eh1act01 - RAID technology

GENERAL CONDITIONS

1- Deadline: **16-3-2025**

2- Send your report as a **PDF** file attached to an e-mail with the following specifications:

a) E-mail address: **cf(at)collados.org** or **jordi.binefa(at)fje.edu** depending on who is your teacher

b) File Names:

b.1) ASIX1:

asix1_surname_name_eh1act01.odt
asix1_surname_name_eh1act01.pdf

b2.) DAW1:

daw1_surname_name_eh1act01 .odt
daw1_surname_name_eh1act01 .pdf

c) Subject:

c.1) ASIX1: **asix1_surname_name_ eh1act01**
c.2) DAW1: **daw1_surname_name_ eh1act01**

3- Make this report individually.

4- Left, right, top and bottom margins: **2cm**.

5- Character format: a) Font: **Arial**, b) Size: **10**, c) Questions typeface: **Bold**, d) Answers typeface: **Regular(Blue/Red)**.

DOCUMENTATION

1- Meaning of RAID:

RAID (Redundant Array of Independent Disks) is a data storage technology that combines multiple physical hard drives into a single unit to improve performance, redundancy, or both.

RAID is commonly used in servers and high-performance computing environments to ensure:

- **Data availability:** Ensures continuous access to data, even in the event of a drive failure.
- **Reliability:** Reduction of downtime (service interruption time) and risk of data loss.

2- Main Features:

- **Data Redundancy:** Duplication or distribution of data across multiple drives to protect against hardware failures. It ensures that if one disk fails, the data remains accessible, preventing data loss and minimizing downtime.
- **Performance Improvement:** Some RAID levels enhance read/write speeds.
- **Fault Tolerance:** Provides system reliability by allowing continued operation even if a drive fails.
- **Scalability:** Can be easily expanded by adding more drives, allowing for increased storage capacity and performance.

3- Advantages:

- Increased data security and redundancy.
- Improved read/write performance (depending on RAID level).
- Reduces downtime in case of drive failure.

4- Disadvantages:

- Higher cost due to the need for multiple disks.
- Complexity in setup and maintenance.
- Some levels may have lower storage efficiency due to redundancy requirements.

5- Types:

- **Software RAID** is managed by the operating system using built-in tools without requiring dedicated RAID hardware. The main advantage of sotware RAID is its the lower cost.
- **Hardware RAID** uses a dedicated RAID controller card or RAID chip on the motherboard to manage the RAID array independently. The main advantage of harware RAID is its the higher performance (for instance read/write speeds).

6- RAID Levels:

RAID levels define how data is stored across multiple drives, balancing performance, redundancy, and fault tolerance. There are 8 different levels but we are going to study the most common RAID configuration called RAID 5.

The Main features of RAID Level 5 are:

- **Functionality:** Data and parity (error correction) information are distributed across multiple drives. If a disk fails, the lost data can be reconstructed using information stored on other disks.
- **Advantages:** Good balance between performance, redundancy, and storage efficiency.
- **Disadvantages:** Requires at least three drives; write performance is slower due to parity calculations.
- **Use Case:** File servers, database storage, and applications requiring both performance and redundancy.

RAID Level 5 formulas:

- **Capacity = (n – 1) * S** where C is the capacity of the RAID 5 array, n is the number of disks and S is the size of one drive.
- **Reading speed gain = (n – 1)**
- **Write speed gain = 1** (no write speed gain)
- **Fault tolerance = 1** (1 drive failure)
- **Minimun number of drives required = 3**

For example, in a RAID 5 matrix with four units of 1000 GB capacity each one,:

- The total capacity of the matrix would be of (4 – 1) * 1000GB = 3000GB
- Reading speed gain = 4 -1 = 3
- Write speed gain = 1
- Fault tolerance = 1

EXAMPLE 1 – HOW TO CREATE AN ARRAY RAID

1- Remove any hard drive but the one where your operating system is installed. Afterwards, install 3 new drives, each of 50GiB, on SATA1, SAT2 and SATA3.

2- Boot your virtual computer. Install **mdadm** (the linux software RAID tool).

3- Check the device identifier of the 3 new drives running the command **lsblk.**

4- Create a RAID 5 array (assuming that the idenfiers for the new drives are **sdb**, **sdc** and **sdd**):

```
sudo mdadm --create /dev/md0 --level=5 --raid-devices=3 /dev/sdb /dev/sdc /dev/sdd
```

where:

- **/dev/md0** specifies the identifier of the RAID device that will be created.
- **--level=5** specifies that RAID5 should be used
- **--raid-devices** specifies the number of disks in the RAID array.
- **sdb**, **sdc** and **sdd** are the drives identifiers that were found with the help of **lsblk**

5- Verify the new array RAID:

```
sudo mdadm --detail /dev/md0
```

6- To ensure the RAID array is properly created when the computer boots run the following commands:

```
sudo mdadm --detail --scan --verbose >> /etc/mdadm/mdadm.conf
sudo update-initramfs -u
```

7- Create a filesystem Ext4 on the RAID array:

```
sudo mkfs -t ext4 /dev/md0
```

8- Mount the RAID array:

```
sudo mkdir /mnt/md0
sudo mount -t ext4 /dev/md0 /mnt/md0
```

9- Add permissions to any member of **users** to work with the new RAID array:

```
sudo chgrp -R users /mnt/md0
sudo chmod -R 770 /mnt/md0
```

10 - Check that the new storage device **/dev/md0** is available and its capacity:

```
df -Th /dev/md0
```

11- Check that your user can read/create/update/remove contents in the new array RAID.

12- To ensure the RAID array is mounted automatically after reboot, open **/etc/fstab** with **root** privileges and the help of **nano**. Afterwards, add the following lines to the end of **/etc/fstab**:

```
# Mountig RAID during the boot process
/dev/md0    /mnt/md0    ext4    defaults        0       0
```

and check again steps **10** and **11**.

EXAMPLE 2 – HOW TO REMOVE AN ARRAY RAID

1- Comment last line of **/etc/fstab:**

```
# /dev/md0    /mnt/md0    ext4    defaults        0       0
```

2- Umount **/dev/md0**:

```
sudo umount /dev/md0
```

3- Stop the array RAID:

```
sudo mdadm --stop /dev/md0
```

4- Remove the array RAID:

```
sudo mdadm --remove /dev/md0
```

NOTE: Do no worry about any error message!!!!

5- Remove any information stored on **sdb**, **sdc** and **sdd** by **mdadm** when **/dev/md0** was created:

```
sudo mdadm  --zero-superblock /dev/sdb /dev/sdc /dev/sdd
```

6- Avoid the creation of **/dev/md0** when the computer boots. First of all, comment last 2 lines of **/etc/mdadm/mdadm.conf**. Afterwards run:

```
sudo sudo update-initramfs -u
```

7- Check that **/dev/md0** does not exist any longer running

```
sudo mdadm --detail /dev/md0
```

Also, check that **/dev/md0** is not mounted during the boot process.

PRACTICAL EXERCISE

PART 1

1- Add 4 new drives, each of 30GiB, on SATA4, SAT5, SATA6 and SATA7. Boot your computer and check the device identifier of these drives. Show clearly the identifier for each device.

2- Create a new array RAID level 5 on your system identified as md1 with the drives added in question 1.

3- Check that the new array was successfully created.

4- Ensure the RAID array is properly created when the computer boots

5- Create a Ext4 filesystem on the new array.

6- Mount the new array on a folder called /mnt/md1. Afterwards add the permissions required to allow any member of users to work with the new array. Show that the array was mounted and its permissions.

7- Modifies /etc/fstab to mount /dev/md1 during the boot process. Show /etc/fstab i check that the array is mounted during the boot process.

PART 2

1- Modifies /etc/fstab to avoid trying to mount /dev/md1 during the boot process.

2- Unmount /dev/md1

3- Stop and remove /dev/md1

4- Remove any information stored by mdadm on the 4 drives added to your system in PART 1 - question 1.

5- Avoid the creation of /dev/md1 when the computer boots.

6- Check that /dev/md1 does not exist any longer. Also, check that /dev/md1 is not mounted during the boot process.