UNRAID
VIRTUALISED STORAGE SYSTEMS

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Introduction

Unraid is an operating system for self-host servers and network-attached storage with great flexibility in terms of hardware and scalability.

- **Architecture:** A unique way to data storage, offers protection to the data using combination of parity, data disks and cache drives.
    - Data disks which can be of different size and be added and removed any time.
    - Parity drive for data protection through parity calculations, which are to be used to reconstruct data in case of disk failure.
    - Cache drive to serve as temporary storage, to improve performance.
- **Key Features**
    - Built-in Docker support for easy deployment of wide selection of applications and services.
    - Virtualization to run multiple virtual machines.
    - User-friendly Web Interface to make configuration and monitoring easy and to offer controls for managing the storage, docker containers, VMs and system settings.
    - Data protection and backup using the parity protection.
    - Community made plug-ins and extensions to enhance the functionality and capabilities of the platform.
    - Very accessible and adaptable to different setups and budgets.
    - Forums and wikis and other resources provided by the community to offer help and knowledge.
- **Setup and Configuration:** An easy-to-follow documentation that guides through the steps and explains the functions.
- **Pricing:** It comes with three license tiers, which differs on how many storage devices can be attached and for how long the operating system will receive updates (which can be extended later).

These features make Unraid a popular choice for building storage and server solutions for home and business use with its flexibility, reliability, and ease of use.

Installation

Minimum requirements

Host computer with 64-bit capable processors (1 GHz or higher) and minimum of 4 GB RAM, Linux driver support (USB, ethernet, storage) and 2 hard disk drives with parity disk.[1]

Resources

- An 8GB USB flash device with unique GUID identifier that serves as the Boot Disk
- A 64GB USB flash devices that serves as the Storage/Disk
- A desktop connected to ethernet, and it boots the USB Device with the Unraid OS
- A laptop that is used to configure and connect to the Desktop with the Unraid OS
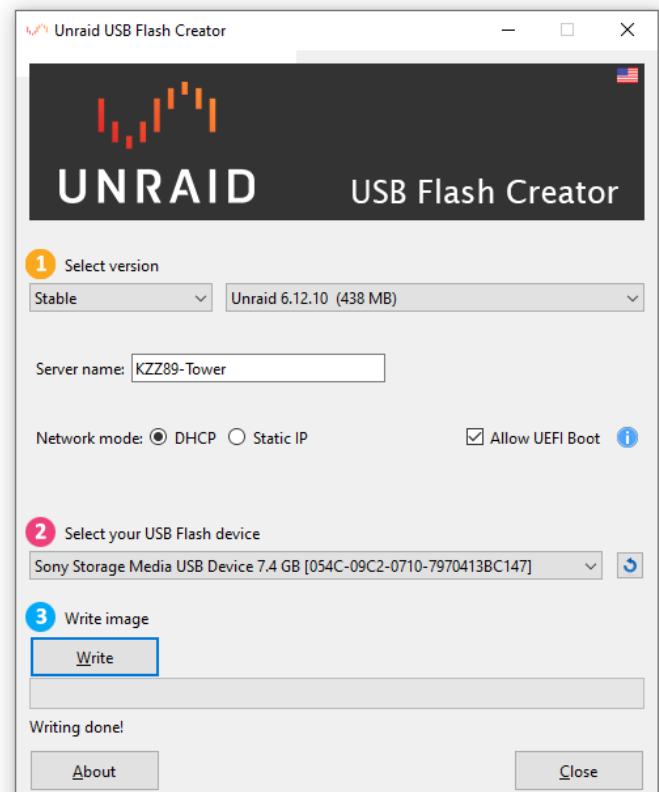
Preparing the Bootable USB

Download Flash Creator

It can be downloaded from unraid.net and there is an easy to follow, step-by-step guide to be able to set up the system as quickly as possible. Unraid offers USB Creator for Windows and Mac.

Installing Unraid OS to the flash device

After downloading and running the installer in the 'Select version' we can choose whether we want it to automatically install and prepare the bootable USB device, or to create a zip

1. USB Flash Creator for Windows

file to be used to prepare the USB device manually. We can select either the latest or the previous version. Then we choose a name for the server, which by default named 'Tower' and its network mode, and whether UEFI boot is allowed or not. The final parts of the creation are selecting the destination USB device and then writing the image to it.

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[1] "Getting Started | Unraid Docs."

Booting the Server

BIOS Settings and Booting

The system must be configured to boot from the USB flash device.

Hardware virtualization-specific features (if available) should be set up at this point:

- Intel VT-x (Intel Virtualization Technology) and AMD-V (AMD Virtualization) These technologies enable the creation and execution of multiple virtual machines on a single physical machine by providing processor-level virtualization support enabling better performance and efficiency.[2]
- IOMMU (Input-Output Memory Management Unit) VT-d (Virtualization Technology for Directed I/O) It allows direct passthrough, where the virtual machine get direct access to the host's PCI devices (graphics cards, network adapters, storage controllers), which let the I/O operations be handled more efficiently.[3]

Boot Options

After selecting to boot from the USB Flash Drive with Unraid installed on it, we are presented with the following options:
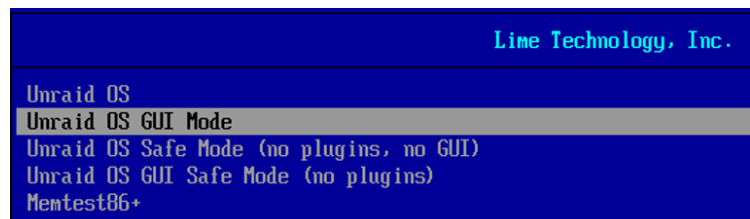
2. The options after booting the flash drive

- Unraid OS launches the system and provides Linux console to access it.
- Unraid OS GUI Mode launches the system, but it provides a graphical interface from where Unraid's WebGUI can be started, where you can complete the system configuration. It also allows you to launch the Linux console as well.
- Unraid OS Safe Mode (no plugins, no GUI) / Unraid OS GUI Safe Mode (no plugins) Both modes let you debug and troubleshoot your system whether with or without graphics user interface. The system is loaded without the plugins, which are community made apps that you can run on your Unraid server.
- Memtest86+ is a memory test software that can be used to test the random-access memory looking for errors and to verify that the RAM works correctly.[4]

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[2] "What Is AMD Virtualization (AMD-V)?"
[3] InformatiWeb, "Enable IOMMU or VT-d in Your Motherboard BIOS - BIOS - Tutorials."
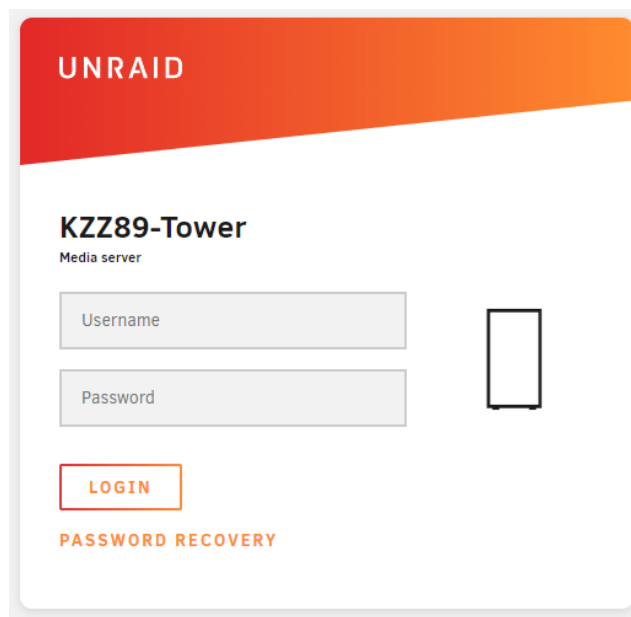[4] "Memtest86+ | The Open-Source Memory Testing Tool."

Starting up the System

Launching the WebGUI

Once the Unraid OS has booted, we login with the username 'root' (there is no password by default) and then start the WebGUI to configure the system.[5]

Alternatively, we can use another computer on the local area network, because after booting up, the Unraid server becomes available on the local area network, and we can use a web browser to connect to configure it by either navigating to http://tower.local, in

3. Login UI after the root password has been set.

my case http://kzz89-tower.local as I modified the default name, or by typing the IP address of the hot computer.

After connecting, it will immediately prompt us to set a strong password for the root.

Registration and license key

A registration in Unraid.net is necessary to continue or can be done at this point, as you are required to have a license, or you obtain a trial license which expires after a month. The trial key will give you access to the mid-tier license to try its functions.
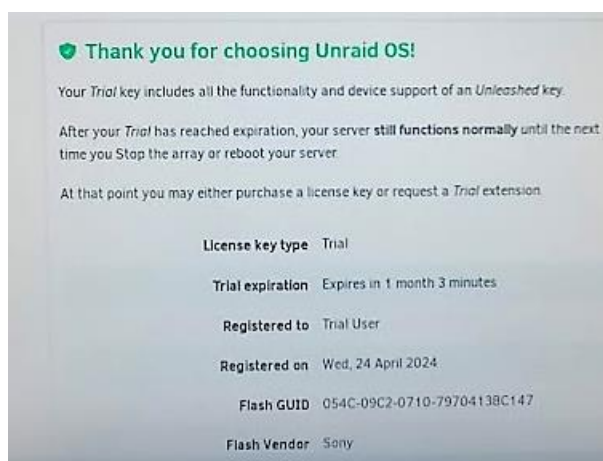
4. Obtaining trial license

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[5] "Quick Install Guide | Unraid Docs."

Configuration of devices

As for storage devices, due to limitations, I am using a 64GB USB drive for the setup and demonstration even though at least two hard disk drives with a parity disk should be considered for a real scenario to ensure data protection.

With the registration ready, we head to the 'Main' tab of the Unraid WebGUI, where we complete the device assignments and to issue commands to the system and to gain information about each device.

TEMP.	READS	WRITES	ERRORS	FS	SIZE	USED	FREE
*	5908	43	0	vfat	7.9 GB	462 MB	7.45 GB

TEMP.	READS	WRITES	ERRORS	FS	SIZE	USED	FREE
35 C	58	0	0				

6. Information of the devices

■ Disk 1	USB_SanDisk_3.2Gen1_05014cb89f2fa51d77f5f1e20911ccc7fc3fc9ded2▼	*
	USB_SanDisk_3.2Gen1_05014cb89f2fa51d77f5f1e20911ccc7fc3fc9ded2f5aa64da16f2d0962 - 61.5 GB (sda)	
■ Disk 2	unassigned	
	ST500DM002-1BD142_S2AD03CS - 500 GB (sdd)	

5. Device selection for assignment is through dropdown menu.

Array Devices

The array devices are the general storage. The device can be either non-parity/disk which you use to contain your custom folders and files meanwhile parity devices are added for fault tolerance and in case of a fault, they are used to rebuild the array. There can be only two parities, and up to 30 disk devices, which can be selected using the slots.

In my case it is a single device is added, but ideally there should be two disks (which are not required to be identical and can be of different sizes) and a parity device, which must be at least as large the largest data drive. (SSD support is experimental here, and some SSD not idea for the array due to how TRIM/Discard is implemented.

7. Array Devices configuration.

Array Devices

| DEVICE	IDENTIFICATION
■ Parity	unassigned
■ Parity 2	unassigned
■ Disk 1	USB_SanDisk_3.2Gen1_05014cb89f2fa5
■ Disk 2	unassigned
Slots:	4 ▼

Pool Devices

Pool devices are the cache storage. SSD for their high read and write speed, unlike for the array. They are used to store the files temporarily until they are offloaded to the array. It can be set up in the shares, that the data is loaded to the cache first and only later it is moved to the arrays and the parity is calculated.
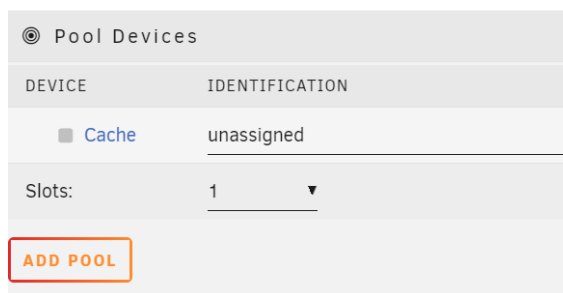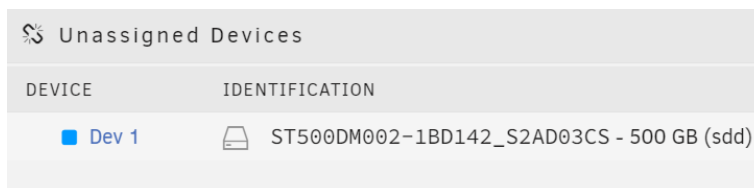

8. Pool Devices configuration

Boot Device

It is the device that is used to boot the Unraid OS from. The 5th picture's first set of information is of this device.
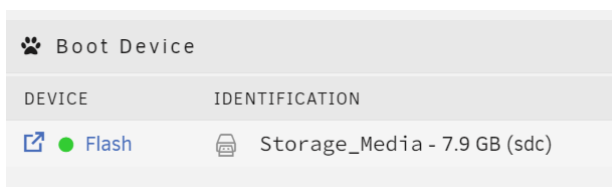
9. The Boot Device

Unassigned Devices

In the Unassigned devices section, you can find the devices, that you can still assign to the array or pool devices.

10. The Unassigned Devices

Array Operation

In this section, we can start/stop brings the array of disks online. In my case, it gives a notification, that the array is unprotected, as no parity has been assigned. Maintenance mode toggles, if it should only start the array, but without mounting any disk. But also here, the system can be rebooted (optionally in safe mode) or shutdown.
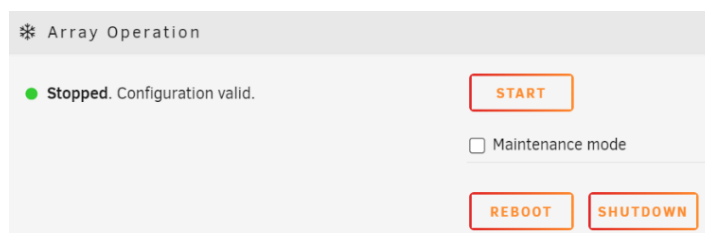
11. The Array Operations without being started.

As the configuration is set up, I will go ahead and start the array.

Demonstration

Starting the array

Unmountable array device

After pressing start, the array was brought online, but disk 1 could not have been mounted, as the USB drive, I am using was used and was not pre-cleared/formatted.

SIZE	USED
Unmountable: Unsupported partition	

12. Unmountable warning before formatting.

Built-in formatting feature

FORMAT	**Format** will create a file system in all **Unmountable** disks.
	☐ Yes, I want to do this

13. Formatting function

In a separate warning message, it states that I have an unmountable disk present. After completing the format process, the information is now available.

TEMP.	READS	WRITES	ERRORS	FS	SIZE	USED	FREE
*	372	21,371	0	xfs	61.5 GB	23.0 GB	38.5 GB

14. Information after formatting

Shares

Shares are key feature of Unraid, they either represent folders or disks, which can be accessed on the network. You can make as much shares as you want each with their own permissions and configurations.

The shares are either:

- **User shares**, which are enabled by default, and they rely on Linux FUSE and represents folders on the system.
- **Disk shares** rely on the drive's file system to share the disk completely. This is disabled/automatic by default, and they must be changed in the Global Share Settings.

User Shares

Since I have only one storage, I will prepare two user shares, with one containing pictures, and another some text files. Unraid offers many useful configurations, minimum free space required to be able to write to this share. In case of multiple disks, allocation method offers three methods:

- **High-water:** The goal is to write as much data as possible to each disk, while at the same time try to keep the same amount of fee space on each disk.
- **Fill-up:** Chooses the lowers numbered disk that still has free space above the currently set Minimum fee space settings.
- **Most-free** chooses the disk that has the most free space.

After creating both shares, Documents and Pictures, they can be viewed, and edited under the shares tab. I made the Documents one with private access, meanwhile the Pictures will be publicly available to all the users.

Upon the first initialization of the array, Unraid also automatically creates user shares, which are needed for common plugins, containers, and virtual machines.

If Disk Shares were enabled, they would be configurable in the bottom on the same page as user shares.

If we were to delete a share, we must select it, and in its edit menu, there will be an option to delete.

15. Shares tab

User Management

In the Users menu, I have added two users, Anna, and Boris. Boris has a description, as a reminder that he will have access to the Documents share, while Anna won't have access to any private share. Png pictures can be added as custom image for the users up to 512KB. Users can be deleted similarly as the shares, upon editing, they can be also deleted.

16. Creating user Boris

17. Current users

SMB User Access   *Guests have* **no** *access.*

anna   No Access   ▼

boris   Read/Write   ▼

APPLY   DONE

18. Changing access at for the shares

Returning to the shares and editing the Documents now will include the users and their access can be selected, whether they have no access, read-only or read/write access.

Virtual Machine

Preparation

I have modified the export security settings for one of the automatically created shares, called 'isos', so it is now accessible, even though it is hidden and only reachable if the share name is known. I copied the iso file there from another computer to be used by the VM.

a gép > isos (KZZ89-Tower (Media server))

linuxconsole. 2022-RC1-x8 6_64.iso
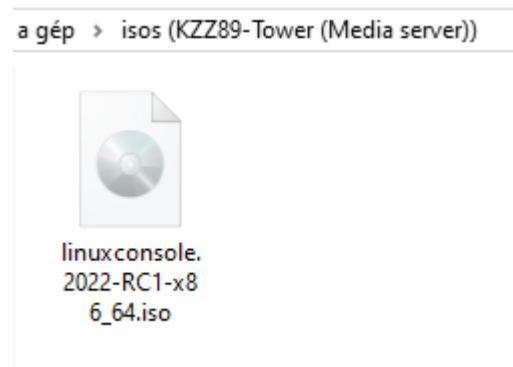
19. Virtual machine iso after copied to the isos share.

Installation

In the virtual machine tab, I was going to a new virtual machine, selected Linux, and the iso was immediately listed, though the installation could not be done as the processor does not have VT-x support.

Icon:

Autostart: NO

Name: LinuxConsole

Description: KZZ89 Demonstation VM

CPU Mode: Host Passthrough (Intel® Core™ i5-3470 @ 3.20GI▼

Logical CPUs: ● cpu 0   ○ cpu 1   ○ cpu 2   ○ cpu 3

Initial Memory: 1024 MB   ▼   Max Memory: 2048 MB   ▼

Machine: Q35-7.2   ▼

BIOS: OVMF   ▼   Enable USB boot: No   ▼

USB Controller: 2.0 (EHCI)   ▼

OS Install ISO: /mnt/user/isos/linuxconsole.2022-RC1-x86_64.iso

20. Virtual Machine setup

Docker

Installation from the built-in community apps

Thanks to the integrated support we do not need to do any preparation and we can choose from a very large and continuously growing community applications. From AI, backup, cloud, though game servers, media servers and applications, network services and tools to security, you can find many applications to install easily. After pressing install, you are prompted to

23. MySQL in the Apps installer tab

configure the MySQL server and followed that it will automatically download and install the container, and it will appear in the Docker Tab.

Additional Requirements:	None Listed
Repository:	mysql
Network Type:	Bridge ▼
Console shell command:	Shell ▼
Privileged:	OFF
MYSQL_TCP_PORT: *	3306 EDIT REMOVE
	Container Port: 3306 MYSQL_TCP_PORT
Generate Random Password:	yes ▼ EDIT REMOVE
	Container Variable: MYSQL_RANDOM_ROOT_PASSWORD Set to yes, to generate a random root password. The generated password will be printed to the logs (Docker > MySQL Icon > Logs).
Database Name: *	MYSQL_DATABASE EDIT REMOVE
	Container Variable: MYSQL_DATABASE This variable is optional and allows you to specify the name of a database to be created on image startup. If a user/password was supplied (see below) then that user will be granted superuser access (corresponding to GRANT ALL) to this database.

21. Configuration of adding MySQL container from the Community Apps

```
⊞ Add Container

─Pulling image: mysql:latest────────────────────────────────────
  IMAGE ID [1858730968]: Pulling from library/mysql.
  IMAGE ID [bd37f6d99203]: Pulling fs layer. Downloading 100% of 49 MB. Verifying Checksum. Download complete. Extracting.
  IMAGE ID [e733cb057651]: Pulling fs layer. Downloading 100% of 884 B. Verifying Checksum. Download complete.
  IMAGE ID [af2fd35011dc]: Pulling fs layer. Downloading 100% of 960 KB. Download complete.
  IMAGE ID [e5233d0f6ee3]: Pulling fs layer. Downloading 100% of 4 MB. Verifying Checksum. Download complete.
  IMAGE ID [cf11fd8658d3]: Pulling fs layer. Downloading 100% of 3 KB. Download complete.
  IMAGE ID [85344d57c3cb]: Pulling fs layer. Downloading 100% of 339 B. Verifying Checksum. Download complete.
  IMAGE ID [0eebca71f40d]: Pulling fs layer. Downloading 100% of 60 MB. Verifying Checksum. Download complete.
  IMAGE ID [18e468a1ddac]: Pulling fs layer. Downloading 100% of 325 B. Download complete.
  IMAGE ID [d9b2b8d35c75]: Pulling fs layer. Downloading 100% of 60 MB. Verifying Checksum. Download complete.
  IMAGE ID [57ba1b7684b4]: Pulling fs layer. Downloading 100% of 5 KB. Verifying Checksum. Download complete.
```

22. process of downloading the container before installing it

Installation from docker hub

I am going to install nextcloud as an example, which I began by making a share dedicated to it. Then in the docker tabs, I use the add container function. I copied its tag from docker hub and used at the repository. I set up the host and container port and assigned the newly made share to the new container.[6]

After continuing it downloaded and installed the container and now it is visible and up and running in the docker along the MySQL.

Repository:	nextcloud:stable-fpm
Network Type:	Bridge ▼
Console shell command:	Bash ▼
Privileged:	OFF
WebUI: *	443
	Container Port: 443 WebUI
Path: /data: *	/mnt/user/nextcloud/
	Container Path: /data Your personal data.
	❯ Show more settings ...

25. Setting up container from scratch using documentation and repository tag from docker hub

nextcloud
Nextcloud manual docker image
◎ Docker Official Image · ⬇ 500M+ · ☆ 4.1K

`docker pull nextcloud`   Copy

Overview   **Tags**

Sort by Newest ▼   Filter Tags 🔍   Analyzed by 🔵 docker scout

TAG
stable-fpm-alpine
Last pushed 11 hours ago by doijanky   `docker pull nextcloud:stable-fpm-alpine` Copy

Digest	OS/ARCH		Vulnerabilities					Compressed Size ⓘ
ee42f8e20fac	linux/386		0	0	2	0	0	244.78 MB
ed0a6b36ffaf	linux/amd64		0	0	2	0	0	244.44 MB
6e1a6ed2d9a6	linux/arm/v6		0	0	2	0	0	241.66 MB
+4 more...								

24. Nextcloud's page and it's tags on docker hub

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[6] "Nextcloud · GitHub."

Monitoring

Unraid offers a complete monitoring of the devices and the server.
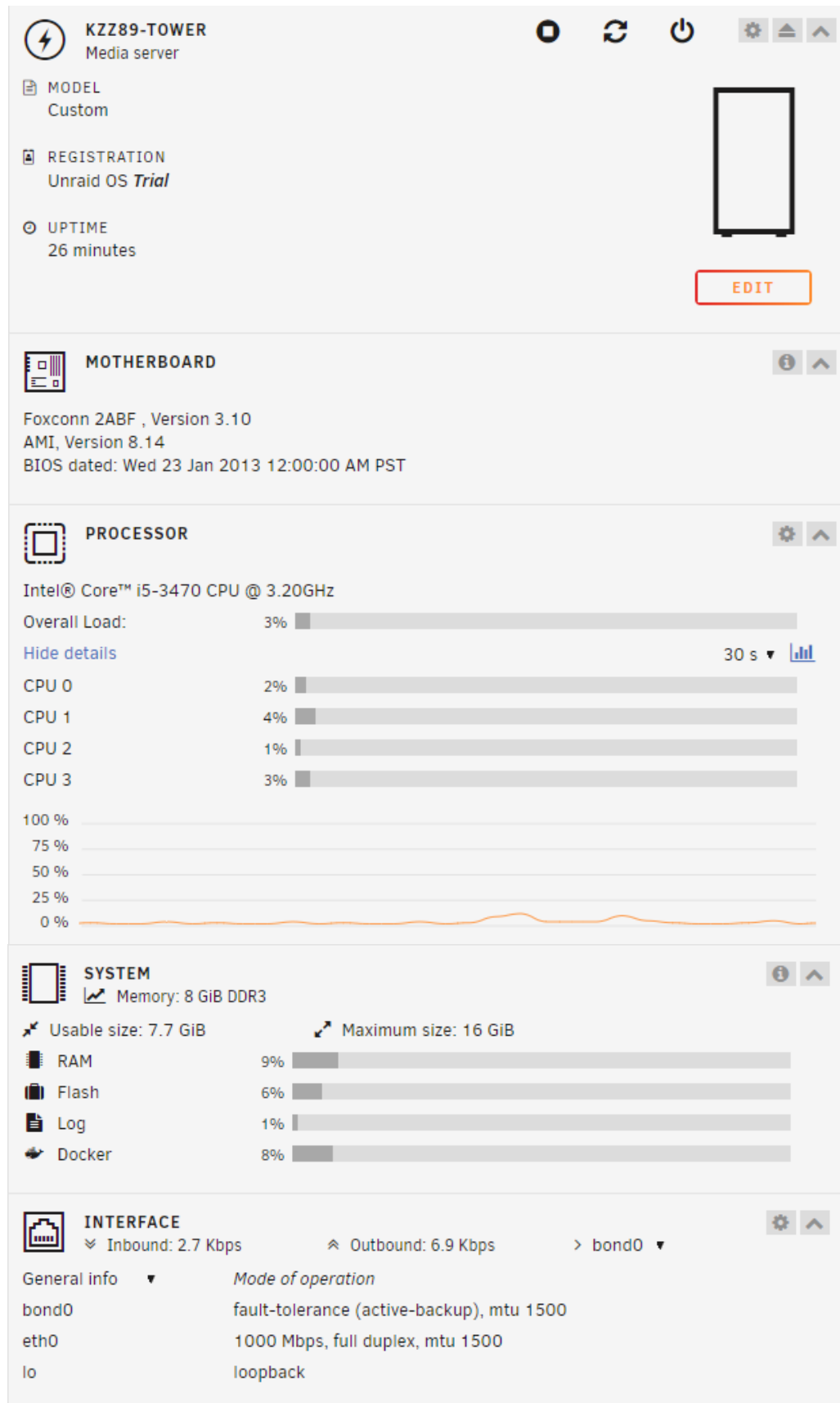
Not only the resources of the machine can be monitored, but all the dockers, virtual machines, shares, and users as well, and can be directly accessed/started.

DOCKER CONTAINERS
All Apps

nextcloud
■ stopped

PostgreSQL_Alpine
▶ started

VIRTUAL MACHINES
All VMs

SHARES   SMB ▼
Share count: 11 with 0 cache only and 0 encrypted

NAME	DESCRIPTION	SECURITY	STREAMS
announcements		Secure	0
appdata	application data	Public	0
documents	Text files	Private	0
domains	saved VM instances	-	0
isos	Containing LinuxConsole for the VM	*Public*	0
jelly		*Public*	0
nextcloud		-	0
owncloud		Public	0
pictures	There are some random pictures	Public	0
plex		-	0
system	system data	-	0

USERS
User count: 4 with 0 unprotected

NAME	DESCRIPTION	WRITE	READ
root	Console and webGui login account	-	-
anna	Some description	5	6
boris	He has access to the documents	6	7

PARITY
Parity disks not present

Parity has not been checked yet

Scheduled parity check is disabled

ARRAY
29.0 GB used of 61.5 GB (47.2 %)

DEVICE	STATUS	TEMP	SMART	UTILIZATION
Disk 1	● active	*	👍 healthy	47%

CACHE
1.88 GB used of 15.5 GB (12.1 %)

DEVICE	STATUS	TEMP	SMART	UTILIZATION
Cache	● active	*	👍 healthy	12%

Testing

Shares testing

I have altered the shares to show the permissions of the users better. There are three kinds of shares: pictures, documents, and announcements. The users are still Anna and Boris. They both has read only access to announcements, meanwhile both can read/write to the pictures, but only Boris has access to documents, meanwhile Anna has no access at all.

Pictures share

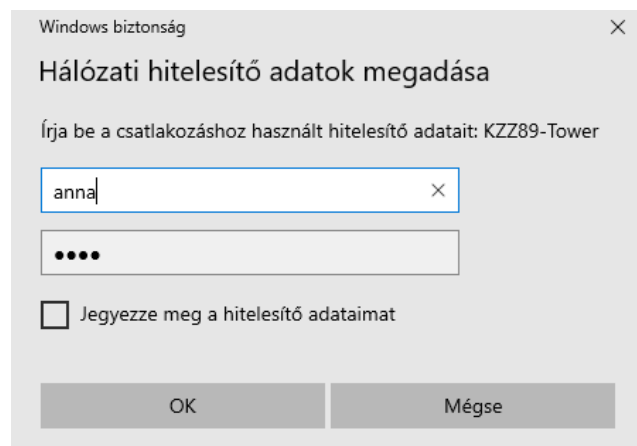I mapped the share using Anna's user and uploaded some pictures to the share.

27. The Picture share after Anna's uploads

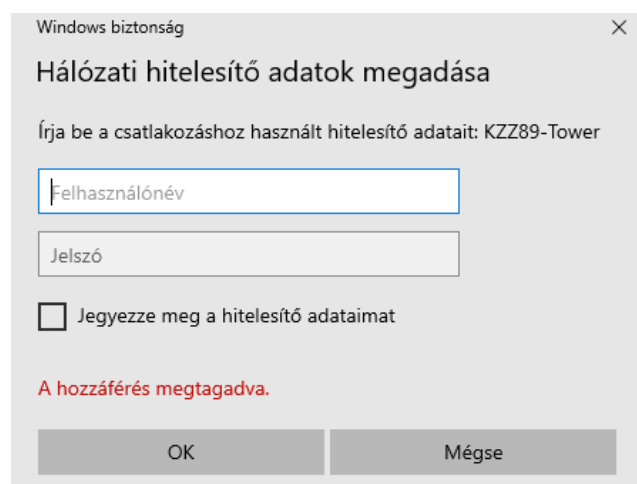

26. Anna login to pictures share

Documents share

Still using Anna's credentials, the folder was added, but the access was denied, as Anna has no rights to it.
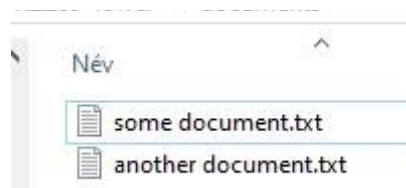
Though the credentials had to be cleared, because Anna's ones were stored, despite I entered Boris' ones. But after that, it worked as intended and some documents were created.
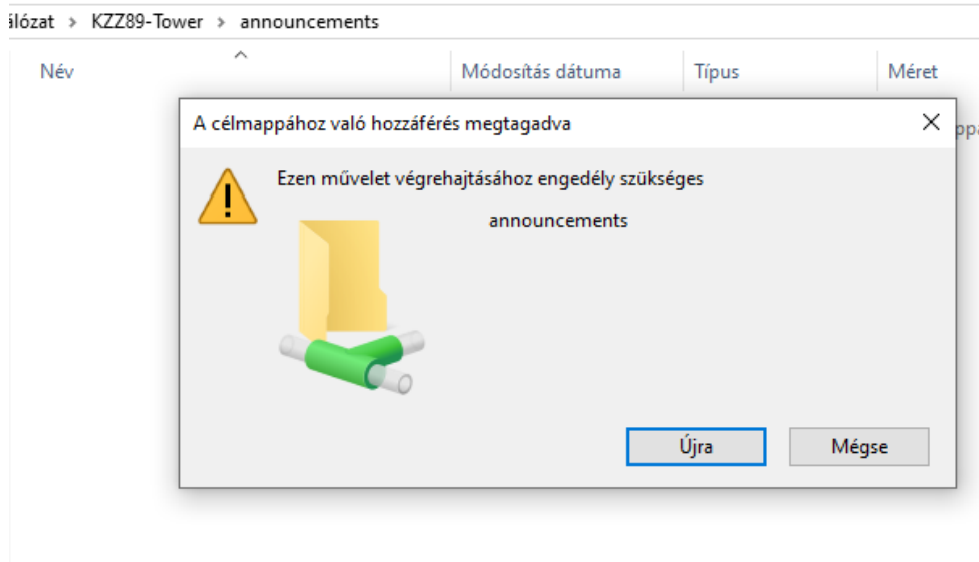

28. Documents folder not being accessible to Anna.

29. Documents folder after Boris' uploads

Announcements share

In this final part of the share test, there is an announcements folder, where another user, like a boss user would have write/read access only, and Anna and Boris can only read the documents, digital flyer pictures.

30. Boris not being able to modify the contents of the share.

Upon attempting to create a new file from Boris, it was denied upon lack of permission. He could only access the share and read its contents.

Docker testing

Postgres

Instead of the MsSQL, I have decided to test Postgres, which I also installed from the community apps, where I did not modify the basic configuration, so the database, the username and the password was 'postgres' as well, and for a very simple test, I just created an empty database called kzz89.

31. Postgres example

NextCloud

After installation, it prompts the root user to make an account. Followed by that, the root user is prompted that many functions can be downloaded automatically, such as calendar, contacts, mail, video chat and NextCloud has its own App Store to discover more useful apps.
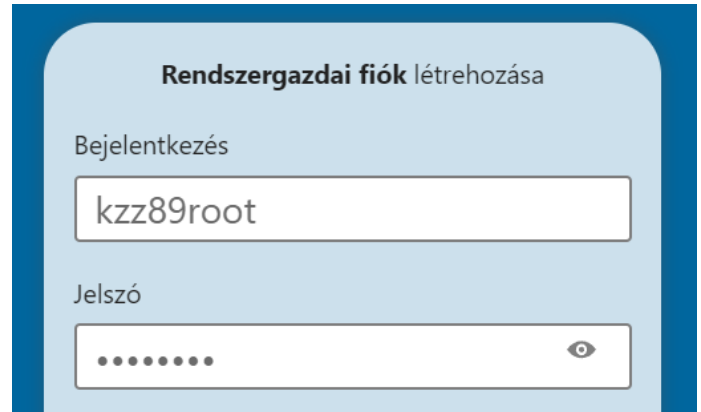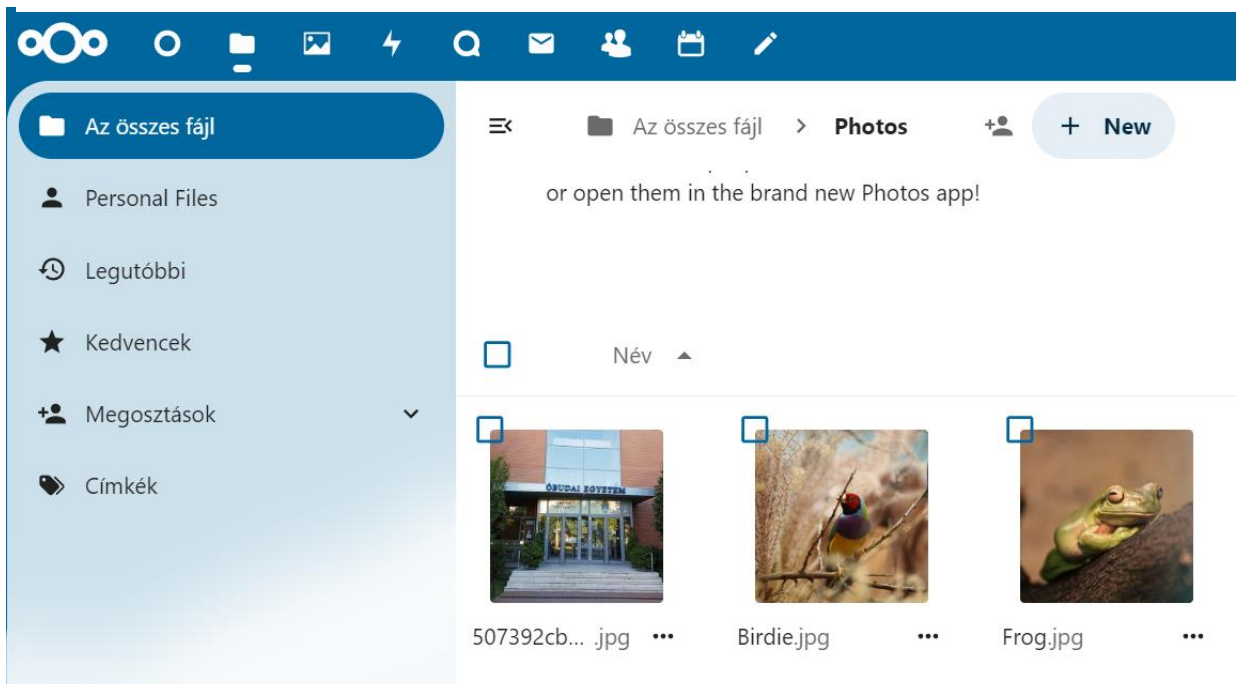

32. First time accessing NextCloud

34. The opening user interface

33. Tested its 'files' function by uploading a picture.

Conclusion

Unraid is very efficient, and it is quick to set up, and you can truly utilize many things to build/turn your own system into a Nas. Setting it up was very easy, a very helpful guide and documentation is provided, and most things related to its setup can be found easily.

Thoughts on the implementation

Originally intended to make it work through a virtual machine, so I could have utilized more resources to show Unraid's features a lot better way. But after many attempts, neither did I manage to start Unraid with GUI in the virtual machine, neither could I trouble shoot the reason for BSOD upon attempting to remotely connect to configure the tower.

As Unraid is not using the traditional RAID levels in its array, I wanted to achieve the standards of RAID 5 by having using 4 equal virtual storage, three of them being array drives, and one being parity. And a fifth one would have been the cache (in reality, it would have been an SSD, while the rest being HDD). I would not have used the cache to move my data faster there and for it to be moved later to the array, but to have the appdata, domains and system shares over it, as for the docker is running always, therefore the array disk could spin down not being used.

Experience

I learnt a lot by doing that and enjoyed the process, despite many times, when it came to the community applications, was troubleshooting and trying to find out it is not working correctly, was something not configured right at the add container interface, or it had a config file, that had to be accessed through ftp or the terminal and had to be changed.

Overall, it was easy and fast to set up, and it was just the extra personalization that took the time. If it had been only just setting up the users and shares, or the disks in case of multiple storage devices, it would have worked immediately, without additional dockers or VMs.

The documentation for Unraid contained every necessary information and explained everything in detail, not to mention usually every configuration had a tooltip, which provided immediate help, without need to look up in the documentation.[7]

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[7] "Unraid OS | Unraid Docs."

References

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