Operating System

Week 8: Storage Devices and RAID Arrays

LEARNING OUTCOME

- The students will be able to deploy and configure storage devices, and implement RAID arrays for redundancy and fault tolerance.

Storage Devices and RAID Arrays

Storage management involves deploying, configuring, and maintaining storage devices to securely store data. To improve data reliability, availability, and performance, systems often use RAID arrays.

Storage Devices

To store data permanently

Holds files, application and operating system

Storage Devices

1. Types of Storage Devices

HDD (Hard Disk Drive)

Uses spinning disks

Slower but cheaper and larger capacity

Storage Devices

1. Types of Storage Devices

HDD (Hard Disk Drive)

`/dev/sda` – first storage device

`/dev/sdb` – second storage device

`/dev/sdc` – third storage device

`/dev/sdd1` – partition 1 on sdd

`/dev/sdd2` – partition 2 on sdd

Storage Devices

1. Types of Storage Devices

NVMe SSD

Very high-speed storage

Used for performance-critical systems

Storage Devices

1. Types of Storage Devices

External Storage

- USB drives, external HDD/SSD
- Used for backups and data transfer

Software Management

Storage Devices

1. Types of Storage Devices

External Storage

SD Cards

Memory cards

Storage Devices

1. Types of Storage Devices

Network Attached Storage (NAS)

storage device connected to a network using ethernet or Wi-fi

Software Management

```
lsblk
```

List block devices

```
sudo hdparm -Tt /dev/sda
```

Check the Performance

Software Management

```
sudo mount /dev/sdb1 mnt/usb
```

Mount

Create a folder where you want to access

Mount the drive into the folder

Software Management

```
df - h
```

Check storage

```
sudo mount -t cifs //192.168.1.10/shared/mnt/nas
\
-o username-user
```

Mount NAS Using SMB

Software Management

```
sudo dnf install cifs-utils -y
```

install smb/cifs utilities

```
sudo mkdir -p /mnt/nas
```

create mount point

```
sudo nano /etc/smb-credentials
```

create a credentials file

Software Management

```
sudo chmod 600 /etc/smb-credentials
```

Secure permission

```
sudo mount -t cifs //192.168.1.10/shared/mnt/nas
\
-o credentials=/etc/smb-credentials,ver=3.0
```

Mount NAS Using SMB

Software Management

```
sudo nano /etc/fstab
```

make it automatic

```
sudo mount -a
```

reload mounts

```
df -h
```

check

```
sudo mount -t nfs
192.168.1.10:/export/data/mnt/nas_nfs
```

Mount NAS Using NFS

Storage Devices

2. Deploying Storage Devices

Deploying storage means making a new disk usable by the system.

Storage Devices

2. Deploying Storage Devices

Steps:

Detect the disk	`lsblk`
	`fdisk -l`
Partition the disk	`fdisk /dev/sdb`
Create a filesystem	`mkfs.ext4 /dev/sdb1`

Storage Devices

2. Deploying Storage Devices

Mount the disk mount `/dev/sdb1 /mnt/storage`

Make it permanent `/etc/fstab`

Auto mount

RAID (Redundant Array of Independent Disks)

RAID combines multiple disks into a single logical unit to provide:

Redundancy

Fault tolerance

Improved performance

Common RAID Levels

RAID 0 – Striping

Data split across disks

✅ High performance

❌ No redundancy

❌ Data loss if one disk fails

Use case: Performance-only systems

Common RAID Levels

RAID 1 – Mirroring

Data copied to two disks

✅ Full redundancy

❌ Uses more disk space

Use case: Critical data storage

Common RAID Levels

RAID 5 – Striping with Parity

Requires at least 3 disks

Data and parity distributed

- ✅ Can survive 1 disk failure
- ✅ Good balance of performance and redundancy

Use case: File servers

Common RAID Levels

RAID 6 – Dual Parity

Requires at least 4 disks

Can survive 2 disk failures

✅ Higher fault tolerance

❌ Slower writes

Common RAID Levels

RAID 10 (1+0) – Mirror + Stripe

Requires at least 4 disks

Combines RAID 1 and RAID 0

- ✅ High performance
- ✅ High redundancy

Use case: Databases

Implementing RAID Arrays (Linux)

Linux uses `mdadm` for software RAID.

1. Create a RAID Array

```
mdadm --create /dev/md0 --level=1 --raid-
devices=2 /dev/sdb /dev/sdc
```

Implementing RAID Arrays (Linux)

Linux uses `mdadm` for software RAID.

2. Check RAID Status

```
cat /proc/mdstat
```

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

Implementing RAID Arrays (Linux)

Linux uses `mdadm` for software RAID.

3. Create Filesystem on RAID

```
mkfs.ext4 /dev/md0
```

Implementing RAID Arrays (Linux)

Linux uses `mdadm` for software RAID.

4. Mount RAID Array

```
mount /dev/md0 /mnt/raid
```

Fault Tolerance and Redundancy

Redundancy: Extra copies of data to prevent loss

Fault tolerance: System continues operating even if a disk fails

Fault Tolerance and Redundancy

RAID helps:

Prevent downtime

Protect data

Improve system reliability

⚠️ Important: RAID is NOT a backup.

Troubleshooting RAID Issues

Disk Failure

```
mdadm --fail /dev/md0 /dev/sdb
```

```
mdadm --remove /dev/md0 /dev/sdb
```

Troubleshooting RAID Issues

Replace Disk

```
mdadm --add /dev/md0 /dev/sdd
```

Monitor RAID

```
watch cat /proc/mdstat
```

End of Discussion