

Лабораторная работа №16

Управление логическими томами

Гурылев Артем Андреевич

Содержание

1	Цель работы	5
2	Выполнение лабораторной работы	6
3	Контрольные вопросы	27
4	Выводы	28

Список иллюстраций

2.1	Создание разделов	6
2.2	Тип разделов	7
2.3	Установка типов разделов на RAID	8
2.4	Состояние дисков	9
2.5	Создание массива	10
2.6	Состояние массива	11
2.7	Создание файловой системы	12
2.8	Монтирование массива	13
2.9	Файл fstab	14
2.10	Работа с дисками в массиве	15
2.11	Состояние массива	16
2.12	Удаление массива	17
2.13	Создание массива и добавление диска	18
2.14	Состояние массива	19
2.15	Состояние массива после сбоя диска	20
2.16	Удаление массива	21
2.17	Создание массива и добавление диска	22
2.18	Состояние массива	23
2.19	Состояние массива после изменения типа	24
2.20	Состояние массива после изменения кол-ва дисков	25
2.21	Файл fstab	26

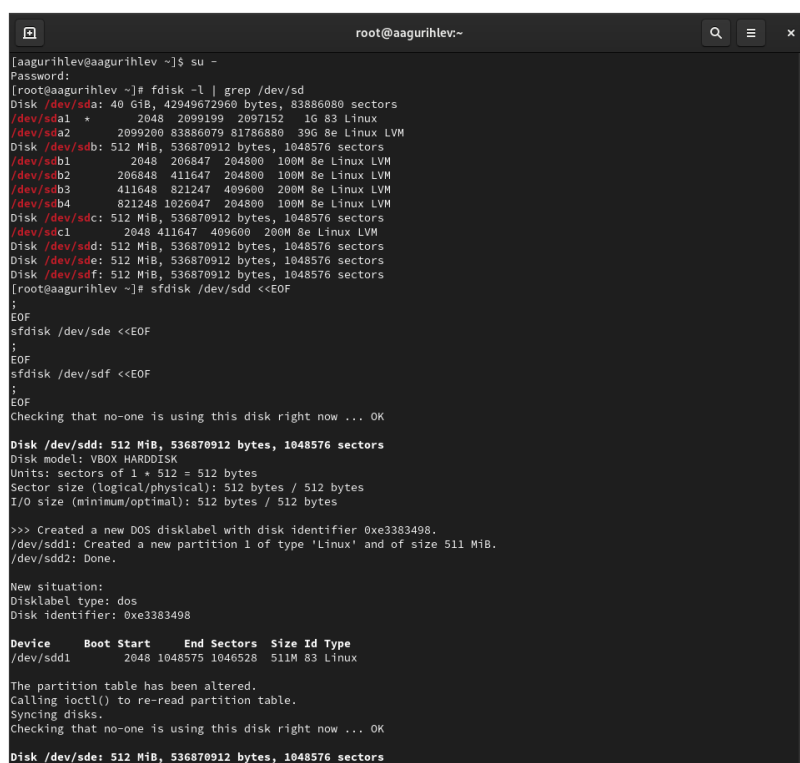
Список таблиц

1 Цель работы

Целью работы является освоение работы с RAID-массивами при помощи утилиты mdadm.

2 Выполнение лабораторной работы

После получения полномочий администратора проверим наличие созданных дисков, а затем создадим на каждом из них раздел типа Linux, как указывает команда `sfdisk`. (рис. 2.1):



```
root@aaagurihlev:~  
[aaagurihlev@aaagurihlev ~]$ su -  
Password:  
[root@aaagurihlev ~]# fdisk -l | grep /dev/sd  
Disk /dev/sda: 40 GiB, 42949672960 bytes, 83886080 sectors  
/dev/sda1 : 2048 2099199 2097152 16 83 Linux  
/dev/sda2 : 2099200 83886079 81786880 39G 8e Linux LVM  
Disk /dev/sdb: 512 MiB, 536870912 bytes, 1048576 sectors  
/dev/sdb1 : 2048 206847 204800 100M 8e Linux LVM  
/dev/sdb2 : 206848 411647 204800 100M 8e Linux LVM  
/dev/sdb3 : 411648 821247 409600 200M 8e Linux LVM  
/dev/sdb4 : 821248 1026047 204800 100M 8e Linux LVM  
Disk /dev/sdc: 512 MiB, 536870912 bytes, 1048576 sectors  
/dev/sdc1 : 2048 411647 409600 200M 8e Linux LVM  
Disk /dev/sdd: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk /dev/sde: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk /dev/sdf: 512 MiB, 536870912 bytes, 1048576 sectors  
[root@aaagurihlev ~]# sfdisk /dev/sdd <<EOF  
;  
EOF  
sfdisk /dev/sde <<EOF  
;  
EOF  
sfdisk /dev/sdf <<EOF  
;  
EOF  
Checking that no-one is using this disk right now ... OK  
  
Disk /dev/sdd: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk model: VBOX HARDDISK  
Units: sectors of 1 * 512 = 512 bytes  
Sector size (logical/physical): 512 bytes / 512 bytes  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
  
>>> Created a new DOS disklabel with disk identifier 0xe3383498.  
/dev/sdd1: Created a new partition 1 of type 'Linux' and of size 511 MiB.  
/dev/sdd2: Done.  
  
New situation:  
Disklabel type: dos  
Disk identifier: 0xe3383498  


| Device    | Boot | Start | End     | Sectors | Size | Id | Type  |
|-----------|------|-------|---------|---------|------|----|-------|
| /dev/sdd1 |      | 2048  | 1048575 | 1046528 | 511M | 83 | Linux |

  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
Checking that no-one is using this disk right now ... OK  
  
Disk /dev/sde: 512 MiB, 536870912 bytes, 1048576 sectors
```

Рис. 2.1: Создание разделов

Дополнительно проверим тип раздела командой `sfdisk`. 83 - код раздела файловой системы Linux (рис. 2.2):

```
root@aagurihlev:~  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
  
>>> Created a new DOS disklabel with disk identifier 0x8fe713f6.  
/dev/sde1: Created a new partition 1 of type 'Linux' and of size 511 MiB.  
/dev/sde2: Done.  
  
New situation:  
Disklabel type: dos  
Disk identifier: 0x8fe713f6  


| Device    | Boot | Start | End     | Sectors | Size | Id | Type  |
|-----------|------|-------|---------|---------|------|----|-------|
| /dev/sde1 |      | 2048  | 1048575 | 1046528 | 511M | 83 | Linux |

  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
Checking that no-one is using this disk right now ... OK  
  
Disk /dev/sdf: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk model: VBOX HARDDISK  
Units: sectors of 1 * 512 = 512 bytes  
Sector size (logical/physical): 512 bytes / 512 bytes  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
  
>>> Created a new DOS disklabel with disk identifier 0xb13c7734.  
/dev/sdf1: Created a new partition 1 of type 'Linux' and of size 511 MiB.  
/dev/sdf2: Done.  
  
New situation:  
Disklabel type: dos  
Disk identifier: 0xb13c7734  


| Device    | Boot | Start | End     | Sectors | Size | Id | Type  |
|-----------|------|-------|---------|---------|------|----|-------|
| /dev/sdf1 |      | 2048  | 1048575 | 1046528 | 511M | 83 | Linux |

  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
[root@aagurihlev ~]# sfdisk --print-id /dev/sdd 1  
sfdisk: print-id is deprecated in favour of --part-type  
83  
[root@aagurihlev ~]# sfdisk --print-id /dev/sde 1  
sfdisk: print-id is deprecated in favour of --part-type  
83  
[root@aagurihlev ~]# sfdisk --print-id /dev/sdf 1  
sfdisk: print-id is deprecated in favour of --part-type  
83  
[root@aagurihlev ~]# sfdisk --part-type /dev/sdf 1  
83  
[root@aagurihlev ~]# █
```

Рис. 2.2: Тип разделов

Посмотрим, какие типы партиций RAID можно задать, после чего установим этот тип разделов в каждой новой партиции.(рис. 2.3):

```
root@aagurihlev:~  
Units: sectors of 1 * 512 = 512 bytes  
Sector size (logical/physical): 512 bytes / 512 bytes  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
  
>>> Created a new DOS disklabel with disk identifier 0xb13c7734.  
/dev/sdf1: Created a new partition 1 of type 'Linux' and of size 511 MiB.  
/dev/sdf2: Done.  
  
New situation:  
Disklabel type: dos  
Disk identifier: 0xb13c7734  
  
Device      Boot Start      End Sectors  Size Id Type  
/dev/sdf1    2048 1048575 1046528   511M 83 Linux  
  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
[root@aagurihlev ~]# sfdisk --print-id /dev/sdd 1  
sfdisk: print-id is deprecated in favour of --part-type  
83  
[root@aagurihlev ~]# sfdisk --print-id /dev/sde 1  
sfdisk: print-id is deprecated in favour of --part-type  
83  
[root@aagurihlev ~]# sfdisk --print-id /dev/sdf 1  
sfdisk: print-id is deprecated in favour of --part-type  
83  
[root@aagurihlev ~]# sfdisk --part-type /dev/sdf 1  
83  
[root@aagurihlev ~]# sfdisk -T | grep -i raid  
fd Linux raid autodetect  
[root@aagurihlev ~]# sfdisk --change-id /dev/sdd 1 fd  
sfdisk: change-id is deprecated in favour of --part-type  
  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
[root@aagurihlev ~]# sfdisk --change-id /dev/sde 1 fd  
sfdisk: change-id is deprecated in favour of --part-type  
  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
[root@aagurihlev ~]# sfdisk --change-id /dev/sdf 1 fd  
sfdisk: change-id is deprecated in favour of --part-type  
  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
[root@aagurihlev ~]#
```

Рис. 2.3: Установка типов разделов на RAID

Посмотрим состояние дисков. Каждый из них имеет тип раздела Linux raid autodetect, сам раздел занимает почти весь размер в 512 MiB, а также у диска есть метка dos(рис. 2.4):


```
root@aagurihlev:~  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
[root@aagurihlev ~]# sfdisk --change-id /dev/sde 1 fd  
sfdisk: change-id is deprecated in favour of --part-type  
  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
[root@aagurihlev ~]# sfdisk --change-id /dev/sdf 1 fd  
sfdisk: change-id is deprecated in favour of --part-type  
  
The partition table has been altered.  
Calling ioctl() to re-read partition table.  
Syncing disks.  
[root@aagurihlev ~]# sfdisk -l /dev/sdd  
Disk /dev/sdd: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk model: VBOX HARDDISK  
Units: sectors of 1 * 512 = 512 bytes  
Sector size (logical/physical): 512 bytes / 512 bytes  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
DiskLabel type: dos  
Disk identifier: 0xe3383498  


| Device    | Boot | Start | End     | Sectors | Size | Id | Type                  |
|-----------|------|-------|---------|---------|------|----|-----------------------|
| /dev/sdd1 |      | 2048  | 1048575 | 1046528 | 511M | fd | Linux raid autodetect |

  
[root@aagurihlev ~]# sfdisk -l /dev/sde  
Disk /dev/sde: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk model: VBOX HARDDISK  
Units: sectors of 1 * 512 = 512 bytes  
Sector size (logical/physical): 512 bytes / 512 bytes  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
DiskLabel type: dos  
Disk identifier: 0x8fe713f6  


| Device    | Boot | Start | End     | Sectors | Size | Id | Type                  |
|-----------|------|-------|---------|---------|------|----|-----------------------|
| /dev/sde1 |      | 2048  | 1048575 | 1046528 | 511M | fd | Linux raid autodetect |

  
[root@aagurihlev ~]# sfdisk -l /dev/sdf  
Disk /dev/sdf: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk model: VBOX HARDDISK  
Units: sectors of 1 * 512 = 512 bytes  
Sector size (logical/physical): 512 bytes / 512 bytes  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
DiskLabel type: dos  
Disk identifier: 0xb13c7734  


| Device    | Boot | Start | End     | Sectors | Size | Id | Type                  |
|-----------|------|-------|---------|---------|------|----|-----------------------|
| /dev/sdf1 |      | 2048  | 1048575 | 1046528 | 511M | fd | Linux raid autodetect |

  
[root@aagurihlev ~]#
```

Рис. 2.4: Состояние дисков

Создадим массив RAID 1 из двух дисков с помощью утилиты mdadm(рис. 2.5):

```
root@aagurihlev:~  
Disk /dev/sdd: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk model: VBOX HARDDISK  
Units: sectors of 1 * 512 = 512 bytes  
Sector size (logical/physical): 512 bytes / 512 bytes  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
Disklabel type: dos  
Disk identifier: 0xe3383498  
  
Device      Boot Start    End Sectors  Size Id Type  
/dev/sdd1   2048 1048575 1046528  511M fd Linux raid autodetect  
[root@aagurihlev ~]# sfdisk -l /dev/sde  
Disk /dev/sde: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk model: VBOX HARDDISK  
Units: sectors of 1 * 512 = 512 bytes  
Sector size (logical/physical): 512 bytes / 512 bytes  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
Disklabel type: dos  
Disk identifier: 0x8fe713f6  
  
Device      Boot Start    End Sectors  Size Id Type  
/dev/sde1   2048 1048575 1046528  511M fd Linux raid autodetect  
[root@aagurihlev ~]# sfdisk -l /dev/sdf  
Disk /dev/sdf: 512 MiB, 536870912 bytes, 1048576 sectors  
Disk model: VBOX HARDDISK  
Units: sectors of 1 * 512 = 512 bytes  
Sector size (logical/physical): 512 bytes / 512 bytes  
I/O size (minimum/optimal): 512 bytes / 512 bytes  
Disklabel type: dos  
Disk identifier: 0xbl3c7734  
  
Device      Boot Start    End Sectors  Size Id Type  
/dev/sdf1   2048 1048575 1046528  511M fd Linux raid autodetect  
[root@aagurihlev ~]# mdadm  
Usage: mdadm --help  
       for help  
[root@aagurihlev ~]# mdadm --create --verbose /dev/md0 --level=1 --raid-devices=2  
/dev/sdd1 /dev/sde1  
mdadm: You haven't given enough devices (real or missing) to create this array  
-bash: /dev/sdd1: Permission denied  
[root@aagurihlev ~]# mdadm --create --verbose /dev/md0 --level=1 --raid-devices=2 /dev/sdd1 /dev/sde1  
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 522240K  
Continue creating array? y  
mdadm: Defaulting to version 1.2 metadata  
mdadm: array /dev/md0 started.  
[root@aagurihlev ~]#
```

Рис. 2.5: Создание массива

Проверии состояние массива с помощью команд `cat` и `mdadm`. В состоянии видно, что массив первого типа, он состоит из двух дисков без запасок, и что он размером в 510 MiB(рис. 2.6):

```
root@aagurihlev:~  
[root@aagurihlev ~]# mdadm --create --verbose /dev/md0 --level=1 --raid-devices=2  
/dev/sdd1 /dev/sde1  
mdadm: You haven't given enough devices (real or missing) to create this array  
-bash: /dev/sdd1: Permission denied  
[root@aagurihlev ~]# mdadm --create --verbose /dev/md0 --level=1 --raid-devices=2 /dev/sdd1 /dev/sde1  
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 522240K  
Continue creating array? y  
mdadm: Defaulting to version 1.2 metadata  
mdadm: array /dev/md0 started.  
[root@aagurihlev ~]# cat /proc/mdstat  
Personalities : [raid1]  
md0 : active raid1 sde1[1] sdd1[0]  
522240 blocks super 1.2 [2/2] [UU]  
  
unused devices: <none>  
[root@aagurihlev ~]# mdadm --query /dev/md0  
/dev/md0: 510.00MiB raid1 2 devices, 0 spares. Use mdadm --detail for more detail.  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
Version : 1.2  
Creation Time : Sat Dec 21 17:30:25 2024  
Raid Level : raid1  
Array Size : 522240 (510.00 MiB 534.77 MB)  
Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
Raid Devices : 2  
Total Devices : 2  
Persistence : Superblock is persistent  
  
Update Time : Sat Dec 21 17:30:29 2024  
State : clean  
Active Devices : 2  
Working Devices : 2  
Failed Devices : 0  
Spare Devices : 0  
  
Consistency Policy : resync  
  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : 52a5d361:040c7399:f1e1f7ab:42b0b0ddb  
Events : 17  
  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
1 8 65 1 active sync /dev/sde1  
[root@aagurihlev ~]#
```

Рис. 2.6: Состояние массива

Создадим файловую систему ext4 для массива(рис. 2.7):

```
root@aagurihlev:~  
mdadm: Defaulting to version 1.2 metadata  
mdadm: array /dev/md0 started.  
[root@aagurihlev ~]# cat /proc/mdstat  
Personalities : [raid1]  
md0 : active raid1 sde1[1] sdd1[0]  
      522240 blocks super 1.2 [2/2] [UU]  
  
unused devices: <none>  
[root@aagurihlev ~]# mdadm --query /dev/md0  
/dev/md0: 510.00MiB raid1 2 devices, 0 spares. Use mdadm --detail for more detail.  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
      Version : 1.2  
      Creation Time : Sat Dec 21 17:30:25 2024  
      Raid Level : raid1  
      Array Size : 522240 (510.00 MiB 534.77 MB)  
      Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
      Raid Devices : 2  
      Total Devices : 2  
      Persistence : Superblock is persistent  
  
      Update Time : Sat Dec 21 17:30:29 2024  
      State : clean  
      Active Devices : 2  
      Working Devices : 2  
      Failed Devices : 0  
      Spare Devices : 0  
  
Consistency Policy : resync  
  
      Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
      UUID : 52a5d361:040c7399:f1e1f7ab:42b0b0ddb  
      Events : 17  
  
      Number Major Minor RaidDevice State  
        0      8      49        0 active sync  /dev/sdd1  
        1      8      65        1 active sync  /dev/sde1  
[root@aagurihlev ~]# mkfs.ext4 /dev/md0  
mke2fs 1.46.5 (30-Dec-2021)  
Creating filesystem with 522240 1k blocks and 130560 inodes  
Filesystem UUID: df8db47f-5973-4cd9-9d87-4947bb129a41  
Superblock backups stored on blocks:  
      8193, 24577, 40961, 57345, 73729, 204801, 221185, 401409  
  
Allocating group tables: done  
Writing inode tables: done  
Creating journal (8192 blocks): done  
Writing superblocks and filesystem accounting information: done  
[root@aagurihlev ~]#
```

Рис. 2.7: Создание файловой системы

Подмонтируем массив(рис. 2.8):

```
root@aagurihlev:~  
[root@aagurihlev ~]# cat /proc/mdstat  
Personalities : [raid1]  
md0 : active raid1 sde1[1] sdd1[0]  
      522240 blocks super 1.2 [2/2] [UU]  
  
unused devices: <none>  
[root@aagurihlev ~]# mdadm --query /dev/md0  
/dev/md0: 510.00MiB raid1 2 devices, 0 spares. Use mdadm --detail for more detail.  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
      Version : 1.2  
      Creation Time : Sat Dec 21 17:30:25 2024  
      Raid Level : raid1  
      Array Size : 522240 (510.00 MiB 534.77 MB)  
      Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
      Raid Devices : 2  
      Total Devices : 2  
      Persistence : Superblock is persistent  
  
      Update Time : Sat Dec 21 17:30:29 2024  
      State : clean  
      Active Devices : 2  
      Working Devices : 2  
      Failed Devices : 0  
      Spare Devices : 0  
  
Consistency Policy : resync  
  
      Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
      UUID : 52a5d361:040c7399:filef7ab:42b0bddd  
      Events : 17  
  
      Number Major Minor RaidDevice State  
        0      8      49        0 active sync  /dev/sdd1  
        1      8      65        1 active sync  /dev/sde1  
[root@aagurihlev ~]# mkfs.ext4 /dev/md0  
mke2fs 1.46.5 (30-Dec-2021)  
Creating filesystem with 522240 1k blocks and 130560 inodes  
Filesystem UUID: df8db47f-5973-4cd9-9d87-4947bb129a41  
Superblock backups stored on blocks:  
      8193, 24577, 40961, 57345, 73729, 204801, 221185, 401409  
  
Allocating group tables: done  
Writing inode tables: done  
Creating journal (8192 blocks): done  
Writing superblocks and filesystem accounting information: done  
  
[root@aagurihlev ~]# mkdir /data  
[root@aagurihlev ~]# mount /dev/md0 /data  
[root@aagurihlev ~]#
```

Рис. 2.8: Монтирование массива

Добавим запись в `fstab` для автомонтирования(рис. 2.9):



```
1
2 #
3 # /etc/fstab
4 # Created by anaconda on Sat Sep 21 10:12:53 2024
5 #
6 # Accessible filesystems, by reference, are maintained under '/dev/disk/'.
7 # See man pages fstab(5), findfs(8), mount(8) and/or blkid(8) for more info.
8 #
9 # After editing this file, run 'systemctl daemon-reload' to update systemd
10 # units generated from this file.
11 #
12 /dev/mapper/rl_vbox-root / xfs defaults 0 0
13 UUID=507ec4f8-6be8-4ce8-b9de-b51df49b3b87 /boot xfs defaults 0 0
14 /dev/mapper/rl_vbox-swap none swap defaults 0 0
15 # UUID=706787e2-55fa-4018-8c1f-5f36102c9a78 /mnt/data xfs defaults 1 2
16 # UUID=980ccf86-105c-455e-ad02-f5cc3b6bb0f0 /mnt/data-ext ext4 defaults 1 2
17 /dev/vgdata/lvdata /mnt/data ext4 defaults 1 2
18 /dev/groupvg/lvggroup /mnt/groups xfs defaults 1 2
19 /dev/md0 /data ext4 defaults 1 2
```

Рис. 2.9: Файл fstab

Сымитируем сбой одного из дисков, после чего удалим этот сбойный диск и заменим его другим(рис. 2.10):

```
root@aagurihlev:~  
Total Devices : 2  
Persistence : Superblock is persistent  
  
Update Time : Sat Dec 21 17:30:29 2024  
State : clean  
Active Devices : 2  
Working Devices : 2  
Failed Devices : 0  
Spare Devices : 0  
  
Consistency Policy : resync  
  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : 52a5d361:040c7399:filef7ab:42b0bddd  
Events : 17  
  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
1 8 65 1 active sync /dev/sdel  
[root@aagurihlev ~]# mkfs.ext4 /dev/md0  
mke2fs 1.46.5 (30-Dec-2021)  
Creating filesystem with 522240 1k blocks and 130560 inodes  
Filesystem UUID: df8db47f-5973-4cd9-9d87-4947bb129a41  
Superblock backups stored on blocks:  
8193, 24577, 40961, 57345, 73729, 204801, 221185, 401409  
  
Allocating group tables: done  
Writing inode tables: done  
Creating journal (8192 blocks): done  
Writing superblocks and filesystem accounting information: done  
  
[root@aagurihlev ~]# mkdir /data  
[root@aagurihlev ~]# mount /dev/md0 /data  
[root@aagurihlev ~]# gedit /etc/fstab  
  
** (gedit:7604): WARNING **: 17:34:08.758: Set document metadata failed: Setting attribute metadata::gedit-spell-langu  
age not supported  
  
** (gedit:7604): WARNING **: 17:34:08.758: Set document metadata failed: Setting attribute metadata::gedit-encoding no  
t supported  
  
** (gedit:7604): WARNING **: 17:34:15.374: Set document metadata failed: Setting attribute metadata::gedit-position no  
t supported  
[root@aagurihlev ~]# mdadm /dev/md0 --fail /dev/sdel  
mdadm: set /dev/sdel faulty in /dev/md0  
[root@aagurihlev ~]# mdadm /dev/md0 --remove /dev/sdel  
mdadm: hot removed /dev/sdel from /dev/md0  
[root@aagurihlev ~]# mdadm /dev/md0 --add /dev/sdf1  
mdadm: added /dev/sdf1  
[root@aagurihlev ~]#
```

Рис. 2.10: Работа с дисками в массиве

Посмотрим состояние массива. Как можно увидеть, массив все также имеет два рабочих устройства, поскольку мы удалили и заменили сбойный диск(рис. 2.11):

```
root@aagurihlev:~  
** (gedit:7604): WARNING **: 17:34:08.758: Set document metadata failed: Setting attribute metadata::gedit-spell-language not supported  
** (gedit:7604): WARNING **: 17:34:08.758: Set document metadata failed: Setting attribute metadata::gedit-encoding not supported  
** (gedit:7604): WARNING **: 17:34:15.374: Set document metadata failed: Setting attribute metadata::gedit-position not supported  
[root@aagurihlev ~]# mdadm /dev/md0 --fail /dev/sde1  
mdadm: set /dev/sde1 faulty in /dev/md0  
[root@aagurihlev ~]# mdadm /dev/md0 --remove /dev/sde1  
mdadm: hot removed /dev/sde1 from /dev/md0  
[root@aagurihlev ~]# mdadm /dev/md0 --add /dev/sdf1  
mdadm: added /dev/sdf1  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
Version : 1.2  
Creation Time : Sat Dec 21 17:30:25 2024  
Raid Level : raid1  
Array Size : 522240 (510.00 MiB 534.77 MB)  
Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
Raid Devices : 2  
Total Devices : 2  
Persistence : Superblock is persistent  
  
Update Time : Sat Dec 21 17:35:23 2024  
State : clean  
Active Devices : 2  
Working Devices : 2  
Failed Devices : 0  
Spare Devices : 0  
  
Consistency Policy : resync  
  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : 52a5d361:040c7399:f1e1f7ab:42b0bddb  
Events : 39  
  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
2 8 81 1 active sync /dev/sdf1  
[root@aagurihlev ~]# mdadm --query /dev/md0  
/dev/md0: 510.00MiB raid1 2 devices, 0 spares. Use mdadm --detail for more detail.  
[root@aagurihlev ~]# cat /proc/mdstat  
Personalities : [raid1]  
md0 : active raid1 sdf1[2] sdd1[0]  
522240 blocks super 1.2 [2/2] [UU]  
  
unused devices: <none>  
[root@aagurihlev ~]#
```

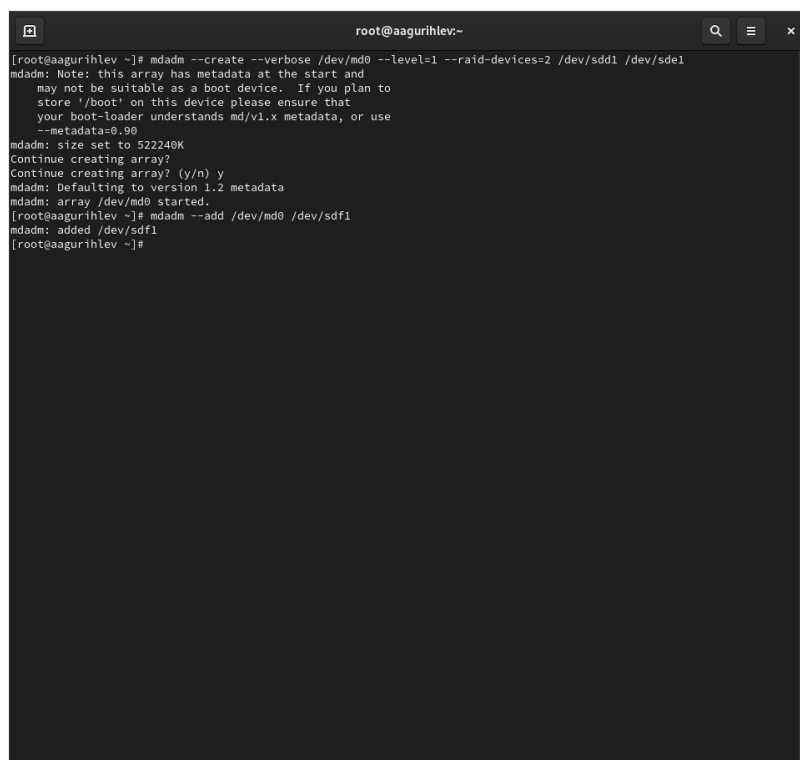
Рис. 2.11: Состояние массива

Удалим массив и очистим метаданные(рис. 2.12):


```
root@aagurihlev:~  
** (gedit:7684): WARNING **: 17:34:15.374: Set document metadata failed: Setting attribute metadata::gedit-position not supported  
[root@aagurihlev ~]# mdadm /dev/md0 --fail /dev/sde1  
mdadm: set /dev/sde1 faulty in /dev/md0  
[root@aagurihlev ~]# mdadm /dev/md0 --remove /dev/sde1  
mdadm: hot removed /dev/sde1 from /dev/md0  
[root@aagurihlev ~]# mdadm /dev/md0 --add /dev/sdf1  
mdadm: added /dev/sdf1  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
    Version : 1.2  
    Creation Time : Sat Dec 21 17:30:25 2024  
    Raid Level : raid1  
    Array Size : 522240 (510.00 MiB 534.77 MB)  
    Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
    Raid Devices : 2  
    Total Devices : 2  
    Persistence : Superblock is persistent  
  
    Update Time : Sat Dec 21 17:35:23 2024  
    State : clean  
    Active Devices : 2  
    Working Devices : 2  
    Failed Devices : 0  
    Spare Devices : 0  
  
Consistency Policy : resync  
  
    Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
    UUID : 52a5d361:040c7399:f1e1f7ab:42b0bddb  
    Events : 39  
  
    Number Major Minor RaidDevice State  
      0      8      49        0 active sync /dev/sdd1  
      2      8      81        1 active sync /dev/sdf1  
[root@aagurihlev ~]# mdadm --query /dev/md0  
/dev/md0: 510.00MiB raid1 2 devices, 0 spares. Use mdadm --detail for more detail.  
[root@aagurihlev ~]# cat /proc/mdstat  
Personalities : [raid1]  
md0 : active raid1 sdf1[2] sdd1[0]  
      522240 blocks super 1.2 [2/2] [UU]  
  
unused devices: <none>  
[root@aagurihlev ~]# umount /dev/md0  
[root@aagurihlev ~]# mdadm --stop /dev/md0  
mdadm: stopped /dev/md0  
[root@aagurihlev ~]# mdadm --zero-superblock /dev/sdd1  
[root@aagurihlev ~]# mdadm --zero-superblock /dev/sde1  
[root@aagurihlev ~]# mdadm --zero-superblock /dev/sdf1  
[root@aagurihlev ~]#
```

Рис. 2.12: Удаление массива

Создадим новый массив и добавим к нему третий диск(рис. 2.13):

A terminal window titled 'root@aagurihlev:~' showing the execution of the 'mdadm' command to create a RAID array. The command is 'mdadm --create --verbose /dev/md0 --level=1 --raid-devices=2 /dev/sdd1 /dev/sde1'. The output shows a note about metadata, a size of 522240K, and a confirmation to create the array. The array is then started. Finally, the command 'mdadm --add /dev/md0 /dev/sdf1' is executed to add a third disk.

```
root@aagurihlev ~]# mdadm --create --verbose /dev/md0 --level=1 --raid-devices=2 /dev/sdd1 /dev/sde1
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 522240K
Continue creating array?
Continue creating array? (y/n) y
mdadm: Defaulting to version 1.2 metadata
mdadm: array /dev/md0 started.
[root@aagurihlev ~]# mdadm --add /dev/md0 /dev/sdf1
mdadm: added /dev/sdf1
[root@aagurihlev ~]#
```

Рис. 2.13: Создание массива и добавление диска

Подмонтируем массив, и проверим его состояние. Как можно увидеть, всего три устройства в массиве, однако активных лишь два, а третий диск находится в запасе(рис. 2.14):

```
root@aagurihlev:~  
your boot-loader understands md/v1.x metadata, or use  
--metadata=0.90  
mdadm: size set to 522240K  
Continue creating array? (y/n) y  
mdadm: Defaulting to version 1.2 metadata  
mdadm: array /dev/md0 started.  
[root@aagurihlev ~]# mdadm --add /dev/md0 /dev/sdf1  
mdadm: added /dev/sdf1  
[root@aagurihlev ~]# mount /dev/md0  
mount: (hint) your fstab has been modified, but systemd still uses  
the old version; use 'systemctl daemon-reload' to reload.  
[root@aagurihlev ~]# cat /proc/mdstat  
Personalities : [raid1]  
md0 : active raid1 sdf1[2](s) sde1[1] sdd1[0]  
522240 blocks super 1.2 [2/2] [UU]  
  
unused devices: <none>  
[root@aagurihlev ~]# mdadm --query /dev/md0  
/dev/md0: 510.00MiB raid1 2 devices, 1 spare. Use mdadm --detail for more detail.  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
Version : 1.2  
Creation Time : Sat Dec 21 17:38:21 2024  
Raid Level : raid1  
Array Size : 522240 (510.00 MiB 534.77 MB)  
Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
Raid Devices : 2  
Total Devices : 3  
Persistence : Superblock is persistent  
  
Update Time : Sat Dec 21 17:38:51 2024  
State : clean  
Active Devices : 2  
Working Devices : 3  
Failed Devices : 0  
Spare Devices : 1  
  
Consistency Policy : resync  
  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : 6a530731:0a9c83fb:53a7df0a:7d3e4b56  
Events : 18  
  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
1 8 65 1 active sync /dev/sde1  
2 8 81 - spare /dev/sdf1  
[root@aagurihlev ~]#
```

Рис. 2.14: Состояние массива

Сымитируем сбой одного из дисков, после чего проверим состояние массива. Диск-запаска встал на место сбойного диска, и таким образом массив продолжил работать. По информации в массиве все также три устройства, но одно сбойное(рис. 2.15):

```
root@aagurihlev:~  
Update Time : Sat Dec 21 17:38:51 2024  
State : clean  
Active Devices : 2  
Working Devices : 3  
Failed Devices : 0  
Spare Devices : 1  
Consistency Policy : resync  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : 6a530731:0a9c83fb:53a7df0a:7d3e4b56  
Events : 18  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
1 8 65 1 active sync /dev/sde1  
2 8 81 - spare /dev/sdf1  
[root@aagurihlev ~]# mdadm /dev/md0 --fail /dev/sde1  
mdadm: set /dev/sde1 faulty in /dev/md0  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
Version : 1.2  
Creation Time : Sat Dec 21 17:38:21 2024  
Raid Level : raid1  
Array Size : 522240 (510.00 MiB 534.77 MB)  
Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
Raid Devices : 2  
Total Devices : 3  
Persistence : Superblock is persistent  
Update Time : Sat Dec 21 17:41:02 2024  
State : clean  
Active Devices : 2  
Working Devices : 2  
Failed Devices : 1  
Spare Devices : 0  
Consistency Policy : resync  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : 6a530731:0a9c83fb:53a7df0a:7d3e4b56  
Events : 37  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
2 8 81 1 active sync /dev/sdf1  
1 8 65 - faulty /dev/sde1  
[root@aagurihlev ~]#
```

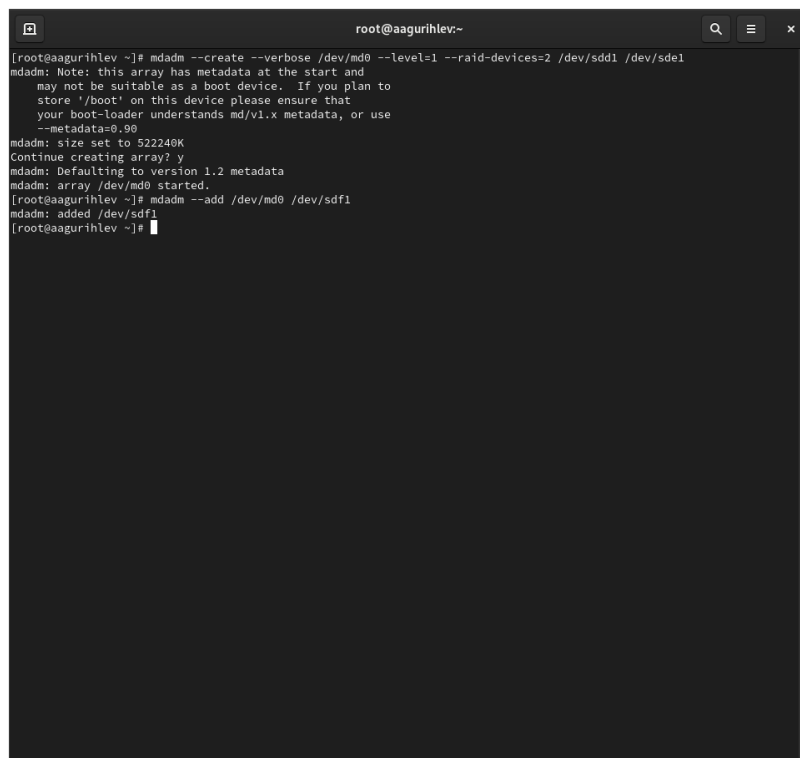
Рис. 2.15: Состояние массива после сбоя диска

Удалим массив и очистим метаданные(рис. 2.16):

```
root@aagurihlev:~  
  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : 6a530731:0a9c83fb:53a7df0a:7d3e4b56  
Events : 18  
  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
1 8 65 1 active sync /dev/sde1  
2 8 81 - spare /dev/sdf1  
[root@aagurihlev ~]# mdadm /dev/md0 --fail /dev/sde1  
mdadm: set /dev/sde1 faulty in /dev/md0  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
Version : 1.2  
Creation Time : Sat Dec 21 17:38:21 2024  
Raid Level : raid1  
Array Size : 522240 (510.00 MiB 534.77 MB)  
Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
Raid Devices : 2  
Total Devices : 3  
Persistence : Superblock is persistent  
  
Update Time : Sat Dec 21 17:41:02 2024  
State : clean  
Active Devices : 2  
Working Devices : 2  
Failed Devices : 1  
Spare Devices : 0  
  
Consistency Policy : resync  
  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : 6a530731:0a9c83fb:53a7df0a:7d3e4b56  
Events : 37  
  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
2 8 81 1 active sync /dev/sdf1  
1 8 65 - faulty /dev/sde1  
[root@aagurihlev ~]# umount /dev/md0  
[root@aagurihlev ~]# mdadm --zero-superblock /dev/sdd1  
mdadm: Couldn't open /dev/sdd1 for write - not zeroing  
[root@aagurihlev ~]# mdadm --stop /dev/md0  
mdadm: stopped /dev/md0  
[root@aagurihlev ~]# mdadm --zero-superblock /dev/sdd1  
[root@aagurihlev ~]# mdadm --zero-superblock /dev/sde1  
[root@aagurihlev ~]# mdadm --zero-superblock /dev/sdf1  
[root@aagurihlev ~]#
```

Рис. 2.16: Удаление массива

Создадим новый массив RAID 1 и добавим к нему третий диск(рис. 2.17):

A terminal window titled 'root@aagurihlev:~' with search, menu, and close icons in the title bar. The terminal shows the following commands and output:

```
[root@aagurihlev ~]# mdadm --create --verbose /dev/md0 --level=1 --raid-devices=2 /dev/sdd1 /dev/sde1
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 522240K
Continue creating array? y
mdadm: Defaulting to version 1.2 metadata
mdadm: array /dev/md0 started.
[root@aagurihlev ~]# mdadm --add /dev/md0 /dev/sdf1
mdadm: added /dev/sdf1
[root@aagurihlev ~]#
```

Рис. 2.17: Создание массива и добавление диска

Подмонтируем массив и проверим его состояние. У массива всего три устройства, но так как при создании мы использовали только два, третий диск ушел в запас(рис. 2.18):

```
root@aagurihlev:~  
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 522240K  
Continue creating array? y  
mdadm: Defaulting to version 1.2 metadata  
mdadm: array /dev/md0 started.  
[root@aagurihlev ~]# mdadm --add /dev/md0 /dev/sdf1  
mdadm: added /dev/sdf1  
[root@aagurihlev ~]# mount /dev/md0  
mount: (hint) your fstab has been modified, but systemd still uses  
the old version; use 'systemctl daemon-reload' to reload.  
[root@aagurihlev ~]# cat /proc/mdstat  
mdadm --query /dev/md0  
mdadm --detail /dev/md0  
Personalities : [raid1]  
md0 : active raid1 sdf1[2](S) sde1[1] sdd1[0]  
522240 blocks super 1.2 [2/2] [UU]  
  
unused devices: <none>  
/dev/md0: 510.00MiB raid1 2 devices, 1 spare. Use mdadm --detail for more detail.  
/dev/md0:  
Version : 1.2  
Creation Time : Sat Dec 21 17:43:32 2024  
Raid Level : raid1  
Array Size : 522240 (510.00 MiB 534.77 MB)  
Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
Raid Devices : 2  
Total Devices : 3  
Persistence : Superblock is persistent  
  
Update Time : Sat Dec 21 17:44:00 2024  
State : clean  
Active Devices : 2  
Working Devices : 3  
Failed Devices : 0  
Spare Devices : 1  
  
Consistency Policy : resync  
  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : bf498fb7:ce2c0f2c:54d3a0bb:108cd507  
Events : 18  
  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
1 8 65 1 active sync /dev/sde1  
2 8 81 - spare /dev/sdf1  
[root@aagurihlev ~]#
```

Рис. 2.18: Состояние массива

Изменим тип массива на RAID 5 и проверим его состояние. Несмотря на то, что мы поменяли тип, активных устройств все равно два. Нужно сделать третий диск активным, ведь для RAID 5 минимально нужно три диска(рис. 2.19):

```
root@aagurihlev:~  
Working Devices : 3  
Failed Devices : 0  
Spare Devices : 1  
Consistency Policy : resync  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : bf498fb7:ce2c0f2c:54d3a0bb:108cd507  
Events : 18  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
1 8 65 1 active sync /dev/sde1  
2 8 81 - spare /dev/sdf1  
[root@aagurihlev ~]# mdadm --grow /dev/md0 --level=5  
mdadm: level of /dev/md0 changed to raid5  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
Version : 1.2  
Creation Time : Sat Dec 21 17:43:32 2024  
Raid Level : raid5  
Array Size : 522240 (510.00 MiB 534.77 MB)  
Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
Raid Devices : 2  
Total Devices : 3  
Persistence : Superblock is persistent  
Update Time : Sat Dec 21 17:45:28 2024  
State : clean  
Active Devices : 2  
Working Devices : 3  
Failed Devices : 0  
Spare Devices : 1  
Layout : left-symmetric  
Chunk Size : 64K  
Consistency Policy : resync  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : bf498fb7:ce2c0f2c:54d3a0bb:108cd507  
Events : 19  
Number Major Minor RaidDevice State  
0 8 49 0 active sync /dev/sdd1  
1 8 65 1 active sync /dev/sde1  
2 8 81 - spare /dev/sdf1  
[root@aagurihlev ~]#
```

Рис. 2.19: Состояние массива после изменения типа

Изменим количество дисков на 3 и проверим состояние массива. Теперь у нашего массива три активных диска и нет диска в запасе.(рис. 2.20):


```
root@aagurihlev:~  
Layout : left-symmetric  
Chunk Size : 64K  
Consistency Policy : resync  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : bf498fb7:ce2c0f2c:54d3a0bb:108cd507  
Events : 19  


| Number | Major | Minor | RaidDevice | State       |           |
|--------|-------|-------|------------|-------------|-----------|
| 0      | 8     | 49    | 0          | active sync | /dev/sdd1 |
| 1      | 8     | 65    | 1          | active sync | /dev/sde1 |
| 2      | 8     | 81    | -          | spare       | /dev/sdf1 |

  
[root@aagurihlev ~]# mdadm --grow /dev/md0 --raid-devices 3  
[root@aagurihlev ~]# mdadm --detail /dev/md0  
/dev/md0:  
Version : 1.2  
Creation Time : Sat Dec 21 17:43:32 2024  
Raid Level : raid5  
Array Size : 522240 (510.00 MiB 534.77 MB)  
Used Dev Size : 522240 (510.00 MiB 534.77 MB)  
Raid Devices : 3  
Total Devices : 3  
Persistence : Superblock is persistent  
  
Update Time : Sat Dec 21 17:46:24 2024  
State : clean, reshaping  
Active Devices : 3  
Working Devices : 3  
Failed Devices : 0  
Spare Devices : 0  
  
Layout : left-symmetric  
Chunk Size : 64K  
Consistency Policy : resync  
  
Reshape Status : 15% complete  
Delta Devices : 1, (2->3)  
Name : aagurihlev.localdomain:0 (local to host aagurihlev.localdomain)  
UUID : bf498fb7:ce2c0f2c:54d3a0bb:108cd507  
Events : 33  


| Number | Major | Minor | RaidDevice | State       |           |
|--------|-------|-------|------------|-------------|-----------|
| 0      | 8     | 49    | 0          | active sync | /dev/sdd1 |
| 1      | 8     | 65    | 1          | active sync | /dev/sde1 |
| 2      | 8     | 81    | 2          | active sync | /dev/sdf1 |

  
[root@aagurihlev ~]#
```

Рис. 2.20: Состояние массива после изменения кол-ва дисков

Удалим массив и очистим метаданные. Также прокомментируем добавленную строку в fstab(рис. 2.21):

```
1
2 #
3 # /etc/fstab
4 # Created by anaconda on Sat Sep 21 10:12:53 2024
5 #
6 # Accessible filesystems, by reference, are maintained under '/dev/disk/'.
7 # See man pages fstab(5), findfs(8), mount(8) and/or blkid(8) for more info.
8 #
9 # After editing this file, run 'systemctl daemon-reload' to update systemd
10 # units generated from this file.
11 #
12 /dev/mapper/rl_vbox-root / xfs defaults 0 0
13 UUID=507ec4f8-6be8-4ce8-b9de-b51df49b3b87 /boot xfs defaults 0 0
14 /dev/mapper/rl_vbox-swap none swap defaults 0 0
15 # UUID=706787e2-55fa-4018-8c1f-5f36102c9a78 /mnt/data xfs defaults 1 2
16 # UUID=980ccf86-105c-455e-ad02-f5cc3b6bb0f0 /mnt/data-ext ext4 defaults 1 2
17 /dev/vgdata/lvdata /mnt/data ext4 defaults 1 2
18 /dev/groupvg/lvgroup /mnt/groups xfs defaults 1 2
19 # /dev/md0 /data ext4 defaults 1 2
```

Рис. 2.21: Файл fstab

3 Контрольные вопросы

1. RAID - массив дисков, созданный для хранения определённых важных данных. Если один диск перестанет работать, другие диски будут хранить ту же информацию, и она не потеряется.
2. Существуют разные RAID, с 0 до 6, 10, 50 и 60.
3. RAID 0, RAID 1, RAID 5, RAID 6.

4 Выводы

В этой лабораторной работе я научился работать с массивами RAID и освоился с утилитой mdadm.