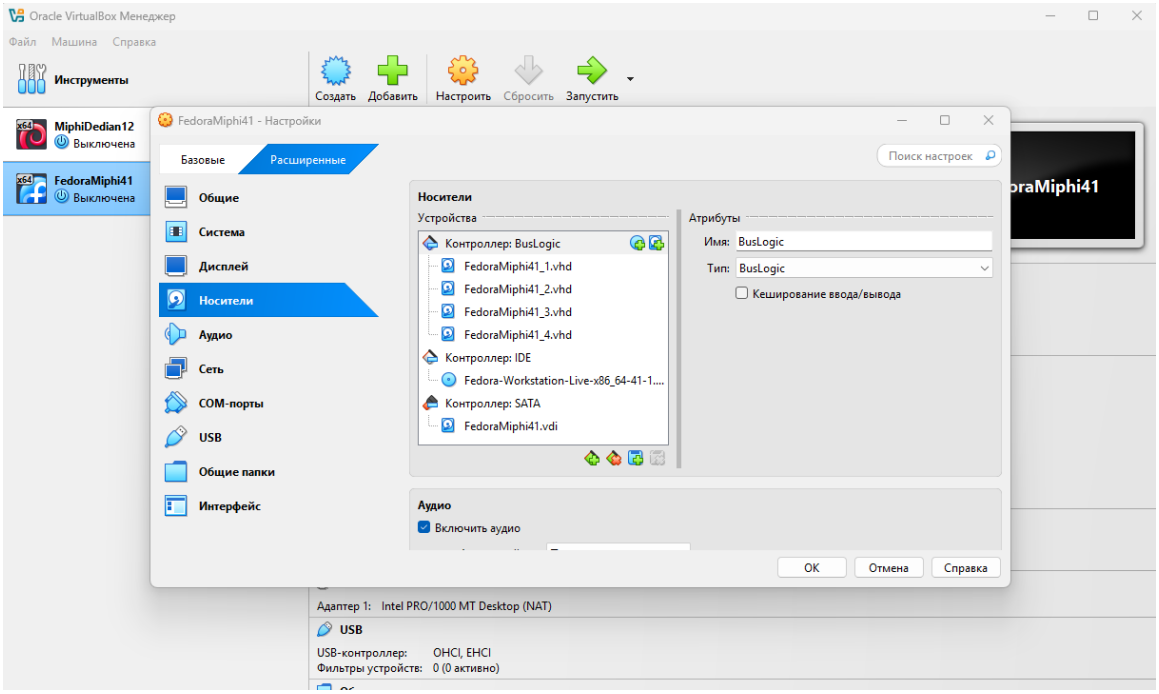
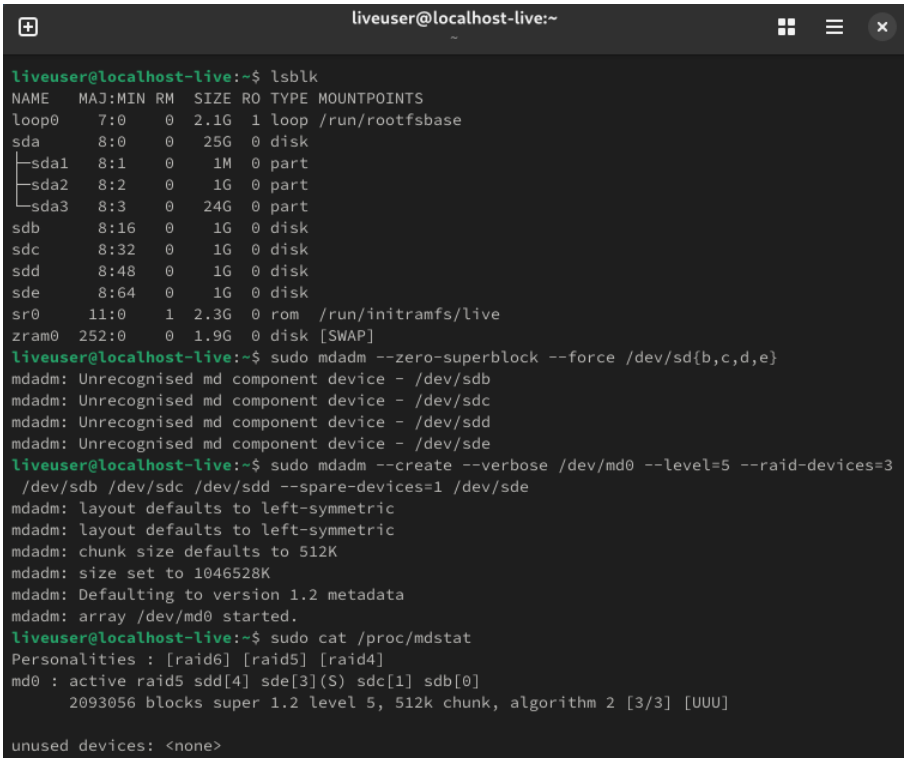
LVM+RAID

1. Настройка RAID

- *Создайте RAID-массив с использованием технологии RAID 5 (или другой подходящей конфигурации) на трех физических дисках.*





```
liveuser@localhost-live:~$ sudo mdadm --detail /dev/md0
/dev/md0:
           Version : 1.2
     Creation Time : Sun Jan  5 01:10:17 2025
        Raid Level : raid5
        Array Size : 2093056 (2044.00 MiB 2143.29 MB)
     Used Dev Size : 1046528 (1022.00 MiB 1071.64 MB)
      Raid Devices : 3
     Total Devices : 4
       Persistence : Superblock is persistent

       Update Time : Sun Jan  5 01:10:30 2025
             State : clean
    Active Devices : 3
   Working Devices : 4
    Failed Devices : 0
     Spare Devices : 1

            Layout : left-symmetric
        Chunk Size : 512K

Consistency Policy : resync

              Name : localhost-live:0  (local to host localhost-live)
              UUID : 02ce2b60:8ed5b92d:53258b0a:7f01c9fc
            Events : 18

    Number   Major   Minor   RaidDevice State
       0       8       16        0      active sync   /dev/sdb
       1       8       32        1      active sync   /dev/sdc
       4       8       48        2      active sync   /dev/sdd

       3       8       64        -      spare   /dev/sde
```

2. Настройка LVM

- *Создайте физические тома на RAID-массиве.*

```
liveuser@localhost-live:~$ sudo pvcreate /dev/md0
  Can't initialize physical volume "/dev/md0" of volume group "myvg_storage0" without -ff
  /dev/md0: physical volume not initialized.
liveuser@localhost-live:~$ sudo pvdisplay
  WARNING: Device /dev/md0 has size of 4186112 sectors which is smaller than corresponding P
V size of 6279168 sectors. Was device resized?
  WARNING: One or more devices used as PVs in VG myvg_storage0 have changed sizes.
  --- Physical volume ---
  PV Name               /dev/md0
  VG Name               myvg_storage0
  PV Size               2.99 GiB / not usable 2.00 MiB
  Allocatable           yes
  PE Size               4.00 MiB
  Total PE              766
  Free PE               766
  Allocated PE          0
  PV UUID               1o73wr-OHD3-jZJR-OW39-lEOE-VVd8-PpRWk1
```

- *Создайте группу томов (VG) на основе физических томов.*

```
liveuser@localhost-live:~$ sudo vgcreate vg0_storage /dev/md0
  Creating devices file /etc/lvm/devices/system.devices
  Volume group "vg0_storage" successfully created
liveuser@localhost-live:~$ sudo vgdisplay
  --- Volume group ---
  VG Name               vg0_storage
  System ID
  Format                lvm2
  Metadata Areas        1
  Metadata Sequence No  1
  VG Access             read/write
  VG Status             resizable
  MAX LV                0
  Cur LV                0
  Open LV               0
  Max PV                0
  Cur PV                1
  Act PV                1
  VG Size               1.99 GiB
  PE Size               4.00 MiB
  Total PE              510
  Alloc PE / Size       0 / 0
  Free  PE / Size       510 / 1.99 GiB
  VG UUID               BqP8GB-JhoK-zzUP-h6nA-M9Ad-iYE6-UA6T3C
```

- *Создайте логический том (LV) на основе группы томов.*

```
liveuser@localhost-live:~$ sudo lvcreate -L 2040M -n lv0_files vg0_storage
  Logical volume "lv0_files" created.
liveuser@localhost-live:~$ sudo lvdisplay
  --- Logical volume ---
  LV Path                /dev/vg0_storage/lv0_files
  LV Name                lv0_files
  VG Name                vg0_storage
  LV UUID                ylTrHo-UbBP-2rVA-2idZ-664z-EWH7-lsngEF
  LV Write Access        read/write
  LV Creation host, time localhost-live, 2025-01-05 01:57:50 -0500
  LV Status              available
  # open                 0
  LV Size                1.99 GiB
  Current LE             510
  Segments               1
  Allocation             inherit
  Read ahead sectors     auto
  - currently set to     4096
  Block device           253:0
```

3. Форматирование и монтирование файловой системы

- *Отформатируйте логический том в файловую систему ext4.*

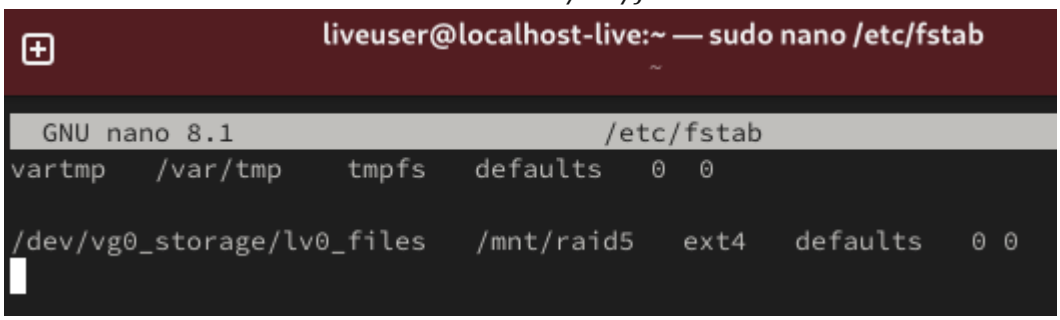
```
liveuser@localhost-live:~$ sudo mkfs.ext4 /dev/vg0_storage/lv0_files
mke2fs 1.47.1 (20-May-2024)
Creating filesystem with 522240 4k blocks and 130560 inodes
Filesystem UUID: 6916b078-b477-4e85-a0e3-a729edd98fcd
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912

Allocating group tables: done
Writing inode tables: done
Creating journal (8192 blocks): done
Writing superblocks and filesystem accounting information: done
```

- *Смонтируйте файловую систему в директорию.*

```
liveuser@localhost-live:~$ sudo mkdir /mnt/raid5
liveuser@localhost-live:~$ sudo mount /dev/vg0_storage/lv0_files /mnt/raid5
liveuser@localhost-live:~$ df -h
Filesystem                      Size  Used Avail Use% Mounted on
LiveOS_rootfs                   393M   24M  369M   6% /
devtmpfs                        4.0M     0  4.0M   0% /dev
tmpfs                           981M   92K  980M   1% /dev/shm
tmpfs                           393M   24M  369M   6% /run
/dev/sr0                        2.3G  2.3G     0 100% /run/initramfs/live
/dev/loop0                      2.2G  2.2G     0 100% /run/rootfsbase
tmpfs                           1.0M     0  1.0M   0% /run/credentials/systemd-journald.service
tmpfs                           1.0M     0  1.0M   0% /run/credentials/systemd-network-generator.service
tmpfs                           1.0M     0  1.0M   0% /run/credentials/systemd-udev-load-credentials.service
tmpfs                           1.0M     0  1.0M   0% /run/credentials/systemd-tmpfiles-setup-dev-early.service
tmpfs                           1.0M     0  1.0M   0% /run/credentials/systemd-sysctl.service
tmpfs                           1.0M     0  1.0M   0% /run/credentials/systemd-tmpfiles-setup-dev.service
tmpfs                           981M  8.0K  981M   1% /tmp
vartmp                          981M     0  981M   0% /var/tmp
tmpfs                           1.0M     0  1.0M   0% /run/credentials/systemd-tmpfiles-setup.service
tmpfs                           1.0M     0  1.0M   0% /run/credentials/systemd-resolved.service
tmpfs                           1.0M     0  1.0M   0% /run/credentials/systemd-vconsole-setup.service
tmpfs                           196M  184K  196M   1% /run/user/1000
/dev/mapper/vg0_storage-lv0_files  2.0G  532K  1.9G   1% /mnt/raid5
```

для автоматического монтирования при загрузке системы, надо добавить запись в /etc/fstab:



```
liveuser@localhost-live:~$ lsblk
NAME                      MAJ:MIN RM  SIZE RO TYPE  MOUNTPOINTS
loop0                       7:0    0  2.1G  1 loop  /run/rootfsbase
sda                         8:0    0   25G  0 disk
├─sda1                      8:1    0    1M  0 part
├─sda2                      8:2    0    1G  0 part
└─sda3                      8:3    0   24G  0 part
sdb                         8:16   0    1G  0 disk
└─md0                       9:0    0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm   /mnt/raid5
sdc                         8:32   0    1G  0 disk
└─md0                       9:0    0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm   /mnt/raid5
sdd                         8:48   0    1G  0 disk
└─md0                       9:0    0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm   /mnt/raid5
sde                         8:64   0    1G  0 disk
└─md0                       9:0    0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm   /mnt/raid5
sr0                        11:0    1  2.3G  0 rom   /run/initramfs/live
zram0                     252:0    0  1.9G  0 disk  [SWAP]
```

4. Эмуляция отказа диска

- *Эмулируйте отказ одного из дисков в RAID-массиве.*

```
liveuser@localhost-live:~$ sudo chmod 0755 /mnt/raid5
liveuser@localhost-live:~$ sudo nano /mnt/raid5/test.txt
liveuser@localhost-live:~$ ls -la /mnt/raid5/
total 24
drwxr-xr-x. 3 root root  4096 Jan  5 03:50 .
drwxr-xr-x. 1 root root    60 Jan  5 02:06 ..
drwx------. 2 root root 16384 Jan  5 02:02 lost+found
-rw-r--r--. 1 root root    11 Jan  5 03:51 test.txt
liveuser@localhost-live:~$ cat /mnt/raid5/test.txt
crash test
```

```
liveuser@localhost-live:~$ sudo mdadm --manage /dev/md0 --fail /dev/sdd
mdadm: set /dev/sdd faulty in /dev/md0
liveuser@localhost-live:~$ cat /proc/mdstat
Personalities : [raid6] [raid5] [raid4]
md0 : active raid5 sdd[4](F) sde[3] sdc[1] sdb[0]
      2093056 blocks super 1.2 level 5, 512k chunk, algorithm 2 [3/3] [UUU]

unused devices: <none>
```

- *Проверьте, что система продолжает работать и доступ к данным сохраняется.*

```
liveuser@localhost-live:~$ sudo mdadm --detail /dev/md0
/dev/md0:
           Version : 1.2
     Creation Time : Sun Jan  5 01:10:17 2025
        Raid Level : raid5
        Array Size : 2093056 (2044.00 MiB 2143.29 MB)
     Used Dev Size : 1046528 (1022.00 MiB 1071.64 MB)
      Raid Devices : 3
     Total Devices : 4
       Persistence : Superblock is persistent

       Update Time : Sun Jan  5 04:04:05 2025
             State : clean
    Active Devices : 3
   Working Devices : 3
    Failed Devices : 1
     Spare Devices : 0

            Layout : left-symmetric
        Chunk Size : 512K

Consistency Policy : resync

              Name : localhost-live:0  (local to host localhost-live)
              UUID : 02ce2b60:8ed5b92d:53258b0a:7f01c9fc
            Events : 37

    Number   Major   Minor   RaidDevice State
       0       8       16        0      active sync   /dev/sdb
       1       8       32        1      active sync   /dev/sdc
       3       8       64        2      active sync   /dev/sde

       4       8       48        -      faulty   /dev/sdd
liveuser@localhost-live:~$ cat /mnt/raid5/test.txt
crash test
```

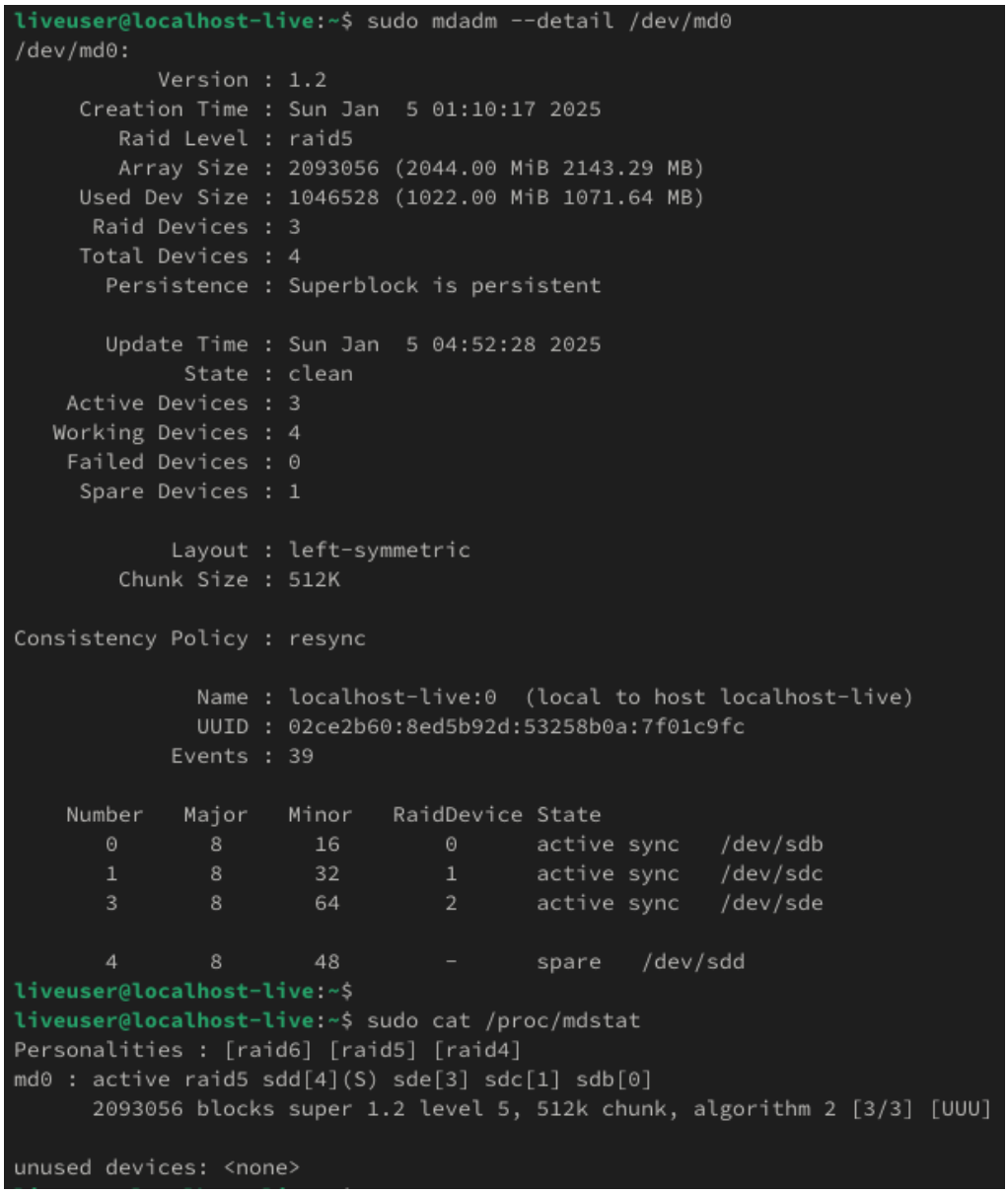
5. Восстановление и проверка

- *Восстановите отказавший диск и добавьте его обратно в RAID-массив.*

```
liveuser@localhost-live:~$ sudo mdadm --remove /dev/md0 /dev/sdd
mdadm: hot removed /dev/sdd from /dev/md0
```

```
liveuser@localhost-live:~$ sudo mdadm /dev/md0 --add /dev/sdd
mdadm: added /dev/sdd
```

- *Проверьте процесс восстановления и убедитесь, что данные корректно синхронизированы.*

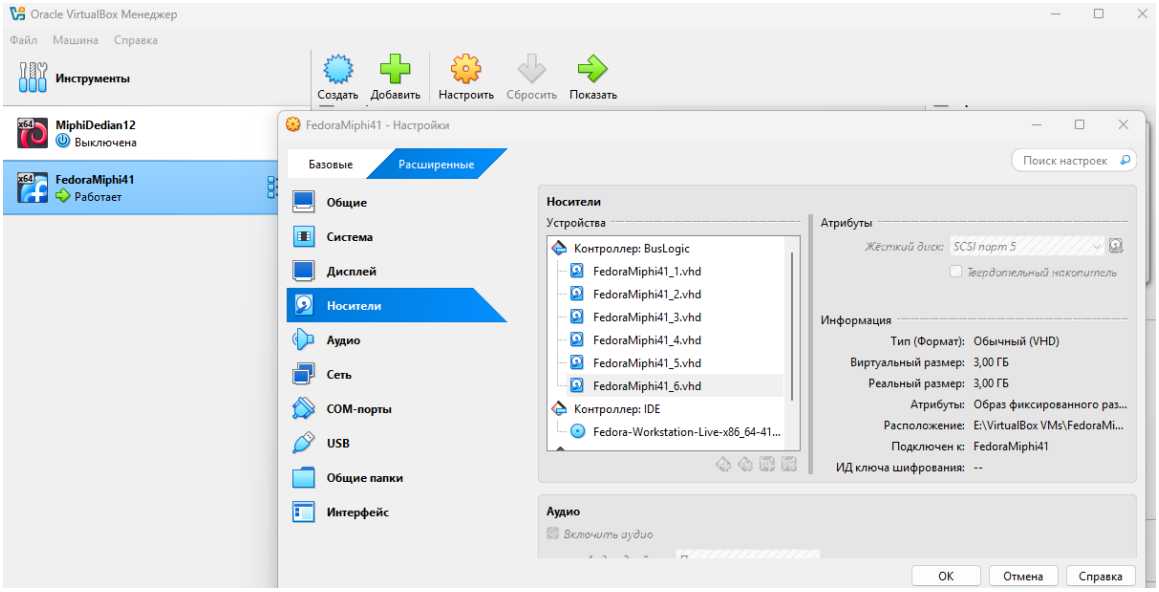


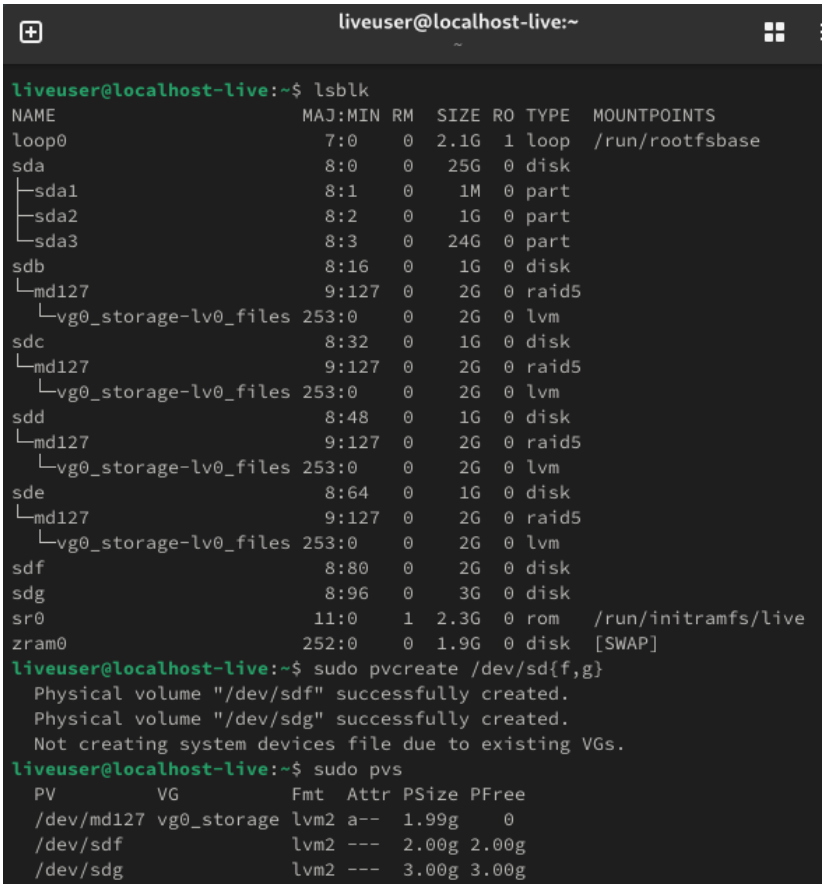
```
liveuser@localhost-live:~$ lsblk
NAME                      MAJ:MIN RM  SIZE RO TYPE  MOUNTPOINTS
loop0                       7:0    0  2.1G  1 loop  /run/rootfsbase
sda                         8:0    0   25G  0 disk
├─sda1                      8:1    0    1M  0 part
├─sda2                      8:2    0    1G  0 part
└─sda3                      8:3    0   24G  0 part
sdb                         8:16   0    1G  0 disk
└─md0                       9:0    0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm   /mnt/raid5
sdc                         8:32   0    1G  0 disk
└─md0                       9:0    0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm   /mnt/raid5
sdd                         8:48   0    1G  0 disk
└─md0                       9:0    0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm   /mnt/raid5
sde                         8:64   0    1G  0 disk
└─md0                       9:0    0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm   /mnt/raid5
sr0                        11:0    1  2.3G  0 rom   /run/initramfs/live
zram0                     252:0    0  1.9G  0 disk  [SWAP]
liveuser@localhost-live:~$
```

RAID+LVM

1. Настройка LVM:

- *Создайте физические тома на отдельных физических дисках (не обязательно использовать RAID на этом этапе).*





- *Создайте группу томов (VG) на основе физических томов.*

```
liveuser@localhost-live:~$ sudo vgcreate vg2_storage /dev/sd{f,g}
  Not creating system devices file due to existing VGs.
  Volume group "vg2_storage" successfully created
```

```
liveuser@localhost-live:~$ sudo vgs
  VG           #PV #LV #SN Attr   VSize VFree
  vg0_storage   1   1   0 wz--n- 1.99g    0
  vg2_storage   2   0   0 wz--n- 4.99g 4.99g
```

- *Создайте логический том (LV) на основе группы томов.*

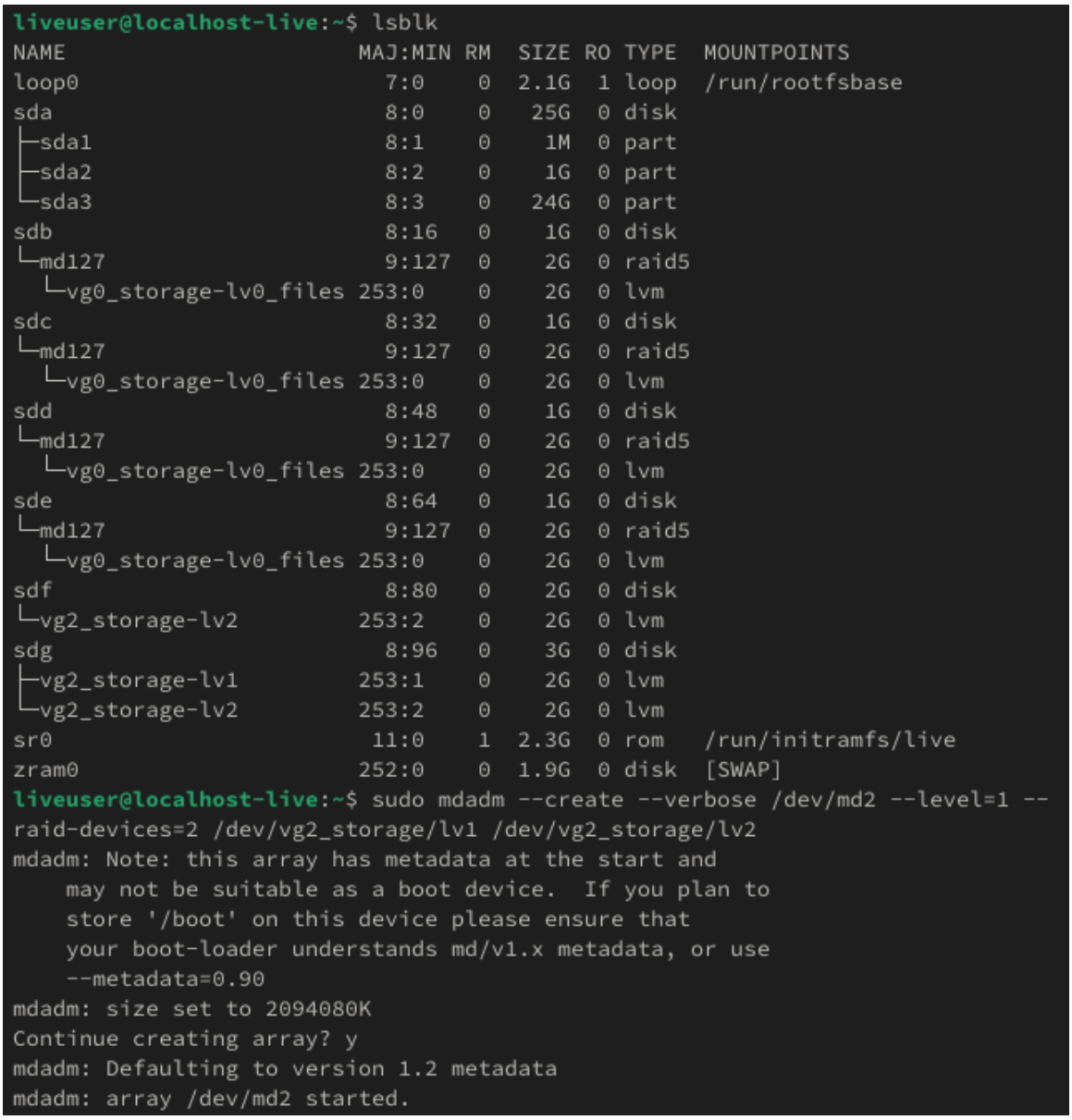
```
liveuser@localhost-live:~$ sudo lvcreate -L 2G -n lv1 vg2_storage
  Logical volume "lv1" created.
liveuser@localhost-live:~$ sudo lvcreate -L 2G -n lv2 vg2_storage
  Logical volume "lv2" created.
liveuser@localhost-live:~$ sudo lvs
  LV        VG          Attr       LSize Pool Origin Data%  Meta%  Move Log Cpy%
Sync Convert
  lv0_files vg0_storage -wi-a----- 1.99g

  lv1       vg2_storage -wi-a----- 2.00g

  lv2       vg2_storage -wi-a----- 2.00g
```

2. Настройка RAID

- *Создайте RAID-массив на основе логических томов (например, RAID 1 или RAID 5).*



```
liveuser@localhost-live:~$ lsblk
NAME                      MAJ:MIN RM  SIZE RO TYPE  MOUNTPOINTS
loop0                       7:0    0  2.1G  1 loop  /run/rootfsbase
sda                         8:0    0   25G  0 disk
├─sda1                      8:1    0    1M  0 part
├─sda2                      8:2    0    1G  0 part
└─sda3                      8:3    0   24G  0 part
sdb                         8:16   0    1G  0 disk
└─md127                     9:127  0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm
sdc                         8:32   0    1G  0 disk
└─md127                     9:127  0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm
sdd                         8:48   0    1G  0 disk
└─md127                     9:127  0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm
sde                         8:64   0    1G  0 disk
└─md127                     9:127  0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm
sdf                         8:80   0    2G  0 disk
└─vg2_storage-lv2         253:2    0    2G  0 lvm
sdg                         8:96   0    3G  0 disk
├─vg2_storage-lv1         253:1    0    2G  0 lvm
└─vg2_storage-lv2         253:2    0    2G  0 lvm
sr0                        11:0    1  2.3G  0 rom   /run/initramfs/live
zram0                     252:0    0  1.9G  0 disk  [SWAP]
liveuser@localhost-live:~$ sudo mdadm --create --verbose /dev/md2 --level=1 --
raid-devices=2 /dev/vg2_storage/lv1 /dev/vg2_storage/lv2
mdadm: Note: this array has metadata at the start and
    may not be suitable as a boot device.  If you plan to
    store '/boot' on this device please ensure that
    your boot-loader understands md/v1.x metadata, or use
    --metadata=0.90
mdadm: size set to 2094080K
Continue creating array? y
mdadm: Defaulting to version 1.2 metadata
mdadm: array /dev/md2 started.
```

- *Проверьте, что RAID-массив успешно создан и работает корректно.*

```
liveuser@localhost-live:~$ cat /proc/mdstat
Personalities : [raid6] [raid5] [raid4] [raid1]
md2 : active raid1 dm-2[1] dm-1[0]
      2094080 blocks super 1.2 [2/2] [UU]

md127 : active raid5 sdd[4](S) sde[3] sdb[0] sdc[1]
      2093056 blocks super 1.2 level 5, 512k chunk, algorithm 2 [3/3] [UUU]

unused devices: <none>
liveuser@localhost-live:~$ sudo mdadm --detail /dev/md2
/dev/md2:
           Version : 1.2
     Creation Time : Sun Jan  5 19:04:23 2025
        Raid Level : raid1
        Array Size : 2094080 (2045.00 MiB 2144.34 MB)
     Used Dev Size : 2094080 (2045.00 MiB 2144.34 MB)
      Raid Devices : 2
     Total Devices : 2
       Persistence : Superblock is persistent

       Update Time : Sun Jan  5 19:04:37 2025
             State : clean
    Active Devices : 2
   Working Devices : 2
    Failed Devices : 0
     Spare Devices : 0

Consistency Policy : resync

              Name : localhost-live:2  (local to host localhost-live)
              UUID : 554aae91:09e4c034:7a2d4e44:a8869275
            Events : 17

    Number   Major   Minor   RaidDevice State
       0     253        1        0      active sync   /dev/dm-1
       1     253        2        1      active sync   /dev/dm-2
```

3. Форматирование и монтирование файловой системы

- *Отформатируйте RAID-массив в файловую систему (например, ext4).*

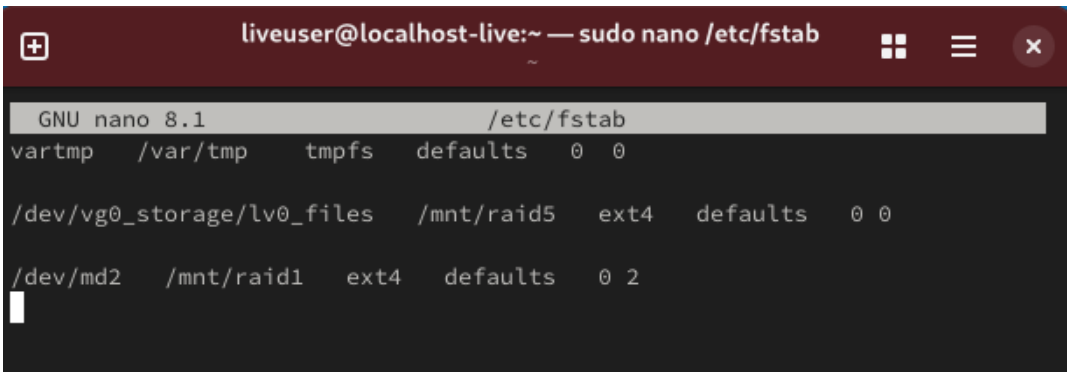
```
liveuser@localhost-live:~$ sudo mkfs.ext4 /dev/md2
mke2fs 1.47.1 (20-May-2024)
Creating filesystem with 523520 4k blocks and 131072 inodes
Filesystem UUID: d87578fe-c336-400b-afc7-07b89cc81928
Superblock backups stored on blocks:
        32768, 98304, 163840, 229376, 294912

Allocating group tables: done
Writing inode tables: done
Creating journal (8192 blocks): done
Writing superblocks and filesystem accounting information: done
```

- *Смонтируйте файловую систему в директорию (например, /mnt/data).*

```
liveuser@localhost-live:~$ sudo mkdir /mnt/raid1
liveuser@localhost-live:~$ sudo mount /dev/md2 /mnt/raid1
liveuser@localhost-live:~$ ls -la /mnt/raid1
total 20
drwxr-xr-x. 3 root root  4096 Jan  5 19:20 .
drwxr-xr-x. 1 root root    60 Jan  5 19:30 ..
drwx------. 2 root root 16384 Jan  5 19:20 lost+found
liveuser@localhost-live:~$ sudo chmod 0755 /mnt/raid1
liveuser@localhost-live:~$ sudo nano /mnt/raid1/test.txt
liveuser@localhost-live:~$ ls -la /mnt/raid1/
total 24
drwxr-xr-x. 3 root root  4096 Jan  5 19:34 .
drwxr-xr-x. 1 root root    60 Jan  5 19:30 ..
drwx------. 2 root root 16384 Jan  5 19:20 lost+found
-rw-r--r--. 1 root root    11 Jan  5 19:34 test.txt
```

```
liveuser@localhost-live:~$ cat /mnt/raid1/test.txt
crash test
```



4. Эмуляция отказа диска

- *Эмулируйте отказ одного из дисков в RAID-массиве.*

```
liveuser@localhost-live:~$ sudo mdadm --manage /dev/md2 --fail /dev/vg2_storage/lv1
mdadm: set /dev/vg2_storage/lv1 faulty in /dev/md2
liveuser@localhost-live:~$ cat /proc/mdstat
Personalities : [raid6] [raid5] [raid4] [raid1]
md2 : active raid1 dm-2[1] dm-1[0](F)
      2094080 blocks super 1.2 [2/1] [_U]

md127 : active raid5 sdd[4](S) sde[3] sdb[0] sdc[1]
      2093056 blocks super 1.2 level 5, 512k chunk, algorithm 2 [3/3] [UUU]

unused devices: <none>
```

- *Проверьте, что система продолжает работать и доступ к данным сохраняется.*

```
liveuser@localhost-live:~$ ls -la /mnt/raid1/
total 24
drwxr-xr-x. 3 root root  4096 Jan  5 19:34 .
drwxr-xr-x. 1 root root    60 Jan  5 19:30 ..
drwx------. 2 root root 16384 Jan  5 19:20 lost+found
-rw-r--r--. 1 root root    11 Jan  5 19:34 test.txt
liveuser@localhost-live:~$ cat /mnt/raid1/test.txt
crash test
```

5. Восстановление и проверка

- *Восстановите отказавший диск и добавьте его обратно в RAID-массив.*

```
liveuser@localhost-live:~$ sudo mdadm --remove /dev/md2 /dev/vg2_storage/lv1
mdadm: hot removed /dev/vg2_storage/lv1 from /dev/md2
liveuser@localhost-live:~$ sudo mdadm /dev/md2 --add /dev/vg2_storage/lv1
mdadm: added /dev/vg2_storage/lv1
liveuser@localhost-live:~$ cat /proc/mdstat
Personalities : [raid6] [raid5] [raid4] [raid1]
md2 : active raid1 dm-1[2] dm-2[1]
      2094080 blocks super 1.2 [2/2] [UU]

md127 : active raid5 sdd[4](S) sde[3] sdb[0] sdc[1]
      2093056 blocks super 1.2 level 5, 512k chunk, algorithm 2 [3/3] [UUU]

unused devices: <none>
```

- *Проверьте процесс восстановления и убедитесь, что данные корректно синхронизированы.*

```
liveuser@localhost-live:~$ sudo mdadm --detail /dev/md2
/dev/md2:
           Version : 1.2
     Creation Time : Sun Jan  5 19:04:23 2025
        Raid Level : raid1
        Array Size : 2094080 (2045.00 MiB 2144.34 MB)
     Used Dev Size : 2094080 (2045.00 MiB 2144.34 MB)
      Raid Devices : 2
     Total Devices : 2
       Persistence : Superblock is persistent

       Update Time : Sun Jan  5 20:36:22 2025
             State : clean
    Active Devices : 2
   Working Devices : 2
    Failed Devices : 0
     Spare Devices : 0

Consistency Policy : resync

              Name : localhost-live:2  (local to host localhost-live)
              UUID : 554aae91:09e4c034:7a2d4e44:a8869275
            Events : 39

    Number   Major   Minor   RaidDevice State
       2     253        1        0      active sync   /dev/dm-1
       1     253        2        1      active sync   /dev/dm-2
```

```
liveuser@localhost-live:~$ lsblk
NAME                      MAJ:MIN RM  SIZE RO TYPE  MOUNTPOINTS
loop0                       7:0    0  2.1G  1 loop  /run/rootfsbase
sda                         8:0    0   25G  0 disk
├─sda1                      8:1    0    1M  0 part
├─sda2                      8:2    0    1G  0 part
└─sda3                      8:3    0   24G  0 part
sdb                         8:16   0    1G  0 disk
└─md127                     9:127  0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm
sdc                         8:32   0    1G  0 disk
└─md127                     9:127  0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm
sdd                         8:48   0    1G  0 disk
└─md127                     9:127  0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm
sde                         8:64   0    1G  0 disk
└─md127                     9:127  0    2G  0 raid5
  └─vg0_storage-lv0_files 253:0    0    2G  0 lvm
sdf                         8:80   0    2G  0 disk
└─vg2_storage-lv2         253:2    0    2G  0 lvm
  └─md2                     9:2    0    2G  0 raid1 /mnt/raid1
sdg                         8:96   0    3G  0 disk
├─vg2_storage-lv1         253:1    0    2G  0 lvm
│ └─md2                     9:2    0    2G  0 raid1 /mnt/raid1
└─vg2_storage-lv2         253:2    0    2G  0 lvm
  └─md2                     9:2    0    2G  0 raid1 /mnt/raid1
sr0                        11:0    1  2.3G  0 rom   /run/initramfs/live
zram0                     252:0    0  1.9G  0 disk  [SWAP]
```