TrueNAS SCALE® Evaluation Guide

Getting Started with TrueNAS®

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CONTENTS

Executive Summary

The TrueNAS SCALE Evaluation guide provides guidelines on the installation, configuration, features, and general usage of TrueNAS SCALE. This document is not intended to replace TrueNAS Documentation, rather, it is a “springboard” or “quick start” to help a new user become familiar with TrueNAS SCALE and its features quickly and efficiently.

1 Welcome

This evaluation guide details the easy process of downloading, deploying, and evaluating TrueNAS SCALE in less than one hour. TrueNAS SCALE is free to use on your own infrastructure and is also available on a family of appliances with enterprise support. With traditional storage, evaluating its full potential is not possible without testing on proprietary hardware. This guide describes the easy steps that anyone can take, using any hardware (or virtual hardware) to experience the full potential of TrueNAS SCALE.

2 Recommended Hardware and Preparing for Installation

TrueNAS SCALE will install on almost any x86-64 hardware. For evaluation purposes, iXsystems has also made a pre-packaged OVF (Open Virtualization Format) template available for download. If you choose to install on physical hardware, we can use the information gathered by both iXsystems and the TrueNAS community to help make some optimal decisions.

2.1 Minimum Required Hardware

TrueNAS SCALE requires a minimum of a dual-core x86-64 processor, 8 GB of memory, and a 16 GB boot device. You’ll also want some additional drives to use to create your storage pool (at least two of them for a mirrored device), but four or more drives are recommended in order to make the most of the settings and scenarios demonstrated in this evaluation guide.

If you’re installing TrueNAS just to get a feel for the web UI, create and populate a few test shares, and familiarize yourself with its use and administration, the minimum resources will suffice In fact, you can even use a virtual machine provided by your favorite hypervisor, and virtual disks instead of physical. For more detailed guidance, read on!

2.2 Start with a Solid Foundation

While TrueNAS will install on just about any existing hardware, choosing a solid base system will provide the best results. Select hardware that is designed for reliability and uptime, such as an existing server or professional workstation, as these platforms tend to offer the highest potential for large amounts of primary memory (RAM), support for Error-Correcting Code (ECC) memory, multiple PCI Express (PCIe) expansion cards, and quality-of-life enhancements such as hot-swap drive trays and remote console access through Intelligent Platform Management Interface (IPMI).

2.3 Provide a Large Amount of RAM

TrueNAS has a higher suggested memory requirement than many other Network Attached Storage software solutions, and for good reason; the OpenZFS file system uses system RAM for a sophisticated caching algorithm known as the Adaptive Replacement Cache or ARC. This algorithm adjusts itself dynamically to balance between your most recently used and most frequently used data, in order to provide peak performance for reads. In addition to caching, RAM is also used to support the different sharing protocols, directory services, plug-ins, or applications, and is used for virtual machines. There are many “guidance rules” that exist, but in general:

- Add 1 GB per drive above eight, for handling ZFS metadata
- Add 2 GB if binding to Active Directory, for internal caching of these objects
- If serving highly random, latency-sensitive data (such as virtual machine hosting over NFS or iSCSI), consider a *minimum* of 32 GB and strongly consider a platform that permits scaling to much larger capacities (256 GB+) over one that is limited at 32/64 GB
- If you are considering using a second-level read cache, or “L2ARC”, add approximately 1 GB per 100 GB of cache

(as a conservative estimate) to be used to index the contents of these additional cache devices

- OpenZFS deduplication puts significant additional workload on the memory capacity of your machine. Provide an additional 5 GB per 1 TB of data to be deduplicated if storing files and 20 GB per 1 TB of data to be deduplicated if storing virtual machines

If additional RAM is provided beyond the suggested minimum, TrueNAS will increase the size of the ARC in order to utilize the space.

2.4 ECC RAM is Strongly Recommended

For testing purposes, ECC is not required, but ECC RAM is strongly recommended to protect against memory errors. These errors can result from interference inside the system or be an early indicator of a failing piece of hardware. Using ECC RAM can correct, and depending on the system, report the occurrence of these errors, providing a benefit to overall system stability. This type of memory is often the standard for server and workstation platforms, but may not be supported on desktop systems.

2.5 CPU Selection is Core to your Success

The selection of a server/workstation platform and the recommendation for ECC RAM may introduce some limitations on the CPU that can be selected for your TrueNAS system. See below for some guidance on selecting the correct processor.

- Both Intel and AMD CPUs can be chosen for TrueNAS SCALE
    - 12th-generation and newer Intel Core-series processors may have unexpected performance variations due to the presence of both P-core (performance) and E-core (efficiency) processors
- An underpowered CPU can create performance bottlenecks due to the OpenZFS checksum calculations and in-line data compression
- If primary sharing will be done over SMB, select a CPU with a higher peak frequency and fewer cores, as TrueNAS uses the Samba software, which is lightly-threaded
- Where multiple applications or virtual machines will be used, consider a CPU with a greater core count to avoid contention between different programs
- Hardware support for AES-NI encryption extensions is available in most modern processors, but it is worth confirming the presence of these instructions if data or network encryption will be used in your TrueNAS operations
- Dual-socket platforms will typically require the presence of a second CPU in order to make use of all available memory sockets and PCIe slots. Check your server or motherboard manual for a “block diagram” that will outline which CPU sockets connect to which memory sockets and expansion slots

If using a workstation or desktop motherboard, consider whether or not your CPU contains an integrated graphics processing unit (iGPU) or if a separate card will be required to obtain the initial console output needed to set up TrueNAS. Server motherboards often contain a Baseband Management Controller (BMC) with its own video output that can be used for this. Some systems can be run “headless” without a GPU following the initial installation, but this is not universally consistent across hardware vendors.

2.6 Storage Controllers

The de facto standard for a storage controller in TrueNAS is a Broadcom (formerly Avago, formerly LSI) SAS Host Bus Adapter (HBA). These are available in 6 Gbps SAS, 12 Gbps SAS, or newer “Tri-Mode” cards with NVMe support. It is recommended to avoid the earliest 3 Gbps SAS generation as they were limited to 2 TB per device in addition to their reduced performance versus newer hardware. These HBAs are often rebranded for use in OEM servers. E include (but are not limited to) the Dell PERC H200/H310, HPE H220, IBM/Lenovo M1015, and Fujitsu D2607. These cards can often be converted to use the original LSI firmware through a process known as “cross-flashing,” which is outside the scope of this guide. Use the latest available “Initiator/Target” or “IT” firmware available for these cards.

Other vendors of HBAs can be used (eg: Microsemi), but the Broadcom cards are strongly preferred due to their long history and mature storage driver.

For smaller-scale systems, the onboard SATA controller of the motherboard can be used. When using these controllers,

note that many motherboards often contain a mixture of 3 Gbps and 6 Gbps SATA This may impact performance, especially when connecting a solid-state drive (SSD). Some motherboards also allow for SATA ports to be configured as "RAID." It is important to disable this functionality by selecting the "AHCI" or "Non-RAID" options.

RAID controllers are strongly discouraged for use with TrueNAS and OpenZFS. These controllers can cause performance or stability issues, mask hardware serial numbers and SMART health, or introduce the potential for data loss if write caching is used on the controller. If a RAID controller is the only available option, consider taking the following steps:

- Enable "HBA Mode", "Drive Passthrough", or "JBOD mode" if possible
- Configure each drive as an individual RAID0 device and continue to use TrueNAS to provide redundancy

Note that the failure of a RAID controller with write-back cache is likely to result in data loss. ***It is suggested to use systems with RAID controllers only to gain familiarity with the TrueNAS software, and not for performance testing or storing critical data. RAID controllers are not supported for production TrueNAS systems.***

TrueNAS fully supports the use of SAS expanders, whether on an internal backplane or in an external disk shelf. Other types of external storage, such as SATA-based port multipliers and USB JBOD enclosures, may cause unexpected issues with pool creation, disconnects under workload, or poor performance.

2.7 Drive Type and Count

TrueNAS SCALE has been validated for up to 250 drives in a single storage array. This offers an unparalleled level of flexibility, allowing you to design a solution that best fits your needs. A combination of magnetic HDDs, SATA or SAS-based NAND, and NVMe devices can be combined in varying roles within TrueNAS.

2.7.1 Magnetic Hard Disk Drives (HDDs)

Until there is a major scientific breakthrough in storage, magnetic spinning hard disks remain the ideal choice for solutions where both high capacity and low cost are desired. With hard drives well into the double-digit terabyte size, a system can be built with a small physical footprint that delivers big usable capacity.

2.7.1.1 Avoid Shingled Magnetic Recording (SMR) Drives

While HDD manufacturers are always seeking to improve the density of their storage and pack more bits into a platter, one particular method of improving this density has been proven to be particularly problematic for copy-on-write filesystems including ZFS.

Shingled Magnetic Recording (SMR) is a term used to describe a method of tightly packing the data tracks on magnetic media together to the point at which they overlap, similar to shingles on the roof of a structure. Much like roofing shingles, the data tracks need to be written "in order," which causes additional "read-modify-write" cycles when data that is "lower in the pile" needs to be overwritten. This extra work causes the drives to perform significantly slower than conventional non-shingled drives and may even result in data integrity issues during a power loss event.

Due to these compatibility issues, iXsystems recommends that you do not use shingled magnetic recording drives with TrueNAS. Please carefully review your drive vendor's datasheet, and if procuring drives specifically for use with TrueNAS, explicitly state that SMR drives are not compatible and should not be supplied.

2.7.2 Solid-State Drives (SSDs)

Thanks to a rapid progression in flash storage technology, solid-state drives have become a common sight in general-purpose PCs and servers. Due to their lack of moving parts, flash drives are not sensitive to vibration and can offer a much higher level of random I/O performance.

2.7.3 NVMe (Non-Volatile Memory Express) SSDs

NVMe SSDs can offer improvements in both bandwidth and latency over SATA and SAS SSDs, as these devices connect to the PCI Express bus, offering multiple gigabytes per second to each connected device. This same connection can introduce challenges for hot-plugging devices. SATA and SAS hotplug is generally well-supported on a variety of hardware, but NVMe devices may not be recognized without a reboot.

While the legacy FreeNAS operating system was often run from small USB thumb drives, modern versions of TrueNAS generate a higher write workload to the boot device, which can quickly consume the endurance available on a typical consumer thumb drive. For this reason, all pre-built TrueNAS storage systems ship with M.2 or SATADOM (Disk On Module) devices.

3 Creating your Install Media and Installing TrueNAS

The first step in creating your install media is to download the TrueNAS SCALE installation ISO file from our website, at https://www.truenas.com/download-truenas-scale/.

3.1 Choosing your Installation Method

While the ISO is downloading, you'll need to determine your installation method. Many servers have the ability to mount an ISO remotely through an out-of-band management interface, presenting it as a virtual optical drive. If this is the case with your hardware, you don't need to create physical installation media.You can simply present the ISO to your server and continue on to section **3.3. Installing TrueNAS SCALE**. Installing on a virtual machine is similar. Use your hypervisor or virtualization software to present the downloaded ISO as a virtual optical drive to your new VM.

TrueNAS SCALE can be installed from a physical DVD if you choose. If this is your preferred method, simply record the ISO to a disc with your preferred media creation software - but it can also be transferred to a bootable USB drive of at least 2 GB in size.

3.2 Creating an Install USB

Depending on your operating system, there are a variety of programs that can be used to transfer the downloaded TrueNAS SCALE ISO to a USB stick. iXsystems does not recommend any specific program, but some examples are:

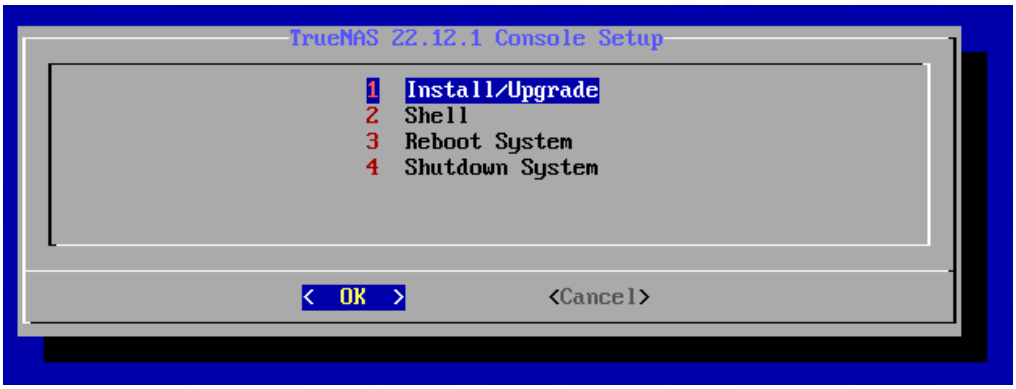
balenaEtcher (etcher.io) - Windows, macOS, Linux
Rufus (rufus.ie) - Windows
dd command-line - Linux

When creating your USB installation device, note that any existing data on your USB device will be overwritten. If prompted by your media creation program, select to use "DD mode," and configure the boot to include "BIOS + EFI" depending on your hardware platform.

3.3 Installing TrueNAS SCALE

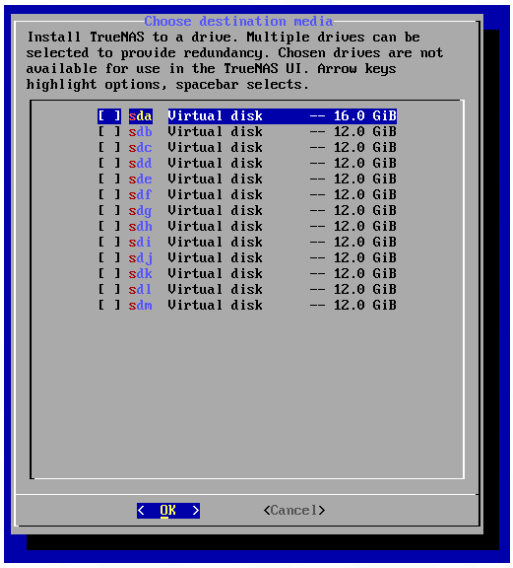
Insert or attach your boot device to the system you'll be installing TrueNAS SCALE on. You may need to press a specific function key during the BIOS or EFI boot process to select a specific boot device.

Once you've booted up, you'll see the TrueNAS SCALE console installation menu. Press Enter to begin the installation or wait for the installer to continue on its own after 15 seconds. The Linux-based installer will perform some initial startup tasks before presenting the TrueNAS Console Setup screen.

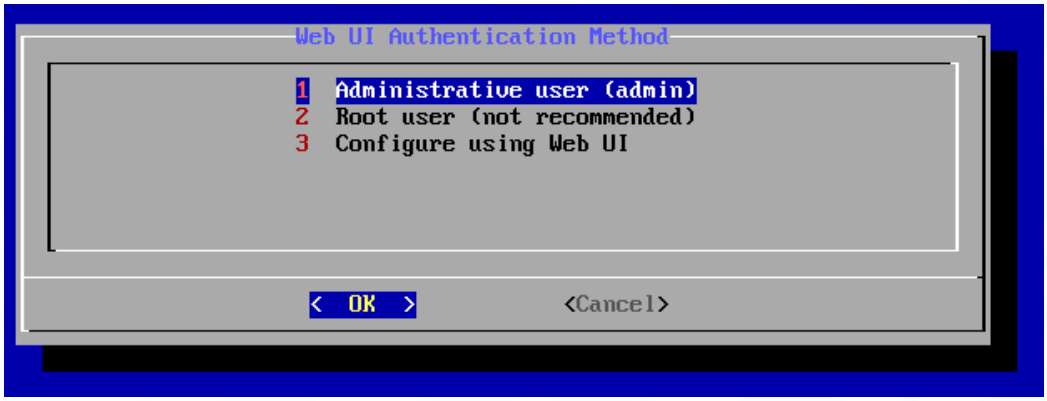


From here, select **Option 1 Install/Upgrade** with the Enter key.

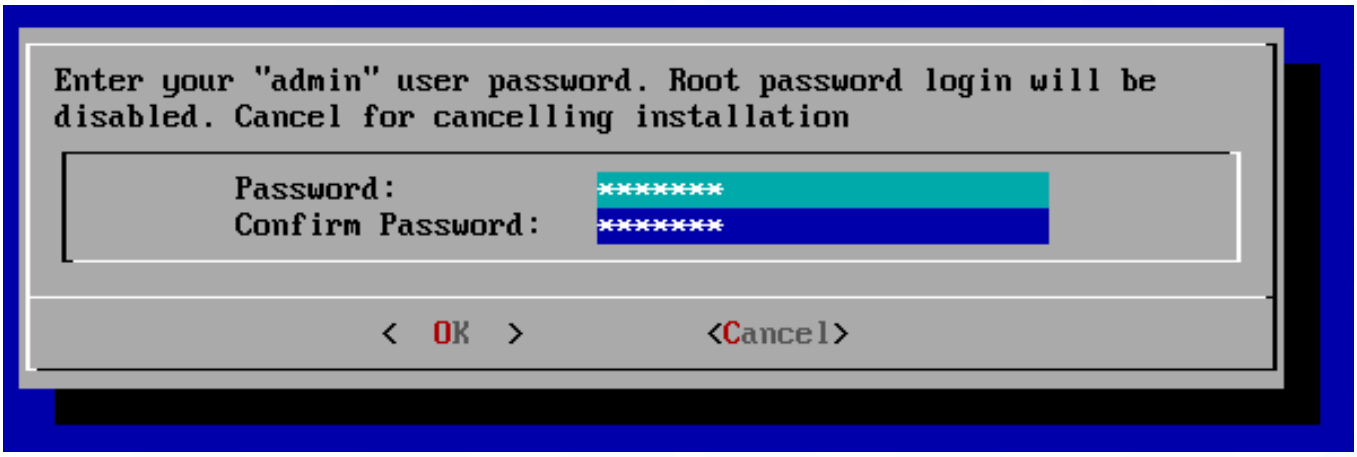
Next, you'll be prompted to select the drive (or drives) to install TrueNAS SCALE on. In our example, we have one 16 GB drive, and twelve 12 GB drives. We'll select the single 16 GB drive with the Spacebar before using the arrow keys to navigate to the OK button at the bottom. Note that any drives chosen for installation and booting are not usable for data storage.



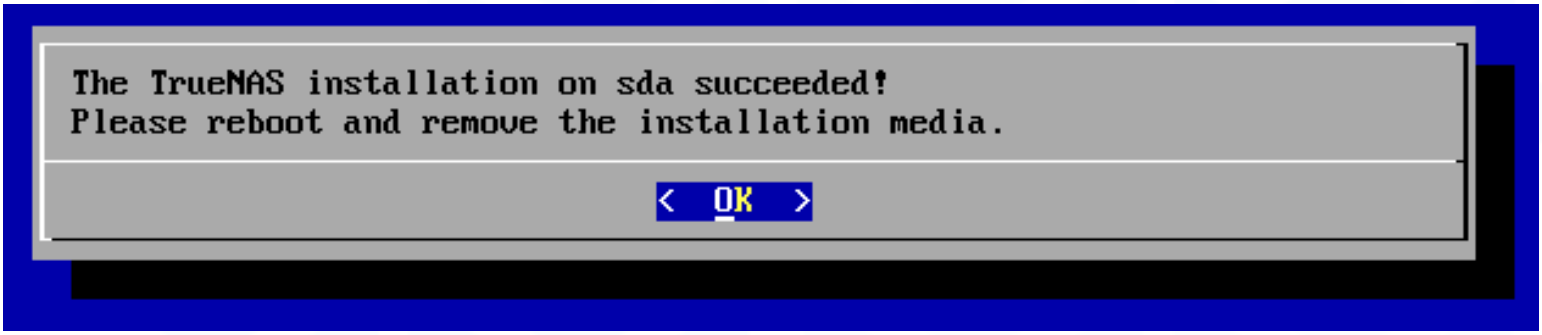
You'll be prompted to select the authentication method for the TrueNAS SCALE Web UI. We recommend the first option of **Administrative user (admin)** to separate the system super-user of "root" from the web UI administrator role.



After making your selection, you'll be prompted to enter the administrator password twice. If this password is forgotten, it can be reset from the TrueNAS SCALE console after installation.



Select the **OK** button using the arrow and **Enter** keys, and the installation will begin. Depending on the speed of your system and the installation method (virtual DVD, physical DVD, USB), this may take several minutes. Once this is complete, you should see a “succeeded!” message.



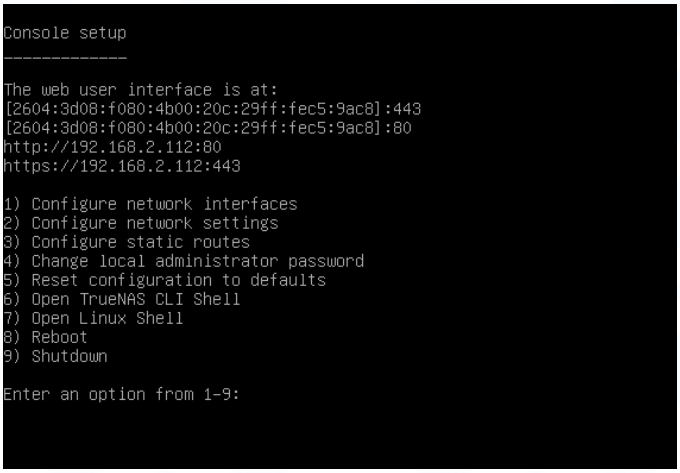
Remove the installation media, and choose to either reboot or shut down the system.

4 The First Boot

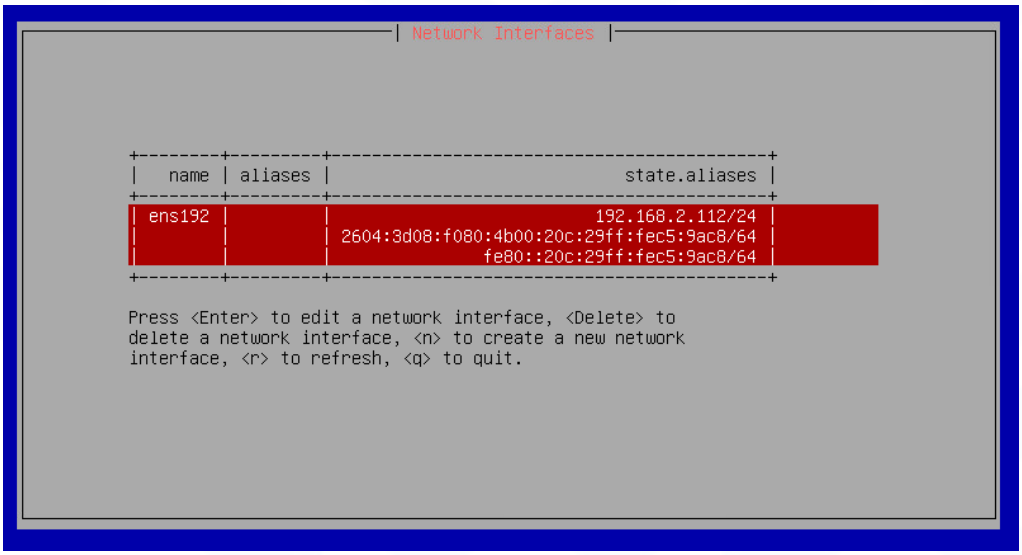
Now that you have TrueNAS installed, attach a single network cable to an available port on your hardware. During the initial setup process, you should only attach a single cable to prevent multiple IP addresses from being claimed on the same network. Once that’s done, power your system on and begin the initial startup phase.

4.1 Checking For DHCP - Assigning an IP Address

The first boot of TrueNAS will take slightly longer as it will be generating a few encryption secrets. Please be patient and wait for the initial console menu screen to appear, as shown below.



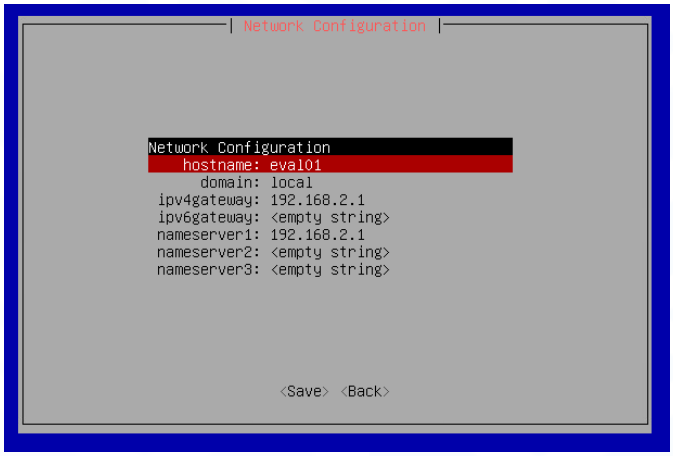
TrueNAS SCALE will attempt to obtain a DHCP lease on any physically connected interface. Even if DHCP is available on your connected network, it is suggested that you configure a fixed or "static" IP address instead for stability purposes. Use the console menu to select `1. Configure Network Interfaces` to launch the menu.



If you have multiple network adapters, you will see them in this menu. TrueNAS SCALE uses network device naming conventions based on the physical location of the adapter. Onboard devices may be referred to as "eno" with add-in cards being labeled as "ens" or "enp" depending on your hardware configuration. In our example, we'll be setting a fixed IP address for the connected "ens192" interface. Press **Enter** to edit the interface. Using the arrow keys and **Enter** to navigate the interface, move down to the **ipv4_dhcp** item, select it, and choose the **No** option. Move to the **Aliases** field, and add a new IP address with subnet bits. We'll choose 192.168.2.65. For most home networks, the subnet will be a "slash 24," but please check with your network administrator if you're unsure. Choose to **Save** these changes, and you'll be prompted to apply the pending changes. Press **(a)** to do so and test your ability to reach the TrueNAS system through a web browser, or with a **ping** test from a client machine. Once you've confirmed that network access is functioning correctly, use the **(p)** key to make the changes permanent, then use the **(q)** key to leave the configuration menu.

4.2 Changing Hostname, setting Gateway and DNS

While we at iX consider "TrueNAS" to be a fine name, it may not work as a hostname for your particular environment. You may want to set up two or more systems on the same domain. Select option `2. Configure Network Settings` from the console menu.

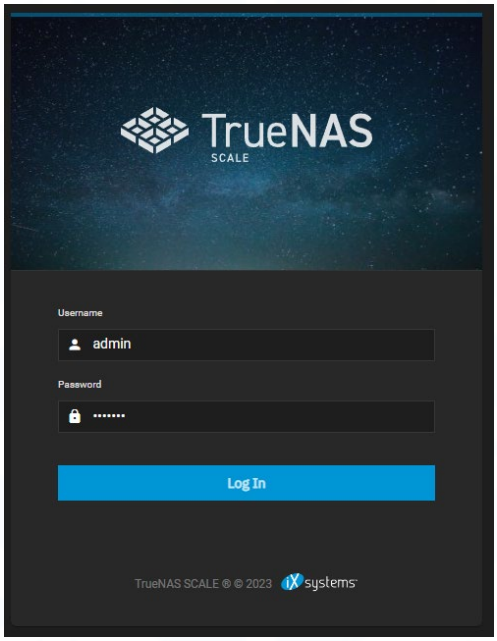


Enter your preferred hostname, domain name, the default gateway, and DNS server (or servers) for your network. If you're unsure of these values, check with your network administrator.

Once you've completed the console configuration, it's time to connect to your TrueNAS system from a web browser.

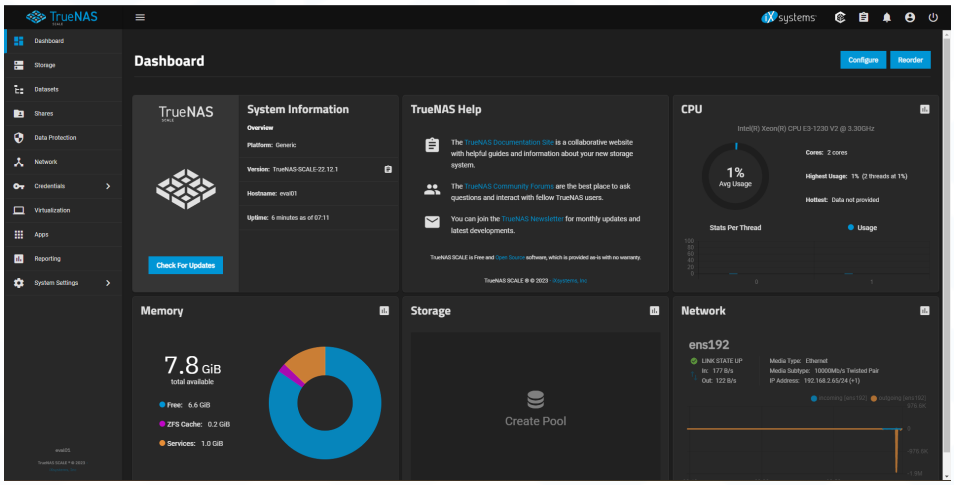
4.3 Signing into the Web UI

TrueNAS SCALE is intended to be operated through an HTML5 interface loaded through a web browser. Once TrueNAS has an IP address, it will advertise itself over the network using the Multicast DNS (mDNS) service with the hostname that was configured above. You can always enter the IP address directly into your browser using either HTTP or HTTPS.



If you're not able to load the TrueNAS logon page, check to see that you can reach the system via ping on the configured IP address, and that there are no network proxy or firewall/ACL rules that would prevent your browser client from reaching that IP address.

If you selected the "rootless" option during the installation of TrueNAS SCALE, the username is "admin." Use the password that was set during the installation process. Once you're logged in, the TrueNAS dashboard should be visible. Verify that the CPU and Memory widgets show the correct thread count and total memory capacity.

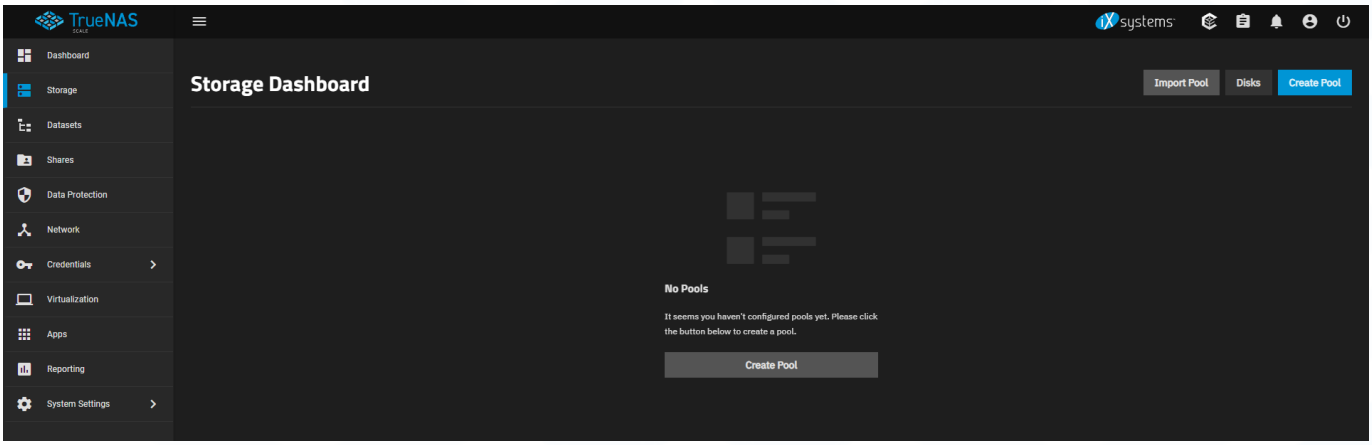


5 Getting Started with your Storage

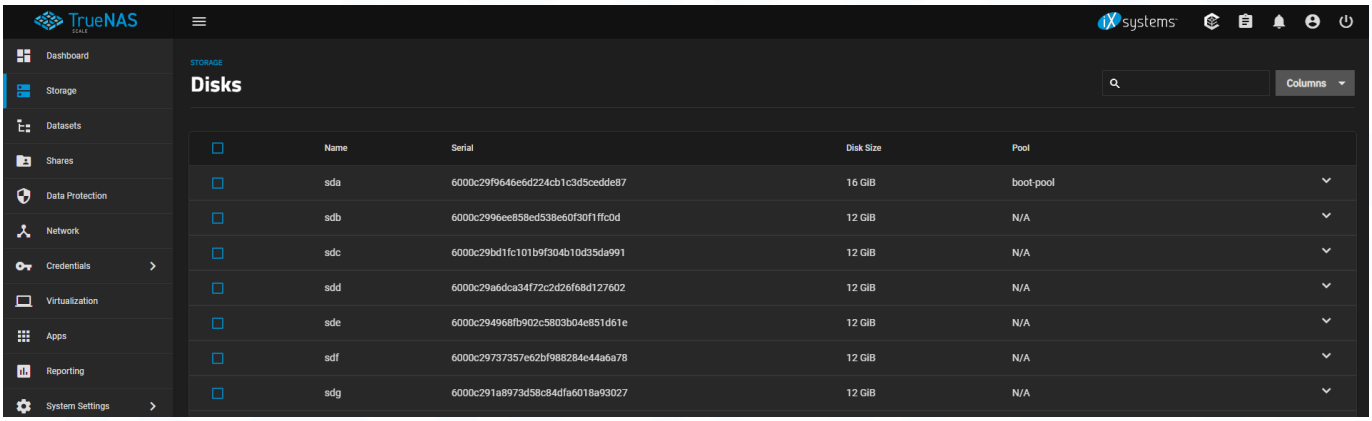
In this section, we'll create a **pool** (the top-level storage element of OpenZFS), provision a **dataset** (like a file system) inside that pool, and then share that pool over SMB.

5.1 Confirming Disk Count

From the menu on the left-hand side of the screen, click on the **Storage** tab, and then the **Disks** button in the top right corner of the new screen.



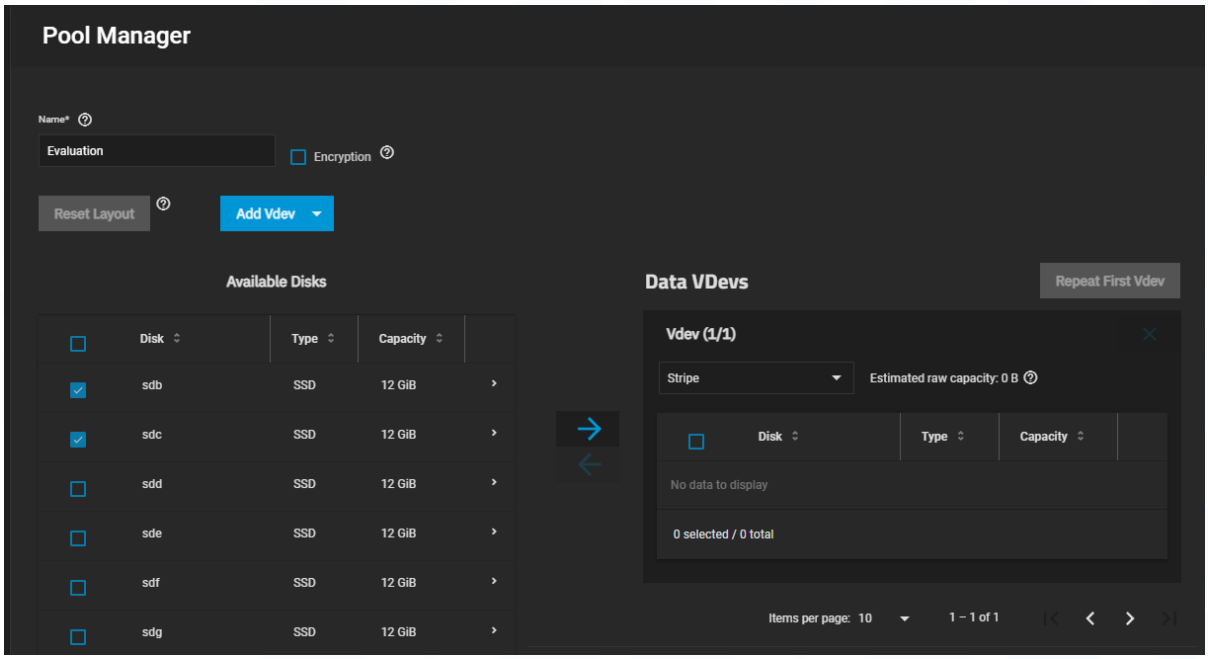
The Disks view should show that you have several unassigned disks. Any disks that you selected during the installation process will be shown as a member of the “boot-pool” and will not be usable for data storage. If you have fewer disks than expected here, check that your internal cable connections are secure. If you have more disks than expected, you may be using SAS devices with a dual-path enclosure.



5.2 Build your First Pool

Click on the **Storage** tab again, and this time use the **Create Pool** button in the top-right corner of the dashboard to start the Pool Manager. Enter a name of your choice in the “Name” field. This name won’t be visible to regular network clients, only to administrators logging in to TrueNAS, so pick one that describes it well for your storage team. The pool name can be changed after creation, but it requires the pool to be taken offline to do so. For this demonstration, we’ll use “Evaluation.”

There are numerous different storage configurations that can be used, and their performance and redundancy characteristics will be discussed further in the guide, but for ease of use and feature demonstration, we will create a pool made from **mirror vdevs**. In a conventional storage system, this might be referred to as a “RAID10” configuration. Use the checkboxes to identify two disks from the “Available Disks” list and click the “Right Arrow” button next to “Data VDevs | Vdev (1/1).”



You should now see the two disks in the vdev type of "Mirror." If you have additional disks available, click the **Repeat First Vdev** button and you'll be given the option to have TrueNAS automatically create additional vdevs using matching pairs that have been found in your system.

Important Troubleshooting Note:

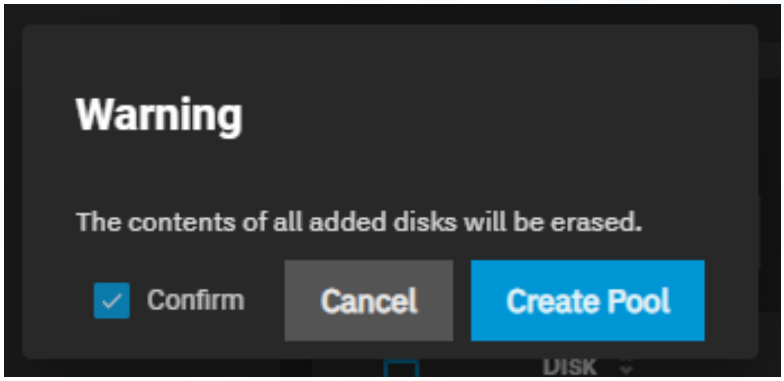
If you are unable to see your disks in the Pool Manager, but did see them in the previous Storage Dashboard, this may be a result of one of the following conditions:

1. Your storage controller is obscuring or failing to pass the drive serial numbers
2. You have installed TrueNAS as a VM on a VMware ESXi machine without vCenter or have used a virtualization platform that doesn't generate serial numbers for virtual disks

For the former, TrueNAS expects to be able to uniquely identify each storage device. Multi-drive enclosures and some consumer-grade single-drive enclosures have been observed reusing serial numbers across multiple pieces of equipment. You can check the "Show disks with non-unique serial numbers" dialog option or try to resolve this by changing the storage controller.

For the latter, you'll need to power off your TrueNAS VM and adjust your hypervisor settings to generate serial numbers. For VMware ESXi without vCenter, check the VM advanced configuration (Edit - Advanced, Configuration Settings) and create the advanced variable `disk.EnableUUID` with a value of `true`, then power the VM on again.

Once all drives have been assigned to vdevs, click the large "Create Pool" button. A warning will be shown indicating that existing data on the drives will be removed. Once you've confirmed that no data is remaining on those drives, check the "Confirm" button and proceed with pool creation.



5.3 Make a Dataset

A ZFS dataset can be thought of as analogous to a typical file system, but we can define some additional ZFS properties on a per-dataset basis, such as cache behavior, storage quota, and the compression algorithm to use. Datasets can be nested, similar to folders in a traditional file system, and will inherit settings from their parent dataset.

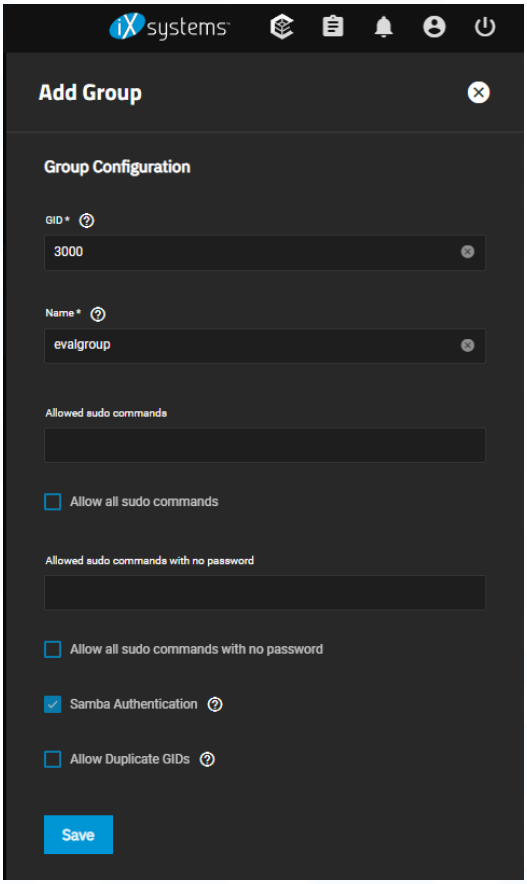
Navigate to the **Datasets** page, select your pool on the left-hand pane, and press the blue **Add Dataset** button on the far right.

Provide a dataset name. In our case, we'll use "EvalData." Scroll to the bottom of the window and change the Share Type from **Generic** to **SMB** which will set the **Case Sensitivity** option to **Disabled**. Once this is finished, click **Save** to create the dataset.

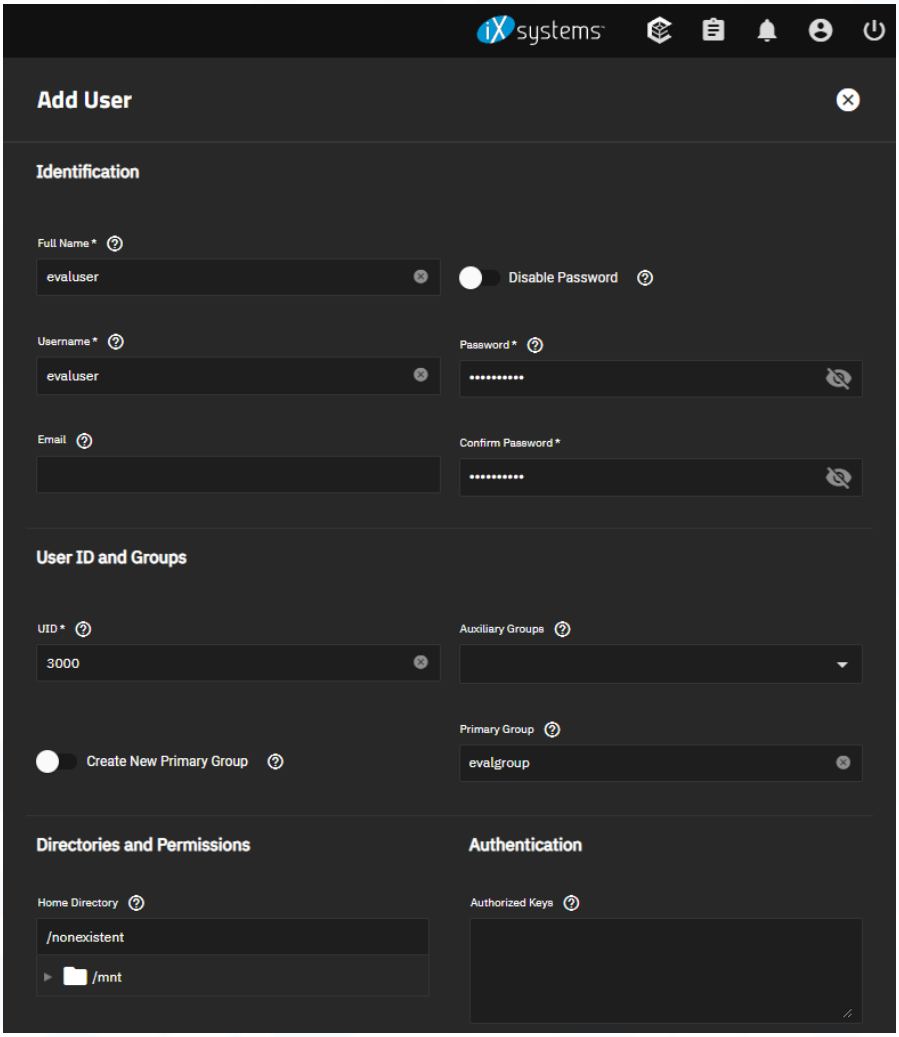
5.4 Creating a Group and a User

Since you don't want to use administrative credentials to map shared network resources, let's create a new group and user for authentication. Open the **Credentials → Local Groups** menu and choose the **Add** button.

The "GID" or "Group ID" is a numeric identifier used by the TrueNAS system. Leave the default value in place and set the name to evalgroup before continuing. Enable the "Samba Authentication" checkbox, as we want to be able to use this group to grant access to a shared folder later.



Next, let's create a local user. Open the **Credentials → Local Users** menu and choose the **Add** button



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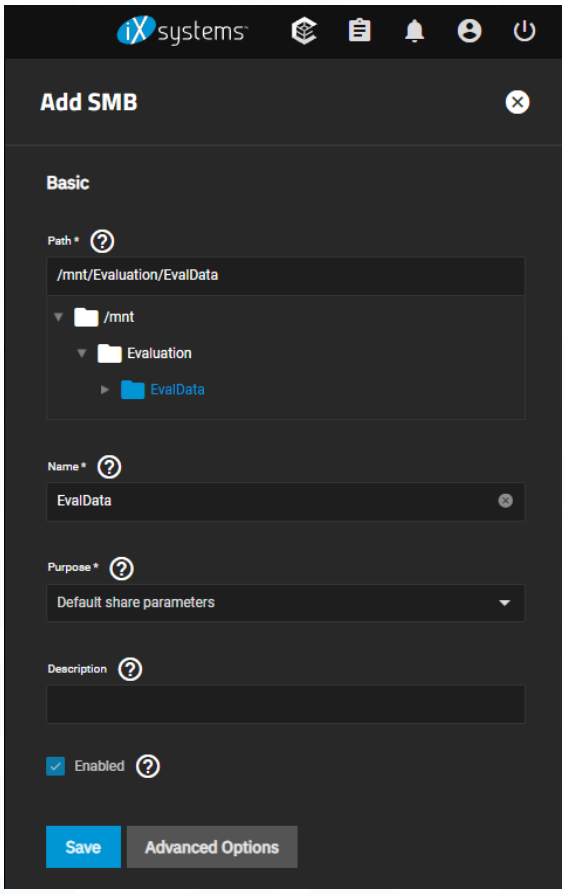
Set the full name to `evaluser` and set a password for remote access. Pay special attention to the limitations on characters that are and aren't allowed in a username. Disable the "Create

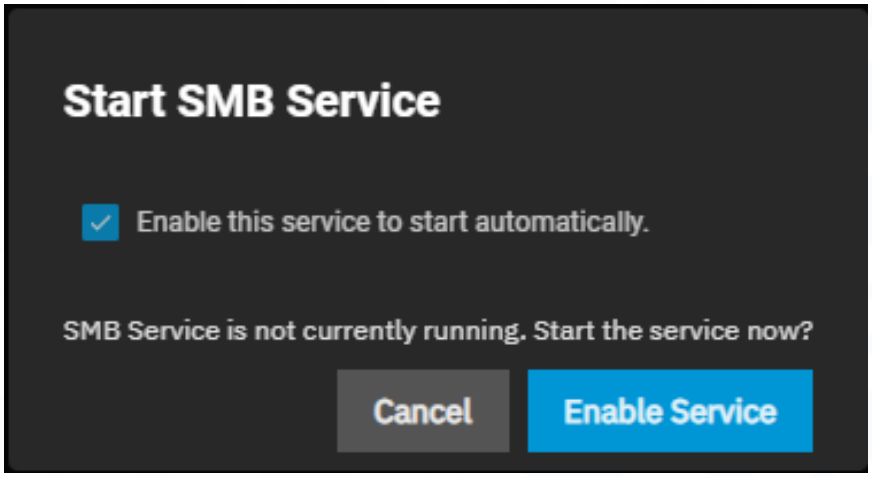
New Primary Group" slider, and search for the "evalgroup" to assign as the Primary Group. Scroll down, and leave the "Home Directory" field set to the default "/nonexistent" for now. Note how the "Samba Authentication" checkbox defaults to Enabled for user account creation, as opposed to when a group was created above.

5.5 Share the Dataset over SMB

Navigate to the **Shares** page. Choose the **Add** button beside **Windows (SMB)** Shares. Select the path to your newly created dataset, and accept the default share name or enter a new one. Leave the "Purpose" as "Default Share Parameters" for now and add a description if desired, which will be visible to clients. Click **Save** and wait for the share to be created.



As this is the first share you've created, you'll be prompted to start the SMB service. Set the "Enable this service to start automatically" checkbox and then click "Enable Service."



Congratulations! You've made your first share available from TrueNAS. Access the system via your previously configured hostname (such as truenas.local) or IP address through a file browser (`\\eval01.local\EvalData` or `\\192.168.2.65\EvalData`) and use the "evaluser" user credentials and password configured previously to sign in.

6 Data Protection, Previous Versions, and Snapshot Scheduling

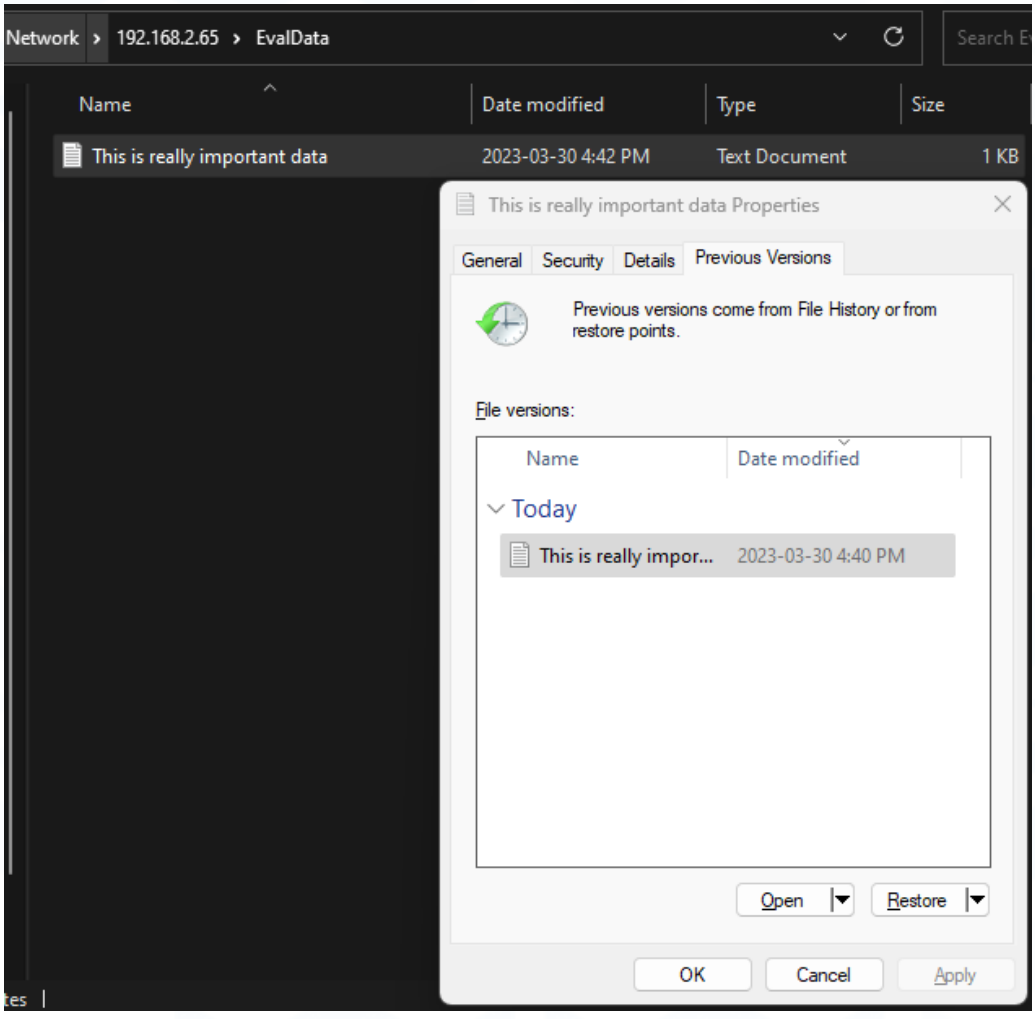
TrueNAS uses ZFS snapshots for recovery, which leverage the copy-on-write behavior of ZFS. Even when overwriting existing data, the older copy is kept, and marked for preservation by this snapshot. We'll demonstrate that using your shared folder. Access your system through a file browser using the hostname or IP address, and sign in using the user credentials you created above. Create a new text file or copy an existing document (a word processor or spreadsheet file is fine) to the shared folder. If you've created a new text file, write a quick note to yourself to represent data you want to protect from changes. Save and then close the file.

6.1 Taking a Manual ZFS Snapshot

From your TrueNAS console, navigate to **Data Protection**, select **Snapshots**, and click the blue **Add** button in the top-right corner. You'll be prompted to select your dataset. For our example, we would use `Evaluation/EvalData`. A snapshot name will automatically be generated with the format of `manual-YYYY-MM-DD_HH-MM` using the current date and a 24-hour clock. Leave "Recursive" unchecked for now, as we have no nested datasets beneath this folder to capture. Click **Save** and you'll be taken back to the Snapshot page almost immediately.

6.2 Going Back in Time

Return back to your shared folder through SMB and modify or delete some of the files you've created. Don't worry, as they are protected through the TrueNAS snapshot operating behind the scenes using the copy-on-write behavior of ZFS. Save any changes to the files and close them again. From here, right-click on the file (if using Windows 11, you may need to shift+right-click or select **Show More Options** (from the context menu) and select the **Restore Previous Versions** dialog. If you have edited multiple files, or deleted any files, navigate up a folder level and right-click on the "EvalData" folder itself before selecting the **Restore Previous Versions** option.

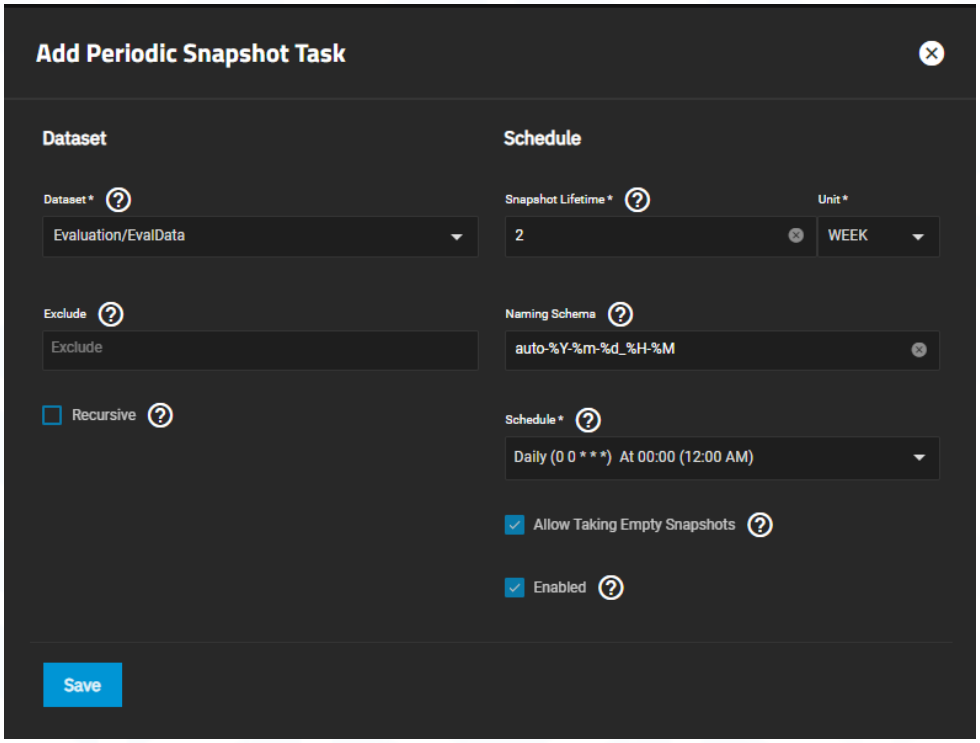


From here, you can double-click to open the previous version of the shared folder. Inside, you'll see the documents from the time of the snapshot, including any that have been deleted since. You can open and review the files there and copy deleted files back to their original location.

6.3 Automated Snapshots and Scheduling

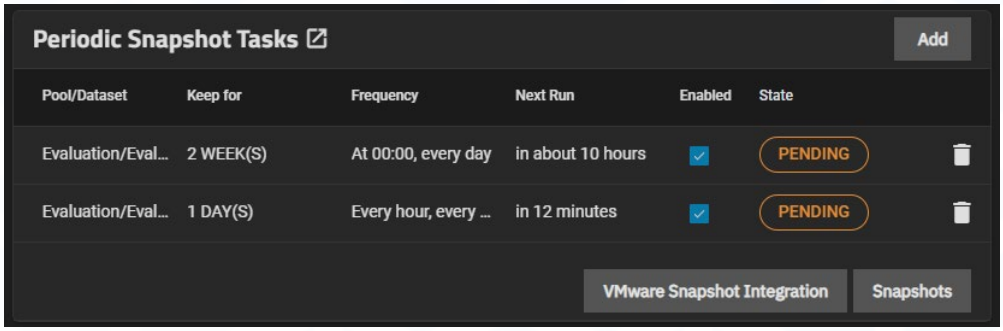
Return to your web browser, which should still be on the **Snapshots** page, and click on **Data Protection** once again. Manual snapshots are fine, but scheduled snapshots allow for this level of protection to be automatically refreshed on a regular basis. In the **Periodic Snapshot Tasks** panel, choose the **Add** button.

In your new side panel, select your dataset from the drop-down list. The default schedule creates a snapshot every day at midnight in your local time zone, and these snapshots are retained for two weeks. Once a snapshot is older than two weeks, it is automatically removed from the system to prevent excess disk consumption.



The snapshot schedule has pre-populated schedules for snapshots every hour, day, week, or month. With the "Allow Taking Empty Snapshots" option checked, snapshot schedules can overlap. A "Daily" and "Weekly" snap of the same dataset can happen at the same time and the "empty" snap will still exist to be retained for a longer lifetime.

For example, select your dataset, and change the "Schedule" to "Hourly" with a "Snapshot Lifetime" of one day. Save this task, and then create a second task with a "Daily" schedule and two week "Lifetime." With this configuration, files can be restored with one-hour accuracy for a 24-hour period, and after that, with one-day accuracy to a two-week period.



Snapshots are also crucial in the use of replication tasks - sending the data to another pool, to another TrueNAS system, or to another OpenZFS replication target.

7 Drive Failure, vdev Removal, and Extending your Pool

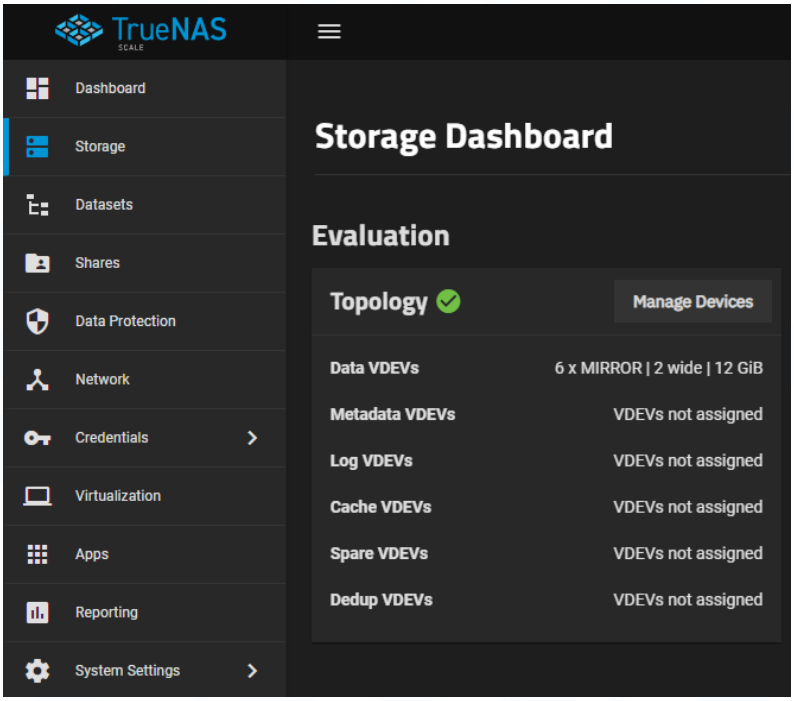
While ZFS is not the same as a traditional RAID array, it does share the first letter of the acronym in that it can provide *redundancy*. A core difference to understand is that redundancy within ZFS is built at the vdev level, not the pool level. Consider the concept of a traditional RAID60, where disks are configured into double-parity groups, and then data is distributed across multiple groups. There is no ZFS equivalent to a "RAID61" where the disks are configured into double-parity and data is then mirrored between them.

In our example, we've created six vdevs that are two-way mirrors. It's important to take note of your configuration and adjust your failure simulation appropriately.

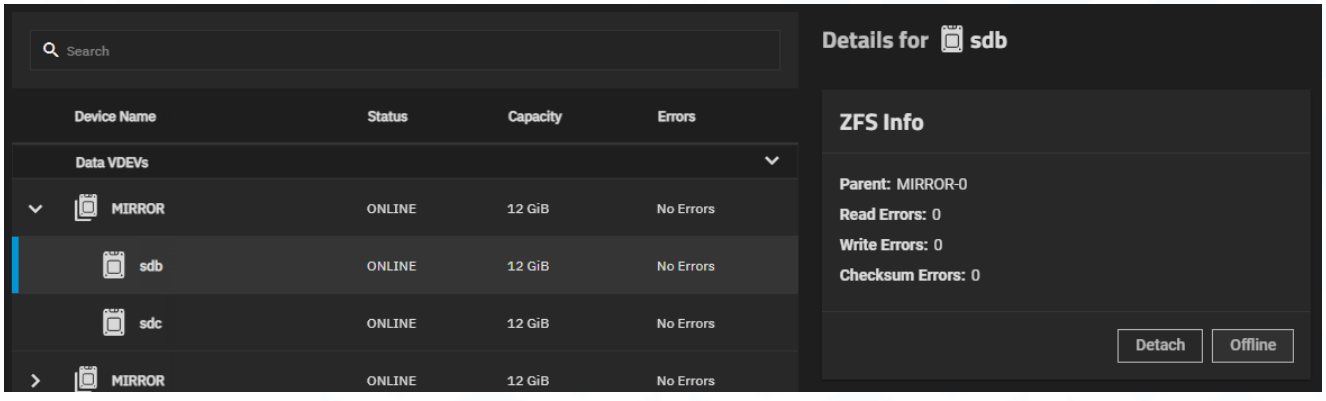
7.1 Simulating a Drive Failure

We can simulate a drive failure by setting a drive to an offline state. From the TrueNAS web UI, navigate to **Storage** and then select the **Manage Devices** button associated with your pool, in the **Topology** pane.

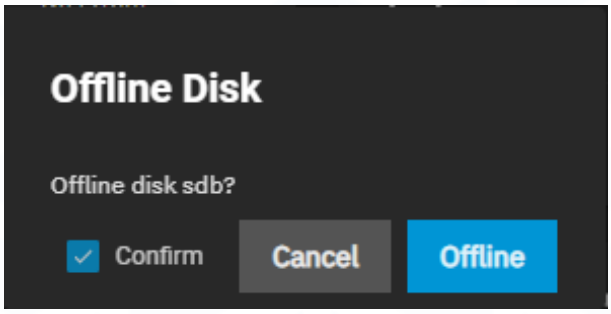
Note: Those who are evaluating TrueNAS SCALE on a hot-swap capable system can also choose to physically remove a disk from their server to test the behavior, rather than simulating a failure. Note that you should not attempt to hot-plug drives unless they are in a system designed for it. If in doubt, use the "simulated failure" approach discussed below.



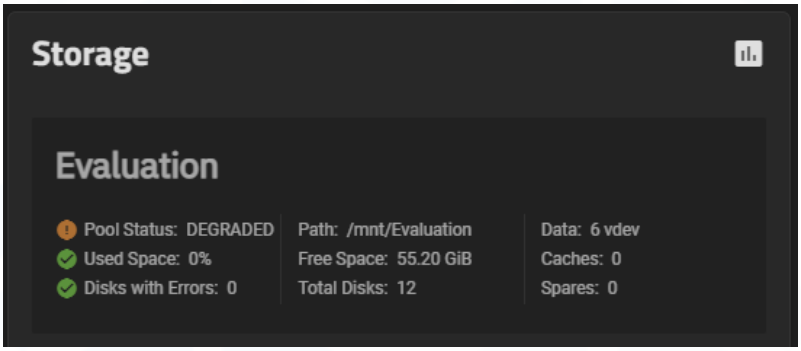
Within the **Storage - Devices** view, expand a MIRROR vdev object in the left-hand pane, and select one of the disks within it. Under the **ZFS Info** pane, choose the **Offline** button.



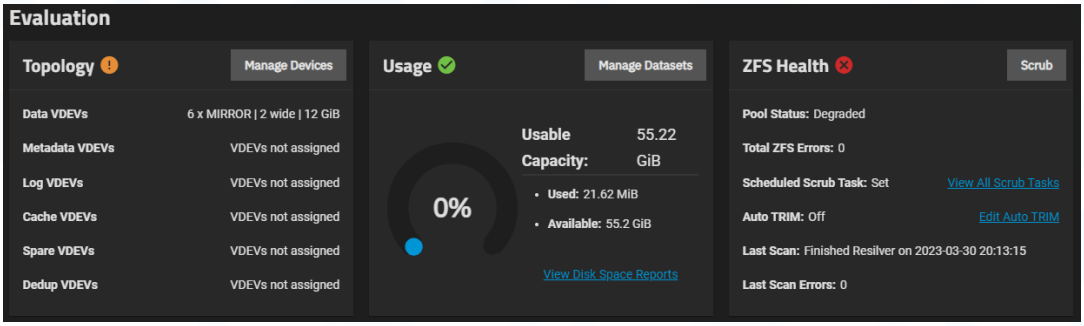
Performing the OFFLINE will treat the disk as failed, but leave an entry for it in the MIRROR vdev. Confirm the operation and click the blue **Offline** button.



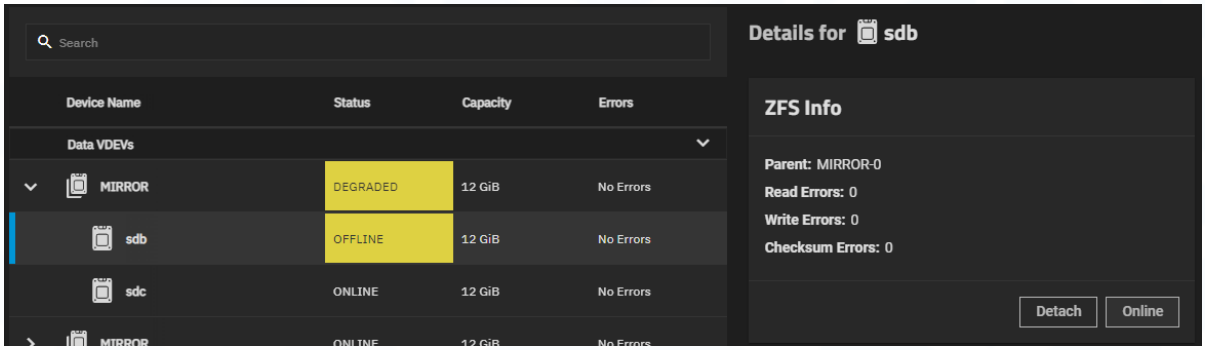
Once the display refreshes, the mirror vdev will immediately change to a status of **DEGRADED**. Click on the **Dashboard** tab on the left-hand side to see how the main screen would look in this scenario. You'll notice that the **Storage** pane will show your **Evaluation** pool with an overall status of **DEGRADED**.



Click on the **Storage** tab on the left-hand side and note the alerts raised in the **Topology** and **ZFS Health** categories:



As the disk is still present in the system, it can easily be replaced. Click the **Manage Devices** button, expand your DEGRADED vdev, select the OFFLINE disk, and click the **Online** button.

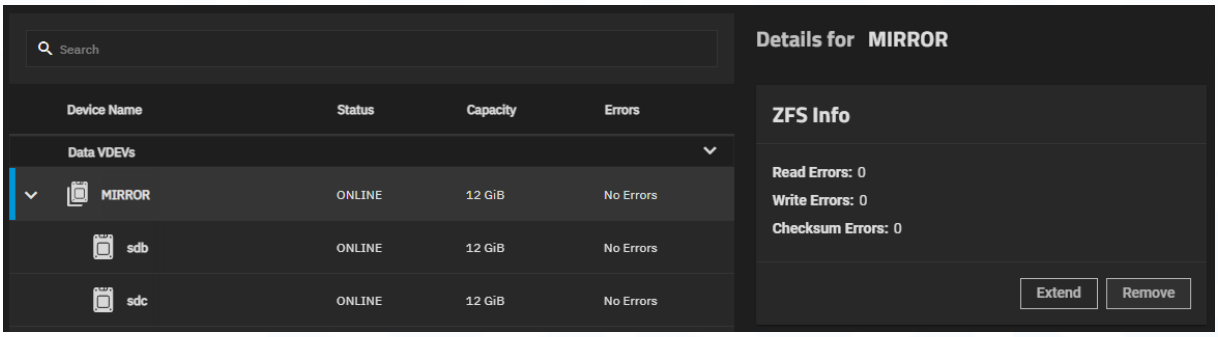


Confirm the operation, and the vdev will return to a healthy state. If data was added to the TrueNAS system while the disk was offline, a process called *resilvering* will begin to restore the redundancy level of the vdev.

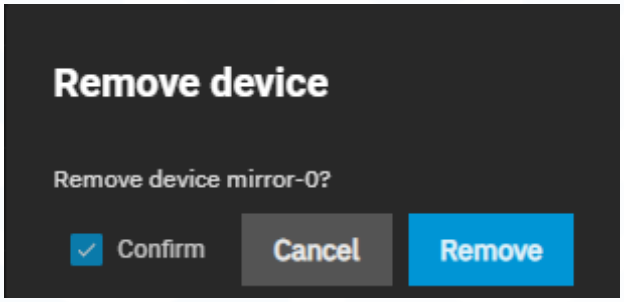
7.2 Removing a vdev

It may occasionally be necessary to remove disks from a pool permanently, perhaps to repurpose them for a second pool within the system, or to correct an inadvertent misconfiguration, such as two disks being added as individual drives rather than a single mirrored pair. With a pool that is composed of only stripe or mirror vdevs, ZFS allows for the removal of an entire vdev, assuming that enough capacity is provided by all remaining disks.

Click the **Storage** tab, and then **Manage Devices** on your pool. Click the first MIRROR vdev in your listing, and choose the **Remove** button in the **ZFS Info** pane.



Confirm the removal and click the **Remove** button again.

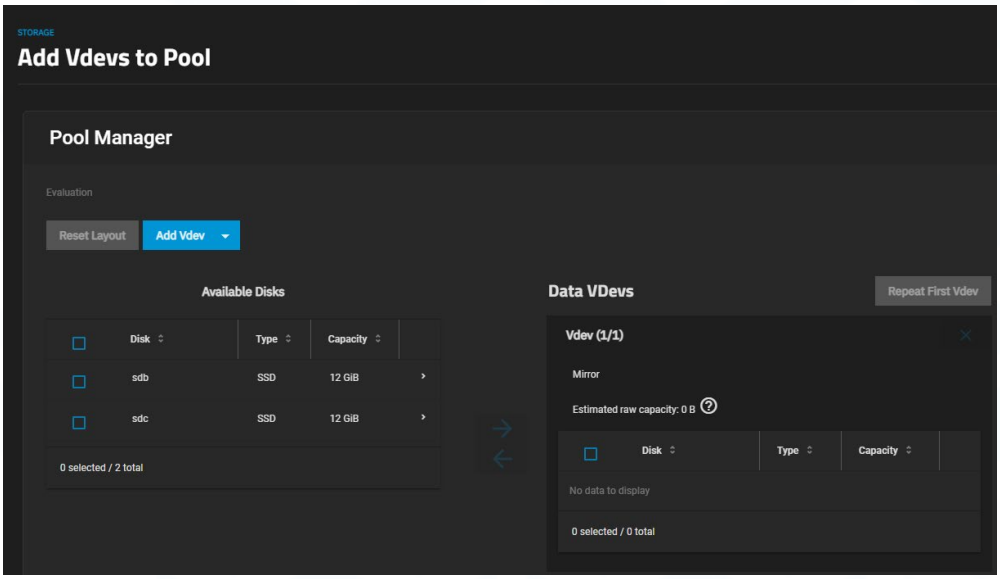


The disks will be marked for evacuation. This process may take a significant amount of time, depending on the amount of data stored on them.

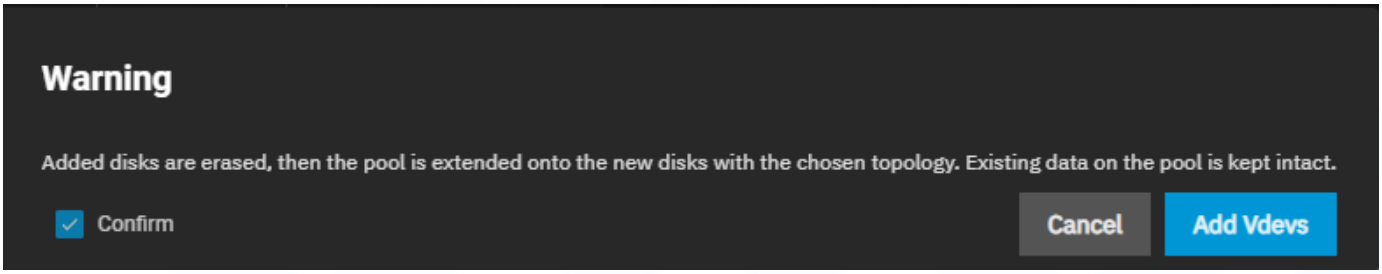
Once the process completes, the pool will be reduced to a smaller number of physical disks.

7.3 Adding a vdev

Much more common than the removal of existing disks is the addition of new ones. Click on the **Add Vdev** button in the top right corner of the **Storage - Devices** window. You'll be presented with a familiar dialog, which is the same **Pool Manager** we used to create the pool initially.



You'll notice that the vdev on the right-hand side is already configured as a MIRROR. Select only the first disk and choose the right arrow button, and note that TrueNAS presents you with a pair of warnings in red text, one indicating that the mirror requires a minimum of two disks, and the second indicating that it is not recommended to use a different number of disks to extend a pool. Select your second disk and use the right arrow button to move it to the vdev, and these errors will disappear. Click the **Add Vdevs** button at the bottom of the screen.



You'll need to confirm that the disks will be erased. Note that existing data on the pool is kept intact and not migrated to the new disks immediately. ZFS will begin to direct new writes to these disks, as well as any data being overwritten that may exist elsewhere. Again, this is due to the copy-on-write nature of ZFS.

8 Wrapping Up

At this point, we've created a data pool, experimented with adding and removing drives, as well as presented a dataset over SMB to a network client, and shown the value of TrueNAS SCALE's immutable snapshot technology to restore the previous versions of files and folders.

This is only a fraction of the feature set available with TrueNAS SCALE. This evaluation guide will continue to grow and evolve to showcase more functionality, with additional sections including:

- Replication - Local and Remote
- Users and Groups
- Permissions (ACLs)
- Joining a Domain/LDAP
- Security Best Practices
- And more...

Have a suggestion on a section to add? We welcome your ideas at marketing@ixsystems.com. We hope that you have found the time learning about TrueNAS to be well-spent, and you have a better understanding of where you can use TrueNAS in your environment on your quest for **True Data Freedom.**