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Networking with Linux on System z - Basic OSA Device Configuration

zLN01

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Linux on System z Development

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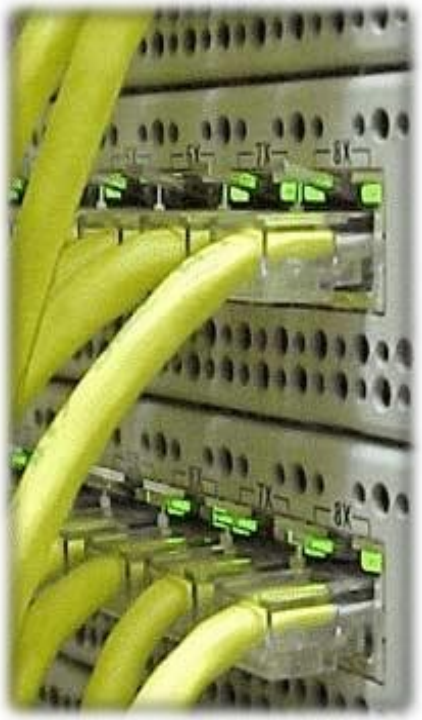
Agenda

- Linux on System z network device drivers
- Configuration of network devices
  - SUSE SLES10 and SLES11
  - RedHat RHEL5
  - Generic (manual)
- Further networking driver aspects
- Advanced aspects
  - Channel Bonding
  - Virtual IP Addresses
  - VLAN

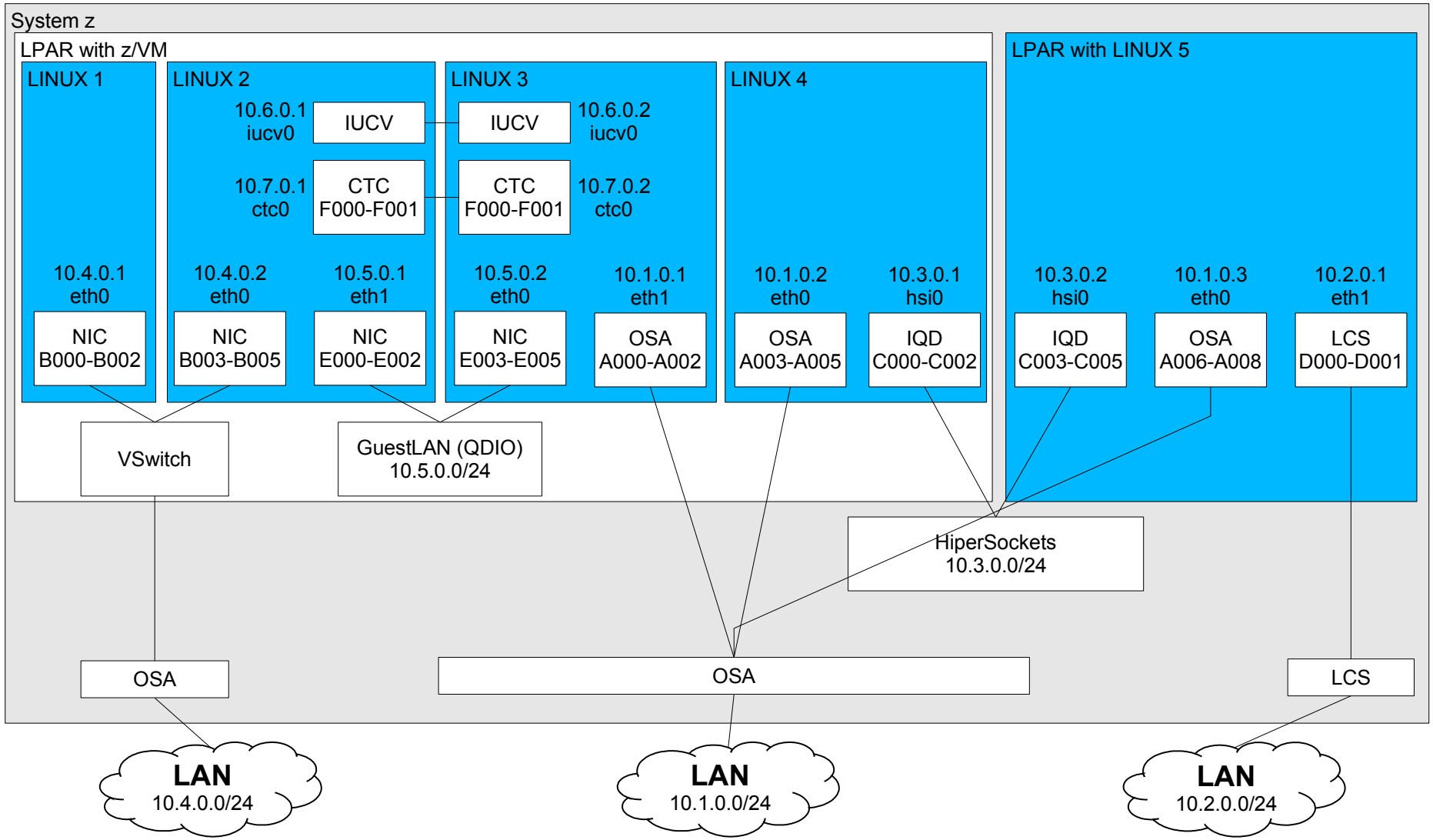
Network Device Drivers

Linux for System z Network Device Drivers

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



Network Example



Linux 2.6 Device Model

- Integrated uniform device model that reflects a system's hardware structure
- Simplified device reference counting and locking
- Unified user interface via sysfs
  - Hierarchical, tree-like representation of system's hardware
  - Several subsystems provide different views of the hardware
  - Configuration of devices via attribute files
  - Dynamic attach/detach of devices possible

Linux 2.6 Device Model – System z Examples

```
/sys
|--block
|   |--dasda
|   |...
|--bus
|    |--ccw
|    |--ccwgroup
|    |    |--devices
|    |         |--0.0.a000
|    |    |--drivers
|    |         |--lcs
|    |         |--qeth
|    |              |--0.0.a000
|    |--css
|--class
|    |--net
|         |--eth0
|              |--device
|--devices
     |--qeth
          |--0.0.a000
```

Block Devices:
DASD, RAM-Disk, Minidisk
SCSI, Loopback

CCW Group Devices:
QETH, LCS

Example: a QETH device

Many ways to find a device

LAN Channel Station (LCS) Device Driver

- Supports:
  - OSA Express(2) (in non-QDIO mode OSE)
    - Fast Ethernet
    - 1000Base-T Ethernet
    - HighSpeed TokenRing (<= z990)
    - ATM (running Ethernet LAN Emulation) (<= z990)
- May be preferred instead of QETH for security reasons
  - Administrator defines OSA Address Table, whereas with QETH each Linux registers its own IP address --> restricted access

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 still available for backward compatibility

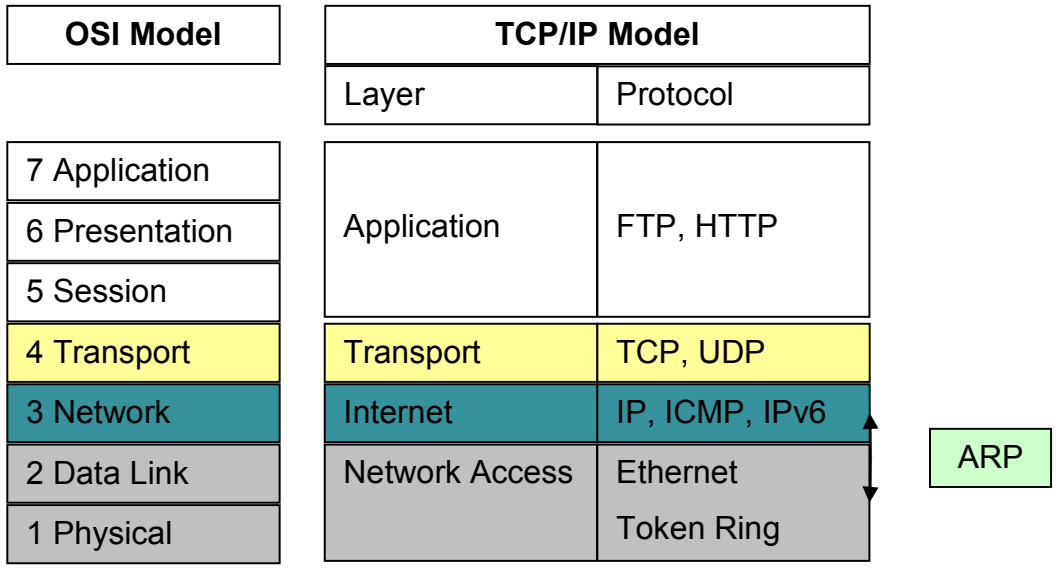
- Migrate
  - Virtual CTC and IUCV (under z/VM) ==> guest LAN HiperSockets or guest LAN type QDIO
  - CTC inside a CEC ==> Hipersockets
  - CTC ==> OSA-Express (QDIO)

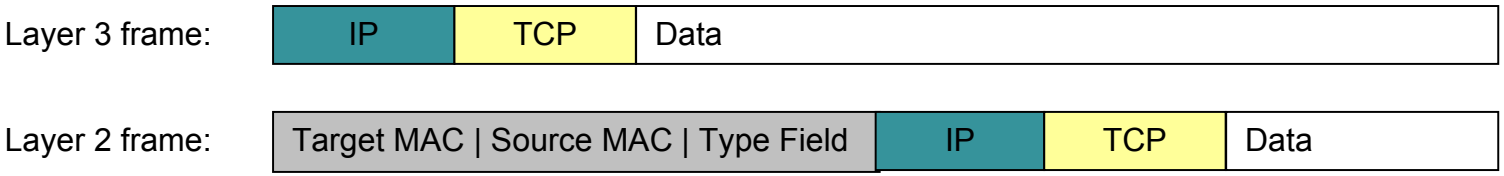
QETH Device Driver

- Supports:
  - OSA Express / OSA Express2 / OSA Express3 – OSD type (=QDIO)
    - Fast/Giga/10GBit Ethernet (fiber infrastructure)
    - 1000Base-T Ethernet (copper infrastructure)
    - HighSpeed TokenRing (<= z990)
    - ATM (running Ethernet LAN Emulation) (<= z990)
  - 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

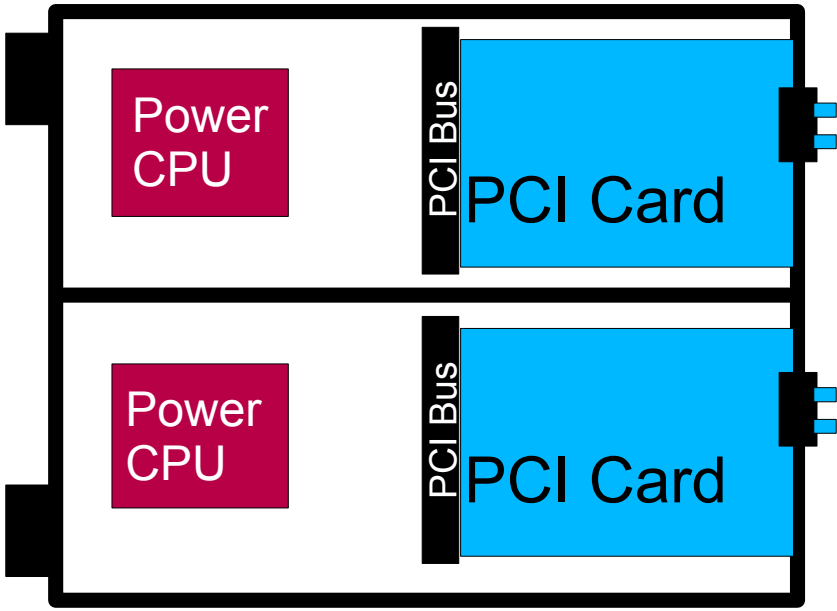
Layer 3 vs. Layer 2





Primary Network Device: OSA Express

- 'Integrated Power computer' with network daughter card
- Shared between up to 640 / 1920 TCP/IP stacks
- OSA Address Table: which OS image has which IP address
- Three devices (I/O subchannels) per stack:
  - Read device (control data <-- OSA)
  - Write device (control data --> OSA)
  - Data device (network traffic)
- Network traffic Linux <--> OSA
  at IP (layer3) or Ethernet (layer2) level
- Layer 3:
  - One MAC address for all stacks
  - OSA handles ARP
    (Address Resolution Protocol)



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 maximum frame sizes / MTU sizes:

frame size	MTU size
16 KB	8 KB
24 KB	16 KB
40 KB	32 KB
64 KB	56 KB

- Support of
  - Broadcast
  - VLAN
  - Ipv6
  - Layer2 (with z10)

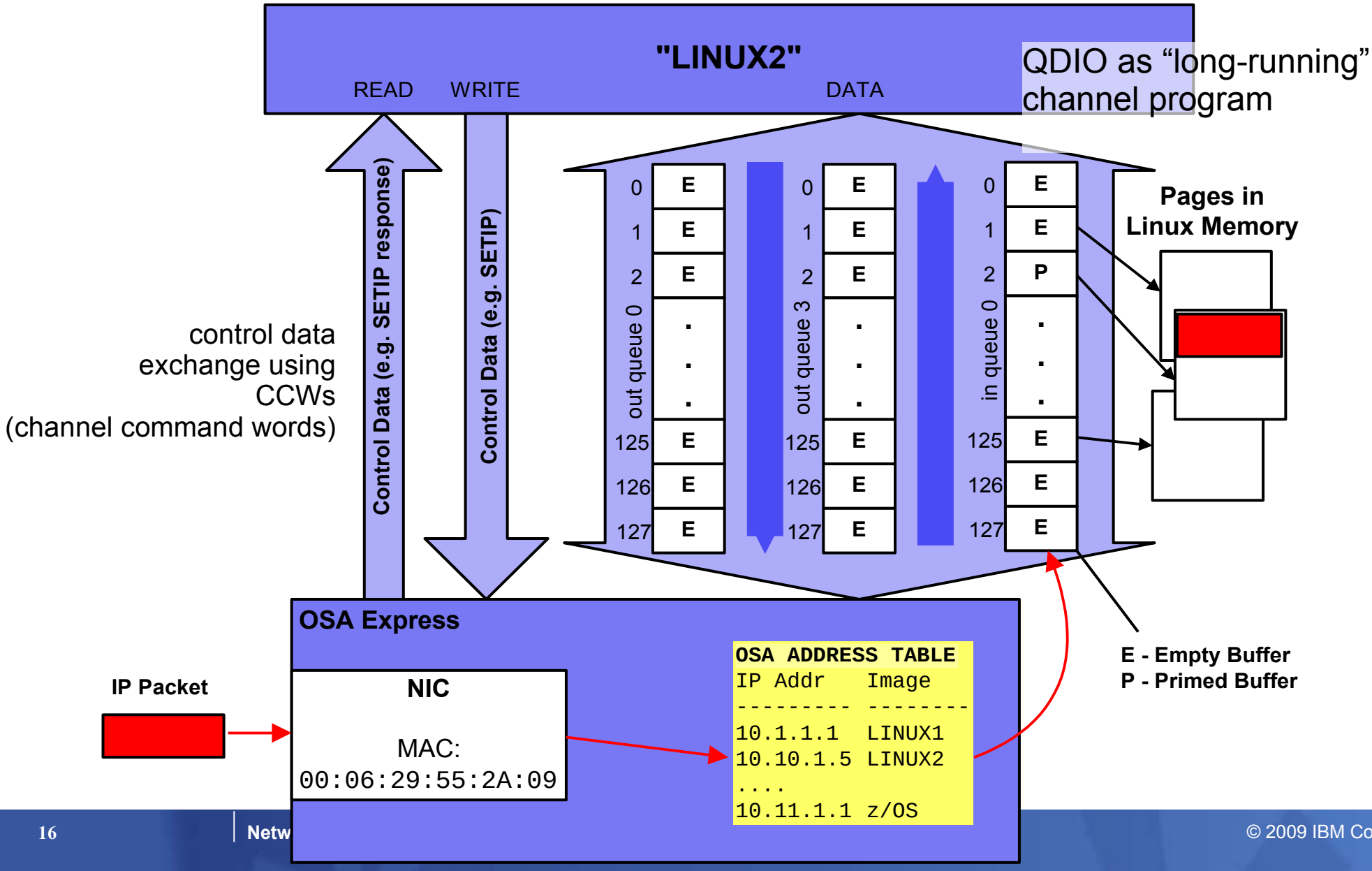
z/VM GuestLANs and VSWITCH

- **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

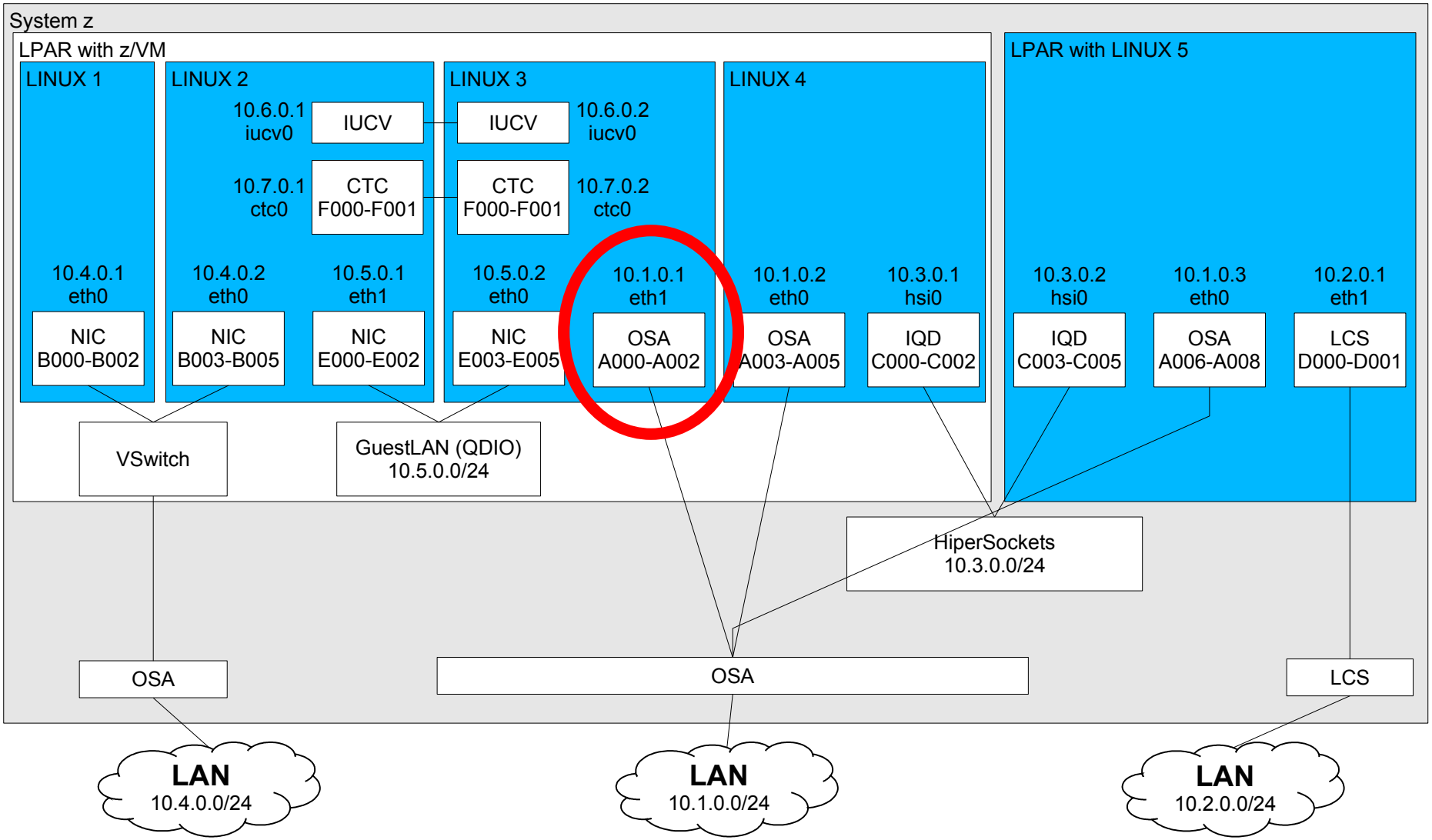
- **Virtual Network Devices – NICs (Virtual Network Interface Cards)**
- Defined by directory or CP DEFINE NIC command
  - Type QDIO or HIPERS (must match LAN type)
- The only thing visible to Linux

The Queued Direct I/O (QDIO) Architecture



Configuration

Networking Device Configuration – Example



Network Device Configuration – Generic

Load the device driver module:

```
# modprobe qeth
```

Create a new device by grouping its CCW devices:

```
# echo 0.0.a000,0.0.a001,0.0.a002 >/sys/bus/ccwgroup/drivers/qeth/group
```

Set optional attributes:

```
# echo 32 > /sys/devices/qeth/0.0.a000/buffer_count
```

Set the device online:

```
# 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:

```
# ifconfig eth0 10.1.0.1 netmask 255.255.255.0
```

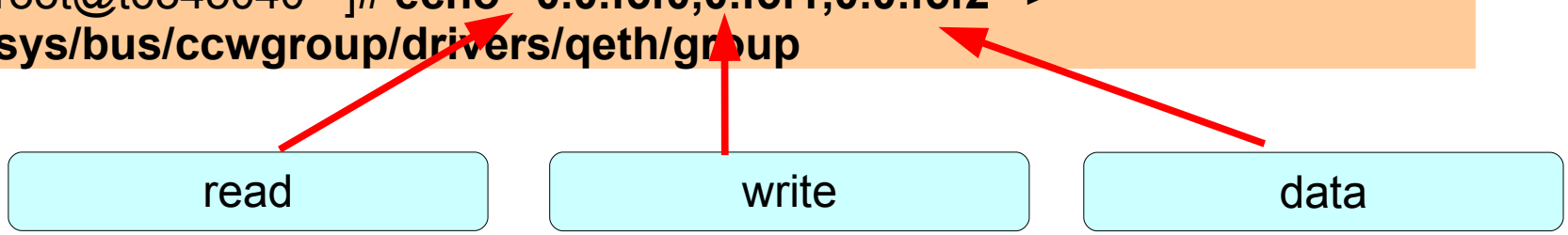
Configuration of the qeth driver (cont.)

- The qeth device driver automatically assigns interface names to the qeth group device and creates the corresponding sysfs structures.
- The following name schema is used:
  - eth[n] for ethernet
  - hsi[n] for Hipersocket devices
  - tr[n] for Token Ring
  - osn[n] for ESCON bridge

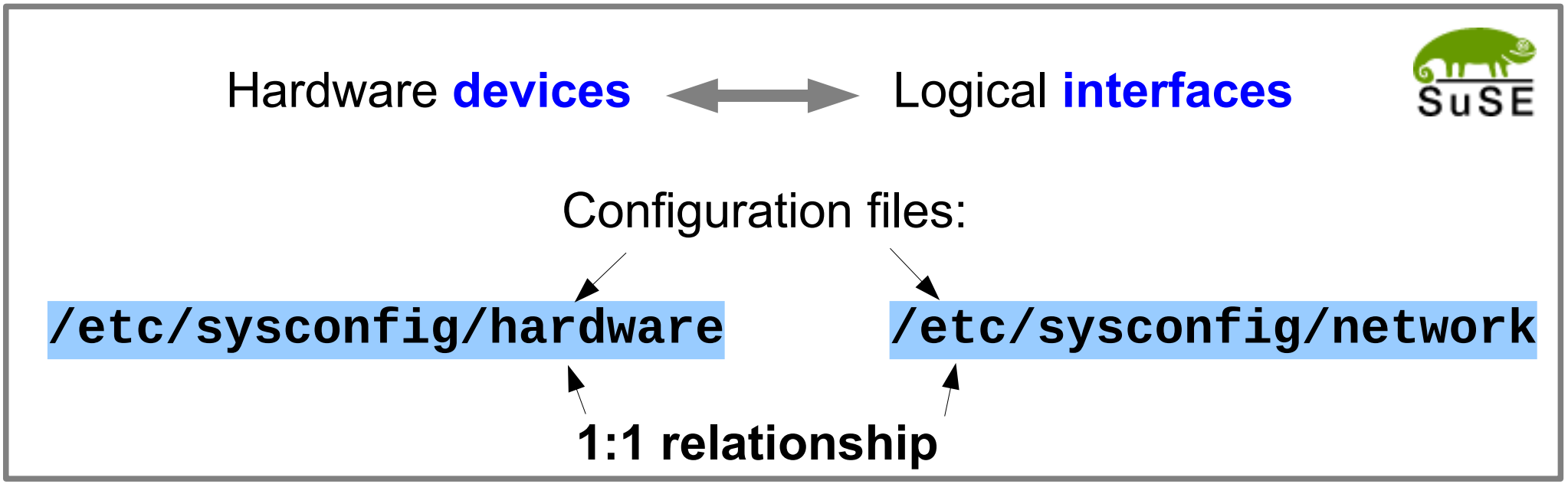
The qeth device driver shares the name space for Ethernet and Token Ring interfaces with the LCS device driver

```
[root@t6345040 ~]# modprobe qeth
```

```
[root@t6345040 ~]# echo “0.0.f5f0,0.f5f1,0.0.f5f2” >
/sys/bus/ccwgroup/drivers/qeth/group
```



SUSE SLES 10 Network Configuration



Naming convention:

hw/ifcfg-<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** and **ifup / ifdown**

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

Static QETH Device Setup (SUSE SLES10)

For LINUX 1 eth0

1. Create a hardware device configuration file (automatically with yast):

```
/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'
```

further attribute

Static QETH Device Setup (SUSE SLES10) (cont.)

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'
```

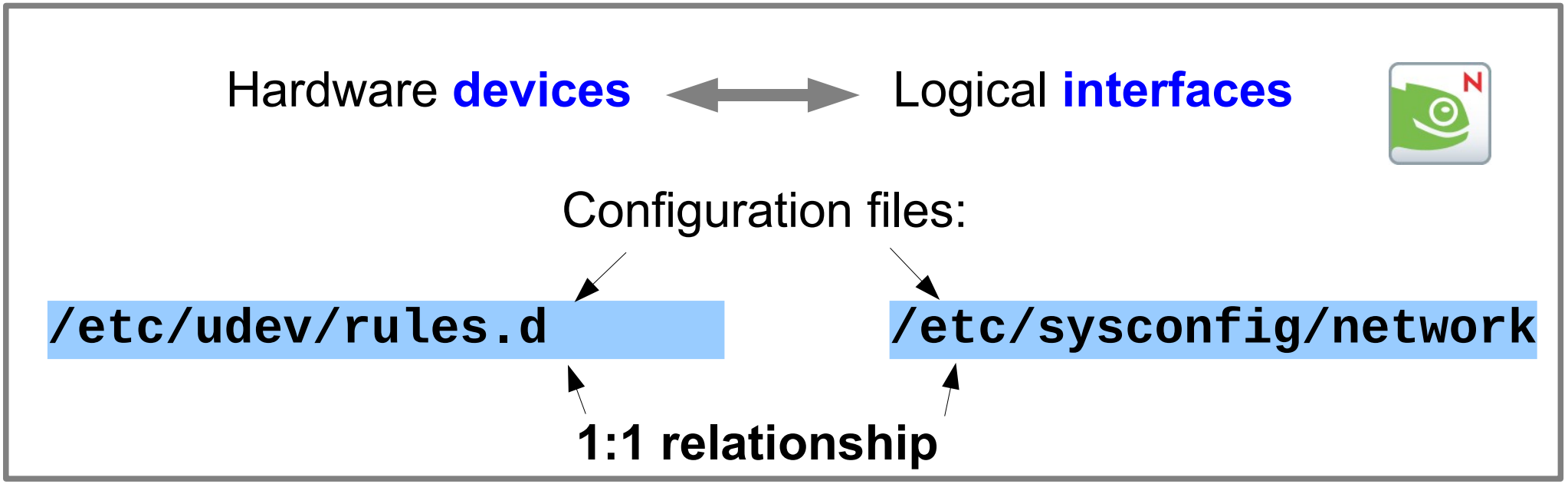
===> hardware device always gets the right IP address
Explanations are found in

```
/etc/sysconfig/network/ifcfg.template
```

3. Before reboot: test your config files:

```
#> hwup qeth-bus-ccw-0.0.a000
```

SUSE SLES 11 Network Configuration



- Devices are configured via udev (Framework for dynamic device conf.)
- udev rules naming: **51-<device type>-<bus location>.rules**
  e.g. **51-qeth-0.0.a000.rules**
- Persistent naming: Mapping bus <==> interface with udev rule
  70-persistent-net.rules
- Interface naming convention: **ifcfg-<ifname>** e.g. **ifcfg-eth0**
- Scripts: **qeth_configure** and **ifup / ifdown**

Static QETH Device Setup (SUSE SLES11)

For LINUX 1 eth0

Created by Yast or

```
qeth_configure -l 0 0.0.a000 0.0.a001 0.0.a002 1
```

1. Hardware Device Configuration rule:

```
/etc/udev/rules.d/51-qeth-0.0.a000.rules:
  # configure qeth device at 0.0.a000/0.0.a001/0.0.a002
  ...
  ACTION=="add", SUBSYSTEM=="ccwgroup",
                 KERNEL=="0.0.a000", ATTR{layer2}="0"
```

further attributes

2. Entry in persistent naming rule:

```
/etc/udev/rules.d/70-persistent-net.rules:
  SUBSYSTEM=="net", ACTION=="add", DRIVERS=="qeth",
                 KERNELS=="0.0.a000", ATTR{type}=="1",
                 KERNEL=="eth*", NAME="eth1"
```

RedHat RHEL5 Network Configuration

- 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 | ctc | iucv
   TYPE          Ethernet | CTC | IUCV
   SUBCHANNELS   0.0.b003,0.0.b004,0.0.b005
   PORTNAME
   OPTIONS
   MACADDR
```

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

Static QETH Device Setup (RedHat RHEL5)

For LINUX 1 eth0

1. Create the 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
  OPTIONS='checksumming=hw_checksumming'
```

further attributes

Static QETH Device Setup (RedHat RHEL5) (cont.)

2. Add / verify alias in /etc/modprobe.conf:

```
/etc/modprobe.conf:
   ...
   alias eth0 qeth
   ...
```

3. For details see:

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

Network Device Drivers – Advanced

QETH Device sysfs Attribute checksumming

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

```
QETH_OPTIONS='checksumming=hw_checksumming'     or
```

```
#> echo hw_checksumming >
  /sys/devices/qeth/0.0.b004/checksumming
```

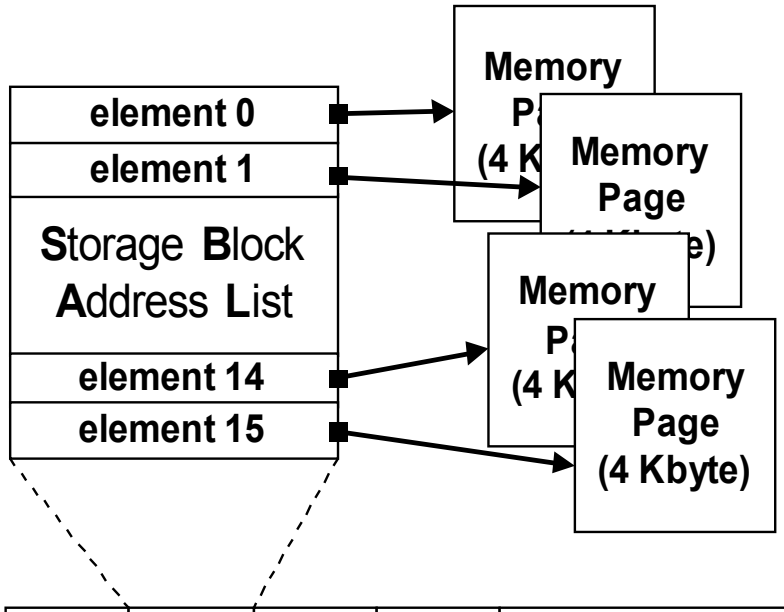
- ===> move workload from Linux to OSA-Express adapter
- Available for OSA-devices in layer3 mode only

- for trusted HiperSockets devices:

```
QETH_OPTIONS='checksumming=no_checksumming'     or
#> echo hw_checksumming >
#> echo no_checksumming >
  /sys/devices/qeth/0.0.b004/checksumming
```

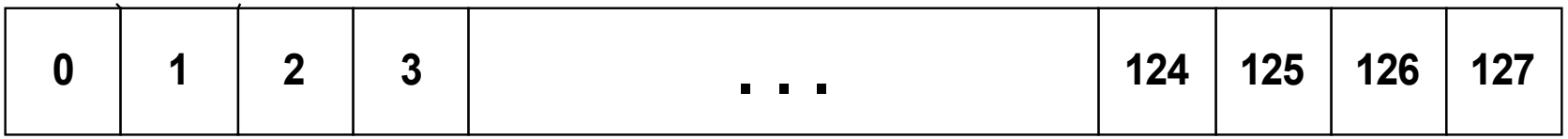
QETH Device sysfs Attribute buffer_count

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



Per QETH card memory usage:

control data structures:	~ 200 KB
memory for one buffer:	64 KB
buffer_count = 8	--> ~ 712 KB
buffer_count = 128	--> ~ 8.4 MB



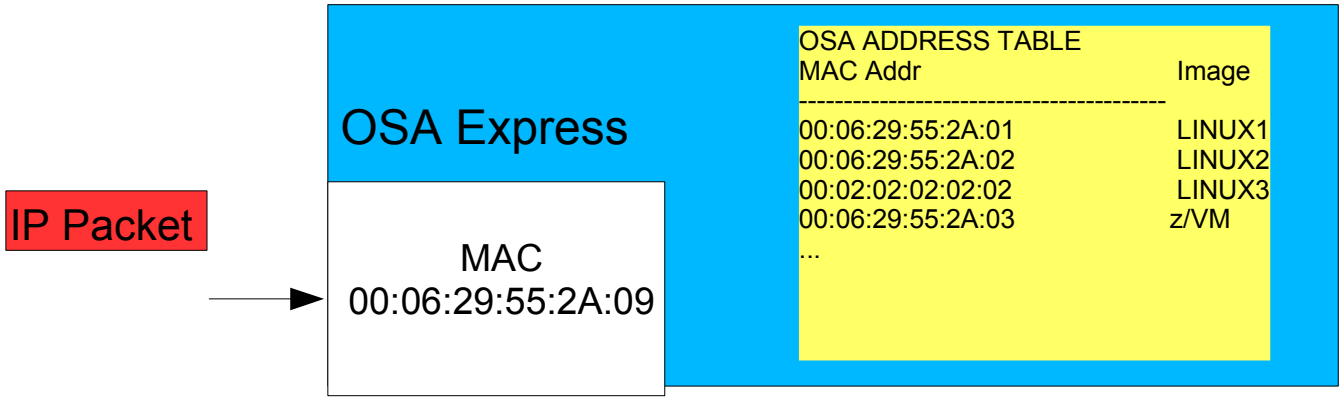
8 buffers **16 buffers (default, recommended)** **128 buffers**

Boost performance

Save memory

QETH Layer 2 mode

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



- udev rule 51-qeth-... (SLES11): `...ATTR{layer2}=1`
- or command (SLES11): `qeth_configure -l ...`
- hwcfg-qeth... file (SLES10) : `QETH_LAYER2_SUPPORT=1`
- ifcfg-qeth... file (SLES10): `LLADDR='<MAC Address>'`
- ifcfg-... file (RHEL5): `MACADDR='<MAC Address>'` `OPTIONS='layer2=1'`
- Direct attached OSA: MAC address must be defined manually
  `ifconfig eth0 hw ether 00:06:29:55:2A:01`
- HiperSocket: **new** layer2 support starting with z10
  MAC address automatically generated
- VSWITCH or GuestLAN under z/VM: MAC address created by z/VM

QETH Layer 2 mode (cont.)

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

- 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

- setting of layer2 attribute is only permitted when device is offline !

- Advantages:
  - Independent of IP-protocol
  - DHCP, tcpdump working without option fake_ll
  - channel bonding possible
  - No OSA-specific setup necessary for
    - Routing, IP Address Takeover, Proxy ARP

QETH Layer 2 mode (cont.)

- Direct attached OSA
  - Restrictions:
  - Older OSA-generation (<= z990):
    Layer2 and Layer3 traffic can be transmitted over the same OSA CHPID, but not between two hosts sharing the same CHPID !

- HiperSocket (new with z10)
  - Layer2 and Layer3 traffic separated

- GuestLAN type QDIO supported
  GuestLAN definition for layer2:

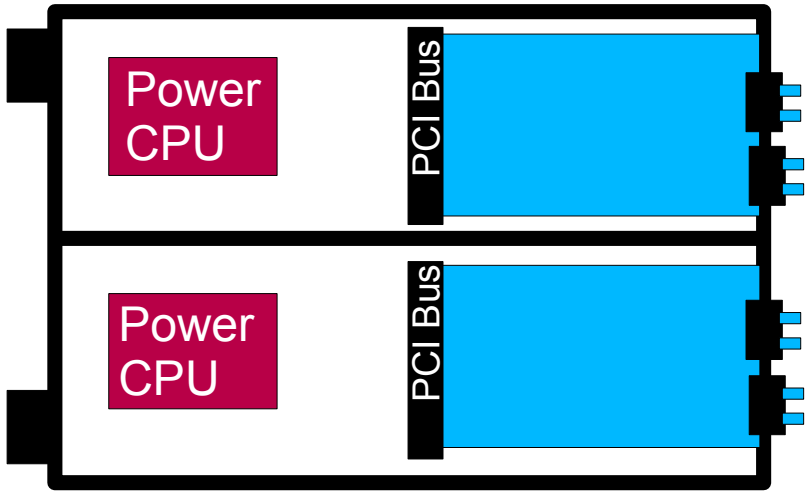
```
define lan <lanname> ... type QDIO ETHERNET
define nic <vdev> QDIO
couple <vdev> <ownerid> <lanname>
```

- VSWITCH

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

OSA Express3 - 2 ports within one 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)
- 2 port numbers: 0 and 1
- Defined with sysfs-attribute “portno”
- OSA-Express3 GbE SX and LX on z10
- udev rule 51-qeth-... (SLES11): `...ATTR{portno}=1`
  or command (SLES11): `qeth_configure -n 1 ...`
- hwcfg-qeth... file (SLES10 SP2) : `QETH_OPTIONS=”portno=1”`
- ifcfg-... file (RHEL5.2): `OPTIONS='portno=1'`



- Provides Hardware data router function
  ==> reduced latency
  ==> full linespeed achieved

Commands / tools for qeth-driven devices

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

```
#> 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.b000/0.0.b001/0.0.b002 xB0   hsi0       HiperSockets 0    sw      ...
```

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

```
#> lsqeth eth0
Device name                          : eth0
-------------------------------------------
        card_type                    : OSD_1000
        cdev0                        : 0.0.f5f0
        cdev1                        : 0.0.f5f1
        cdev2                        : 0.0.f5f2
        chpid                        : 76
        online                       : 1
        checksumming                 : sw checksumming
        state                        : UP (LAN ONLINE)
        buffer_count                 : 16
        layer2                       : 0
```

Clip of displayed attributes only

Commands / tools for qeth-driven devices (cont.)

- Managing IP-addresses on OSA / HiperSockets: ***qetharp***
  - *Suitable for layer3 devices only*
- Configuration support for IPA, VIPA, Proxy ARP: ***qethconf***
  - *Suitable for layer3 devices only*

Other networking tools for System z

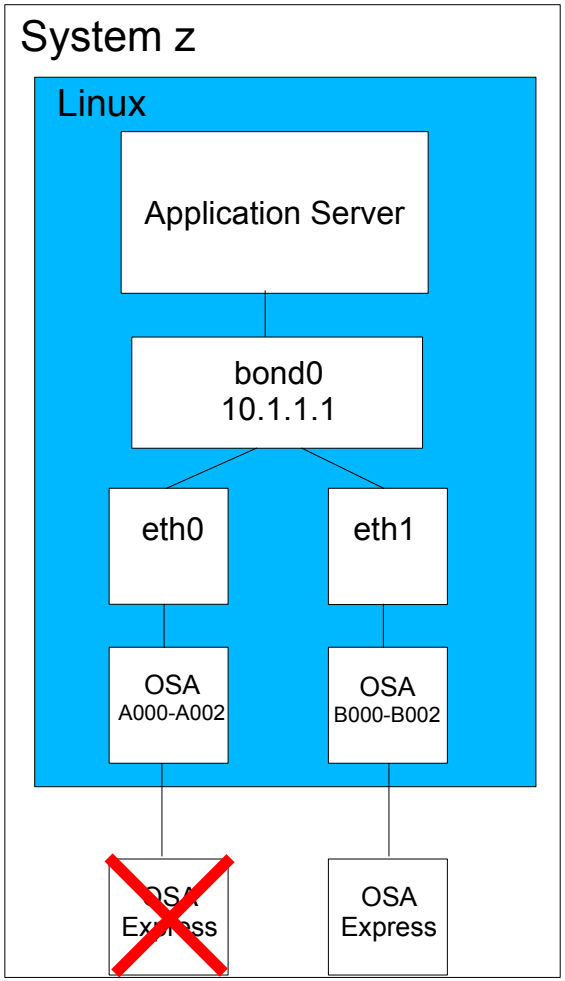
SNMP support: ***osasnmpd***

Subagent for the snmpd daemon to provide OSA Express information

Linux image control for LPAR and z/VM: ***snipl***

Can boot, stop, reset Linux images, send and receive OS messages

Channel Bonding



- The Linux bonding driver provides a method for aggregating multiple network interfaces into a single logical "bonded" interface
- provides failover and / or load-balancing

  active/backup / aggregation modes
- Detects loss of NIC connectivity

  ==> automatical failover
- transparent for LAN infrastructure
- applies to layer2-devices only
- No dynamic routing (OSPF) dependency
- latest setup description:

  http://sourceforge.net/projects/bonding/

Channel bonding setup

- Add MAC address to eth0 & eth1 (not necessary for GuestLAN or Vswitch)

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

- Load bonding module with miimon option (otherwise bonding will not detect link failures)

```
#> modprobe bonding miimon=100 mode=balance-rr
```

- Bring up bonding device bond0

```
#> ifconfig bond0 10.1.1.1 netmask 255.255.255.0
```

- connect eth0 & eth1 to bond0

```
#> ifenslave bond0 eth0
#> ifenslave bond0 eth1
```

Channel bonding setup (SLES10 – config files)

- interface configuration file for a slave

```
/etc/sysconfig/network/ifcfg-qeth-bus-ccw-0.0.a000
   BOOTPROTO='static'
   IPADDR=''
   SLAVE='yes'
   STARTMODE='onboot'
```

- interface configuration file for a master

```
/etc/sysconfig/network/ifcfg-bond0
   BOOTPROTO='static'
   BROADCAST='10.1.255.255'
   IPADDR='10.1.1.1'
   NETMASK='255.255.0.0'
   NETWORK='10.1.0.0'
   STARTMODE='onboot'

  BONDING_MASTER='yes'
   BONDING_MODULE_OPTS='mode=1 miimon=1'
   BONDING_SLAVE0='qeth-bus-ccw-0.0.a000'
   BONDING_SLAVE1='qeth-bus-ccw-0.0.b000'
```

Channel bonding setup (RHEL5 – config files)

- interface configuration file for slave

```
/etc/sysconfig/network/ifcfg-eth0

  DEVICE=eth0
   IPADDR=''
   SLAVE='yes'

   MASTER='bond0'
```

- interface configuration file for master

```
/etc/sysconfig/network/ifcfg-bond0

   DEVICE = bond0
   BROADCAST='10.1.255.255'
   IPADDR='10.1.1.1'
   NETMASK='255.255.0.0'
   NETWORK='10.1.0.0'
```

- Module loader

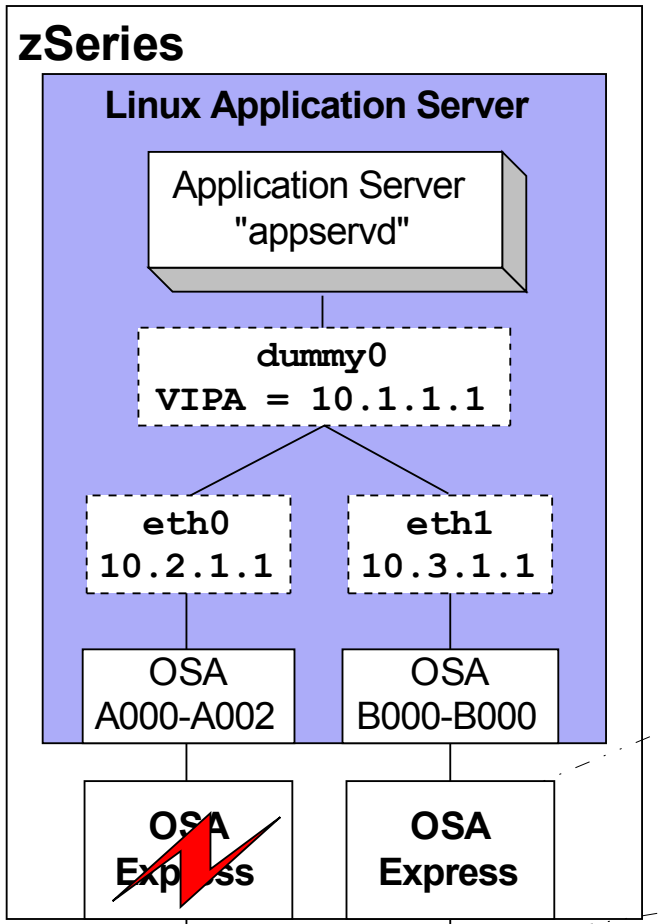
```
/etc/modprobe.conf

alias eth0 qeth

alias eth1 qeth

alias bond0 bonding

options bond0 miimon=100 mode=1
```

Channel bonding setup (cont.)

```
#> 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:01
          UP BROADCAST RUNNING SLAVE MULTICAST  MTU:1500 ...
```

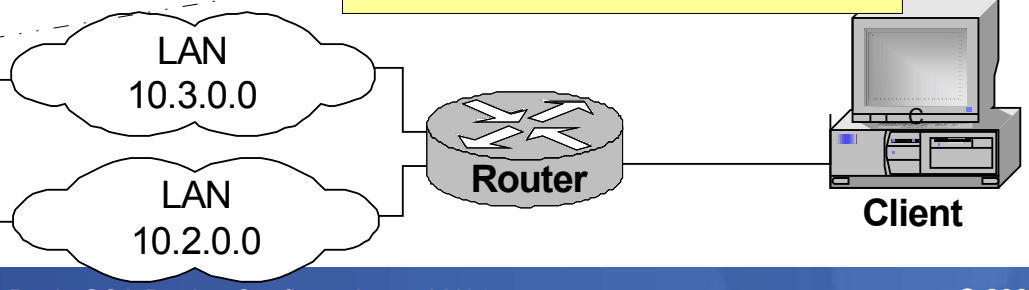
```
#> cat /proc/net/bonding/bond0

Bonding Mode: load balancing (round-robin)
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: 00:05:27:54:21:04
```

Virtual IP Addresses



- Minimize outage due to adapter or network failure
- Bind server applications to system-wide virtual IP addresses (instead of adapter specific addresses)
- Server can be reached via different routes

```
OSA ADDR. TABLE - layer3
IP Addr    Image   Flags
---------  ------  -----
10.1.1.1   LINUX1 vipa
10.3.1.1   LINUX1
...
```



Virtual IP Address Setup

1. Create a virtual interface and assign the VIPA using a dummy interface:

```
#> modprobe dummy
#> ifconfig dummy0 10.1.1.1 netmask 255.255.0.0
```

or using an interface alias:

```
#> ifconfig eth0:1 10.1.1.1 netmask 255.255.0.0
```

2. Layer3 only: register virtual IP address with physical devices:

```
#> echo 10.1.1.1 > /sys/class/net/eth0/device/vipa/add4
#> echo 10.1.1.1 > /sys/class/net/eth1/device/vipa/add4
```

3. On the router add a route to the routing table:

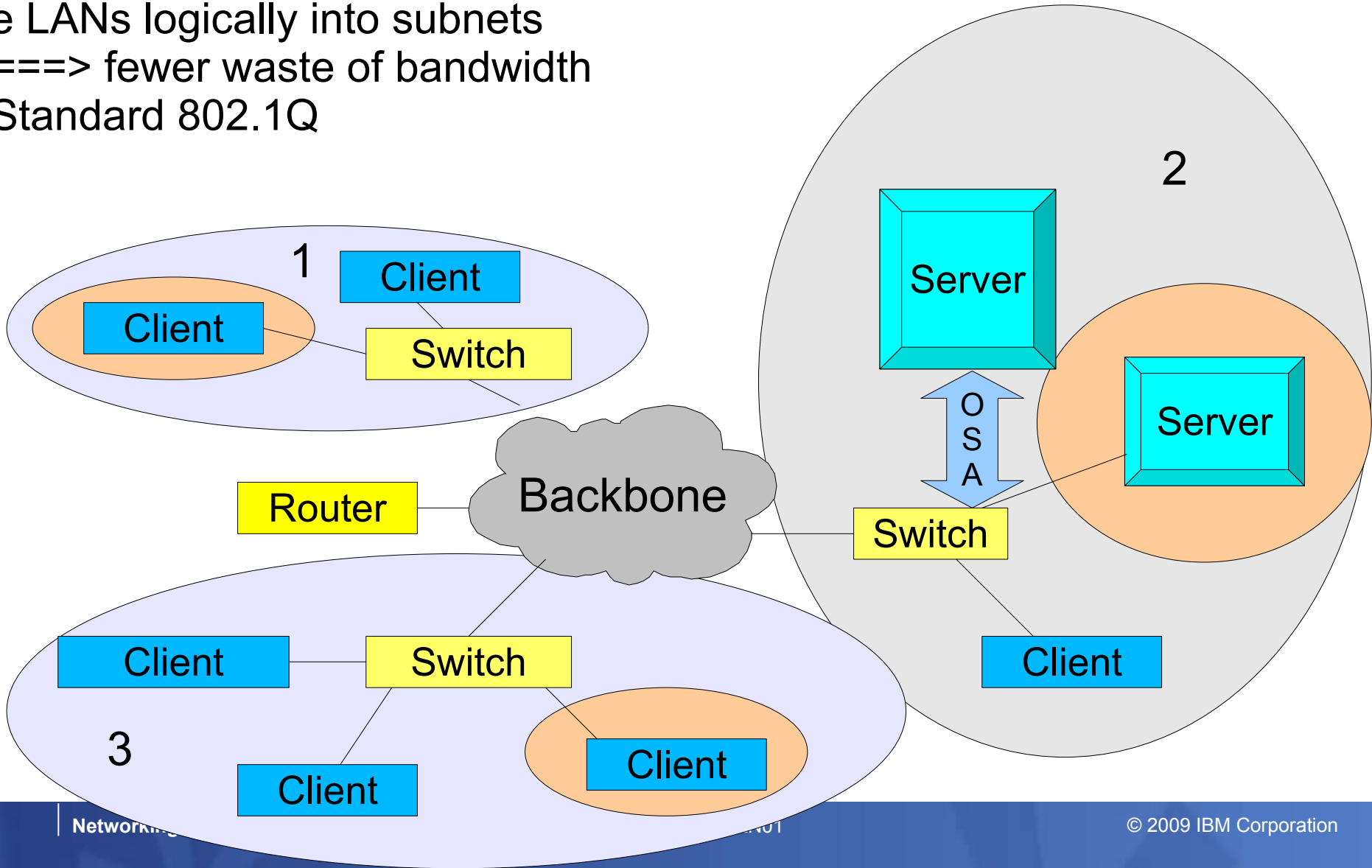
```
#> route add -host 10.1.1.1 gw 10.2.1.1
```
if LAN1 works

```
#> route add -host 10.1.1.1 gw 10.3.1.1
```
if LAN2 works

or, better, configure the routes with a dynamic routing daemon (e.g. quagga: http://quagga.net).

Virtual LAN (VLAN) support

- Risk of big switched LANs: flooded with broadcast traffic
- Devide LANs logically into subnets
  ===> fewer waste of bandwidth
- IEEE Standard 802.1Q



Virtual LAN (VLAN) support (cont.)

- Setup:

```
ifconfig eth1 9.164.160.23 netmask 255.255.224.0
vconfig add eth1 3
ifconfig eth1.3 1.2.3.4 netmask 255.255.0.0
```

- Displaying info:

```
cat /proc/net/vlan/config
VLAN Dev name    | VLAN_ID
Name-Type: VLAN_NAME_TYPE_RAW_PLUS_VID_NO_PAD
eth1.3           | 3  | eth1
```

- Implemented:
  VLAN tag, added to packets transmitted
- Supported by:
  real OSA-card, HiperSockets, z/VM Guest LAN, z/VM VSWITCH

Interface names

Interface Name	Device Driver	Interface / Link Type	Model / Submodel	Used for
eth<x>	qeth lcs lcs	Ethernet	1731/01 3088/01 3088/60	OSA-card / type OSD P390-LCS-card OSA-card / type OSE
hsi<x>	qeth	Ethernet	1731/05	HiperSockets / type IQD
tr<x>	qeth lcs lcs	Token Ring	1731/01 3088/01 3088/60	OSA-card / type OSD P390-LCS-card OSA-card / type OSE
osn<x>	qeth	SNA<->Ethernet	1731/06	OSA-card / type OSN
ctc<x>	ctc	Point-to-Point	3088/08 3088/1e 3088/1f virtual	Channel-To-Channel adapter FICON adapter ESCON adapter VM-guest communication
iucv<x>	netiucv	Point-to-Point	virtual	VM-guest communication

Summary of Linux Network Device Drivers

	QETH					LCS	CTC	IUCV
	OSA	Hiper-Sockets	GuestLAN QDIO	GuestLAN Hiper	VSWITCH			
Adapters	100 Mbps, 1/10Gbps, 1000 Base-T, HSTR					100 Mbps, 1000 Base-T, HSTR	ESCON, FICON, Virtual CTC/A	
Connection type	LAN	LAN	LAN	LAN	LAN	LAN	point-to-point	point-to-poin
Layer	Layer2 / 3	Layer2 /3	Layer2 / 3	Layer3	Layer2 / 3	Layer3		
Protocols	IPv4, IPv6	Ipv4, Ipv6	IPv4, IPv6	IPv4	Ipv4, Ipv6	IPv4	IPv4	IPv4
Remarks	**Primary network device driver for Linux on System z**					restricted access (admin defines OSA Address Table)	Deprecated	Deprecated

AF_IUCV protocol support

- Enable socket applications in Linux to use Inter-User Communication Vehicle (IUCV) in z/VM
- Communication between z/VM guests
- Stream-oriented sockets (SOCK_STREAM) and
- Connection-oriented datagram sockets (SOCK_SEQPACKET)
- SLES9 SP4, SLES10 SP2, RHEL5 U2 (module af_iucv), SLES11

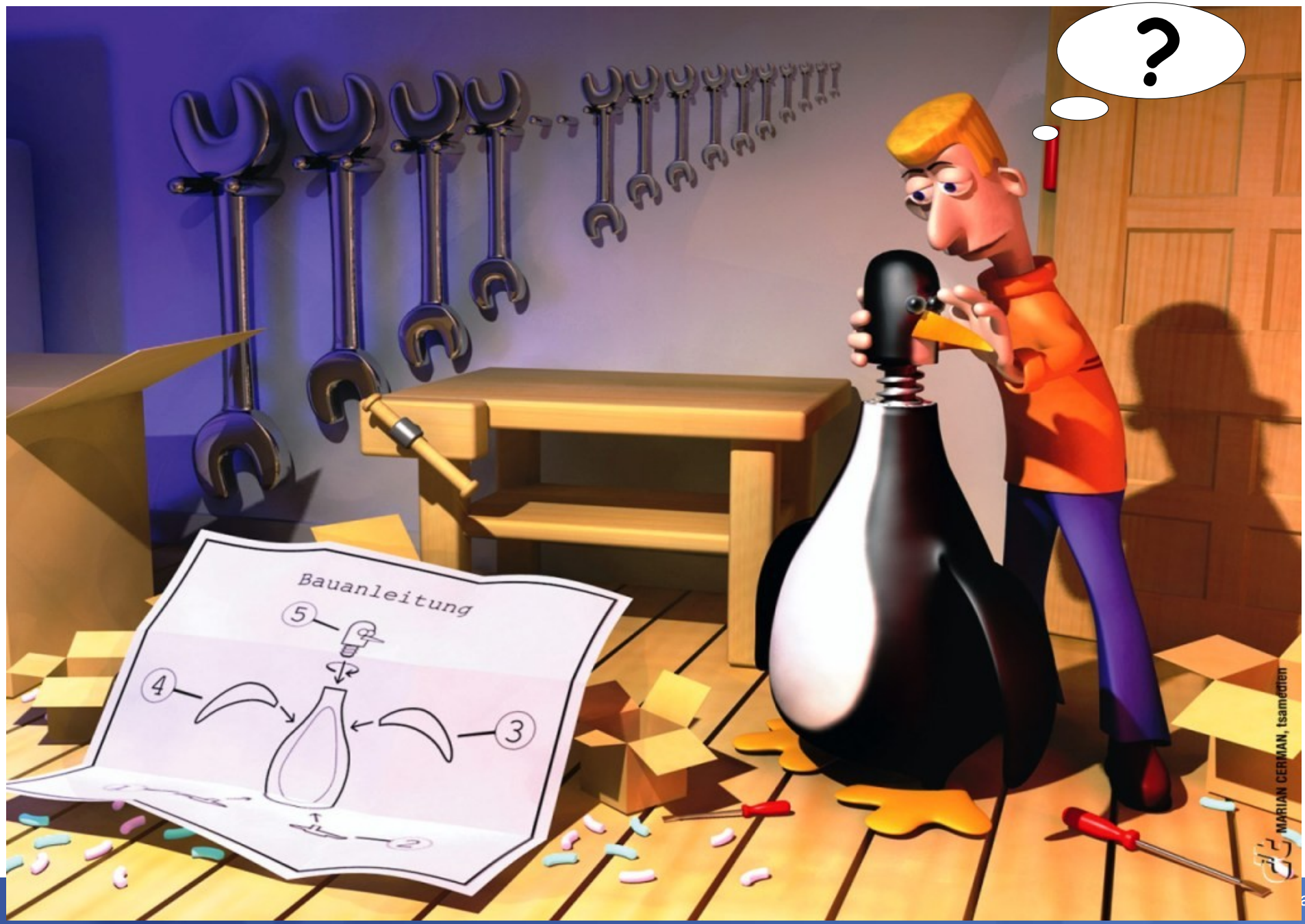
```
struct sockaddr_iucv {
  sa_family_t     siucv_family;     /* 32           */
  unsigned short  siucv_port;       /* Reserved     */
  unsigned int    siucv_addr;       /* Reserved     */
  char            siucv_nodeid[8];  /* Reserved     */
  char            siucv_userid[8];  /* Guest UserId */
  char            siucv_name[8];    /* Appl. Name   */
```

AF_IUCV socket calls

- Calls to establish connection
  - sockno = socket(**32**, SOCK_STREAM, 0)
  - bind(sockno, **own_iucv_sockaddr,** len)
  - listen(sockno, backlog)
  - accept(sockno, **client_iucv_sockaddr**, len)
  - connect(sockno, **server_iucv_sockaddr,** len)
- Transfer Calls
  - read / write, recv / send
- Finishing Calls
  - shutdown / close

References

- Linux on System z on developerWorks
  http://www.ibm.com/developerworks/linux/linux390/index.html
- Linux on System z Documentation
  http://www.ibm.com/developerworks/linux/linux390/development_documentation.html
- Linux on System z, snipl
  http://www.ibm.com/developerworks/linux/linux390/snipl.html
- 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
- IBM System z OSA-Express Implementation Guide
  http://www.redbooks.ibm.com/abstracts/sg245948.html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