Networking with Linux® on zSeries (Part 1 of 2)

Session 9267

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Agenda

- Linux 2.6 device model
- Networking example
- Linux on zSeries network device drivers:
  - QETH
  - LCS
  - CTC
  - IUCV
- Summary
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 (cont.)

/sys
|--block
|--bus
|--class
|--net
|--devices
...

Block subsystem (view):
Block devices and partitions (dasda, ram0)

Bus subsystem (view):
Device drivers and devices sorted by bus (ccw)

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
Linux 2.6 Device Model - zSeries

- **Fully integrated into common device model** (sysfs and underlying kernel structures)
- **Bus and device types:**
  - Channel subsystem bus / I/O subchannel devices
    - ID: subchannel number
    - Attributes: channel paths, detach state, path masks
  - CCW device bus / CCW devices
    - ID: device number
    - Attributes: CU type, device type, online state [, group_device]
      + driver specific
  - CCW group device bus / CCW group devices
    - Groups of single CCW devices make up a functional unit
    - ID: device number of first device in group
    - Attributes: CCW devices, CHPID, aggregate online state, ungroup
      + driver specific
Block Devices:
DASD, RAM-Disk, Minidisk
SCSI, Loopback

CCW Group Devices:
QETH, LCS, CTC

Example: a QETH device

Many ways to find a device
SUSE SLES 9 Network Configuration

Hardware devices ↔ Logical interfaces

Configuration files:

/etc/sysconfig/hardware
/etc/sysconfig/network

1:1 relationship

--> A hardware device always gets the right IP address

Naming convention:

hw/ifcfg-<device type>-bus-<bus type>-<bus location>  or
hw/ifcfg-<device type>-id-<identifier>  (e.g. for IUCV)

e.g. hwcfg-qeth-bus-ccw-0.0.a000
     ifcfg-qeth-bus-ccw-0.0.a000
SUSE SLES 9 Network Configuration (cont.)

See also: /usr/share/doc/packages/sysconfig/README and README.s390
Networking Example

zSeries

z/VM in LPAR

LINUX 1
- iucv0 10.5.1.1
- IUCV
- ctc0 10.6.1.1
- CTC
- eth0 10.1.1.1
- NIC A000-A002

LINUX 2
- iucv0 10.5.1.2
- IUCV
- ctc0 10.6.1.2
- CTC
- eth0 10.2.1.1
- NIC B003-B005

LINUX 3
- iucv0 10.5.1.3
- IUCV
- ctc0 10.6.1.3
- LCS
- eth0 10.4.1.3

OSA Express

LAN 10.1.0.0

LCS Card

LAN 10.4.0.0

GuestLAN (Type QDIO) 10.2.0.0

HiperSockets 10.3.0.0
Linux for zSeries Network Device Drivers

- QETH
- LCS
- CTC
- IUCV

- Major rework of existing Linux 2.4 device drivers
  - To integrate into Linux 2.6 common device model
  - To port old user interfaces to sysfs
  - Cleanup of source code --> improved readability and maintainability
  - Performance improvements
QETH Device Driver

- Supports:
  - OSA Express
  - Gigabit Ethernet
  - 10 Gbit Ethernet
  - Highspeed Tokenring
  - ATM (running Ethernet LAN Emulation)
  - z/VM GuestLAN
  - Type QDIO
  - Type Hiper
  - zSeries HiperSockets
  - IPv4, IPv6, VLAN, VIPA, Proxy ARP, IP Address Takeover
- **Primary network driver for Linux on zSeries**
- **Has main focus in current and future development**
Primary Network Device: OSA Express

- 'Integrated Power computer' with network daughter card
- Shared between up to 640 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 or ARP level
- One MAC address for all stacks
- OSA handles ARP (Address Resolution Protocol)
The Queued Direct I/O (QDIO) Architecture

**OSA Express**

**NIC**

MAC: 00:06:29:55:2A:09

**OSA ADDRESS TABLE**

<table>
<thead>
<tr>
<th>IP Addr</th>
<th>Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.1.1.1</td>
<td>LINUX1</td>
</tr>
<tr>
<td>10.10.1.5</td>
<td>LINUX2</td>
</tr>
<tr>
<td>....</td>
<td>....</td>
</tr>
<tr>
<td>10.11.1.1</td>
<td>z/OS</td>
</tr>
</tbody>
</table>

---

**QDIO as “long-running” channel program**

**Pages in Linux Memory**

E - Empty Buffer
P - Primed Buffer

**control data exchange using CCWs (channel command words)**

**READ**

**WRITE**

**DATA**

in queue 0

out queue 0

out queue 3

---

**READ WRITE DATA**

IP Packet

control data exchange using CCWs (channel command words)

"LINUX2"
Static QETH Device Setup

For LINUX 1 eth0 (see Networking Example)

1. Create a 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=''
    SCRIPTDOWN='hwdown-ccw'
    SCRIPTUP='hwup-ccw'
    SCRIPTUP_ccw='hwup-ccw'
    SCRIPTUP_ccwgroup='hwup-qeth'
    STARTMODE='auto'
    QETH_OPTIONS='fake_ll=1'
```
Static QETH Device Setup (cont.)

- **CCW_CHAN_IDS** are Read, Write, Data channels
  - Read must be even, Write must be Read + 1 (for older microcode)
  - Hexadecimal characters must be lowercase

- **STARTMODE** 'auto' --> started by hotplug agents
  'manual' --> manual startup

- **QETH_OPTIONS** allows to set optional attributes
  
  e.g. `QETH_OPTIONS='fake_ll=1'`

- A sample hwcfg-file for QETH can be found at
  `/etc/sysconfig/hardware/skel/hwcfg-qeth`
Static QETH Device Setup (cont.)

2. Create an interface configuration file:

```
/etc/sysconfig/network/ifcfg-qeth-bus-ccw-0.0.a000
BOOTPROTO='static'
BROADCAST='10.1.255.255'
IPADDR='10.1.1.1'
NETMASK='255.255.0.0'
NETWORK='10.1.0.0'
STARTMODE='onboot'
PERSISTANT_NAME='interf0'
```

3. Before reboot: test your config files:

```
#> hwup qeth-bus-ccw-0.0.a000
```
Static QETH Device Setup on Linux 2.4

Hardware configuration is in /etc/chandev.conf:

```
qeth0,0xa000,0xa001,0xa002
add_parms,0x10,0xa000,0xa002,portname:OSAPORT
```

A script exists which can convert your Linux 2.4 chandev.conf into Linux 2.6 hwcfg-files (for QETH, LCS and CTC):

```
/etc/sysconfig/hardware/scripts/chandev-to-hwcfg.sh
```
Static QETH Device Setup on Linux 2.4 (cont.)

Interface configuration:

```
/etc/sysconfig/network-scripts/ifcfg-eth0
  DEVICE=eth0
  USERCTL=no
  ONBOOT=yes
  BOOTPROTO=none
  BROADCAST=10.1.255.255
  NETWORK=10.1.0.0
  NETMASK=255.255.0.0
  IPADDR=10.1.1.1
  ARP=no
```

Device – IP address mapping:

```
qeth<n> notation in chandev.conf
  ifcfg-eth<n>
    DEVICE=eth<n>
```
Dynamic QETH Device Setup

For LINUX 2 eth0 (see Networking Example)

1. In your z/VM console (if not already defined in user directory) do

   1.1. Create a GuestLAN
       
       #CP DEFINE LAN MY_LAN TYPE QDIO

   1.2. Create a virtual NIC
       
       #CP DEFINE NIC B003 TYPE QDIO

   1.3. Couple virtual NIC to GuestLAN
       
       #CP COUPLE B003 TO * MY_LAN
Dynamic QETH Device Setup (cont.)

2. Load the QETH device driver module:

   `#> modprobe qeth`

3. Create a new QETH device by grouping its CCW devices:

   `#> echo 0.0.b003,0.0.b004,0.0.b005 > /sys/bus/ccwgroup/drivers/qeth/group`

4. Set optional attributes:

   `#> echo 64 > /sys/bus/ccwgroup/drivers/qeth/0.0.b004/buffer_count`

   `#> echo 1 > /sys/devices/qeth/0.0.b004/fake_ll`

Note the alternative ways to your device
Dynamic QETH Device Setup (cont.)

5. Set the new device online:

```
$ echo 1 > /sys/devices/qeth/0.0.b003/online
```

6. Check your QETH devices:

```
$ cat /proc/qeth
```

<table>
<thead>
<tr>
<th>devices</th>
<th>CHPID</th>
<th>interface</th>
<th>cardtype</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>xC0</td>
<td>hsi0</td>
<td>HiperSockets</td>
</tr>
<tr>
<td>0.0.b003/0.0.b004/0.0.b005</td>
<td>x01</td>
<td>eth0</td>
<td>GuestLAN QDIO</td>
</tr>
</tbody>
</table>

7. Configure your new eth0 interface:

```
$ ifconfig eth0 10.2.1.2 netmask 255.255.0.0
```
Dynamic QETH Device Setup on Linux 2.4

1. Add definition of the new device to /etc/chandev.conf:
   ```
   qeth0,0xb003,0xb004,0xb005
   add_parms,0x10,0xb003,0xb005,fake_ll:1
   ```
   can also be echoed directly to /proc/chandev
   ```
   #> echo "qeth0,0xb003,0xb004,0xb005;
   add_parms,0x10,0xb003,0xb005,fake_ll:1"
   > /proc/chandev
   ```

2. Activate the new configuration:
   ```
   #> echo readconf > /proc/chandev
   #> echo reprobe > /proc/chandev
   ```

3. Configure the interface:
   ```
   #> ifconfig eth0 10.2.1.2 netmask 255.255.0.0
   ```
Interesting QETH Device sysfs Attributes

fake_ll

- Build fake ethernet headers before handing packets to the network stack.
- Required by some network applications, e.g. DHCP or TCPDUMP

```
fake_ll=1
```

```
Ethernet Header:
  src. MAC addr
  dest. MAC addr

IP Header:
  src. IP addr
  dest. IP addr

Payload

OSA Express

QETH Driver

Network Stack

Application

Linux
```
Interesting QETH Device sysfs Attributes

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

Save memory

Boost performance
Interesting QETH Device sysfs Attributes - layer2

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

![OSA Express diagram](image)

- hwcfg-qeth... file: `QETH_LAYER2_SUPPORT=1`
- ifcfg-qeth... file: `LLADDR='<MAC Address>'`
- Direct attached OSA:
  - MAC address must be defined with ifconfig manually
  - `ifconfig eth0 hw ether 00:06:29:55:2A:01`
- with VSWITCH under z/VM
  - MAC address created by z/VM VSWITCH
- DHCP, tcpdump working without option fake_ll
- channel bonding possible
Interesting QETH Device sysfs Attributes – layer2 (cont.)

- Direct attach OSA and GuestLAN type QDIO supported
  GuestLAN definition for layer2:
  ```
  define lan <lanname> ... type QDIO ETHERNET
  define nic
  ```

- Prerequisites:
  - z/VM 5.1 RSU 1 + PTF VM63505, VM63506, VM 63538, PQ97436
  - OSA code level 6.25( MCL J13477.066, Bundle 28)
  - SUSE SLES8 kernel 2.4.21-266
  - SUSE SLES9 SP2

- Restrictions:
  - Layer2 and Layer3 traffic can be transmitted over the same OSA CHPID, but not between two hosts sharing the same CHPID!
LCS Device Driver

- LCS – LAN Channel Station
- Supports:
  - OSA-2 Ethernet and Tokenring
  - OSA-Express Fast Ethernet and Highspeed Tokenring (in non-QDIO mode)
  - Since z990: OSA-Express Gigabit Ethernet (incl. 1000Base-T) (in non-QDIO mode)
- 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!!!
Static LCS Device Setup

For LINUX 3 eth0 (see Networking Example)

1. Create a hardware device configuration file:

```
/etc/sysconfig/hardware/hwcfg-lcs-bus-ccw-0.0.d000:
  CCW_CHAN_IDS='0.0.d000 0.0.d001'
  CCW_CHAN_MODE='0'
  CCW_CHAN_NUM='2'
  MODULE='lcs'
  MODULE_OPTIONS=''
  SCRIPTDOWN='hwdown-ccw'
  SCRIPTUP='hwup-ccw'
  SCRIPTUP_ccw='hwup-ccw'
  SCRIPTUP_ccwgroup='hwup-lcs'
  STARTMODE='auto'
```
Static LCS Device Setup (cont.)

- **CCW_CHAN_IDS** are Read and Write channels
  - Read must be even, Write must be Read + 1
  - Hexadecimal characters must be lowercase

- **CCW_CHAN_MODE** selects the card's relative port
  - Applies to OSA-Express ATM cards only
  - Possible values: 0 .. 15
  - Default is 0

- **STARTMODE**  
  'auto' --> started by hotplug agents
  'manual' --> manual startup

- A sample hwcfg-file for QETH can be found at
  `/etc/sysconfig/hardware/skel/hwcfg-lcs`
Static LCS Device Setup (cont.)

2. Create an interface configuration file:

```
/etc/sysconfig/network/ifcfg-lcs-bus-ccw-0.0.d000:
  BOOTPROTO='static'
  BROADCAST='10.4.255.255'
  IPADDR='10.4.1.3'
  NETMASK='255.255.0.0'
  NETWORK='10.4.0.0'
  STARTMODE='onboot'
```

3. Before reboot: test your config files:

```
#> hwup lcs-bus-ccw-0.0.d000
```
Static LCS Device Setup on Linux 2.4

Hardware configuration is in `/etc/chandev.conf`:

```
lcs0,0xd000,0xd001
```

Interface configuration:

```
/etc/sysconfig/network-scripts/ifcfg-eth0
DEVICE=eth0
USERCTL=no
ONBOOT=yes
BOOTPROTO=none
BROADCAST=10.4.255.255
NETWORK=10.4.0.0
NETMASK=255.255.0.0
IPADDR=10.4.1.3
ARP=no
```

Device – IP address mapping:

```
<table>
<thead>
<tr>
<th>lcs&lt;n&gt; notation in chandev.conf</th>
</tr>
</thead>
<tbody>
<tr>
<td>ifcfg-eth&lt;n&gt;</td>
</tr>
<tr>
<td>DEVICE=eth&lt;n&gt;</td>
</tr>
</tbody>
</table>
```

Dynamic LCS Device Setup

1. Load the LCS device driver module:

   ```shell
   #> modprobe lcs
   ```

2. Create a new LCS device by grouping its CCW devices:

   ```shell
   #> echo 0.0.d000,0.0.d001 > /sys/bus/ccwgroup/drivers/lcs/group
   ```

3. Set optional attributes:

   ```shell
   #> echo 2 > /sys/bus/ccwgroup/drivers/lcs/0.0.d000/portno
   ```

4. Set the new device online:

   ```shell
   #> echo 1 > /sys/devices/lcs/0.0.d000/online
   ```

Note the alternative ways to your device.
5. Find out the interface for your new device:

At the moment only possible by checking the 'device' link of each `/sys/class/net` entry:

```
#> ls -Al /sys/class/net/*/device
lrwxrwxrwx  1 root root 0 Jul  6 11:17 /sys/class/net/eth0/device -> ../../../devices/lcs/0.0.d000
lrwxrwxrwx  1 root root 0 Jul 12 15:14 /sys/class/net/hsi0/device -> ../../../devices/qeth/0.0.c0
```

6. Configure your new eth0 interface:

```
#> ifconfig eth0 10.4.1.3 netmask 255.255.0.0
```
Dynamic LCS Device Setup on Linux 2.4

1. Add definition of the new device to `/etc/chandev.conf`:

   ```
   lcs0,0xd000,0xd001
   ```

2. Activate the new configuration:

   ```
   #> echo reandconf > /proc/chandev
   #> echo reprobe > /proc/chandev
   ```

3. Configure the interface:

   ```
   #> ifconfig eth0 10.4.1.3 netmask 255.255.0.0
   ```
CTC Device Driver

- CTC – Channel-to-Channel connection
- Direct intra- or inter-mainframe communication
- Supports:
  - ESCON
  - FICON
  - Virtual CTC/A (VM)
Static CTC Device Setup

For LINUX 1 ctc0 (see Networking Example)

1. Create a virtual CTC connection on your VM console

1.1. Create virtual CTC devices in both LINUX1 and LINUX2

   #CP DEFINE CTC E000
   #CP DEFINE CTC E001

1.2. Couple CTC devices cross-over, i.e. LINUX1's Read device with LINUX2's Write device ...

   #CP COUPLE E000 TO LINUX2 E001
   #CP COUPLE E001 TO LINUX2 E000
Static CTC Device Setup (cont.)

2. Create a hardware device configuration file:

```
/etc/sysconfig/hardware/hwcfg-ctc-bus-ccw-0.0.e000:
  CCW_CHAN_IDS='0.0.e000 0.0.e001'
  CCW_CHAN_MODE='0'
  CCW_CHAN_NUM='2'
  MODULE='ctc'
  MODULE_OPTIONS=''
  SCRIPTDOWN='hwdown-ccw'
  SCRIPTUP='hwup-ccw'
  SCRIPTUP_ccw='hwup-ccw'
  SCRIPTUP_ccwgroup='hwup-ctc'
  STARTMODE='auto'
```
Static CTC Device Setup (cont.)

- **CCW_CHAN_IDS** are Read and Write channels
  - Hexadecimal characters must be lowercase

- **CCW_CHAN_MODE** selects protocol for CTC
  - 0 – compatibility with peers other than OS/390 and z/OS (default)
  - 1 – extended mode for Linux peers
  - 2 – for CTC tty based connections to Linux peers
  - 3 – compatibility with OS/390 and z/OS

- **STARTMODE** 'auto' --> started by hotplug agents
  'manual' --> manual startup

- A sample hwcfg-file for QETH can be found at
  /etc/sysconfig/hardware/skel/hwcfg-ctc
3. Create an interface configuration file:

/etc/sysconfig/network/ifcfg-ctc-bus-ccw-0.0.e000:
BOOTPROTO='static'
BROADCAST='10.6.255.255'
IPADDR='10.6.1.1'
MTU=''
NETMASK='255.255.0.0'
NETWORK='10.6.0.0'
REMOTE_IPADDR='10.6.1.2'
STARTMODE='onboot'

4. Before reboot: test your config files:

  #> hwup lcs-bus-ccw-0.0.e000
Static CTC Device Setup on Linux 2.4

Hardware configuration is in /etc/chandev.conf:

```
ctc0,0xe000,0xe001
```

Interface configuration:

```
/etc/sysconfig/network-scripts/ifcfg-ctc0
  DEVICE=ctc0
  USERCTL=no
  ONBOOT=yes
  BOOTPROTO=none
  BROADCAST=10.6.255.255
  NETWORK=10.6.0.0
  NETMASK=255.255.0.0
  IPADDR=10.6.1.1
  REMOTE_IPADDR=10.6.1.2
  ARP=no
```

Device – IP address mapping:

```
ctc<n> notation in chandev.conf

ifcfg-ctc<n>
  DEVICE=ctc<n>
```

Hardware configuration is in /etc/chandev.conf:

```
ctc0,0xe000,0xe001
```
Dynamic CTC Device Setup

1. Load the CTC device driver module:
   
   ```bash
   #> modprobe ctc
   ```

2. Create a new CTC device by grouping its CCW devices:
   
   ```bash
   #> echo 0.0.e000,0.0.e001 > /sys/bus/ccwgroup/drivers/ctc/group
   ```

3. Set optional attributes:
   
   ```bash
   #> echo 0 > /sys/bus/ccwgroup/drivers/ctc/0.0.e000/protocol
   ```

4. Set the new device online:
   
   ```bash
   #> echo 1 > /sys/bus/ccwgroup/drivers/ctc/0.0.e000/online
   ```
Dynamic CTC Device Setup (cont.)

5. Find out the interface for your new device:

At the moment only possible by checking the 'device' link of each /sys/class/net/ctc* entry:

```bash
#> ls -Al /sys/class/net/ctc*/device
lrwxrwxrwx 1 root root 0 Jul  6 11:17 /sys/class/net/ctc0/device -> ../../../devices/cu3088/0.0.e000
lrwxrwxrwx 1 root root 0 Jul 12 15:14 /sys/class/net/ctc1/device -> ../../../devices/cu3088/0.0.f000
```

6. Configure your new ctc0 interface:

```bash
#> ifconfig ctc0 10.6.1.1 pointopoint 10.6.1.2
```
Dynamic CTC Device Setup on Linux 2.4

1. Add definition of the new device to `/etc/chandev.conf`:
   ```
   ctc0,0xe000,0xe001
   ```

2. Activate the new configuration:
   ```
   #> echo readconf > /proc/chandev
   #> echo reprobe > /proc/chandev
   ```

3. Configure the interface:
   ```
   #> ifconfig ctc0 10.6.1.1 pointopoint 10.6.1.2
   ```
IUCV Device Driver

- IUCV – Inter User Communication Vehicle
- VM communication facility for inter guest data exchange
- Point to point communication
- Linux device driver builds IP networking semantics on top of IUCV --> NETIUCV

Recommendation:
Use GuestLAN where possible
Static IUCV Device Setup

For LINUX 1 iucv0 (see Networking Example)

1. Create a hardware device configuration file:

/etc/sysconfig/hardware/hwcfg-iucv-id-linux2:
STARTMODE="auto"
MODULE="netiucv"
MODULE_OPTIONS=""
MODULE_UNLOAD="yes"
SCRIPTUP="hwup-iucv"
SCRIPTUTDOWN="hwdown-iucv"

Note, that the peer user “LINUX2” is specified solely via the file name.
Static IUCV Device Setup (cont.)

2. Create an interface configuration file:

```
/etc/sysconfig/network/ifcfg-iucv-id-linux2:
    BOOTPROTO='static'
    BROADCAST='10.5.255.255'
    IPADDR='10.5.1.1'
    MTU=''
    NETMASK='255.255.0.0'
    NETWORK='10.5.0.0'
    REMOTE_IPADDR='10.5.1.2'
    STARTMODE='onboot'
```

3. Before reboot: test your config files:

```
#> hwup iucv-id-linux2
```
Static IUCV Device Setup on Linux 2.4

Peer VM guests to connect to are specified as kernel parameters:

```
iucv=<vm guest ID>[{:vm guest ID}]
```

e.g. `iucv=LINUX2:VMTCPIP`

Interface configuration:

```
/etc/sysconfig/network-scripts/ifcfg-iucv0
DEVICE=iucv0
USERCTL=no
ONBOOT=yes
BOOTPROTO=None
BROADCAST=10.5.255.255
NETWORK=10.5.0.0
NETMASK=255.255.0.0
IPADDR=10.5.1.1
REMOTE_IPADDR=10.5.1.2
ARP=no
```

Device – IP address mapping:

position in kernel parameter line

```
ifcfg-iucv<n>
DEVICE=iucv<n>
```
Dynamic IUCV Device Setup

1. Load the IUCV network device driver module:

   `#> modprobe netiucv`

2. Create a connection to the peer user:

   `#> echo linux2 > /sys/bus/iucv/drivers/netiucv/connection`

   This creates the following sysfs entries:

   `/sys/bus/iucv/devices/netiucv<n>`
   `/sys/devices/iucv/netiucv/netiucv<n>`
   `/sys/class/net/iucv<n>`

   where \( n \) is the first free index assigned to the new iucv device (in our example 0).
Dynamic IUCV Device Setup (cont.)

3. Verify which iucv interface is connected to which user:

```bash
$ cat /sys/bus/iucv/devices/iucv0/user
linux2
```

4. Configure your new iucv interface:

```bash
$ ifconfig iucv0 10.5.1.1 pointopoint 10.5.1.2
```
Dynamic IUCV Device Setup on Linux 2.4

Only possible if netiucv is compiled as a loadable module

1. Unload the module. This removes all current connections!

```bash
#> rmmod netiucv
```

2. Load module and specify all peers as module parameters:

```bash
#> modprobe netiucv iucv=LINUX2:VMTCPPIP
```

3. Configure the interfaces:

```bash
#> ifconfig iucv0 10.5.1.1 pointopoint 10.5.1.2
#> ifconfig iucv1 ...
```
## Summary of Linux Network Device Drivers

<table>
<thead>
<tr>
<th></th>
<th>QETH</th>
<th></th>
<th></th>
<th>LCS</th>
<th>CTC</th>
<th>IUCV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OSA</td>
<td>HiperSockets</td>
<td>GuestLAN QDIO</td>
<td>GuestLAN Hiper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adapters</td>
<td>100 Mbps, 1Gbps, 1000 Base-T, HSTR</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connection type</td>
<td>LAN</td>
<td>LAN</td>
<td>LAN</td>
<td>LAN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max bandwidth</td>
<td>0.9 Gbps</td>
<td>9.6 Gbps</td>
<td>3.6 Gbps</td>
<td>4.8 Gbps</td>
<td>0.48 Gbps (1000Base-T)</td>
<td>1.2 Gbps (VCTC)</td>
</tr>
<tr>
<td>Avg response time</td>
<td>0.9 ms</td>
<td>0.09 ms</td>
<td>0.28 ms</td>
<td>0.24 ms</td>
<td>4.4 ms (1000Base-T)</td>
<td>0.39 ms (VCTC)</td>
</tr>
<tr>
<td>Remarks</td>
<td>Primary network device driver for Linux on zSeries</td>
<td></td>
<td></td>
<td>restricted access (admin defines OSA Address Table)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**References**

- Linux for zSeries and S/390 on DeveloperWorks
  

- Linux for zSeries and S/390 Documentation
  

- Linux for zSeries and S/390, useful add-ons
  
Outlook for Session 2

- Router setup for Linux on zSeries
- Failover and availability solutions:
  - IP Address Takeover
  - Virtual IP Addresses (VIPA)
  - Proxy ARP
- The qethconf tool
- The qetharp tool
- HiperSockets Network Concentrator (HSNC)