Building and Configuring an OpenMediaVault NAS: From Hardware to File Sharing

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Written by
AL-ASADI Ahmed
NGUYEN Auguste Duc-Liêm Kim
Class: BTS – Cloud Computing

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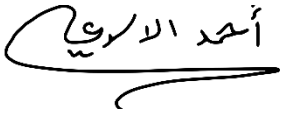
Certification and declaration of honour

I the undersigned solemnly declare that the project report "Building and Configuring an OpenMediaVault NAS: From Hardware to File SharingCloud Infrastructure" is based on my own work carried out during the course CLOIF2 and VIRCL of the BTS cloud computing.

I assert the statements made and conclusions drawn are an outcome of my research work. I further certify that:

1. The work contained in the report is original and has been done by me.
2. The work has not been submitted to any other Institution.
3. We have followed the guidelines provided by the teachers in charge of the course(s).
4. Wherever we have used materials (data, theoretical analysis, and text, images, videos, …) from other sources, we have formatted in an outstanding way and given due credit to them in the text of the project report and giving their details in the references.

AL-ASADI Ahmed



NGUYEN Auguste Duc-Liem Kim

Introduction

The **purpose** of this project is to build a **reliable and efficient Network-Attached Storage** (NAS) system using **OpenMediaVault** (OMV) as operating system. The **NAS** will provide **centralized data storage**, **file sharing**, **and backup solutions** for a home or small business environment.

By implementing **RAID 5**, the system will ensure **data redundancy and fault tolerance**, protecting against hardware failures. Additionally, the **NAS** will support **multiple network protocols (SMB, NFS, FTP, and iSCSI)** to enable file access across different operating systems (Windows, Linux, macOS).

The **project** will **focus on**:

Figure 1 - Project Roadmap

This **NAS deployment** will serve as a **practical learning experience** in cloud infrastructure, covering key concepts such as **server administration, virtualization, networking, and data security**. The **final outcome** will be a **fully functional NAS** solution, complete with a project report and a presentation to demonstrate its capabilities.

Information

a. Do some research about the topic NAS. What is it? What is it used for?

Network-attached storage (NAS) is a **dedicated file storage** that enables **multiple users or client devices** to **retrieve data** from a **centralized disk** capacity. The **purpose of NAS** is to enable users on **a local area network** (LAN) **to collaborate** and **to share data** more effectively.

b. What it the difference between DAS, NAS and a SAN?

The **main difference** between **network-attached storage (NAS)**, **direct-attached storage (DAS)** and **storage area networks (SANs)** lies in how they connect to systems and how they handle storage access.

DAS (Direct-Attached Storage):

Connection:
Directly attached to a single computer or server.

Data Access:
The system accessing the storage does so directly through internal interfaces like SATA, SAS, or USB. It is usually not shared over a network.

Use Cases: Ideal for personal or single-user environments with minimal network requirements.

NAS (Network-Attached Storage):

Connection:
Connected to a **network** and accessible by multiple devices.

Data Access:
Provides file-level data access over a network using protocols such as **SMB/CIFS, NFS**, or **FTP**.

Use Cases:
Used for **unstructured data** like documents, multimedia files, and backups, and is ideal for small-to-medium-sizred businesses or home networks

SAN (Storage Area Network):

Connection:
A **high-performance network** that connects multiple servers to centralized storage devices, using block-level protocols like **Fibre Channel** or **iSCSI**.

Data Access: Handles **block-level data** and is primarily used for applications that require high-speed access to structured data, such as databases or virtual machine storage.

Use Cases: Designed for **large enterprises** or data centers with demanding storage needs, where high throughput and reliability are critical.

c. Explain why in a professional environment, compute (CPU/RAM) and storage are usually separated.

Separating **CPU** (Central Processing Unit)**/ RAM** (Random Access Memory), and **storage** optimizes **performance**, **scalability**, **reliability**, **cost efficiency**, and **thermal management** in both general computing and professional IT environments.

Performance & Functionality	○**CPU & RAM:** The CPU&RAM are directly responsible for handling computations, multitasking, and the overall responsiveness of your server. ○**Storage:** Unlike RAM, storage retains data permanently and operates at lower speeds, ensuring data-intensive operations don't slow down computing tasks.
Scalability & Flexibility	**Independent Scaling:** Compute and storage needs grow at different rates. By separating them, you can independently upgrade each resource without over-provisioning.
Cost Efficiency	**Specialized Manufacturing:** Specialized storage solutions (**like NAS and SAN**) **reduce costs**, as centralized storage systems are often more economical than integrating high-capacity storage into each compute node.
Reliability & Data Protection	**Redundancy & Backups:** Storage failures **don't impact computing performance**—redundancy, backups, and disaster recovery can be managed separately.
Thermal & Power Management	**Efficient Cooling:** CPUs generate significant heat, and keeping storage separate simplifies the design of cooling solutions and power distribution, allowing each component to be optimized for its specific needs.
Memory Hierarchy & Design Complexity	**Memory Hierarchy:** The computing **memory hierarchy (Registers → Cache → RAM → Storage)** ensures efficiency—merging them would **disrupt system performance**.

To conclude, a **modular approach** to CPU, RAM, and storage **enhances flexibility, performance, and reliability**. While **SoCs (System on Chip)** integrate components in mobile devices, professional environments prioritize **scalability and independent upgrades**.

d. Describe the server form factor and casing dimensions

The term ***form factor*** describes the physical shape of the chassis and housing of the server's hardware. Beyond **size and shape**, each form factor has its **own unique requirements** for housing, maintenance and usage. These are the **most commonly used** form factors for servers:

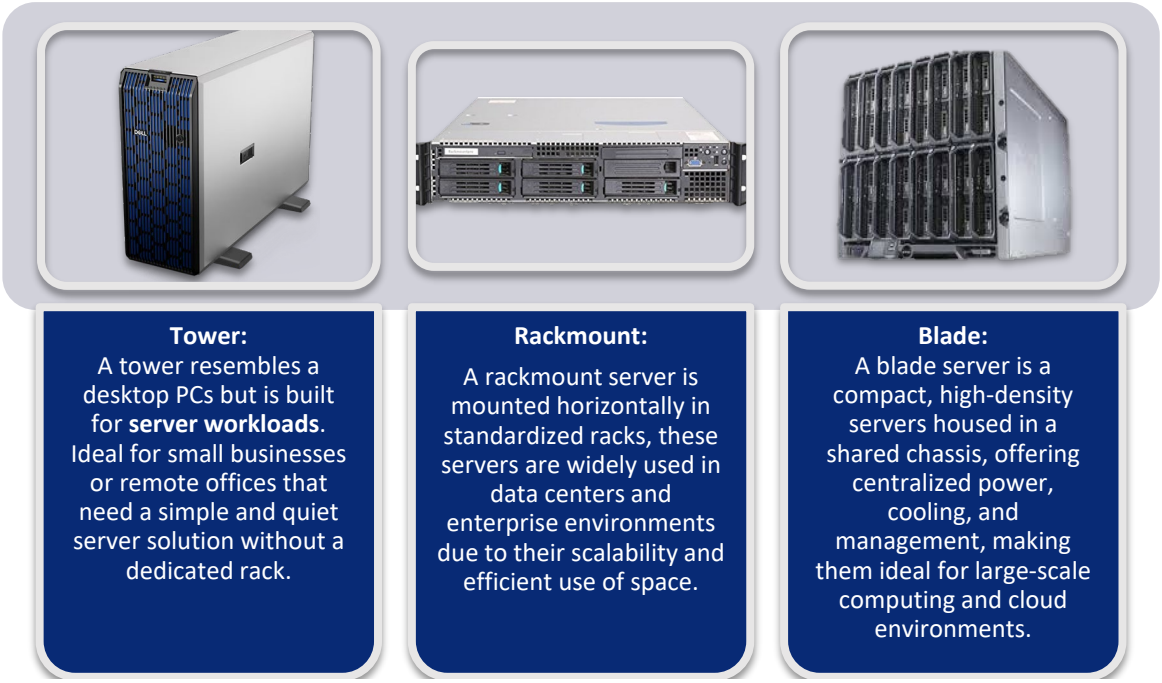
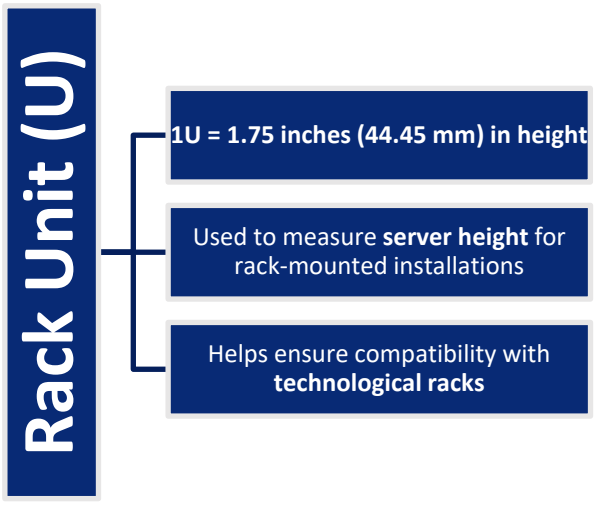


Figure 2- Types of Server

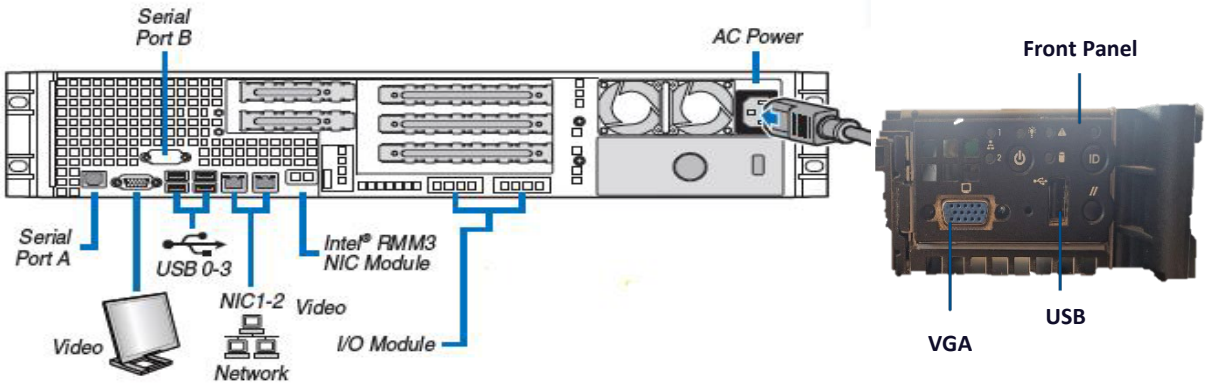
For all of them there is a single measurement system. All server **form factors** follow a **single standardized measurement system** based on **rack units (U)**. The server we are using for this project is a **2U rack server.**



Understanding **rack units** is crucial for selecting and configuring server hardware, ensuring **proper installation and efficient space utilization** in **data centres** and IT environments.

e. Describe all the external server ports and connectors

The **external server ports** and **connectors** allow the server to **interface** with **peripheral devices** and **network systems**.



f. Open the casing and describe all the internal hardware components

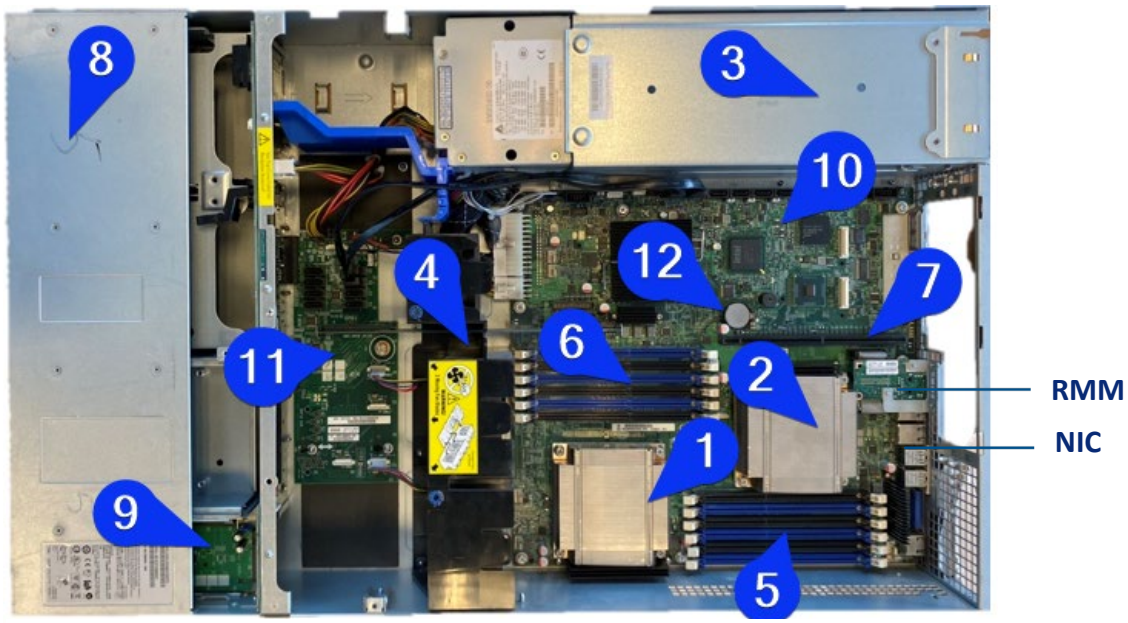


Figure 3 - Internal Hardware

1	CPU 0	**5**	DIMM/RAM (not hot swapable)	**9**	Front Panel
2	CPU 1	**6**		**10**	Motherboard
3	Power Supply	**7**	PCIE Slot	**11**	Daughterboard
4	Cooling Fans	**8**	Hard Disks (hot swapable)	**12**	Motherboard Battery

g. Describe all internal ports and connectors

The **internal ports** and **connectors** inside a server **enable communication between the components**. These **connectors** are **essential** for **internal system functionality** and **maintaining the server's overall performance**.

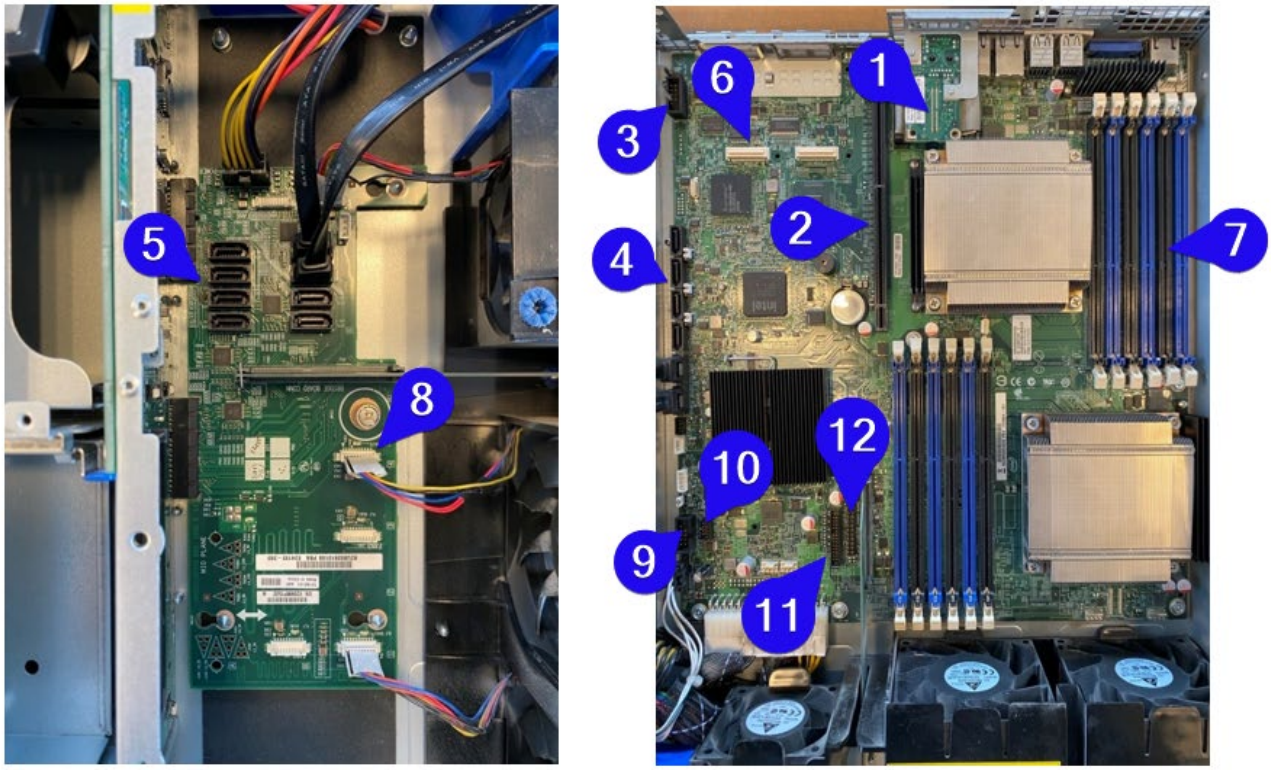


Figure 4 - Internal Ports & Connectors

1	RMM3 (connector)	5	8x SATA connectors	9	Front USB
2	PCIe Riser	6	2x I/O module connectors	10	SSD USB
3	Serial B Port	7	DIMM	11	Fan Board
4	6x SATA	8	Fan connectors	12	Front Panel

Staging

a. Install the RAM modules (Optimal 8-DIMM Configuration for Dual-Processor Server)

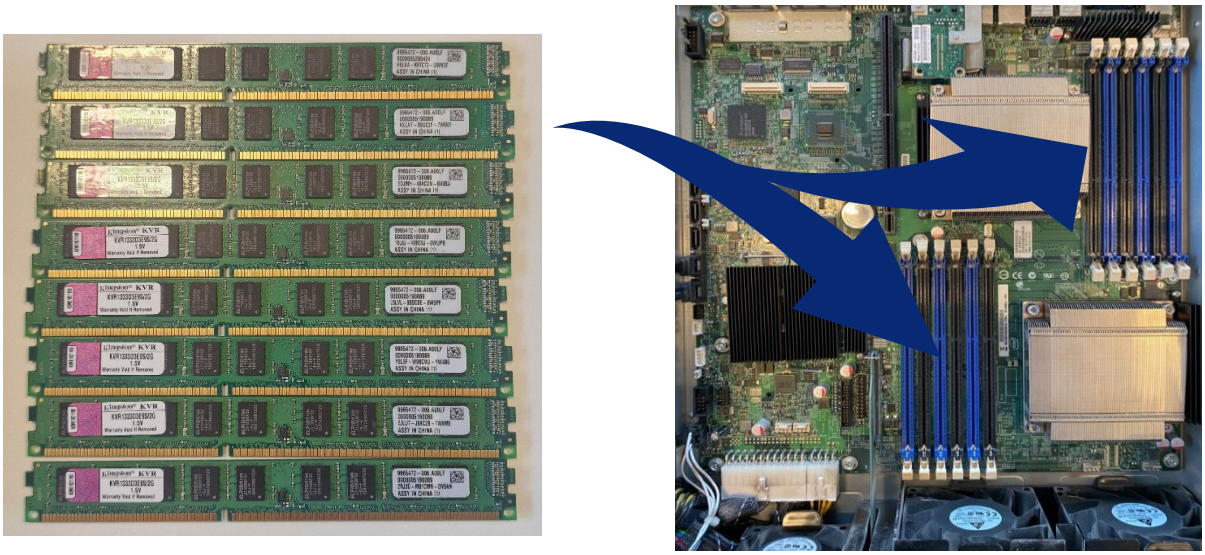
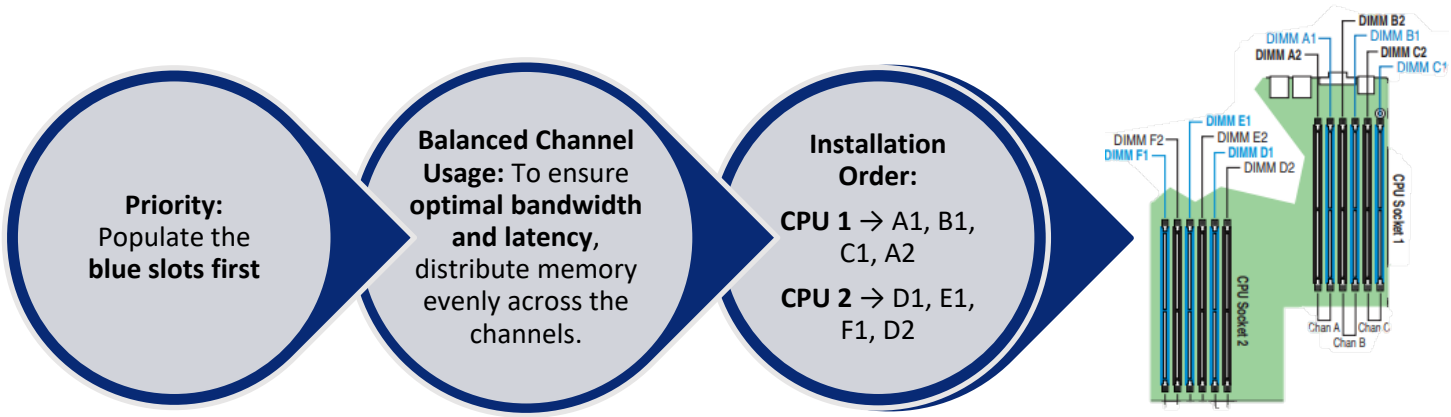


Figure 5 - RAM Installation

In a **single-processor** configuration, always populate **A1 DIMM first**. In a **dual-processor** configuration, always populate **A1 DIMM** first for **CPU 1** and **D1 DIMM** first for **CPU 2.**

Since there are **two CPUs**, distribute the **8 DIMMs evenly** across both processors.



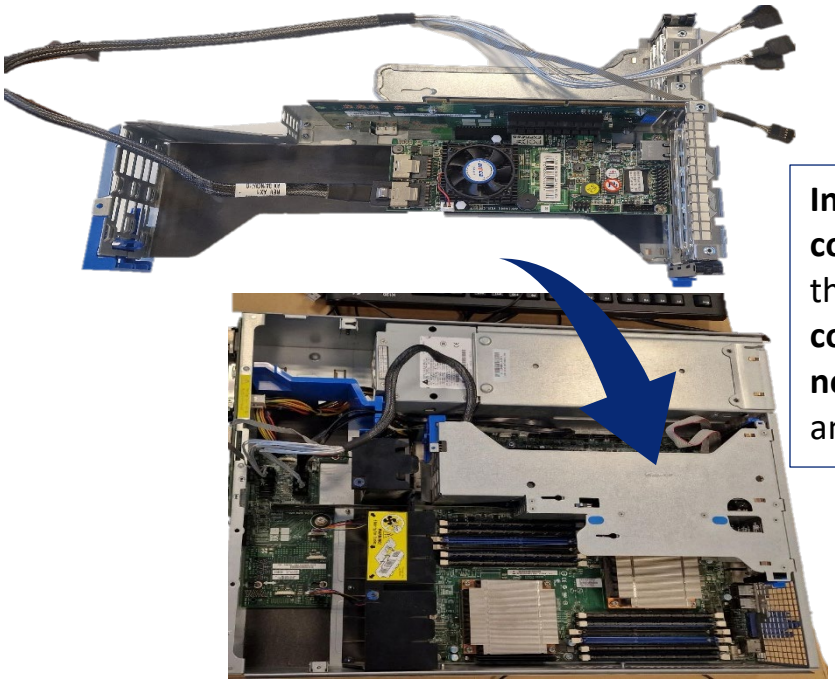
b. Install the native HDDs and the RAID HDDs

Figure 6 - Native & RAID HDDs Installation

Install the native HDDs & the RAID HDDs

- **Identify** the **internal drive bays** where the **HDDs** will be mounted.
- Slide **each HDD** into its designated **hot-swap bay** and **secure it** with screws inside a drive cage.
- Connect **SATA cables** from the HDDs to the **motherboard** and **RAID controller**.

c. Install the RAID controller

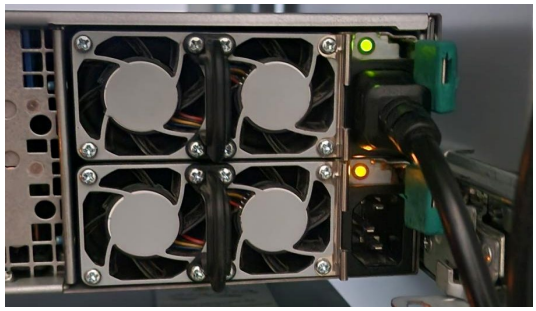


Insert the **RAID controller card** into the **PCIe slot** and **connect** the **necessary power** and **data cables.**

Figure 7 - RAID Installation

d. Check the power supplies for correct function and simulate a failure

Check the **power supplies** by looking at the **LEDs** on the **PSU** or through the **server's management interface**



Check for **beep codes** indicating power supply failure
Look for **amber** or **blinking LEDs** and review **server logs** or **remote management alerts**

To simulate a failure:
Manually disconnect one of **the power supplies** if the server has redundant power supplies.
Or use the **server's management interface** to simulate a power supply failure.
(This depends on the server model, not working with ours).

e. Connect a monitor, a keyboard and a mouse to the server

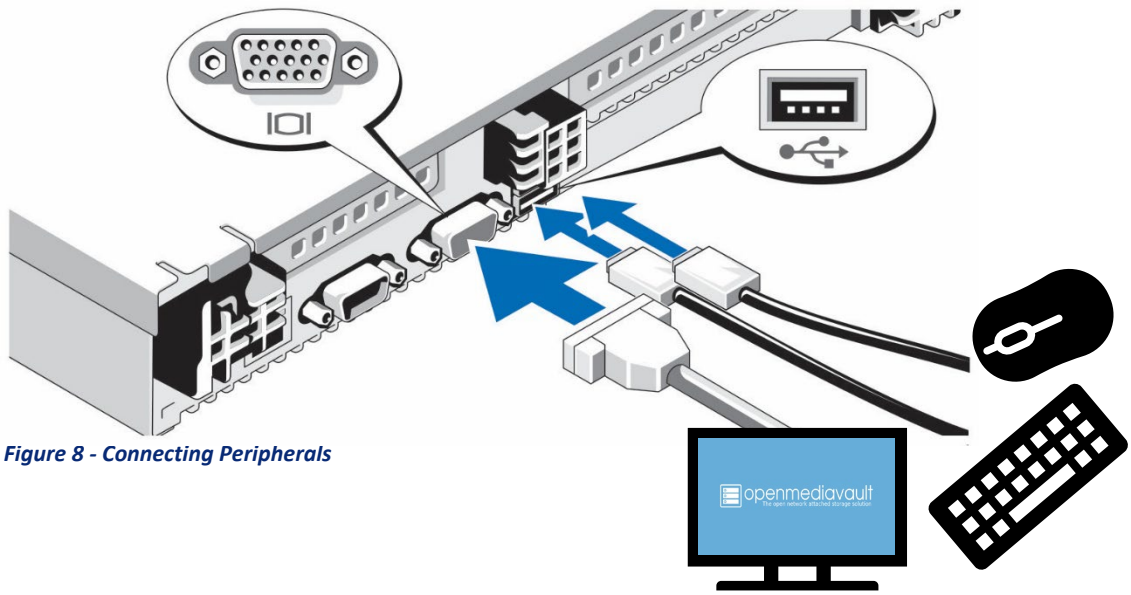
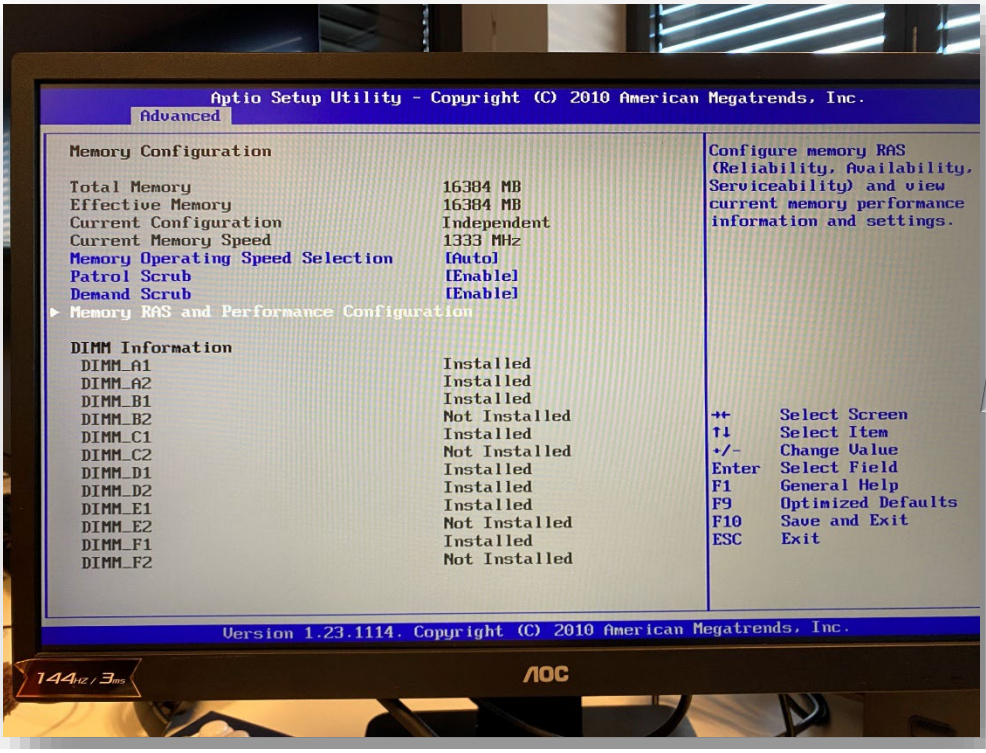


Figure 8 - Connecting Peripherals

f. Check the hardware in the BIOS (Has everything been detected correctly? Any error codes or messages?)



Everything has been detected an no error messages shown. The installation was successful

Figure 9 - Hardware Check

g. Check the BIOS configuration (RMM IP address, boot media, ...)

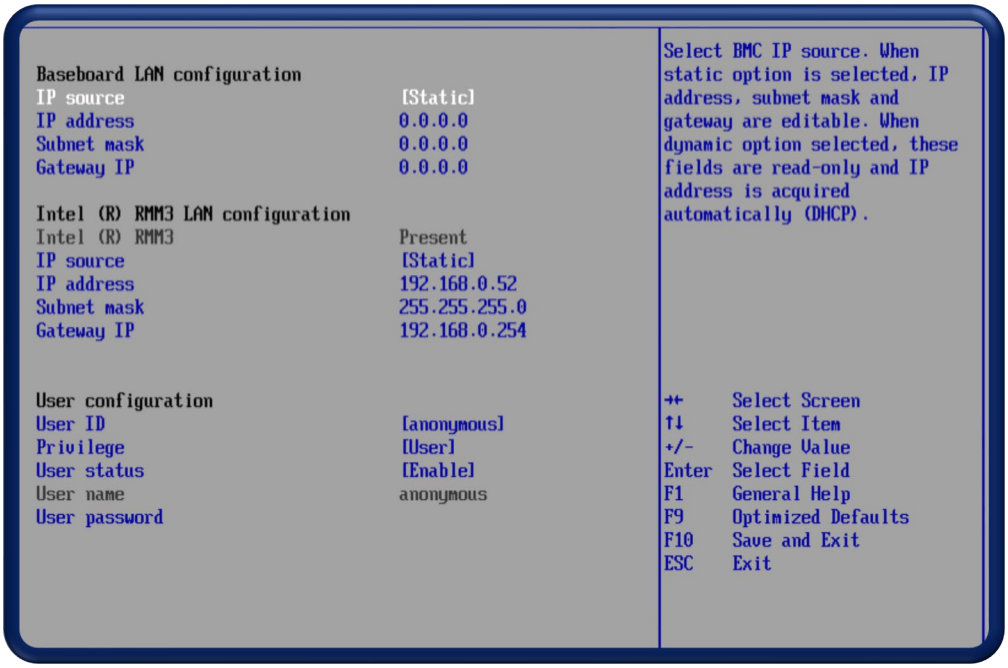


Figure 11 - RMM IP

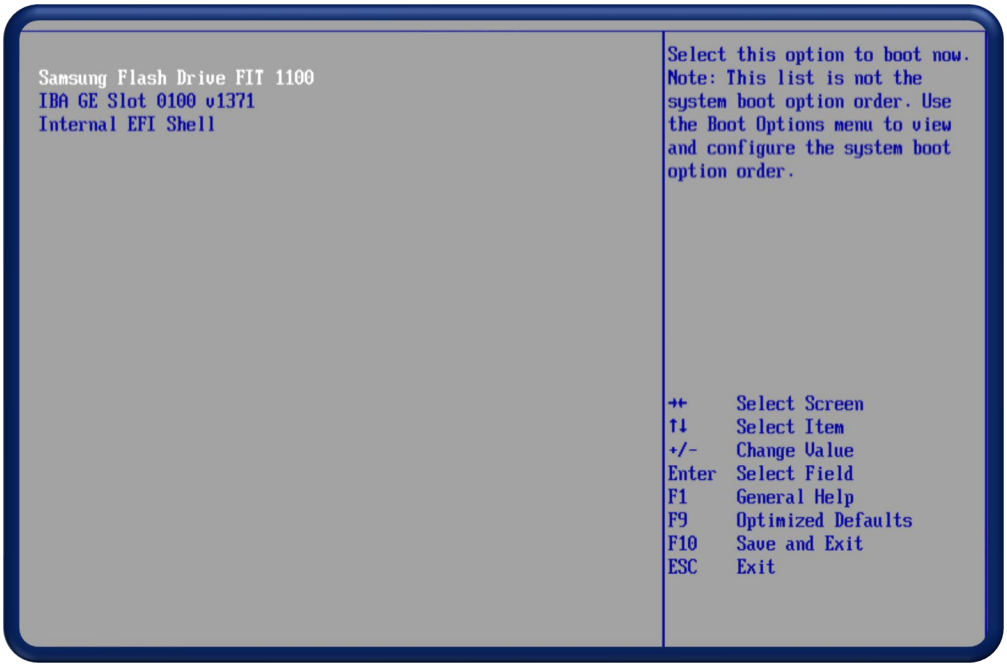


Figure 10 - Boot Media

h. Check the RAID controller IP configuration

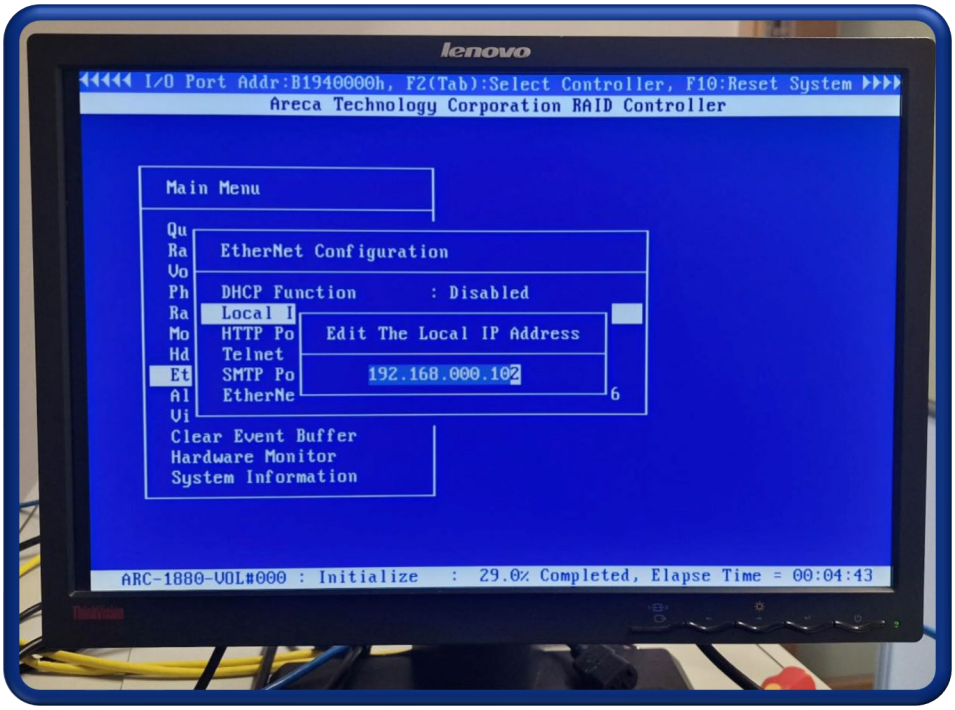


Figure 12 - RAID IP Configuration

RAID Controller Configuration

a. **Connect the RAID controller network port and open the RAID controller web interface**

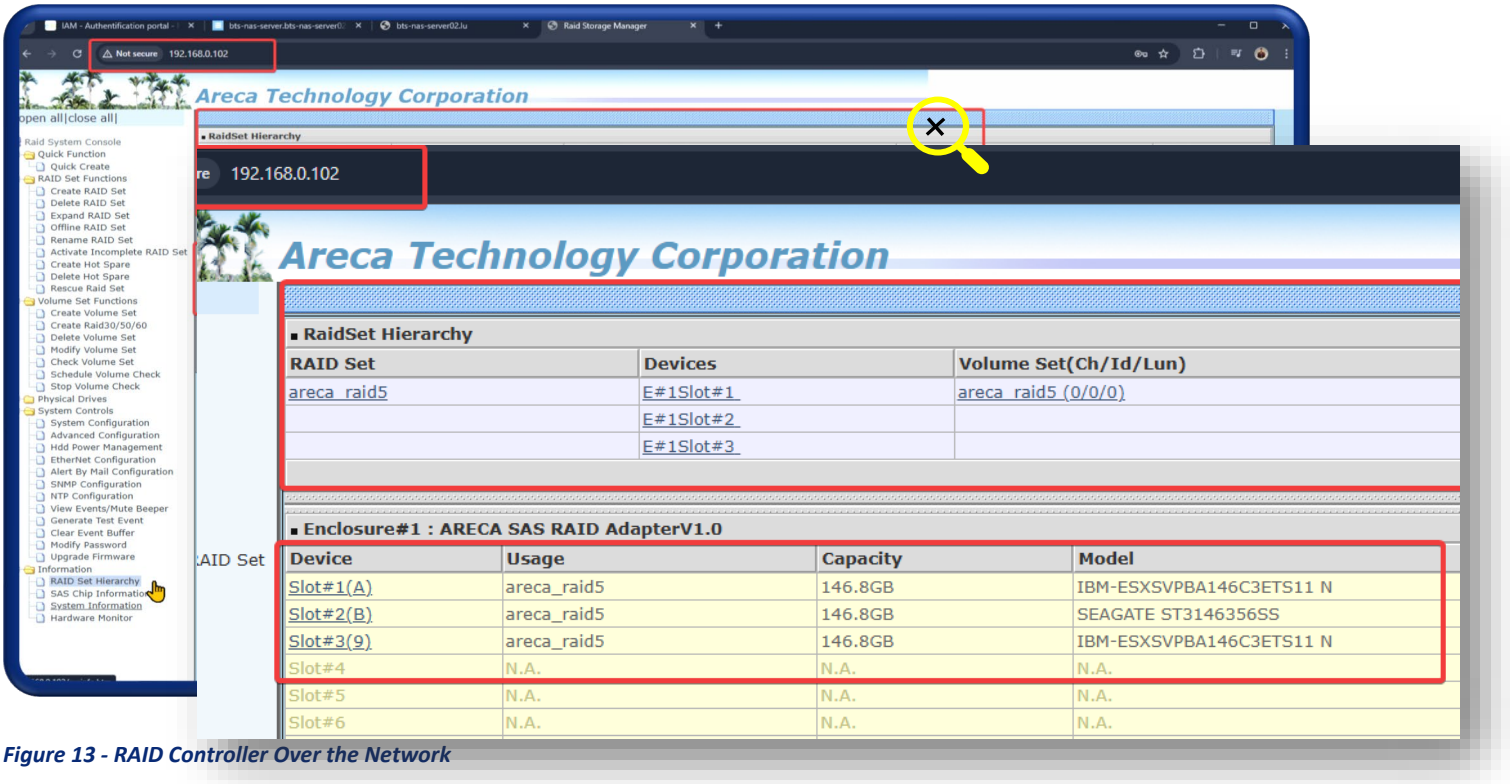


Figure 13 - RAID Controller Over the Network

b. **Create a new RAID 5 array consisting of the 3 SAS disks naming the volume areca_raid5.**

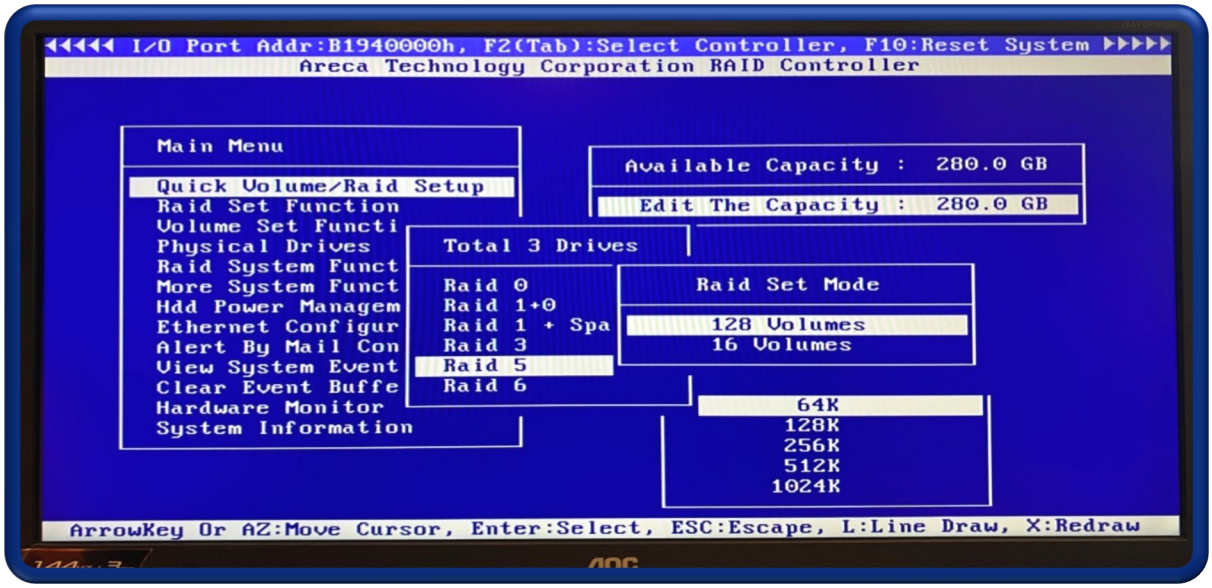


Figure 14 - Creating a New RAID 5 Array with 3 SAS Disks

OS Installation

a. Describe your NAS software.

I. What is it?

Openmediavault is a **NAS solution** built on **Debian Linux**. It comes **pre-configured** with **various services**, such as **SSH**, **(S)FTP**, **SMB/CIFS**, and **RSync**.
Its modular framework lets you easily **extend** its **capabilities** with **plugins**.

While it's primarily aimed at small or home offices, its **flexibility** makes it suitable for many **different environments**.
With its **simplicity**, **Openmediavault** allows **anyone** to **set up** and **manage** a **Network Attached Storage system** without needing in-depth technical expertise.

II. Who created it?

OpenMediaVault is originally developed by **Volker Theile** and is maintained by an active community of contributors.

III. Which is the latest release?

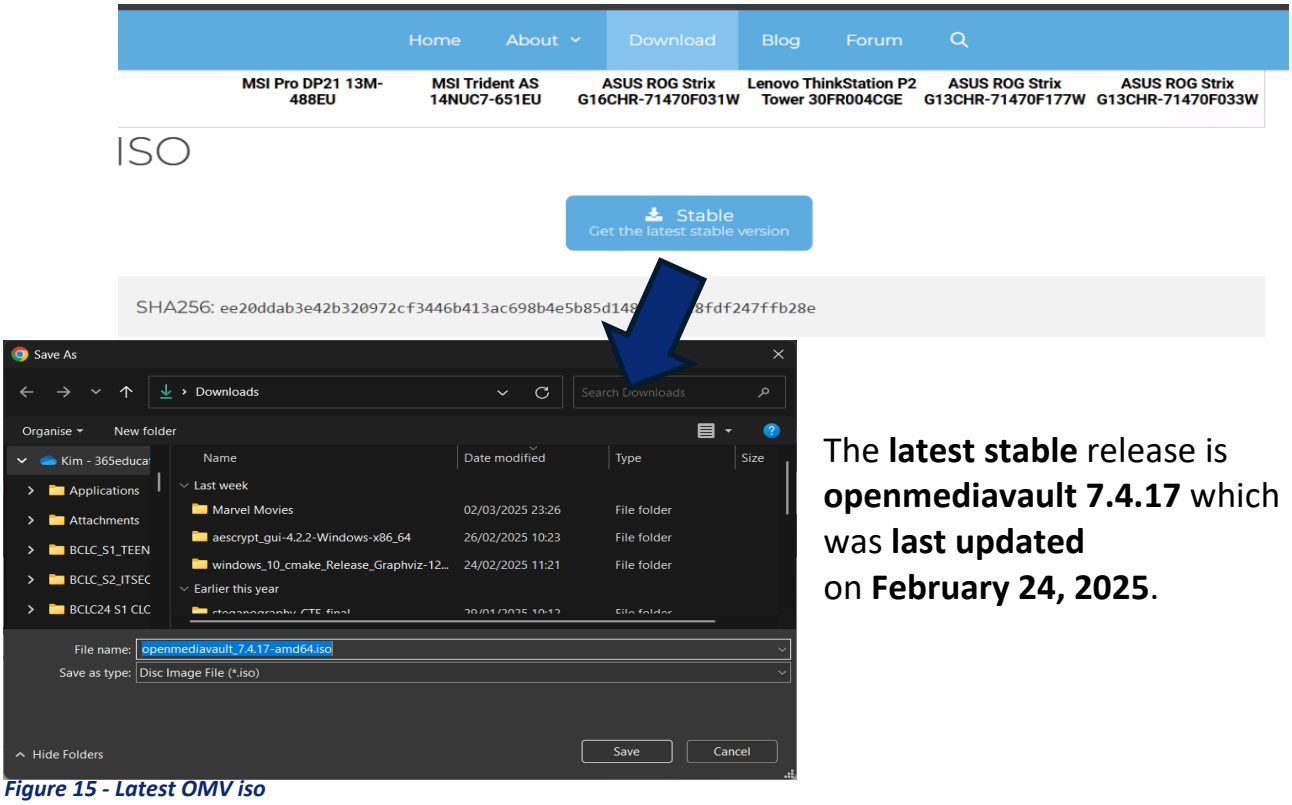


Figure 15 - Latest OMV iso

The **latest stable** release is **openmediavault 7.4.17** which was **last updated** on **February 24, 2025**.

IV. How much does it cost?

OpenMediaVault is **completely free** to use, as it is released under an **open-source license**.

Figure 16 - Free

V. What are the most important features?

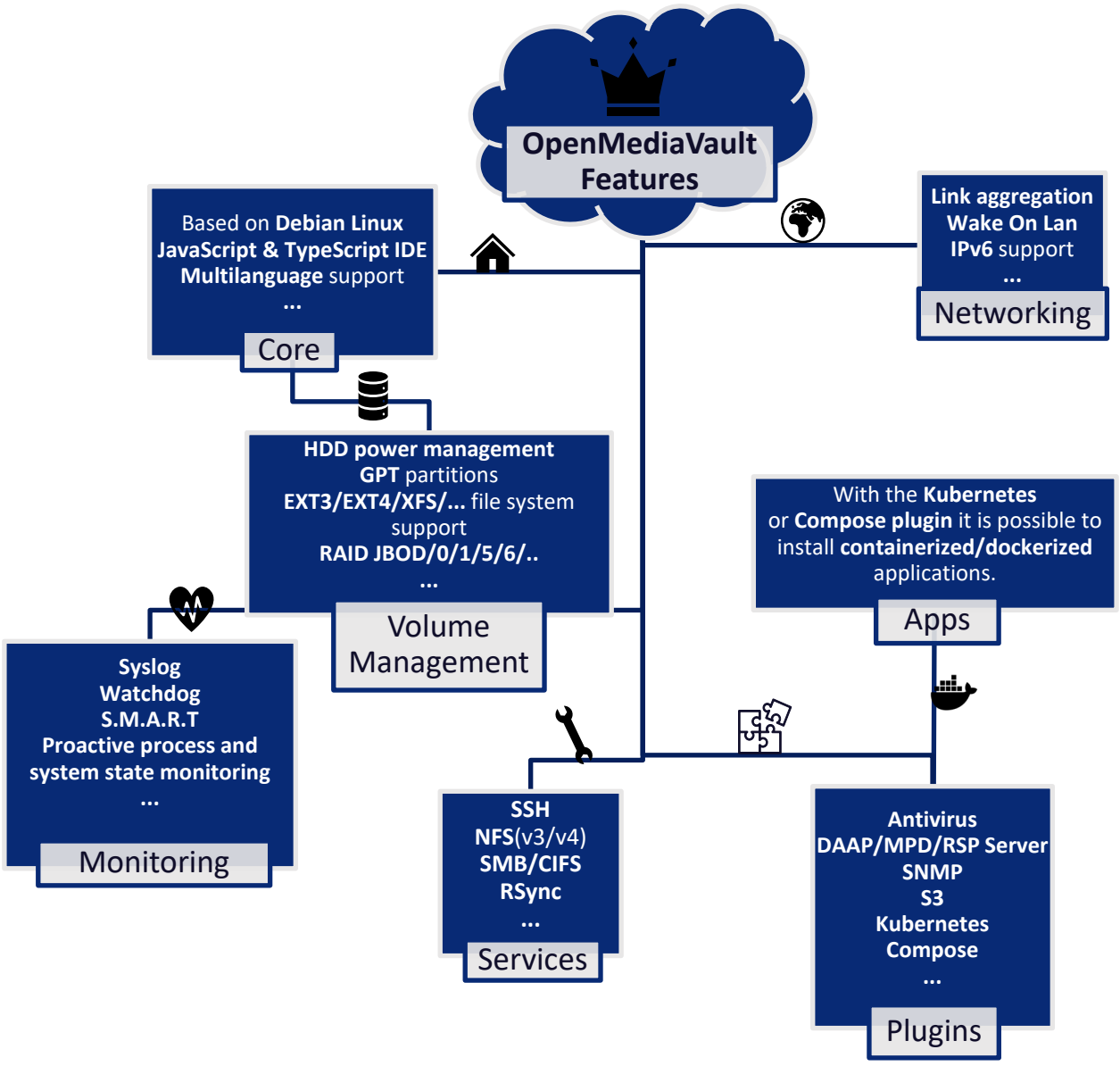


Figure 17 - OMV Features

VI. Why should or shouldn't you use it?

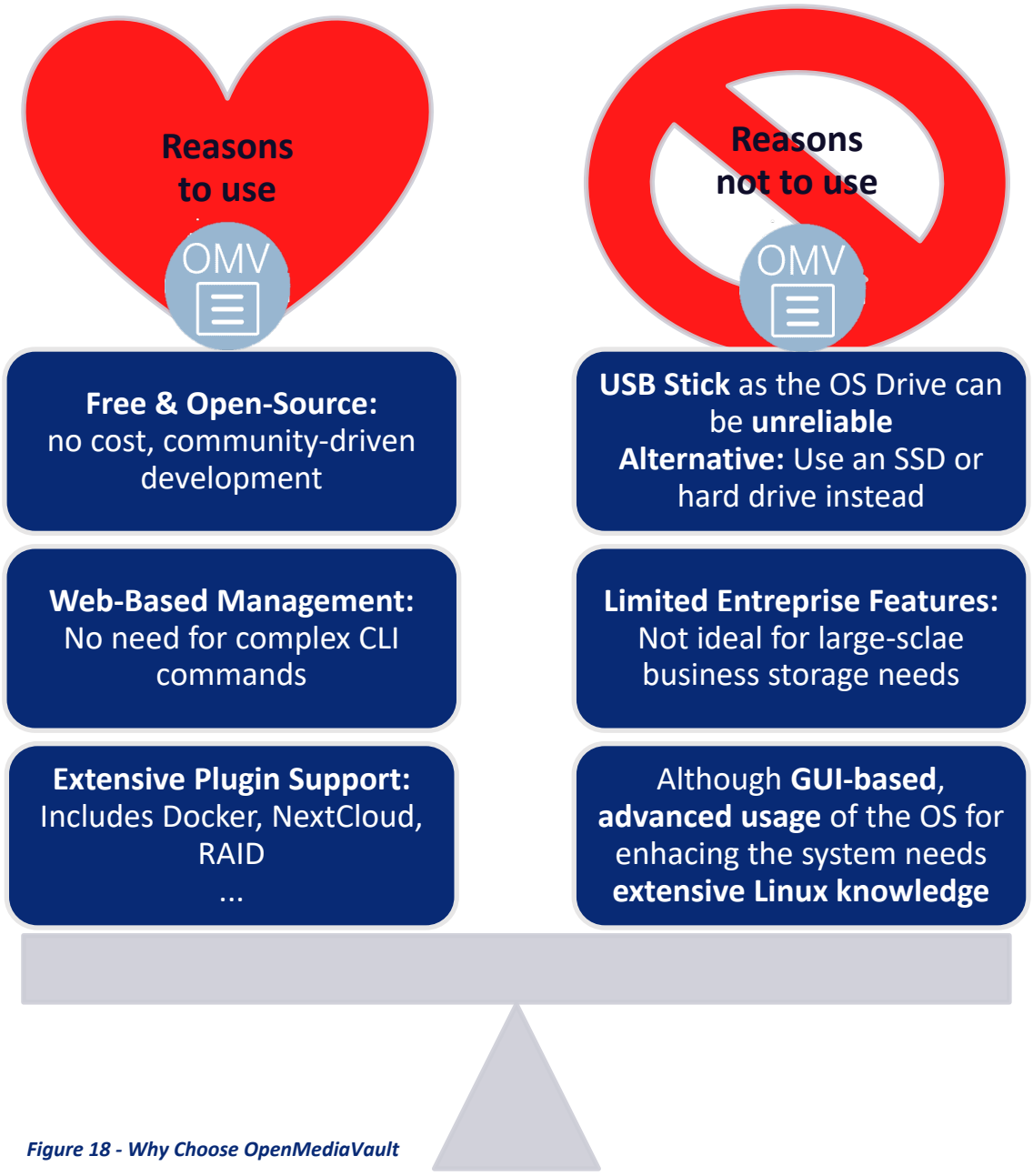
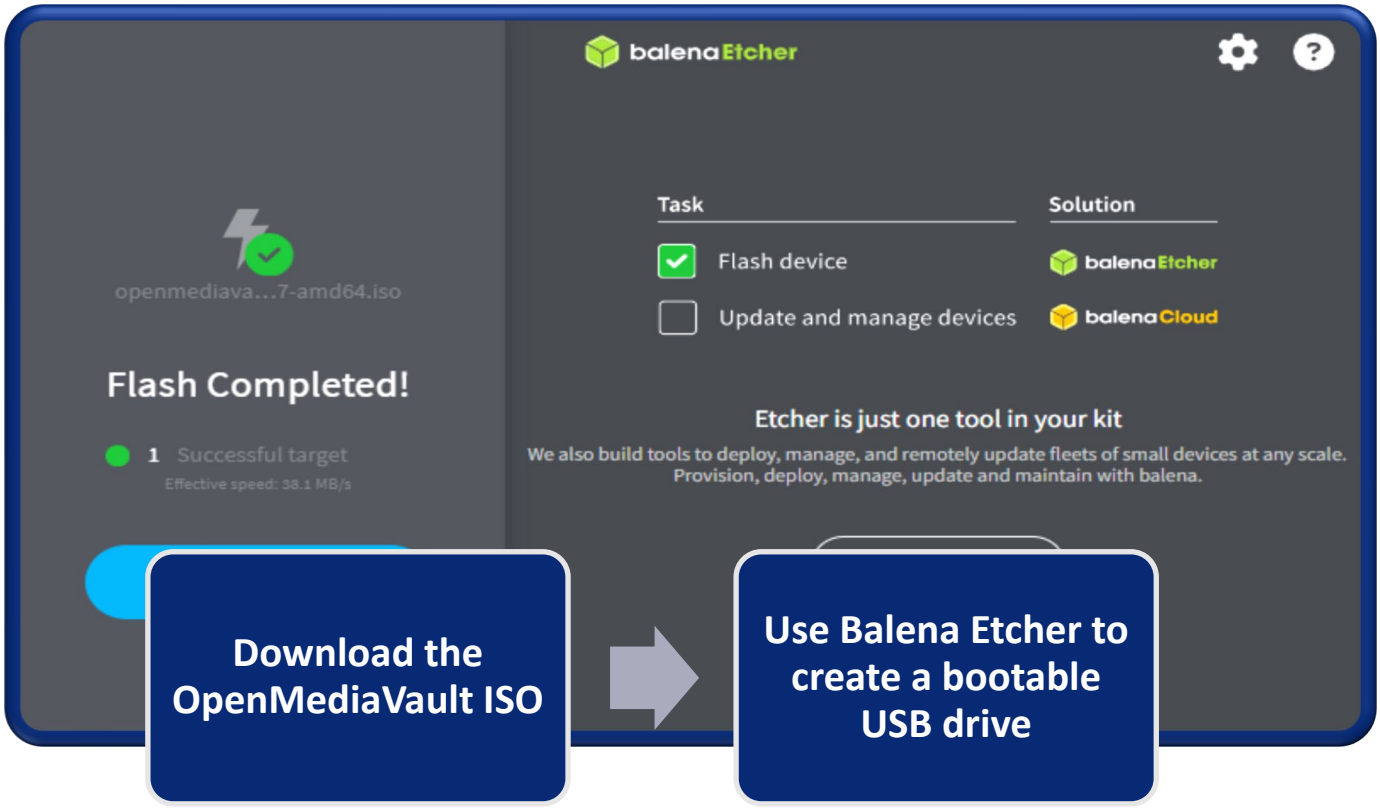


Figure 18 - Why Choose OpenMediaVault

To conclude, use **OMV** if you want a **flexible** and **lightweight NAS** solution for personal or small office use. Although **OMV** can be pushed to **enterprise-level** performance, it **requires significant manual setup** and **ongoing maintenance.**

b. Create a separate USB installation medium



c. Plug in the installation USB medium in the front of the server and boot from it.

Figure 19 - USB medium

d. **Install the NAS operating system onto the rear connected empty USB stick.**

Figure 20 - Rear USB

e. **After the installation, remove the installation medium from the front USB port, start your NAS OS from the rear USB stick and perform the main configuration**

I. **Username/Password**

Default OMV login

Username: admin

Password: openmediavault
(Change the password immediately!)

II. Network configuration

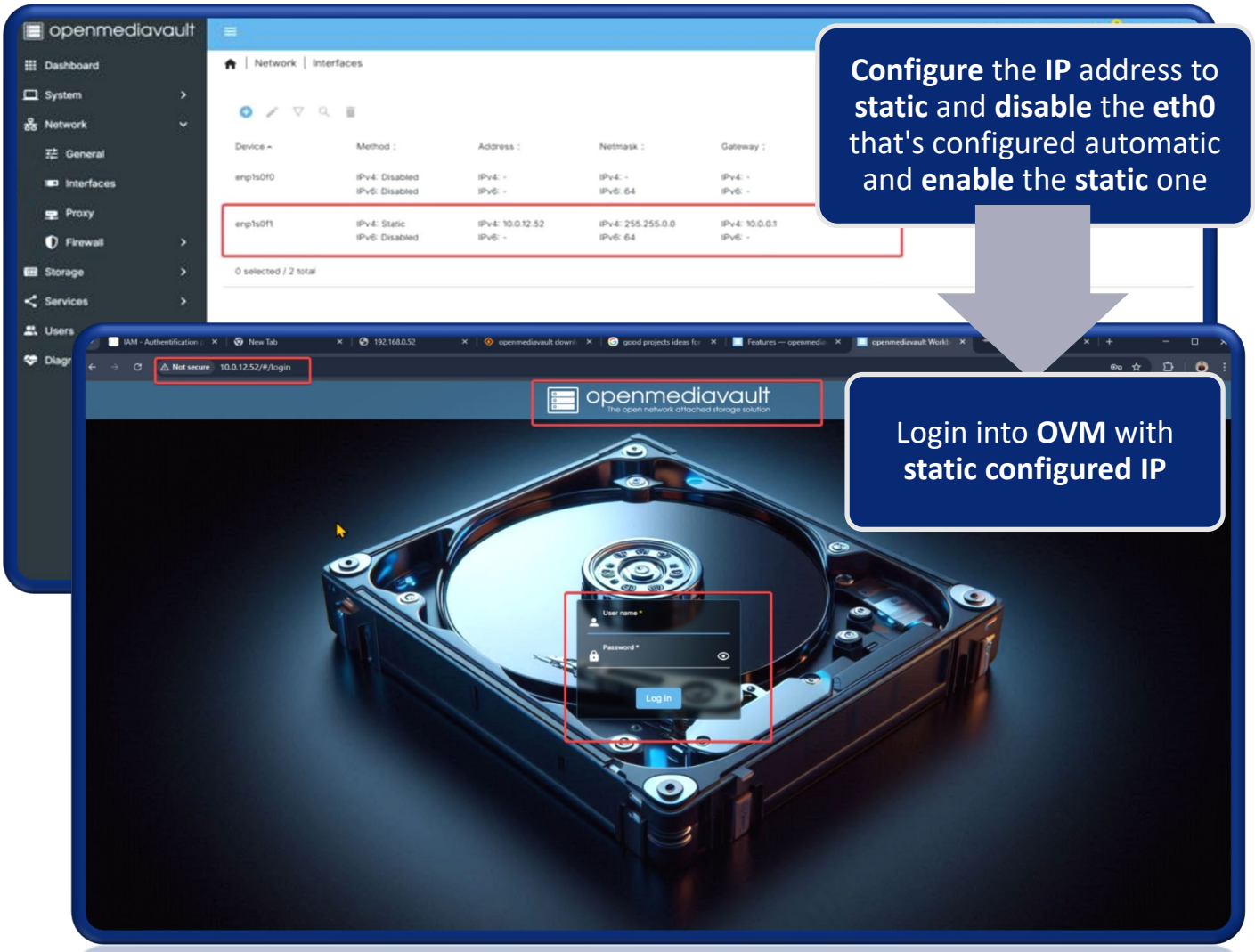


Figure 21 - OMV Network Configuration

III. Hostname

We change the **hostname** to **bts-nas-server** and the **domain name** to **bts-nas-server02.lu**

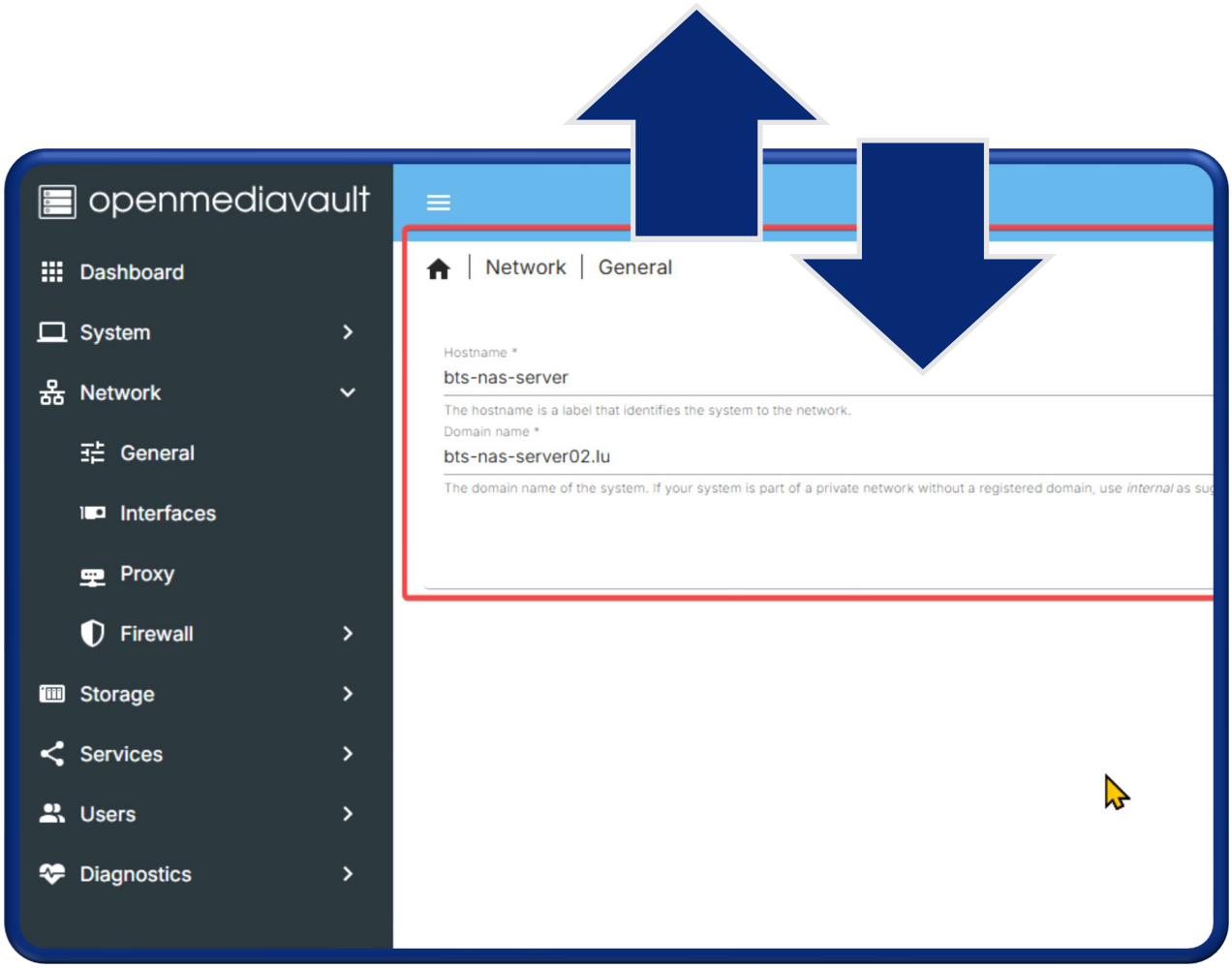


Figure 22 - Hostname

Installation

a. Plan the rack installation and coordinate with other teams on timing and spacing

When **planning** the **rack installation**, **precision** and **order** is **key**.
Here's a concise breakdown:

Physical Space & Clearance

Confirm the **rack fits** the designated area, **ensuring** there's **enough room** not only for the rack itself but also for **adequate airflow** to prevent overheating

Ensure there's **sufficient clearance** around the rack for **maintenance access**, allowing technicians to **reach** the **hardware comfortably** during **servicing** or **upgrades**.

Cable Management

Use cables of the **same color** to streamline organization and make troubleshooting easier.

Share a detailed **connection plan**, including **how to plug the three cables** into the **switch**, specifying **port assignments** and **routing guidelines**.

This **structured approach** helps guarantee a **well-organized**, **efficient installation** that meets both **operational** and **maintenance** needs.

Figure 24 - Front of the Server Rack

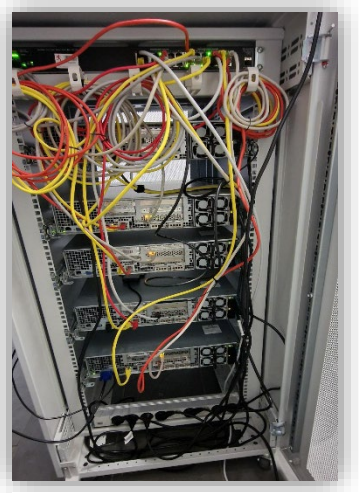


Figure 23 - Back of the Server Rack

b. **Install both rails horizontally in the rack (pay attention to install them correctly!)**

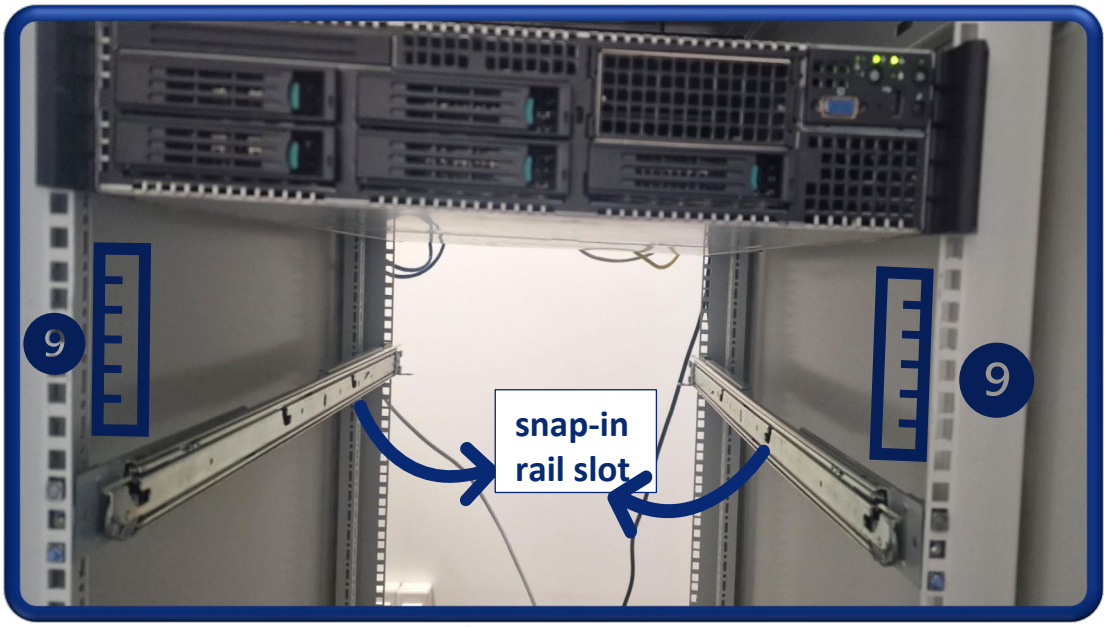


Figure 25 - Server Rails

c. **Place the server on rails and make sure that the rails snap in place so the server is mounted tightly.**

Figure 26 - Server in the Rack

d. Connect the power and network cables

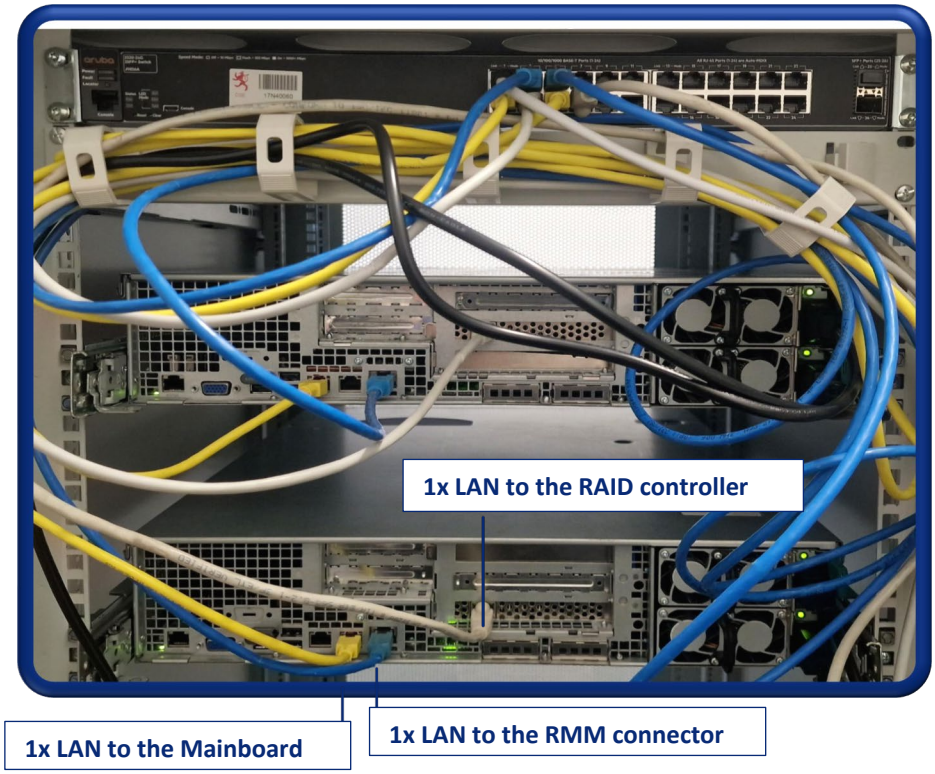


Figure 27 - Server Cabling

e. Connect to the server using the Remote Management Module (RMM)

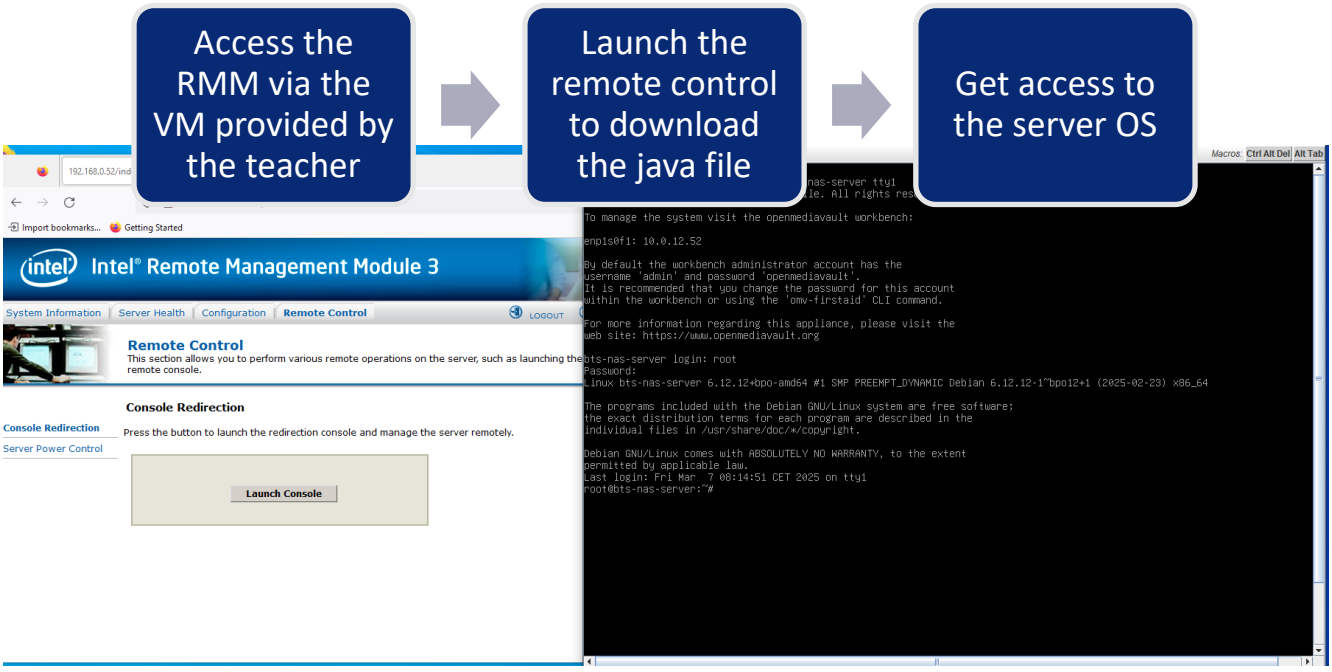


Figure 28 - Connection with RMM

NAS Configuration and Testing

a. **In the NAS interface, you should find the areca_raid5 volume which is already redundant due to the RAID controller.**

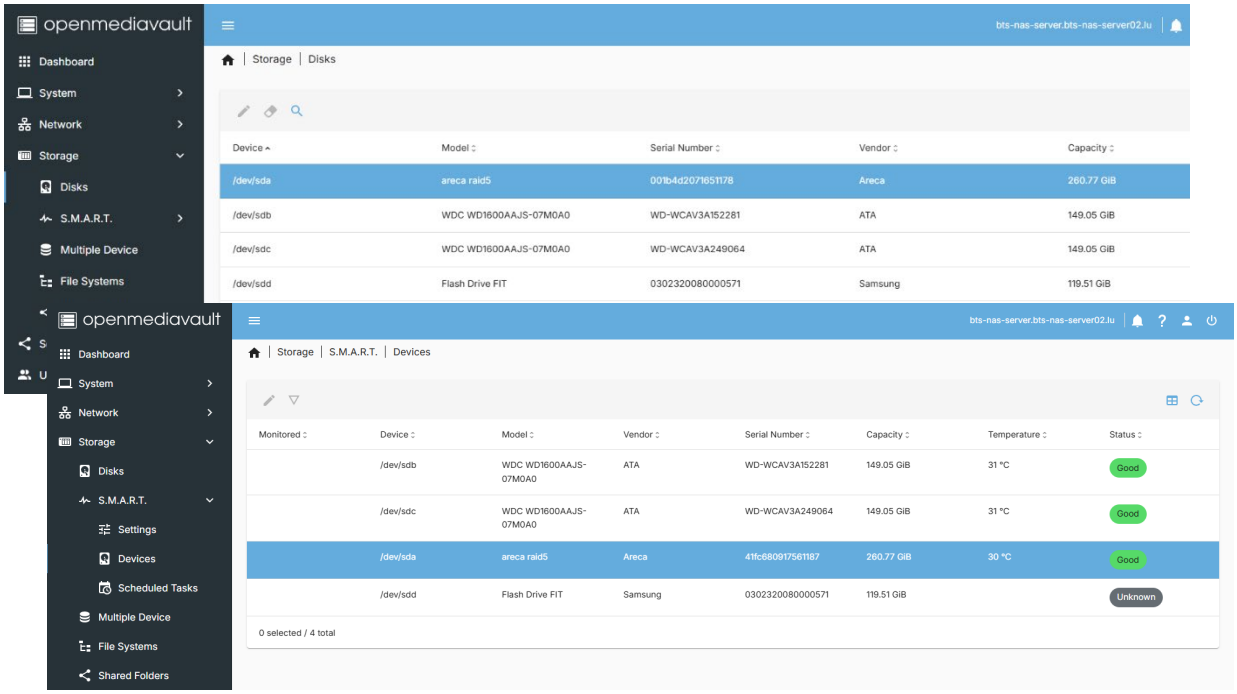


Figure 29 - Storage Devices

b. **Create another RAID 1 volume in the NAS OS using the 2 SATA disks in the server calling it software_raid1. At the end you should have 2 RAID volumed:**

   i. **RAID 5 “areca_raid5” using the Areca hardware RAID controller**

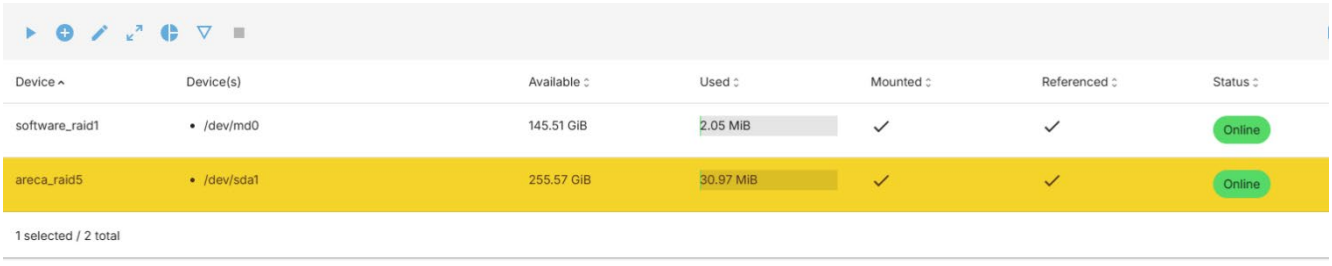


Figure 30 - RAID 5 "areca_raid5"

ii. RAID 1 “software_raid1” using your NAS OS software RAID feature

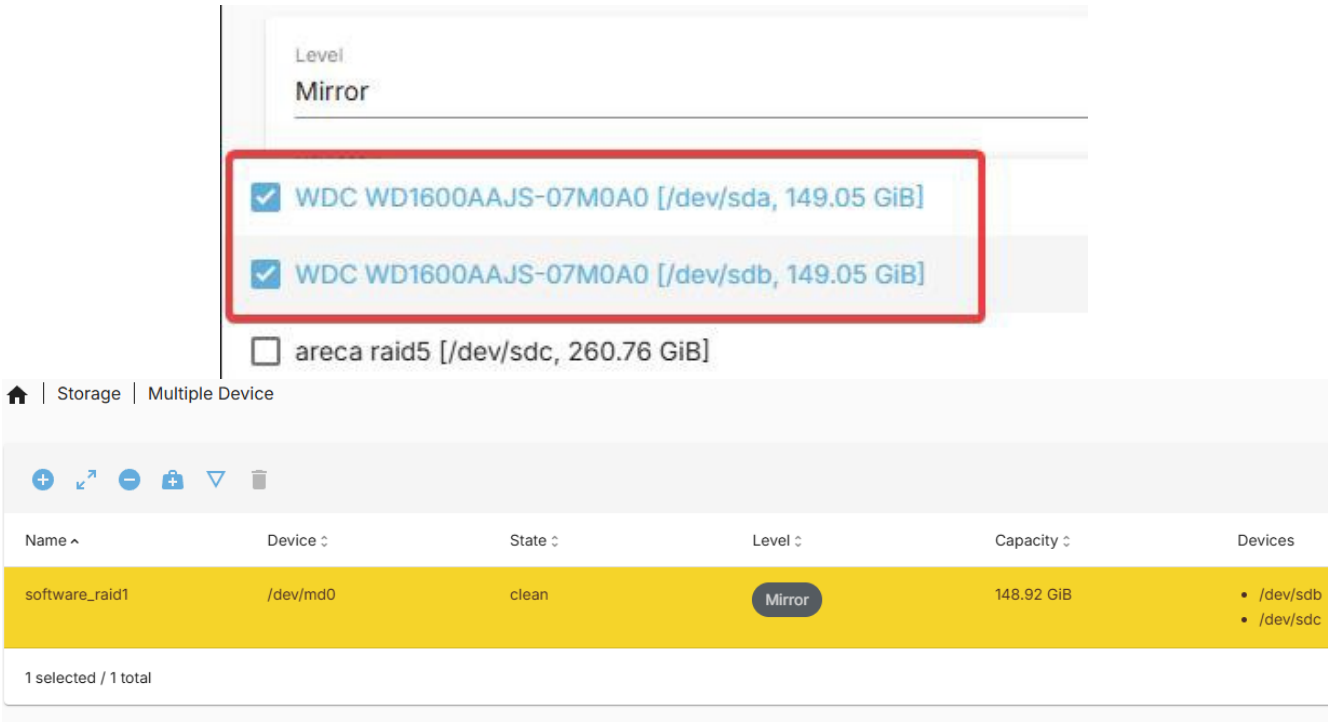


Figure 31 - RAID 1 "software_raid1"

c. **Create a file sharing system using the two RAID arrays and propose a shared folder structure, user permissions, and network protocols for the following scenario.**
"A family wants to use your server as a central home storage for their data like pictures, video, document and also backups. Many users should have mixed access rights and they use a variety of client devices to access the shared folders (Windows, Linux, Mac)."

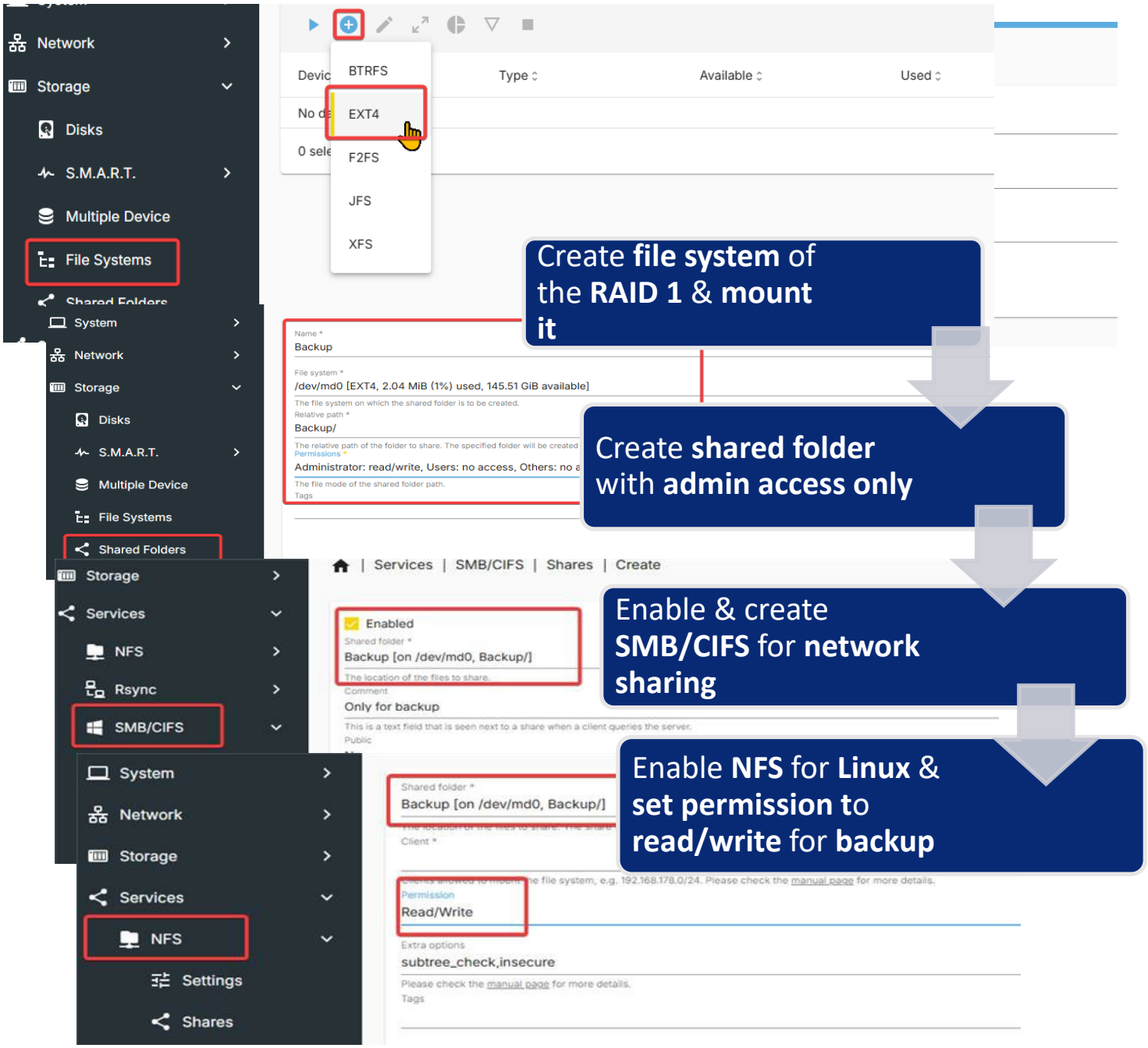


Figure 32 - Creating RAID 1 Volume

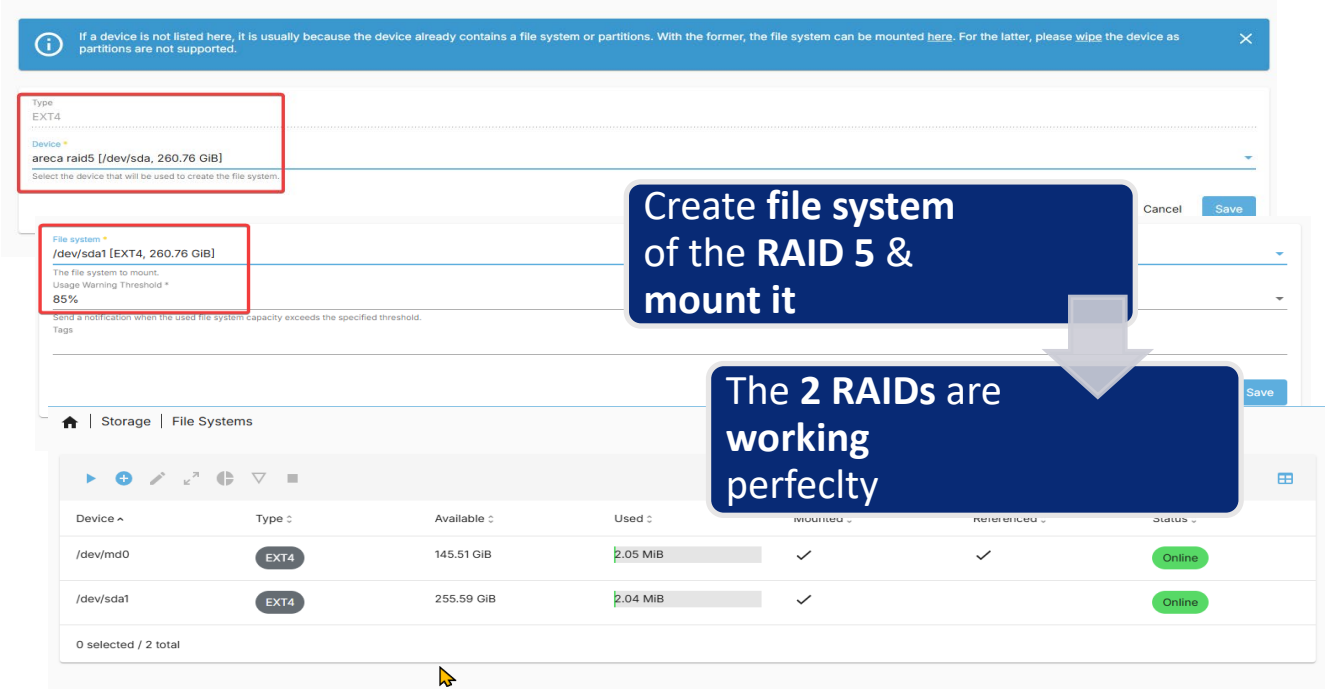
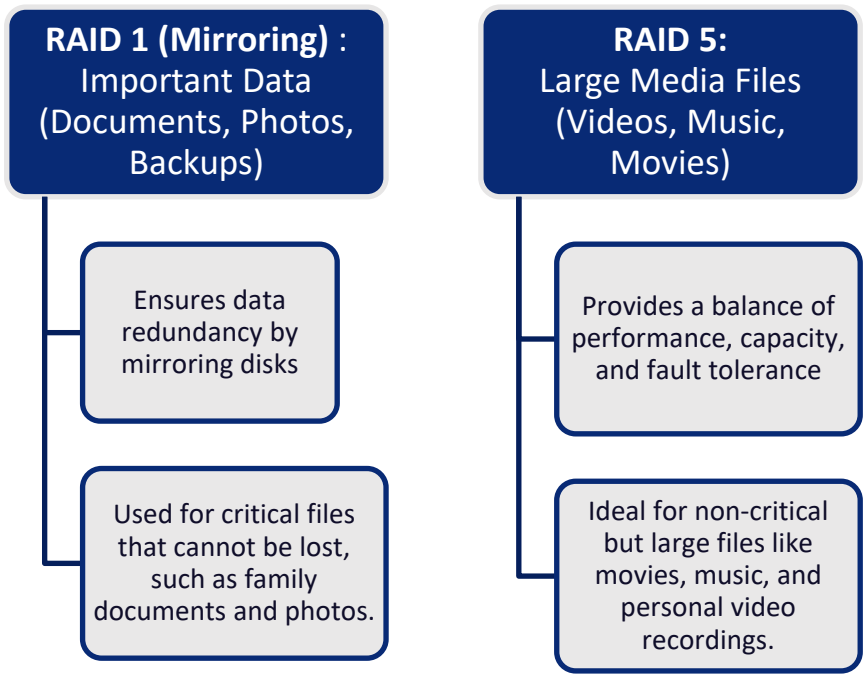


Figure 33 - Creation of RAID 5 Volume

For the **given scenario**, the **system** will use **two RAID arrays** to balance **performance, redundancy**, and **data organization**:



The **following tables** will show the **shared folder structure,** as well as the **user accounts with its permissions:**

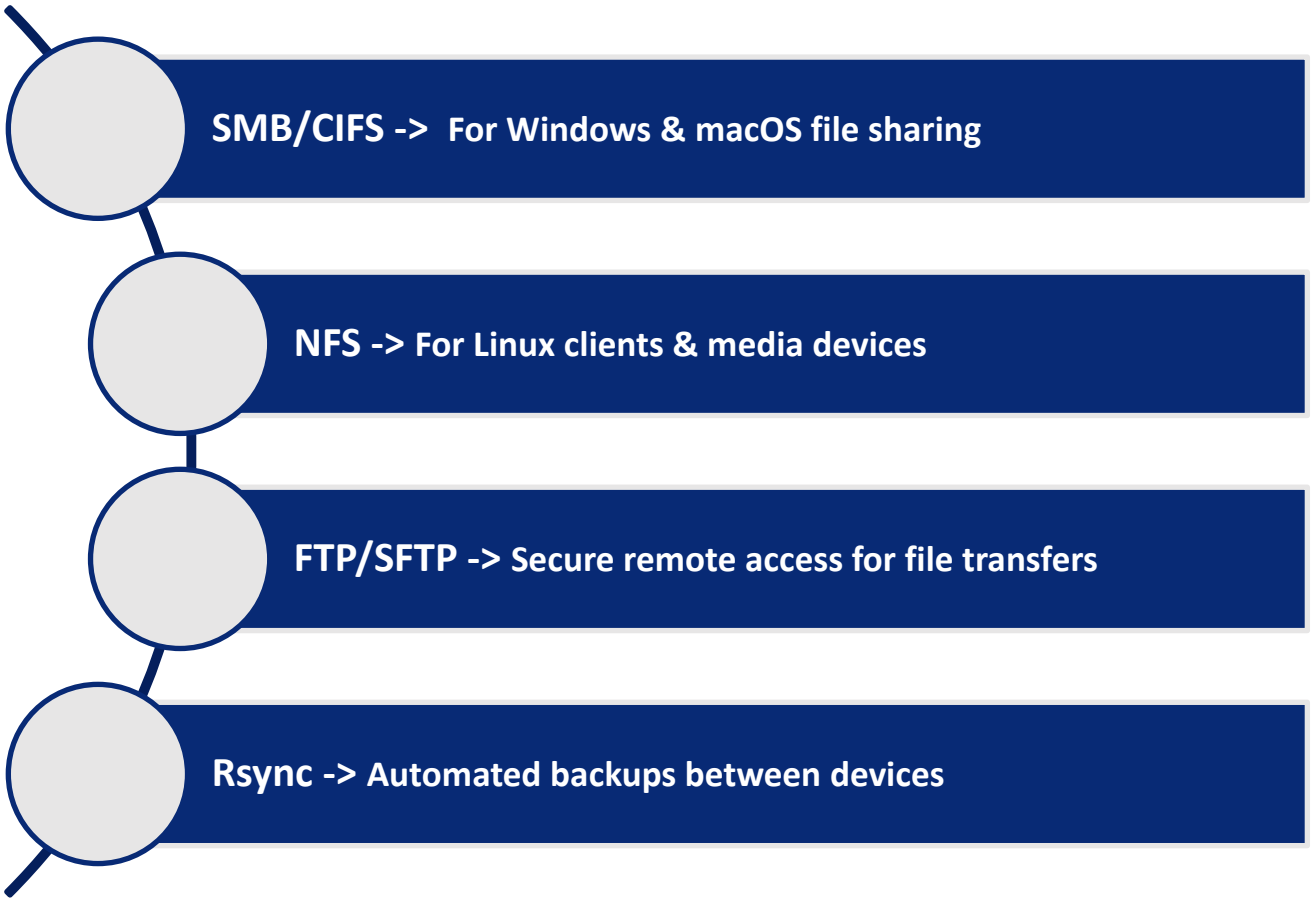
Folder Name	RAID Level	Purpose	Access Control
Documents	RAID 1	Family documents, PDFs, work files	Full access: Parents Read-only: Kids
Photos	RAID 5	Family pictures, albums	Full access: All family members
Backups	RAID 1	PC & phone backups	Full access: Parents, Restricted for kids
Parents Private	RAID 1	Personal files for parents only	Full access: Parents only
Videos	RAID 5	Family videos, home movies	Full access: All family members
Music	RAID 5	MP3s, albums, playlists	Full access: All family members
Kids Zone	RAID 5	Schoolwork, kids' media	Full access: All family members
Public Share	RAID 5	Temporary files, shared downloads	Full access: All family members

Figure 34 - Table of Folder Structure

User	Role	Permissions
Dad	Admin	Full access to all folders, NAS management
Mom	Admin	Full access to all folders, NAS management
Teen (16y)	User	Read/write access to Photos, Videos, Kids Zone, Public Share
Kid (10y)	User	Read-only access to Photos, Videos, Kids Zone, Public Share
Guests	Restricted	Access only to Public Share

Figure 35 - Table of User Structure

To ensure **compatibility** with **Windows**, **Mac**, and **Linux**, the **following protocols** will be **enabled**:



This setup ensures **reliable storage**, **easy access** across devices, and **controlled user permissions**. The **RAID 1 array** secures **important files**, while **RAID 5** provides **efficient storage** for **large media files**.
Using a combination of **SMB**, **NFS**, **FTP**, and **Rsync**, **all family members** can conveniently **access their data** while **ensuring privacy, security, and data integrity.**

d. Try connecting to those shared folders using your computer/phone as a client. Upload and download data to test if it works fine. Try out different user permission settings.

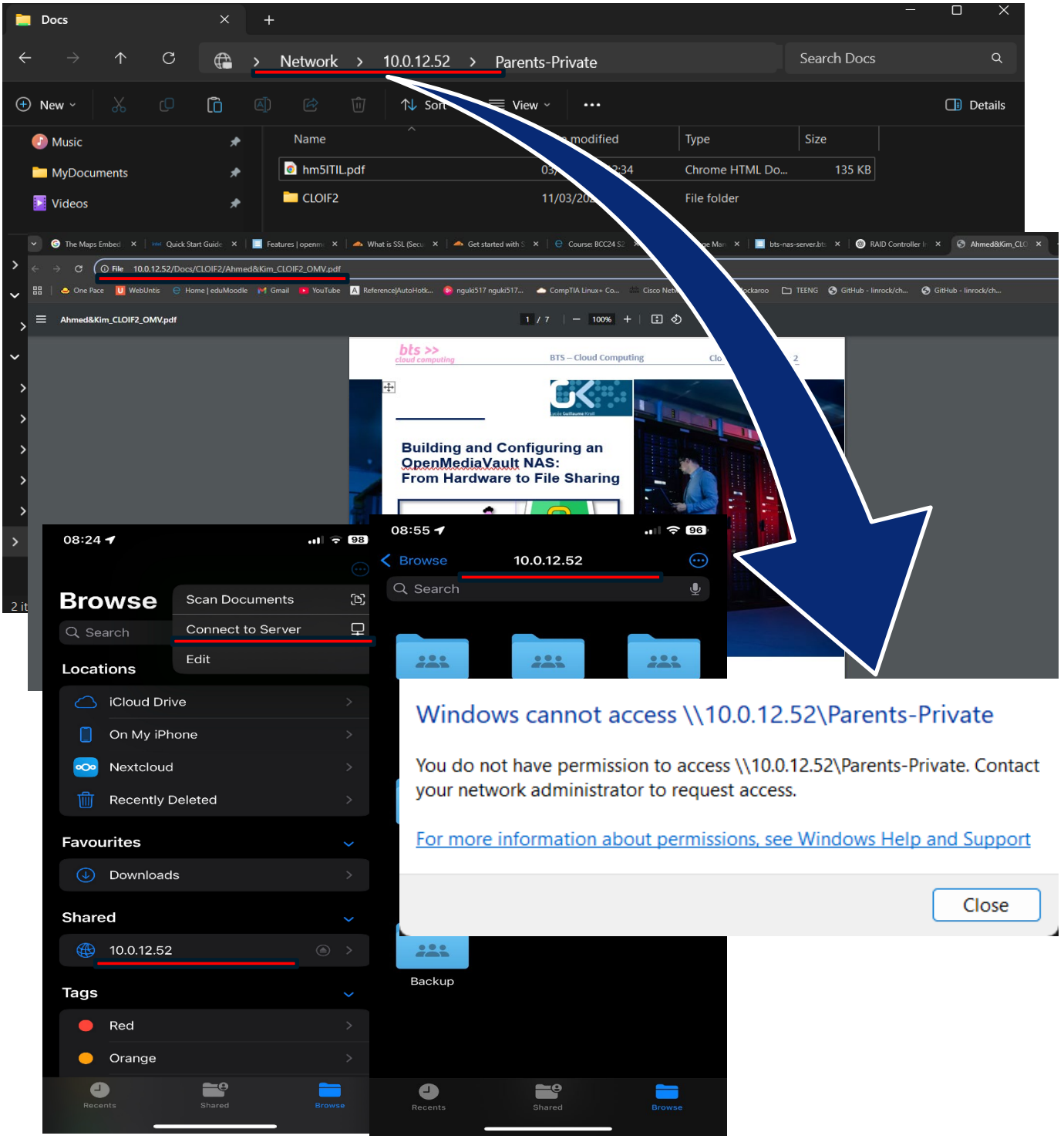


Figure 36 - Testing the Shared Folders

e. **Do research on the iSCSI protocol. What is the difference to NFS or SMB? Check if iSCSI is supported by your NAS OS and test iSCSI.**

What is iSCSI?

- **iSCSI (Internet Small Computer System Interface)** is a **block storage protocol** used to connect **storage devices over a network**.
- as if they were **local disks**.
- **iSCI** is commonly used in **virtualization (VMware, Hyper-V)**, **database storage** and **enterprise storage**.

iSCSI vs. NFS vs. SMB: Key Differences

FEATURE	ISCSI	NFS	SMB
TYPE	Block Storage (low-level access)	File Storage (shared folders)	File Storage (Windows sharing)
ACCESS METHOD	Mounts as a local disk	Mounts as a remote folder	Mounts as a network drive
BEST FOR	Databases, Virtual Machines (VMs), high-performance apps	Linux file sharing	Windows & Mac file sharing
PERFORMANCE	Fastest (Direct Disk Access)	Slower (Network Overhead)	Slower (Protocol Overhead)
AUTHENTICATION	Uses CHAP (Challenge-Handshake Authentication Protocol)	Unix/Linux user-based	Windows user-based
USE CASES	Enterprise storage, SAN, VM storage	Linux NAS, Linux backups	Windows file sharing, mixed OS environments

Figure 37 - Differences between iSCI, NFS & SMB

iSCSI is supported by OMV:
Download the plugin & Connect to the tgt

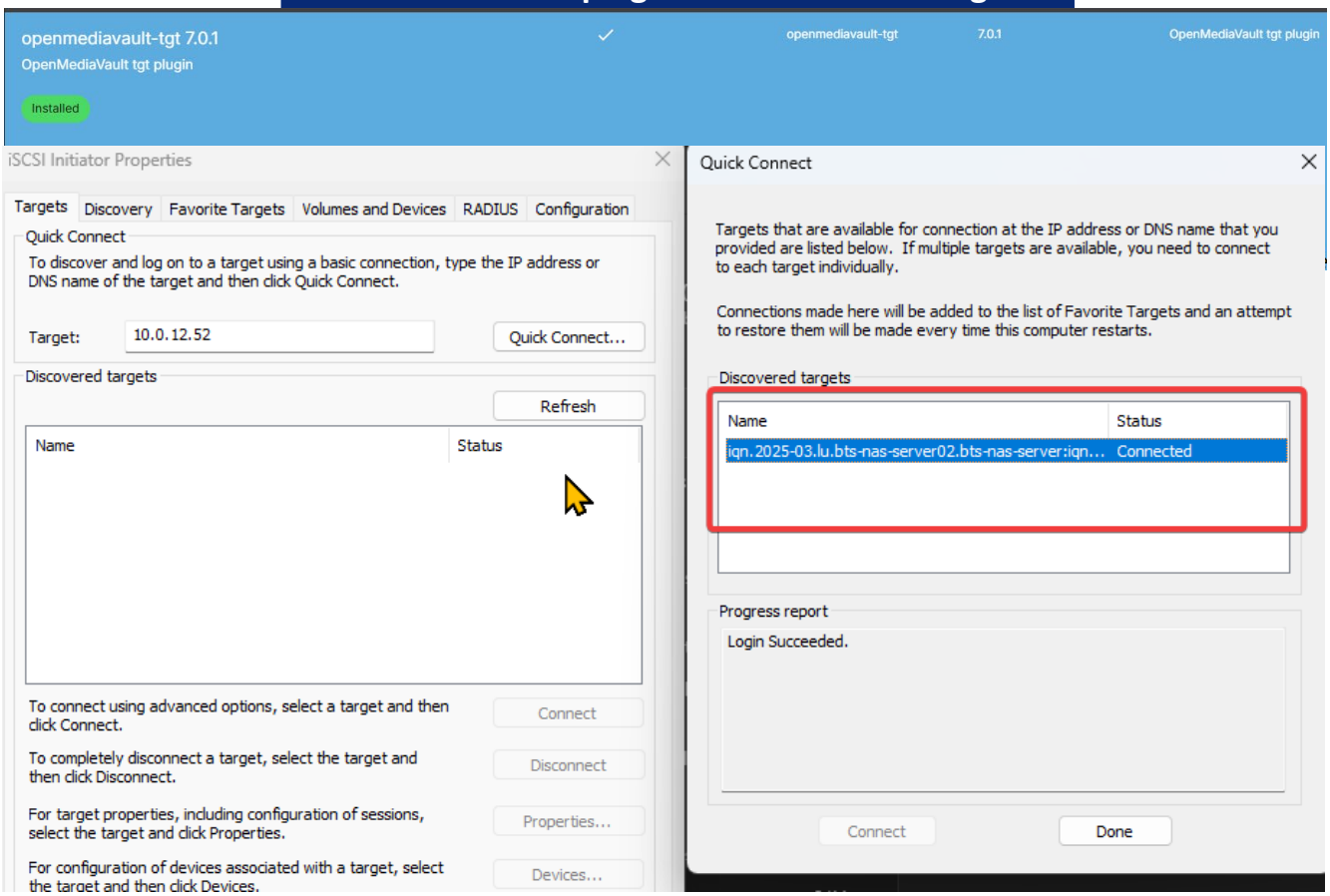


Figure 38 - iSCI Configuration

Additional Features

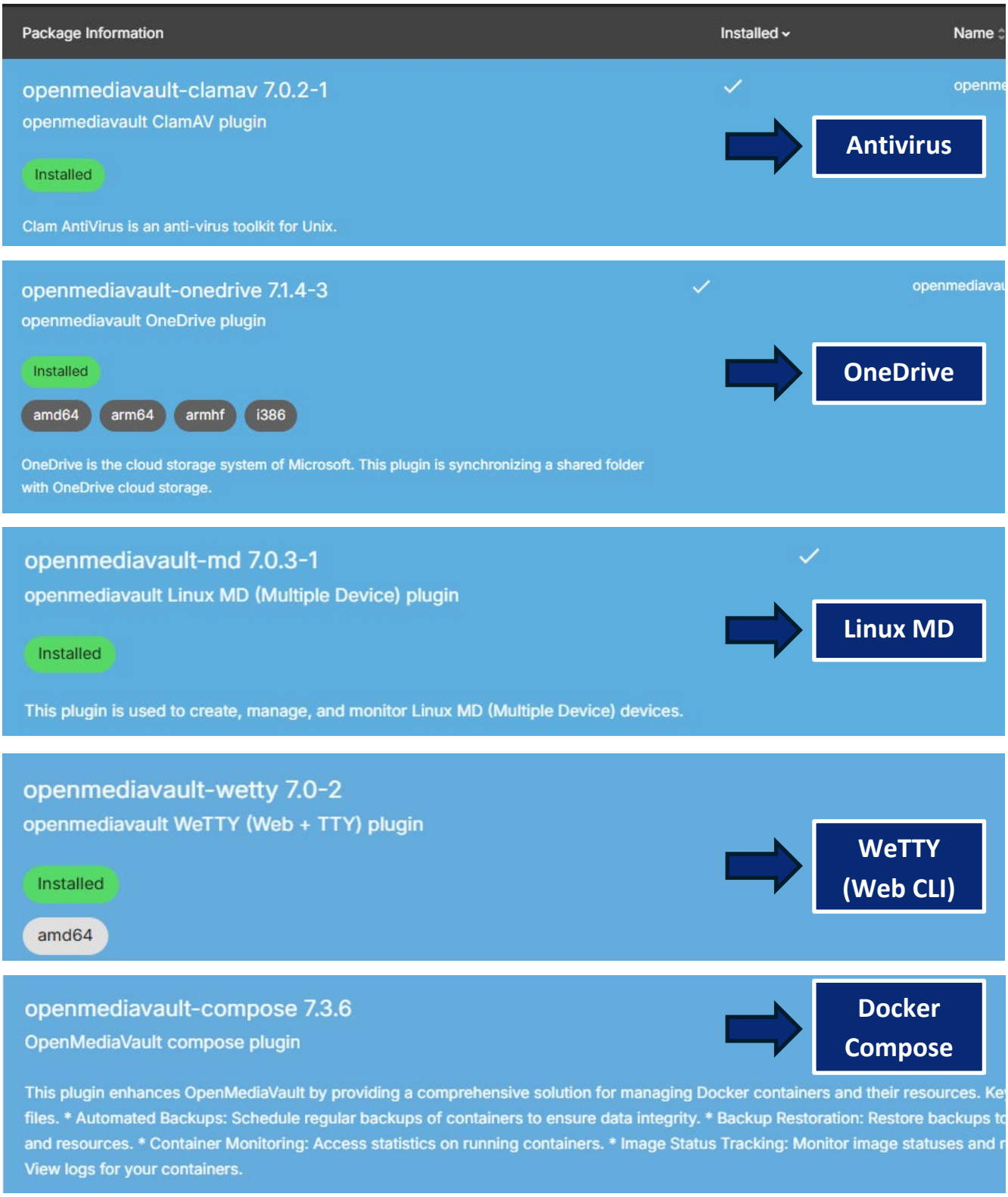


Figure 39 - Additional Features

Conclusion

Setting up an **OpenMediaVault NAS** from **hardware to file sharing** can be a **rewarding experience**, offering a **powerful, flexible**, **user-friendly**, and **cost-effective storage** solution. With the right configuration, OMV supports **RAID**, **Docker**, **advanced networking**, and even enterprise-grade enhancements like **ZFS** and **high availability**.

While **OMV** is **accessible** to beginners, unlocking its **full potential** requires **Linux knowledge** and **ongoing optimization**. In the right hands, it can **rival** commercial NAS solutions, providing a **customized**, **high-performance**, and **feature-rich system**. However, it also demands **manual setup** and **maintenance**, making it best suited for users willing to fine-tune their NAS for maximum efficiency.

Ultimately, **OMV** is **as powerful as the expertise behind it**, offering unmatched flexibility for those who take the **time to master it**.

Thank you for reading,

AL-ASADI Ahmed

NGUYEN Auguste Duc-Liêm Kim

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