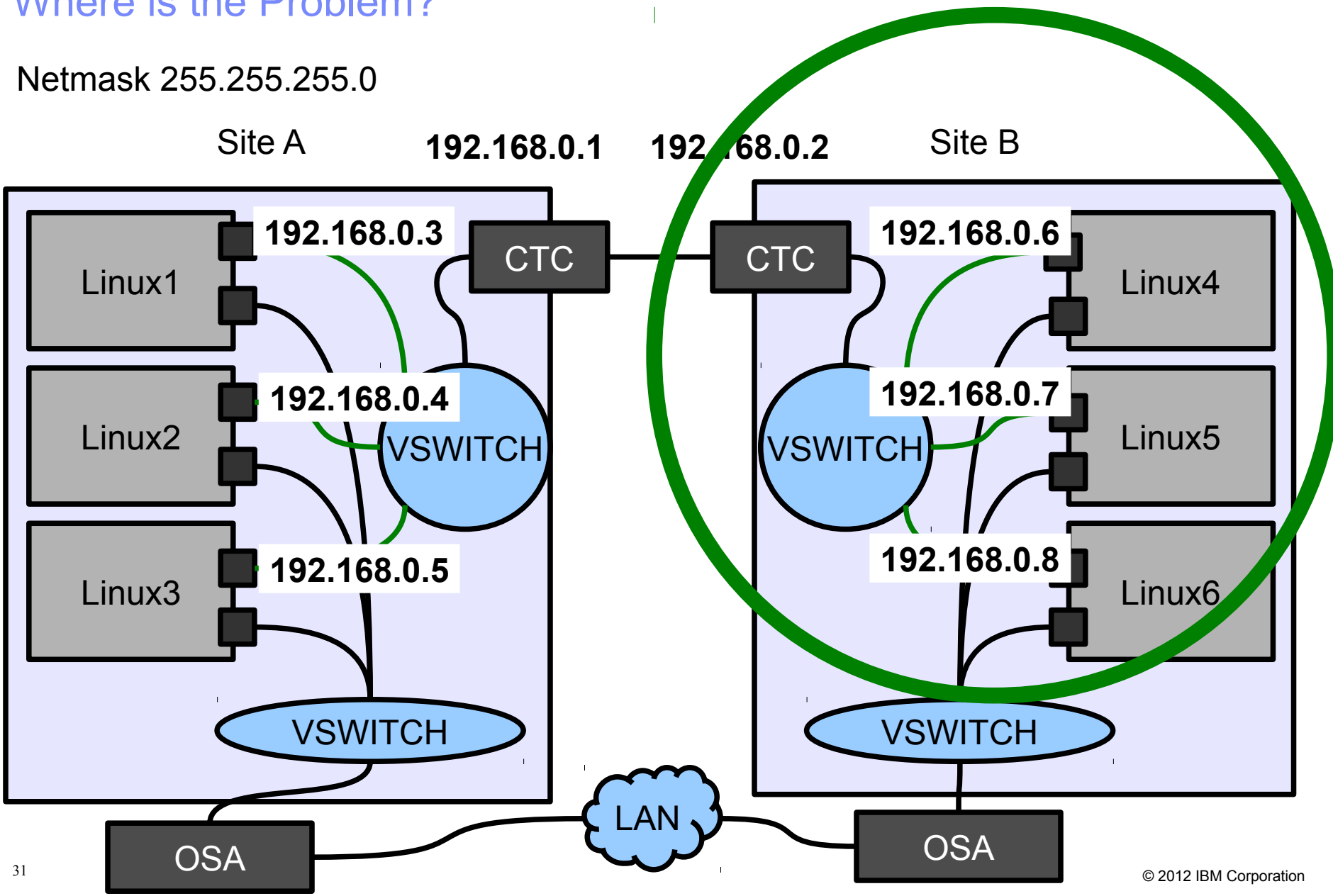

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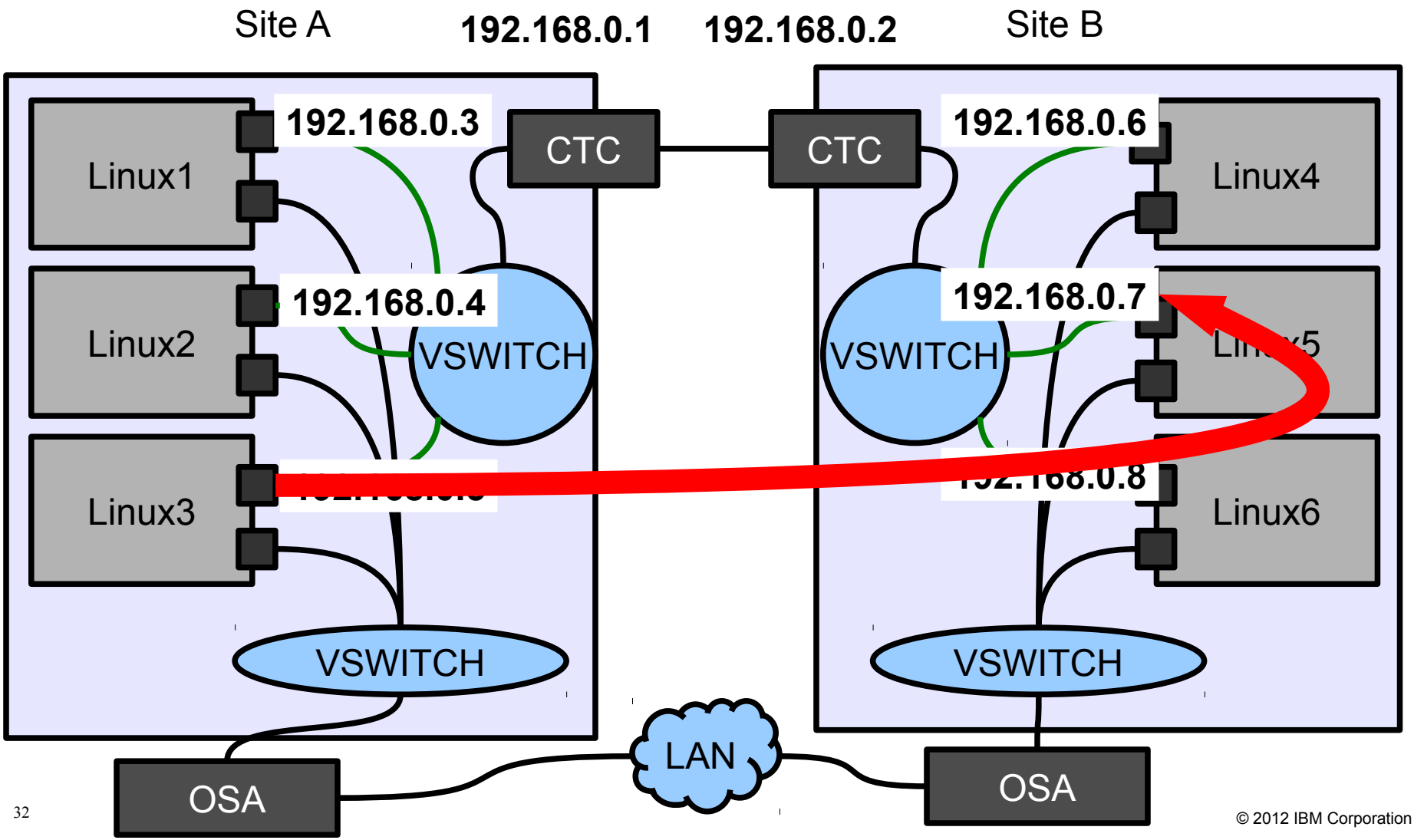

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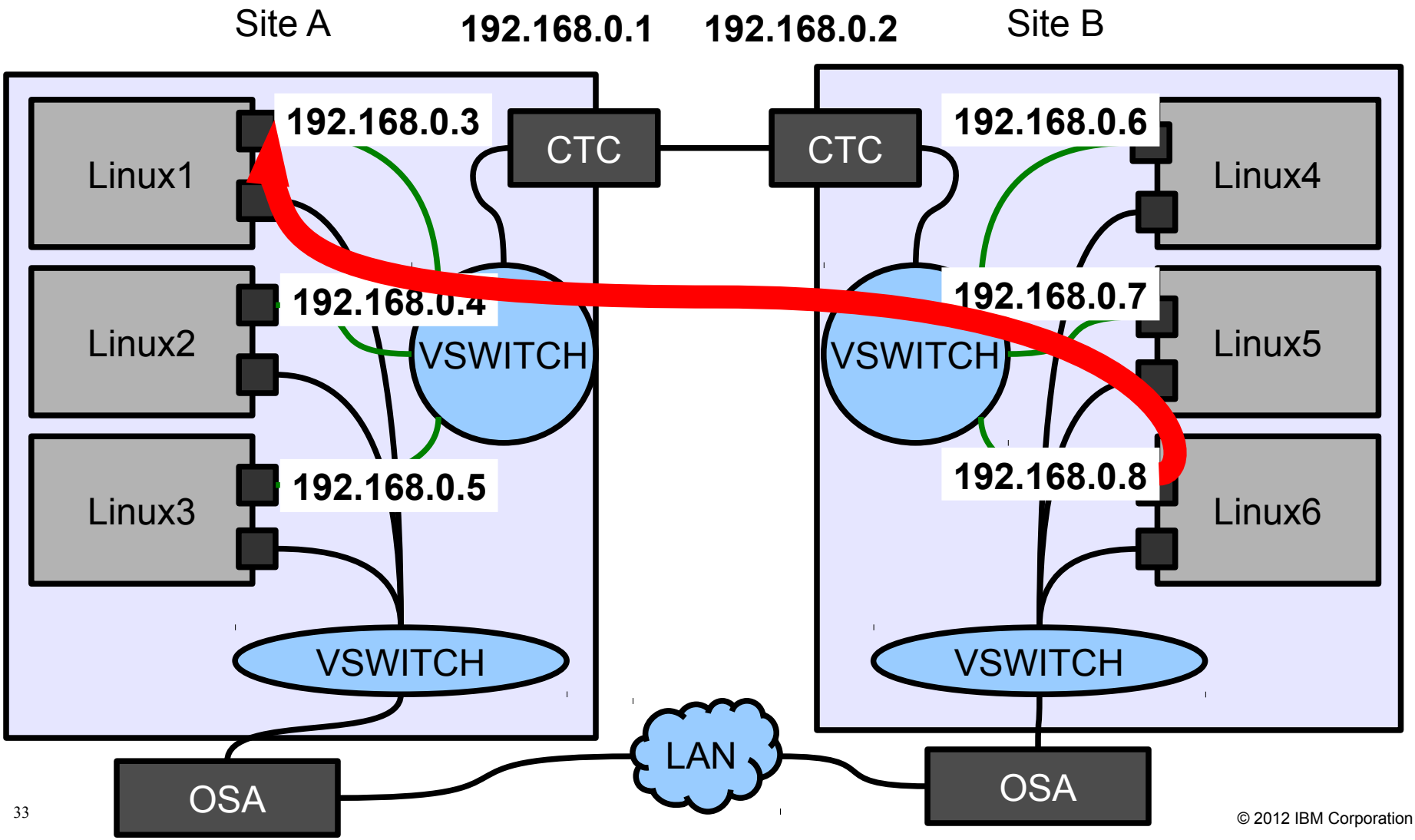

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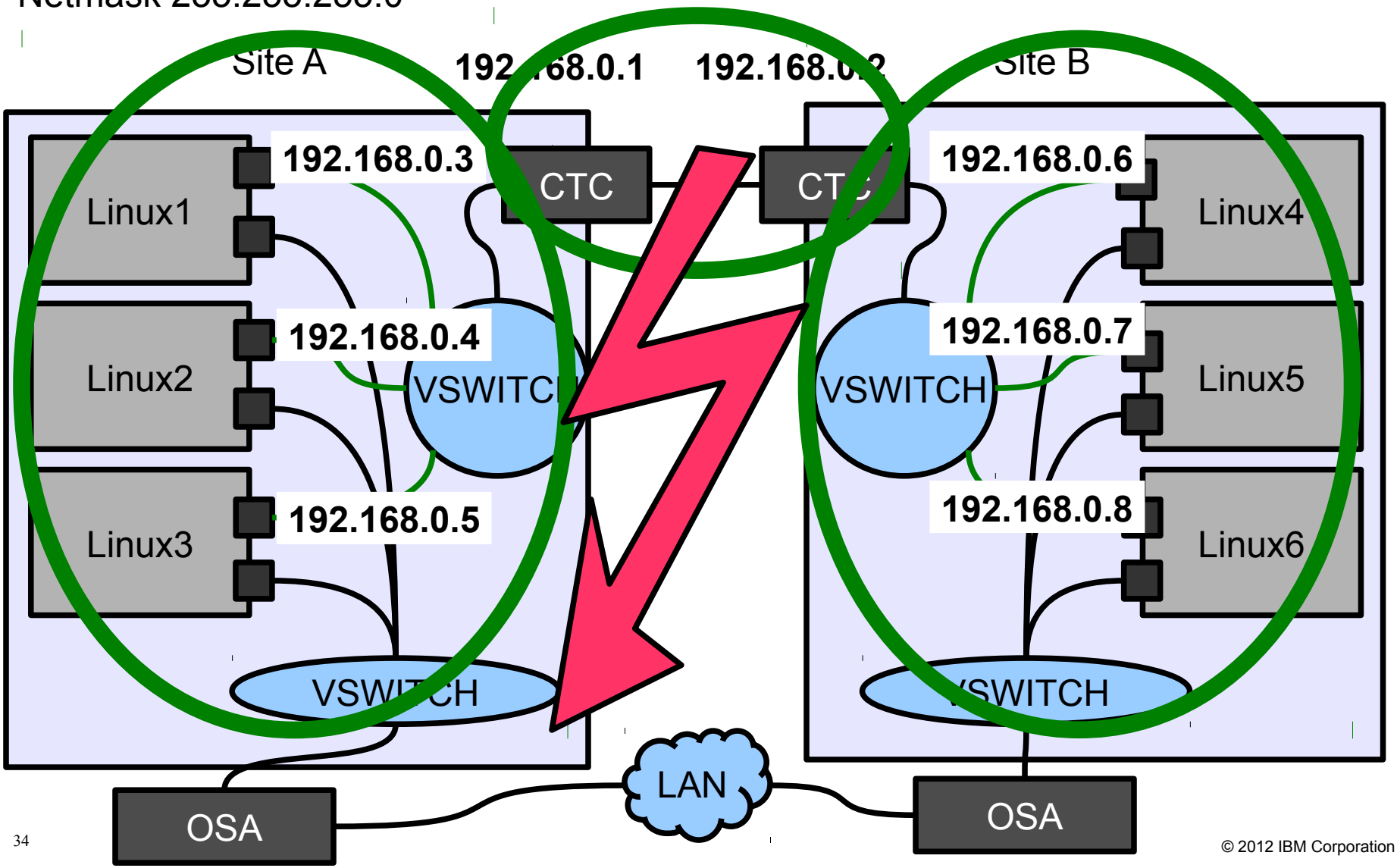

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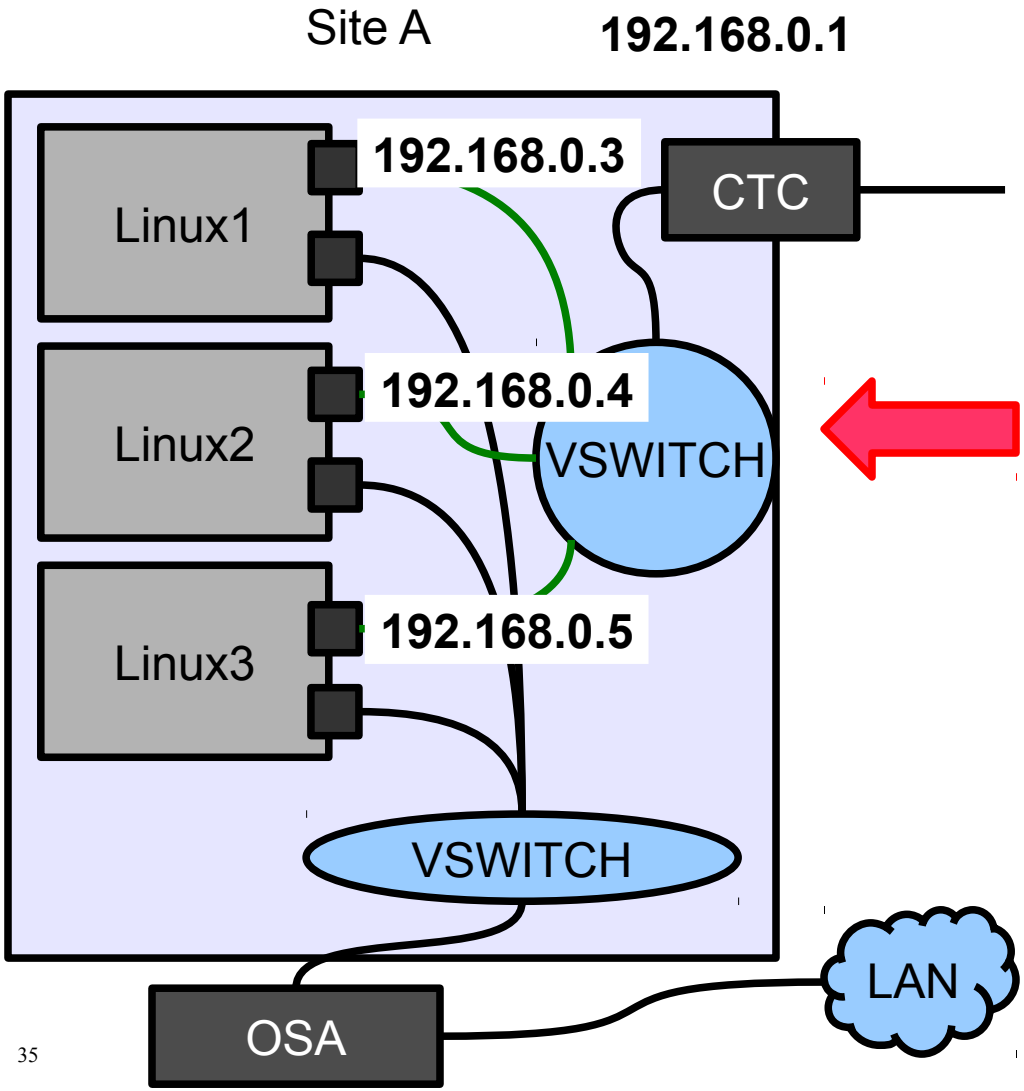
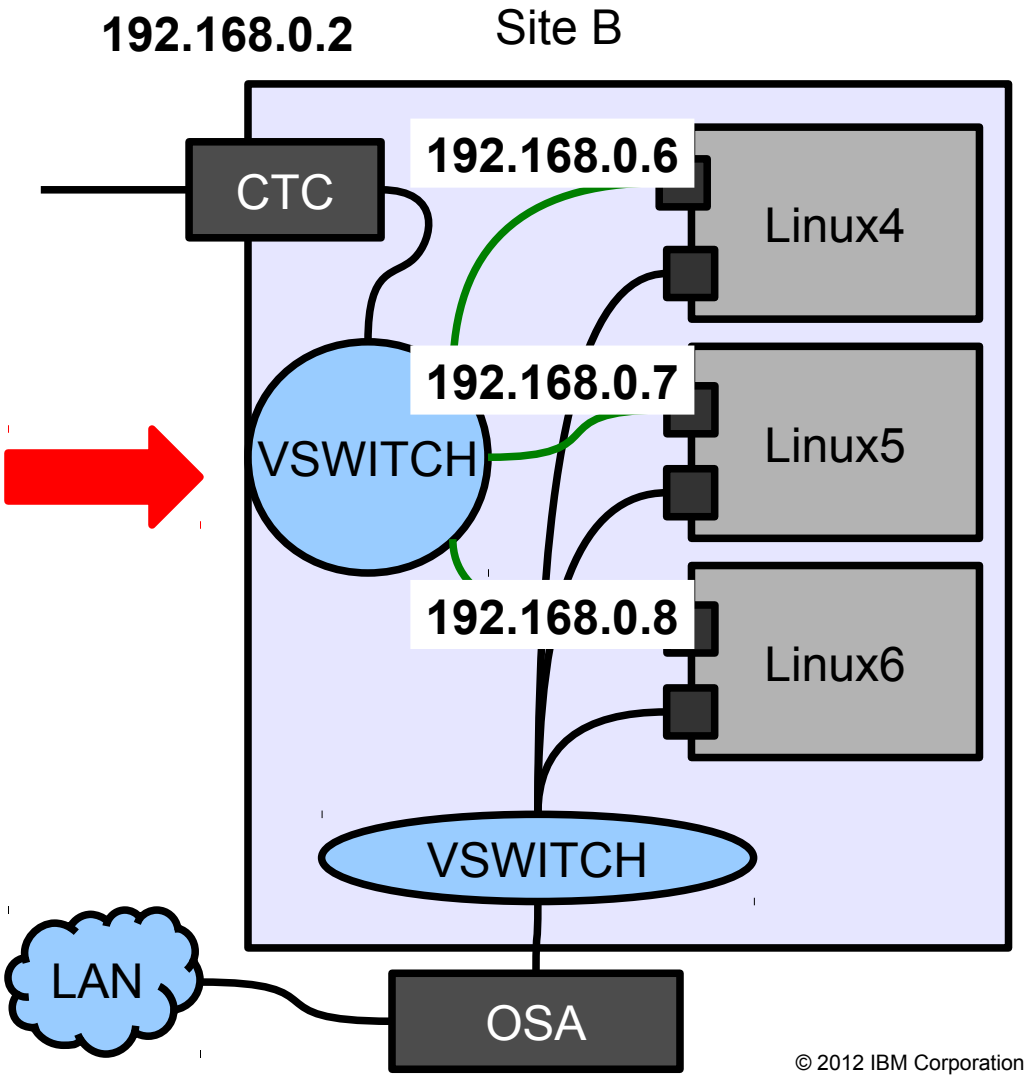


I am responsible for 192.168.0.0/24

Where is the Problem?

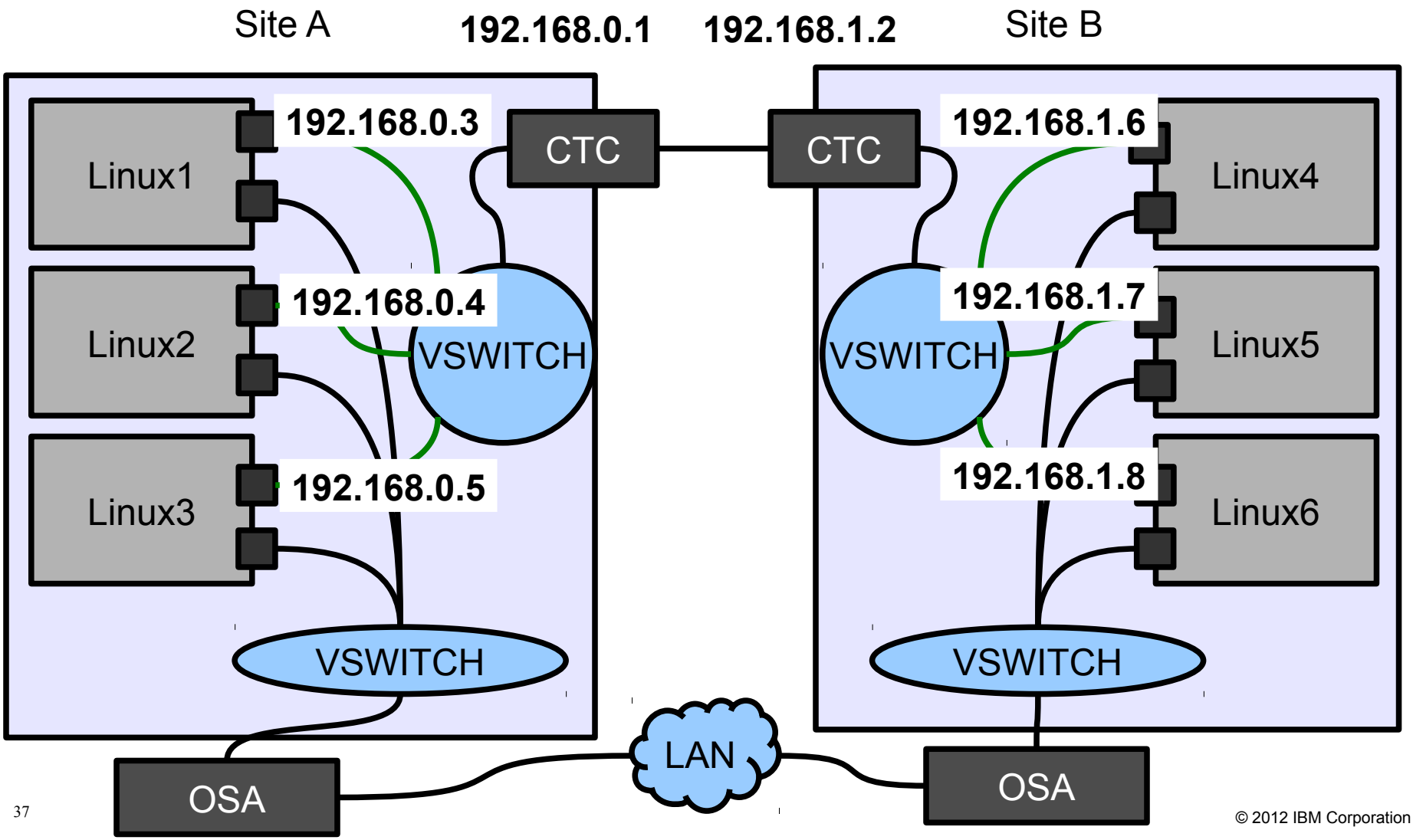
Netmask 255.255.255.0

I am responsible for 192.168.0.0/24



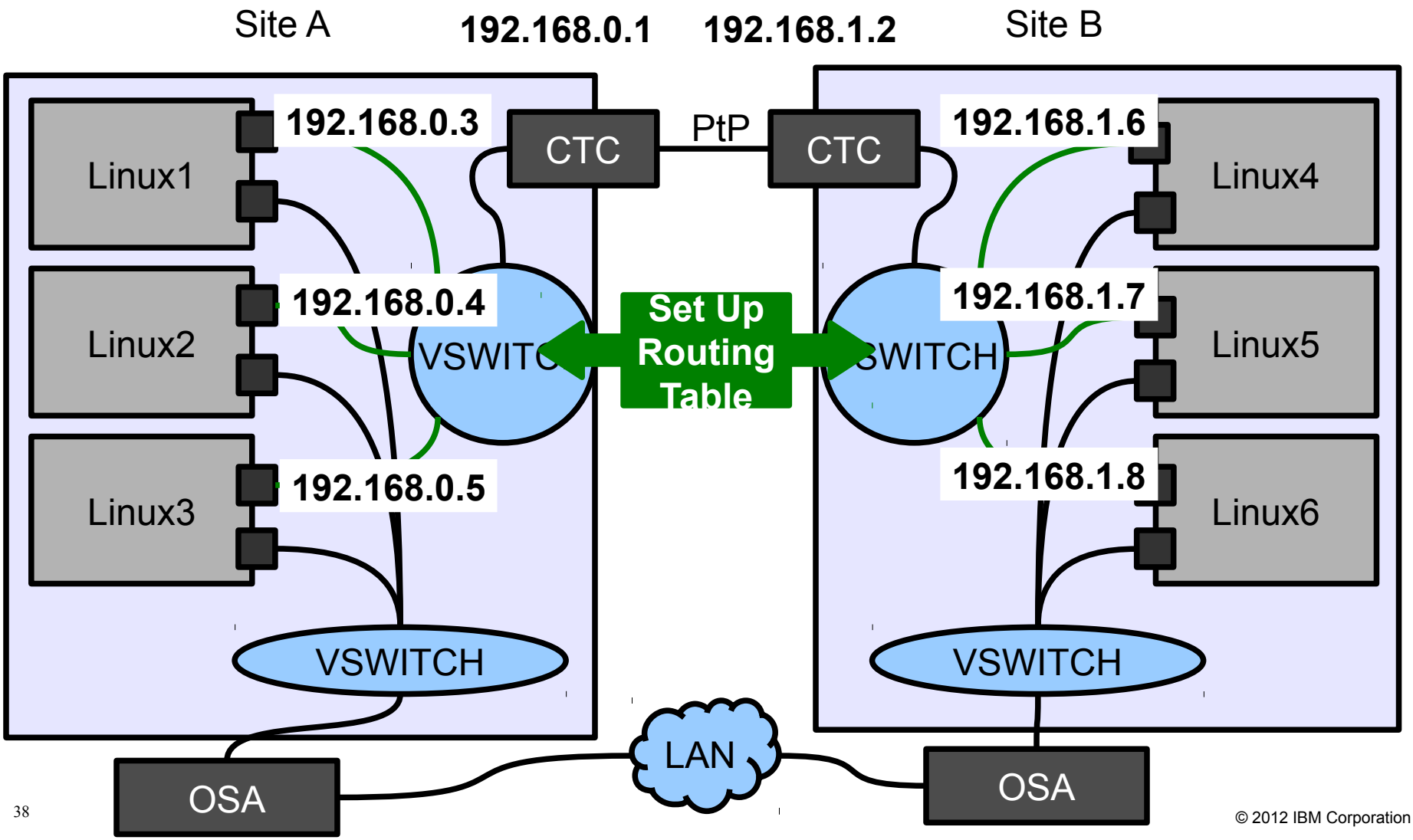
Where is the Problem?

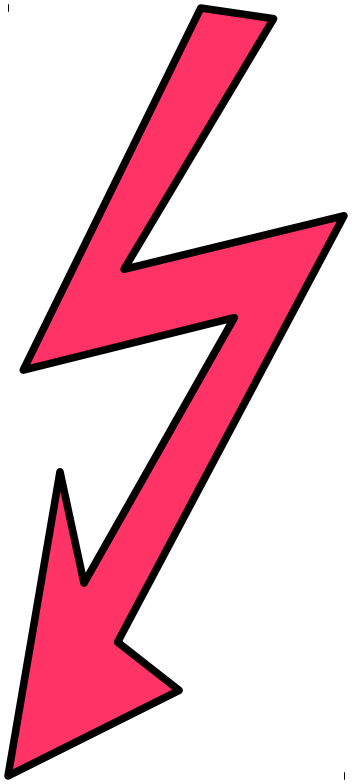
Netmask 255.255.255.0



Where is the Problem?

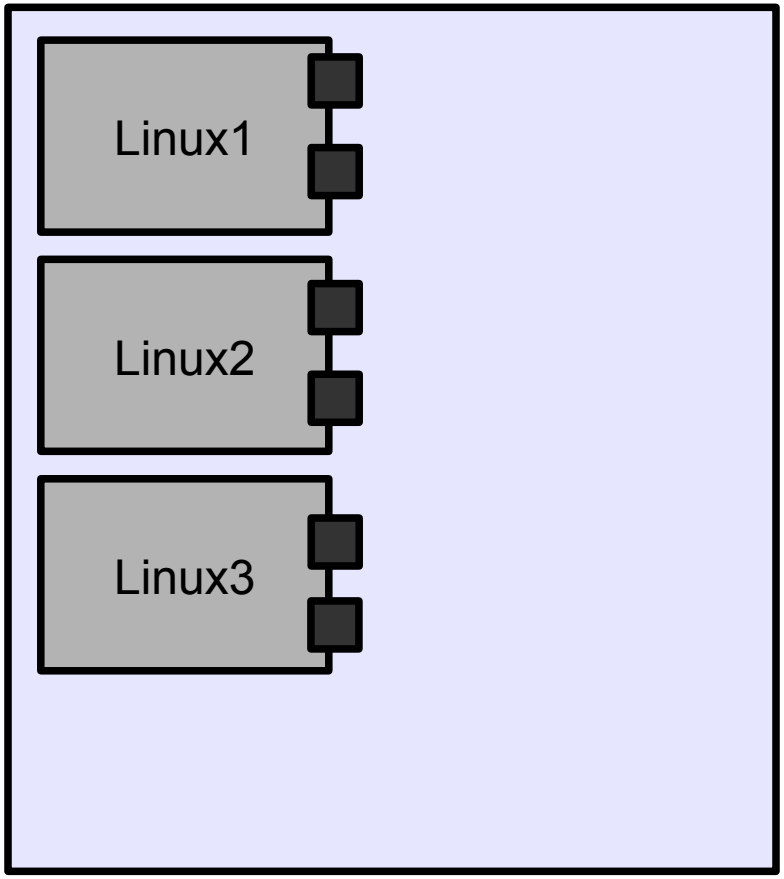
Netmask 255.255.255.0





This was not a System z specific problem!

Where is the Problem?



The customer has Linux Systems with multiple network interfaces!

Where is the Problem?

root@Linux1:~/ > **route -n**

Kernel IP routing table

Destination	Gateway	Genmask	Flags	Metric	Ref	Use	Iface
10.9.15.0	0.0.0.0	255.255.255.0	U	0	0	0	hsi0
10.9.14.0	0.0.0.0	255.255.255.0	U	0	0	0	eth0
10.9.16.0	0.0.0.0	255.255.255.0	U	0	0	0	eth3
169.254.0.0	0.0.0.0	255.255.0.0	U	1002	0	0	hsi0
169.254.0.0	0.0.0.0	255.255.0.0	U	1003	0	0	eth0
169.254.0.0	0.0.0.0	255.255.0.0	U	1004	0	0	eth3
0.0.0.0	10.9.14.2	0.0.0.0	UG	0	0	0	eth0

Ip of eth0 = 10.9.14.100

ip of eth3 = 10.9.16.100

hsi0 is not used at the moment

Where is the Problem?

My laptop ip is 10.12.32.198
netmask 255.255.255.0

I can ping 10.9.14.100 but not 10.9.16.100

Where is the Problem?

Here's is more information you might what to look at:

When I do a traceroute from my linux laptop to the 10.9.14.100 ip I get through:

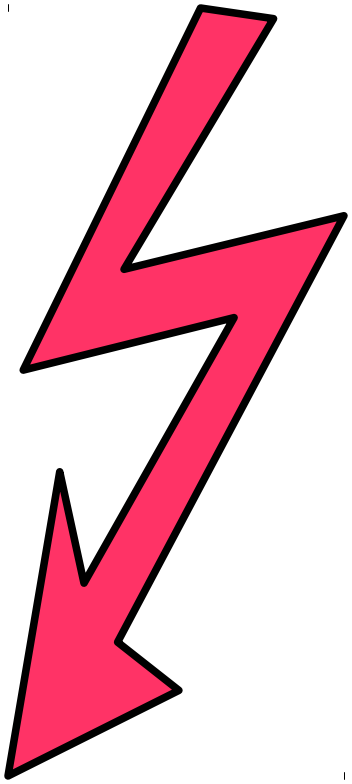
```
root@laptop:~/ > traceroute linux1
traceroute to linux1 (10.9.14.100), 30 hops max, 60 byte packets
1  10.12.32.3 (10.12.32.3)  0.763 ms  2.671 ms  2.682 ms
2  10.12.35.134 (10.12.35.134)  2.614 ms  2.547 ms  2.509 ms
3  X.X.X.X (X.X.X.X)  6.388 ms X.X.X.X (X.X.X.X)  6.367 ms X.X.X.X
(X.X.X.X)  6.337 ms
4  X.X.X.X (X.X.X.X)  10.233 ms  10.207 ms  10.187 ms
5  X.X.X.X (X.X.X.X)  10.124 ms  11.027 ms  9.972 ms
6  10.50.9.239 (10.50.9.239)  11.846 ms  11.745 ms  8.886 ms
7  10.9.1.6 (10.59.1.6)  8.856 ms  8.832 ms  8.799 ms
8  linux1 (10.9.14.100)  9.681 ms  9.654 ms  9.619 ms
```

Where is the Problem?

When I do the same to the the other IP (10.9.16.100) I do not get through

```
root@laptop:~/ > traceroute 10.9.16.100

raceroute to 10.9.16.100 (10.9.16.100), 30 hops max, 60 byte packets
1  10.12.32.3 (10.12.32.3)  1.496 ms  2.377 ms  2.370 ms
2  10.12.35.134 (10.12.35.134)  2.335 ms  4.229 ms  4.218 ms
3  X.X.X.X (X.X.X.X)  10.132 ms X.X.X.X (X.X.X.X)  7.086 ms 165.149.24.105
(1X.X.X.X)  10.051 ms
4  X.X.X.X (X.X.X.X)  10.910 ms  10.916 ms  10.840 ms
5  X.X.X.X (X.X.X.X)  9.785 ms  10.780 ms  10.707 ms
6  10.50.9.239 (10.50.9.239)  11.573 ms  8.608 ms  8.800 ms
7  10.9.1.14 (10.9.1.14)  8.775 ms  8.754 ms  8.718 ms
8  * * *
9  * * *
10  * * *
11  * * *
12  * * *
```

Where is the Problem?



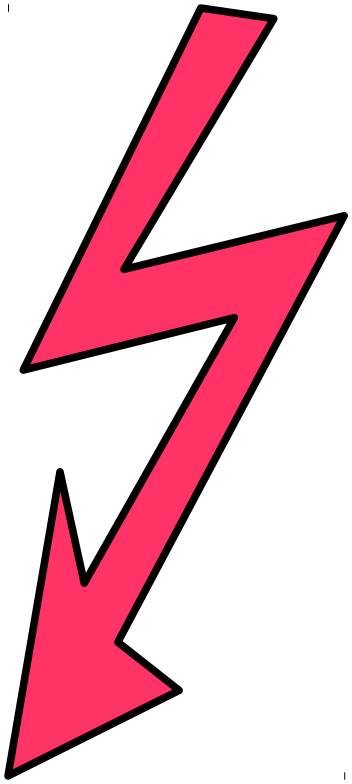
Where is the Problem?

On some proprietary Unix systems you can declare a default route per interface/network.

Linux instead has a "last default route declared is the default route"design.

This is why you experience here also a different behaviour between Linux and z/OS.

While Linux may, in fact, receive your connection request at the 10.9.16.100 address, its default routing behavior is to send it back out through its 10.9.14.100 address.



This was not a System z specific problem!

Solution: Linux's "advanced routing" functionality

```
ip route add 10.9.14.0/24 dev eth0 src 10.9.14.100 table 1
ip route add default via 10.9.14.2 dev eth0 table 1
ip rule add from 10.9.14.100/32 table 1
ip rule add to 10.9.14.100/32 table 1
ip route add 10.9.16.0/24 dev eth3 src 10.9.16.100 table 2
ip route add default via 10.9.16.2 dev eth3 table 2
ip rule add from 10.9.16.100/32 table 2
ip rule add to 10.9.16.100/32 table 2
```

The Linux Device Driver

Linux for System z Network Device Drivers

- QETH
- LCS
- CTC(M) (stabilized)
- NETIUCV (stabilized)

LAN Channel Station (LCS) Device Driver

- Supports:
  - OSA Express (in non-QDIO mode)
    - (HighSpeed TokenRing)
    - (ATM (running Ethernet LAN Emulation))
- May be preferred instead of QETH for security reasons
  - Administrator defines OSA Address Table → restricted access, whereas with QETH each Linux registers its own IP address
- But: performance is inferior to QETH's performance!!!

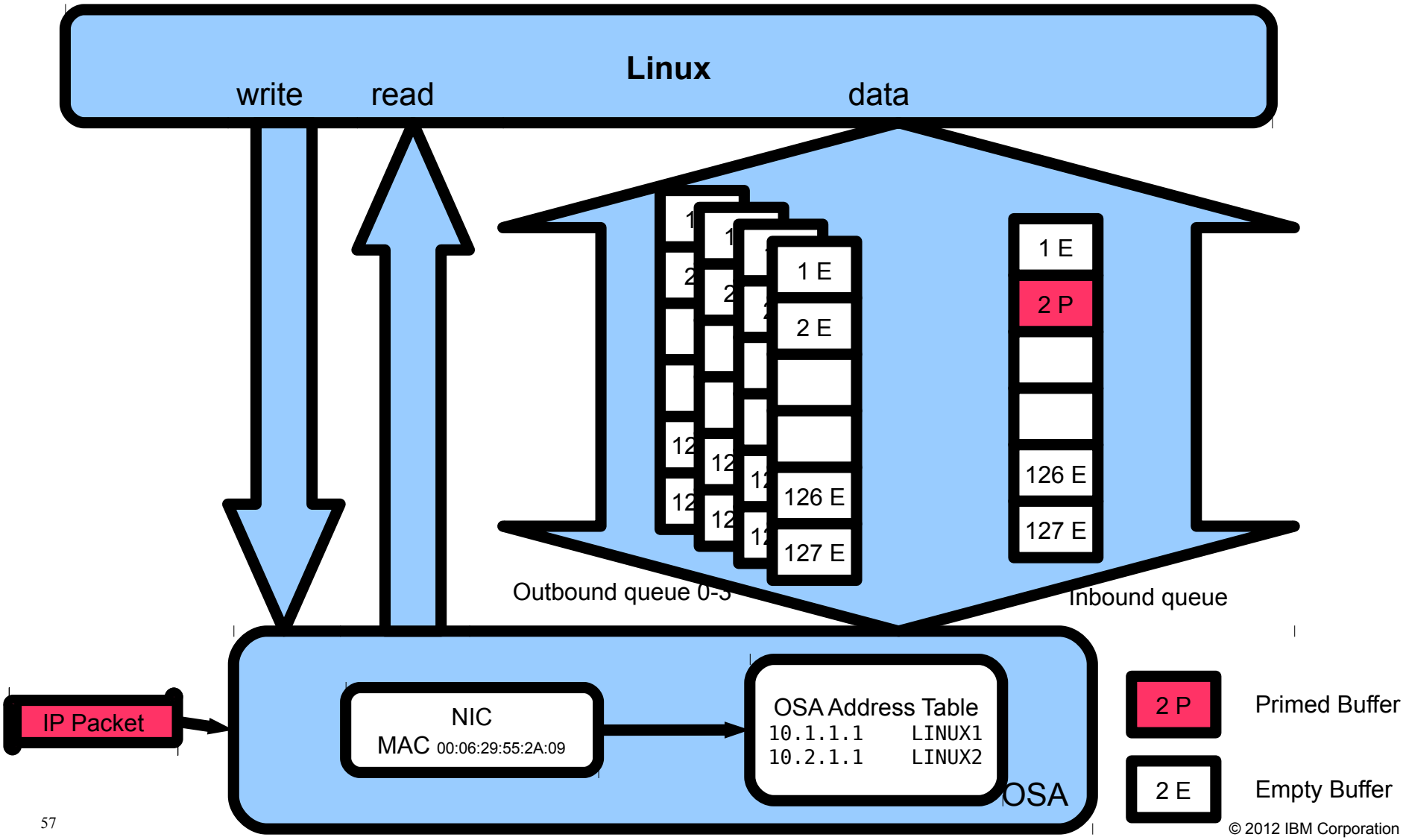
Message to CTC and IUCV users

- CTC = Channel-to-Channel connection
- IUCV = Inter User Communication Vehicle
- CTC(M) and NETIUCV device drivers are deprecated (Linux 2.6+)
- Device drivers are still available for backward compatibility
- Please consider migration
  - Virtual CTC and IUCV (under z/VM) ==> guest LAN HiperSocket or guest LAN type QDIO
  - CTC inside a CEC ==> Hipersockets
  - CTC ==> OSA-Express (QDIO)

QETH Device Driver

- Supports
  - OSA Express / OSA Express2 / OSA Express3 – OSD type (=QDIO)
    - Fast/Giga/10GBit Ethernet (fiber infrastructure)
    - 1000Base-T Ethernet (copper infrastructure)
  - System z HiperSockets
  - z/VM
    - GuestLAN Type QDIO (layer2 / layer3), Type Hiper
    - z/VM VSWITCH (layer2 / layer3)
  - IPv4, IPv6, VLAN, VIPA, Proxy ARP, IP Address Takeover, Channel Bonding
- Primary network driver for Linux on System z
- Main focus in current and future development

Queued Direct I/O (QDIO) Architecture

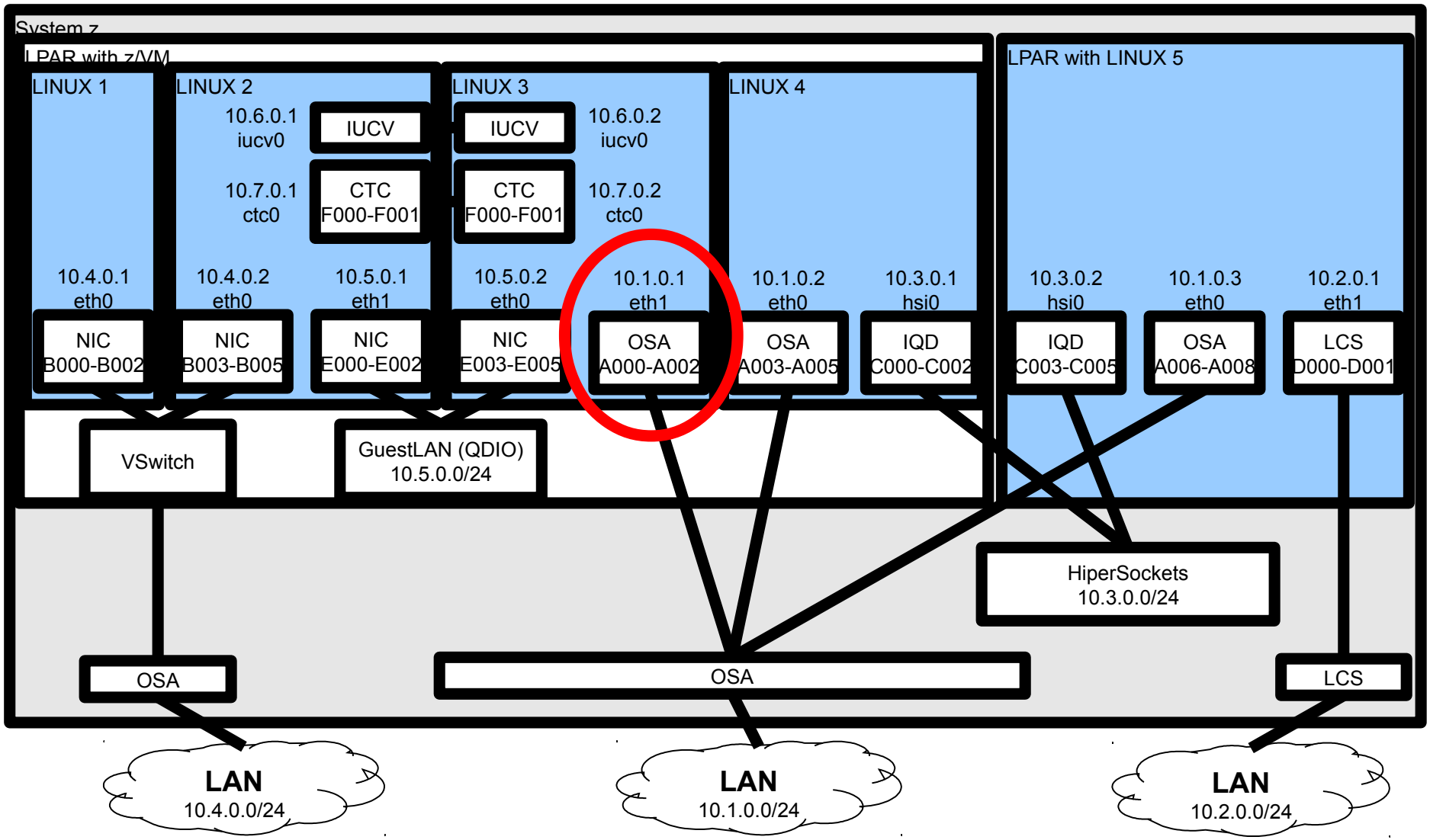


Network Configuration

Network Device Configuration (QETH)

- Example Network
- Generic (manual)
- Novell/SuSE SLES 10 / 11
- Red Hat RHEL 5 / 6

Networking Device Configuration – Example



Network Device Configuration – Generic

- Load the device driver module

```
root@larsson:~> modprobe qeth
```

- Create a new device by grouping its CCW devices:

```
root@larsson:~> echo 0.0.a000,0.0.a001,0.0.a002  > \
/sys/bus/ccwgroup/drivers/qeth/group
```

- Set optional attributes:

```
root@larsson:~> echo 64 > /sys/devices/qeth/0.0.a000/buffer_count
```

- Set the device online:

```
root@larsson:~> echo 1 > /sys/devices/qeth/0.0.a000/online
```

  - automatically assigns an interface name to the qeth device:
    - eth[n] for OSA devices
    - hsi[n] for HiperSocket devices

- Configure an IP address:

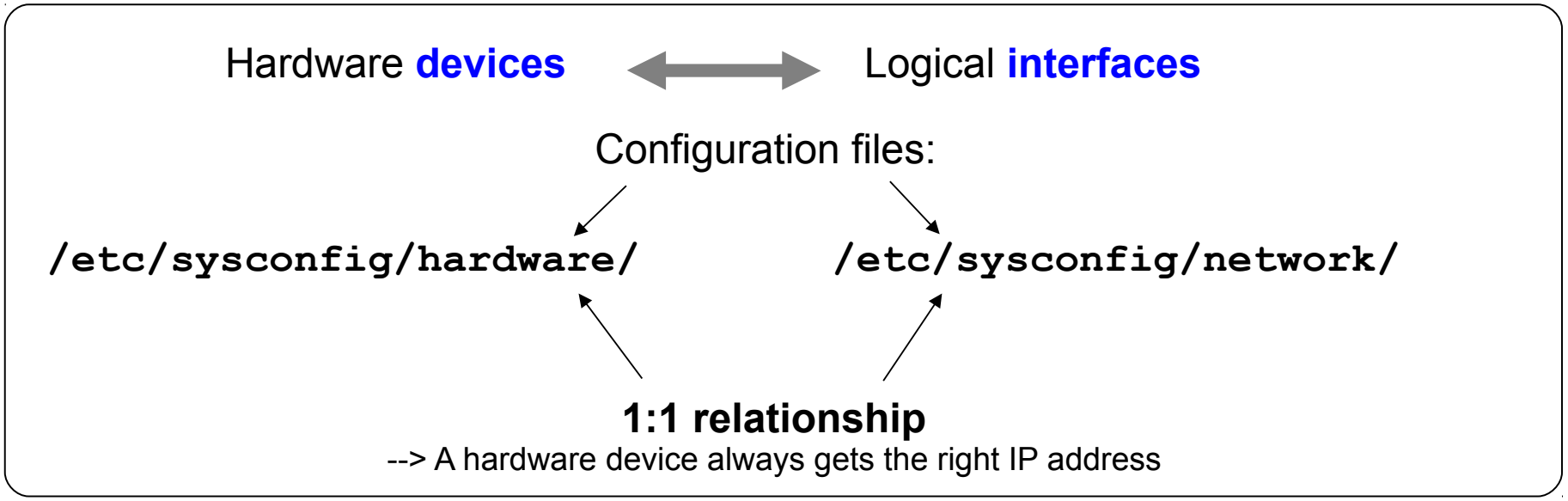
```
root@larsson:~> ifconfig eth0 10.1.0.1 netmask 255.255.255.0
```

The previous page is only important in case something goes wrong and your network connection does not come up automatically!

...unless you prefer sed & awk via 3270 over vi & emacs via ssh

You should use the distribution tools for the configuration....but it is always good to understand what is happening in the background

Network Device Configuration – SLES 10



Naming convention:

```
(hw|if)cfg-<device type>-bus-<bus type>-<bus location>
    e.g.   hwcfg-qeth-bus-ccw-0.0.a000
           ifcfg-qeth-bus-ccw-0.0.a000
```

Scripts:

```
hwup / hwdown, ifup / ifdown
```

see */etc/sysconfig/hardware/skel/hwcfg-<device type>*

Network Device Configuration – SLES 10 (cont'd)

1. Create an OSA hardware device configuration file:
   /etc/sysconfig/hardware/hwcfg-qeth-bus-ccw-0.0.a000

```
CCW_CHAN_IDS='0.0.a000 0.0.a001 0.0.a002'
CCW_CHAN_MODE='OSAPORT'
CCW_CHAN_NUM='3'
MODULE='qeth'
MODULE_OPTIONS=''
MODULE_UNLOAD='yes'
SCRIPTDOWN='hwdown-ccw'
SCRIPTUP='hwup-ccw'
SCRIPTUP_ccw='hwup-ccw'
SCRIPTUP_ccwgroup='hwup-qeth'
STARTMODE='auto'
QETH_LAYER2_SUPPORT='0'
QETH_OPTIONS='checksumming=hw_checksumming'
```

Network Device Configuration – SLES 10 (cont'd)

2. Create an interface configuration file
   /etc/sysconfig/network/ifcfg-qeth-bus-ccw-0.0.a000

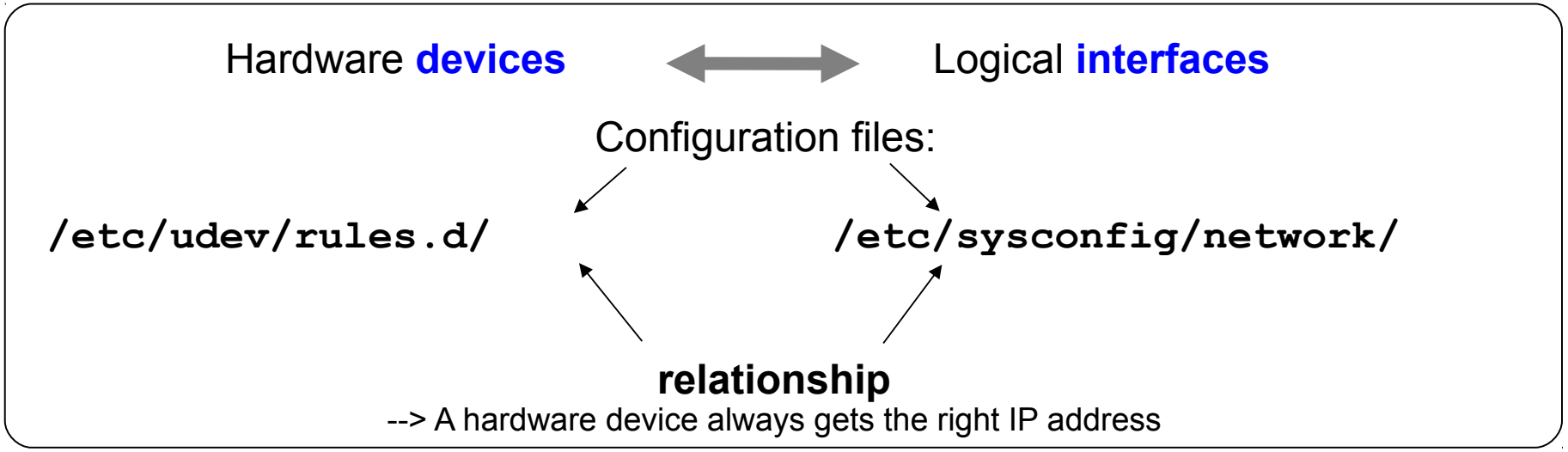
```
BOOTPROTO='static'
BROADCAST='10.1.0.255'
IPADDR='10.1.0.1'
NETMASK='255.255.255.0'
NETWORK='10.1.0.0'
STARTMODE='onboot'
```

For more details about configuration variables see:
/etc/sysconfig/network/ifcfg.template

3. Before you reboot: Test the configuration, bring the device up and then the interface

```
root@larsson:~> hwup qeth-bus-ccw-0.0.a000
root@larsson:~> ifup qeth-bus-ccw-0.0.a000
```

Network Device Configuration – SLES 11



Devices are configured via udev (framework for dynamic device configuration)

Naming convention:

```
51-<device type>-<bus location>.rules
70-persistent-net.rules
ifcfg-<interface name>
    e.g.   51-qeth-bus-0.0.a000.rules
           ifcfg-eth0
```

Scripts: `qeth_configure` and `ifup/ifdown`

Network Device Configuration – SLES 11 (cont'd)

1. "`qeth_configure -p OSAPORT 0.0.a000 0.0.a001 0.0.a002 1`" → */etc/udev/rules.d/51-qeth-bus-0.0.a000.rules*

```
# Configure qeth device at 0.0.a000/0.0.a001/0.0.a002
ACTION=="add", SUBSYSTEM=="drivers", KERNEL=="qeth",
IMPORT{program}="collect 0.0.a000 %k 0.0.a000 0.0.a001 0.0.a002 qeth"
ACTION=="add", SUBSYSTEM=="ccw", KERNEL=="0.0.a000",
IMPORT{program}="collect 0.0.a000 %k 0.0.a000 0.0.a001 0.0.a002 qeth"
ACTION=="add", SUBSYSTEM=="ccw", KERNEL=="0.0.a001",
IMPORT{program}="collect 0.0.a000 %k 0.0.a000 0.0.a001 0.0.a002 qeth"
ACTION=="add", SUBSYSTEM=="ccw", KERNEL=="0.0.a002",
 IMPORT{program}="collect 0.0.a000 %k 0.0.a000 0.0.a001 0.0.a002 qeth"
TEST=="[ccwgroup/0.0.a000]", GOTO="qeth-0.0.a000-end"
ACTION=="add", SUBSYSTEM=="ccw", ENV{COLLECT_0.0.a000}=="0",
ATTR{[drivers/ccwgroup:qeth]group}="0.0.a000,0.0.a001,0.0.a002"
ACTION=="add", SUBSYSTEM=="drivers", KERNEL=="qeth", ENV{COLLECT_0.0.a000}=="0",
ATTR{[drivers/ccwgroup:qeth]group}="0.0.a000,0.0.a001,0.0.a002"
LABEL="qeth-0.0.a000-end"
ACTION=="add", SUBSYSTEM=="ccwgroup", KERNEL=="0.0.a000", ATTR{layer2}="0"
ACTION=="add", SUBSYSTEM=="ccwgroup", KERNEL=="0.0.a000", ATTR{portname}="OSAPORT"
ACTION=="add", SUBSYSTEM=="ccwgroup", KERNEL=="0.0.a000", ATTR{portno}="0"
ACTION=="add", SUBSYSTEM=="ccwgroup", KERNEL=="0.0.a000", ATTR{online}="1"
```

Has to be first

Network Device Configuration – SLES 11 (cont'd)

2. Mapping between hardware device and Linux device
   /etc/udev/rules.d/70-persistent-net.rules

```
...
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth", \
 KERNELS=="0.0.a000",ATTR{type}=="1",KERNEL=="eth*", NAME="eth0"
...
```

3. Create an interface configuration file
   /etc/sysconfig/network/ifcfg-eth0 (For more details about configuration variables see: */etc/sysconfig/network/ifcfg.template*)

```
BOOTPROTO='static'
BROADCAST='10.1.0.255'
IPADDR='10.1.0.1'
NETMASK='255.255.255.0'
NETWORK='10.1.0.0'
STARTMODE='onboot'
```

4. Before you reboot: Test the configuration

```
root@larsson:~> udevadm trigger
root@larsson:~> ifup eth0
```

Network Device Configuration – RHEL 5

- Configuration files

  /etc/modprobe.conf

```
alias eth0 qeth
alias eth1 qeth
alias hsi0 qeth
alias eth2 lcs
```

  /etc/sysconfig/network-scripts/ifcfg-<ifname>

```
NETTYPE         qeth | lcs
TYPE            Ethernet
SUBCHANNELS     0.0.a000,0.0.a001,0.0.a002
PORTNAME
OPTIONS                 e.g.  “layer2=1,portno=1”
MACADDR
```

- **ifup/ifdown** scripts contain mainframe-specifics

Network Device Configuration – RHEL 5 (cont'd)

1. Create a network device configuration file:
   /etc/sysconfig/network-scripts/ifcfg-eth0

```
DEVICE=eth0
SUBCHANNELS='0.0.a000 0.0.a001 0.0.a002'
PORTNAME='OSAPORT'
NETTYPE='qeth'
TYPE='Ethernet'
BOOTPROTO=static
ONBOOT=yes
BROADCAST='10.1.0.255'
IPADDR='10.1.0.1'
NETMASK='255.255.255.0'
NETWORK='10.1.0.0‘
MACADDR='00:09:6B:1A:9A:89‘
OPTIONS='layer2=0'
```

Network Device Configuration – RHEL 5 (cont'd)

2. Add / verify alias in module configuration file */etc/modprobe.conf*

```
…
alias eth0 qeth
…
```

For further information, see

http://www.redhat.com/docs/manuals/enterprise

Network Device Configuration – RHEL 6

1. Create a network device configuration file:
   /etc/sysconfig/network-scripts/ifcfg-eth0

```
DEVICE=eth0
SUBCHANNELS='0.0.a000,0.0.a001,0.0.a002'
PORTNAME='OSAPORT'
NETTYPE='qeth'
TYPE='Ethernet'
BOOTPROTO=static
ONBOOT=yes
IPADDR='10.1.0.1'
NETMASK='255.255.255.0'
NETWORK='10.1.0.0'
OPTIONS='layer2=0 portno=0'
```

Network Device Configuration – RHEL 6 (cont'd)

2. Mapping between hardware device and Linux device
   /etc/udev/rules.d/70-persistent-net.rules

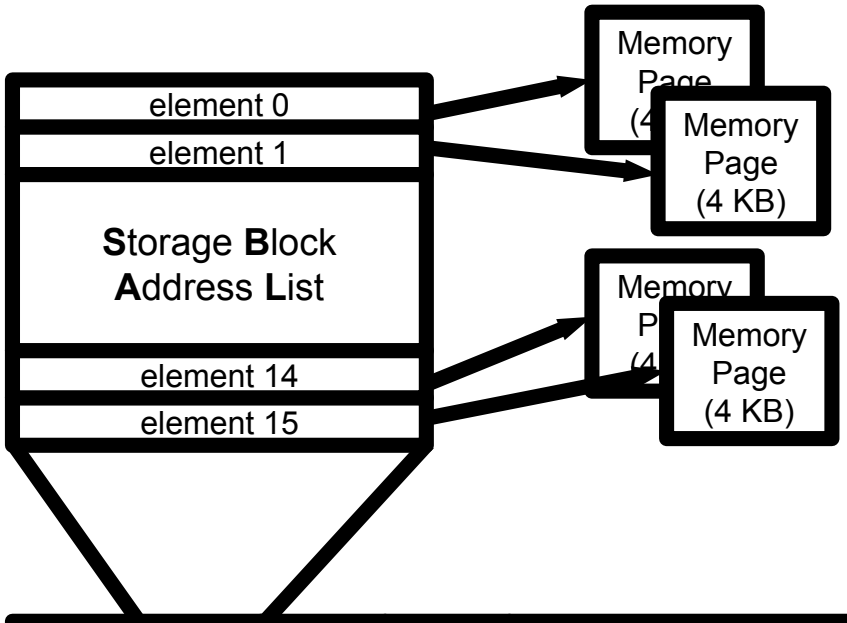
```
…
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="?*",
ENV{INTERFACE_NAME}=="eth0", DRIVERS=="qeth", KERNELS=="0.0.a000",
ATTR{type}=="1", KERNEL=="eth*", NAME="eth0"
…
```

3. Before you reboot: Test the configuration

```
root@larsson:~> ifup eth0
```

QETH Device sysfs Attribute buffer_count

- The number of allocated buffers for inbound QDIO traffic
  → Memory usage.



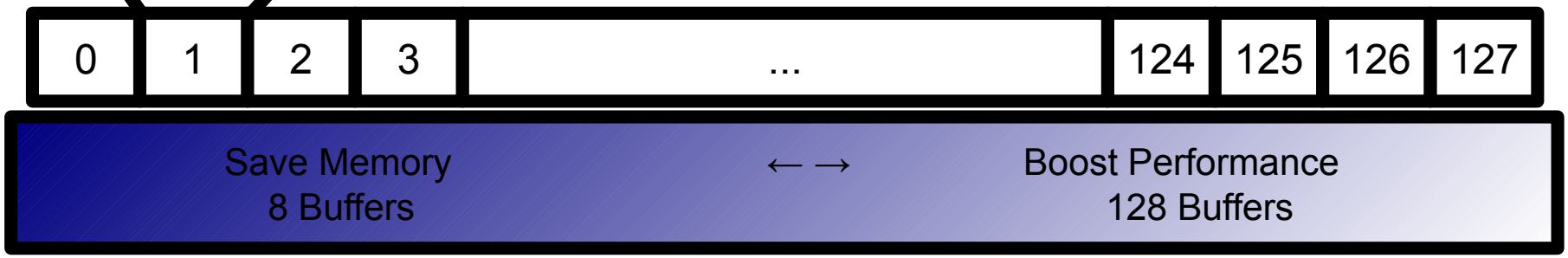
Per QETH device memory usage:

control data structures: ~ 200 KB
memory for one buffer: 64 KB

buffer_count = 8 --> ~ 712 KB

buffer_count = 128 --> ~ 8.4 MB

(hipersocket numbers depend on MTU size)



QETH Device sysfs Attribute checksumming

- Additional redundancy check to protect data integrity
- Offload checksumming for incoming IP packages from Linux stack to OSA-card

```
QETH_OPTIONS='checksumming=hw_checksumming'   or
echo hw_checksumming > …  or
ethtool -K …
```

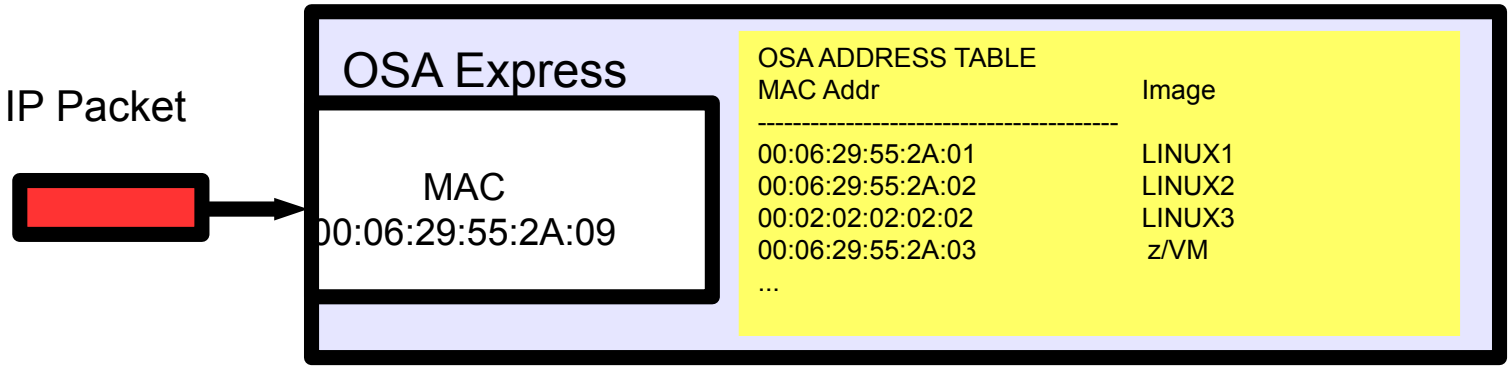
```
root@larsson:~> echo hw_checksumming > \
/sys/devices/qeth/0.0.a000/checksumming

root@larsson:~> ethtool -K eth0 rx on
```

===> move workload from Linux to OSA-Express adapter

- Available for OSA-devices in layer3 mode only

QETH Layer 2 mode

- OSA works with MAC address ==> no longer stripped from packets



hwcfg-qeth... file (SLES10): QETH_LAYER2_SUPPORT=1

ifcfg-qeth... file (SLES10): LLADDR='<MAC Address>'

51.qeth....rule (SLES11): ATTR{layer2}="1"

ifcfg-qeth... file (SLES11): LLADDR='<MAC Address>'

ifcfg-... file (RHEL5/6): MACADDR='<MAC Address>'

OPTIONS='layer2=1'

QETH Layer 2 mode (cont'd)

- Direct attached OSA:
  - MAC address must be defined manually with ifconfig
    ```
    ifconfig eth0 hw ether 00:06:29:55:2A:01
    ```
  - Restrictions: Older OSA-generation (≤ z990):
    Layer2 and Layer3 traffic can be transmitted over the same OSA CHPID, but not between two images sharing the same CHPID !
- Hipersockets:
  - new layer2 support starting with z10 - MAC address automatically generated
  - Layer2 and Layer3 traffic separated
- VSWITCH or GuestLAN under z/VM: MAC address created by z/VM

```
define lan <lanname> ... type QDIO ETHERNET
      define nic <vdev> QDIO
      couple <vdev> <ownerid> <lanname>
define vswitch <vswname> ... ETHERNET …
      define nic <vdev> QDIO
      couple <vdev> <ownerid> <lanname>
```

QETH Layer 2 mode (cont'd)

- activating Layer 2 is done
  per device via sysfs attributes
- possible layer2 values:
  - 0: use device in Layer 3 mode
  - 1: use device in Layer 2 mode

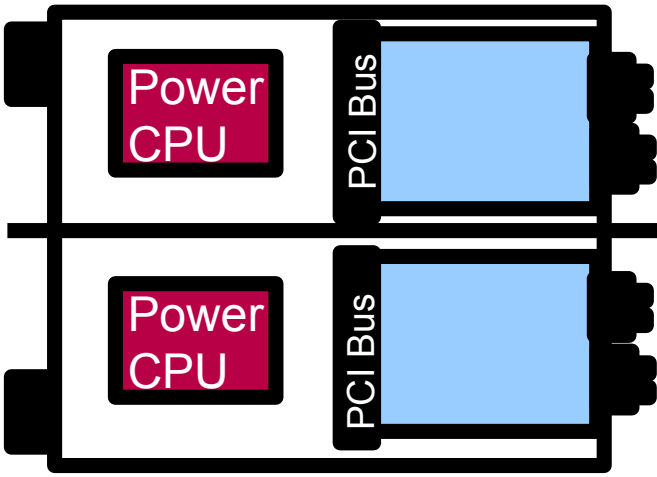
```
/sys
|--devices
   |--qeth
      |--0.0.<devno>
         |--layer2
```

- setting of layer2 attribute only permitted when device is offline!
- Advantages:
  - Independent of IP-protocol or any layer3 protocol
  - channel bonding possible

OSA Express 3 – 2 ports within 1 chpid

- OSA Express2 – 2 CHPIDs with 1 port per CHPID – 2 ports totally
- OSA Express3 – 2 CHPIDs with 2 ports per CHPID – 4 ports totally (>= z10)
- New sysfs-attribute “portno” can contain '0' or '1'
- OSA-Express3 GbE SX and LX

hwcfg-qeth... file (SLES10):	QETH_OPTIONS=”portno=1”
51.qeth....rule (SLES11):	ATTR{portno}="1"
Or command (SLES11):	`qeth_configure -n 1` ....
ifcfg-... file (RHEL5/6):	OPTIONS='portno=1



Commands / tools for qeth-driven devices

- List of known qeth devices: cat /proc/qeth or lsqeth -p

```
root@larsson:~> cat /proc/qeth
devices                  CHPID interface cardtype   port chksum
 ------------------------ ----- --------- ---------  ---- ------
0.0.a000/0.0.a001/0.0.a002 xA0   eth0      OSD_1000     0    sw
0.0.c000/0.0.c001/0.0.c002 xC0   hsi0      HiperSockets 0    sw
```

- Attributes of qeth device: lsqeth or lsqeth <interface>

```
root@larsson:~> lsqeth eth0
Device name                : eth0
-----------------------------------------
        card_type            : OSD_1000
        cdev0               : 0.0.a000
        cdev1               : 0.0.a001
        cdev2               : 0.0.a002
        chpid               : 76
        online              : 1
        state               : UP (LAN ONLINE)
        buffer_count           : 16
        layer2              : 0
```

Commands / tools for qeth-driven devices: znetconf

- Allows the user to list, add, remove & configure System z network devices
- To list all configured network devices:

```
root@larsson:~>  znetconf -c
Device IDs                Type    Card Type CHPID Drv. Name  State
------------------------------------------------------------------
0.0.a000,0.0.a001,0.0.a002 1731/01 OSD_1000     76 qeth eth0  online
```

- To list all potential network devices, us the **-u** option
- Configure device 0.0.a000 in layer2 mode and with portnumber “1”

```
root@larsson:~>  znetconf -a a000 -o layer2=0 -n portno=1
```

- Remove network device 0.0.a000

```
root@larsson:~>  znetconf -r a000
```

Commands / tools for qeth-driven devices: ethtool

- Use ethtool to query, set and change attributes
- To query ethernet driver information:

```
root@larsson:~>  ethtool -i eth0
driver: qeth_l3
version: 1.0
firmware-version: 0893
bus-info: 0.0.a000/0.0.a001/0.0.a002
```

- To query the offload information of the specified ethernet device

```
root@larsson:~>  ethtool -k eth0
Offload parameters for eth0:
rx-checksumming: off
tx-checksumming: off .....
```

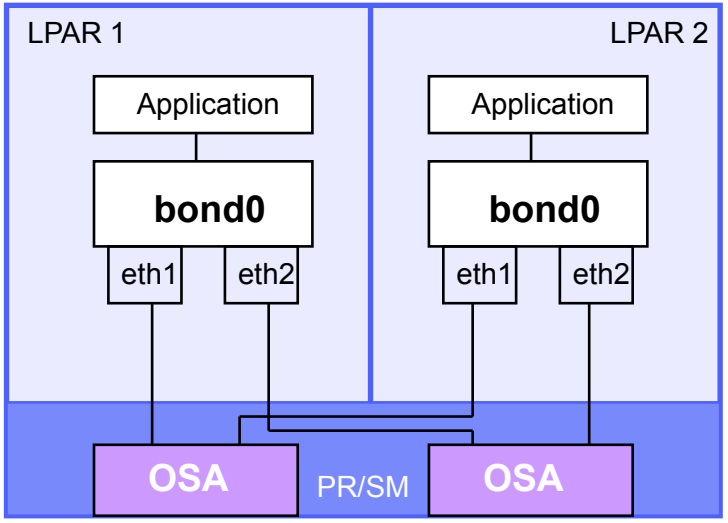
- Example: to change the inbound checksumming offload parameter

```
root@larsson:~>  ethtool -K eth0 rx on
```

Advanced Topics

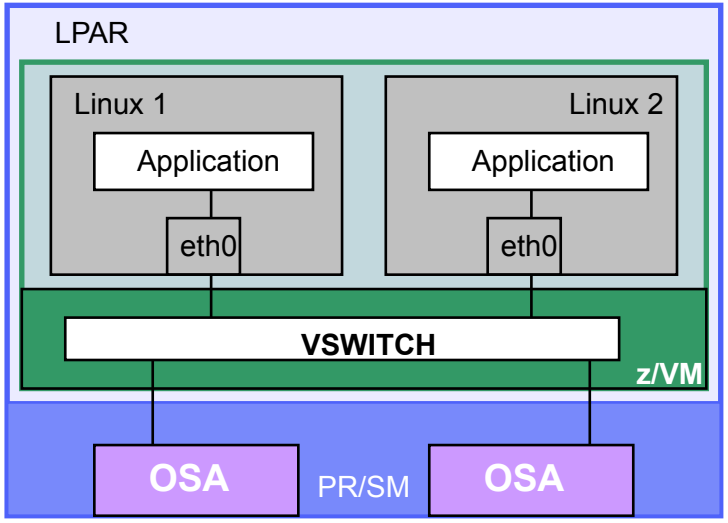
Leveraging Virtualization for Network Interface Redundancy and Automated Failover

Resource Virtualization: OSA Channel Bonding



- Linux *bonding* driver enslaves multiple OSA connections to create a single logical network interface card (NIC)
- Detects loss of NIC connectivity and automatically fails over to surviving NIC
- No dynamic routing (OSPF) dependency
- Active/backup & aggregation modes
- **Separately configured for each Linux**

System Virtualization: z/VM VSWITCH



- z/VM *VSWITCH* enslaves multiple OSA connections. Creates virtual NICs for each Linux guest
- Detects loss of physical NIC connectivity and automatically fails over to surviving NIC
- No dynamic routing (OSPF) dependency
- Active/backup & aggregation modes
- **Centralized configuration benefits all guests**

Channel Bonding Support

- The Linux bonding driver provides a method for aggregating multiple network interfaces into a single, logical “bonded” interface
- Provides failover and/or load-balancing functionality
- Better performance depending on bonding mode
- Applies to layer2-devices only
- Further information http://sourceforge.net/projects/bonding

Setting Up Channel Bonding

- Load bonding module with miimon option

```
root@larsson:~> modprobe bonding miimon=100 mode=balance-rr
```

(miimon option enables link monitoring)

- Add MAC addresses to slave devices eth0 & eth1 (not necessary for GuestLAN or Vswitch)

```
root@larsson:~> ifconfig eth0 hw ether 00:06:29:55:2A:01
root@larsson:~> ifconfig eth1 hw ether 00:05:27:54:21:04
```

- Activate the bonding device bond0

```
root@larsson:~> ifconfig bond0 10.1.1.1 netmask 255.255.255.0
```

- Connect slave devices eth0 & eth1 to bonding device bond0

```
root@larsson:~> ifenslave bond0 eth0 eth1
```

Setting Up Channel Bonding (SLES10/11)

- Interface configuration file for a slave device
  - SLES10: */etc/sysconfig/network/ifcfg-qeth-bus-ccw-0.0.a000*
  - SLES11: */etc/sysconfig/network/ifcfg-eth0*

```
BOOTPROTO='static'
IPADDR=''
SLAVE='yes'
STARTMODE='onboot'
LLADDR='00:06:29:55:2A:01'
```

Setting Up Channel Bonding (SLES10/11) (cont'd)

- Interface configuration file for a master device
  /etc/sysconfig/network/ifcfg-bond0

```
BOOTPROTO='static'
BROADCAST='10.1.1.255'
IPADDR='10.1.1.1'
NETMASK='255.255.255.0'
NETWORK='10.1.1.0'
STARTMODE='onboot'
BONDING_MASTER='yes'
BONDING_MODULE_OPTS='mode=active_backup fail_over_mac=active
      miimon=100'
LLADDR='00:06:29:55:2A:03'
# SLES10
BONDING_SLAVE0='qeth-bus-ccw-0.0.a000'
BONDING_SLAVE1='qeth-bus-ccw-0.0.b000'
# SLES11
BONDING_SLAVE0='eth0'
BONDING_SLAVE1='eth1'
```

Setting Up Channel Bonding (RHEL5/RHEL6)

- Interface configuration file for a slave device
  /etc/sysconfig/network/ifcfg-eth0

```
DEVICE=eth0
USERCTL='yes'
BOOTPROTO='none'
SLAVE='yes'
MASTER='bond0'
ONBOOT='yes'
SUBCHANNELS=0.0.a000,0.0.a001,0.0.a002
TYPE=Ethernet
OPTIONS="layer2=1"
MACADDR=00:06:29:55:2A:01
```

- Add / verify alias in module configuration file /etc/modprobe.conf (RHEL5 only)

```
…
alias bond0 bonding
options bond0 miimon=100 mode=active_backup fail_over_mac=active
…
```

Setting Up Channel Bonding (RHEL5/RHEL6) (cont'd)

- Interface configuration file for a master device
  /etc/sysconfig/network/ifcfg-bond0

```
DEVICE=bond0
BOOTPROTO='none'
BROADCAST='10.1.1.255'
IPADDR='10.1.1.1'
NETMASK='255.255.255.0'
NETWORK='10.1.1.0'
ONBOOT='yes'
USERCTL='yes'
NETTYPE='qeth'
TYPE=Bonding
MACADDR=00:06:29:55:2A:03
# RHEL6 only
BONDING_OPTS='mode=active_backup fail_over_mac=active miimon=100'
```

Setting Up Channel Bonding (cont'd)

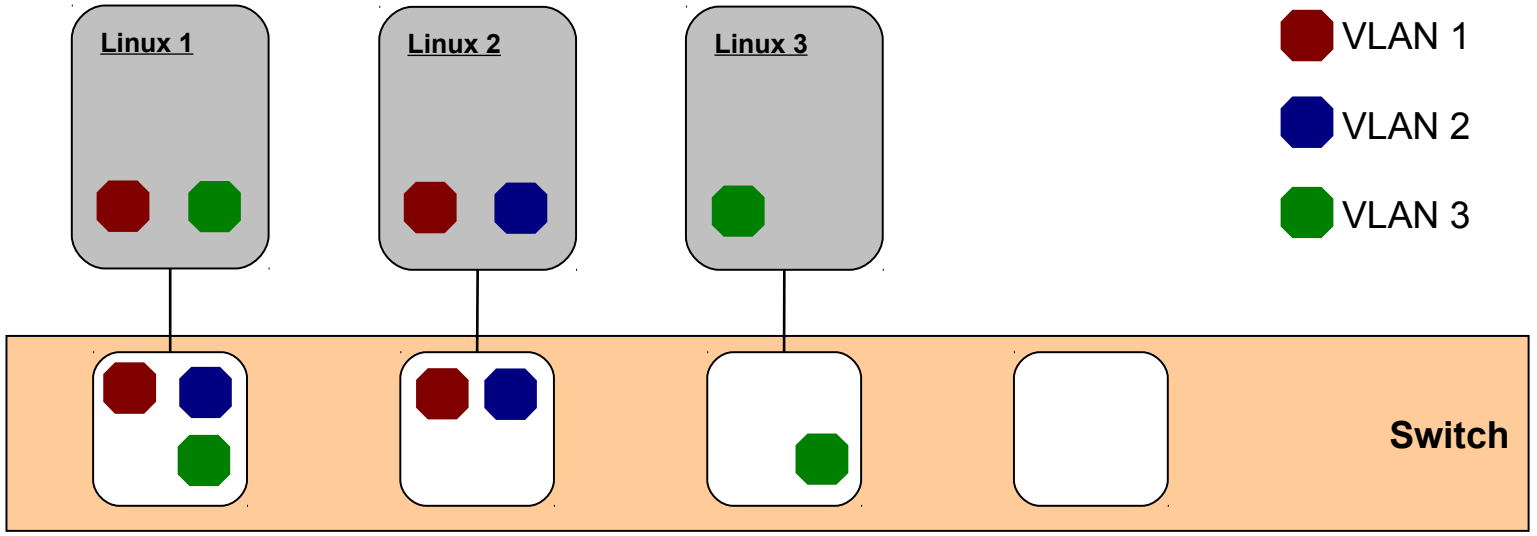
- Display the interface and bonding configuration

```
root@larsson:~> ifconfig
bond0     Link encap:Ethernet  HWaddr 00:06:29:55:2A:01
          inet addr:10.1.1.1  Bcast:10.255.255.255 ...

eth0      Link encap:Ethernet  HWaddr 00:06:29:55:2A:01
          UP BROADCAST RUNNING SLAVE MULTICAST  MTU:1500...

eth1      Link encap:Ethernet  HWaddr 00:06:29:55:2A:02
          UP BROADCAST RUNNING SLAVE MULTICAST  MTU:1500 ...
```

```
root@larsson:~> cat /proc/net/bonding/bond0
Bonding Mode: fault-tolerance (active-backup) (fail_over_mac active)
Primary Slave: None
Currently Active Slave: eth0
MII Status: up
MII Polling Interval (ms): 100
Slave Interface: eth0
MII Status: up
Permanent HW addr: 00:06:29:55:2A:01
Slave Interface: eth1
MII Status: up
Permanent HW addr: 00:06:29:55:2A:02
```

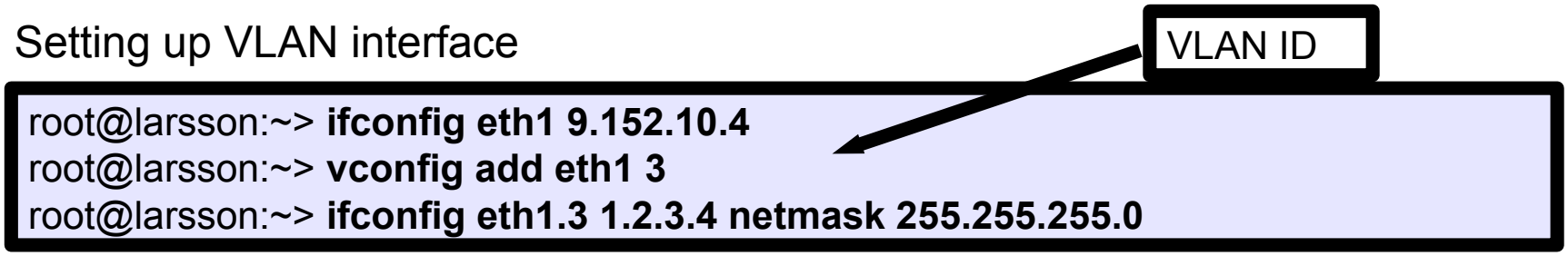
Virtual LAN (VLAN) Support

- IEEE Standard 802.1Q
- Reduce broadcast traffic
- Divide LANs logically into subnets to optimize bandwidth utilization
- Network devices supporting VLAN:
  - real OSA card, HiperSockets, z/VM GuestLAN, z/VM VSWITCH



Setting Up Virtual LAN (VLAN)

- Setting up VLAN interface



- Removing a VLAN interface

```
root@larsson:~> ifconfig eth1.3 down
root@larsson:~> vconfig rem eth1.3
```

- Displaying the VLAN configuration

```
root@larsson:~> cat /proc/net/vlan/config
VLAN Dev name    | VLAN ID
Name-Type: VLAN_NAME_TYPE_RAW_PLUS_VID_NO_PAD
eth1.3         | 3  | eth1
```

- Implementation:
  - VLAN tag added to transmitted frames and removed from received frames

Customer Cases

Network: network connection is too slow

Configuration:

- z/VSE running CICs, connection to DB2 in Linux on System z
- Hipersocket connection from Linux to z/VSE
- But also applies to hipersocket connections between Linux and z/OS

Problem Description:

- When CICS transactions were monitored, some transactions take a couple of seconds instead of milliseconds

Tools used for problem determination:

- dbginfo.sh
- s390 debug feature
- sadc/sar
- CICS transaction monitor

Network: network connection is too slow (cont'd)

- s390 debug feature
  - Check for qeth errors:

```
cat /sys/kernel/debug/s390dbf/qeth_qerr
00 01282632346:099575 2 - 00 0000000180b20218  71 6f 75 74 65 72 72 00 | qouterr.
00 01282632346:099575 2 - 00 0000000180b20298  20 46 31 35 3d 31 30 00 |  F15=10.
00 01282632346:099576 2 - 00 0000000180b20318  20 46 31 34 3d 30 30 00 |  F14=00.
00 01282632346:099576 2 - 00 0000000180b20390  20 71 65 72 72 3d 41 46 |  qerr=AF
00 01282632346:099576 2 - 00 0000000180b20408  20 73 65 72 72 3d 32 00 |  serr=2.
```

- dbginfo file
  - Check for buffer count:

```
cat /sys/devices/qeth/0.0.1e00/buffer_count
16
```

- Problem Origin:
  - Too few buffers

Network: network connection is too slow (cont'd)

Solution:

- Increase buffer count (default: 16, max 128)
- Check actual buffer count with `'lsqeth -p'`
- Set the buffer count in the appropriate config file:
  - SUSE SLES10:
    - in /etc/sysconfig/hardware/hwcfg-qeth-bus-ccw-0.0.F200
    - add `QETH_OPTIONS="buffer_count=128"`
  - SUSE SLES11:
    - in /etc/udev/rules.d/51-qeth-0.0.f200.rules add
      ACTION=="add",
      `SUBSYSTEM=="ccwgroup", KERNEL=="0.0.f200",`
      `ATTR{buffer_count}="128"`
  - Red Hat:
    - in /etc/sysconfig/network-scripts/ifcfg-eth0
    - add OPTIONS=`"buffer_count=128"`

Bonding throughput not matching expectations

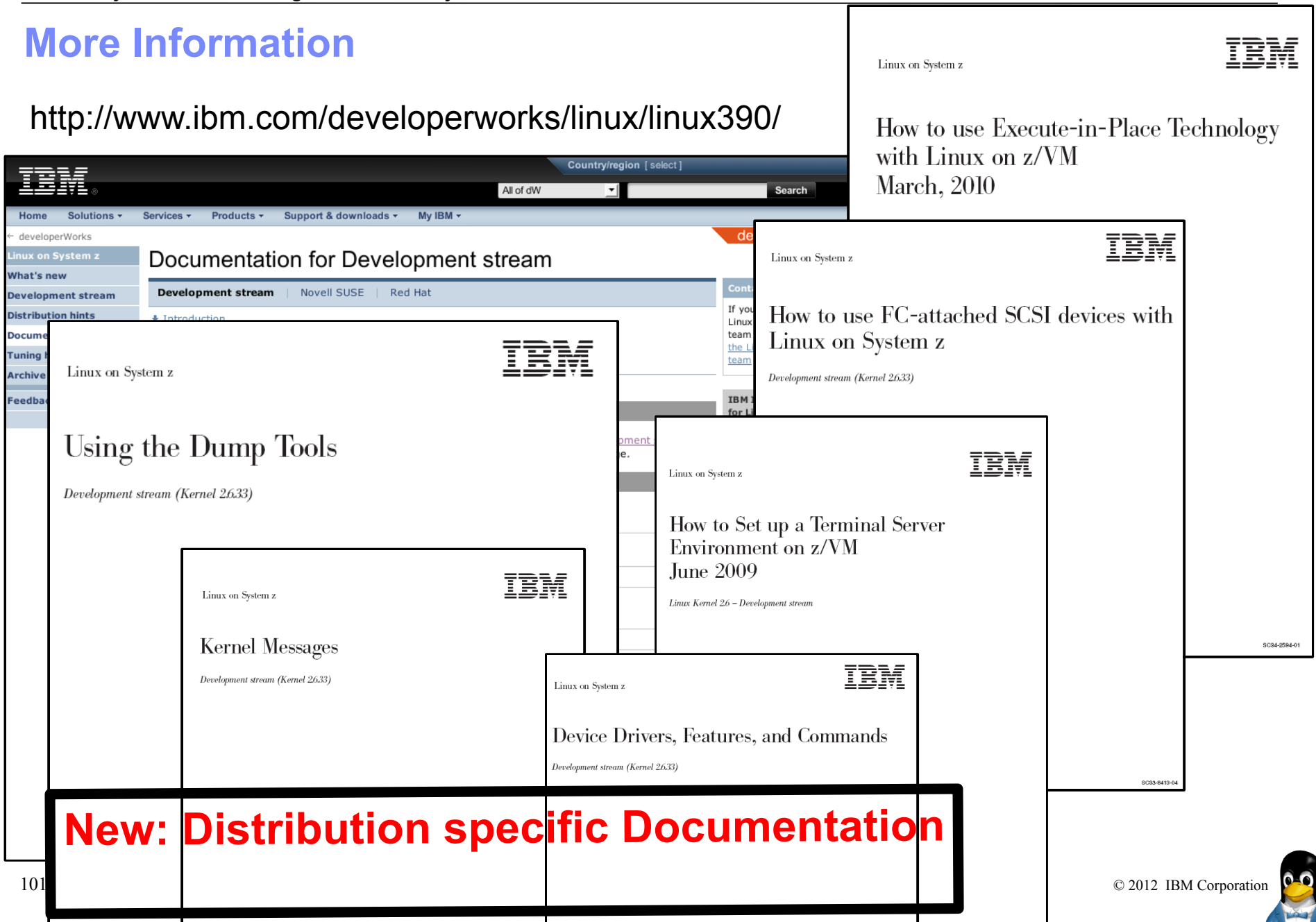
- Configuration:
  - SLES10 system, connected via OSA card and using bonding driver
- Problem Description:
  - Bonding only working with 100mbps
  - FTP also slow
- Tools used for problem determination:
  - dbginfo.sh, netperf
- Problem Origin:
  - ethtool cannot determine line speed correctly because qeth does not report it
- Solution:
  - Ignore the 100mbps message – upgrade to SLES11

bonding: bond1: Warning: failed to get speed and duplex from eth0, assumed to be 100Mb/sec and Full

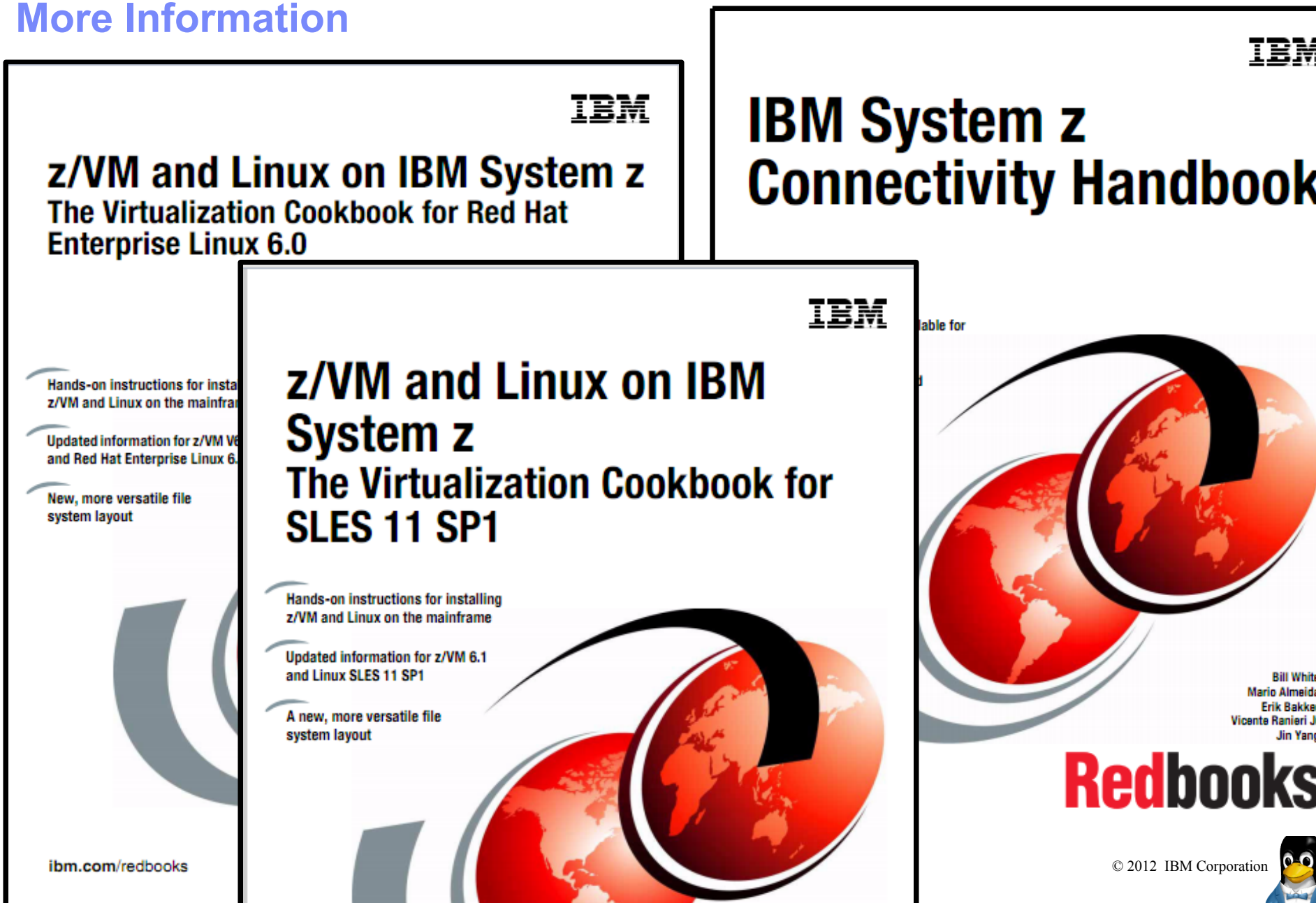
More Information

More Information

http://www.ibm.com/developerworks/linux/linux390/



More Information



References

- Linux on System z on developerWorks

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- Linux on System z documentation

http://www.ibm.com/developerworks/linux/linux390/documentation_dev.html

- Linux on System z – Downloads

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- Linux on System z - Tuning Hints & Tips

http://www.ibm.com/developerworks/linux/linux390/perf/index.html

- IBM System z Connectivity Handbook

http://www.redbooks.ibm.com/redpieces/abstracts/sg245444.html

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http://www.vm.ibm.com/education/lvc/

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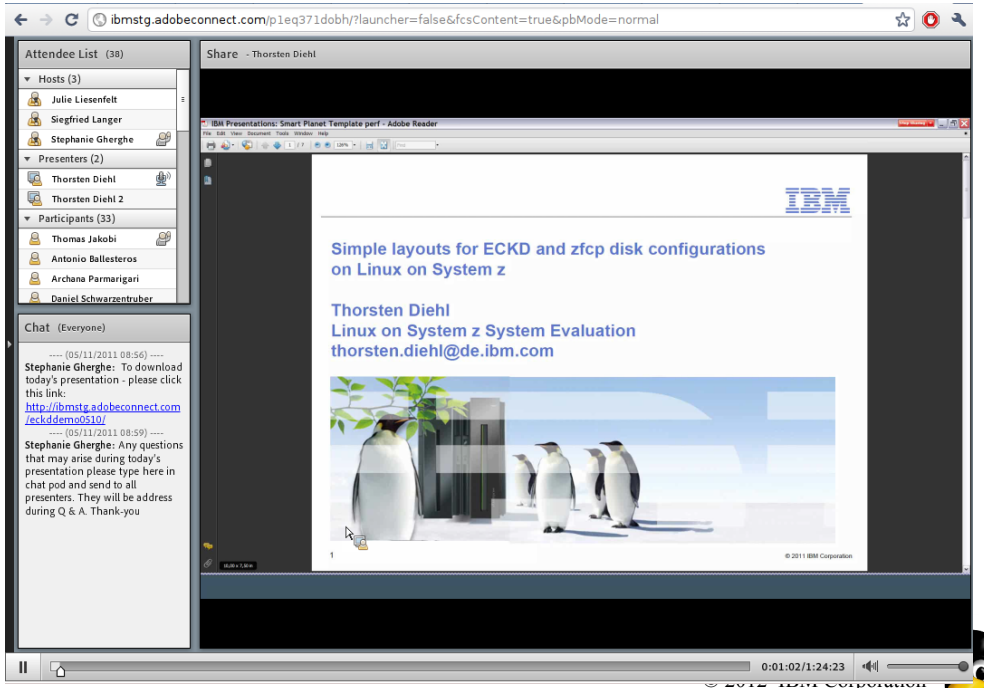
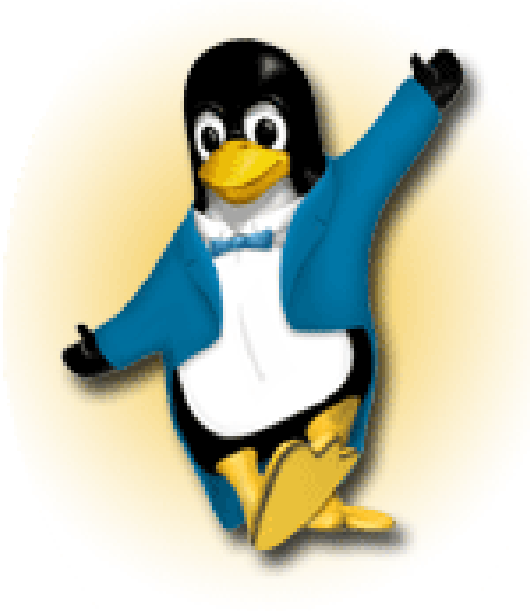


Questions?



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