Additional Feet for the Penguin – SCSI over FCP Multipathing for Linux on System z

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Abstract

Using storage attachments with less than two independent paths is more than grossly negligent. So the solution is a waterproof multipathing setup. But that sounds easier than it is and there are several configuration pitfalls. This presentation will give you a multipathing overview and lights the multipathing configuration for SCSI devices connected over FCP.

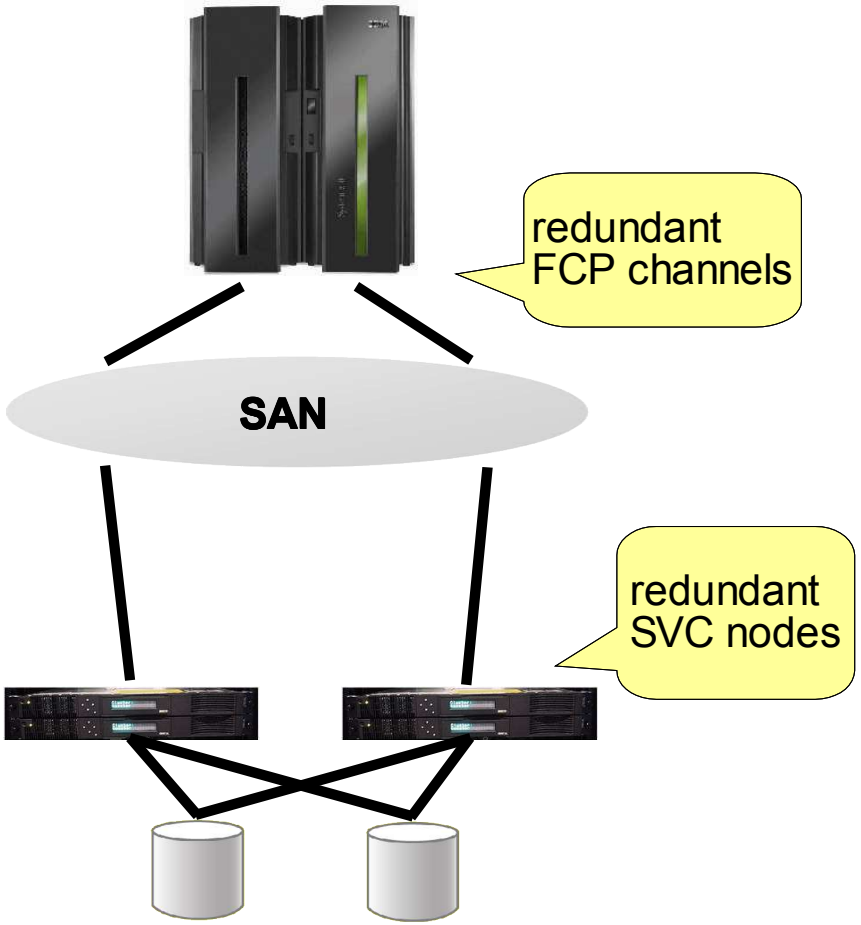
Agenda

- Why multipathing?
- Multipathing for disk storage
- Root filesystem on multipathing device
- Multipathing for IBM tape drives

Why multipathing?

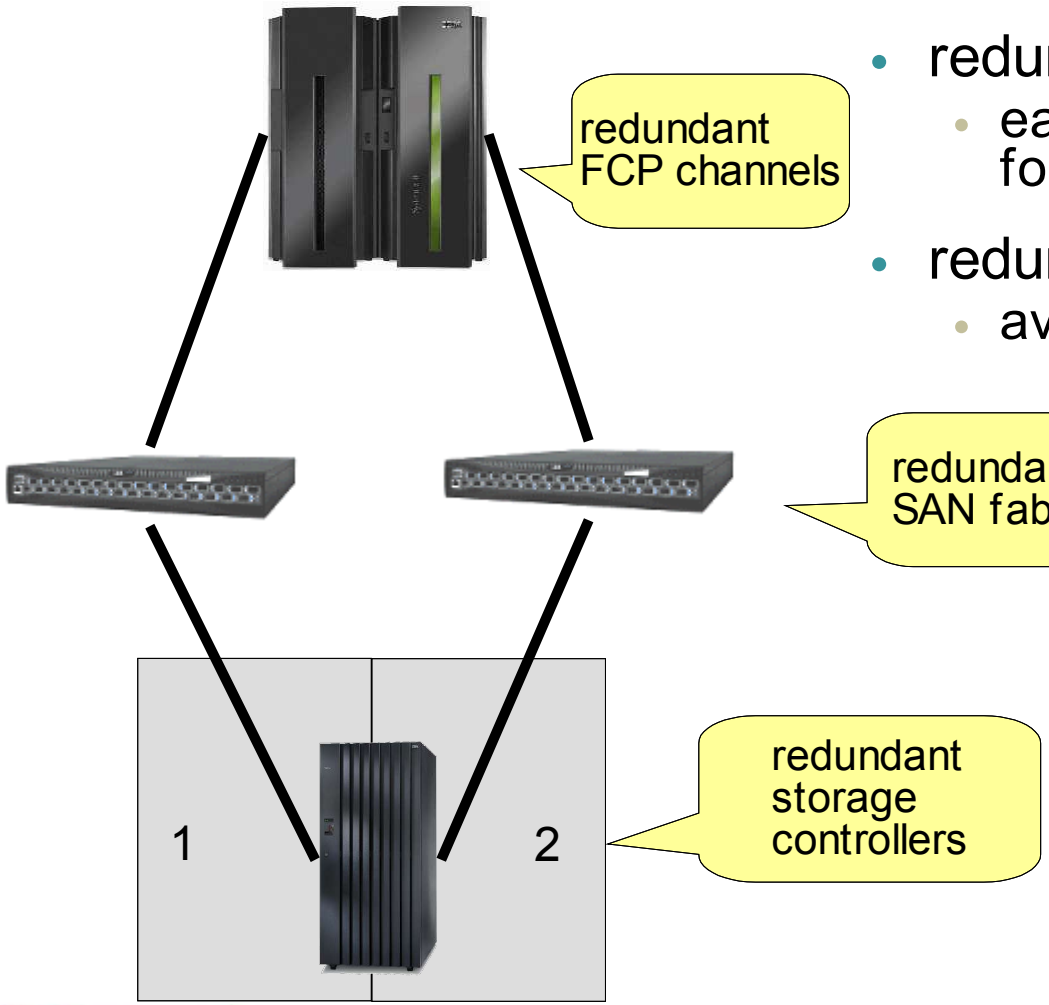
- High availability
  - Access during storage system maintenance
  - Usually required by enterprise disk systems
- Higher performance through load balancing
  - spread I/O load across multiple paths
  - ... across multiple FCP adapters
  - some storage systems use a preferred path
- Failover and Failback
  - hardware maintenance
  - microcode upgrades
  - storage system internal resets

Multipathing for disk storage



- spread load across channels
- keep I/O running during
  - channel recovery
  - configuration changes
- failover and failback
  - during storage maintenance
  - during channel maintenance
  - microcode updates
  - storage internal resets

Mulipathing for disk storage



- redundant controllers in DS8000
  - each controller can be offline for maintenance
- redundant SAN fabrics
  - availability during maintenance

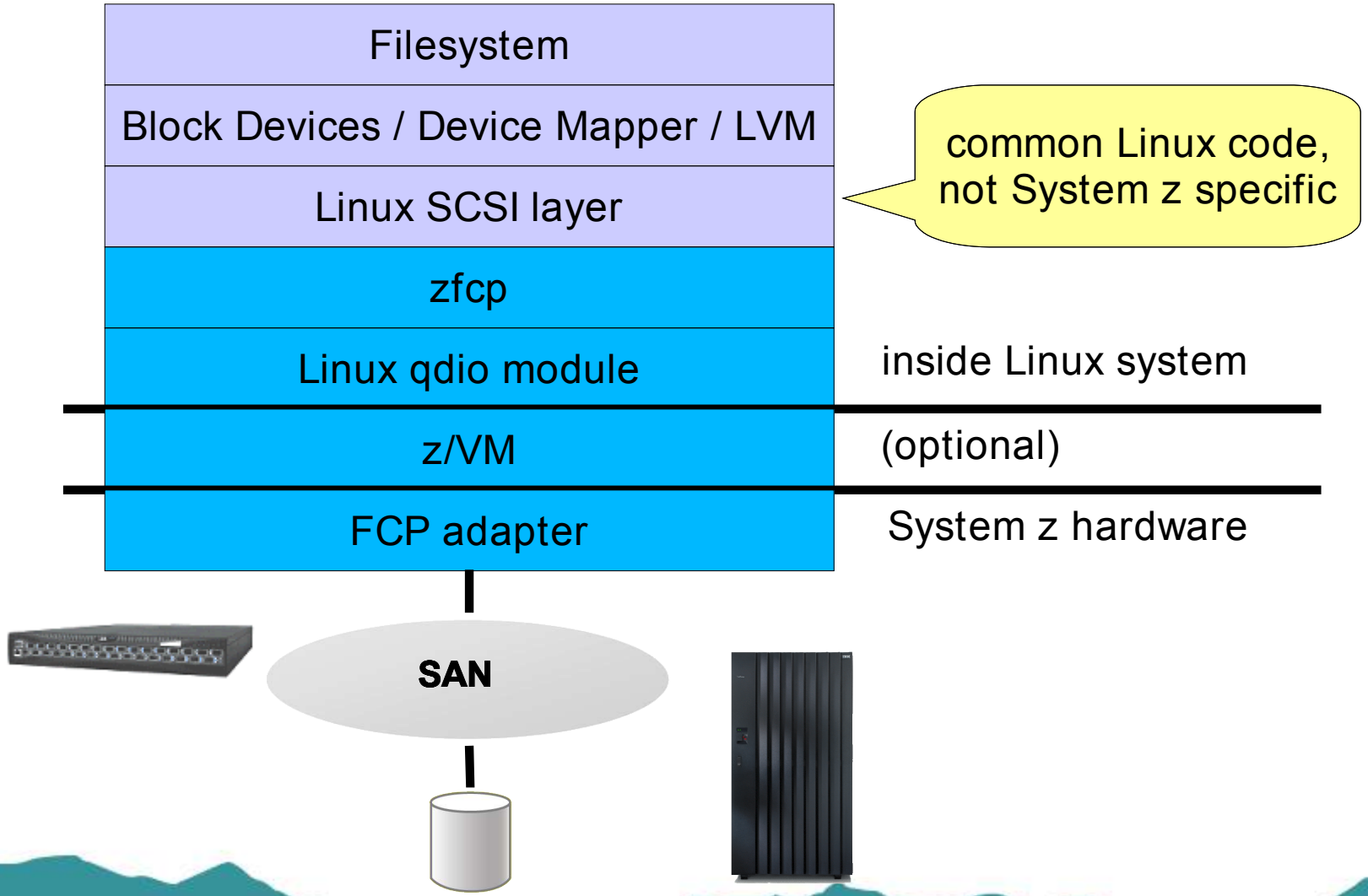
Multipathing for disk storage in Linux

- device-mapper in Linux kernel and multipath-tools
- standard in distributions: RHEL, SLES, ...
- multipathing layer above block devices
- A SCSI device in Linux is now a path!
- Cross-platform: Linux on System z, p, x, ...
- Cross-vendor
- Used throughout storage test and device qualification tests
- supports more than two paths, the following example only uses two

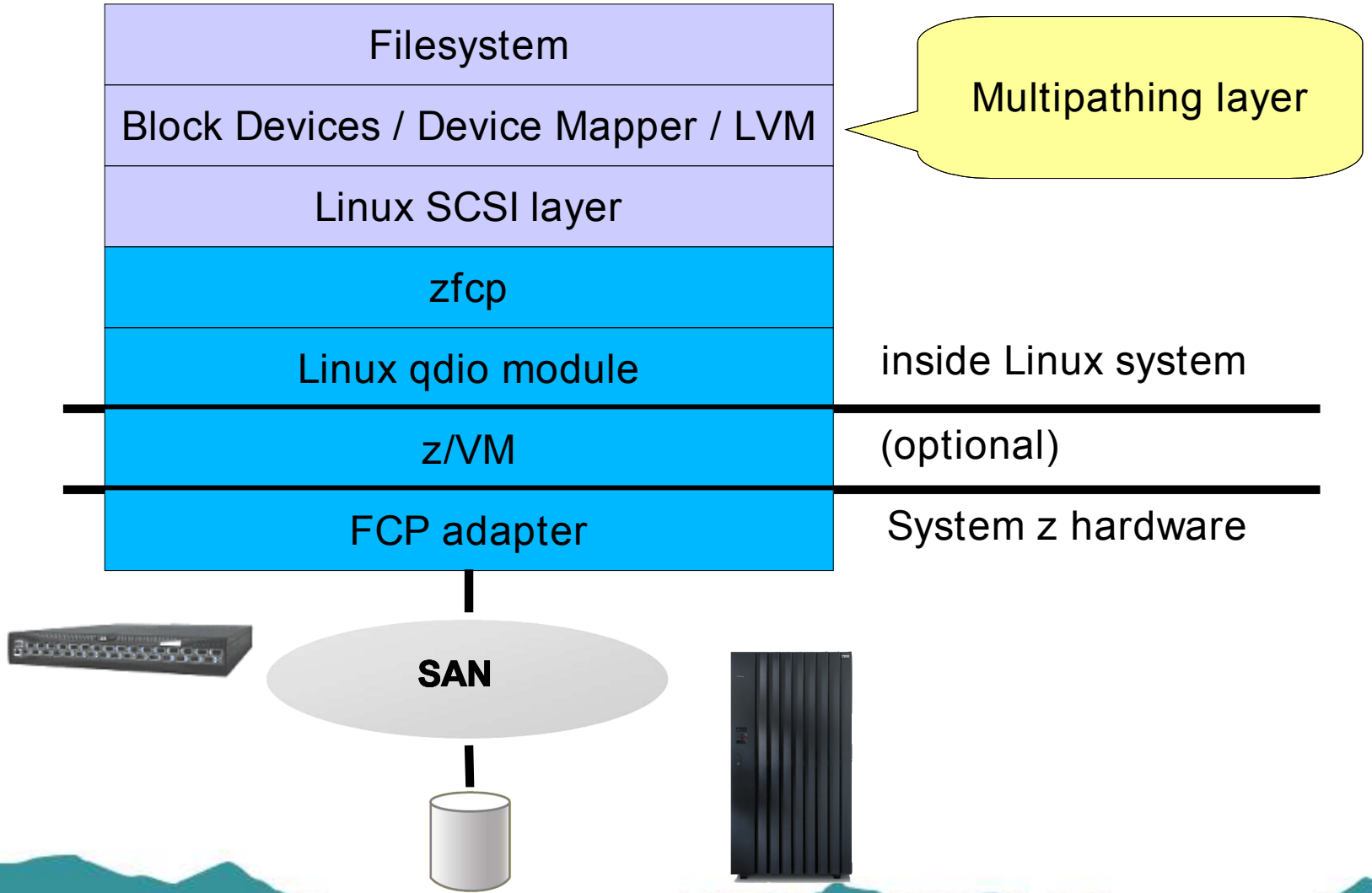
multipathing components

- device-mapper: kernel infrastructure
- multipathd
  - reads configuration
  - establishes setup
  - queries storage
  - checks paths periodically: failback
- command line interface
  - multipath
  - multipathd
- kpartx: helper for partitions on multipath devices
- setup already includes sane default settings

I/O Stack for SCSI on Linux on System z

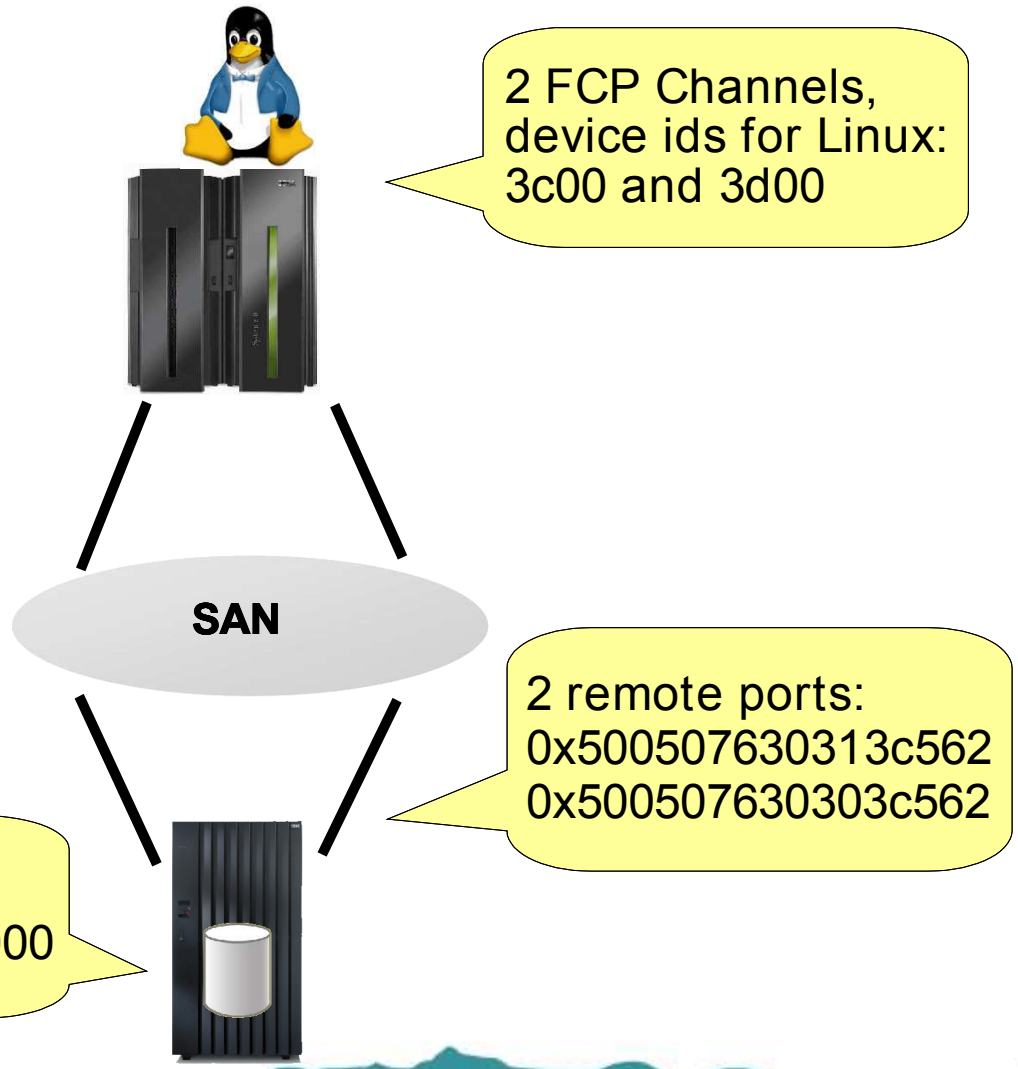


I/O Stack for SCSI on Linux on System z



multipathing example

- one disk
- two paths



multipathing example

- attach ports and units for all paths
- path 1: 0.0.3c00 -> 0x500507630313c562 -> LUN
- path 2: 0.0.3d00 -> 0x500507630303c562 -> LUN
- recommendation: use zfcp config file from distribution
  - RHEL: /etc/zfcp.conf
  - SLES: /etc/sysconfig/hardware/hwcfg-zfcp-bus-ccw-0.0.*

multipathing example

- recommendation: use zfcp config file from distribution
- manual steps would be:

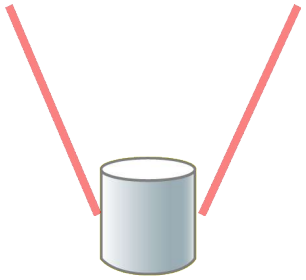
```
# cd /sys/bus/ccw/drivers/zfcp/
# echo 1 > 0.0.3c00/online
# echo 1 > 0.0.3d00/online
# echo 0x500507630313c562 > 0.0.3c00/port_add
# echo 0x500507630303C562 > 0.0.3d00/port_add
# echo 0x401040CC00000000 > 0.0.3c00/0x500507630313c562/unit_add
# echo 0x401040CC00000000 > 0.0.3d00/0x500507630303c562/unit_add
```

multipathing example

- zfcp and SCSI report each path as device

```
# lszfcp -D
0.0.3d00/0x50050763030bc562/0x401040cc00000000 0:0:0:1087127568
0.0.3c00/0x500507630313c562/0x401040cc00000000 1:0:0:1087127568

# lsscsi
[0:0:0:1087127568]disk    IBM      2107900      2.27  /dev/sda
[1:0:0:1087127568]disk    IBM      2107900      2.27  /dev/sdb
```



multipathing example

- 2 SCSI devices for the same disk volume:

```
# scsi_id -g -s /block/sda
36005076303ffc56200000000000010cc
# scsi_id -g -s /block/sdb
36005076303ffc56200000000000010cc
```

Worldwide Identifier (WWID)
Id for storage System + Id for disk volume

- queried from storage system
- multipathd uses this mechanism for mapping paths to disks

multipathing example

- Manually start multipathing (not recommended):

```
# modprobe dm-multipath

# multipathd

# multipath -ll
36005076303ffc56200000000000010cc dm-0 IBM,2107900
[size=5.0G][features=0][hwhandler=0]
\_ round-robin 0 [prio=2][active]
 \_ 1:0:0:1087127568 sdb   8:16  [active][ready]
 \_ 0:0:0:1087127568 sda   8:0   [active][ready]
```

multipathing setup for SLES10

- add all paths to system
  - YaST or edit /etc/sysconfig/hardware/hwcfg-zfcp-*
  - hwup zfcp-bus-ccw-0.0.3c00
- enable device scanning and multipathd
  - chkconfig multipathd on
  - chkconfig boot.multipath on
- reboot or manually start multipath scripts
  - /etc/init.d/boot.multipath start
  - /etc/init.d/multipath start

multipathing setup for RHEL5

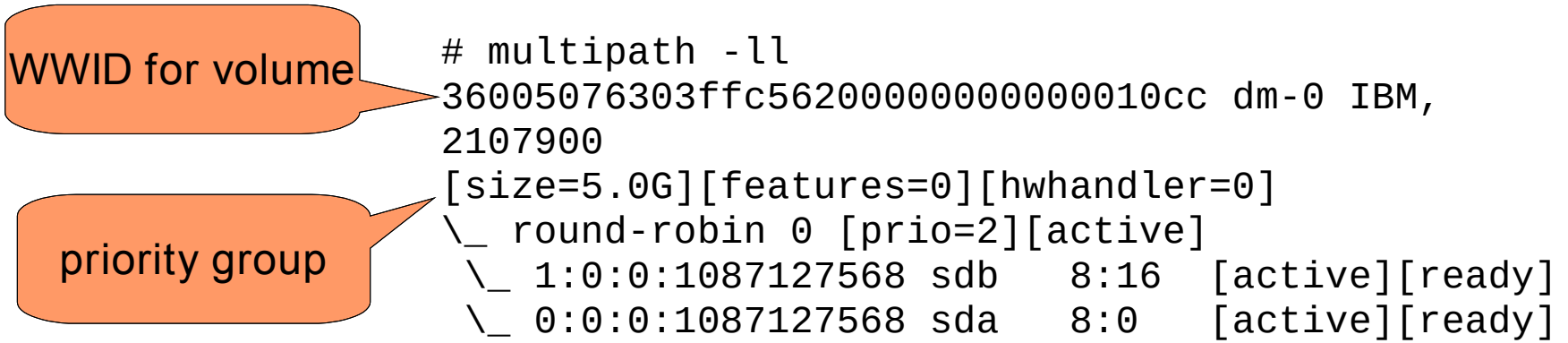
- attach all paths to system
  - /etc/zfcp.conf
  - /sbin/zfcpconf.sh or reboot
- Adjust provided /etc/multipath.conf

```
#blacklist {
#        devnode "*"
#}

#defaults {
#       user_friendly_names yes
#}
```

- chkconfig --add multipathd
- /etc/init.d/multipathd start

Checking multipathing status

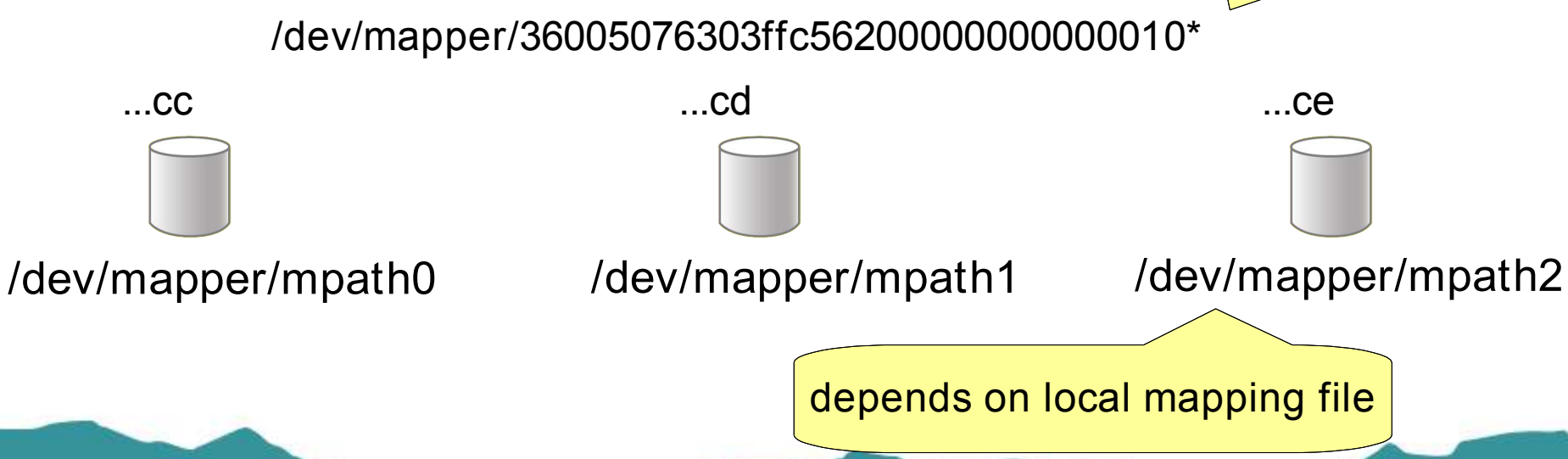


- Paths are combined automatically
- Each path is in one priority group
- multipathing device file /dev/mapper/36005076303ffc56200000000000010cc
- Default settings are good, but can also be changed

Multipathing names and aliases

- user_friendly_names and aliases
  - /dev/mapper/mpath0 instead of /dev/mapper/36005076303ffc56200000000000010cc
- But: WWID is unique, alias maybe not
  - mapping depends on file /var/lib/multipath/bindings
- Recommendation: Use WWIDs

WWIDs from storage system



depends on local mapping file

Multipathing with preferred path

- active / passive controller (DS6000)
- standard storage devices in default hardware table
- 2 pathgroups
  - active/enabled
  - automatically queried from storage (ALUA)

2 priority groups

```
# multipath -ll
3600507630efffca2000000000001229 dm-0 IBM,1750500
[size=3.0G][features=1 queue_if_no_path]
[hwhandler=0]
\_ round-robin 0 [prio=50][active]
 \_ 0:0:0:1076445202 sdaw 67:0   [active][ready]
\_ round-robin 0 [prio=10][enabled]
 \_ 1:0:0:1076445202 sdcb 68:240 [active][ready]
```

hardware table

- combination of
  - default settings
  - redefined settings in /etc/multipath.conf

```
# multipath -t
...
devices {
...
        device {
                vendor "IBM"
                product "1750500"
                path_grouping_policy "group_by_prio"
                path_checker "tur"
                features "1 queue_if_no_path"
                prio "alua"
                failback "immediate"
        }
...
```

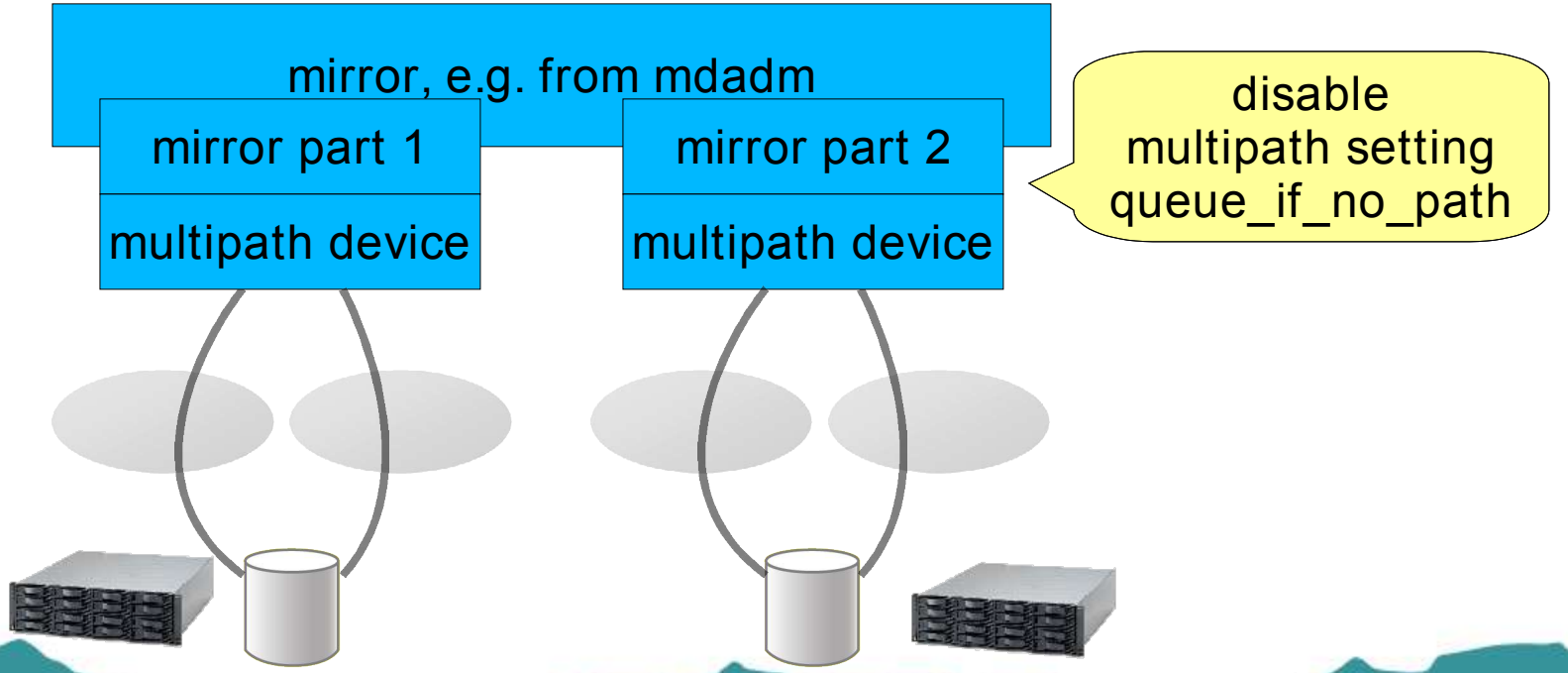
blacklist

- add and change in /etc/multipath.conf

```
# multipath -t
...
blacklist {
        devnode ^(ram|raw|loop|fd|md|dm-|sr|scd|st)[0-9]*
        devnode ^hd[a-z]
        devnode ^dcssblk[0-9]*
        device {
                vendor DGC
                product LUNZ
        }
        device {
                vendor IBM
                product S/390.*
        }
}
blacklist_exceptions {
}
...
```

queue_if_no_path

- set as default
- queues I/O in memory in case all paths are down
- hides path failures from next layer
- disable for software mirror



LVM2 and md on multipathing

- consider queue_if_no_path setting
- mirror and LVM on multipath devices, not SCSI device files!
- setup in /etc/lvm/lvm.conf
  - filter = ["r|/dev/sd*”]

multipathd: more status information

```
# multipathd -k
multipathd> show paths
hcil             dev dev_t pri dm_st   chk_st  next_check
1:0:0:1087127568 sdb 8:16  1   [active][ready] XXXXXXX... 15/20
0:0:0:1087127568 sda 8:0   1   [active][ready] XXXXXXX... 15/20


multipathd> show multipaths status
name                                failback queueing paths dm-st
36005076303ffc56200000000000010cc -        off      2     active


multipathd> show multipaths stats
name                                path_faults switch_grp map_loads
total_q_time q_timeouts
36005076303ffc56200000000000010cc 0           0          1         0
      0


multipathd> help
...
```

Root file system on multipathing device

- example assumed root filesystem on dasd
- root file system on SCSI possible with SCSI IPL
- reliability requirements demand multipathing
- the same applies to swap partition
- Issues:
  - no support for multipathing in distro installers
  - start multipathing before mounting root filesystem
  - zipl does not write IPL record on multipath device file

zipl for multipath device

- add boot entry for single path
  - update procedure
    - boot to single path
    - update
    - zipl
    - boot to multipath
  - reliability during maintenance?
- or use additional disk volume for /boot
  - / on multipath
  - /boot on single path disk volume
  - write zipl IPL record on /boot disk volume
  - IPL /boot disk volume
  - uses additional disk volume
- recommendation: use additional disk volume for reliability

Installing root filesystem on multipath

- Install on single path.
- additional small disk for /boot
- Change to multipath setup after first boot
  - setup second path
  - use multipath device for root filesystem
  - recreate initrd with multipathing
  - zipl for changed initrd

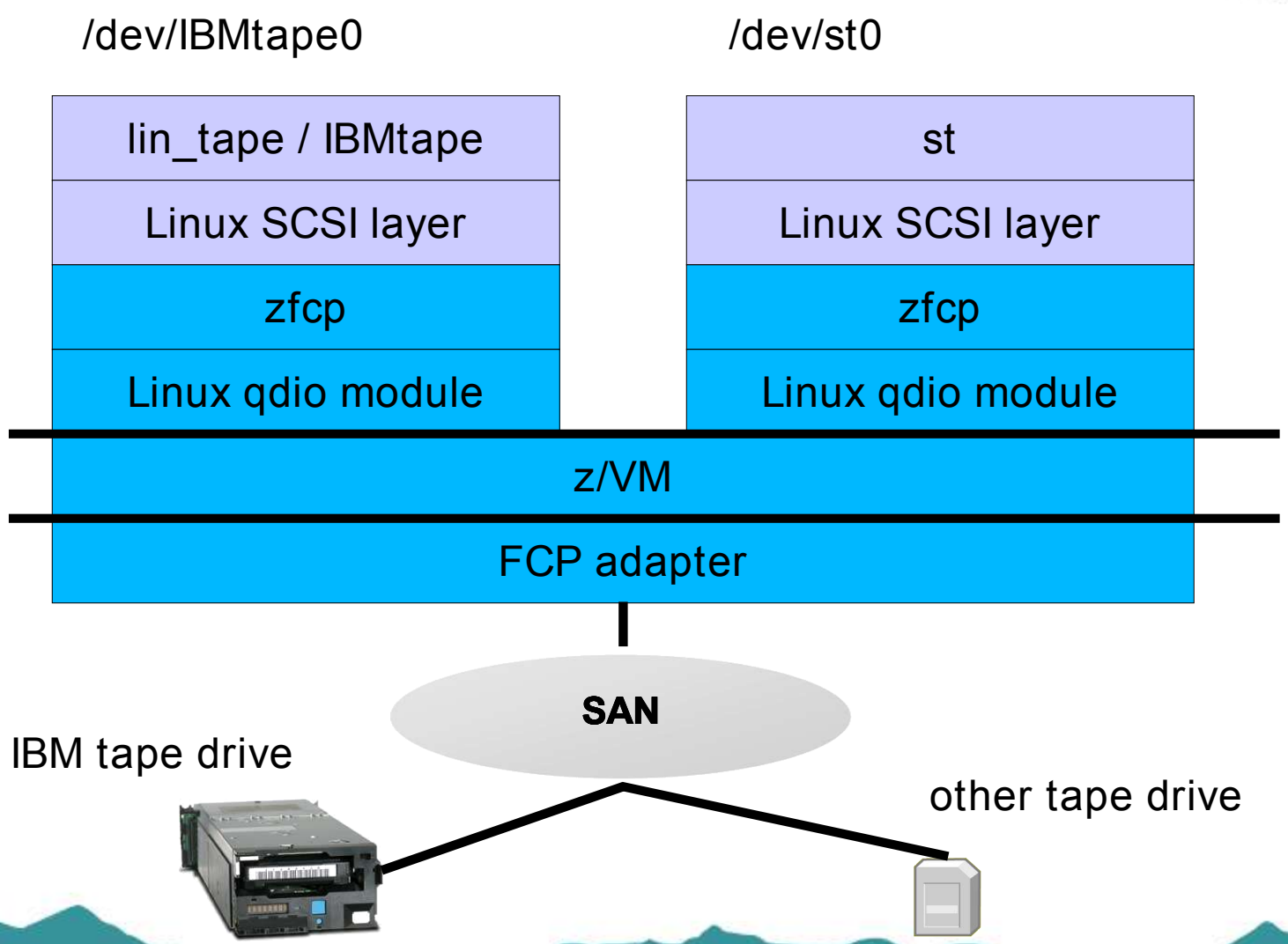
root filesystem on multipath device

- final setup after reboot

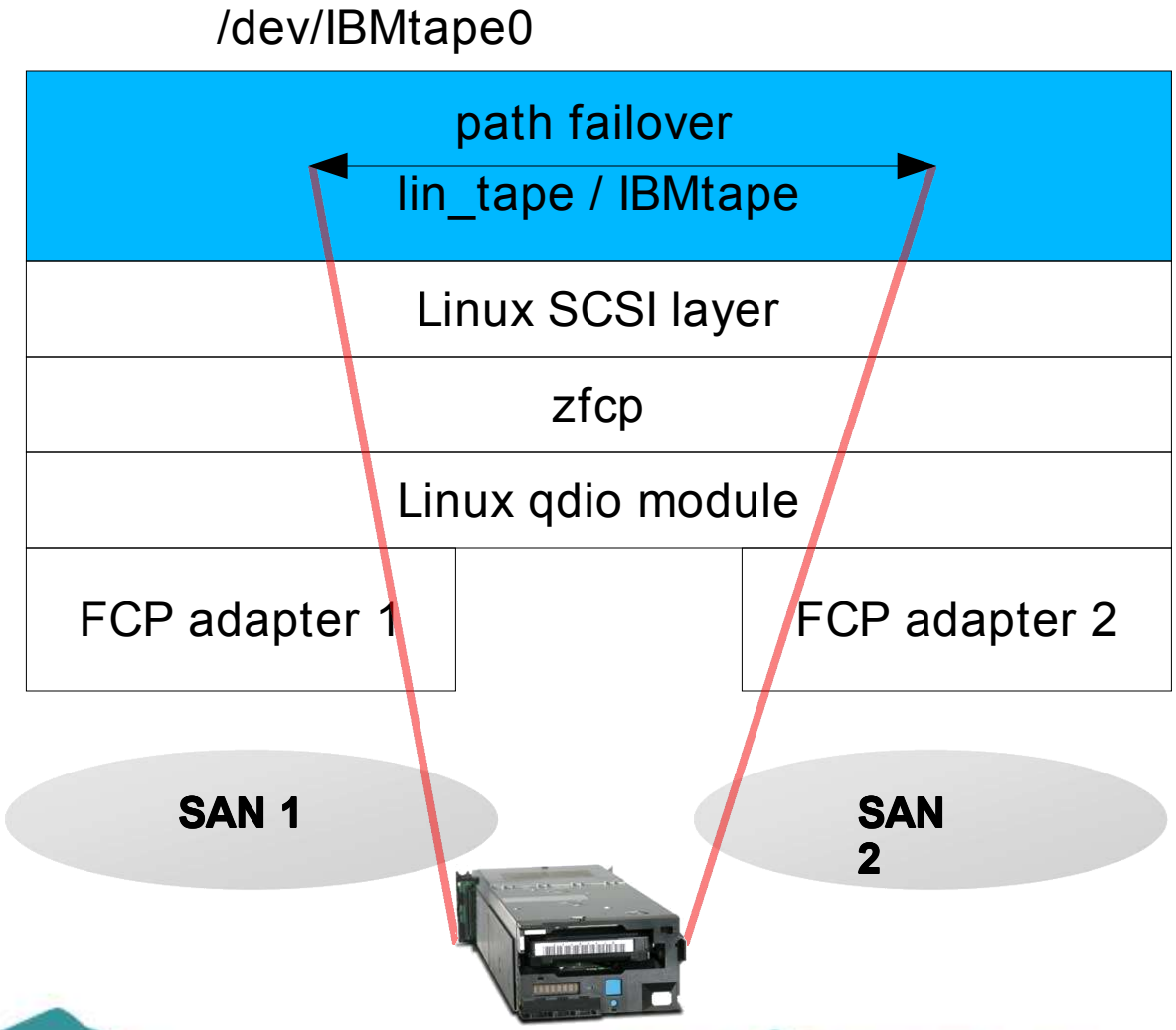
```
# multipath -ll
36005076303ffc56200000000000010cc dm-0 IBM,2107900
[size=5.0G][features=1 queue_if_no_path][hwhandler=0]
\_ round-robin 0 [prio=2][active]
 \_ 1:0:0:1087127568 sdc 8:32  [active][ready]
 \_ 0:0:0:1087127568 sda 8:0   [active][ready]

# mount
/dev/mapper/36005076303ffc56200000000000010cc-part1 on /
type ext3 (rw,acl,user_xattr)
/dev/sdb1 on /boot type ext3 (rw,acl,user_xattr)
```

Tape drives and FCP



Multipathing for IBM tape drives



Multipathing for IBM tape drives

- multipath-tools only cover disk storage
- lin_tape device driver provides multipathing for IBM tape drives
  - (IBMtape is the previous name for the same device driver)
- supported together with tape hardware
- does not cover data mirroring or drive failover, handled by
  - backup application
  - media management application
- lin_tape setup in /etc/modprobe.conf.local
    - options lin_tape alternate_pathing=1

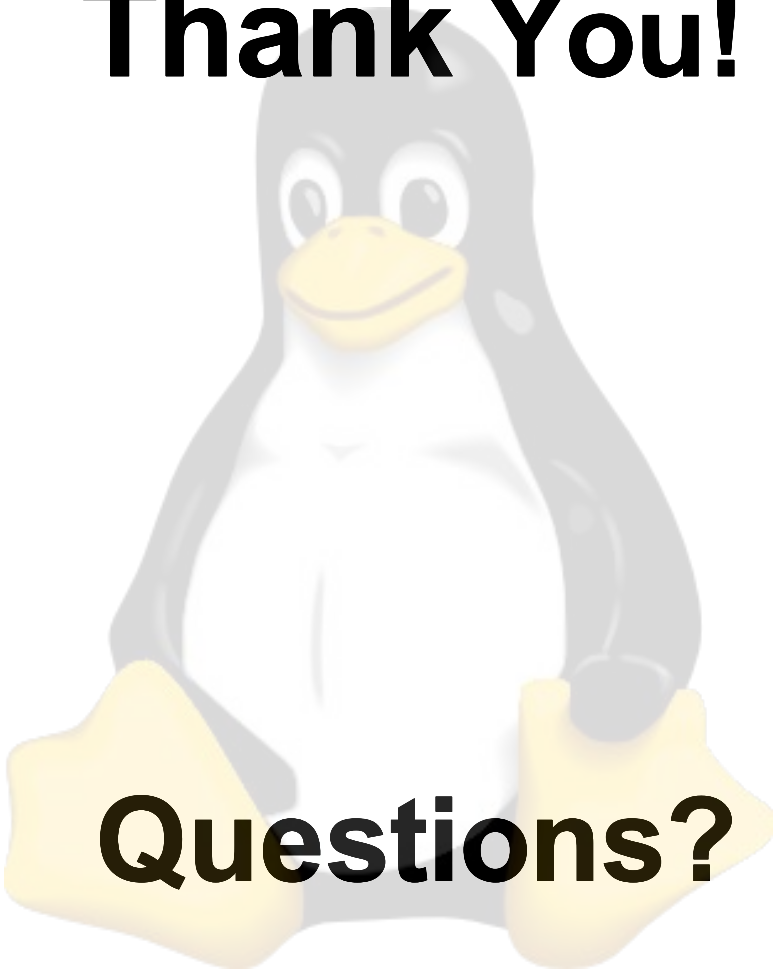
Summary

- multipathing is required for reliability
- multipath-tools are the standard solution for disks
- go with default settings, only do minimal changes
- SCSI device files are paths in multipathing
- basic setup is simple
- root filesystem on multipath device requires more effort
- multipathing for IBM tape drives available

Resources

- Device-mapper Resource Page (link to Multipath bug tracking)
  http://sources.redhat.com/dm/
- Device-mapper and LVM2 Wiki
  http://sources.redhat.com/lvm2/wiki/MultipathUsageGuide
- multipath tools FAQ
  http://git.kernel.org/?p=linux/storage/multipath-tools/.git;a=blob;f=FAQ
- How to setup / use multipathing on SLES
  http://support.novell.com/techcenter/sdb/en/2005/04/sles_multipathing.html
- Enabling root-on-multipath for SLES9 on zSeries
  http://linuxvm.org/Info/HOWTOs/root-on-multipath.html
- Redhat: Using Device-Mapper Multipath
  http://www.redhat.com/docs/manuals/enterprise/RHEL-5-manual/en-US/RHEL510/DM_Multipath/
- IBMtape/lin_tape driver and documentation
  ftp://ftp.software.ibm.com/storage/devdrvr/
- multipath-tools
  http://christophe.varoqui.free.fr/

Thank You!



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