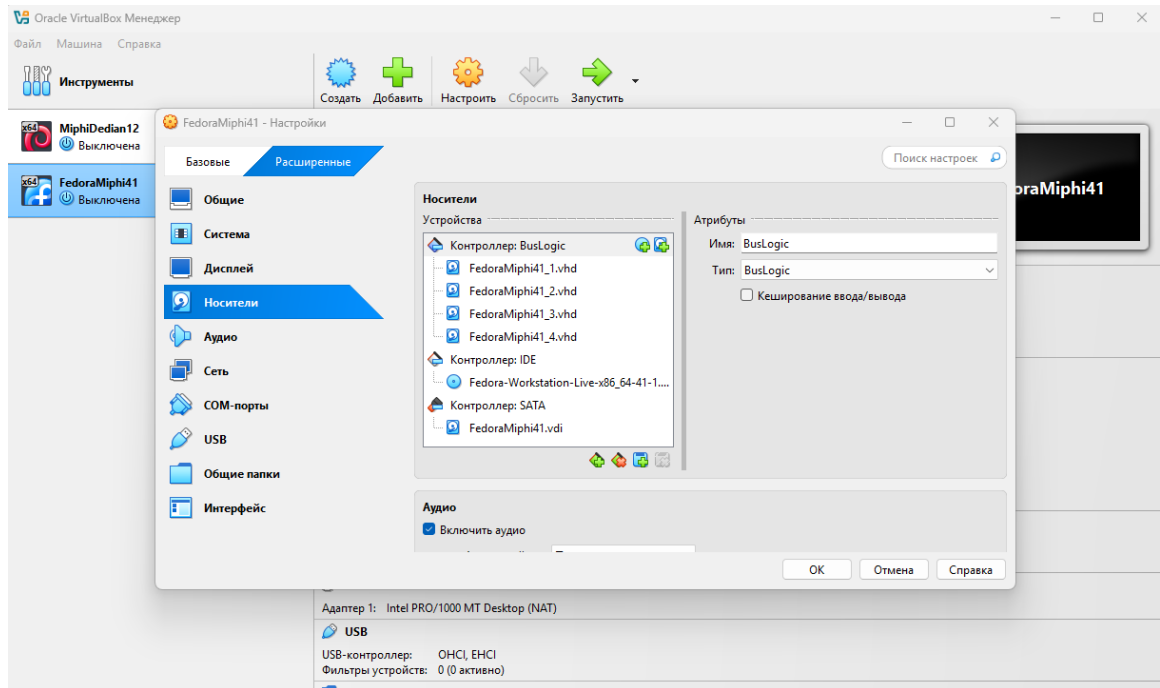


# LVM+RAID

## 1. Настройка RAID

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



```
liveuser@localhost-live:~  
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  
sdc         8:32   0    1G  0 disk  
sdd         8:48   0    1G  0 disk  
sde         8:64   0    1G  0 disk  
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 --zero-superblock --force /dev/sd{b,c,d,e}  
mdadm: Unrecognised md component device - /dev/sdb  
mdadm: Unrecognised md component device - /dev/sdc  
mdadm: Unrecognised md component device - /dev/sdd  
mdadm: Unrecognised md component device - /dev/sde  
liveuser@localhost-live:~$ sudo mdadm --create --verbose /dev/md0 --level=5 --raid-devices=3  
/dev/sdb /dev/sdc /dev/sdd --spare-devices=1 /dev/sde  
mdadm: layout defaults to left-symmetric  
mdadm: layout defaults to left-symmetric  
mdadm: chunk size defaults to 512K  
mdadm: size set to 1046528K  
mdadm: Defaulting to version 1.2 metadata  
mdadm: array /dev/md0 started.  
liveuser@localhost-live:~$ sudo cat /proc/mdstat  
Personalities : [raid6] [raid5] [raid4]  
md0 : active raid5 sdd[4] sde[3](S) sdc[1] sdb[0]  
      2093056 blocks super 1.2 level 5, 512k chunk, algorithm 2 [3/3] [UUU]  
unused devices: <none>
```

```
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   /dev/sdb
     0         8       16         0   active sync
     1         8       32         1   active sync
     4         8       48         2   active sync
     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-0HD3-jZJR-0W39-lE0E-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
mkfs.ext4 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
var/tmp	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

```
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	16	0	part	
└─sda3	8:3	0	24G	0	part	
sdb	8:16	0	16	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	16	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	16	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	16	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:~$ 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 04:52:28 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 : 39

   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         -     spare   /dev/sdd

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

unused devices: <none>
```

```
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:~$
```