Networking with Linux on System z

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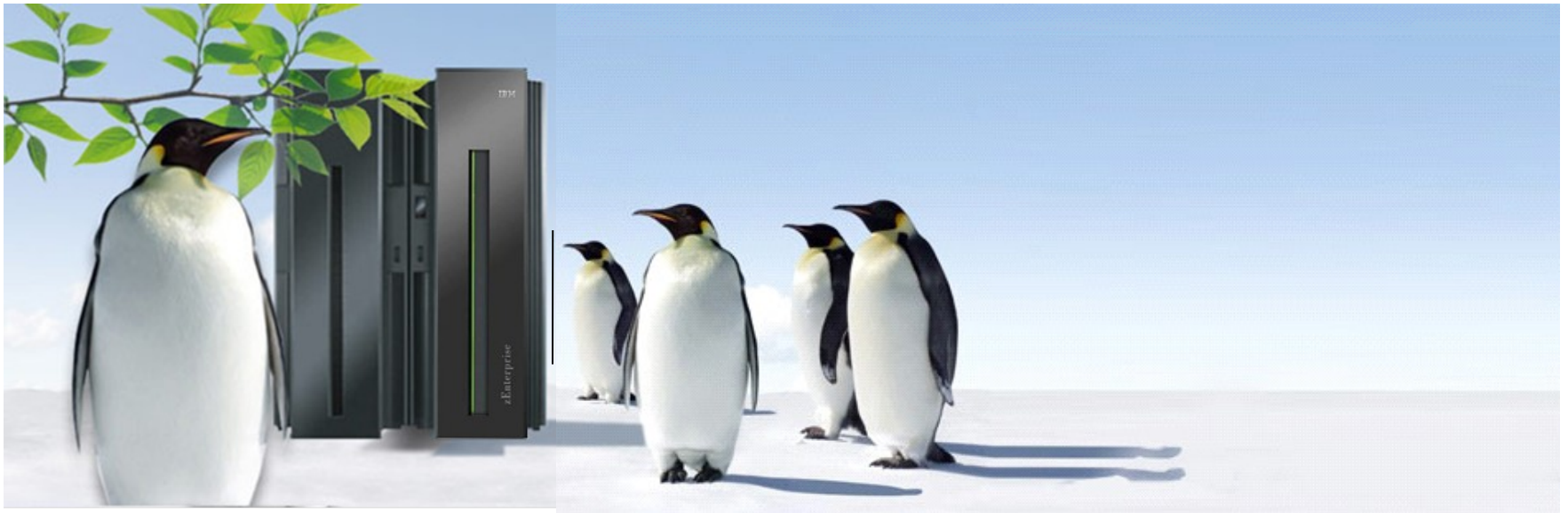
Linux on System z Development



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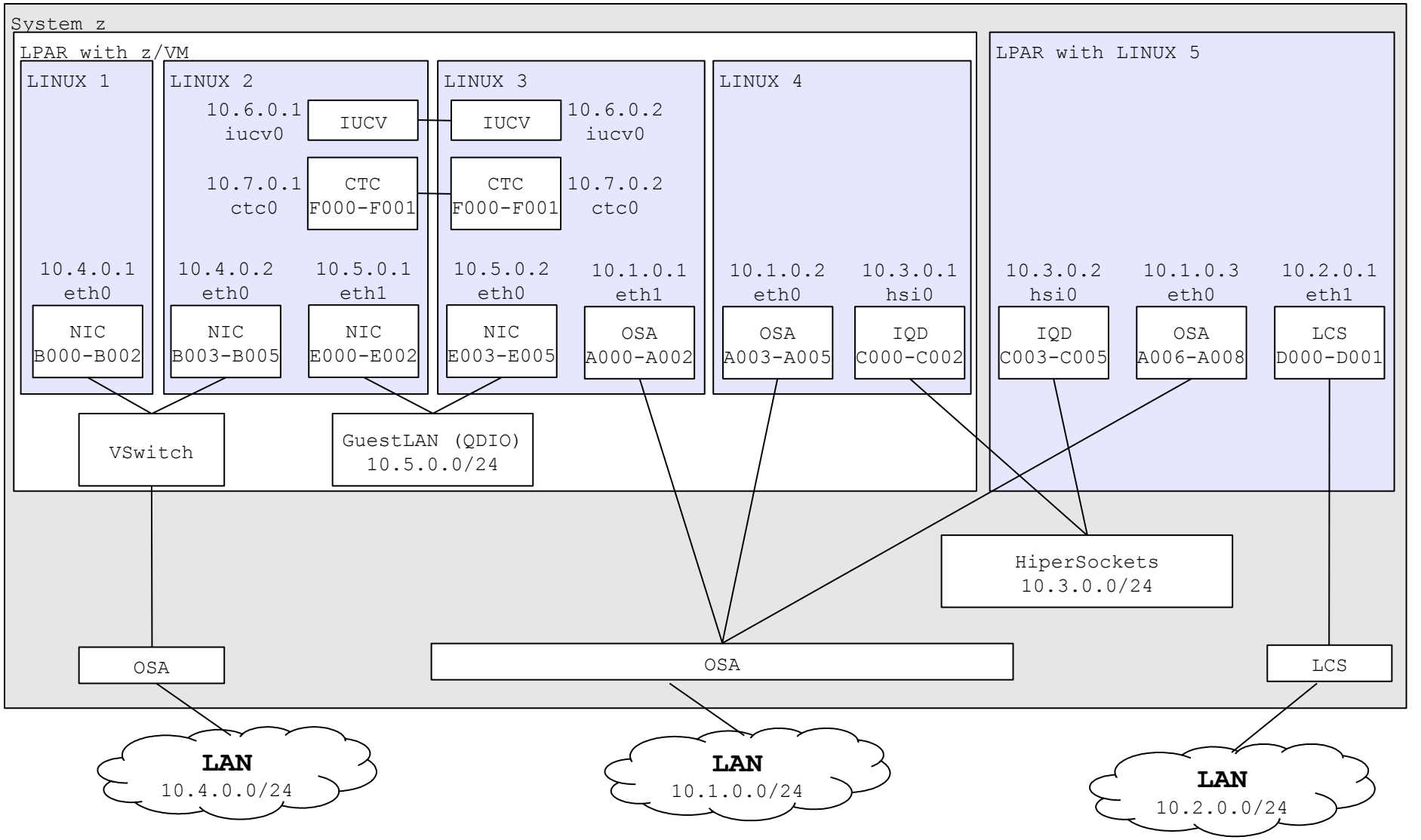
Agenda

- Linux on System z Device Drivers
- Configuration of network devices
  - Generic (manual)
  - Novell/SUSE SLES10 and SLES11
  - RedHat RHEL5 and RHEL6
- Further networking driver aspects
- System z related networking commands and tools
- Advanced topics
  - Channel Bonding
  - VLAN
- Performance aspects
- Troubleshooting

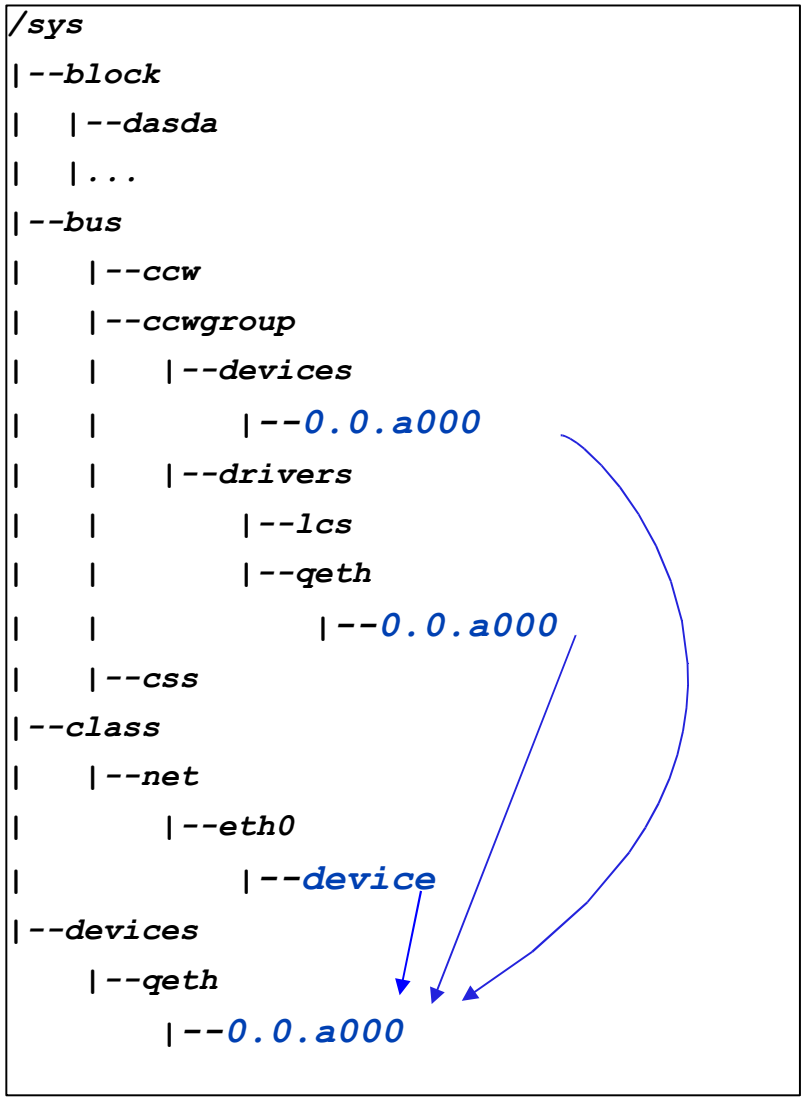
Linux for System z Network Device Drivers

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

Network Example



Linux 2.6 Device Model – System z



- Block subsystem (view):
  Block devices and partitions (dasda, sda, ram0)
- Bus subsystem (view):
  Device drivers and devices sorted by bus (ccw)
  CCW Group Devices: QETH, LCS
  Example: a QETH device
- Class subsystem (view):
  Logical devices sorted by type, i.e. to which class they belong; Logical devices have link to hardware device
- Devices subsystem (view):
  All the devices of a system

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!

Feature	z196, z114, z10	z9	zSeries
OSA-Express3	1000Base-T Eth.	Not supported	Not supported
OSA-Express2	1000Base-T Eth.	1000Base-T Eth.	Not supported
OSA-Express	Not supported	Fast Ethernet 1000Base-T Eth.	Fast Ethernet 1000Base-T Eth. Token Ring

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)

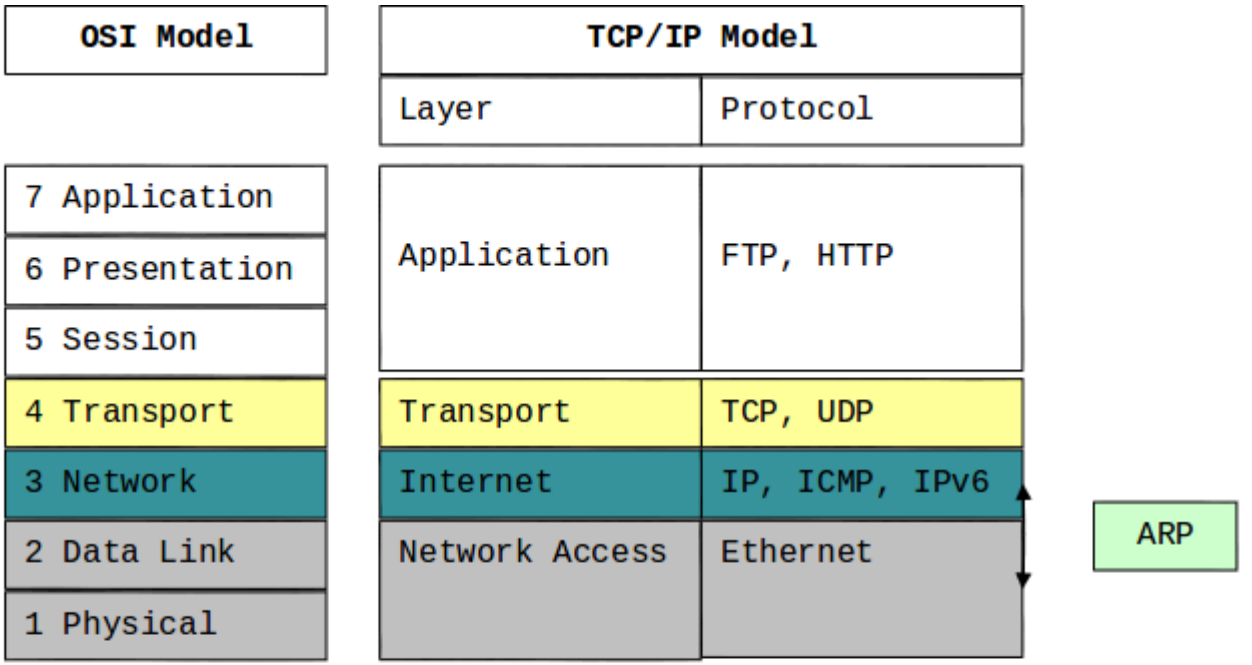
QETH Device Driver

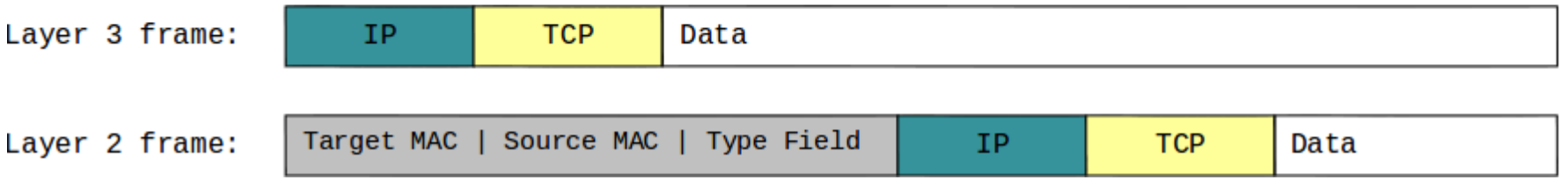
- Supports
  - OSA Express / OSA Express2 / OSA Express3 – OSD type (=QDIO)
    - Fast/Giga/10GBit Ethernet (fiber infrastructure)
    - 1000Base-T Ethernet (copper infrastructure)
  - System z HiperSockets
  - z/VM
    - GuestLAN Type QDIO (layer2 / layer3), Type Hiper
    - z/VM VSWITCH (layer2 / layer3)
  - 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

HiperSockets and OSA-Express features

Feature	z196, z114	System z10	System z9	zSeries
HiperSockets	Yes	Yes	Yes (layer3)	Yes (layer3)
OSA-Express4	Gigabit Ethernet 10 Gigabit Eth.	Not supported	Not supported	Not supported
OSA-Express3	Gigabit Ethernet 10 Gigabit Eth. 1000Base-T Eth.	Gigabit Ethernet 10 Gigabit Eth. 1000Base-T Eth.	Not supported	Not supported
OSA-Express2	Gigabit Ethernet 1000Base-T Eth.	Gigabit Ethernet 10 Gigabit Eth. 1000Base-T Eth.	Gigabit Ethernet 10 Gigabit Eth. 1000Base-T Eth.	Not supported
OSA-Express	Not supported	Not supported	Fast Ethernet Gigabit Ethernet 1000Base-T Eth.	Fast Ethernet Gigabit Ethernet 1000Base-T Eth. Token Ring ATM

QETH Layer 3 vs Layer 2 mode

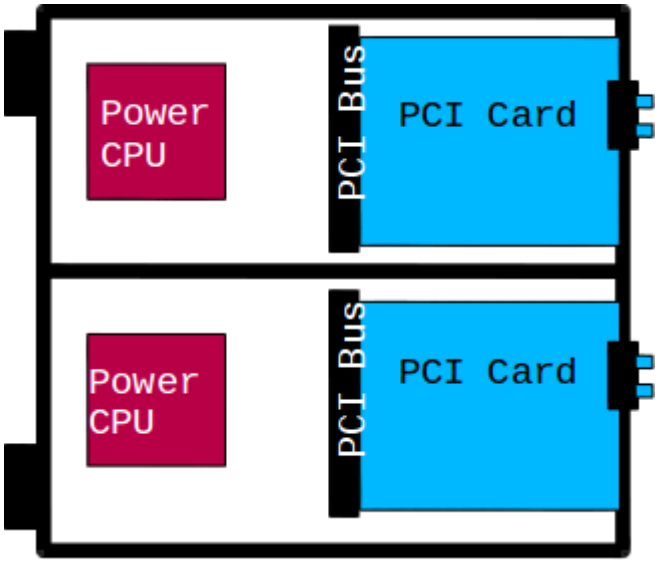




Primary Network Device: OSA Express

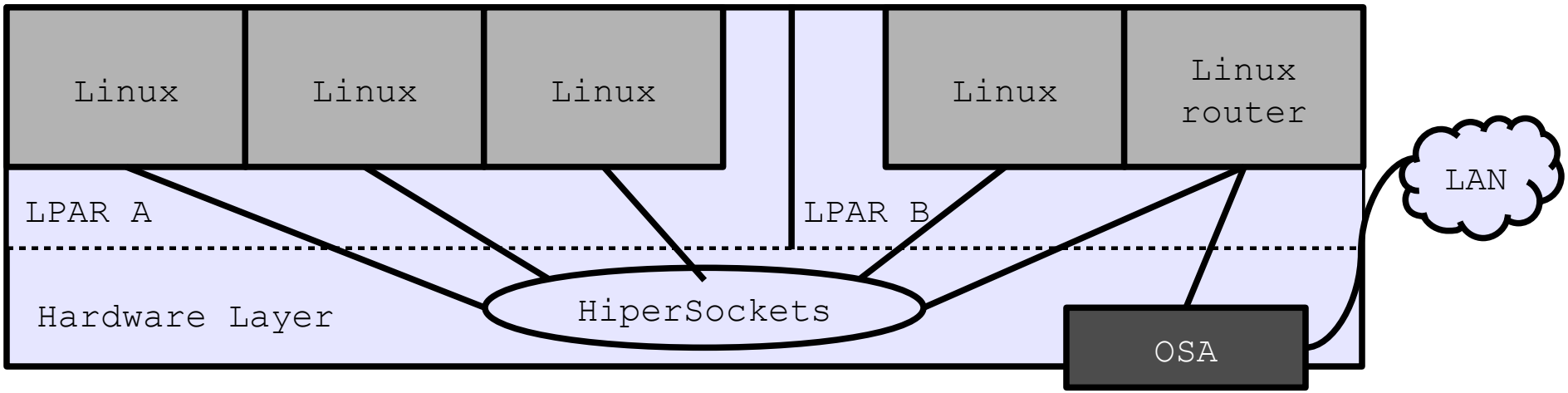
- 'Integrated Power computer' with network daughter card
- Shared between up to 640 OSA devices
- Three devices numbers (ccw devices) per OSA device:
  - Read device (control data ← OSA)
  - Write device (control data → OSA)
  - Data device (network traffic)
- OSA Address Table:
  - Maps addresses to OS images
  - Layer 2: MAC addresses
  - Layer 3: IP addresses
- 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)



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 (starting with z10)



Virtual Switch

- Create simulated Layer 2 switch device
- VM access control and VLAN authorization
- Create ports
- Connect NIC to Virtual Switch (LAN Segment)
- Full MAC address management

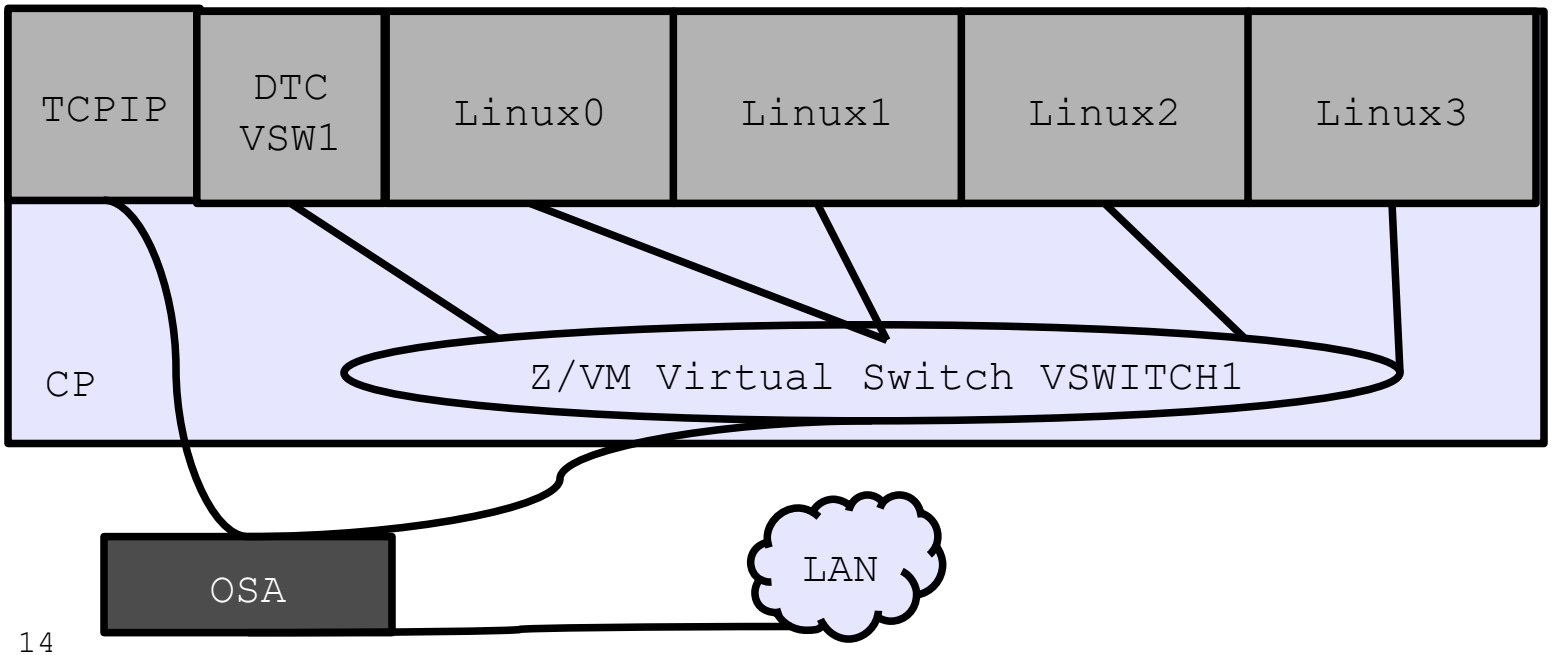
  (generation and assignment)
- 1-n VSWITCHs per z/VM Image

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
```



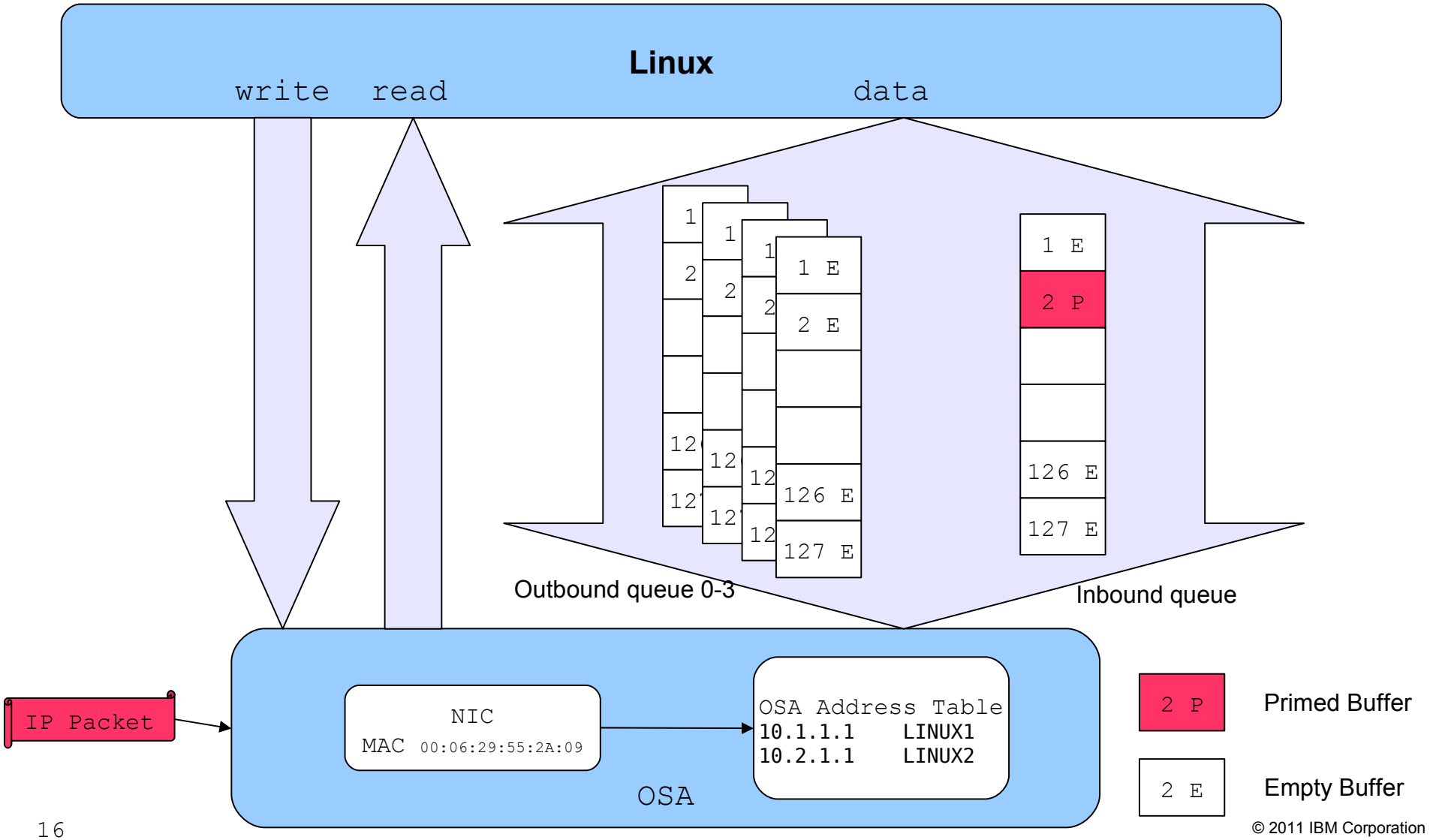
z/VM GuestLANs and VSWITCH

- **z/VM Guest LAN**
  - A simulated LAN segment
  - Types:
    - QDIO: IPv4 and IPv6 (layer3)
    - Ethernet: lots of protocols (layer2)
    - HiperSockets: IPv4 and IPv6 (layer3)
  - No physical connection
  - Unrestricted / restricted
  - Persistent / transient
  - As many as you want

- **z/VM VSWITCH**
  - Special purpose GuestLAN
    - Ethernet, type QDIO
    - Built-in IEEE 802.1q bridge to outside network
  - 1-8 associated OSA-connections
  - Restricted
  - Persistent
  - Failover and Link Aggregation
  - Port Isolation

- **Virtual Network Devices – NICs (Virtual Network Interface Cards)**
  - Defined by directory or CP DEFINE NIC command
    - Type QDIO or HIPERS (must match LAN type)
  - The only thing visible to Linux

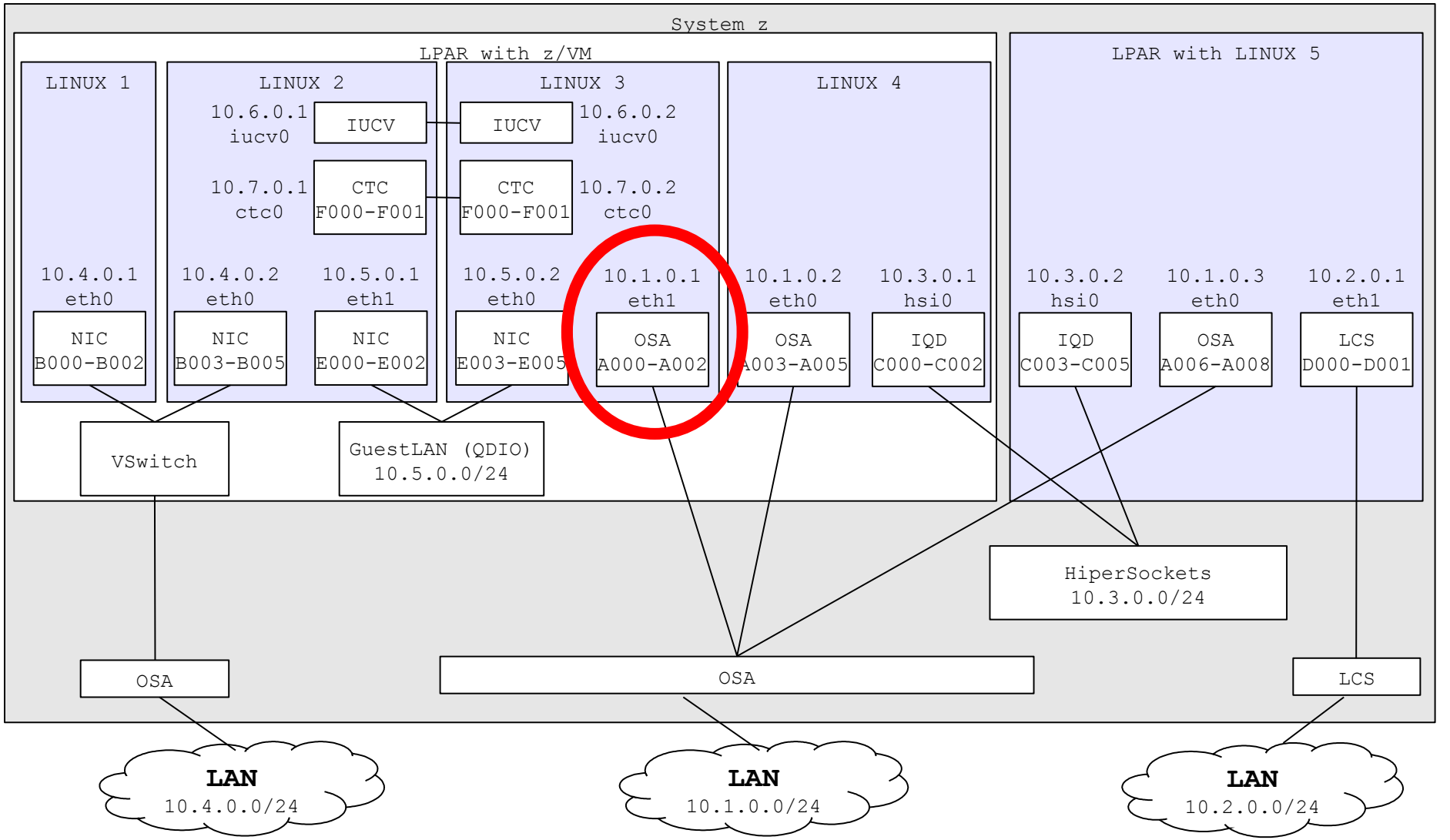
Queued Direct I/O (QDIO) Architecture



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:

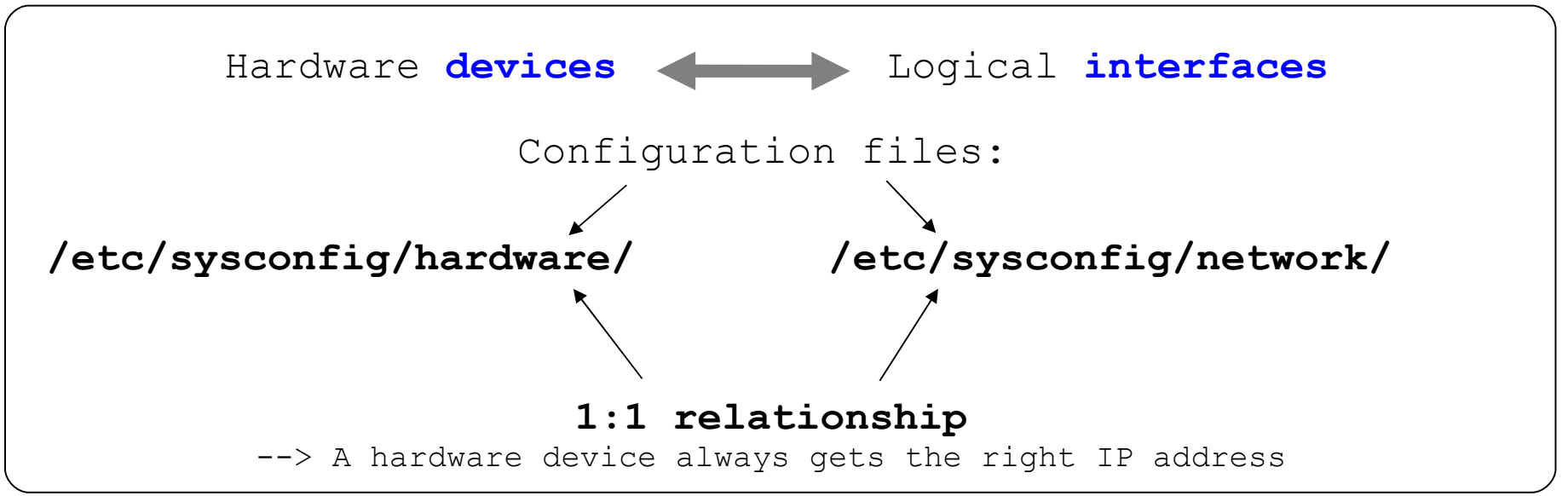
```
root@larsson:~> echo 1 > /sys/devices/qeth/0.0.a000/online
```

  - 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
```

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

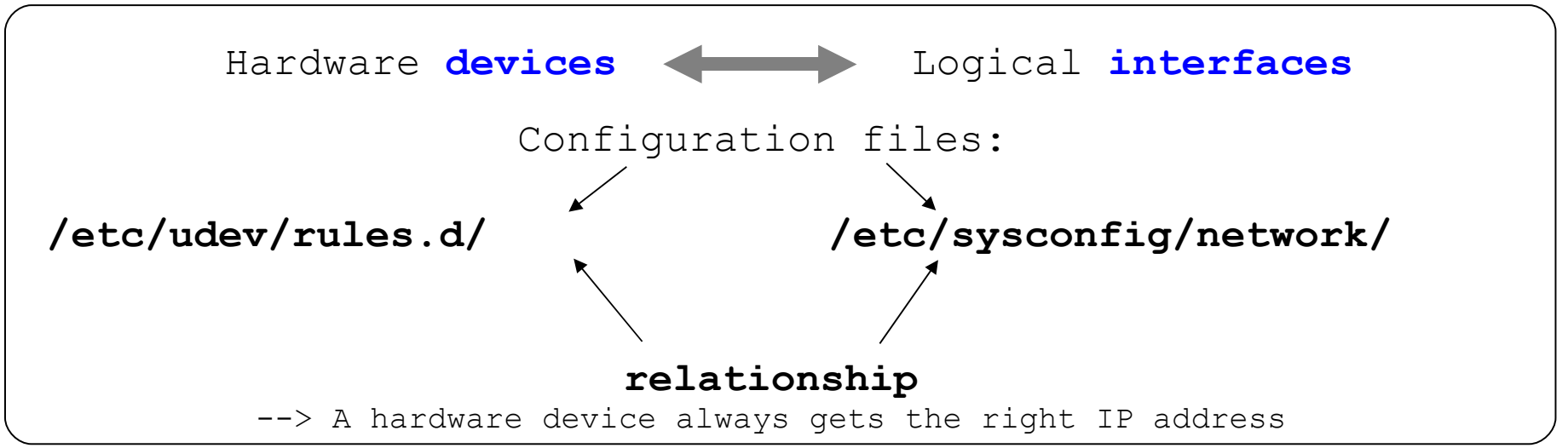
```
BOOTPROTO='static'
BROADCAST='10.1.0.255'
IPADDR='10.1.0.1'
NETMASK='255.255.255.0'
NETWORK='10.1.0.0'
STARTMODE='onboot'
```

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 (RHEL 5)

/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'
IPV6INIT=yes
IPV6ADDR=fd00:10:30::30:31/80
```

Network Device Configuration – RHEL 6 (cont'd)

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

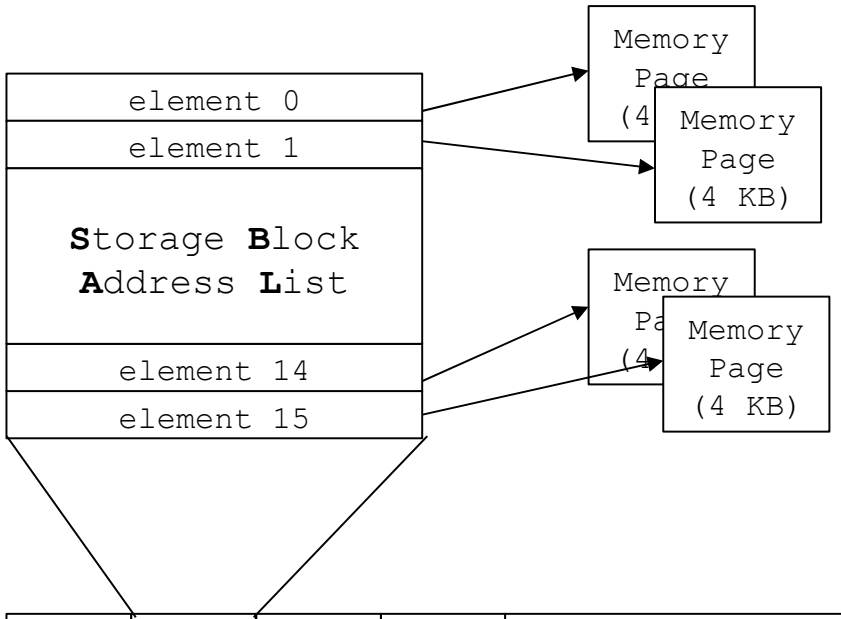
```
...
SUBSYSTEM=="net", ACTION=="add", DRIVERS=="?*",
ENV{INTERFACE_NAME}=="eth0", DRIVERS=="qeth",
KERNELS=="0.0.a000", ATTR{type}=="1", KERNEL=="eth*", NAME="eth0"
...
```

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.



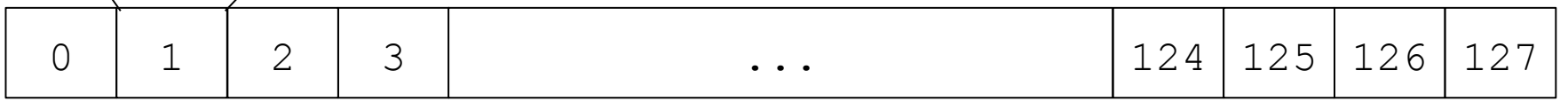
Per QETH device memory usage:

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)



Save Memory
8 Buffers

←→

Boost Performance
128 Buffers

OSA-devices in layer3 mode: offload checksumming and TCP segmentation

- TCP checksum calculation done for data integrity checks
- Offload checksumming for inbound IP packages from Linux stack to OSA-card

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

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

- Offload checksumming for outbound IP packages from Linux stack to OSA-card

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

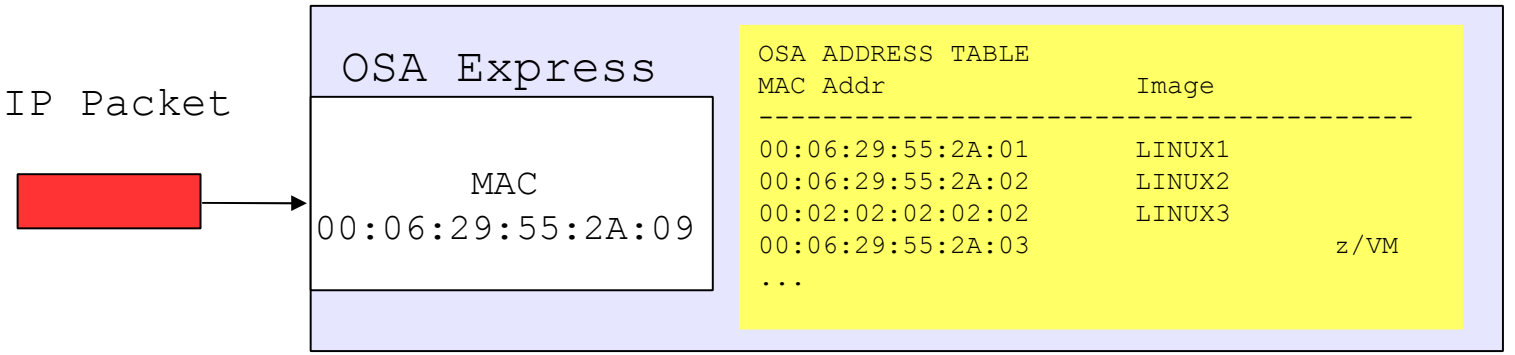
- Offload TCP segmentation from Linux stack to OSA-card

```
root@larsson:~> echo tso > /sys/devices/qeth/0.0.a000/large_send

root@larsson:~> ethtool -K eth0 tx on sg on tso on
```

===> move workload from Linux to OSA-Express adapter
===> configure only for non-shared usage of OSA-Express adapter

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
  - tcpdump output readable without option fake_ll
  - no OSA-specific setup required for routing, proxy ARP

OSA Express 3 – 2 ports within 1 chpid

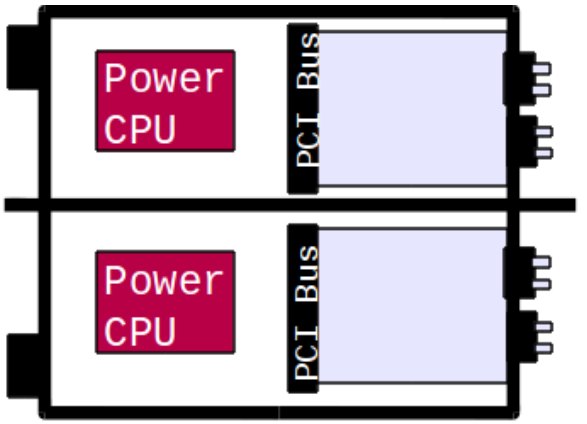
- OSA Express2 – 2 CHPIDs with 1 port per CHPID – 2 ports totally
- OSA Express3 – 2 CHPIDs with 2 ports per CHPID – 4 ports totally (>= z10)
- New sysfs-attribute “portno” can contain '0' or '1'
- OSA-Express3 GbE SX and LX

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 -u 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
```

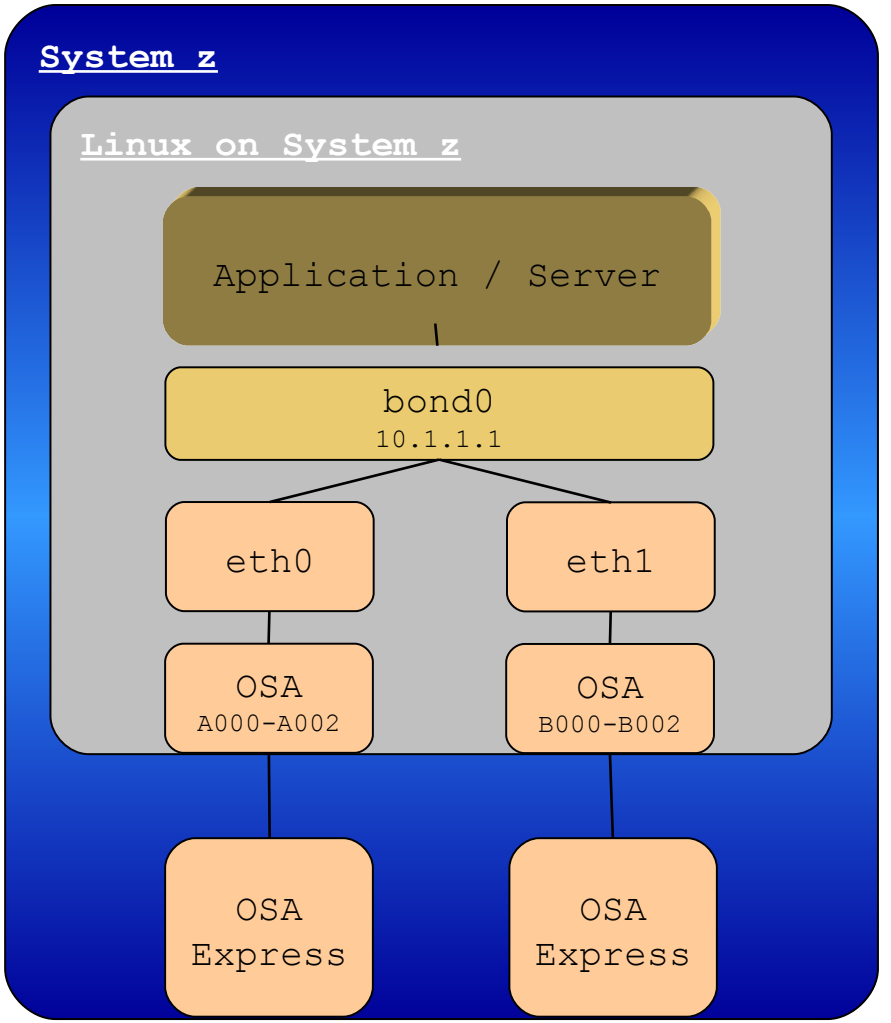
Advanced Topics

- Channel Bonding
- VLAN

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

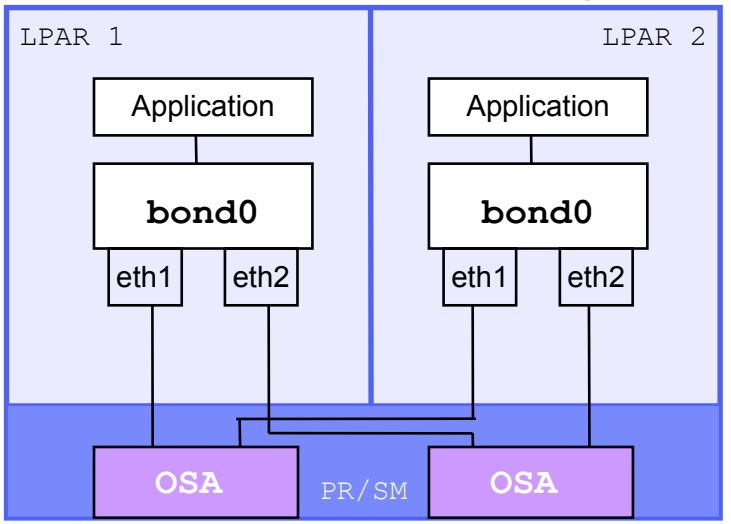
http://sourceforge.net/projects/bonding



Leveraging Virtualization for Network Interface Redundancy and Automated Failover

Resource Virtualization:

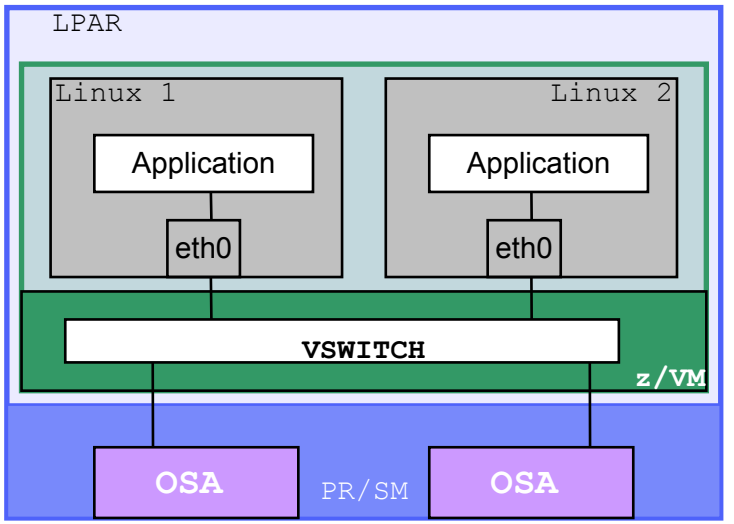
OSA Channel Bonding



- 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**

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=
# RHEL6 only
BONDING_OPTS='mode=active_backup fail_over_mac=active miimon=100'
```

Setting Up Channel Bonding (cont'd)

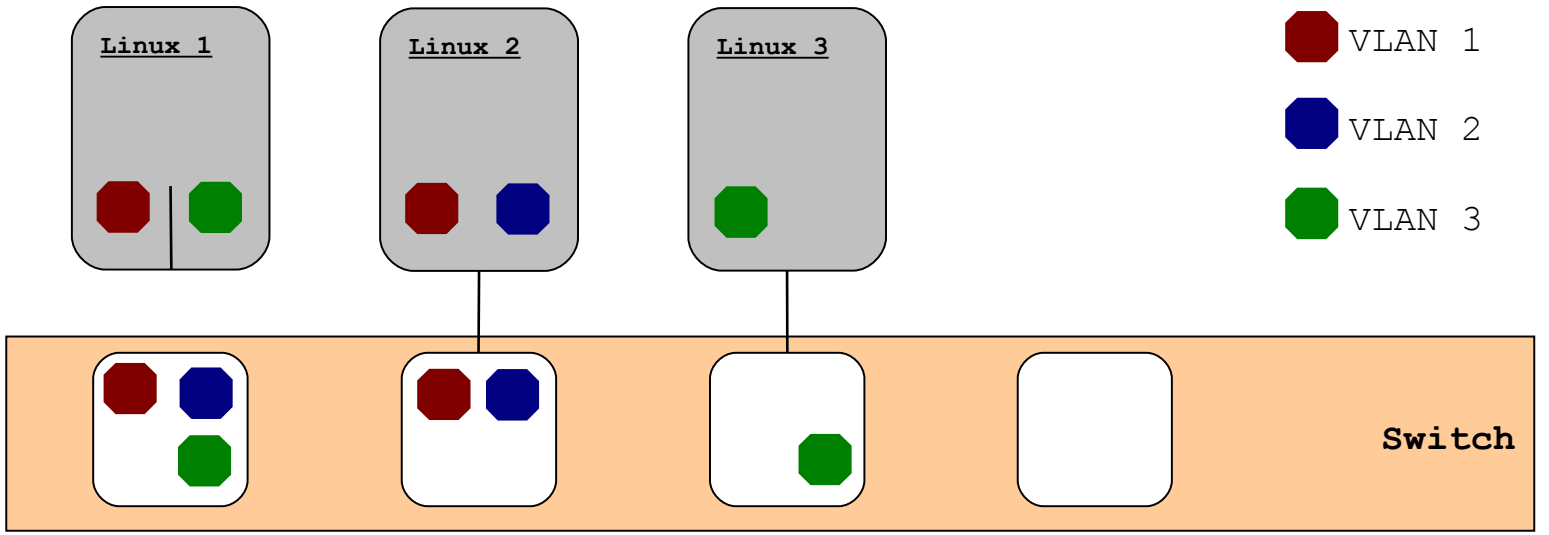
- Display the interface and bonding configuration

```
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


```
root@larsson:~> ifconfig eth1 9.152.10.4
root@larsson:~> vconfig add eth1 3
root@larsson:~> ifconfig eth1.3 1.2.3.4 netmask 255.255.255.0
```

- 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

Network Performance Summary

- Which connectivity to use:
  - External connectivity:
    - LPAR: 10 GbE cards
    - z/VM: VSWITCH with 10GbE card(s) attached
    - z/VM: For maximum throughput and minimal CPU utilization attach OSA directly to Linux guest
  - Internal connectivity:
    - LPAR: HiperSockets for LPAR-LPAR communication
    - z/VM: VSWITCH for guest-guest communication
- For highly utilized network devices consider
  - to use z/VM VSWITCH with link aggregation
  - to use channel bonding
  - that channel bonding for high availability has low overhead

Troubleshooting: HiperSockets connection appears to be slow

- lfconfig output

```
ifconfig hsi0
hsi0      Link encap:Ethernet  HWaddr 06:00:F2:01:00:1B
          inet addr:10.10.32.5  Bcast:10.10.63.255  Mask:255.255.224.0
          inet6 addr: fe80::400:f2ff:fe01:1b/64 Scope:Link
          UP BROADCAST RUNNING NOARP MULTICAST  MTU:32768  Metric:1
          RX packets:32285 errors:0 dropped:0 overruns:0 frame:0
          TX packets:44539 errors:382 dropped:0 overruns:0 carrier:0
```

- s390 debug feature
  - Check for qeth errors:

```
cat /sys/kernel/debug/s390dbf/qeth_qerr
00 01316676190:387699 2 - 00 000003c001070a08  71 6f 75 74 65 72 72 00 | qouterr.
00 01316676190:387699 2 - 00 000003c00106ec82  20 46 31 35 3d 31 30 00 |  F15=10.
00 01316676190:387699 2 - 00 000003c00106ec82  20 46 31 34 3d 30 30 00 |  F14=00.
00 01316676190:387700 2 - 00 000003c00106ec82  20 71 65 72 72 3d 31 00 |  qerr=1.
```

- dbginfo file
  - Check for buffer count of receiving partner:

```
lsqeth hsi0 | grep buffer_count
buffer_count          : 16
```

Troubleshooting: HiperSockets connection appears to be slow (cont'd)

- netstat -s

```
netstat -s
...
Tcp:
    ...
    39409 segments received
    51294 segments send out
    70 segments retransmited
    0 bad segments received.
    ...
```

- Problem Origin: Input buffers of receiving partner are full:
  - Too few input buffers
    - increase buffer_count to 128
  - CPUs busy with something else
  - LPAR share / VM guest share too low
  - …
- Imbalance between sender and receiver

References

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Questions?

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