



SCSI over Fibre Channel Support

# *SCSI over Fibre Channel Support for Linux on zSeries*

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Linux on zSeries Development

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## Agenda



- zSeries Hardware
  - Hardware Requirements
  - zSeries in a FC SAN
  - Topologies
- zSeries Software
  - Software Requirements
  - Linux SCSI/FCP Support
  - Multi-Pathing
- Storage Devices
  - Disk, Tape
- SCSI IPL

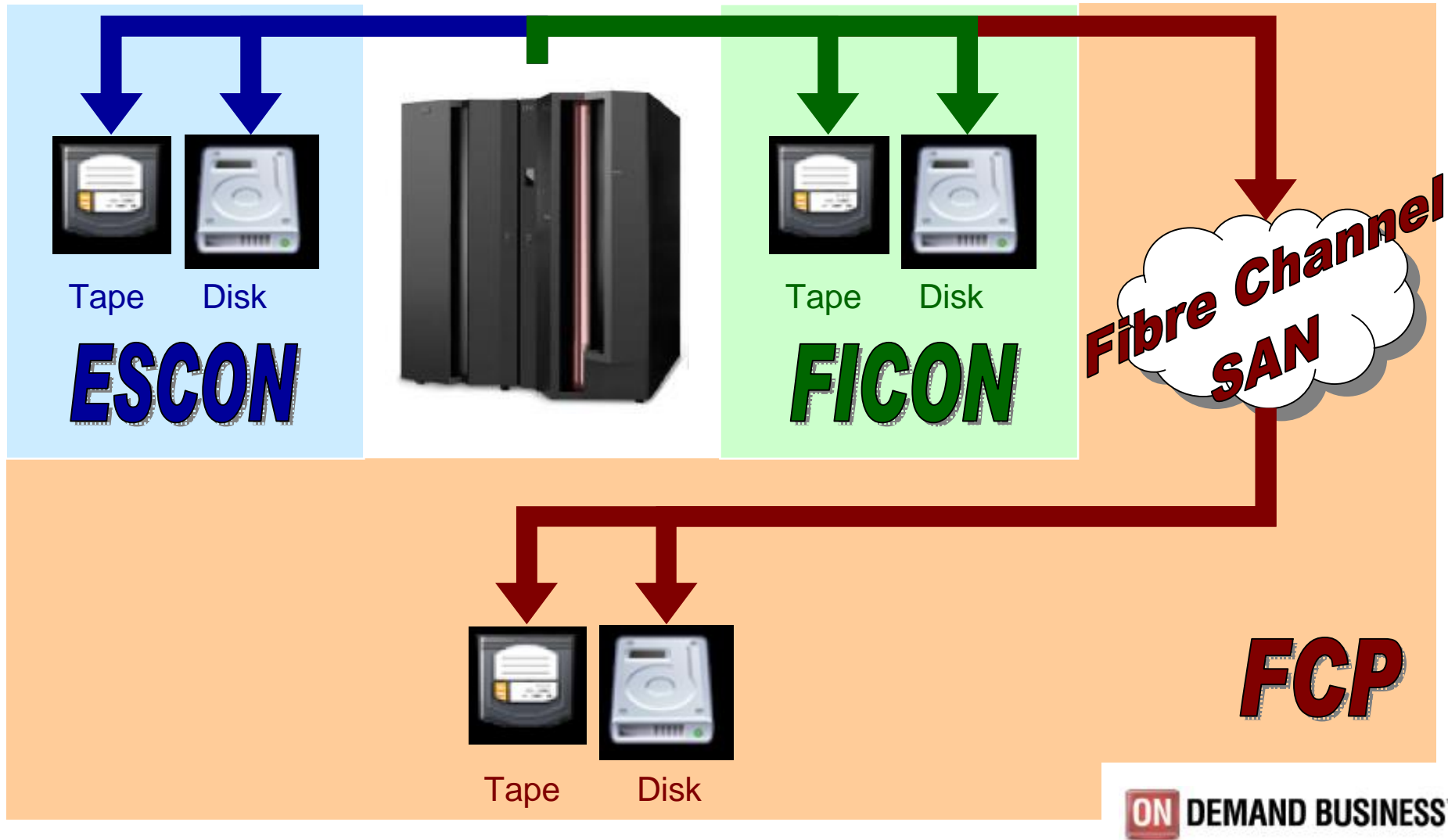
## zSeries in a SAN – Sharing Storage Resources



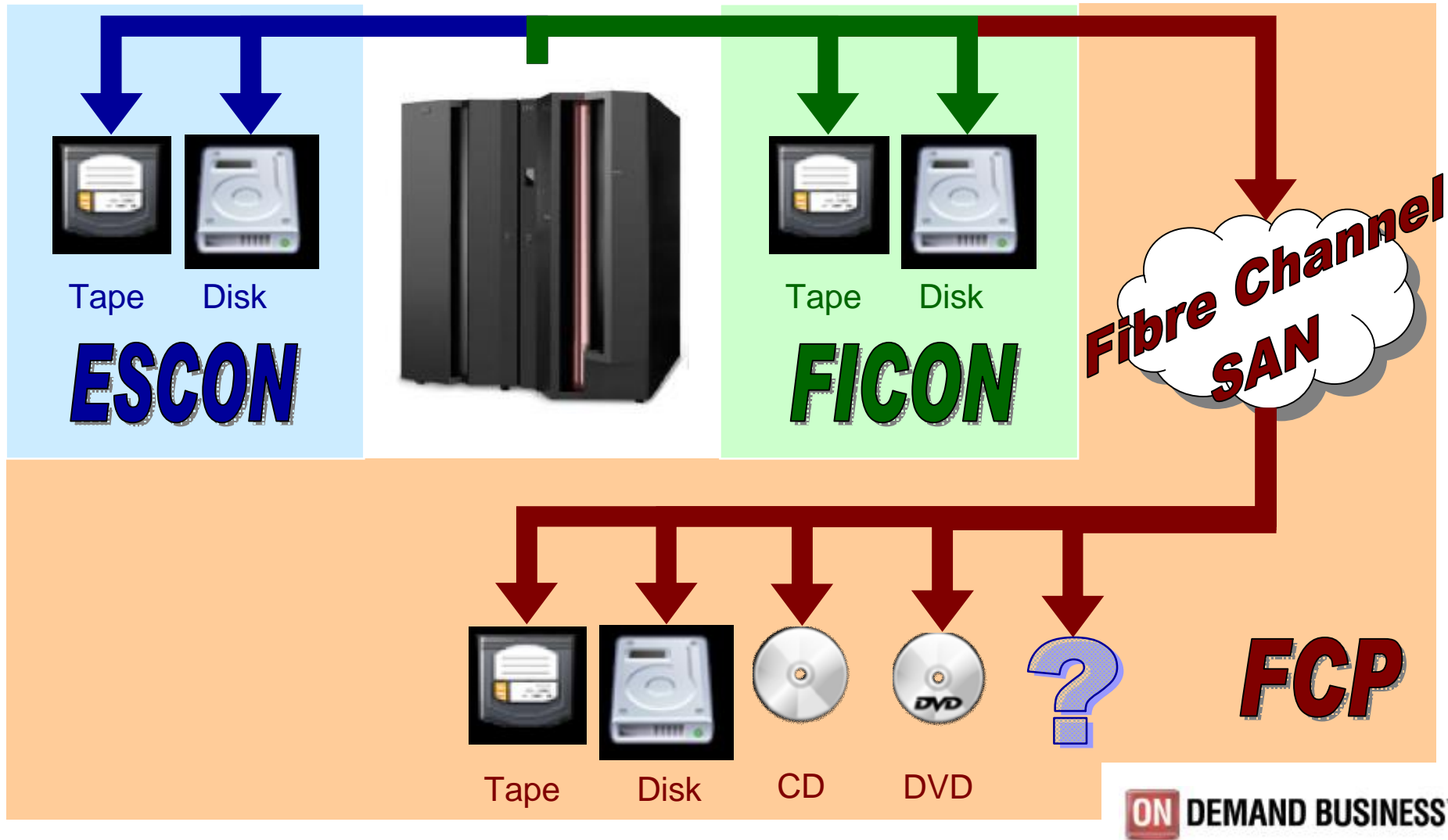
# zSeries in a SAN – Sharing Storage Resources



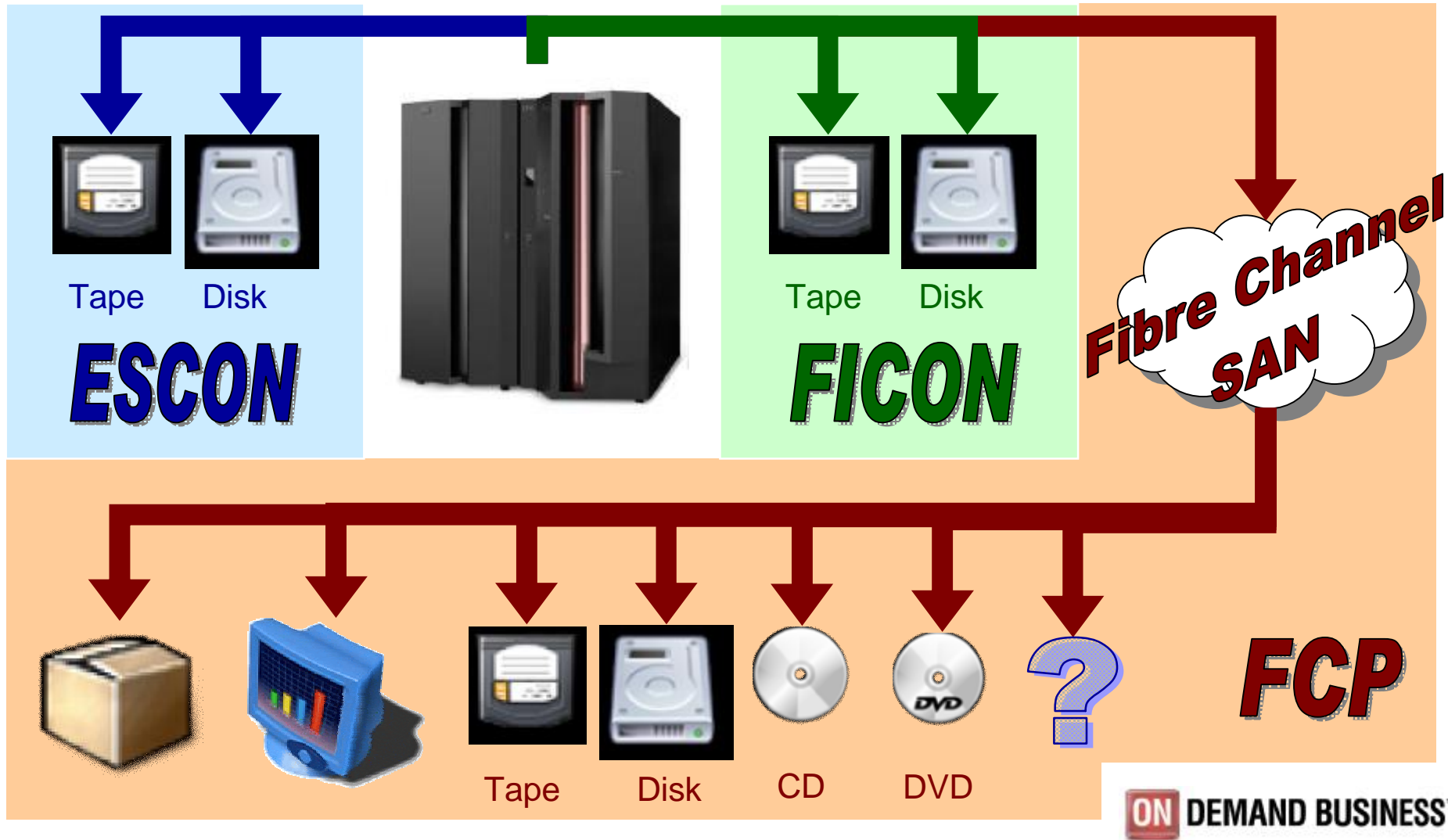
# zSeries in a SAN – Sharing Storage Resources



# zSeries in a SAN – Sharing Storage Resources



# zSeries in a SAN – Sharing Storage Resources



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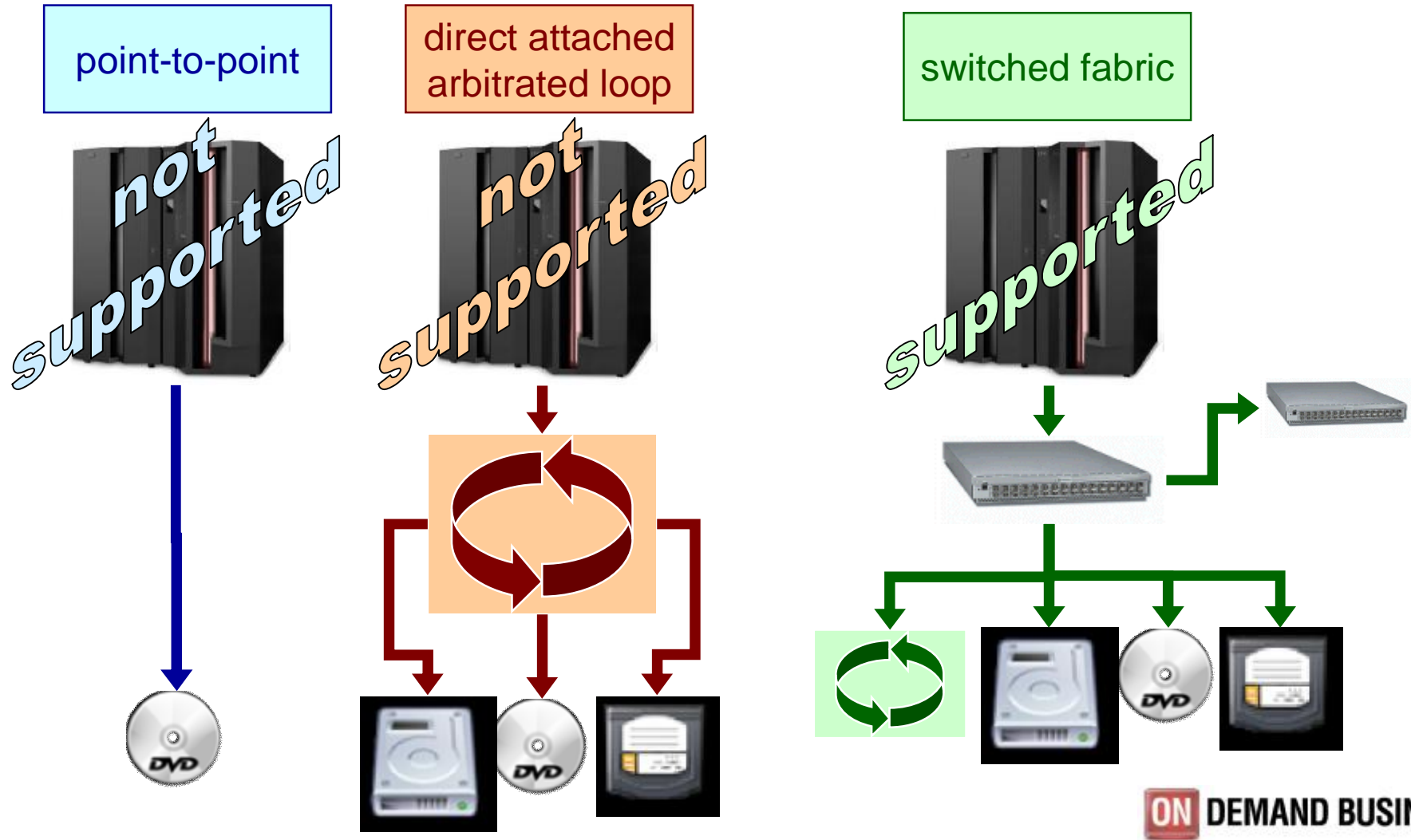
## zSeries in a SAN – Hardware Requirements



- IBM zSeries 800, 890, 900 or 990
- FICON or FICON Express adapter card
- Additional CHPID type FCP
- FC fabric switch
- FC attached storage devices
- Optional: FCP-SCSI bridge  
+ SCSI devices



# zSeries in a SAN – Topologies



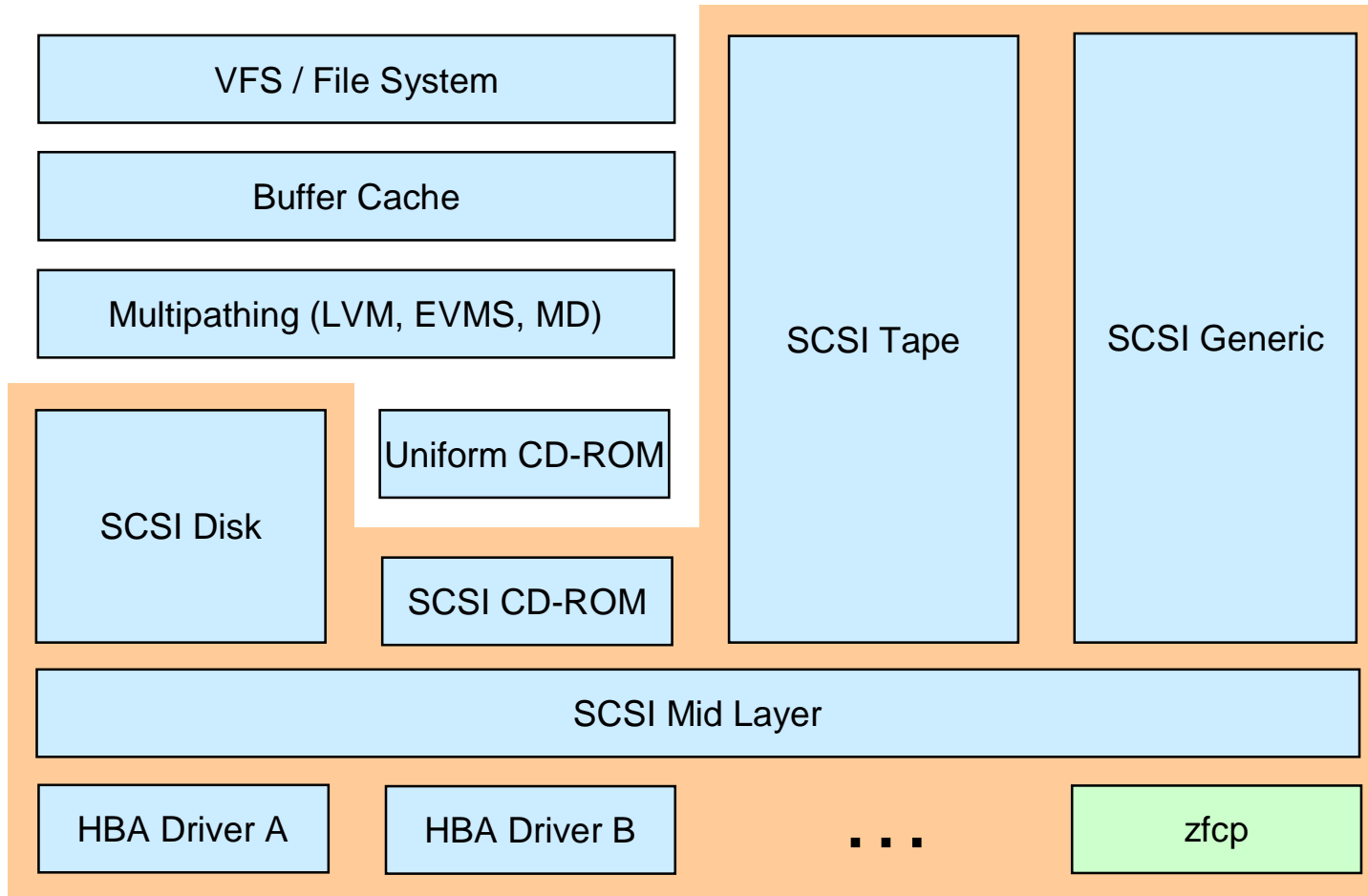
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## FC and SCSI – Software Requirements

- SUSE Linux Enterprise Server 8 (SLES8)
  - GA November 2002
  - Currently SP3 (submarine)
- SUSE Linux Enterprise Server 9 (SLES9)
  - GA August 2004
- Red Hat Enterprise Linux 3 (RHEL3)
  - GA October 2003
  - Update 3
- z/VM 4.3
  - GA May 2002
  - Includes FCP channel guest support for Linux
  - Currently z/VM 5.1



# Linux SCSI Stack

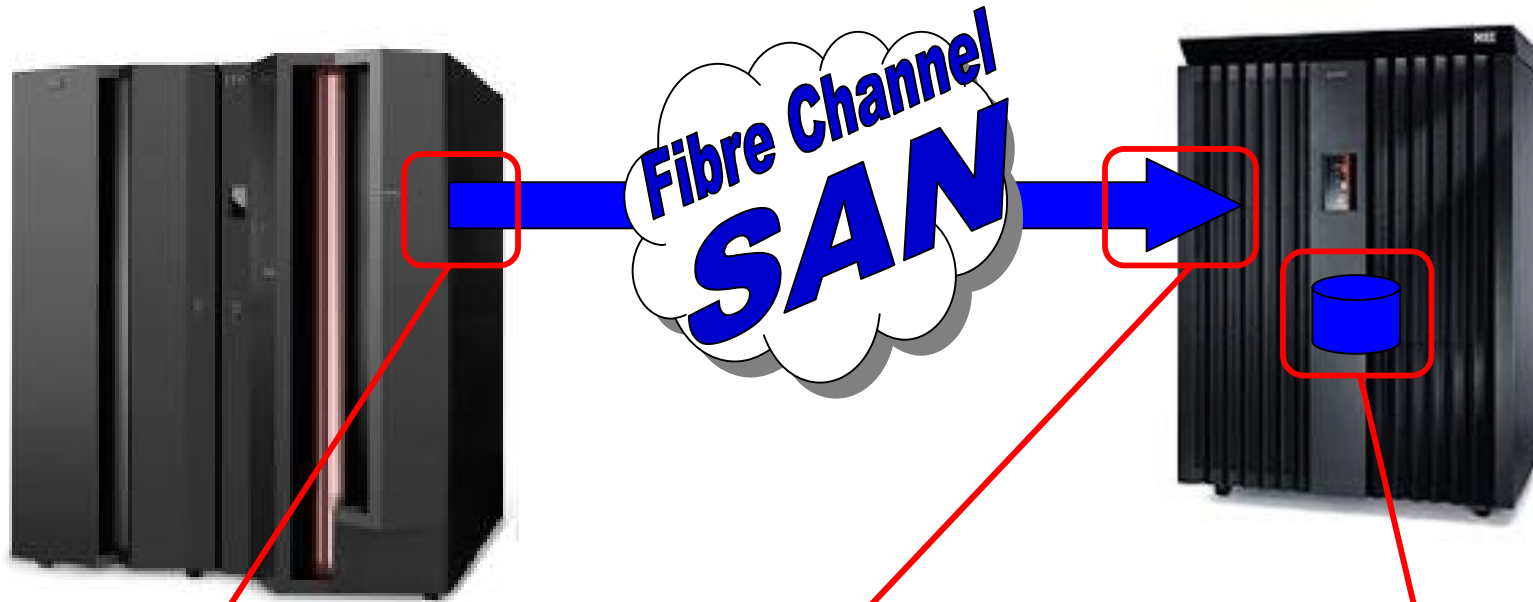


*SCSI Stack*

## zfcplib's Task in the Linux SCSI Stack

- o zfcplib drives the zSeries FCP host bus adapter.
  - maintains connections through the SAN to SCSI devices attached via a zSeries FCP adapter.
  - maps SAN devices to SCSI devices as seen by the Linux SCSI subsystem.
  - sends SCSI commands and associated data on behalf of the Linux SCSI subsystem to SCSI devices attached via a zSeries FCP adapter.
  - returns replies and data from SCSI devices to the Linux SCSI subsystem.

# SAN Addressing



**Device Number**

(devno)

e.g. 0x6000

**Worldwide Port Name**

(WWPN)

e.g. 0x5005076300ce93a7

**Logical Unit Number**

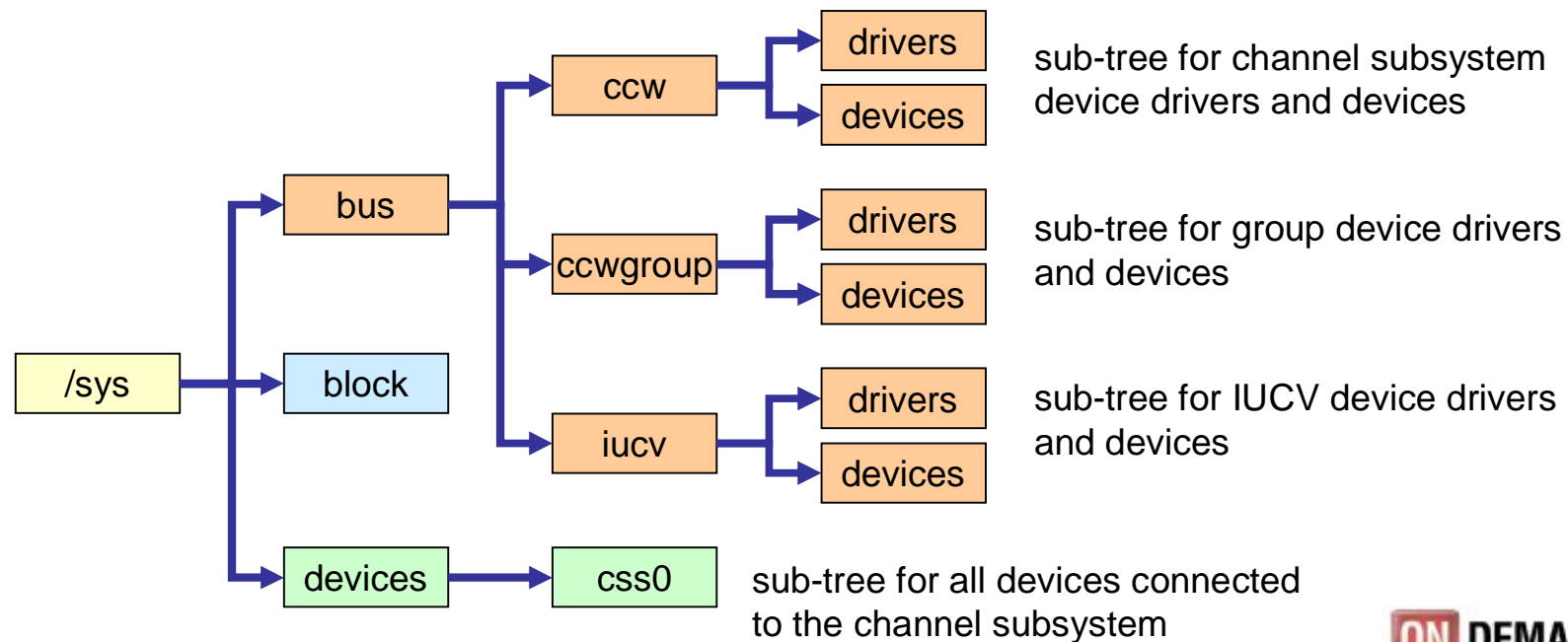
(LUN)

e.g. 0x1234000000000000

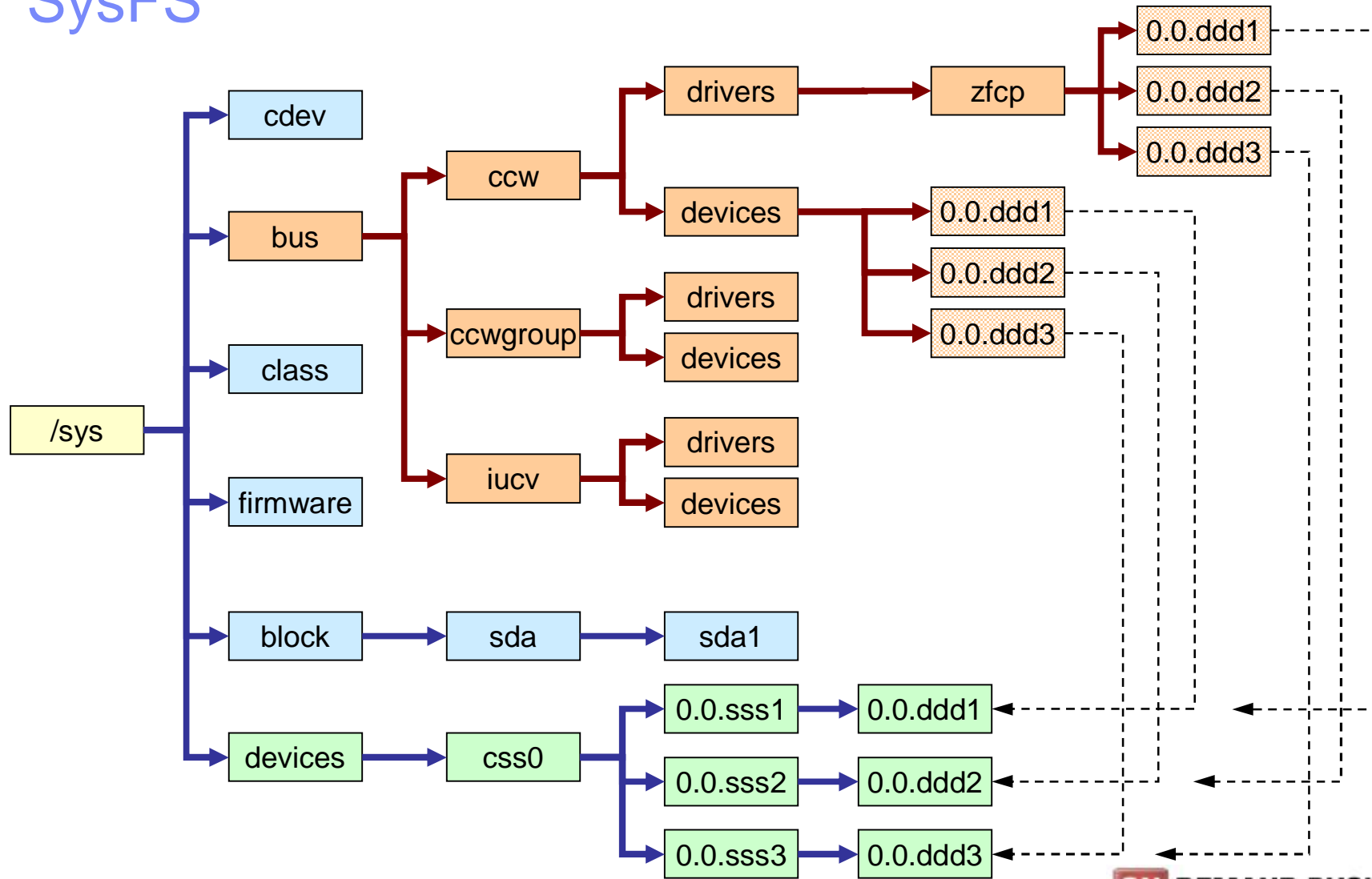


## SysFS

- New file system with Linux kernel 2.6
- Contains all device drivers and device specific information
- It is NOT a substitution of the /proc file system
- Used to configure device drivers



# SysFS



## Configuration – Set Adapter Online

```
[root: root]# cd /sys/bus/ccw/drivers/zfcp/
[root: zfcp]# ls
0.0.5588 loglevel_cio loglevel_config loglevel_erp
loglevel_fc loglevel_fsf loglevel_other
loglevel_qdio loglevel_scsi version
[root: zfcp]# cd 0.0.5588/
[root: 0.0.5588]# ls
availability card_version cmb_enable cutype detach_state
devtype failed fc_link_speed fc_service_class fc_topology
hardware_version in_recovery lic_version online port_add
port_remove s_id scsi_host_no serial_number status wwnn
wwpn

[root: 0.0.5588]# cat online
0
[root: 0.0.5588]# echo 1 > online
[root: 0.0.5588]# cat online
1
```





## Configuration – Add a Port to the Adapter

```
[root: 0.0.5588]# ls
availability card_version cmb_enable
... port_add ... status wwpn
[root: 0.0.5588]# echo 0x5005076300c693cb > port_add
[root: 0.0.5588]# ls
0x5005076300c693cb availability card_version
cmb_enable cutype detach_state devtype failed
fc_link_speed fc_service_class fc_topology
hardware_version host0 in_recovery lic_version
nameserver online port_add port_remove s_id
scsi_host_no serial_number status wwnn wwpn
[root: 0.0.5588]# cd 0x5005076300c693cb
[root: 0x5005076300c693cb]# ls
d_id detach_state failed in_recovery scsi_id
status unit_add unit_remove wwnn
```



## Configuration – Add a Unit to the Port

```
[root: 0x5005076300c693cb]# ls
d_id detach_state failed in_recovery scsi_id
status unit_add unit_remove wwnn
[root: 0x5005076300c693cb]# echo 0x5125000000000000 > unit_add
[root: 0x5005076300c693cb]# ls
0x5125000000000000 d_id detach_state failed
in_recovery scsi_id status unit_add unit_remove
wwnn
[root: 0x5005076300c693cb]# cd 0x5125000000000000/
[root: 0x5125000000000000]# ls
detach_state failed in_recovery scsi_lun status

[root: 0x5125000000000000]# lsscsi
[0:0:1:0] disk IBM 2105F20 .693 /dev/sda
[root: 0x5125000000000000]#
```

## Block Device View

```
[root: root]# cd /sys/block/  
[root: block]# ls  
dasda dasdb loop0 loop1 loop2 loop3 loop4 loop5  
loop6 loop7 ram0 ram1 ram2 ram3 ram4 ram5 ram6 ram7  
ram8 ram9 ram10 ram11 ram12 ram13 ram14 ram15 sda  
[root: block]# cd sda  
[root: sda]# ls  
dev device queue range sda1 size stat
```

```
[root: sda]# cat dev  
8:0  
[root: sda]# cat range  
16  
[root: sda]# cat size  
3906304
```

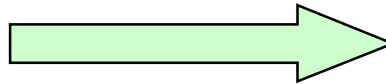


# FCP – SCSI Mapping

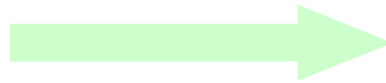
## FCP World



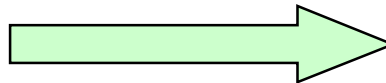
**HBA**



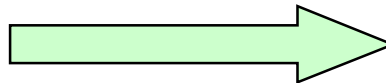
**0**



**WWPN**



**FCP LUN**



## SCSI World

**Host**



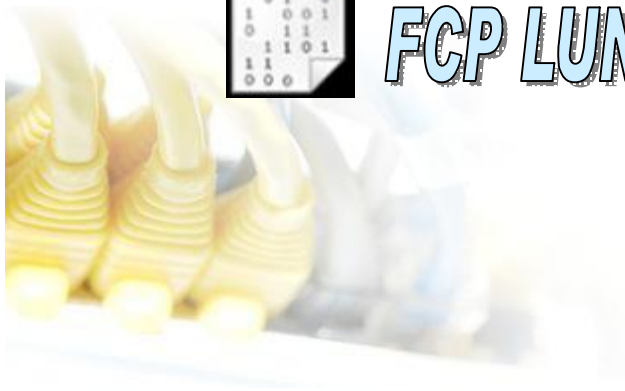
**Bus**



**SCSI ID**



**SCSI LUN**



## SCSI View

```
[root: root]# cd /sys/bus/scsi/devices/  
[root: devices]# ls  
0:0:1:0  
[root: devices]# cd 0\:0\:1\:0  
[root: 0:0:1:0]# ls  
block delete detach_state device_blocked  
fc_lun generic hba_id model online  
queue_depth rescan rev scsi_level type  
vendor wwpn
```



## FCP – SCSI Mapping

```
[root: root]# cd /sys/bus/ccw/drivers/zfcp/0.0.5588/
```

```
[root: 0.0.5588]# cat scsi_host_no
```

```
0x0
```

```
[root: 0.0.5588]# cd 0x5005076300c693cb
```

```
[root: 0x5005076300c693cb]# cat scsi_id
```

```
0x1
```

```
[root: 0x5005076300c693cb]# cd 0x5125000000000000
```

```
[root: 0x5125000000000000]# cat scsi_lun
```

```
0x0
```

```
[root: root]# cd /sys/bus/scsi/devices/0\:0\:1\:0/
```

```
[root: 0:0:1:0]# cat hba_id
```

```
0.0.5588
```

```
[root: 0:0:1:0]# cat wwpn
```

```
0x5005076300c693cb
```

```
[root: 0:0:1:0]# cat fcp_lun
```

```
0x5125000000000000
```



## Adapter Information



- o <directory for each configured target port>
- o serial\_number - Adapter serial number
- o lic\_version - LIC version number
- o scsi\_host\_no - SCSI host number
- o wwnn - Worldwide node name
- o wwpn - Worldwide port name
- o fc\_topology - Fibre Channel topology
- o fc\_link\_speed - Link Speed

```
# cd /sys/bus/ccw/drivers/zfcp/0.0.5588/
# cat serial_number          # cat wwnn
IBM0200000001AB8A          0x5005076400c1ab8a
# cat lic_version           # cat wwpn
0x00000206                 0x5005076401602fd8
# cat scsi_host_no         # cat fc_topology
0x0                          fabric
# cat fc_link_speed        # cat fc_link_speed
                             2 Gb/s
```



## Port Information



- o <directory for each FCP LUN>
- o in\_recovery - Recovery status
- o scsi\_id - SCSI ID
- o failed - Port error recovery status
- o d\_id - Destination ID
- o wwnn - Worldwide node name



```
# cd /sys/bus/ccw/drivers/zfcp/0.0.5588/0x5005076300c693cb/  
# ls  
0x5125000000000000 d_id detach_state failed in_recovery  
scsi_id status unit_add unit_remove wwnn  
# cat in_recovery  
0  
# cat scsi_id  
0x1  
# cat d_id  
0x632e13
```



## Unit Information



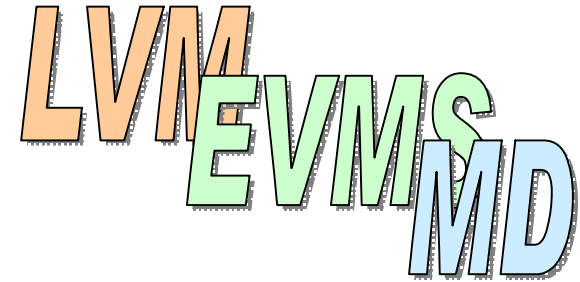
- o in\_recovery - Recovery status
- o scsi\_lun - Linux SCSI LUN
- o failed - Unit error recovery status
- o status - Debug Info



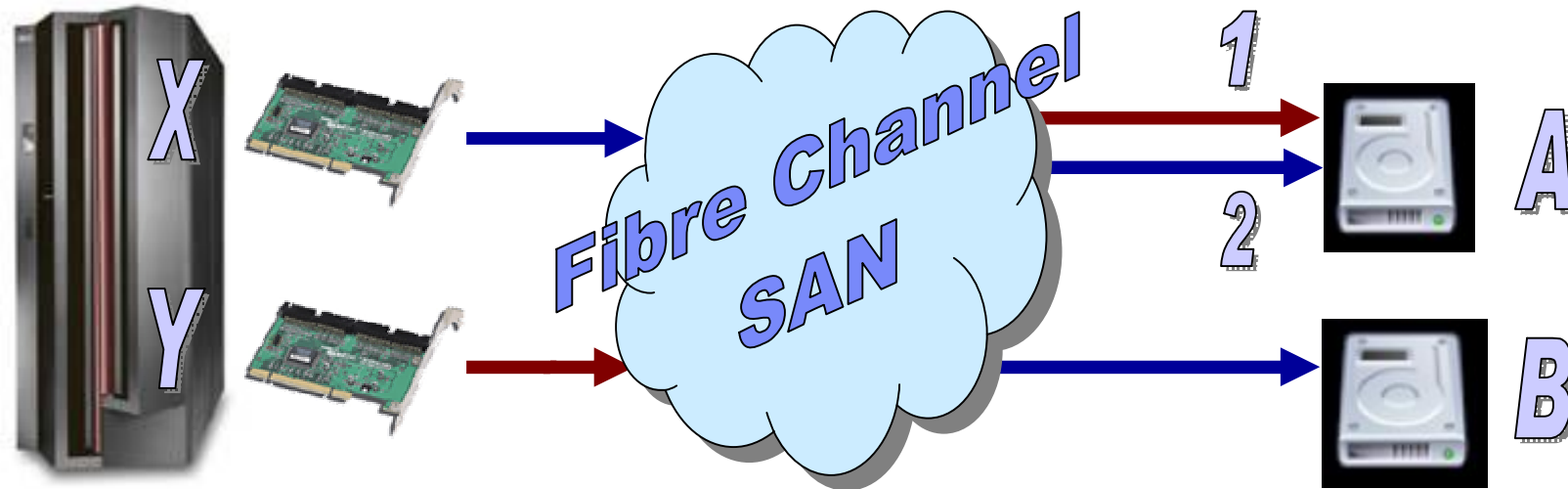
```
# cd /sys/bus/ccw/drivers/zfcp/0.0.5911/0x5005076300cc0b8e/0x5108000000000000/  
# ls  
detach_state  failed  in_recovery  scsi_lun  status  
# cat failed  
0  
# cat in_recovery  
0  
# cat scsi_lun  
0x0  
# cat status  
0x60000000
```

# FCP Multipathing

- SLES8
  - LVM – Logical Volume Manager
- SLES9
  - Device Mapper subsystem in 2.6 kernel
  - EVMS – Enterprise Volume Management System
  - LVM2 – Logical Volume Manager
- RHEL3
  - MD
  - mdadm – multiple device administration

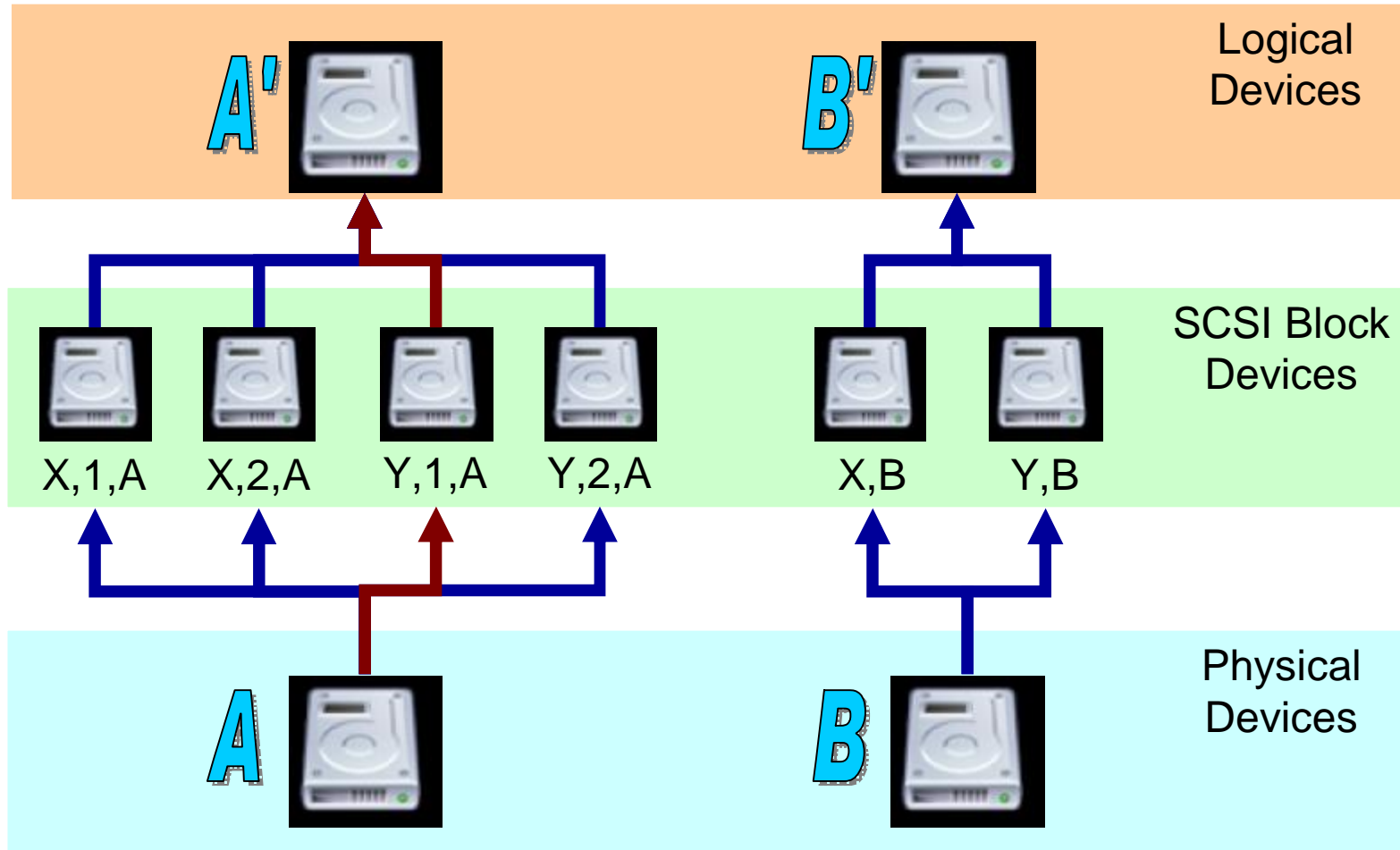


## FCP Multipathing



- Failover on path-failure
- Failback if recovered path is detected (retries)
- Load balancing (use of multiple paths for concurrent I/Os according to assigned priorities)
- Designed to cover all block devices

# FCP Multipathing – Devices



## FCP Multipathing – LVM

### ○ Notations

- Physical volumes
- Logical volumes
- Volume groups

### ○ /etc/zfcp.conf

### ○ Only one path enabled by default

### ○ /proc/lvm/



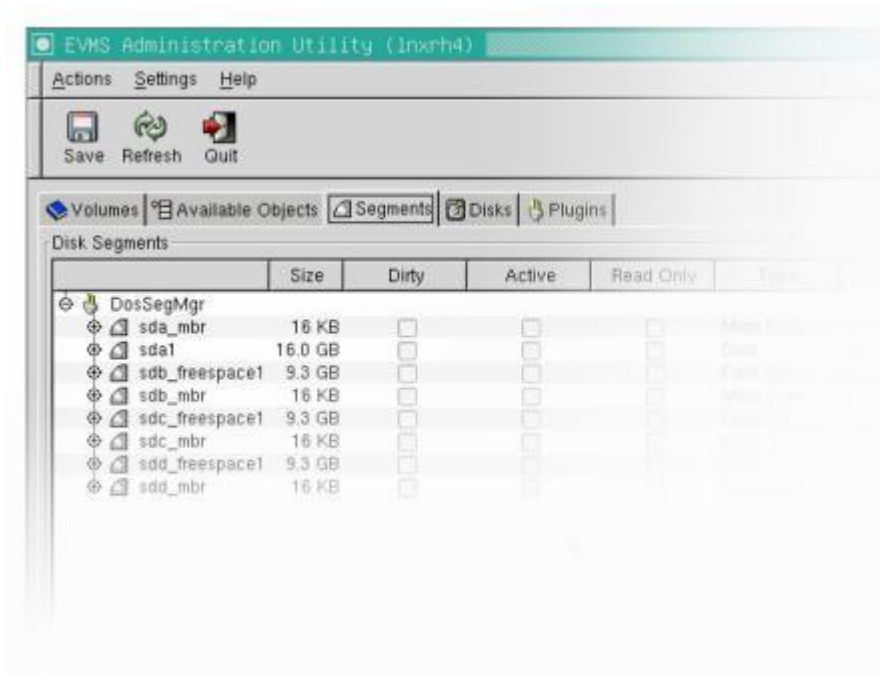
### ○ Standard LVM commands

- pvcreate
- vgcreate
- vgdisplay
- lvcreate

### ○ Multipath LVM commands

- pvpath
- pvpathsave
- pvpathrestore

# FCP Multipathing – EVMS



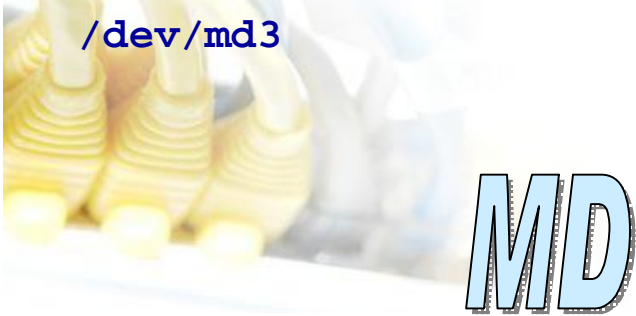
- Graphical EVMS management tool
- Segment, segment manager
- Region and MD multipath region manager
- MD Raid 0 Region manager



## FCP Multipathing – MD

- No load balancing
- Primary – secondary path or actual path – spare path
- Attention: md subsystem is quite verbose
  
- FCP mapping in modules.conf on ramdisk (single line!)
- Create device nodes (mknod /dev/sda b 8 0)
- Configure mdadm (/etc/mdadm.conf)
- /etc/rc.d/rc.sysinit – enabling on Linux startup

```
mdadm -C /dev/md1 -level=multipath -raid-device=2 /dev/sda1 /dev/sdd1
mdadm -C /dev/md2 -level=multipath -raid-device=2 /dev/sdb1 /dev/sde1
mdadm -C /dev/md3 -level=multipath -raid-device=2 /dev/sdc1 /dev/sdf1
mdadm -C /dev/md0 -level=raid0 -raid-devices=3 /dev/md1 /dev/md2
/dev/md3
```



# Disk Usage – ECKD DASD and SCSI Comparison

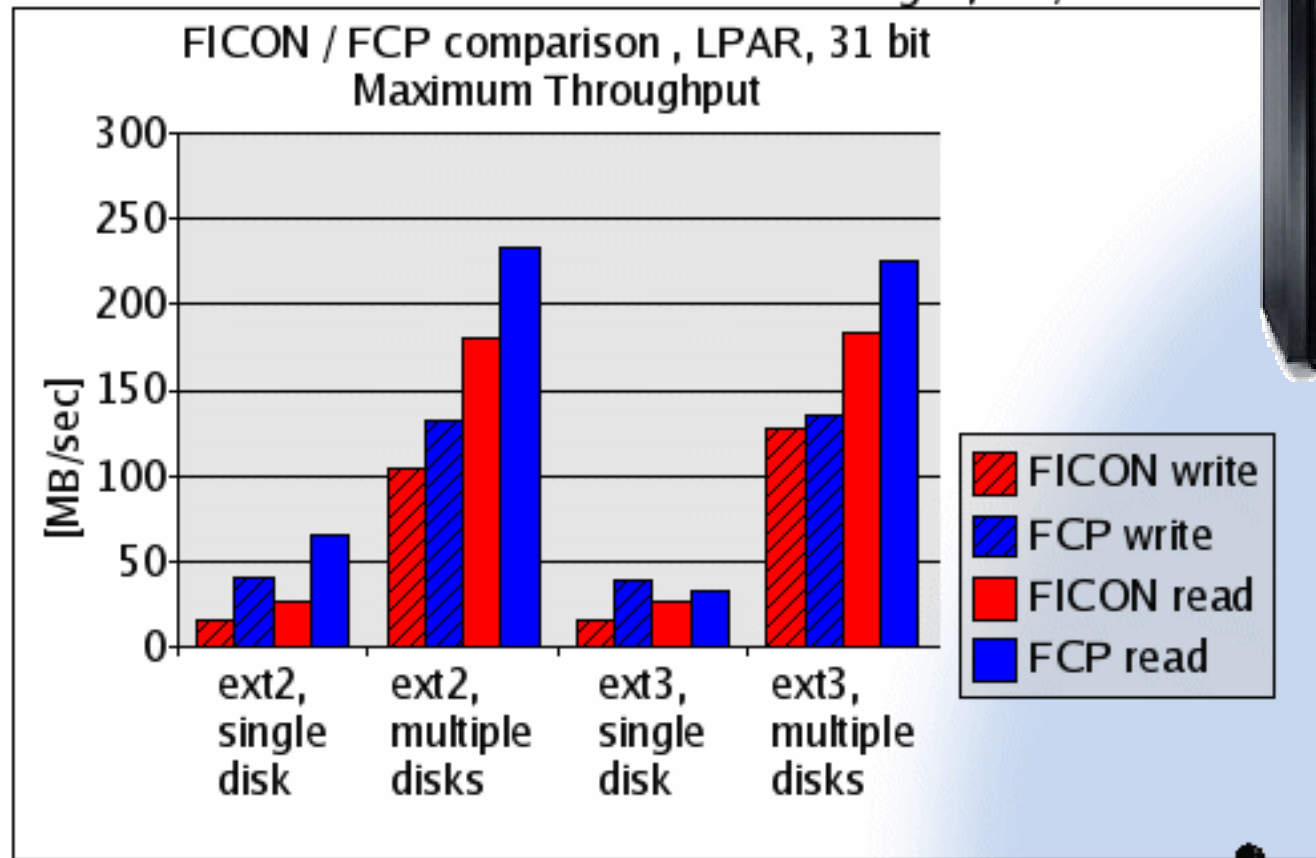


	ECKD DASD	SCSI Disk
Configuration	IOCDS/VM (Operator)	IOCDS/VM & Linux (Operator & Linux Admin)
Access Method	SSCH	QDIO
Block Size (Byte)	512, 1K, 2K, 4K	512
Disk Size	3390 Model 3/9/27 now variable too	any
Formatting (low level)	dasdfmt	not necessary
Partitioning	fdasd	fdisk
File System	mke2fs (or others)	
Access	mount	



# FICON and FCP Performance

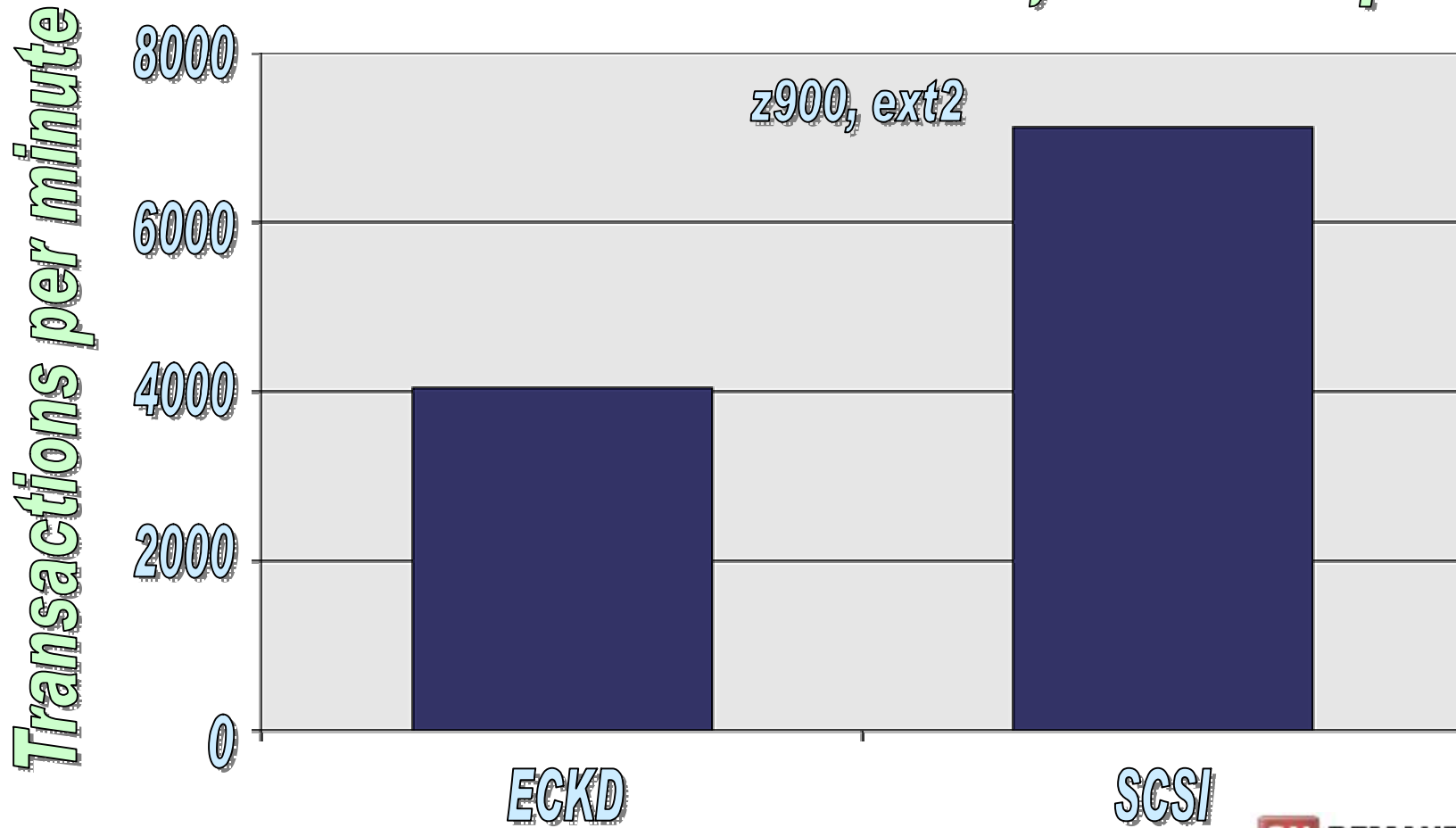
IBM Lab Boeblingen, 03/2003



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# OLTP Workload Informix – I/O Options

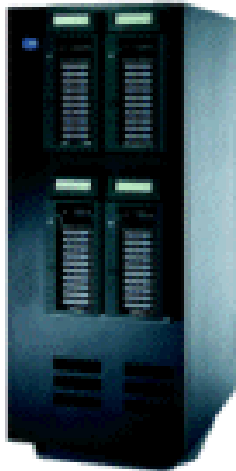
## Informix database server, disk I/O options



## FCP/SCSI Tape Support

### o Tape Devices:

- IBM TotalStorage Enterprise Tape System 3590.
- IBM TotalStorage Enterprise Tape Drive 3592.
- IBM TotalStorage Enterprise Tape Library 3494.
- IBM TotalStorage UltraScalable Tape Library 3582, 3583 and 3584 w/ Ultrium 2 Fibre Channel Tape Drives.



### o IBMtape and IBMtapeutil packages required

- `/lib/modules/(Your system's kernel name)/kernel/drivers/scsi/IBMtape.o`
- `/usr/bin/IBMtapeconfig`
- `/usr/bin/IBMtaped`
- `/usr/bin/IBMtapeutil`



## FCP/SCSI Tape Support

- o IBMtape special files (created by IBMtapeconfig):

- /dev/IBMtape0
- /dev/IBMtape0n
- /dev/IBMchanger0



- o Tape utility program (IBMtapeutil):

```
# Mount cartridge from slot 3  
IBMtapeutil -f /dev/IBMchanger0 mount 3
```

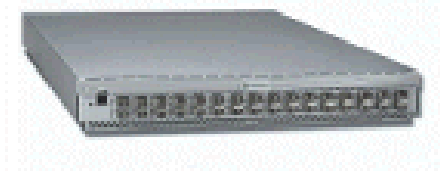
```
# Backup myfile.tar to tape  
IBMtapeutil -f /dev/IBMtape0 write -s myfile.tar
```

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## Device Support - Summary

### o Devices (via switch)

- IBM TotalStorage Enterprise Tape System 3590
- IBM TotalStorage Enterprise Tape Drive 3592
- IBM TotalStorage Enterprise Tape Library 3494
- IBM TotalStorage Enterprise Storage Server Models 750, 800, F20, F10
- IBM TotalStorage UltraScalable Tape Library 3582, 3583 and 3584 w/ Ultrium 2 Fibre Channel Tape Drives



### o Director/Switch Support

- CISCO MDS 9000 Family (IBM 2062)
- CNT (INRANGE) FC/9000 64-port, 128-port and 256-port models (IBM 2042)
- McDATA Intrepid 6064 (IBM 2032) and 6140 (IBM 2032)
- McDATA 3232 (IBM 2031-232)
- McDATA Sphereon 4500 Fabric Switch (IBM 2031-224)
- IBM total Storage SAN Switch 2109-M12, 2109-F16 and S16/S08
- IBM 2108-G07 SAN Data Gateway (parallel SCSI connectivity to non-IBM storage)
- McDATA ES-1000 Loop Switch (IBM 2031-L00) FCP-to-FC-AL Bridge
- McDATA ED-5000 (IBM 2032-001)



## SCSI IPL & SCSI Dump

- SCSI IPL from FCP attached SCSI disks.
- SCSI Dump to FCP attached SCSI disks (LPAR only).
- Expand the world of open I/O attachments on zSeries from pure data access to allow IPL and Dump support.
- Enhances the setup to allow Linux on zSeries to run completely on SCSI disks - incl. IPL, Data access and Dump support.
- New set of IPL parameters.
- LPAR and z/VM guests supported.



## SCSI IPL & SCSI Dump – Cont.

**Load**

CPC: P000F12B  
Image: ZFCP4

Load type:  Normal  Clear  SCSI  SCSI dump

Store status

Load address: 5C00

Load parameter:

Time-out value: 060 00 to 600 seconds

World wide port name: 5005076300CE93A7

Logical unit number: 5732000000000000

Boot program selector: 0

Boot record logical block address: 0000000000000000

OS specific load parameters:

OK Reset Cancel Help

- Disk preparation with Linux „zipl“ tool
- Up to 31 boot configurations possible

### ○ Requirements

- Requires enablement by FC9904
- Requires FCP channels
- IBM zSeries server 800, 890, 900 or 990
- z/VM 4.4 (PTF UM30989)

## FCP/SCSI on Linux For zSeries - Summary

- FCP/SCSI support for IBM zSeries.
  - New FCP channel based on FICON / FICON Express cards.
  - FCP channel support in z/VM 4.3 and higher for Linux guests.
  - First FCP/SCSI exploitation for zSeries in SLES8 and RHEL3.
- Integration of your zSeries into standard based FC SANs.
- New device types.
- Reduced emulation overhead in OS and ESS compared to ECKD due to native use of fixed block I/O.
- Larger disks in comparison to ESCON/FICON.
- Current restrictions:
  - Only switched fabric supported.
  - No LUN sharing or zoning on a single adapter → use separate physical adapters.



## Useful Links



- I/O Connectivity on IBM zSeries mainframe servers
  - <http://www-1.ibm.com/servers/eserver/zseries/connectivity/#fcp>
- Getting Started with zSeries Fibre Channel Protocol, IBM Redpaper
  - <http://www.redbooks.ibm.com/redpapers/pdfs/redp0205.pdf>
- z/VM Version 4 Release 4
  - Version 4.4: <http://www.vm.ibm.com/zvm440/>
  - Version 5.1: <http://www.vm.ibm.com/zvm510/>
- SUSE Linux Enterprise Server 8
  - <http://www.suse.de/de/business/products/server/sles/index.html>
- Linux for zSeries and S/390
  - Kernel 2.4: [http://oss.software.ibm.com/linux390/june2003\\_recommended.shtml](http://oss.software.ibm.com/linux390/june2003_recommended.shtml)
  - Kernel 2.6: [http://oss.software.ibm.com/linux390/april2004\\_recommended.shtml](http://oss.software.ibm.com/linux390/april2004_recommended.shtml)
- Linux Device Drivers and Installation Commands
  - Kernel 2.4: <http://oss.software.ibm.com/linux390/docu/lx24jun03dd02.pdf>
  - Kernel 2.6: <http://oss.software.ibm.com/linux390/docu/lx26apr04dd00.pdf>
- IBM TotalStorage Tape Device Drivers – Installation and User's Guide
  - <ftp://ftp.software.ibm.com/storage/devdvr/Doc/>
- ESS Fibre Channel Attachment White Paper
  - <http://www.storage.ibm.com/disk/ess/support/essfcwp.pdf>

# SCSI over Fibre Channel Support for Linux on zSeries

# Questions ?



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