LVM2 – data recovery

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Linux IO storage stack

- **[VFS]**
  filesystem
- **[volumes]**
  MD / LVM / LUKS / MPATH ...
- **[partitions]**
  legacy partition table
- **driver / IO scheduler**
  block device layer, iSCSI, ...
- **HW**

recovery
from the bottom up

(also benchmark and optimize performance this way)

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Common storage problems

- **Storage failures**
  - missing disk (cable, power, network – iSCSI)
  - bad sectors
  - intermittent HW failures
- **Accidental changes**
- **Overwritten metadata**
- **Bugs**
  - firmware
  - drivers
  - volume manager
  - filesystem

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Planning storage (failures)

- **Failures are inevitable**
- **Losing data - problem?**
  - redundancy (RAID, replication)
  - backups (RAID is NOT a backup)
- **TEST all changes first**
  - most problems can be solved without data loss
  - **data loss is very often caused by operator error when trying to "fix" the problem**

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Houston, we have a problem...

- **Don't panic!**
- **Think, try to understand the problem.**
  read manual, error messages, logs, …
- **Don't make changes before the problem is understood.**
- **Backup.**
- **Test recovery strategy.**
- **Seek advice.**
  paid support, mailing list, IRC

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HW failures – intermittent / permanent

- **Disks, cables, connectors, power**
- **Firmware bugs**
- **Operator error (again)**
  - wrong cable connection

  1) Fix HW
  2) recover data
- **Bad sectors – use binary backups**
  - dd, dd_rescue, ...

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Driver & disk partition problems

- **Driver / kernel version**
  - what changed – an update?
  - which version works, which not
- **Legacy partitions**
  - fdisk, parted – legacy partition table, GPT
  - partprobe – refresh in-kernel metadata
  - Gpart – guess & recover partition table
- **Check device sizes**
  - blockdev
  - fdisk / parted
  - sysfs

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MD / LUKS / multipath – some pointers

- **MD – multiple device (RAID)**
  - metadata, configuration
  - mdadm, mdadm.conf
  - cat /proc/mdstat, sysfs
- **LUKS – disk encryption**
  - cryptsetup luksDump, status
- **Multipath**
  - multipath -ll, multipath.conf

...

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Volume management - metadata

- **Metadata – "how to construct device"**

- **Where are metadata stored?**
  - **on-disk** (in first or last sectors)
  - **in configuration file**

  - **MD** – on-disk, persistent superblock, handled in kernel
  - **LVM2, LUKS** – on disk, handled in userspace
  - **multipath** – multipath.conf, userspace daemon

- **Recover metadata then data**

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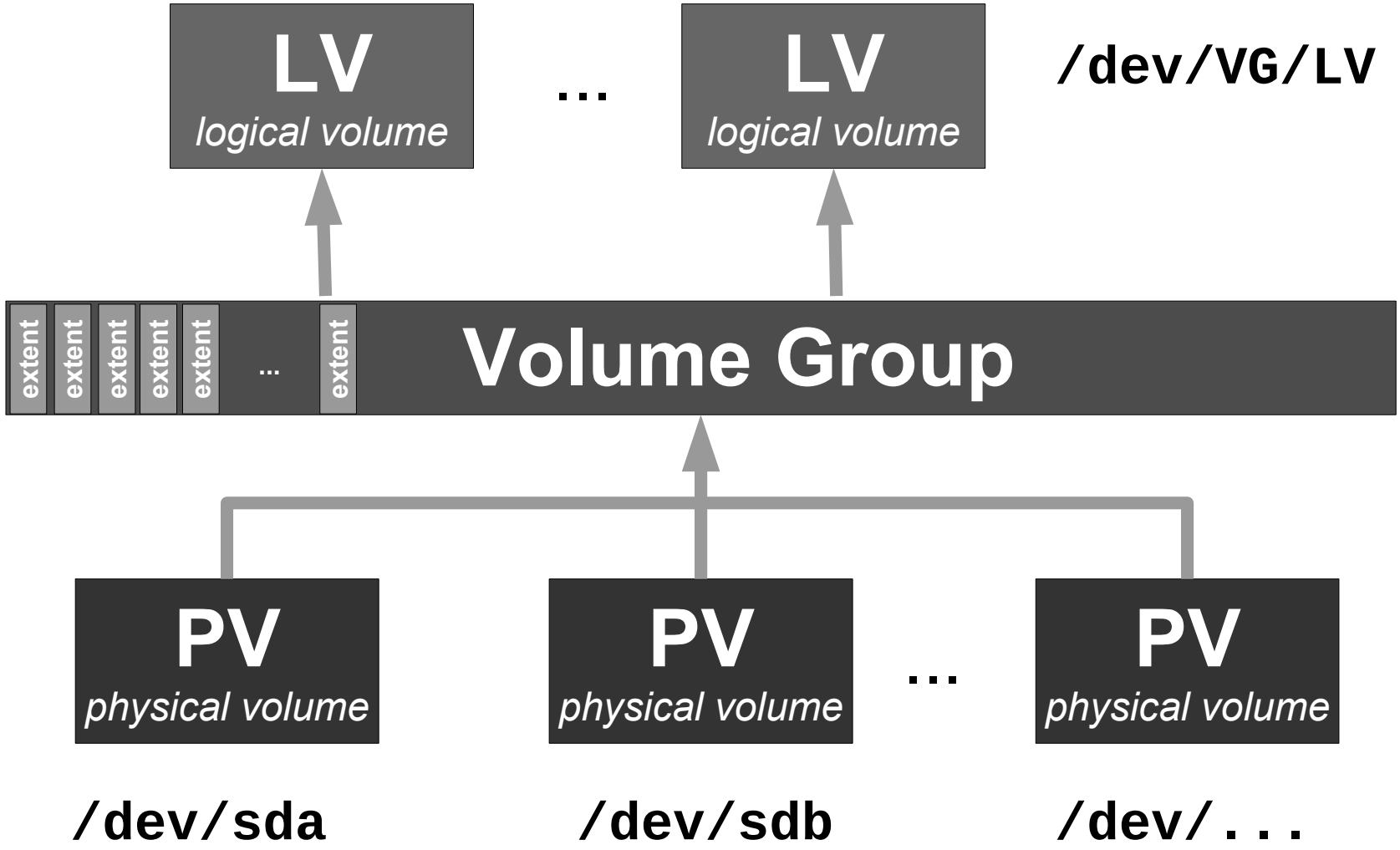
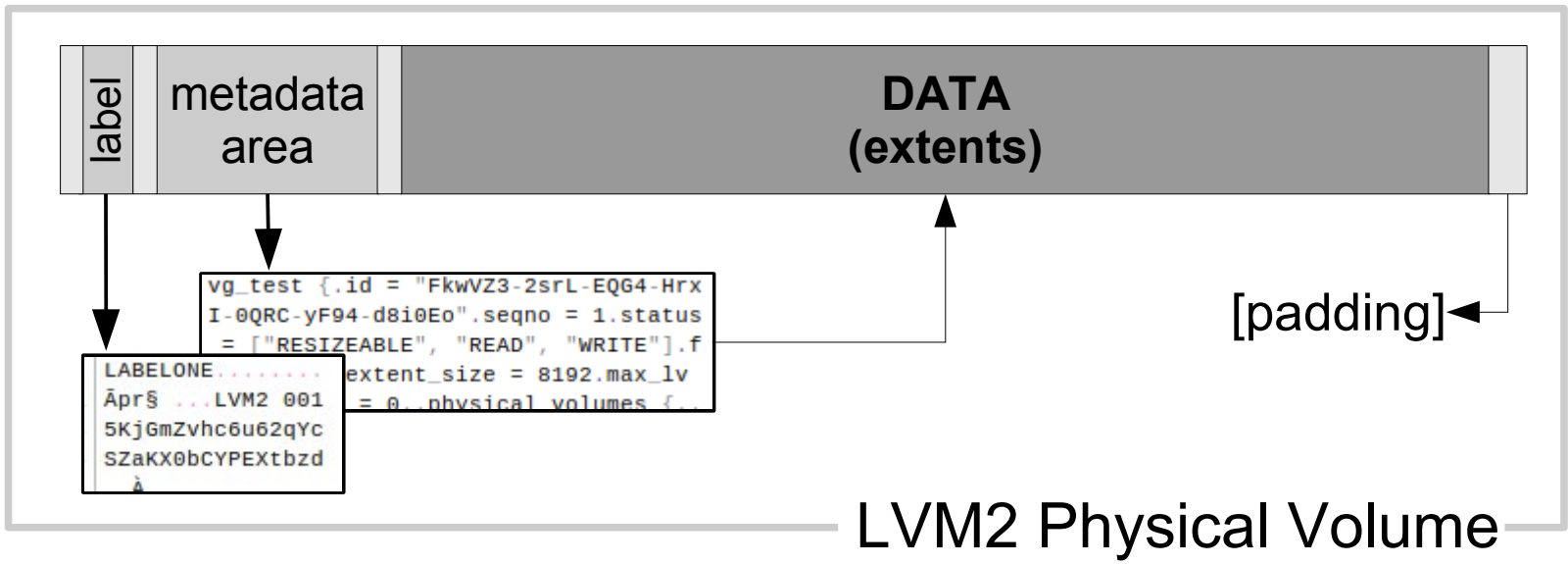
LVM2 - overview



LVM2 – on-disk PV format

- **Label**
  - 1 sector: signature, PV UUID, metadata area position
- **Metadata Area**
  - 1 sector: **metadata area header** – pointer to metadata
  - **circular buffer, text format** (at least 2 versions of metadata)
  - **atomic update** – 1) write new version 2) update pointer
  - **SEQNO** – sequential number
  - checksum, redundancy, autorepair



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LVM2 – text metadata example

```
creation_time = …
description = "Created *after* executing … "
...
vg_test {
        id = "xxxxxx-xxxx-xxxx-xxxx-xxxx-xxxx-xxxxxx"
        seqno = 25
        ...
        physical_volumes {
           pv0 {
                 id = "xxxxxx-xxxx-xxxx-xxxx-xxxx-xx...
                 device = "/dev/sdb1"  # Hint only
                 ...
                 pe_start = 384
                 pe_count = 50   # 200 Megabytes }
           pv1 { ... }
        }
        logical_volumes {
           lv1 {
                    id = "xxxxxx-xxxx-xxxx-xxxx-xx...
                    ...
```

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Metadata backup

- **Archive & backup in /etc/lvm**
- **vgcfgbackup, vgcfgrestore**
- **Partial mode**
  - e.g. vgchange --partial
- **Test mode**
  - no metadata updates
  - --test
- **LVM2 & system info / debug**
  - lvmdump
  - -vvvv (all commands)

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Example: [1/6] missing PV

Rescan all devices on system

```
# vgscan
  Reading all physical volumes.  This may take a while...
  Couldn't find device with uuid 'DHmMDP-bqQy-TalG-2GLa-sh6o-fyVW-3XQ3gp'.
  Found volume group "vg_test" using metadata type lvm2
```

Let's check what is on the missing device:

```
# pvs -o +uuid
  Couldn't find device with uuid 'DhmMDP-bqQy-TalG-2GLa-sh6o-fyVW-3XQ3gp'.
  PV             VG      Fmt  Attr PSize   PFree PV UUID
  /dev/sdb       vg_test lvm2 a-   200.00m    0  5KjGmZ-vhc6-u62q-YcSZ-aKX0-bCYP-EXtbzd
  unknown device vg_test lvm2 a-   200.00m    0  DHmMDP-bqQy-TalG-2GLa-sh6o-fyVW-3XQ3gp
```

```
# lvs -o +devices
  Couldn't find device with uuid 'DHmMDP-bqQy-TalG-2GLa-sh6o-fyVW-3XQ3gp'.
  LV   VG      Attr   LSize   Devices
  lv1  vg_test -wi--- 100.00m /dev/sdb(0)
  lv2  vg_test -wi--- 100.00m unknown device(0)
  lv3  vg_test -wi--- 200.00m /dev/sdb(25)
  lv3  vg_test -wi--- 200.00m unknown device(25)
```

Resume: lv1 is OK, lv2 is lost, lv3 – half is lost.

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Example: [2/6] missing PV

You can activate only full available LVs now.

```
# vgchange -a y vg_test
  Couldn't find device with uuid 'DHmMDP-bqQy-TalG-2GLa-sh6o-fyVW-3XQ3gp'.
  Refusing activation of partial LV lv2. Use --partial to override.
  Refusing activation of partial LV lv3. Use --partial to override.
  1 logical volume(s) in volume group "vg_test" now active
```

- for --partial, **missing parts are replaced** by device specified in

  /etc/lvm.conf: missing_stripe_filler = "error"

- default is error (returns IO error on access)

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Example: [3/6] missing PV

Let's try to recover at least something from lv3.

Prepare block "zero" device

```
# dmsetup create zero_missing --table "0 10000000 zero"

   missing_stripe_filler = "/dev/mapper/zero_missing"

# vgchange -a y vg_test --partial
  ...
  3 logical volume(s) in volume group "vg_test" now active
```

Always copy volume to another disk,
"zero" is replacement, not real disk – writes are ignored.

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Example: [4/6] missing PV

Remove all LVs on missing disk.

```
# vgreduce --removemissing vg_test
  Couldn't find device with uuid 'DHmMDP-bqQy-TalG-2GLa-sh6o-fyVW-3XQ3gp'.
  WARNING: Partial LV lv2 needs to be repaired or removed.
  WARNING: Partial LV lv3 needs to be repaired or removed.
  WARNING: There are still partial LVs in VG vg_test.
  To remove them unconditionally use: vgreduce --removemissing --force.
  Proceeding to remove empty missing PVs.

# vgreduce --removemissing vg_test --force
  Couldn't find device with uuid 'DhmMDP-bqQy-TalG-2GLa-sh6o-fyVW-3XQ3gp'.
  ...
  Wrote out consistent volume group vg_test

# pvs
  PV         VG      Fmt  Attr PSize   PFree
  /dev/sdb   vg_test lvm2 a-   200.00m 100.00m

# lvs -o +devices
  LV   VG      Attr   LSize   Devices
  lv1  vg_test -wi--- 100.00m /dev/sdb(0)
```

Done.

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Example: [5/6] missing PV

And now ... something completely different.

"operator error" - old device magically reappears!

```
# vgscan
  Reading all physical volumes.  This may take a while...
  WARNING: Inconsistent metadata found for VG vg_test - updating to use version 18
  Removing PV /dev/sdc (DHmMDP-bqQy-TalG-2GLa-sh6o-fyVW-3XQ3gp) that no longer belongs
  to VG vg_test
  Found volume group "vg_test" using metadata type lvm2

# pvs
  PV         VG      Fmt  Attr PSize   PFree
  /dev/sdb   vg_test lvm2 a-   200.00m 100.00m
  /dev/sdc           lvm2 --   204.00m 204.00m
```

Fixed automagically – SEQNO 18 – new metadata version.

Example: [6/6] missing PV

Recover the old metadata from backup.

```
# vgcfgrestore -f /etc/lvm/archive/vg_test_01564.vg vg_test
  Cannot restore Volume Group vg_test with 1 PVs marked as missing.
  Restore failed.
```

Device marked 'missing' – remove flag manually.
Edit the backup file:

```
 ...
pv1 {
        id = "DHmMDP-bqQy-TalG-2GLa-sh6o-fyVW-3XQ3gp"
        device = "unknown device"

        flags = ["MISSING"]
 ...
```

```
# vgcfgrestore -f vg_test_edited.vg vg_test
  Restored volume group vg_test
```

Done.

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Example: [1/3] overwritten PV header

Original system configuration (live example)

```
# pvs
  PV         VG         Fmt  Attr PSize PFree
  /dev/sda2  system_vg lvm2 a-   7.89G    0
  /dev/sdb   system_vg lvm2 a-   8.00G    0

# lvs
  LV   VG         Attr   LSize
  root system_vg -wi-ao 13.86G
  swap system_vg -wi-ao  2.04G
```

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Example: [2/3] overwritten PV header

```
  Found volume group "system_vg" using metadata type lvm2
Activating logical volumes
  Couldn't find device with uuid 'x8NH50-2CTA-LCHV-BSUF-ebJP-9531-j8d47f'.
  Couldn't find device with uuid 'x8NH50-2CTA-LCHV-BSUF-ebJP-9531-j8d47f'.
  Refusing activation of partial LV root. Use --partial to override.
  Couldn't find device with uuid 'x8NH50-2CTA-LCHV-BSUF-ebJP-9531-j8d47f'.
  1 logical volume(s) in volume group "system_vg" now active
Trying to resume from /dev/system_vg/swap
No suspend signature on swap, not resuming.
Creating root device.
Mounting root filesystem.
mount: could not find filesystem '/dev/root'
Setting up other filesystems.
Setting up new root fs
setuproot: moving /dev failed: No such file or directory
no fstab.sys, mounting internal defaults
setuproot: error mounting /proc: No such file or directory
setuproot: error mounting /sys: No such file or directory
Switching to new root and running init.
unmounting old /dev
unmounting old /proc
unmounting old /sys
switchroot: mount failed: No such file or directory
Kernel panic - not syncing: Attempted to kill init!
 _
```

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Example: [3/3] overwritten PV header

Rescue boot from DVD (log from live example)

1) Check the system state, volumes, partitions...

```
# lvm pvs
# lvm lvs -o name,devices
# lvm pvs -a
# fdisk -l /dev/sdb
# lvm pvs /dev/sdb1
# lvm pvs /dev/sdb
```

Resume: there is new partition table on /dev/sdb and new swap partition on sdb1
but correct lvm2 label on sdb is still present (but maybe metadata corrupted).
Task: remove partition table and recreate lvm metadata.

2) recover LVM metadata

```
# fdisk /dev/sdb
# lvm vgcfgbackup -f /vg system_vg
# (remove MISSING flag from /vg file)
# lvm pvcreate -u <missing PV UUID> --restorefile /vg system_vg
# lvm vgcfgrestore -f /vg system_vg

# lvm vgchange -a y system_vg
# fsck -f -C /dev/system_vg/root
...
```

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Some common problems

- Duplicated volume UUID
- Checksum error
- pvmove & suspended devices
- udev
- initrd missing drivers

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Storage performance

IO scheduler

CFQ / deadline / noop
per device / default (elevator= …)
CFQ for desktop vs avoid for NFS, iSCSI, KVM
SSD – no seek time (noop, deadline)

Partitions

offset alignment (for SSD, fdisk -u to use sector units)
Beware of magic 63 sector offset (legacy DOS)

MD & LVM

MD chunk size aligned to LVM data offset

Readahead

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LVM2 storage performance

Most values automatically detected now

- automatic alignment for MD device
- automatic readahead by default
- detects IO topology layer (kernel > 2.6.31)

Large VG (many PVs)

- only several metadata areas needed
- pvcreate –metadatacopies 0

Read more in Red Hat Summit presentation
by Mike Snitzer
https://www.redhat.com/f/pdf/summit/msnitzer_1120_optimize_storage.pdf