

FreeNAS® 11.3-U1 User Guide

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Written by users of the FreeNAS® network-attached storage operating system.

Version 11.3

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Welcome

This Guide covers the installation and use of FreeNAS® 11.3.

The FreeNAS® User Guide is a work in progress and relies on the contributions of many individuals. If you are interested in helping us to improve the Guide, read the instructions in the [README](https://github.com/freenas/freenas-docs/blob/master/README.md) (<https://github.com/freenas/freenas-docs/blob/master/README.md>). IRC Freenode users are welcome to join the *#freenas* channel where you will find other FreeNAS® users.

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Typographic Conventions

Typographic Conventions

The FreeNAS® 11.3 User Guide uses these typographic conventions:

Table 1: Text Format Examples

Item	Visual Example
Graphical elements: buttons, icons, fields, columns, and boxes	Click the <i>Import CA</i> button.
Menu selections	Select <i>System</i> → <i>Information</i> .
Commands	Use the <code>scp</code> command.
File names and pool and dataset names	Locate the <code>/etc/rc.conf</code> file.
Keyboard keys	Press the <code>Enter</code> key.
Important points	This is important.
Values entered into fields, or device names	Enter <code>127.0.0.1</code> in the address field.

Table 2: FreeNAS® Icons

Icon	Usage
<i>ADD</i>	Add a new item.
⚙️ (Settings)	Show a settings menu.
⋮ (Options)	Show an Options menu.
📁 (Browse)	Shows an expandable view of system directories.
⏻ (Power)	Show a power options menu.
👁️ (Show)	Reveal characters in a password field.
🙁 (Hide)	Hide characters in a password field.
✏️ (Configure)	Edit settings.
🚀 (Launch)	Launch a service.
▶ (Start)	Start jails.
■ (Stop)	Stop jails.
🔄 (Update)	Update jails.
🗑️ (Delete)	Delete jails.
🔒 (Encryption Options)	Encryption options for a pool.
📌 (Pin)	Pin a help box to the screen.
✕ (Close)	Close a help box.

INTRODUCTION

FreeNAS® is an embedded open source network-attached storage (NAS) operating system based on FreeBSD and released under a [2-clause BSD license](https://opensource.org/licenses/BSD-2-Clause) (<https://opensource.org/licenses/BSD-2-Clause>). A NAS has an operating system optimized for file storage and sharing.

FreeNAS® provides a browser-based, graphical configuration interface. The built-in networking protocols provide storage access to multiple operating systems. A plugin system is provided for extending the built-in features by installing additional software.

1.1 New Features in 11.3

FreeNAS® 11.3 is a feature release, which includes new significant features, many improvements and bug fixes to existing features, and version updates to the operating system, base applications, and drivers. Users are encouraged to [Update](#) (page 105) to this release in order to take advantage of these improvements and bug fixes.

Major New Features and Improvements

The replication framework has been redesigned, adding new back-end systems, files, and screen options to the [Replication system](#) (page 142) and [Periodic Snapshot Tasks](#) (page 133). The redesign adds these features:

- New peers/credentials API for creating and managing credentials. The [SSH Connections](#) (page 98) and [SSH Keypairs](#) (page 102) screens have been added and a wizard makes it easy to generate new keypairs. Existing SFTP and SSH replication keys created in 11.2 or earlier will be automatically added as entries to [SSH Keypairs](#) (page 102) during upgrade.
- New transport API adds netcat support, for greatly improved speed of transfer.
- Snapshot creation has been decoupled from replication tasks, allowing replication of manually created snapshots.
- The ability to use custom names for snapshots.
- Configurable snapshot retention on the remote side.
- A new replication wizard makes it easy to configure replication scenarios, including local replication and replication to systems running legacy replication (pre-11.3).
- Replication is resumable and failed replication tasks will automatically try to resume from a previous check-point. Each task has its own log which can be accessed from the *State* column.
- Replications run in parallel as long as they do not conflict with each other. Completion time depends on the number and size of snapshots and the bandwidth available between the source and destination computers.

[Network interface management](#) (page 155) has been redesigned to streamline management of both physical and virtual interfaces using one screen. VLANs and LAGGs are now classified as interface types and support for the [Bridge interface](#) (page 158) type has been added. The addressing details for all physical interfaces, including DHCP, are now displayed but are read-only if the interface is a member of a LAGG. When applying interface changes, the web interface provides a window to cancel the change and revert to the previous network configuration. A new MTU field makes it easier to set the MTU as it no longer has to be typed in as an Auxiliary Parameter.

[Automatic Certificate Management Environment \(ACME\)](https://ietf-wg-acme.github.io/acme/draft-ietf-acme-acme.html) (<https://ietf-wg-acme.github.io/acme/draft-ietf-acme-acme.html>) support has been added. ACME simplifies the process of issuing and renewing certificates using a set of DNS challenges to verify a user is the owner of the domain. While the new API supports the addition of multiple DNS authenticators, support for [Amazon Route 53](https://aws.amazon.com/route53/) (<https://aws.amazon.com/route53/>) has been added as the initial implementation. The [ACME DNS](#) (page 119) screen is used for authenticator configuration which adds the [ACME Certificates](#) (page 118) option for Certificate Signing Requests. Once configured, FreeNAS® will automatically renew ACME certificates as they expire.

Support for collecting daily anonymous usage statistics has been added. Collected non-identifying data includes hardware information such as CPU type, number and size of disks, and configured NIC types as well as an indication of which services, types of shares, and Plugins are configured. The collected data will assist in determining where to best focus engineering and testing efforts. Collection is enabled by default. To opt-out, unset *System → General → Usage collection*.

The [Alert](#) (page 339) system has been improved:

- Support for one-shot critical alerts has been added. These alerts remain active until dismissed by the user.
- [Alert Settings](#) (page 93) has been reorganized: alerts are grouped functionally rather than alphabetically and per-alert severity and alert thresholds are configurable.
- Periodic alert scripts have been replaced by the [Alert](#) (page 339) framework. Periodic alert emails are disabled by default and previous email alert conditions have been added to the FreeNAS® alert system. E-mail or other alert methods can be configured in [Alert Services](#) (page 91).

A [Task Manager](#) (page 342) in the top menu bar displays the status and progress of configured tasks.

The Dashboard has been rewritten to provide an overview of the current state of the system rather than repeat the historical data found in [Reporting](#) (page 320). It now uses middleware to handle data collection and provide the web interface with real-time events. Line charts have been replaced with meters and gauges. CPU graphs have been consolidated into a single widget which provides average usage and per-thread statistics for both temperature and usage. Interfaces are represented as a separate card per physical NIC unless they are part of a LAGG card. Pool and Interface widgets feature mobile-inspired lateral navigation, allowing users to “drill down” into the data without leaving the page.

[Reporting](#) (page 320) has been greatly improved. Data is now prepared on the backend by the middleware and operating system. Any remaining data manipulation is done in a web worker, keeping expensive processing off of the main UI thread/context. The SVG-based charting library was replaced with a GPU-accelerated canvas-based library. Virtual scroll and lazy loading prevent overloading the browser and eliminate the need for a pager. Users can zoom by X or Y axis and reset the zoom level with a double click. Graphs do not display if there is no related data. Support for UPS and NFS statistics has been added.

Options for configuring the reporting database have been moved to *System → Reporting*. This screen adds the ability to configure *Graph Age* as well as the number of points for each hourly, daily, weekly, monthly, or yearly graph (*Graph Points*). The location of the reporting database defaults to tmpfs and a configurable alert if the database exceeds 1 GiB has been added to [Alert Settings](#) (page 93).

The web interface has received many improvements and bug fixes. Usability enhancements include: ability to move, pin, and copy help text, persistent layout customizations, customizable column views, size units which accept humanized input, improved caching and browser support, and improved error messages, popup dialogs, and help text. An iX Official theme has been added which is the default for new installations.

NAT support has been added as the default for most [Plugins](#) (page 283). With NAT, a plugin is contained in its own network and does not require any knowledge of the physical network to work properly. This removes the need to manually configure IP addresses or have a DHCP server running. When installing a plugin into a virtualized environment, NAT removes the requirement to enable Promiscuous Mode for the network.

The [Plugins](#) (page 283) page has been streamlined so that most operations can be performed without having to go to the [Jails](#) (page 294) page. Support for collections has been added to differentiate between iXsystems plugins, which receive updates every few weeks, and Community plugins. In addition, there have been many bug fixes and improvements to iocage, the Plugins backend, resulting in a much better Plugins user experience.

An [ACL Manager](#) (page 183) has been added to *Storage → Pools → ⓘ (Options)* and the [permissions editor](#) (page 182) has been redesigned.

A new iSCSI wizard in *Block (iSCSI)* (page 215) makes it easy to configure iSCSI shares.

There have been several *Pool Manager* (page 164) improvements. The labels and tooltips for encryption operations are clearer. Disk type, rotation rate, and manufacturer information makes it easier to differentiate between selectable disks when creating a pool. A *REPEAT* button makes it easy to create large pools using the same vdev layout, such as a series of striped mirrors.

Significant improvements to *SMB sharing* (<https://jira.ixsystems.com/browse/NAS-102108>) include ZFS user quotas support, web service discovery support, and improved directory listing performance for newly-created shares.

The middleware and websockets APIv2 rewrite is complete. APIv1 remains for backwards compatibility but will be deprecated and no longer available in the next major release.

Deprecated and Removed Features

- The legacy web interface has been removed and no longer appears as an option in the *login screen* (page 61).
- Warden has been removed along with all CLI and web interface support for warden jails or plugins installed using FreeNAS® 11.1 or earlier.
- Hipchat has been removed from *Alert Services* (page 91) as it has been *discontinued* (<https://www.atlassian.com/partnerships/slack>). The web interface can still be used to delete an existing Hipchat configuration.
- *Domain Controller* has been removed from *Services* (page 252).
- *Netdata* has been removed from *Services* (page 252) due to a long-standing upstream memory leak. *TrueCommand* (<https://www.ixsystems.com/truecommand/>) provides similar reporting plus advanced management capabilities for single or multiple FreeNAS® systems and is free to use to manage up to 50 drives.
- The built-in Docker template has been removed from *Virtual Machines* (page 322). Instructions for manually installing Docker can be found in *Installing Docker* (page 327).

New or Updated Software

- The FreeBSD operating system has been patched up to *EN-19:18* (<https://www.freebsd.org/security/advisories/FreeBSD-EN-19:18.tzdata.asc>) and *SA-19:26* (<https://security.freebsd.org/advisories/FreeBSD-SA-19:26.mcu.asc>).
- OS support for reporting the CPU temperature of AMD Family 15h, Model >=60h has been added.
- QLogic 10 Gigabit Ethernet driver support has been added with *qlxgbe(4)* (<https://www.freebsd.org/cgi/man.cgi?query=qlxgbe>).
- The base FreeBSD ports have been updated to their latest versions as of September 24, 2019.
- Python has been updated to version *3.7.5* (<https://www.python.org/downloads/release/python-375/>) to address *CVE-2019-15903* (<https://nvd.nist.gov/vuln/detail/CVE-2019-15903>).
- Angular has been updated to version *8.2.13* (<https://github.com/angular/angular/blob/master/CHANGELOG.md>).
- Samba has been updated to version *4.10.10* (<https://www.samba.org/samba/history/samba-4.10.10.html>).
- Netatalk has been updated to version *3.1.12_2,1* (<http://netatalk.sourceforge.net/3.1/ReleaseNotes3.1.12.html>).
- Rclone has been updated to version *1.49.4* (<https://rclone.org/changelog/#v1-49-4-2019-09-29>).
- collectd has been updated to version *5.8.1_1* (https://collectd.org/wiki/index.php/Version_5.8).
- sudo has been updated to version 1.8.29 to address *CVE-2019-14287* (<https://nvd.nist.gov/vuln/detail/CVE-2019-14287>).
- *p7zip* (<http://p7zip.sourceforge.net/>) has been added.
- The *zettarepl* (<https://github.com/freenas/zettarepl>) replication tool has been added.

Misc UI Changes


- The *Hostname* and *Domain* set in *Global Configuration* (page 153) are shown under the iXsystems logo at the top left of the web interface.
- The web interface now indicates when a *system update is in progress* (page 109).

- *Directory Services Monitor* (page 198) has been added to the top toolbar row.
- The *Theme Selector* has been removed from the top navigation bar. The theme is now selected in *Preferences* (page 63).
- The redundant *Account* entry has been removed from the gear icon of the top navigation bar.
- *Add to Favorites*, *Enable Help Text*, and *Enable "Save Configuration" Dialog Before Upgrade* have been removed from *Preferences* (page 63).
- *Reset Table Columns to Default* has been added to *Preferences* (page 63).
- Right-click help dialog has been added to the *Shell* (page 335).

System

- The *GUI SSL Certificate*, *WebGUI HTTP -> HTTPS Redirect*, *Usage collection*, and *Crash reporting* fields have been added to and the *Protocol* field has been removed from *General* (page 75).
- The *WebGUI IPv4 Address* and *WebGUI IPv6 Address* fields in the *General* (page 75) system options have been updated to allow selecting multiple IP addresses.
- The *Language* field can now be sorted by *Name* or *Language code*.
- An *Export Pool Encryption Keys* option has been added to the *SAVE CONFIG dialog* (page 77).
- *System* → *Boot Environments* has been renamed to *Boot* (page 80). *Automatic scrub interval (in days)* and information about the operating system device have been moved to *ACTIONS* → *Stats/Settings*.
- *Periodic Notification User* has been removed from the *Advanced* (page 83) system options because periodic script notifications have been replaced by alerts.
- *Show tracebacks in case of fatal error* has been removed from the *Advanced* (page 83) system options.
- Setting *messages* in the *Advanced* (page 83) system options provides a button to show console messages on busy spinner dialogs.
- *Remote Graphite Server Hostname* and *Report CPU usage in percentage* have been moved to *System Reporting* (page 91).
- *From Name* has been added to *Email* (page 88).
- *Reporting Database* has moved from *System Dataset* (page 90) to *System* → *Reporting*.
- *Level* has been added and the *SHOW SETTINGS* button removed from the *Alert Services* (page 91) options.
- *API URL* has been added to the *OpsGenie alert service options* (page 91).
- *SNMP Trap* has been added to *Alert Services* (page 91).
- *IPMI SEL Low Space Left*, *IPMI System Event*, *Device is Causing Slow I/O on Pool*, *Rsync Task Failed*, and *Rsync Task Succeeded* have been added to *Alert Settings* (page 93). *Clear All Alerts* has been changed to *Dismiss All Alerts*.
- *OAuth Client ID* and *OAuth Client Secret* have been removed from the *Box*, *Dropbox*, *Microsoft OneDrive*, *pCloud*, and *Yandex* providers in the *Cloud Credentials* (page 94) options.
- *VERIFY CREDENTIAL* has been added to the *Cloud Credentials* (page 94) options.
- *Region* has been added to the *Amazon S3 Cloud Credentials* (page 94) options.
- *PEM-encoded private key file path* has been changed to *Private Key ID* in the *SFTP cloud credential options* (page 96).
- *Comment* has been changed to *Description* in *Tunables* (page 102).
- *FETCH AND INSTALL UPDATES* has been renamed to *DOWNLOAD UPDATES* in *Update* (page 105).
- *Elliptic Curve Cryptography (ECC)* (https://en.wikipedia.org/wiki/Elliptic-curve_cryptography) key support has been added to the options for *Certificate Authorities* (page 112) and *Certificates* (page 117).
- *Organizational Unit* has been added to the *CAs* (page 110) and *Certificates* (page 113) options.
- *Import Certificate Signing Request* has been added to the *Certificates* (page 113) options.

Tasks

- The  icon (page 20) has been added to the *Schedule* column for created *Tasks* (page 123).
- *Timeout* has been added to the *Init/Shutdown Scripts options* (page 125).
- The log entries for individual *Rsync Tasks* (page 126) can be displayed and downloaded by clicking the *Status* of the task.
- The FreeBSD *path and name length* (page 17) criteria have been applied to the *Path* field in *rsync tasks* (page 127).
- *All Disks* has been added to the *S.M.A.R.T. Tests options* (page 133).
- *Exclude*, *Snapshot Lifetime*, and *Allow taking empty snapshots* have been added to the *Periodic Snapshot task options* (page 134).
- *Minutes* can be specified in *Custom Periodic Snapshot schedules* (page 134).
- The replication log has been moved to `/var/log/zettarepl.log`. The log entries for individual *Replication Tasks* (page 142) can be displayed and downloaded by clicking the *State* of the task.
- A *Last Snapshot* column has been added to *Replication Tasks* (page 142).
- *Name*, *Properties*, and *Hold Pending Snapshots* have been added to the *Replication Task options* (page 139).
- *Limit (KiBs)* has been renamed to *Limit (Ex. 500 KiB/s, 500M, 2 TB)* in the *Replication Task options* (page 139) and accepts various size units like *K* and *M*.
- *Stream Compression* in *Replication Task options* (page 139). only appears when *SSH* is chosen for *Transport* type.
- *Storage Class*, *Use -fast-list*, *Take Snapshot*, *Stop*, *Pre-script*, *Post-script*, *Transfers*, *Follow Symlinks*, *Bandwidth Limit*, *Upload Chunk Size (MiB)*, and *Exclude* have been added to the *Cloud Sync Task options* (page 148).
- The log entries for individual *Cloud Sync Tasks* (page 146) can be displayed and downloaded by clicking the *Status* of the task.

Network

- The *Interface name* field has been renamed to *Description* and the *MTU* and *Disable Hardware Offloading* fields have been added to *Interfaces options* (page 156).

Storage

- Disk type, rotation rate, and manufacturer information can be viewed on the *Disks* (page 191) page and when *creating a pool* (page 164).
- The *Export/Disconnect Pool* (page 171) dialog shows system services that are affected by the export action.
- The dataset *permissions editor* (page 182) has been redesigned. The *ACL Type*, *Apply User*, *Apply Group*, and *Apply Access Mode* fields have been removed and *Traverse* has been added.
- *ACL Mode* has been added to the *Add Dataset advanced mode* (page 178).
- A dataset deletion confirmation dialog with a force delete option has been added to the *Delete Dataset dialog* (page 179).
- *Time Remaining* displays when the pool has an active scrub in *Pool Status* (page 176).
- *Naming Schema* has been added to the *single snapshot* (page 189) options.
- *Critical*, *Difference*, *Informational*, and *Clear SED Password* fields have been added to *Disk Options* (page 192).
- *Detach* and *REFRESH* options have been added to *Pool Status* (page 193).
- The *Filesystem type* option behavior in *Import Disk* (page 196) has been updated to select the detected filesystem of the chosen disk. After importing a disk, a dialog allows viewing or downloading the disk import log.
- *Adding a dataset* (page 177) shows *options to configure warning or critical alerts* (page 178) when a dataset reaches a certain percent of the quota.

Directory Services

- *Computer Account OU* has been added and the *Enable AD monitoring*, *UNIX extensions*, *Domain Controller*, *Global Catalog Server*, *Connectivity Check*, and *Recovery Attempts* fields have been removed from [Active Directory](#) (page 199).
- *Leave Domain* dynamically appears in [Active Directory](#) (page 198) when the FreeNAS® system is joined to an Active Directory domain.
- *fruit* and *tdb2* have been removed from the [Idmap backend options](#) (page 201).
- *Validate Certificate* has been added to [Active Directory](#) (page 199) and [LDAP](#) (page 204) configuration options.
- The *Disable LDAP User/Group Cache* checkbox has been added and the *User Suffix*, *Group Suffix*, *Password Suffix*, *Machine Suffix*, *SUDO Suffix*, *Netbios Name*, and *Netbios alias* fields have been removed from [LDAP configuration options](#) (page 204).
- The *Hostname* in [LDAP](#) (page 203) supports multiple hostnames as a failover priority list.

Sharing

- *Enable Shadow Copies* has been added to the [Windows Shares \(SMB\) options](#) (page 240). *Default Permissions* has been removed from [Windows \(SMB\) Shares](#) (page 239) as permissions are now configured using [ACL manager](#) (page 183).
- The *acl_tdb*, *acl_xattr*, *aio_fork*, *cacheprime*, *cap*, *commit*, *default_quota*, *expand_msdfs*, *extd_audit*, *fake_perms*, *linux_xfs_sgid*, *netatalk*, *posix_eadb*, *readahead*, *readonly*, *shadow_copy*, *shadow_copy_zfs*, *shell_snap*, *streams_depot*, *syncops*, *time_audit*, *united_media*, *virusfilter*, *worm*, and *xattr_tdb* [VFS objects](#) (page 243) have been removed and the *shadow_copy2* VFS object has been added.
- *Comment* has been renamed to *Description* for [Block \(iSCSI\)](#) (page 215) Portals, Initiators, and Extents.

Services

- *Email* has been removed from the [S.M.A.R.T. Service Options](#) (page 268). S.M.A.R.T. alerts are configured as part of an [alert service](#) (page 91). Note that email addresses previously configured to receive S.M.A.R.T. alerts now receive all FreeNAS® [alerts](#) (page 339).
- *Time Server for Domain*, *File Mask*, *Directory Mask*, *Allow Empty Password*, *DOS Charset*, and *Allow Execute Always* have been removed from the [SMB service options](#) (page 270).
- *Unix Extensions*, *Domain logons*, and *Obey pam restrictions* have been removed from the [SMB services options](#) (page 270). These options are now dynamically enabled.
- *Expose zilstat via SNMP* has been added to the [SNMP service options](#) (page 273).
- *Host Sync* has been added to the [UPS service options](#) (page 279), search functionality has been added to *Driver*, and USB port detection has been added to the *Port or Hostname*.
- UPS events now generate [Alerts](#) (page 339).
- [NUT](#) (<http://networkupstools.org/>) (Network UPS Tools) now listens on `:::1` (IPv6 localhost) in addition to `127.0.0.1` (IPv4 localhost).

Virtual Machines

- Grub boot loader support has been added for virtual machines that will not boot with other loaders.
- *Description* and *System Clock* have been added to the [Virtual Machines wizard](#) (page 325). The Wizard now displays system memory and *Delay VM boot Until VNC Connects* has been added to the first step of the Wizard.
- An optional, custom name can be specified when [cloning Virtual Machines](#) (page 322).
- Log files for each VM are stored in `/var/log/vm/`. Log files have the same name as the VM.

Plugins and Jails

- *Browse a Collection*, *REFRESH INDEX*, and *POST INSTALL NOTES* have been added to [Plugins](#) (page 283).
- [Template jails](#) (page 305) can now be created from the web interface.
- *allow_vmm*, *allow_mount_fusefs*, *ip_hostname*, *assign_localhost*, *Autoconfigure IPv6 with rtsold*, and *NAT* options have been added in [Advanced Jail Creation](#) (page 297).

- *NAT Port Forwarding* and the associated *Protocol*, *Jail Port Number*, and *Host Port Number* fields have been added to the *Network Properties* section of *Advanced Jail Creation* (page 297).
- *ip6_saddrsel* and *ip4_saddrsel* in *Advanced Jail Creation* (page 297) have been renamed to *ip6.saddrsel* and *ip4.saddrsel*.
- Log files for jail status and command output are stored in `/var/log/iocage.log`.

1.1.1 U1

U1 is the first maintenance release to 11.3-RELEASE, including nearly one hundred bug fixes and other improvements. For a detailed change list, see the completed tickets in the [FreeNAS/TrueNAS Jira Project](https://jira.ixsystems.com/issues/?jql=project%20%3D%20NAS%20AND%20resolution%20in%20(Complete%2C%20Done)%20AND%20A1) ([https://jira.ixsystems.com/issues/?jql=project%20%3D%20NAS%20AND%20resolution%20in%20\(Complete%2C%20Done\)%20AND%20A1](https://jira.ixsystems.com/issues/?jql=project%20%3D%20NAS%20AND%20resolution%20in%20(Complete%2C%20Done)%20AND%20A1)).

1.2 Path and Name Lengths

Names of files, directories, and devices are subject to some limits imposed by the FreeBSD operating system. The limits shown here are for names using plain-text characters that each occupy one byte of space. Some UTF-8 characters take more than a single byte of space, and using those characters reduces these limits proportionally. System overhead can also reduce the length of these limits by one or more bytes.

Table 1.1: Path and Name Lengths

Type	Maximum Length	Description
File Paths	1023 bytes	Total file path length (<i>PATH_MAX</i>). The full path includes directory separator slash characters, subdirectory names, and the name of the file itself. For example, the path <code>/mnt/tank/mydataset/mydirectory/myfile.txt</code> is 42 bytes long. Using very long file or directory names can be problematic. If a path with long directory and file names exceeds the 1023-byte limit, it prevents direct access to that file until the directory names or filename are shortened or the file is moved into a directory with a shorter total path length.
File and Directory Names	255 bytes	Individual directory or file name length (<i>NAME_MAX</i>).
Mounted Filesystem Paths	88 bytes	Mounted filesystem path length (<i>MNAMELEN</i>). Longer paths can prevent a device from being mounted.
Device Filesystem Paths	63 bytes	<code>devfs(8)</code> (https://www.freebsd.org/cgi/man.cgi?query=devfs) device path lengths (<i>SPECNAMLEN</i>). Longer paths can prevent a device from being created.

Note: 88 bytes is equal to 88 ASCII characters. The number of characters varies when using Unicode.

Warning: If the mounted path length for a snapshot exceeds 88 bytes, the data in the snapshot is safe but inaccessible. When the mounted path length of the snapshot is less than the 88 byte limit, the data will be accessible again.

The 88 byte limit affects automatic and manual snapshot mounts in slightly different ways:

- **Automatic mount:** ZFS temporarily mounts a snapshot whenever a user attempts to view or search the files within the snapshot. The mountpoint used will be in the hidden directory `.zfs/snapshot/name` within the same ZFS dataset. For example, the snapshot `mypool/dataset/snap1@snap2` is mounted at `/mnt/`

`mypool/dataset/.zfs/snapshot/snap2/`. If the length of this path exceeds 88 bytes the snapshot will not be automatically mounted by ZFS and the snapshot contents will not be visible or searchable. This can be resolved by renaming the ZFS pool or dataset containing the snapshot to shorter names (`mypool` or `dataset`), or by shortening the second part of the snapshot name (`snap2`), so that the total mounted path length does not exceed 88 bytes. ZFS will automatically perform any necessary unmount or remount of the file system as part of the rename operation. After renaming, the snapshot data will be visible and searchable again.

- **Manual mount:** The same example snapshot is mounted manually from the [Shell](#) (page 335) with `mount -t zfs mypool/dataset/snap1@snap2 /mnt/mymountpoint`. The path `/mnt/mountpoint/` must not exceed 88 bytes, and the length of the snapshot name is irrelevant. When renaming a manual mountpoint, any object mounted on the mountpoint must be manually unmounted with the `umount` command before renaming the mountpoint. It can be remounted afterwards.

Note: A snapshot that cannot be mounted automatically by ZFS can still be mounted manually from the [Shell](#) (page 335) with a shorter mountpoint path. This makes it possible to mount and access snapshots that cannot be accessed automatically in other ways, such as from the web interface or from features such as “File History” or “Versions”.

1.3 Using the Web Interface

1.3.1 Tables and Columns

Tables show a subset of all available columns. Additional columns can be shown or hidden with the *COLUMNS* button. Set a checkmark by the fields to be shown in the table. Column settings are remembered from session to session.

The original columns can be restored by clicking *Reset to Defaults* in the column list.

Each row in a table can be expanded to show all the information by clicking the `>` (Expand) button.

1.3.2 Advanced Scheduler

When choosing a schedule for different FreeNAS® [Tasks](#) (page 123), clicking *Custom* opens the custom schedule dialog.

Fig. 1.1: Creating a Custom Schedule

Choosing a preset schedule fills in the rest of the fields. To customize a schedule, enter `crontab` (<https://www.freebsd.org/cgi/man.cgi?query=crontab&sektion=5>) values for the *Minutes/Hours/Days*.

These fields accept standard `cron` values. The simplest option is to enter a single number in the field. The task runs when the time value matches that number. For example, entering 10 means that the job runs when the time is ten minutes past the hour.

An asterisk (*) means “match all values”.

Specific time ranges are set by entering hyphenated number values. For example, entering 30–35 in the *Minutes* field sets the task to run at minutes 30, 31, 32, 33, 34, and 35.

Lists of values can also be entered. Enter individual values separated by a comma (,). For example, entering 1, 14 in the *Hours* field means the task runs at 1:00 AM (0100) and 2:00 PM (1400).

A slash (/) designates a step value. For example, while entering * in *Days* means the task runs every day of the month, */2 means the task runs every other day.

Combining all these examples together creates a schedule running a task each minute from 1:30-1:35 AM and 2:30-2:35 PM every other day.

There is an option to select which *Months* the task will run. Leaving each month unset is the same as selecting every month.

The *Days of Week* schedules the task to run on specific days. This is in addition to any listed *Days*. For example, entering 1 in *Days* and setting *W* for *Days of Week* creates a schedule that starts a task on the first day of the month **and** every Wednesday of the month.

Schedule Preview shows when the current schedule settings will cause the task to run.

1.3.3 Schedule Calendar

The *Schedule* column has a calendar icon (📅). Clicking this icon opens a dialog showing scheduled dates and times for the related task to run.

Pool	Threshold days	Description	Schedule	Next Run	Enabled	
pool1	35		📅 00 00 ** 7	in 4 days	yes	⋮

Upcoming tasks

- Sun Sep 08 2019 00:00:00 GMT-0400
- Sun Sep 15 2019 00:00:00 GMT-0400
- Sun Sep 22 2019 00:00:00 GMT-0400
- Sun Sep 29 2019 00:00:00 GMT-0400
- Sun Oct 06 2019 00:00:00 GMT-0400

Fig. 1.2: Example Schedule Popup

Scrub Tasks (page 144) can have a number of *Threshold days* set. The configured scrub task continues to follow the displayed calendar schedule, but it does not run until the configured number of threshold days have elapsed.

1.3.4 Changing FreeNAS® Settings

It is important to use the web interface or the Console Setup menu for all configuration changes. FreeNAS® stores configuration settings in a database. Commands entered at the command line **do not modify the settings database**. This means that changes made at the command line will be lost after a restart and overwritten by the values in the settings database.

1.3.5 Web Interface Troubleshooting

If the web interface is shown but seems unresponsive or incomplete:

- Make sure the browser allows cookies, Javascript, and custom fonts from the FreeNAS® system.
- Try a different browser. [Firefox](https://www.mozilla.org/en-US/firefox/all/) (<https://www.mozilla.org/en-US/firefox/all/>) is recommended.

If a web browser cannot connect to the FreeNAS® system by IP address, DNS hostname, or mDNS name:

- Check or disable proxy settings in the browser.
- Verify the network connection by pinging the FreeNAS® system by IP address from another computer on the same network. For example, if the FreeNAS® system is at IP address 192.168.1.19, enter `ping 192.168.1.19` on the command line of the other computer. If there is no response, check network configuration.

1.3.6 Help Text

Most fields and settings in the web interface have a ⓘ (Help Text) icon. Additional information about the field or setting can be shown by clicking ⓘ (Help Text). The help text window can be dragged to any location, and will remain there until ✕ (Close) or ⓘ (Help Text) is clicked to close the window.

1.3.7 Humanized Fields

Some numeric value fields accept *humanized* values. This means that the field accepts numbers or numbers followed by a unit, like `M` or `MiB` for megabytes or `G` or `GiB` for gigabytes. Entering `1048576` or `1M` are equivalent. Units of `KiB`, `MiB`, `GiB`, `TiB`, and `PiB` are available, and decimal values like `1.5 GiB` are supported when the field allows them. Some fields have minimum or maximum limits on the values which can restrict the units available.

1.3.8 File Browser

Certain sections of the web interface have a built in file browser. The file browser is used to traverse through directories and choose datasets on the system. Datasets that have *complex ACL permissions* (page 183) are tagged so they can be distinguished from non-ACL datasets.

1.4 Hardware Recommendations

FreeNAS® 11.3 is based on FreeBSD 11.3 and supports the same hardware found in the [FreeBSD Hardware Compatibility List](https://www.freebsd.org/releases/11.3R/hardware.html) (https://www.freebsd.org/releases/11.3R/hardware.html). Supported processors are listed in section 2.1 `amd64` (https://www.freebsd.org/releases/11.3R/hardware.html#proc). FreeNAS® is only available for 64-bit processors. This architecture is called *amd64* by AMD and *Intel 64* by Intel.

Note: FreeNAS® boots from a GPT partition. This means that the system BIOS must be able to boot using either the legacy BIOS firmware interface or EFI.

Actual hardware requirements vary depending on the workflow of your FreeNAS® system. This section provides some starter guidelines. The [FreeNAS® Hardware Forum](https://www.ixsystems.com/community/forums/hardware-discussion/) (https://www.ixsystems.com/community/forums/hardware-discussion/) has performance tips from FreeNAS® users and is a place to post questions regarding the hardware best suited to meet specific requirements. The [Official FreeNAS® Hardware Guide](https://www.ixsystems.com/blog/hardware-guide/) (https://www.ixsystems.com/blog/hardware-guide/) gives in-depth recommendations for every component needed in a FreeNAS® build. [Building, Burn-In, and Testing your FreeNAS® system](https://forums.freenas.org/index.php?threads/building-burn-in-and-testing-your-freenas-system.17750/) (https://forums.freenas.org/index.php?threads/building-burn-in-and-testing-your-freenas-system.17750/) has detailed instructions on testing new hardware.

Note: The FreeNAS® team highly recommends [Western Digital Red](https://www.westerndigital.com/products/internal-drives/wd-red-hdd) (https://www.westerndigital.com/products/internal-drives/wd-red-hdd) NAS Disk Drives as the preferred storage drive of FreeNAS®.

1.4.1 RAM

The best way to get the most out of a FreeNAS® system is to install as much RAM as possible. More RAM allows ZFS to provide better performance. The [iXsystems® Community Forums](https://www.ixsystems.com/community/) (https://www.ixsystems.com/community/) provide anecdotal evidence from users on how much performance can be gained by adding more RAM.

General guidelines for RAM:

- **A minimum of 8 GiB of RAM is required.**

Additional features require additional RAM, and large amounts of storage require more RAM for cache. An old, somewhat overstated guideline is 1 GiB of RAM per terabyte of disk capacity.

- To use Active Directory with many users, add an additional 2 GiB of RAM for the winbind internal cache.
- For iSCSI, install at least 16 GiB of RAM if performance is not critical, or at least 32 GiB of RAM if good performance is a requirement.
- *Jails* (page 294) are very memory-efficient, but can still use memory that would otherwise be available for ZFS. If the system will be running many jails, or a few resource-intensive jails, adding 1 to 4 additional gigabytes of RAM can be helpful. This memory is shared by the host and will be used for ZFS when not being used by jails.
- *Virtual Machines* (page 322) require additional RAM beyond any amounts listed here. Memory used by virtual machines is not available to the host while the VM is running, and is not included in the amounts described above. For example, a system that will be running two VMs that each need 1 GiB of RAM requires an additional 2 GiB of RAM.
- When installing FreeNAS® on a headless system, disable the shared memory settings for the video card in the BIOS.
- For ZFS deduplication, ensure the system has at least 5 GiB of RAM per terabyte of storage to be deduplicated.

If the hardware supports it, install ECC RAM. While more expensive, ECC RAM is highly recommended as it prevents in-flight corruption of data before the error-correcting properties of ZFS come into play, thus providing consistency for the checksumming and parity calculations performed by ZFS. If your data is important, use ECC RAM. This [Case Study](http://research.cs.wisc.edu/adsl/Publications/zfs-corruption-fast10.pdf) (<http://research.cs.wisc.edu/adsl/Publications/zfs-corruption-fast10.pdf>) describes the risks associated with memory corruption.

Do not use FreeNAS® to store data without at least 8 GiB of RAM. Many users expect FreeNAS® to function with less memory, just at reduced performance. The bottom line is that these minimums are based on feedback from many users. Requests for help in the forums or IRC are sometimes ignored when the installed system does not have at least 8 GiB of RAM because of the abundance of information that FreeNAS® may not behave properly with less memory.

1.4.2 The Operating System Device

The FreeNAS® operating system is installed to at least one device that is separate from the storage disks. The device can be an SSD, a small hard drive, or a USB stick.

Note: To write the installation file to a USB stick, **two** USB ports are needed, each with an inserted USB device. One USB stick contains the installer, while the other USB stick is the destination for the FreeNAS® installation. Be careful to select the correct USB device for the FreeNAS® installation. FreeNAS® cannot be installed onto the same device that contains the installer. After installation, remove the installer USB stick. It might also be necessary to adjust the BIOS configuration to boot from the new FreeNAS® operating system device.

When determining the type and size of the target device where FreeNAS® is to be installed, keep these points in mind:

- The absolute *bare minimum* size is 8 GiB. That does not provide much room. The *recommended* minimum is 16 GiB. This provides room for the operating system and several boot environments created by updates. More space provides room for more boot environments and 32 GiB or more is preferred.
- SSDs (Solid State Disks) are fast and reliable, and make very good FreeNAS® operating system devices. Their one disadvantage is that they require a disk connection which might be needed for storage disks.

Even a relatively large SSD (120 or 128 GiB) is useful as a boot device. While it might appear that the unused space is wasted, that space is instead used internally by the SSD for wear leveling. This makes the SSD last longer and provides greater reliability.

- When planning to add your own boot environments, budget about 1 GiB of storage per boot environment. Consider deleting older boot environments after making sure they are no longer needed. Boot environments can be created and deleted using *System* → *Boot*.
- Use quality, name-brand USB sticks, as ZFS will quickly reveal errors on cheap, poorly-made sticks.
- For a more reliable boot disk, use two identical devices and select them both during the installation. This will create a mirrored boot device.

Note: Current versions of FreeNAS® run directly from the operating system device. Early versions of FreeNAS® ran from RAM, but that has not been the case for years.

1.4.3 Storage Disks and Controllers

The [Disk section](https://www.freebsd.org/releases/11.3R/hardware.html#disk) (<https://www.freebsd.org/releases/11.3R/hardware.html#disk>) of the FreeBSD Hardware List shows supported disk controllers.

FreeNAS® supports hot-pluggable SATA drives when AHCI is enabled in the BIOS. The FreeNAS® team highly recommends [Western Digital Red](https://www.westerndigital.com/products/internal-drives/wd-red-hdd) (<https://www.westerndigital.com/products/internal-drives/wd-red-hdd>) NAS Disk Drives as the preferred storage drive of FreeNAS®.

Suggestions for testing disks can be found in this [forum post](https://forums.freenas.org/index.php?threads/checking-new-hdds-in-raid.12082/#post-55936) (<https://forums.freenas.org/index.php?threads/checking-new-hdds-in-raid.12082/#post-55936>). [badblocks](https://linux.die.net/man/8/badblocks) (<https://linux.die.net/man/8/badblocks>) is installed with FreeNAS® for disk testing.

[ZFS Disk Space Requirements for ZFS Storage Pools](https://docs.oracle.com/cd/E19253-01/819-5461/6n7ht6r12/index.html) (<https://docs.oracle.com/cd/E19253-01/819-5461/6n7ht6r12/index.html>) recommends a minimum of 16 GiB of disk space. FreeNAS® allocates 2 GiB of swap space on each drive.

New ZFS users purchasing hardware should read through [ZFS Storage Pools Recommendations](https://web.archive.org/web/20161028084224/http://www.solarisinternals.com/wiki/index.php/ZFS_Best_Practices_Guide#ZFS_first) (https://web.archive.org/web/20161028084224/http://www.solarisinternals.com/wiki/index.php/ZFS_Best_Practices_Guide#ZFS_first) first.

ZFS *vdevs*, groups of disks that act like a single device, can be created using disks of different sizes. However, the capacity available on each disk is limited to the same capacity as the smallest disk in the group. For example, a vdev with one 2 TiB and two 4 TiB disks will only be able to use 2 TiB of space on each disk. In general, use disks that are the same size for the best space usage and performance.

The [ZFS Drive Size and Cost Comparison spreadsheet](https://forums.freenas.org/index.php?threads/zfs-drive-size-and-cost-comparison-spreadsheet.38092/) (<https://forums.freenas.org/index.php?threads/zfs-drive-size-and-cost-comparison-spreadsheet.38092/>) is available to compare usable space provided by different quantities and sizes of disks.

1.4.4 Network Interfaces

The [Ethernet section](https://www.freebsd.org/releases/11.3R/hardware.html#ethernet) (<https://www.freebsd.org/releases/11.3R/hardware.html#ethernet>) of the FreeBSD Hardware Notes indicates which interfaces are supported by each driver. While many interfaces are supported, FreeNAS® users have seen the best performance from Intel and Chelsio interfaces, so consider these brands when purchasing a new NIC. Realtek cards often perform poorly under CPU load as interfaces with these chipsets do not provide their own processors.

At a minimum, a GigE interface is recommended. While GigE interfaces and switches are affordable for home use, modern disks can easily saturate their 110 MiB/s throughput. For higher network throughput, multiple GigE cards can be bonded together using the LACP type of [Link Aggregations](#) (page 158). The Ethernet switch must support LACP, which means a more expensive managed switch is required.

When network performance is a requirement and there is some money to spend, use 10 GigE interfaces and a managed switch. Managed switches with support for LACP and jumbo frames are preferred, as both can be used to increase network throughput. Refer to the [10 Gig Networking Primer](https://forums.freenas.org/index.php?threads/10-gig-networking-primer.25749/) (<https://forums.freenas.org/index.php?threads/10-gig-networking-primer.25749/>) for more information.

Note: At present, these are not supported: InfiniBand, FibreChannel over Ethernet, or wireless interfaces.

Both hardware and the type of shares can affect network performance. On the same hardware, SMB is slower than FTP or NFS because Samba is [single-threaded](https://www.samba.org/samba/docs/old/Samba3-Developers-Guide/architecture.html) (<https://www.samba.org/samba/docs/old/Samba3-Developers-Guide/architecture.html>). So a fast CPU can help with SMB performance.

Wake on LAN (WOL) support depends on the FreeBSD driver for the interface. If the driver supports WOL, it can be enabled using [ifconfig\(8\)](https://www.freebsd.org/cgi/man.cgi?query=ifconfig) (<https://www.freebsd.org/cgi/man.cgi?query=ifconfig>). To determine if WOL is supported on a particular interface, use the interface name with the following command. In this example, the capabilities line indicates that WOL is supported for the *igb0* interface:

```
[root@freenas ~]# ifconfig -m igb0
igb0: flags=8943<UP,BROADCAST,RUNNING,PROMISC,SIMPLEX,MULTICAST> metric 0 mtu 1500
      options=6403bb<RXCSUM, TXCSUM, VLAN_MTU, VLAN_HWTAGGING, JUMBO_MTU, VLAN_HWCSUM,
TSO4, TSO6, VLAN_HWTSO, RXCSUM_IPV6, TXCSUM_IPV6>
      capabilities=653fbb<RXCSUM, TXCSUM, VLAN_MTU, VLAN_HWTAGGING, JUMBO_MTU,
VLAN_HWCSUM, TSO4, TSO6, LRO, WOL_UCAST, WOL_MCAST, WOL_MAGIC, VLAN_HWFILTER, VLAN_HWTSO,
RXCSUM_IPV6, TXCSUM_IPV6>
```

If WOL support is shown but not working for a particular interface, create a bug report using the instructions in [Support](#) (page 120).

1.5 Getting Started with ZFS

Readers new to ZFS should take a moment to read the [ZFS Primer](#) (page 366).

INSTALLING AND UPGRADING

The FreeNAS[®] operating system has to be installed on a separate device from the drives which hold the storage data. With only one disk drive, the FreeNAS[®] web interface is available, but there is no place to store any data. And storing data is, after all, the whole point of a NAS system. Home users experimenting with FreeNAS[®] can install FreeNAS[®] on an inexpensive USB stick and use the computer disks for storage.

This section describes:

- *Getting FreeNAS[®]* (page 25)
- *Preparing the Media* (page 26)
- *Performing the Installation* (page 28)
- *Installation Troubleshooting* (page 34)
- *Upgrading* (page 35)
- *Virtualization* (page 41)

2.1 Getting FreeNAS[®]

The latest STABLE version of FreeNAS[®] 11.3 is available for download from <https://www.freenas.org/download-freenas-release/>.

The download page has links to FreeNAS[®] release notes, `.iso` integrity checksums, and PGP security keys.

Clicking *Download* opens a dialog to save an `.iso` file. This bootable installer must be *written to physical media* (page 26) before it can be used to install FreeNAS[®].

2.1.1 Checking Installer Integrity

FreeNAS[®] uses the [OpenPGP standard](https://en.wikipedia.org/wiki/Pretty_Good_Privacy#OpenPGP) (https://en.wikipedia.org/wiki/Pretty_Good_Privacy#OpenPGP) to confirm that downloaded files have been provided by a trustworthy source. OpenPGP compliant software like [gnupg](https://www.freebsd.org/cgi/man.cgi?query=gpg) (<https://www.freebsd.org/cgi/man.cgi?query=gpg>), [Kleopatra](https://www.openpgp.org/software/kleopatra/) (<https://www.openpgp.org/software/kleopatra/>), or [Gpg4win](https://gpg4win.org/) (<https://gpg4win.org/>) can check the PGP signature of a FreeNAS[®] installer file.

The `sha256.txt` file is used to confirm the integrity of the downloaded `.iso`. See [SHA256 Verification](#) (page 26) for more details.

2.1.1.1 PGP Verification

To verify the `.iso` source, go to <https://www.freenas.org/download-freenas-release/> and click *PGP Signature* to download the software signature file. Open the *PGP Public key* link and note the browser address and `Search results` string.

Use one of the OpenPGP encryption tools mentioned above to import the public key and verify the PGP signature.

This example shows verifying the FreeNAS[®] `.iso` using `gpg` in a command prompt:

- Go to the `.iso` and `.iso.gpg` download location and import the public key using the keyserver address and search results string:

```
tmoore@Observer ~> cd Downloads/
tmoore@Observer ~/Downloads> gpg --keyserver sks-keyservers.net --recv-keys_
↪0xc8d62def767c1db0dff4e6ec358eaa9112cf7946
gpg: /usr/home/tmoore/.gnupg/trustdb.gpg: trustdb created
gpg: key 358EAA9112CF7946: public key "IX SecTeam <security-officer@ixsystems.com>" imported
gpg: Total number processed: 1
gpg:             imported: 1
tmoore@Observer ~/Downloads>
```

- Use `gpg --verify` to compare the `.iso` and `.iso.gpg` files:

```
tmoore@Observer ~/Downloads> gpg --verify FreeNAS-11.2-U6.iso.gpg FreeNAS-11.2-U6.iso
gpg: Signature made Tue Nov  5 13:48:18 2019 EST
gpg:             using RSA key C8D62DEF767C1DB0DFF4E6EC358EAA9112CF7946
gpg: Good signature from "IX SecTeam <security-officer@ixsystems.com>" [unknown]
gpg: WARNING: This key is not certified with a trusted signature!
gpg:             There is no indication that the signature belongs to the owner.
Primary key fingerprint: C8D6 2DEF 767C 1DB0 DFF4 E6EC 358E AA91 12CF 7946
tmoore@Observer ~/Downloads>
```

- This response means the signature is correct but still untrusted. Go back to the browser page that has the *PGP Public key* open and manually confirm that the key was issued for the iX Security Team on October 15, 2019 and has been signed by iXsystems accounts.

2.1.1.2 SHA256 Verification

The command to verify the checksum varies by operating system:

- on a BSD system use the command `sha256 isofile`
- on a Linux system use the command `sha256sum isofile`
- on a Mac system use the command `shasum -a 256 isofile`
- Windows or Mac users can install additional utilities like [HashCalc](http://www.slavasoft.com/hashcalc/) (<http://www.slavasoft.com/hashcalc/>) or [HashTab](http://implbits.com/products/hashtab/) (<http://implbits.com/products/hashtab/>).

The value produced by running the command must match the value shown in the `sha256.txt` file. Different checksum values indicate a corrupted installer file that should not be used.

2.2 Preparing the Media

The FreeNAS® installer can run from either a CD or a USB stick.

A CD burning utility is needed to write the `.iso` file to a CD.

The `.iso` file can also be written to a USB stick. The method used to write the file depends on the operating system. Examples for several common operating systems are shown below.

Note: To install from a USB stick to another USB stick, **two** USB ports are needed, each with an inserted USB device. One USB stick contains the installer. The other USB stick is the destination for the FreeNAS® installation. Take care to select the correct USB device for the FreeNAS® installation. It is **not** possible to install FreeNAS® onto the same USB stick containing the installer. After installation, remove the installer USB stick. It might also be necessary to adjust the BIOS configuration to boot from the new FreeNAS® USB stick.

Ensure the operating system device order in the BIOS is set to boot from the device containing the FreeNAS® installer media, then boot the system to start the installation.

2.2.1 On FreeBSD or Linux

On a FreeBSD or Linux system, the `dd` command is used to write the `.iso` file to an inserted USB stick.

Warning: The `dd` command is very powerful and can destroy any existing data on the specified device. Make **absolutely sure** of the device name to write to and do not mistype the device name when using `dd`! This command can be avoided by writing the `.iso` file to a CD instead.

This example demonstrates writing the image to the first USB device connected to a FreeBSD system. This first device usually reports as `/dev/da0`. Replace `FreeNAS-RELEASE.iso` with the filename of the downloaded FreeNAS® ISO file. Replace `/dev/da0` with the device name of the device to write.

```
dd if=FreeNAS-RELEASE.iso of=/dev/da0 bs=64k
6117+0 records in
6117+0 records out
400883712 bytes transferred in 88.706398 secs (4519220 bytes/sec)
```

When using the `dd` command:

- **if=** refers to the input file, or the name of the file to write to the device.
- **of=** refers to the output file; in this case, the device name of the flash card or removable USB stick. Note that USB device numbers are dynamic, and the target device might be `da1` or `da2` or another name depending on which devices are attached. Before attaching the target USB stick, use `ls /dev/da*`. Then attach the target USB stick, wait ten seconds, and run `ls /dev/da*` again to see the new device name and number of the target USB stick. On Linux, use `/dev/sdX`, where `X` refers to the letter of the USB device.
- **bs=** refers to the block size, the amount of data to write at a time. The larger 64K block size shown here helps speed up writes to the USB stick.

2.2.2 On Windows

Image Writer (<https://launchpad.net/win32-image-writer/>) and **Rufus** (<http://rufus.akeo.ie/>) can be used for writing images to USB sticks on Windows.

2.2.3 On macOS

Insert the USB stick. In Finder, go to *Applications* → *Utilities* → *Disk Utility*. Unmount any mounted partitions on the USB stick. Check that the USB stick has only one partition, or partition table errors will be shown on boot. If needed, use Disk Utility to set up one partition on the USB stick. Selecting *Free space* when creating the partition works fine.

Determine the device name of the inserted USB stick. From **TERMINAL**, navigate to the Desktop, then type this command:

```
diskutil list
/dev/disk0

#:          TYPE NAME          SIZE          IDENTIFIER
0:      GUID_partition_scheme      *500.1 GB      disk0
1:          EFI                  209.7 MB      disk0s1
2:      Apple_HFS Macintosh HD    499.2 GB      disk0s2
3:      Apple_Boot Recovery HD    650.0 MB      disk0s3

/dev/disk1
#:          TYPE NAME          SIZE          IDENTIFIER
0:      FDisk_partition_scheme      *8.0 GB      disk1
1:          DOS_FAT_32 UNTITLED      8.0 GB      disk1s1
```


This shows which devices are available to the system. Locate the target USB stick and record the path. To determine the correct path for the USB stick, remove the device, run the command again, and compare the difference. Once sure of the device name, navigate to the Desktop from **TERMINAL**, unmount the USB stick, and use the `dd` command to write the image to the USB stick. In this example, the USB stick is `/dev/disk1`. It is first unmounted. The `dd` command is used to write the image to the faster “raw” version of the device (note the extra `r` in `/dev/rdisk1`).

When running these commands, replace `FreeNAS-RELEASE.iso` with the name of the FreeNAS® ISO and `/dev/rdisk1` with the correct path to the USB stick:

```
diskutil unmountDisk /dev/disk1
Unmount of all volumes on disk1 was successful

dd if=FreeNAS-RELEASE.iso of=/dev/rdisk1 bs=64k
```

Note: If the error “Resource busy” is shown when the `dd` command is run, go to *Applications* → *Utilities* → *Disk Utility*, find the USB stick, and click on its partitions to make sure all of them are unmounted. If a “Permission denied” error is shown, use `sudo` for elevated rights: `sudo dd if=FreeNAS-11.0-RELEASE.iso of=/dev/rdisk1 bs=64k`. This will prompt for the password.

The `dd` command can take some minutes to complete. Wait until the prompt returns and a message is displayed with information about how long it took to write the image to the USB stick.

2.3 Performing the Installation

With the installation media inserted, boot the system from that media.

The FreeNAS[®] installer boot menu is displayed as is shown in [Figure 2.1](#).



Fig. 2.1: Installer Boot Menu

The FreeNAS® installer automatically boots into the default option after ten seconds. If needed, choose another boot option by pressing the `Spacebar` to stop the timer and then enter the number of the desired option.

Tip: The *Serial Console* option is useful on systems which do not have a keyboard or monitor, but are accessed through a serial port, *Serial over LAN*, or *IPMI* (page 160).

Note: If the installer does not boot, verify that the installation device is listed first in the boot order in the BIOS. When booting from a CD, some motherboards may require connecting the CD device to SATA0 (the first connector) to boot from CD. If the installer stalls during bootup, double-check the SHA256 hash of the `.iso` file. If the hash does not match, re-download the file. If the hash is correct, burn the CD again at a lower speed or write the file to a different USB stick.

Once the installer has finished booting, the installer menu is displayed as shown in [Figure 2.2](#).

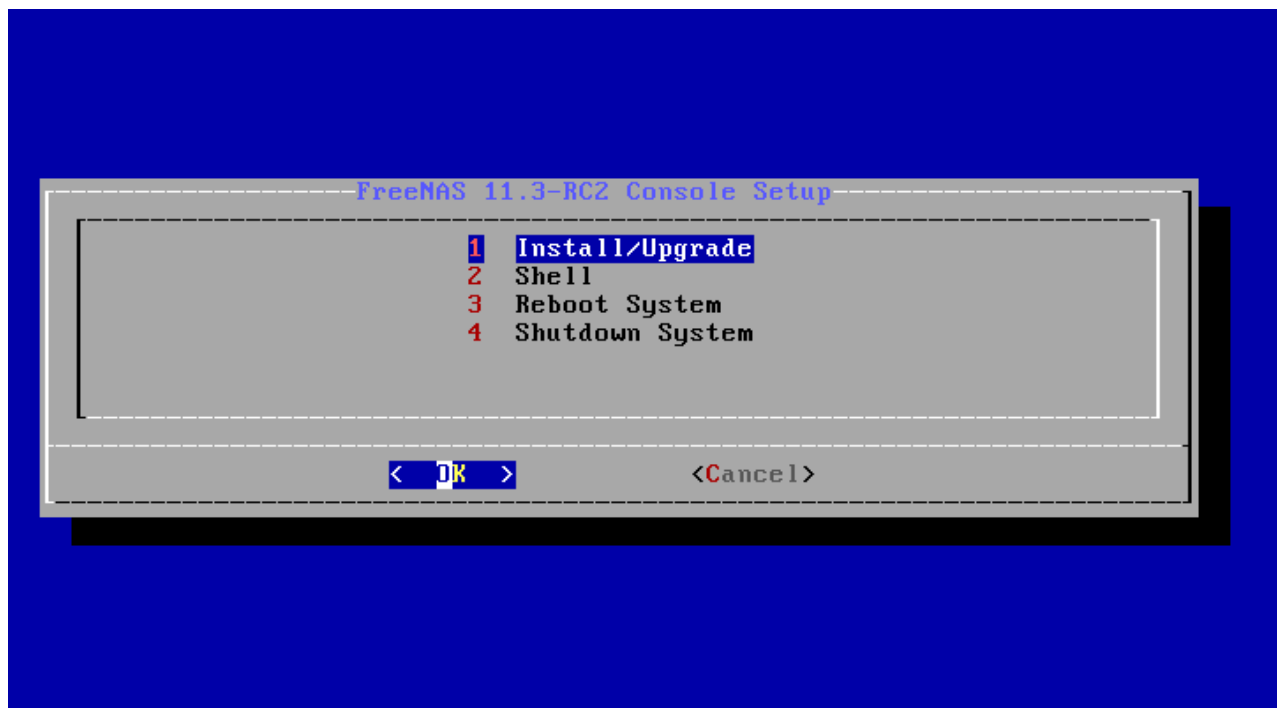


Fig. 2.2: Installer Menu

Press `Enter` to select the default option, *1 Install/Upgrade*. The next menu, shown in [Figure 2.3](#), lists all available drives. This includes any inserted operating system devices, which have names beginning with *da*.

Note: A minimum of 8 GiB of RAM is required and the installer will present a warning message if less than 8 GiB is detected.

In this example, the user is performing a test installation using VirtualBox and has created a 16 GiB virtual disk to hold the operating system.

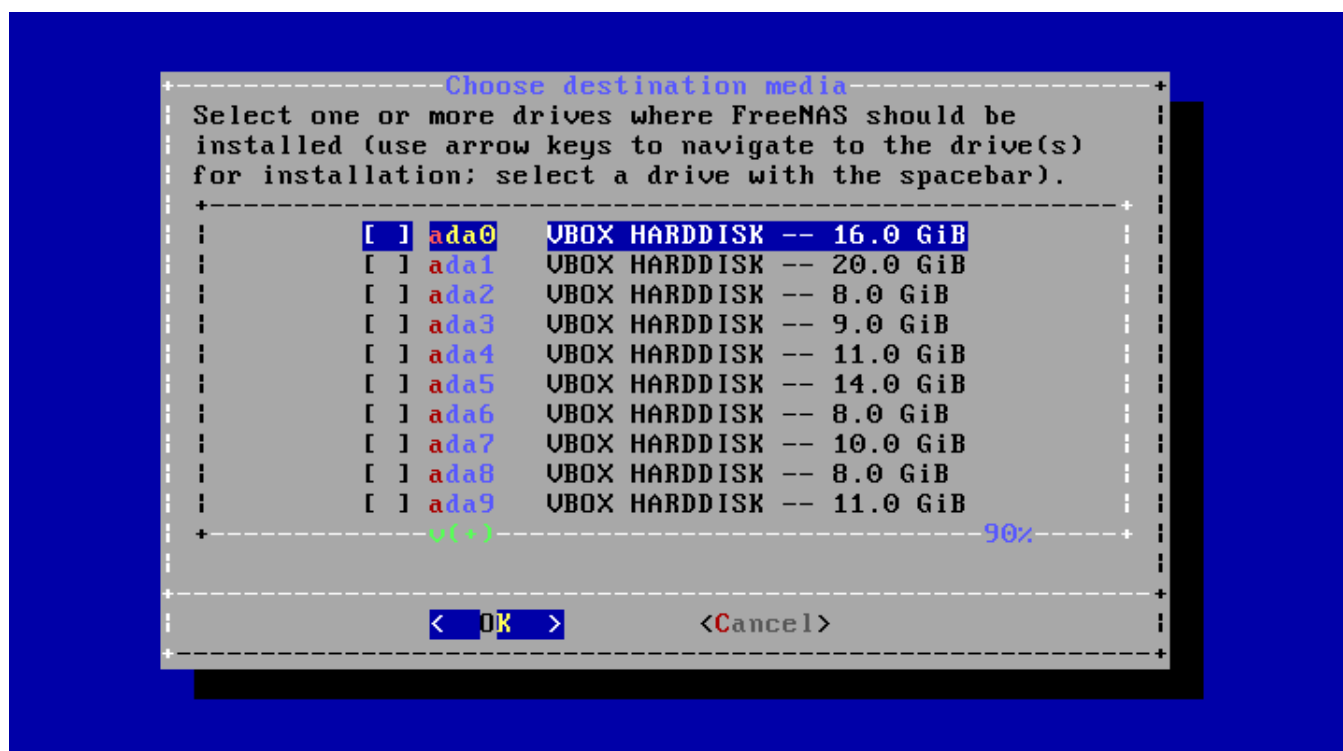


Fig. 2.3: Selecting the Install Drive

Use the arrow keys to highlight the destination SSD, hard drive, USB stick, or virtual disk. Press the `spacebar` to select it.

To mirror the operating system device, move to additional devices and press `spacebar` to select them also. If all of the selected devices are larger than 64 GiB and none are connected through USB, a 16 GiB swap partition is also created.

After making selections, press `Enter`. The warning shown in [Figure 2.4](#) is displayed, a reminder not to install the operating system on a drive that is meant for storage. Press `Enter` to continue on to the screen shown in [Figure 2.6](#).

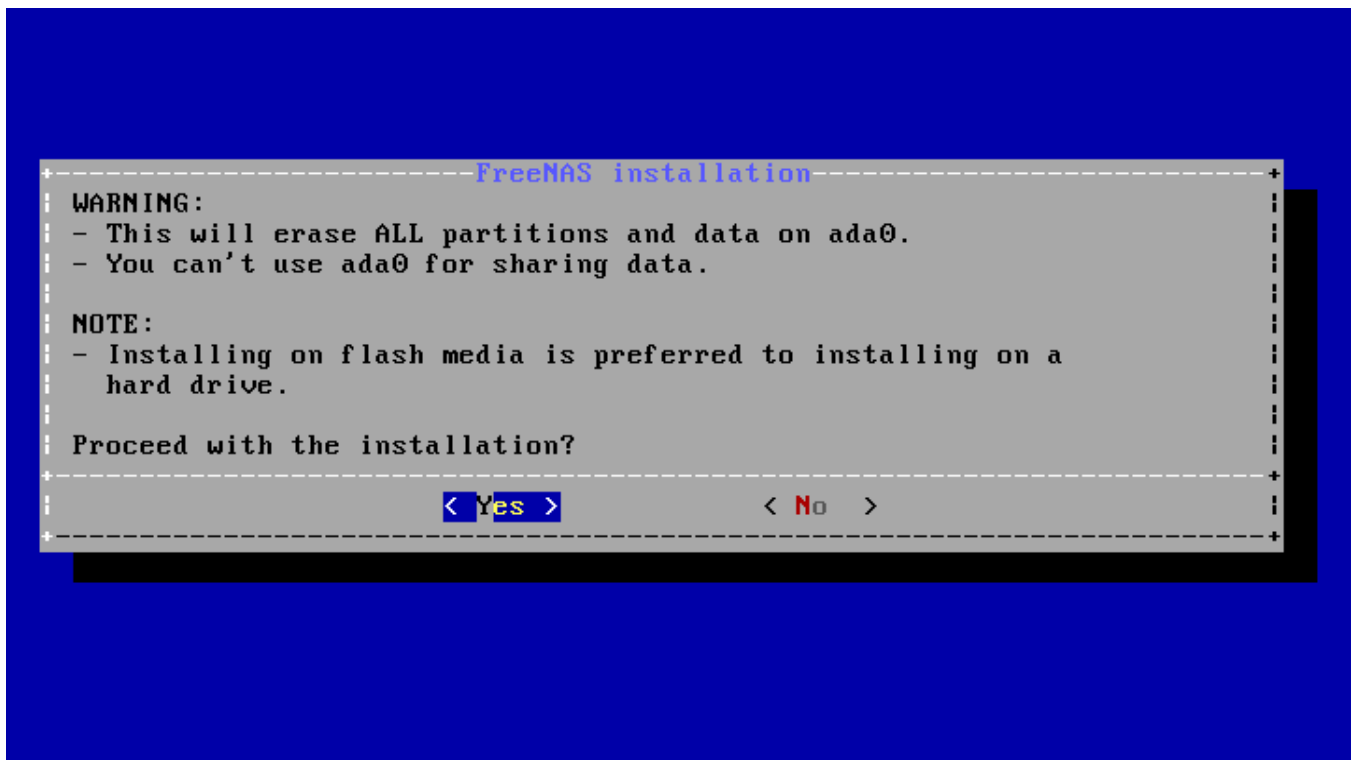


Fig. 2.4: Installation Warning

See the [operating system device](#) (page 22) section to ensure the minimum requirements are met.

The installer recognizes existing installations of previous versions of FreeNAS®. When an existing installation is present, the menu shown in [Figure 2.5](#) is displayed. To overwrite an existing installation, use the arrows to move to *Fresh Install* and press `Enter` twice to continue to the screen shown in [Figure 2.6](#).

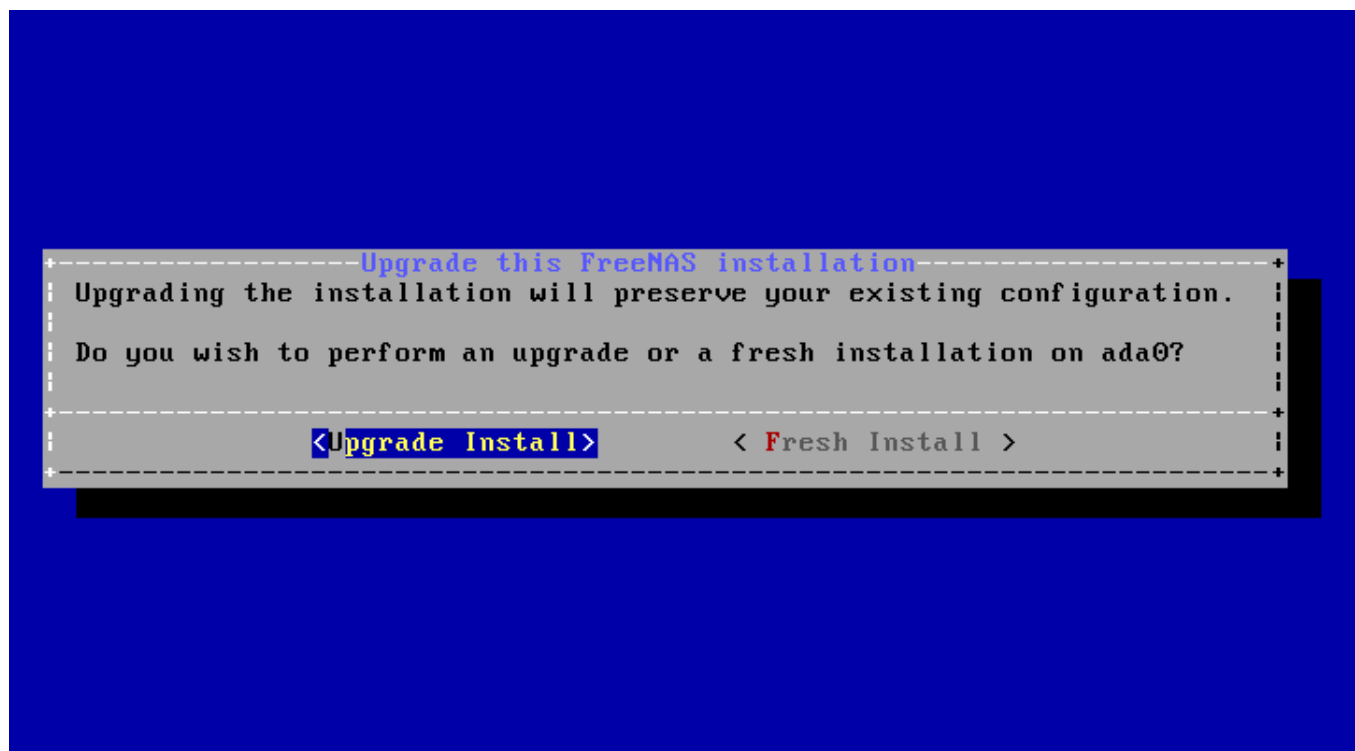


Fig. 2.5: Performing a Fresh Install

The screen shown in [Figure 2.6](#) prompts for the *root* password which is used to log in to the web interface.

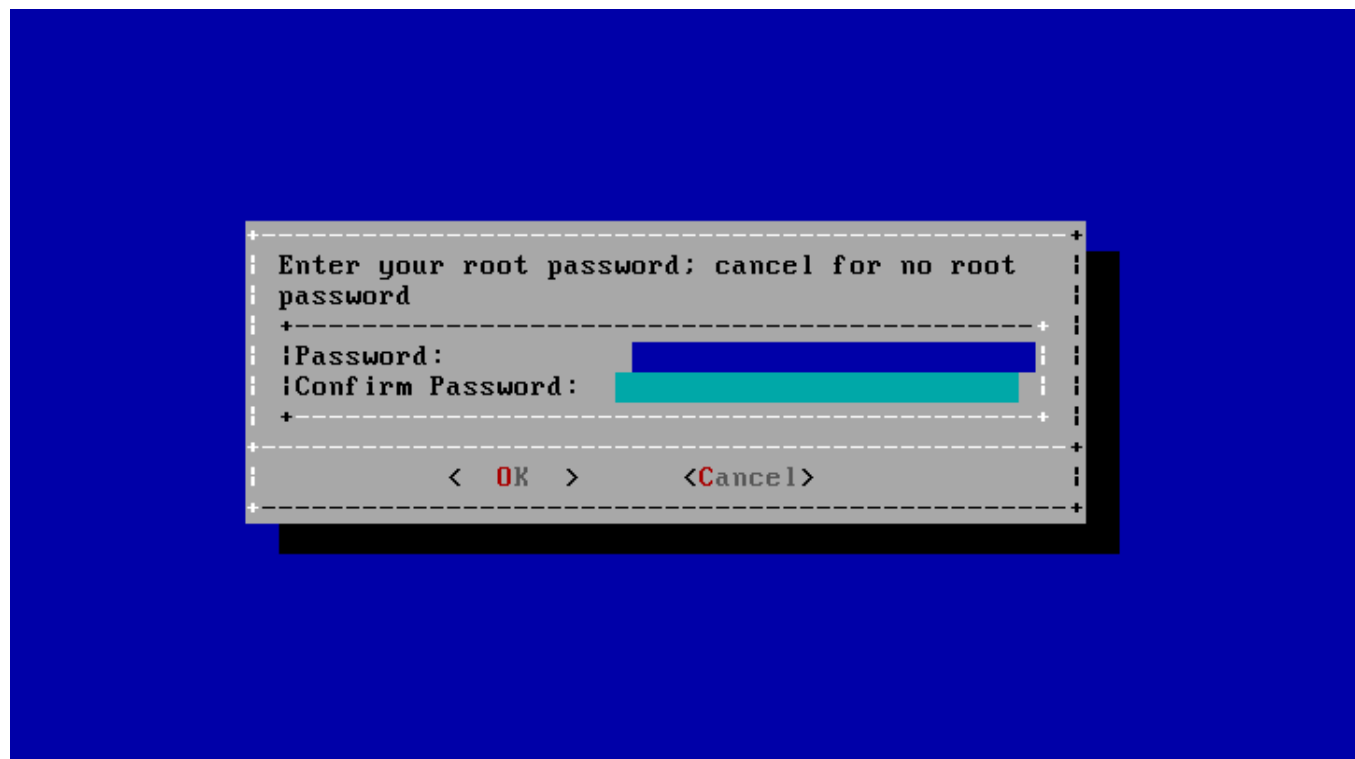


Fig. 2.6: Set the Root Password

Setting a password is mandatory and the password cannot be blank. Since this password provides access to the

web interface, it needs to be hard to guess. Enter the password, press the down arrow key, and confirm the password. Then press `Enter` to continue with the installation. Choosing *Cancel* skips setting a root password during the installation, but the web interface will require setting a root password when logging in for the first time.

Note: For security reasons, the SSH service and *root* SSH logins are disabled by default. Unless these are set, the only way to access a shell as *root* is to gain physical access to the console menu or to access the web shell within the web interface. This means that the FreeNAS® system needs to be kept physically secure and that the web interface needs to be behind a properly configured firewall and protected by a secure password.

FreeNAS® can be configured to boot with the standard BIOS boot mechanism or UEFI booting as shown [Figure 2.7](#). BIOS booting is recommended for legacy and enterprise hardware. UEFI is used on newer consumer motherboards.

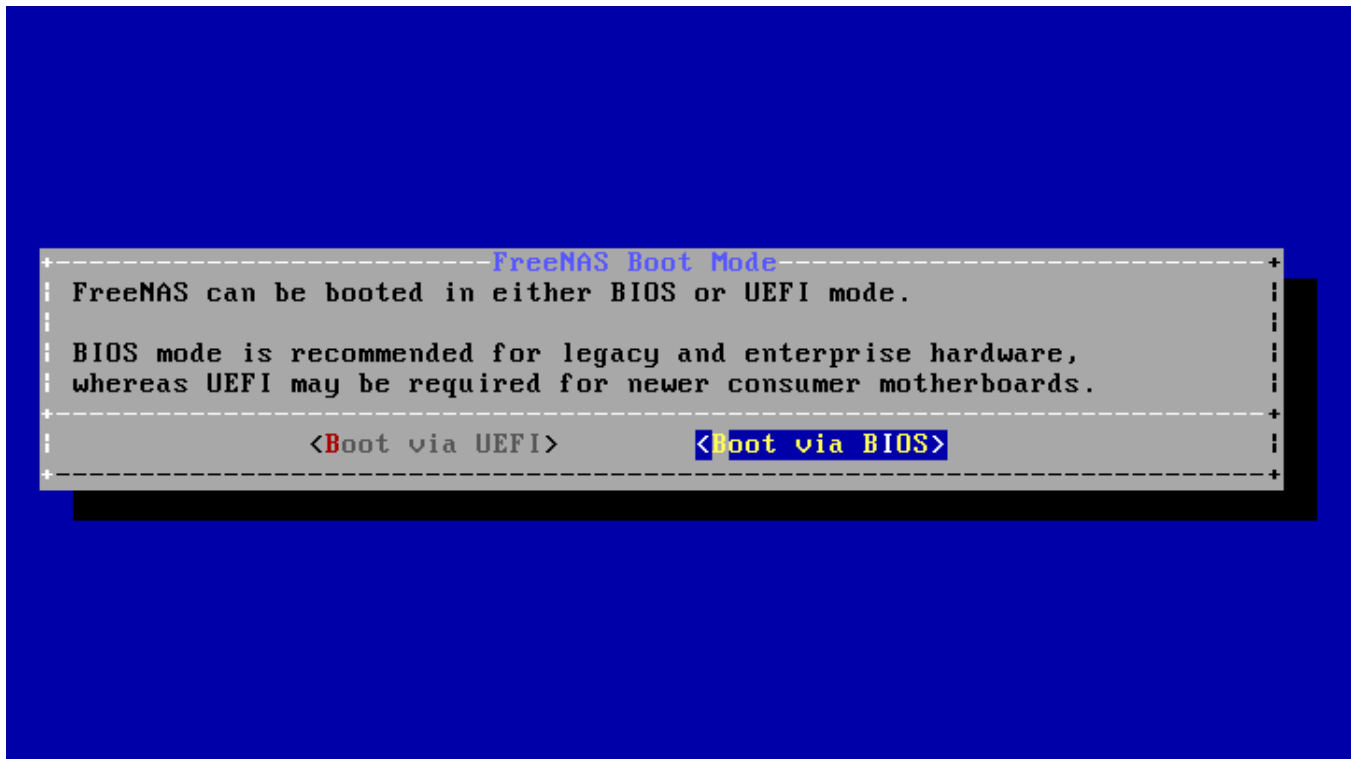


Fig. 2.7: Choose UEFI or BIOS Booting

Note: Most UEFI systems can also boot in BIOS mode if CSM (Compatibility Support Module) is enabled in the UEFI setup screens.

The message in [Figure 2.8](#) is shown after the installation is complete.

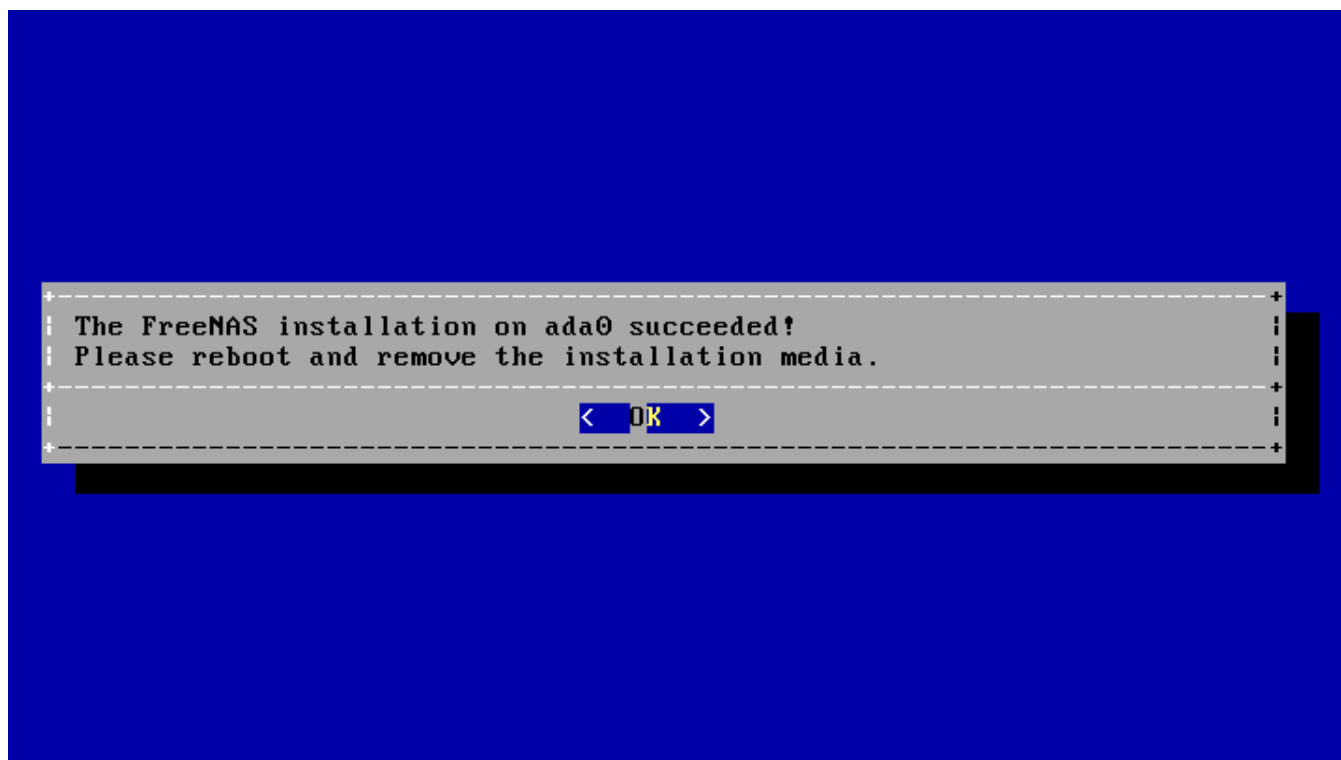


Fig. 2.8: Installation Complete

Press `Enter` to return to *Installer Menu* (page 29). Highlight *3 Reboot System* and press `Enter`. If booting from CD, remove the CDROM. As the system reboots, make sure that the device where FreeNAS® was installed is listed as the first boot entry in the BIOS so the system will boot from it.

FreeNAS® boots into the *Console Setup* menu described in *Bootimg* (page 59) after waiting five seconds in the *boot menu* (page 39). Press the `Spacebar` to stop the timer and use the boot menu.

2.4 Installation Troubleshooting

If the system does not boot into FreeNAS®, there are several things that can be checked to resolve the situation.

Check the system BIOS and see if there is an option to change the USB emulation from CD/DVD/floppy to hard drive. If it still will not boot, check to see if the card/drive is UDMA compliant.

If the system BIOS does not support EFI with BIOS emulation, see if it has an option to boot using legacy BIOS mode.

When the system starts to boot but hangs with this repeated error message:

```
run_interrupt_driven_hooks: still waiting after 60 seconds for xpt_config
```

go into the system BIOS and look for an onboard device configuration for a 1394 Controller. If present, disable that device and try booting again.

If the system starts to boot but hangs at a *moutroot>* prompt, follow the instructions in *Workaround/Semi-Fix for Moutroot Issues with 9.3* (<https://forums.freenas.org/index.php?threads/workaround-semi-fix-for-moutroot-issues-with-9-3.26071/>).

If the burned image fails to boot and the image was burned using a Windows system, wipe the USB stick before trying a second burn using a utility such as *Active@ KillDisk* (<http://how-to-erase-hard-drive.com/>). Otherwise, the second burn attempt will fail as Windows does not understand the partition which was written from the image file. Be very careful to specify the correct USB stick when using a wipe utility!

2.5 Upgrading

FreeNAS® provides flexibility for keeping the operating system up-to-date:

1. Upgrades to major releases, for example from version 9.3 to 9.10, can still be performed using either an ISO or the web interface. Unless the Release Notes for the new major release indicate that the current version requires an ISO upgrade, either upgrade method can be used.
2. Minor releases have been replaced with signed updates. This means that it is not necessary to wait for a minor release to update the system with a system update or newer versions of drivers and features. It is also no longer necessary to manually download an upgrade file and its associated checksum to update the system.
3. The updater automatically creates a boot environment, making updates a low-risk operation. Boot environments provide the option to return to the previous version of the operating system by rebooting the system and selecting the previous boot environment from the boot menu.

This section describes how to perform an upgrade from an earlier version of FreeNAS® to 11.3. After 11.3 has been installed, use the instructions in [Update](#) (page 105) to keep the system updated.

2.5.1 Caveats

Be aware of these caveats **before** attempting an upgrade to 11.3:

- **Warning: upgrading the ZFS pool can make it impossible to go back to a previous version.** For this reason, the update process does not automatically upgrade the ZFS pool, though the [Alert](#) (page 339) system shows when newer [ZFS Feature Flags](#) (page 369) are available for a pool. Unless a new feature flag is needed, it is safe to leave the pool at the current version and uncheck the alert. If the pool is upgraded, it will not be possible to boot into a previous version that does not support the newer feature flags.
- Upgrading the firmware of Broadcom SAS HBAs to the latest version is recommended.
- If upgrading from 9.3.x, read the [FAQ: Updating from 9.3 to 9.10](#) (<https://forums.freenas.org/index.php?threads/faq-updating-from-9-3-to-9-10.54260/>) first.
- **Upgrades from FreeNAS® 0.7x are not supported.** The system has no way to import configuration settings from 0.7x versions of FreeNAS®. The configuration must be manually recreated. If supported, the FreeNAS® 0.7x pools or disks must be manually imported.
- **Upgrades on 32-bit hardware are not supported.** However, if the system is currently running a 32-bit version of FreeNAS® **and** the hardware supports 64-bit, the system can be upgraded. Any archived reporting graphs will be lost during the upgrade.
- **UFS is not supported.** If the data currently resides on **one** UFS-formatted disk, create a ZFS pool using **other** disks after the upgrade, then use the instructions in [Importing a Disk](#) (page 196) to mount the UFS-formatted disk and copy the data to the ZFS pool. With only one disk, back up its data to another system or media before the upgrade, format the disk as ZFS after the upgrade, then restore the backup. If the data currently resides on a UFS RAID of disks, it is not possible to directly import that data to the ZFS pool. Instead, back up the data before the upgrade, create a ZFS pool after the upgrade, then restore the data from the backup.

2.5.2 Initial Preparation

Before upgrading the operating system, perform the following steps:

1. **Back up the FreeNAS® configuration** in *System* → *General* → *Save Config*.
2. If any pools are encrypted, **remember** to set a passphrase and download a copy of the encryption key and the latest recovery key. After the upgrade is complete, use the instructions in [Importing a Pool](#) (page 173) to import the encrypted pools.

3. Warn users that the FreeNAS® shares will be unavailable during the upgrade; it is recommended to schedule the upgrade for a time that will least impact users.
4. Stop all services in *Services*.

2.5.3 Upgrading Using the ISO

To perform an upgrade using this method, [download](http://download.freenas.org/latest/) (<http://download.freenas.org/latest/>) the `.iso` to the computer that will be used to prepare the installation media. Burn the downloaded `.iso` file to a CD or USB stick using the instructions in *Preparing the Media* (page 26).

Insert the prepared media into the system and boot from it. The installer waits ten seconds in the *installer boot menu* (page 28) before booting the default option. If needed, press the `Spacebar` to stop the timer and choose another boot option. After the media finishes booting into the installation menu, press `Enter` to select the default option of *1 Install/Upgrade*. The installer presents a screen showing all available drives.

Warning: All drives are shown, including boot drives and storage drives. Only choose boot drives when upgrading. Choosing the wrong drives to upgrade or install will cause loss of data. If unsure about which drives contain the FreeNAS® operating system, reboot and remove the install media. In the FreeNAS® web interface, use *System* → *Boot* to identify the boot drives. More than one drive is shown when a mirror has been used.

Move to the drive where FreeNAS® is installed and press the `Spacebar` to mark it with a star. If a mirror has been used for the operating system, mark all of the drives where the FreeNAS® operating system is installed. Press `Enter` when done.

The installer recognizes earlier versions of FreeNAS® installed on the boot drive or drives and presents the message shown in [Figure 2.9](#).

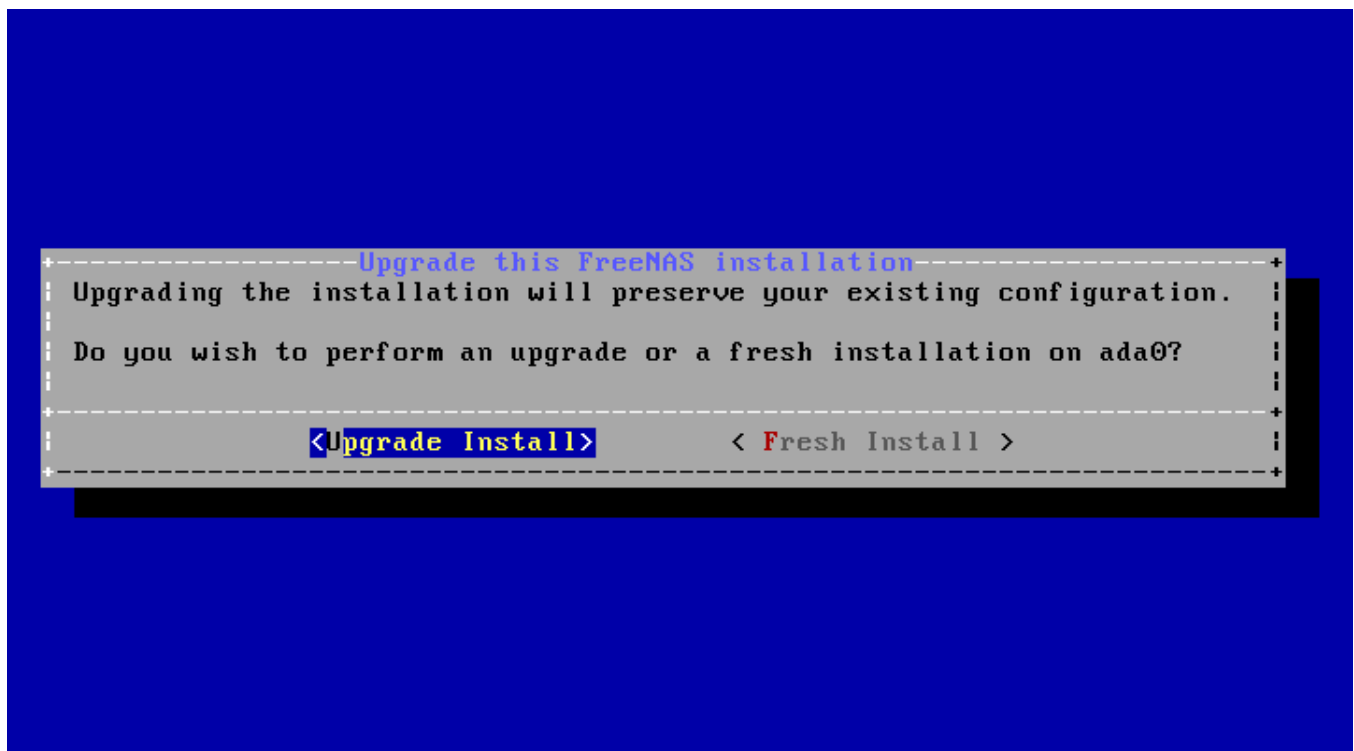


Fig. 2.9: Upgrading a FreeNAS® Installation

To perform an upgrade, press `Enter` to accept the default of *Upgrade Install*. Again, the installer will display a reminder that the operating system should be installed on a disk that is not used for storage.

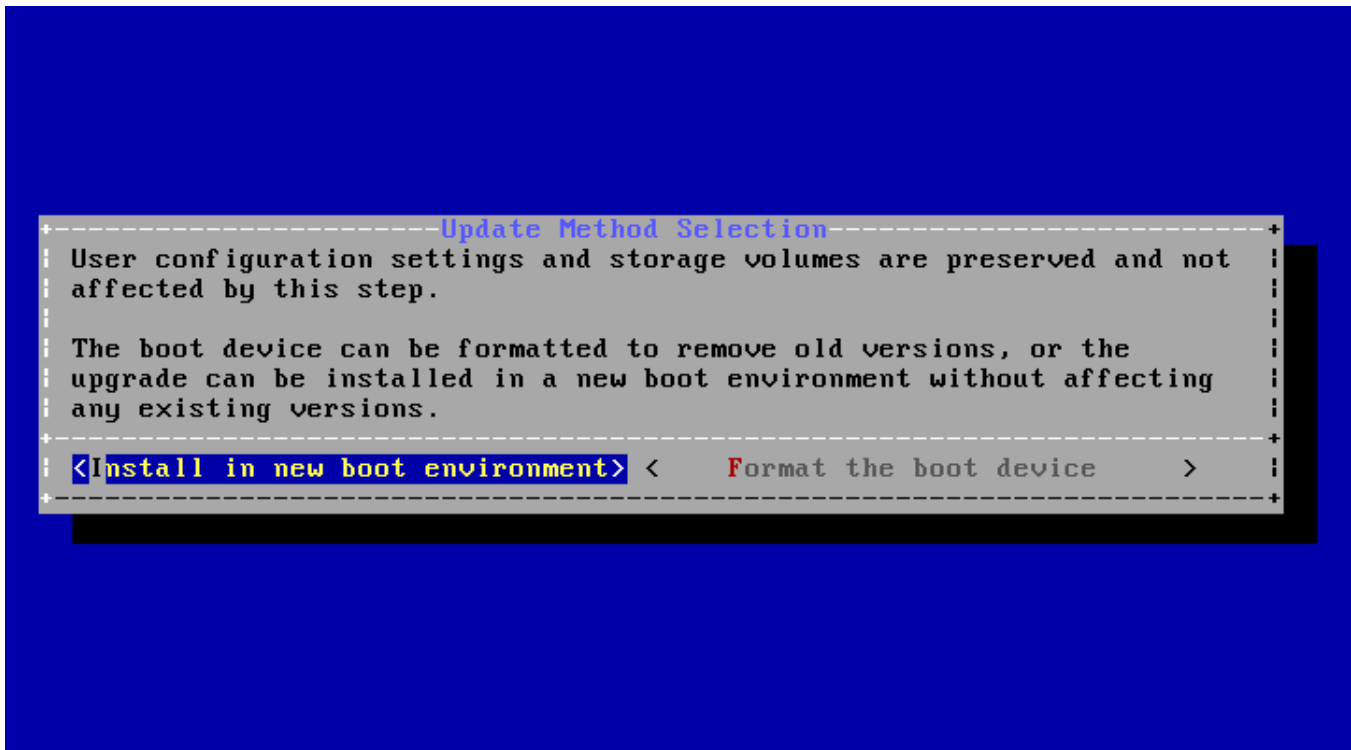


Fig. 2.10: Install in New Boot Environment or Format

The updated system can be installed in a new boot environment, or the entire operating system device can be formatted to start fresh. Installing into a new boot environment preserves the old code, allowing a roll-back to previous versions if necessary. Formatting the boot device is usually not necessary but can reclaim space. User data and settings are preserved when installing to a new boot environment and also when formatting the operating system device. Move the highlight to one of the options and press `Enter` to start the upgrade.

The installer unpacks the new image and displays the menu shown in [Figure 2.11](#). The database file that is preserved and migrated contains your FreeNAS® configuration settings.

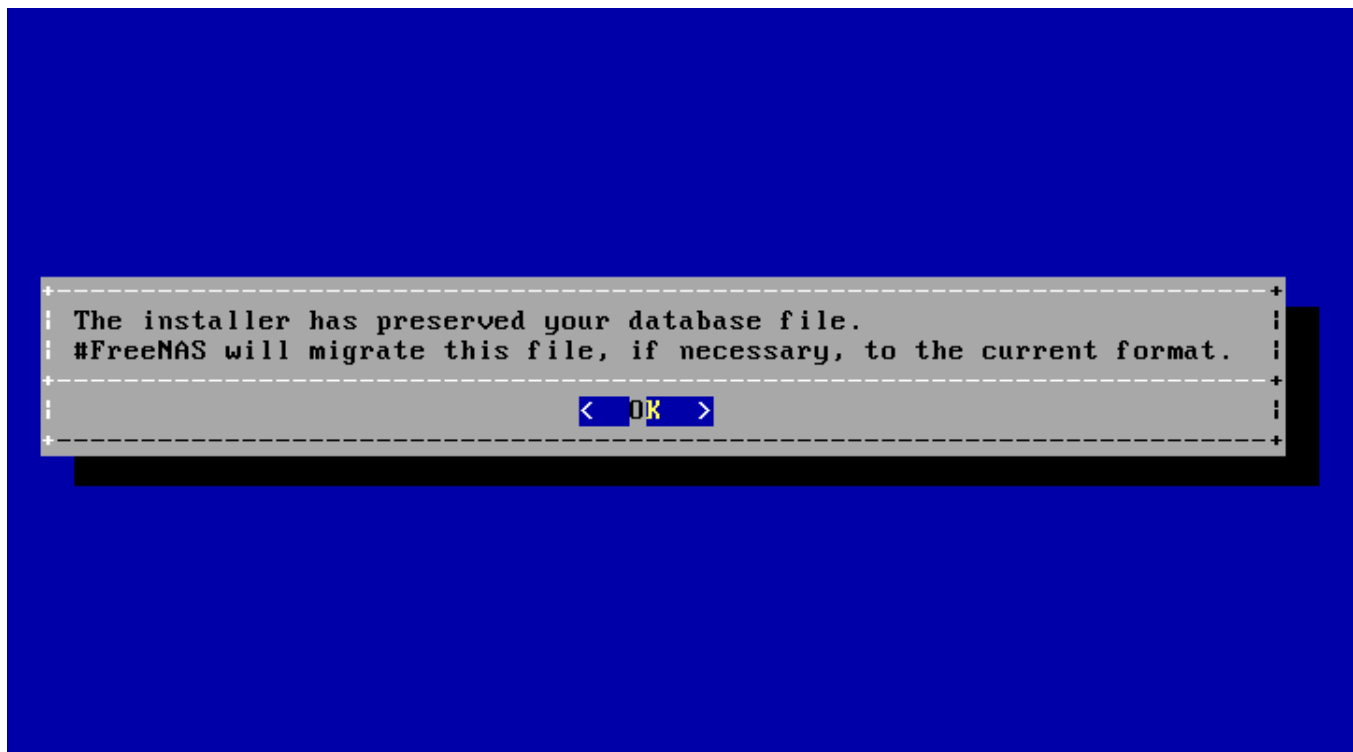


Fig. 2.11: Preserve and Migrate Settings

Press `Enter`. FreeNAS® indicates that the upgrade is complete and a reboot is required. Press `OK`, highlight *3 Reboot System*, then press `Enter` to reboot the system. If the upgrade installer was booted from CD, remove the CD.

During the reboot there can be a conversion of the previous configuration database to the new version of the database. This happens during the “Applying database schema changes” line in the reboot cycle. This conversion can take a long time to finish, sometimes fifteen minutes or more, and can cause the system to reboot again. The system will start normally afterwards. If database errors are shown but the web interface is accessible, go to *Settings* → *General* and use the *UPLOAD CONFIG* button to upload the configuration that was saved before starting the upgrade.

2.5.4 Upgrading From the Web Interface

To perform an upgrade using this method, go to *System* → *Update*. See [Update](#) (page 105) for more information on upgrading the system.

The connection is lost temporarily when the update is complete. It returns after the FreeNAS® system reboots into the new version of the operating system. The FreeNAS® system normally receives the same IP address from the DHCP server. Refresh the browser after a moment to see if the system is accessible.

2.5.5 If Something Goes Wrong

If an update fails, an alert is issued and the details are written to `/data/update.failed`.

To return to a previous version of the operating system, physical or IPMI access to the FreeNAS® console is needed. Reboot the system and watch for the boot menu:



Fig. 2.12: Boot Menu

FreeNAS® waits five seconds before booting into the default boot environment. Press the Spacebar to stop the automatic boot timer. Press 4 to display the available boot environments and press 3 as needed to scroll through multiple pages.



Fig. 2.13: Boot Environments

In the example shown in [Figure 2.13](#), the first entry in *Boot Environments* is `11.2-MASTER-201807250900`. This is the current version of the operating system, after the update was applied. Since it is the first entry, it is the default selection.

The next entry is `Initial-Install`. This is the original boot environment created when FreeNAS® was first installed. Since there are no other entries between the initial installation and the first entry, only one update has been applied to this system since its initial installation.

To boot into another version of the operating system, enter the number of the boot environment to set it as *Active*. Press `Backspace` to return to the *Boot Menu* (page 39) and press `Enter` to boot into the chosen *Active* boot environment.

If an operating system device fails and the system no longer boots, don't panic. The data is still on the disks and there is still a copy of the saved configuration. The system can be recovered with a few steps:

1. Perform a fresh installation on a new operating system device.
2. Import the pools in *Storage* → *Auto Import Pool*.
3. Restore the configuration in *System* → *General* → *Upload Config*.

Note: It is not possible to restore a saved configuration that is newer than the installed version. For example, if a reboot into an older version of the operating system is performed, a configuration created in a later version cannot be restored.

2.5.6 Upgrading a ZFS Pool

In FreeNAS®, ZFS pools can be upgraded from the graphical administrative interface.

Before upgrading an existing ZFS pool, be aware of these caveats first:

- the pool upgrade is a one-way street, meaning that **if you change your mind you cannot go back to an earlier ZFS version or downgrade to an earlier version of the software that does not support those ZFS features**.
- before performing any operation that may affect the data on a storage disk, **always back up all data first and verify the integrity of the backup**. While it is unlikely that the pool upgrade will affect the data, it is always better to be safe than sorry.
- upgrading a ZFS pool is **optional**. Do not upgrade the pool if the possibility of reverting to an earlier version of FreeNAS® or repurposing the disks in another operating system that supports ZFS is desired. It is not necessary to upgrade the pool unless the end user has a specific need for the newer *ZFS Feature Flags* (page 369). If a pool is upgraded to the latest feature flags, it will not be possible to import that pool into another operating system that does not yet support those feature flags.

To perform the ZFS pool upgrade, go to *Storage* → *Pools* and click ⚙ (Settings) to upgrade. Click the *Upgrade Pool* button as shown in [Figure 2.14](#).

Note: If the *Upgrade Pool* button does not appear, the pool is already at the latest feature flags and does not need to be upgraded.

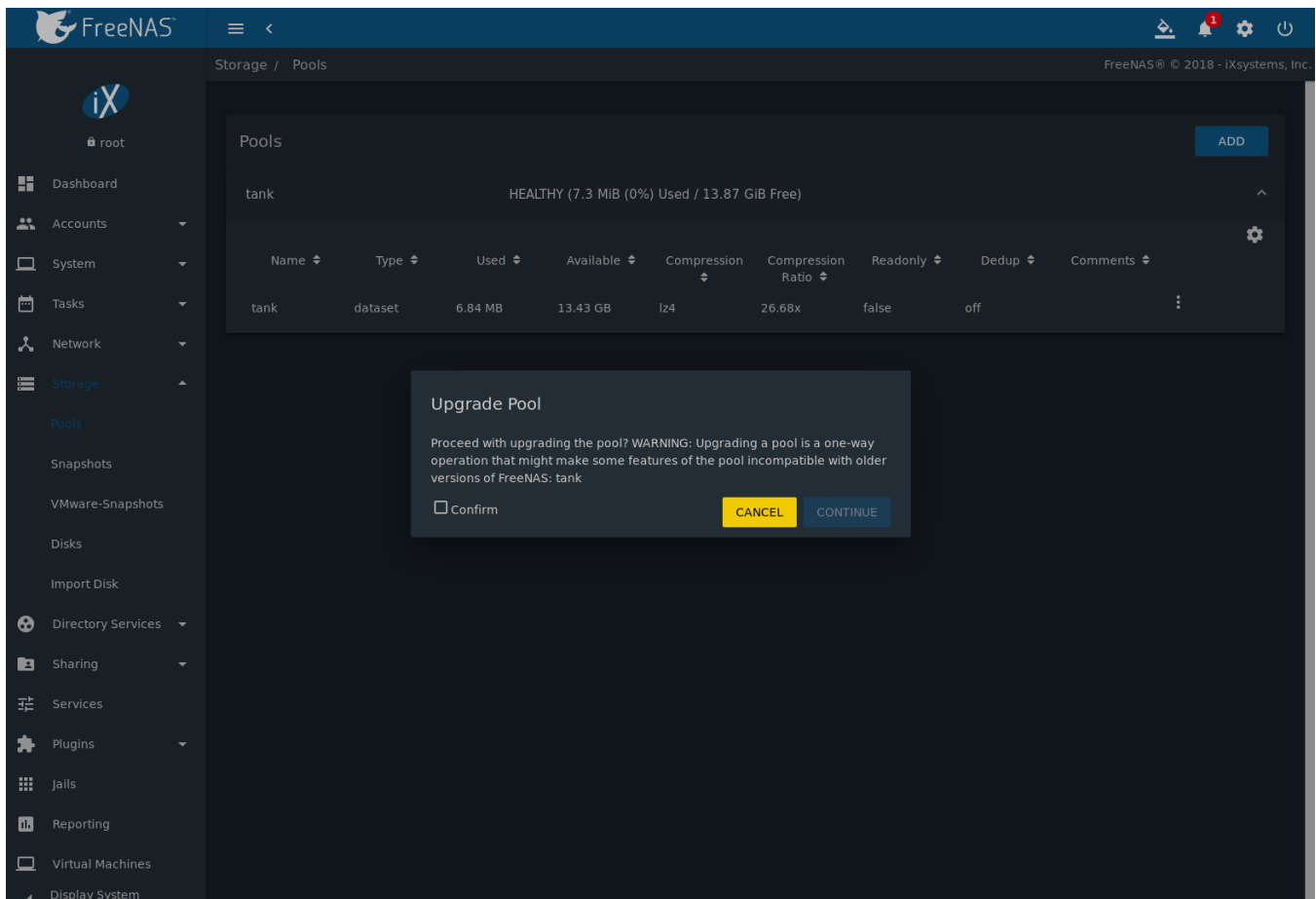


Fig. 2.14: Upgrading a Pool

The warning serves as a reminder that a pool upgrade is not reversible. Click *OK* to proceed with the upgrade.

The upgrade itself only takes a few seconds and is non-disruptive. It is not necessary to stop any sharing services to upgrade the pool. However, it is best to upgrade when the pool is not being heavily used. The upgrade process will suspend I/O for a short period, but is nearly instantaneous on a quiet pool.

2.6 Virtualization

FreeNAS® can be run inside a virtual environment for development, experimentation, and educational purposes. Note that running FreeNAS® in production as a virtual machine is **not recommended** (<https://forums.freenas.org/index.php?threads/please-do-not-run-freenas-in-production-as-a-virtual-machine.12484/>). When using FreeNAS® within a virtual environment, **read this post first** (<https://forums.freenas.org/index.php?threads/absolutely-must-virtualize-freenas-a-guide-to-not-completely-losing-your-data.12714/>) as it contains useful guidelines for minimizing the risk of losing data.

To install or run FreeNAS® within a virtual environment, create a virtual machine that meets these minimum requirements:

- **at least** 8192 MiB (8 GiB) base memory size
- a virtual disk **at least 8 GiB in size** to hold the operating system and boot environments
- at least one additional virtual disk **at least 4 GiB in size** to be used as data storage
- a bridged network adapter

This section demonstrates how to create and access a virtual machine within VirtualBox and VMware ESXi environments.

2.6.1 VirtualBox

VirtualBox (<https://www.virtualbox.org/>) is an open source virtualization program originally created by Sun Microsystems. VirtualBox runs on Windows, BSD, Linux, Macintosh, and OpenSolaris. It can be configured to use a downloaded FreeNAS® .iso file, and makes a good testing environment for practicing configurations or learning how to use the features provided by FreeNAS®.

To create the virtual machine, start VirtualBox and click the *New* button, shown in [Figure 2.15](#), to start the new virtual machine wizard.

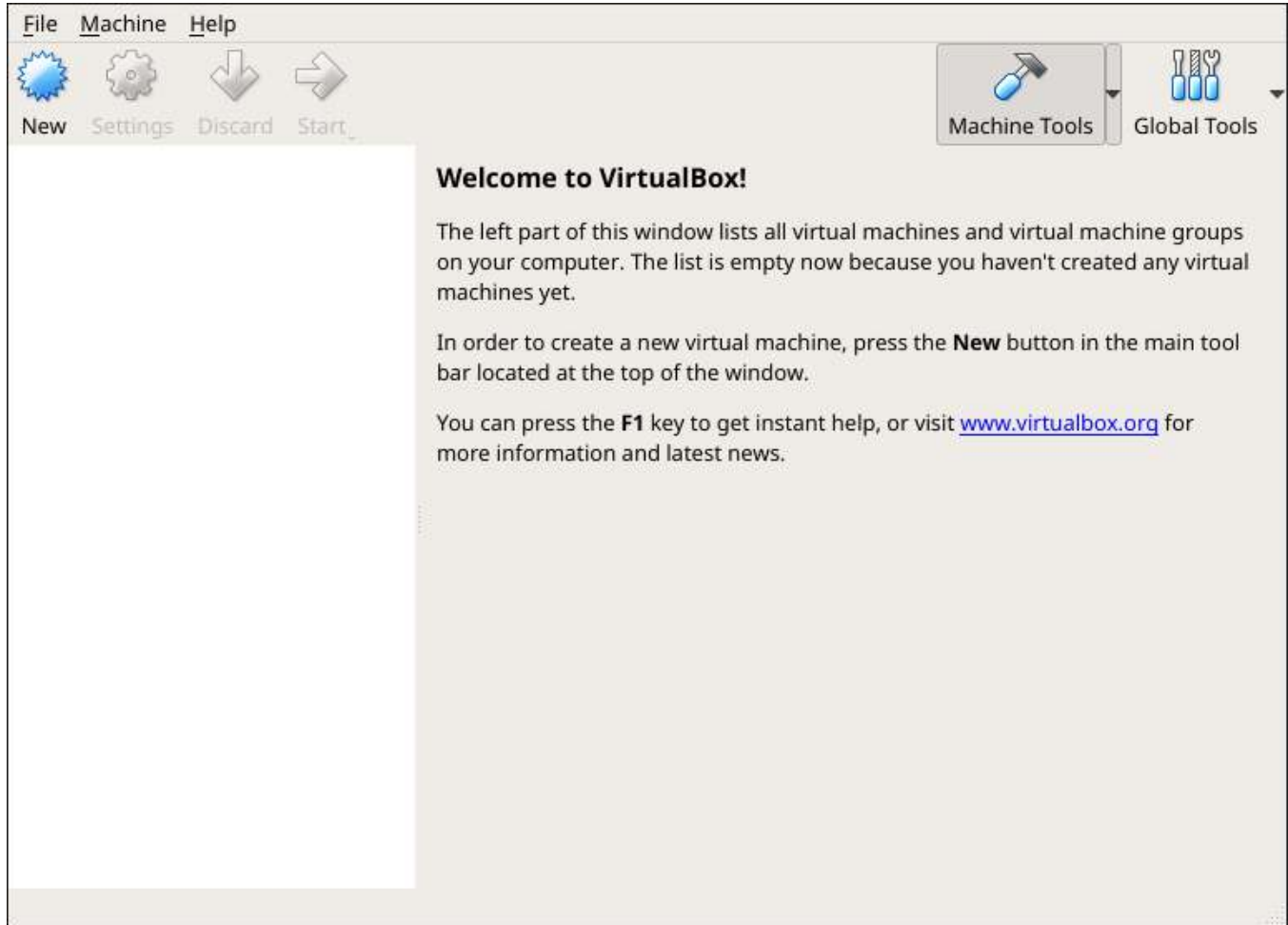


Fig. 2.15: Initial VirtualBox Screen

Click the *Next* button to see the screen in [Figure 2.16](#). Enter a name for the virtual machine, click the *Operating System* drop-down menu and select BSD, and select *FreeBSD (64-bit)* from the *Version* dropdown.



Name and operating system

Please choose a descriptive name for the new virtual machine and select the type of operating system you intend to install on it. The name you choose will be used throughout VirtualBox to identify this machine.

Name:

Type:

Version:

Fig. 2.16: Enter Name and Operating System for the New Virtual Machine

Click *Next* to see the screen in [Figure 2.17](#). The base memory size must be changed to **at least 8192 MiB**. When finished, click *Next* to see the screen in [Figure 2.18](#).

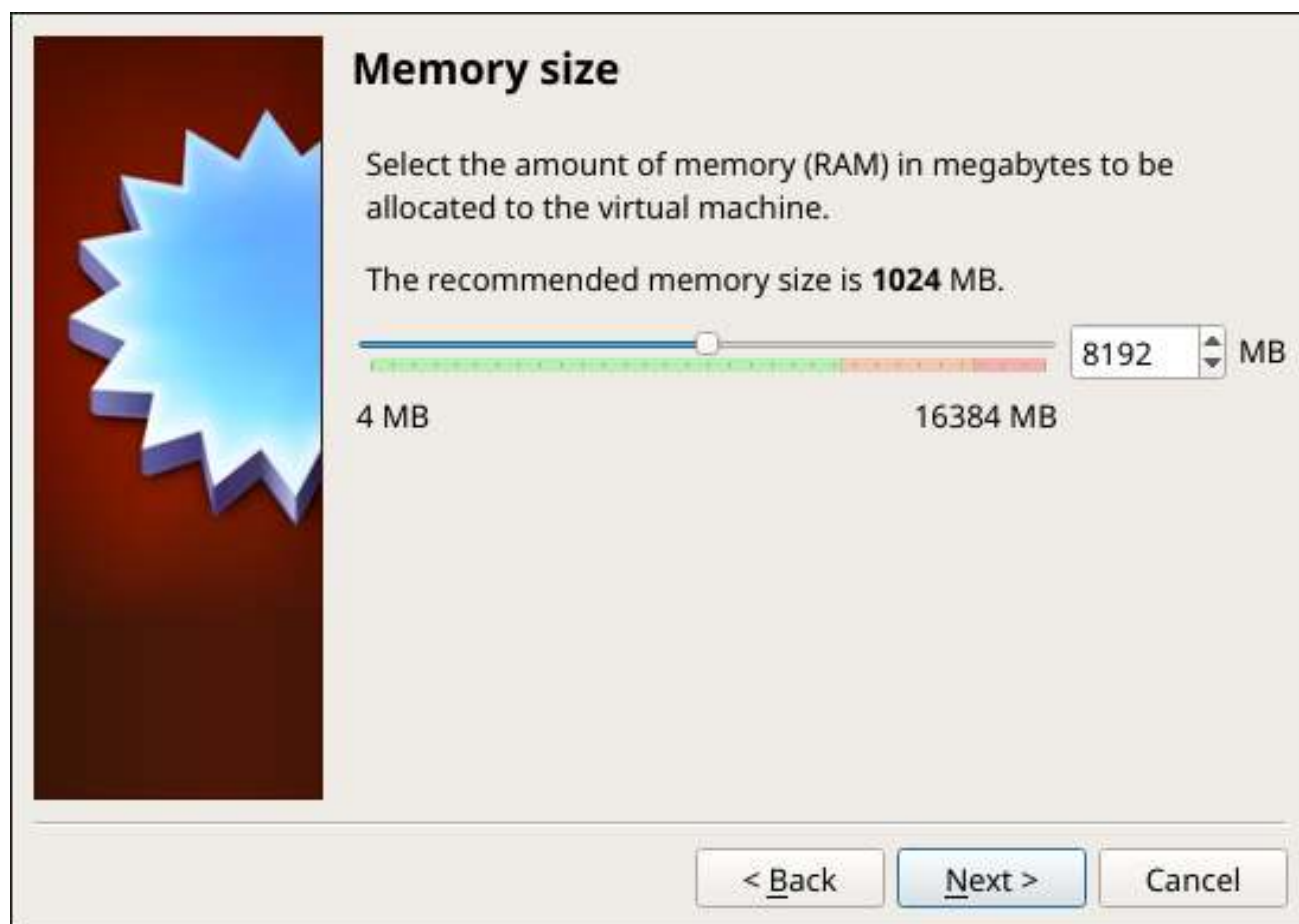


Fig. 2.17: Select the Amount of Memory Reserved for the Virtual Machine



Fig. 2.18: Select Existing or Create a New Virtual Hard Drive

Click *Create* to launch the *Create Virtual Hard Drive Wizard* shown in [Figure 2.19](#).



Fig. 2.19: Create New Virtual Hard Drive Wizard

Select *VDI* and click the *Next* button to see the screen in [Figure 2.20](#).

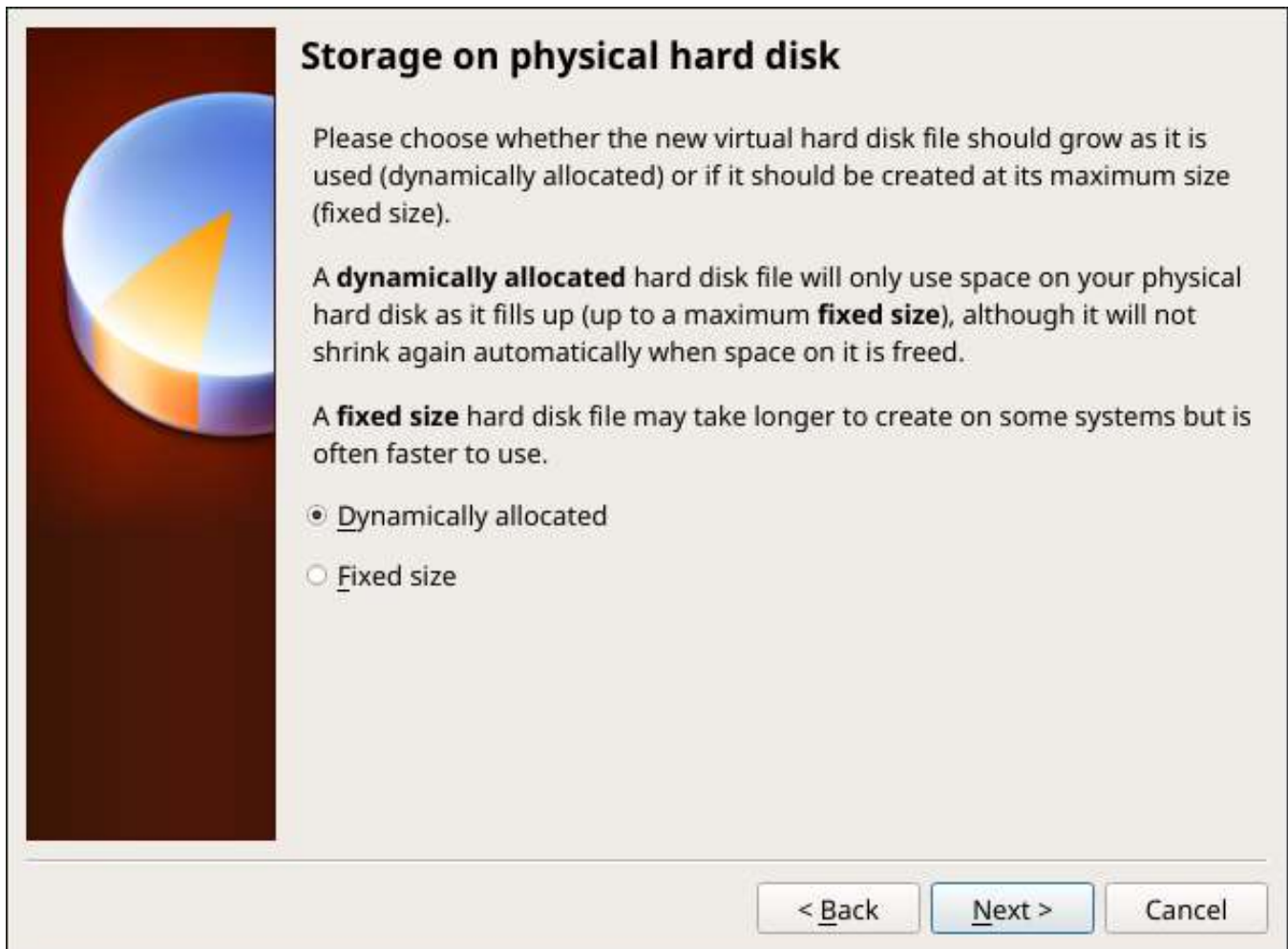


Fig. 2.20: Select Storage Type for Virtual Disk

Choose either *Dynamically allocated* or *Fixed-size* storage. The first option uses disk space as needed until it reaches the maximum size that is set in the next screen. The second option creates a disk the full amount of disk space, whether it is used or not. Choose the first option to conserve disk space; otherwise, choose the second option, as it allows VirtualBox to run slightly faster. After selecting *Next*, the screen in [Figure 2.21](#) is shown.



File location and size

Please type the name of the new virtual hard disk file into the box below or click on the folder icon to select a different folder to create the file in.

test

Select the size of the virtual hard disk in megabytes. This size is the limit on the amount of file data that a virtual machine will be able to store on the hard disk.

4.00 MB 2.00 TB 8.00 GB

< Back Create Cancel

Fig. 2.21: Select File Name and Size of Virtual Disk

This screen is used to set the size (or upper limit) of the virtual disk. **Set the default size to a minimum of 8 GiB.** Use the folder icon to browse to a directory on disk with sufficient space to hold the virtual disk files. Remember that there will be a system disk of at least 8 GiB and at least one data storage disk of at least 4 GiB.

Use the *Back* button to return to a previous screen if any values need to be modified. After making a selection and pressing *Create*, the new VM is created. The new virtual machine is listed in the left frame, as shown in the example in [Figure 2.22](#). Open the *Machine Tools* drop-down menu and select *Details* to see extra information about the VM.

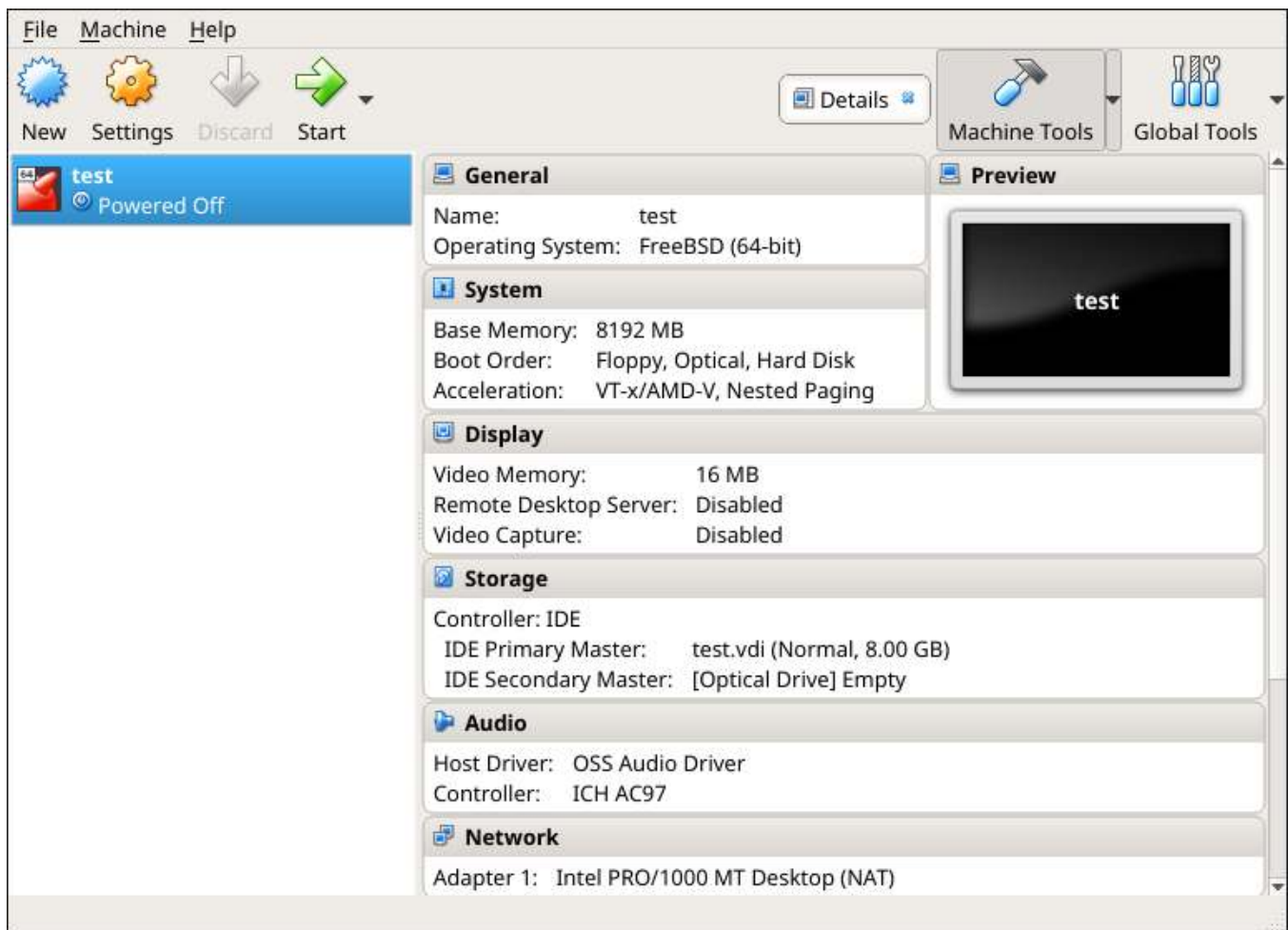


Fig. 2.22: The New Virtual Machine

Create the virtual disks to be used for storage. Highlight the VM and click *Settings* to open the menu. Click the *Storage* option in the left frame to access the storage screen seen in [Figure 2.23](#).

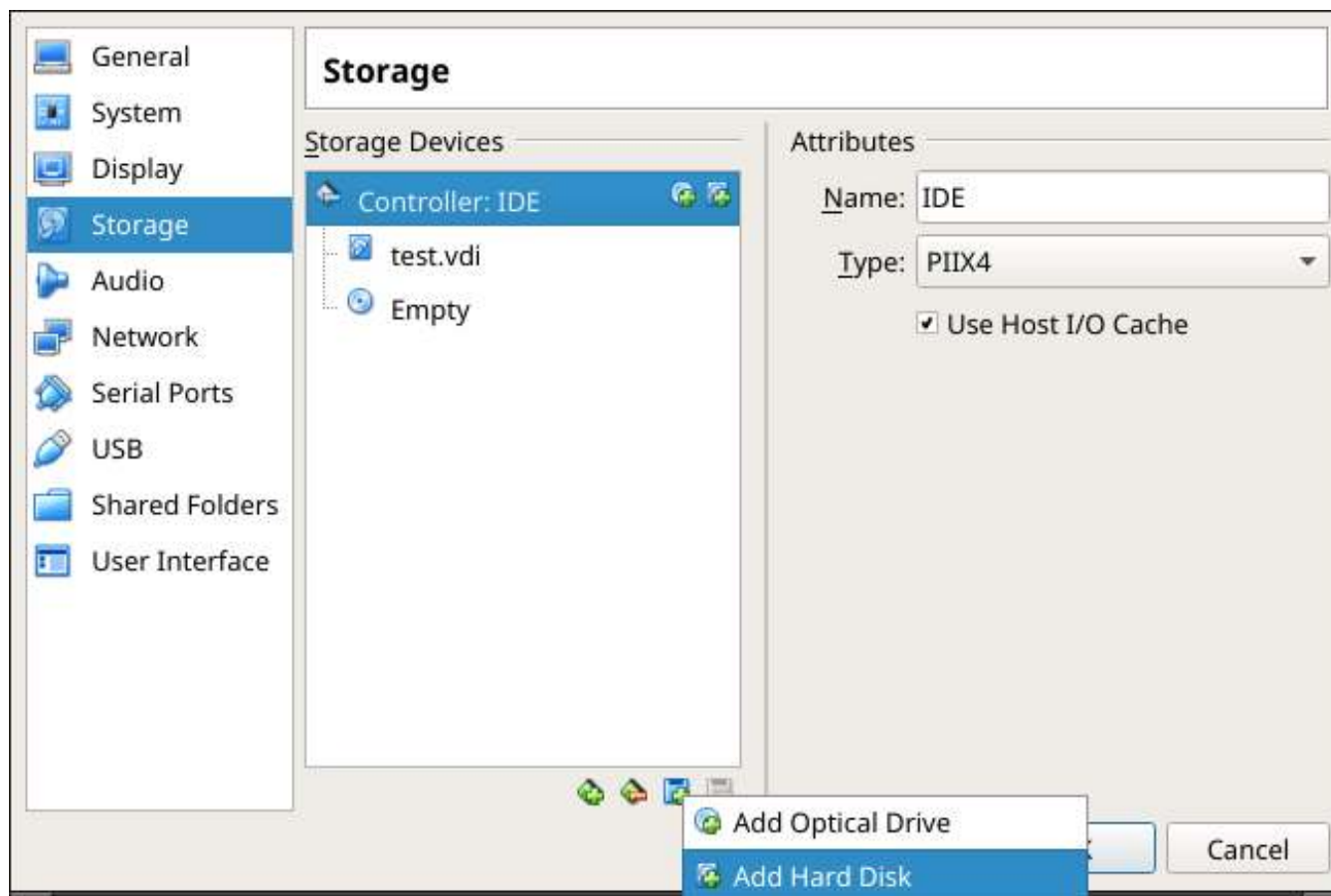


Fig. 2.23: Storage Settings of the Virtual Machine

Click the *Add Attachment* button, select *Add Hard Disk* from the pop-up menu, then click the *Create new disk* button. This launches the *Create Virtual Hard Disk* wizard seen in [Figure 2.19](#) and [2.20](#).

Create a disk large enough to hold the desired data. The minimum size is **4 GiB**. To practice with RAID configurations, create as many virtual disks as needed. Two disks can be created on each IDE controller. For additional disks, click the *Add Controller* button to create another controller for attaching additional disks.

Create a device for the installation media. Highlight the word “Empty”, then click the CD icon as shown in [Figure 2.24](#).

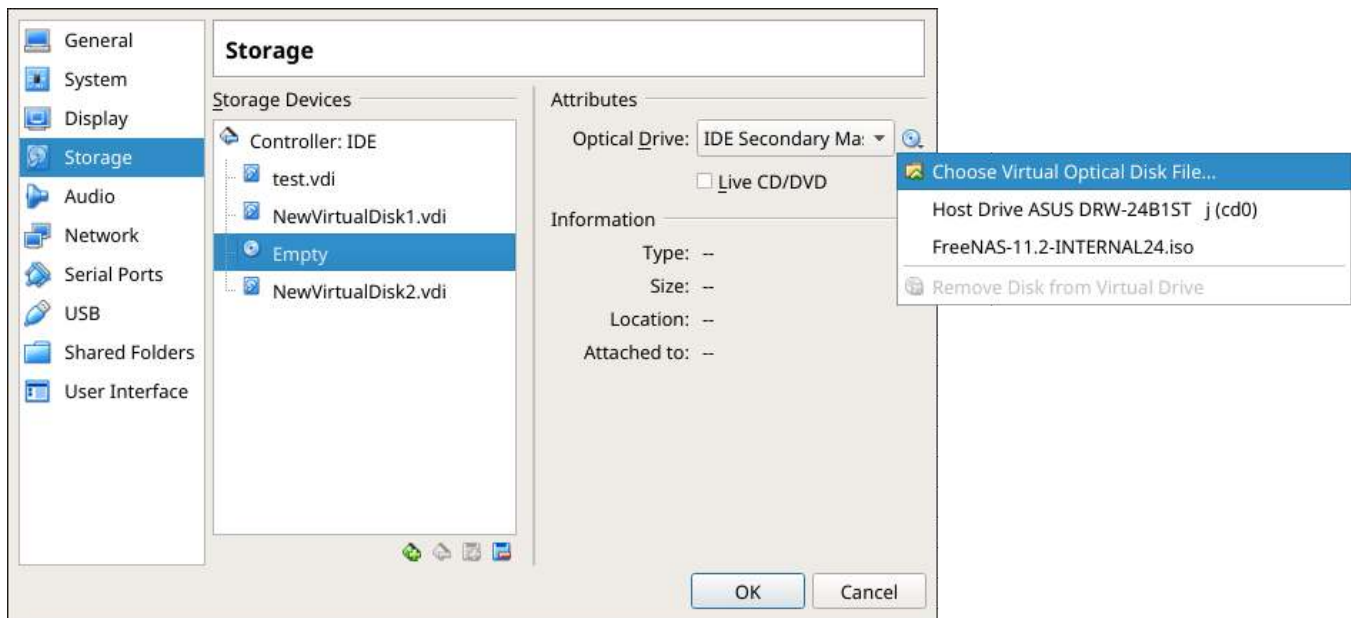


Fig. 2.24: Configuring ISO Installation Media

Click *Choose Virtual Optical Disk File...* to browse to the location of the `.iso` file. If the `.iso` was burned to CD, select the detected *Host Drive*.

Depending on the extensions available in the host CPU, it might not be possible to boot the VM from an `.iso`. If “your CPU does not support long mode” is shown when trying to boot the `.iso`, the host CPU either does not have the required extension or AMD-V/VT-x is disabled in the system BIOS.

Note: If there is a kernel panic when booting into the ISO, stop the virtual machine. Then, go to *System* and check the box *Enable IO APIC*.

To configure the network adapter, go to *Settings* → *Network* → *Adapter 1*. In the *Attached to* drop-down menu select *Bridged Adapter*, then choose the name of the physical interface from the *Name* drop-down menu. In the example shown in [Figure 2.25](#), the Intel Pro/1000 Ethernet card is attached to the network and has a device name of `em0`.

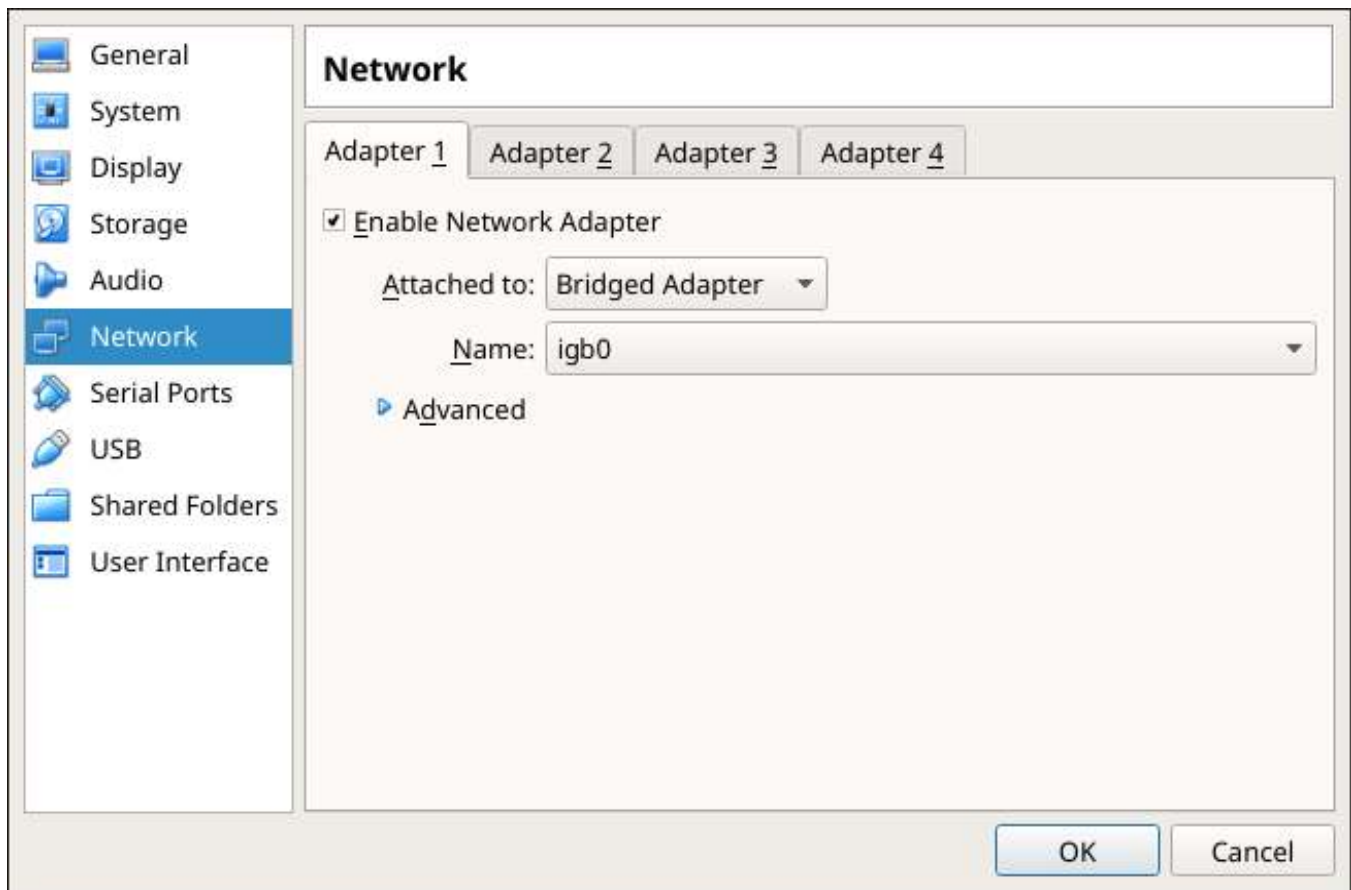


Fig. 2.25: Configuring a Bridged Adapter in VirtualBox

After configuration is complete, click the *Start* arrow and install FreeNAS® as described in [Performing the Installation](#) (page 28). After FreeNAS® is installed, press **F12** when the VM starts to boot to access the boot menu. Select the primary hard disk as the boot option. You can permanently boot from disk by removing the *Optical* device in *Storage* or by unchecking *Optical* in the *Boot Order* section of *System*.

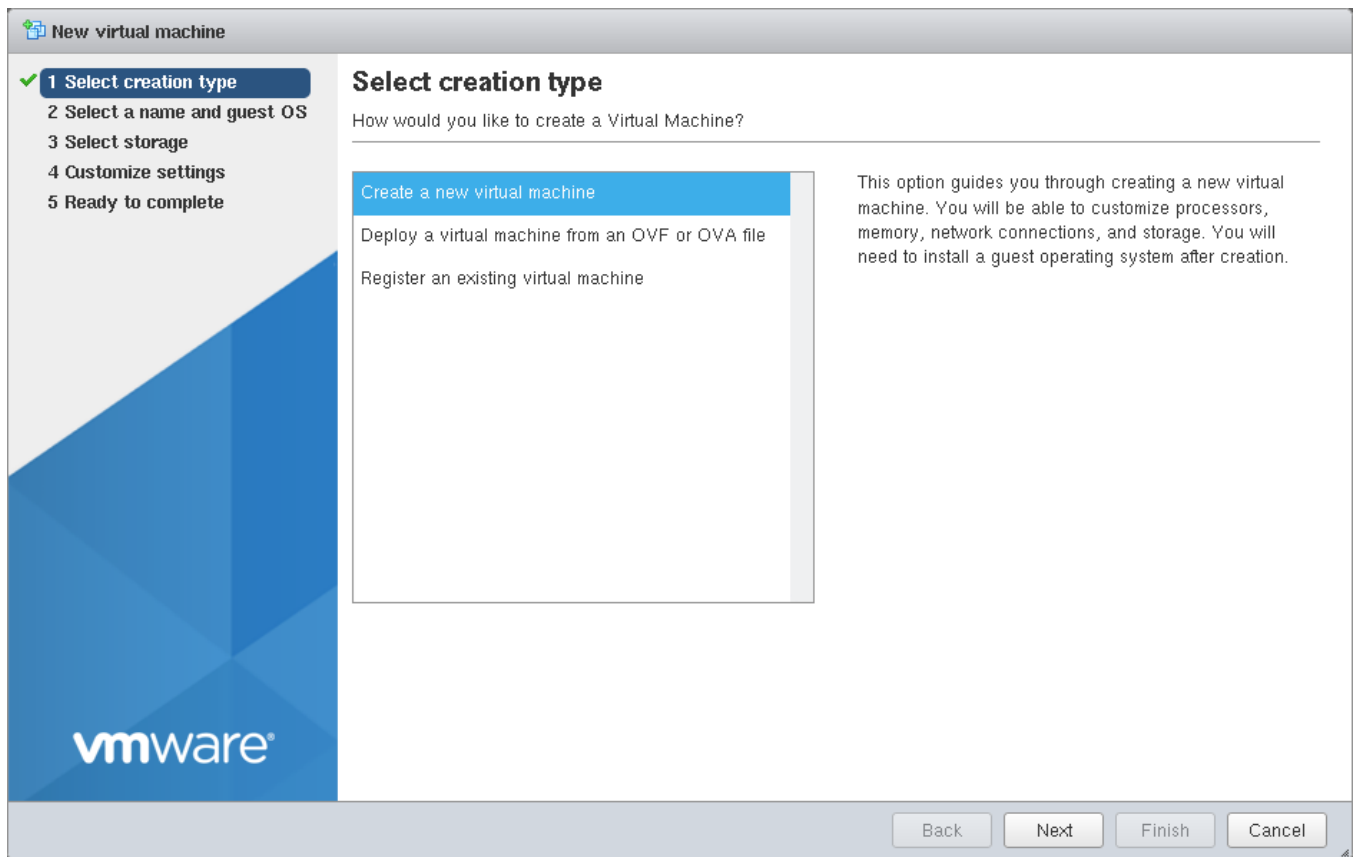
2.6.2 VMware ESXi

ESXi is a bare-metal hypervisor architecture created by VMware Inc. Commercial and free versions of the VMware vSphere Hypervisor operating system (ESXi) are available from the [VMware website](https://www.vmware.com/products/esxi-and-esx.html) (<https://www.vmware.com/products/esxi-and-esx.html>).

Install and use the VMware vSphere client to connect to the ESXi server. Enter the username and password created when installing ESXi to log in to the interface. After logging in, go to *Storage* to upload the FreeNAS® .iso. Click *Datastore browser* and select a datastore for the FreeNAS® .iso. Click *Upload* and choose the FreeNAS® .iso from the host system.

Click *Create / Register VM* to create a new VM. The *New virtual machine* wizard opens:

1. **Select creation type:** Select *Create a new virtual machine* and click *Next*.



2. **Select a name and guest OS:** Enter a name for the VM. Leave ESXi compatibility version at the default. Select `Other` as the Guest OS family. Select `FreeBSD12` or later versions (64-bit) as the Guest OS version. Click `Next`.

The screenshot shows the 'New virtual machine - sampleVM (ESXi 6.7 virtual machine)' wizard. On the left, a progress bar indicates five steps: 1. Select creation type (checked), 2. Select a name and guest OS (active), 3. Select storage, 4. Customize settings, and 5. Ready to complete. The main area is titled 'Select a name and guest OS' and prompts the user to 'Specify a unique name and OS'. A text box for 'Name' contains 'sampleVM'. Below this, a note states: 'Virtual machine names can contain up to 80 characters and they must be unique within each ESXi instance.' Another note says: 'Identifying the guest operating system here allows the wizard to provide the appropriate defaults for the operating system installation.' Three dropdown menus are provided: 'Compatibility' is set to 'ESXi 6.7 virtual machine', 'Guest OS family' is set to 'Other', and 'Guest OS version' is set to 'FreeBSD 12 or later versions (64-bit)'. The VMware logo is visible in the bottom left corner. At the bottom right, there are four buttons: 'Back', 'Next', 'Finish', and 'Cancel'.

New virtual machine - sampleVM (ESXi 6.7 virtual machine)

✓ 1 Select creation type
2 Select a name and guest OS
3 Select storage
4 Customize settings
5 Ready to complete

Select a name and guest OS

Specify a unique name and OS

Name
sampleVM

Virtual machine names can contain up to 80 characters and they must be unique within each ESXi instance.

Identifying the guest operating system here allows the wizard to provide the appropriate defaults for the operating system installation.

Compatibility: ESXi 6.7 virtual machine

Guest OS family: Other

Guest OS version: FreeBSD 12 or later versions (64-bit)

vmware®

Back Next Finish Cancel

3. **Select storage:** Select a datastore for the VM. The datastore must be at least 32 GiB.

New virtual machine - sampleVM (ESXi 6.7 virtual machine)

- ✓ 1 Select creation type
- ✓ 2 Select a name and guest OS
- ✓ 3 Select storage
- 4 Customize settings
- 5 Ready to complete

Select storage

Select the storage type and datastore

Standard Persistent Memory

Select a datastore for the virtual machine's configuration files and all of its' virtual disks.

Name	Capacity	Free	Type	Thin pro...	Access
datastore1	924 GB	917.99 GB	VMFS6	Supported	Single
datastore2	7.5 GB	3.8 GB	VMFS6	Supported	Single

2 items

Back Next Finish Cancel

4. **Customize settings:** Enter the recommended minimums of at least 8 GiB of memory and 32 GiB of storage. Select Datastore ISO file from the CD/DVD Drive 1 drop-down. Use the Datastore browser to select the uploaded FreeNAS® .iso. Click Next.

New virtual machine - sampleVM (ESXi 6.7 virtual machine)

- ✓ 1 Select creation type
- ✓ 2 Select a name and guest OS
- ✓ 3 Select storage
- ✓ 4 **Customize settings**
- 5 Ready to complete

Customize settings

Configure the virtual machine hardware and virtual machine additional options

Virtual Hardware VM Options

Add hard disk Add network adapter Add other device

CPU	1	
Memory	8192	MB
Hard disk 1	32	GB
SCSI Controller 0	LSI Logic SAS	
SATA Controller 0		
USB controller 1	USB 2.0	
Network Adapter 1	VM Network	<input checked="" type="checkbox"/> Connect
CD/DVD Drive 1	Datastore ISO file	<input checked="" type="checkbox"/> Connect
Video Card	Default settings	

Back Next Finish Cancel

5. **Ready to complete:** Review the VM settings. Click *Finish* to create the new VM.

New virtual machine - sampleVM (ESXi 6.7 virtual machine)

- ✓ 1 Select creation type
- ✓ 2 Select a name and guest OS
- ✓ 3 Select storage
- ✓ 4 Customize settings
- ✓ 5 Ready to complete

Ready to complete

Review your settings selection before finishing the wizard

Name	sampleVM
Datastore	datastore1
Guest OS name	FreeBSD 12 or later versions (64-bit)
Compatibility	ESXi 6.7 virtual machine
vCPUs	1
Memory	8192 MB
Network adapters	1
Network adapter 1 network	VM Network
Network adapter 1 type	VMXNET 3
IDE controller 0	IDE 0
IDE controller 1	IDE 1
SCSI controller 0	LSI Logic SAS
SATA controller 0	New SATA controller
Hard disk 1	
Capacity	32GB
Datastore	[datastore1] sampleVM/

Back Next Finish Cancel

To add more disks to a VM, right-click the VM and click *Edit Settings*.

Click *Add hard disk* → *New standard hard disk*. Enter the desired capacity and click *Save*.

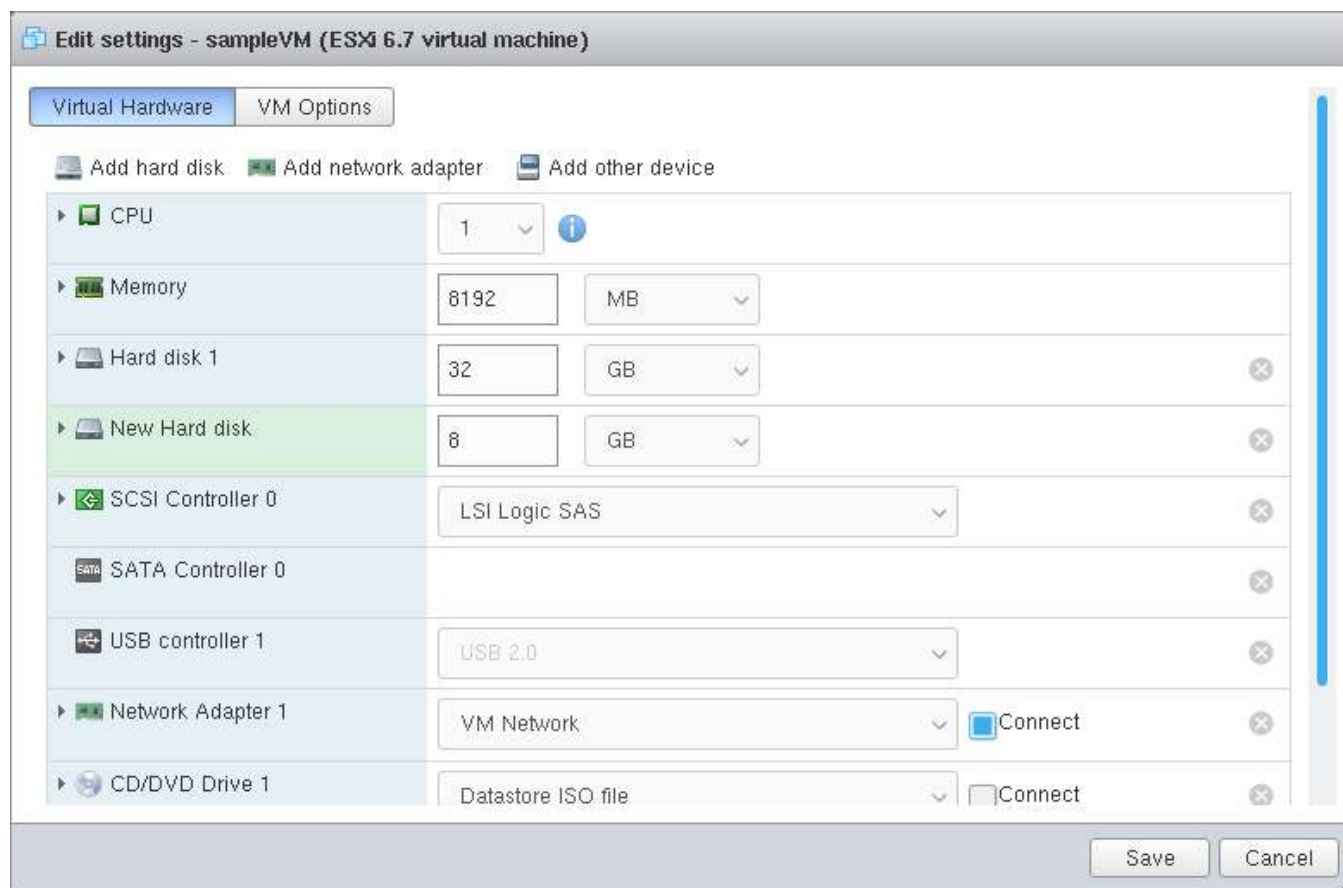


Fig. 2.26: Adding a Storage Disk

Virtual HPET hardware can prevent the virtual machine from booting on some older versions of VMware. If the virtual machine does not boot, remove the virtual HPET hardware:

- On ESXi, right-click the VM and click *Edit Settings*. Click *VM Options* → *Advanced* → *Edit Configuration....* Change *hpet0.present* from *TRUE* to *FALSE* and click *OK*. Click *Save* to save the new settings.
- On Workstation or Player, while in *Edit Settings*, click *Options* → *Advanced* → *File Locations*. Locate the path for the Configuration file named `filename.vmx`. Open the file in a text editor and change *hpet0.present* from *true* to *false*, then save the change.

BOOTING

The Console Setup menu, shown in [Figure 3.1](#), appears at the end of the boot process. If the FreeNAS® system has a keyboard and monitor, this Console Setup menu can be used to administer the system.

Note: When connecting to the FreeNAS® system with SSH or the web [Shell](#) (page 335), the Console Setup menu is not shown by default. It can be started by the *root* user or another user with root permissions by typing `/etc/netcli`.

The Console Setup menu can be disabled by unchecking *Enable Console Menu* in *System* → *Advanced*.



```
Console setup
-----
1) Configure Network Interfaces
2) Configure Link Aggregation
3) Configure VLAN Interface
4) Configure Default Route
5) Configure Static Routes
6) Configure DNS
7) Reset Root Password
8) Reset Configuration to Defaults
9) Shell
10) Reboot
11) Shut Down

The web user interface is at:
http://10.0.0.102

Enter an option from 1-11: █
```

Fig. 3.1: Console Setup Menu

The menu provides these options:

- 1) *Configure Network Interfaces* provides a configuration wizard to set up the system's network interfaces.
- 2) *Configure Link Aggregation* is for creating or deleting link aggregations.
- 3) *Configure VLAN Interface* is used to create or delete VLAN interfaces.
- 4) *Configure Default Route* is used to set the IPv4 or IPv6 default gateway. When prompted, enter the IP address of the default gateway.
- 5) *Configure Static Routes* prompts for the destination network and gateway IP address. Re-enter this option for each static route needed.

6) *Configure DNS* prompts for the name of the DNS domain and the IP address of the first DNS server. When adding multiple DNS servers, press `Enter` to enter the next one. Press `Enter` twice to leave this option.

7) *Reset Root Password* is used to reset a lost or forgotten `root` password. Select this option and follow the prompts to set the password.

8) *Reset Configuration to Defaults* **Caution!** This option deletes *all* of the configuration settings made in the administrative GUI and is used to reset a FreeNAS® system back to defaults. **Before selecting this option, make a full backup of all data and make sure all encryption keys and passphrases are known!** After this option is selected, the configuration is reset to defaults and the system reboots. *Storage* → *Pools* → *Import Pool* can be used to re-import pools.

9) *Shell* starts a shell for running FreeBSD commands. To leave the shell, type `exit`.

10) *Reboot* reboots the system.

11) *Shut Down* shuts down the system.

Note: The numbering and quantity of options on this menu can change due to software updates, service agreements, or other factors. Please carefully check the menu before selecting an option, and keep this in mind when writing local procedures.

3.1 Obtaining an IP Address

During boot, FreeNAS® automatically attempts to connect to a DHCP server from all live network interfaces. After FreeNAS® successfully receives an IP address, the address is displayed so it can be used to access the web interface. The example in [Figure 3.1](#) shows a FreeNAS® system that is accessible at `http://10.0.0.102`.

Some FreeNAS® systems are set up without a monitor, making it challenging to determine which IP address has been assigned. On networks that support Multicast DNS (mDNS), the hostname and domain can be entered into the address bar of a browser. By default, this value is `freenas.local`.

If the FreeNAS® server is not connected to a network with a DHCP server, use the console network configuration menu to manually configure the interface as shown here. In this example, the FreeNAS® system has one network interface, `em0`.

```
Enter an option from 1-11: 1
1) em0
Select an interface (q to quit): 1
Remove the current settings of this interface? (This causes a momentary disconnection of the network.) (y/n) n
Configure interface for DHCP? (y/n) n
Configure IPv4? (y/n) y
Interface name:      (press enter, the name can be blank)
Several input formats are supported
Example 1 CIDR Notation:
    192.168.1.1/24
Example 2 IP and Netmask separate:
    IP: 192.168.1.1
    Netmask: 255.255.255.0, or /24 or 24
IPv4 Address: 192.168.1.108/24
Saving interface configuration: Ok
Configure IPv6? (y/n) n
Restarting network: ok

...

The web user interface is at
http://192.168.1.108
```


ACCESSING THE WEB INTERFACE

On a computer that can access the same network as the FreeNAS[®] system, enter the IP address in a web browser to connect to the web interface. The password for the root user is requested.

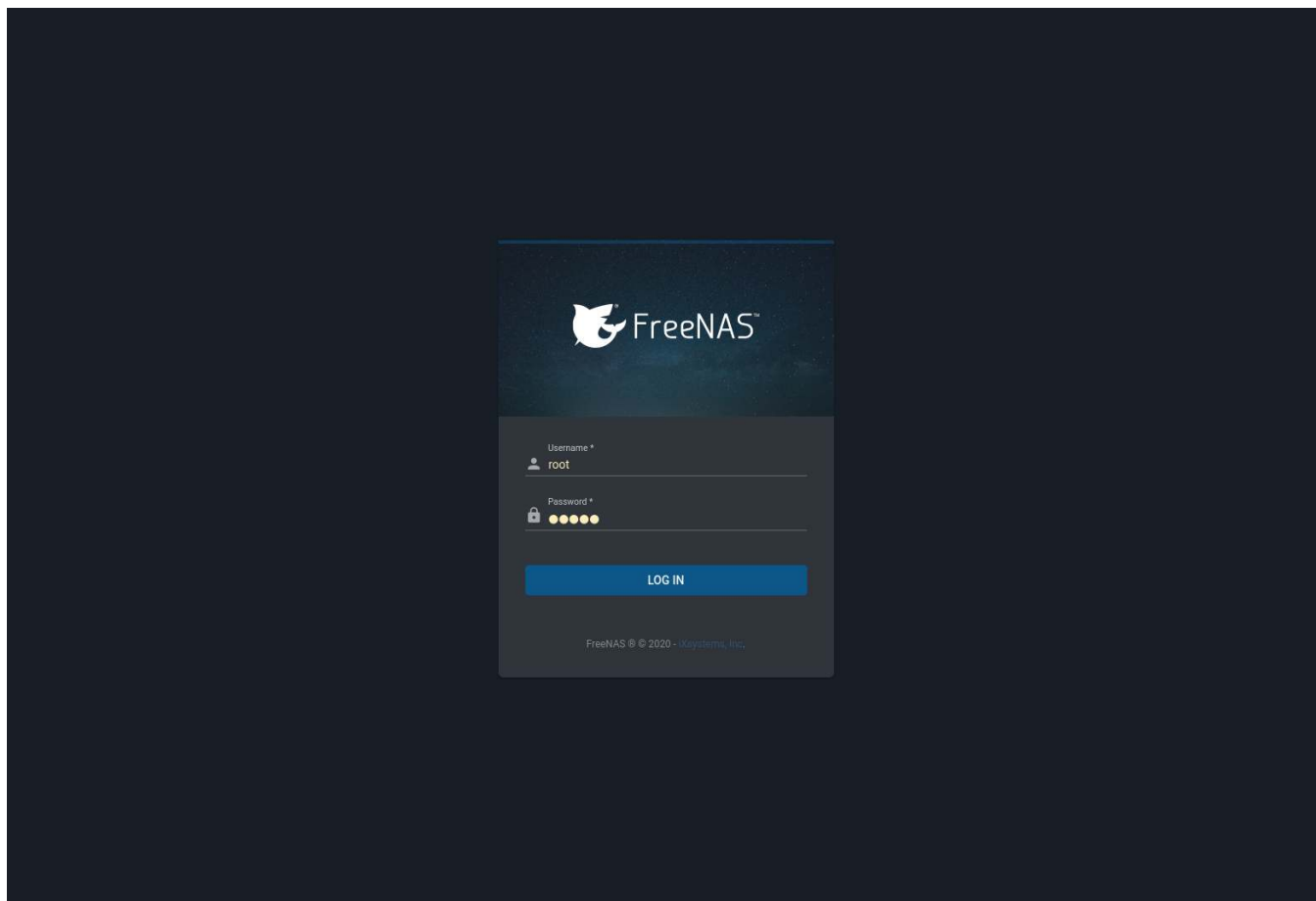


Fig. 4.1: Login Screen

Enter the password chosen during the installation. A prompt is shown to set a root password if it was not set during installation.

The web interface is displayed after login:

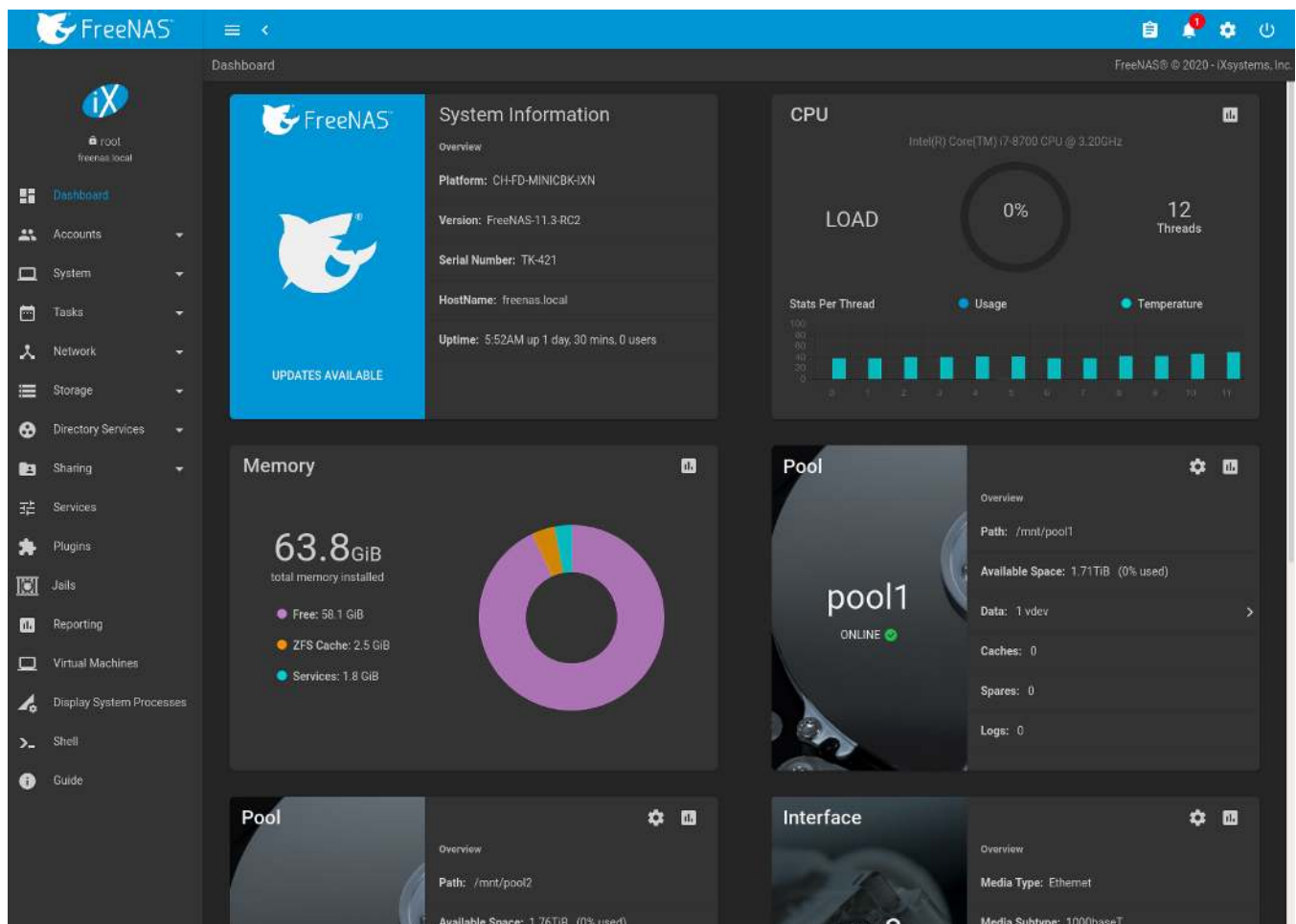


Fig. 4.2: Dashboard

The *Dashboard* shows details about the system. These details are grouped into sections about the hardware components, networking, storage, and other categories.

4.1 Web Interface Troubleshooting

If the user interface is not accessible by IP address from a browser, check these things:

- Are proxy settings enabled in the browser configuration? If so, disable the settings and try connecting again.
- If the page does not load, make sure that a `ping` reaches the FreeNAS® system's IP address. If the address is in a private IP address range, it is only accessible from within that private network.

The rest of this User Guide describes the FreeNAS® web interface in more detail. The layout of this User Guide follows the order of the menu items in the tree located in the left frame of the web interface.

SETTINGS

The ⚙️ (Settings) menu provides options to change the administrator password, set preferences, and view system information.

5.1 Change Password

To change the `root` account password, click ⚙️ (Settings) and *Change Password*. The current `root` password must be entered before a new password can be saved.

5.2 Preferences

The FreeNAS® User Interface can be adjusted to match the user preferences. Go to the *Web Interface Preferences* page by clicking the ⚙️ (Settings) menu in the upper-right and clicking *Preferences*.

5.2.1 Web Interface Preferences

This page has options to adjust global settings in the web interface, manage custom themes, and create new themes. [Figure 5.1](#) shows the different options:

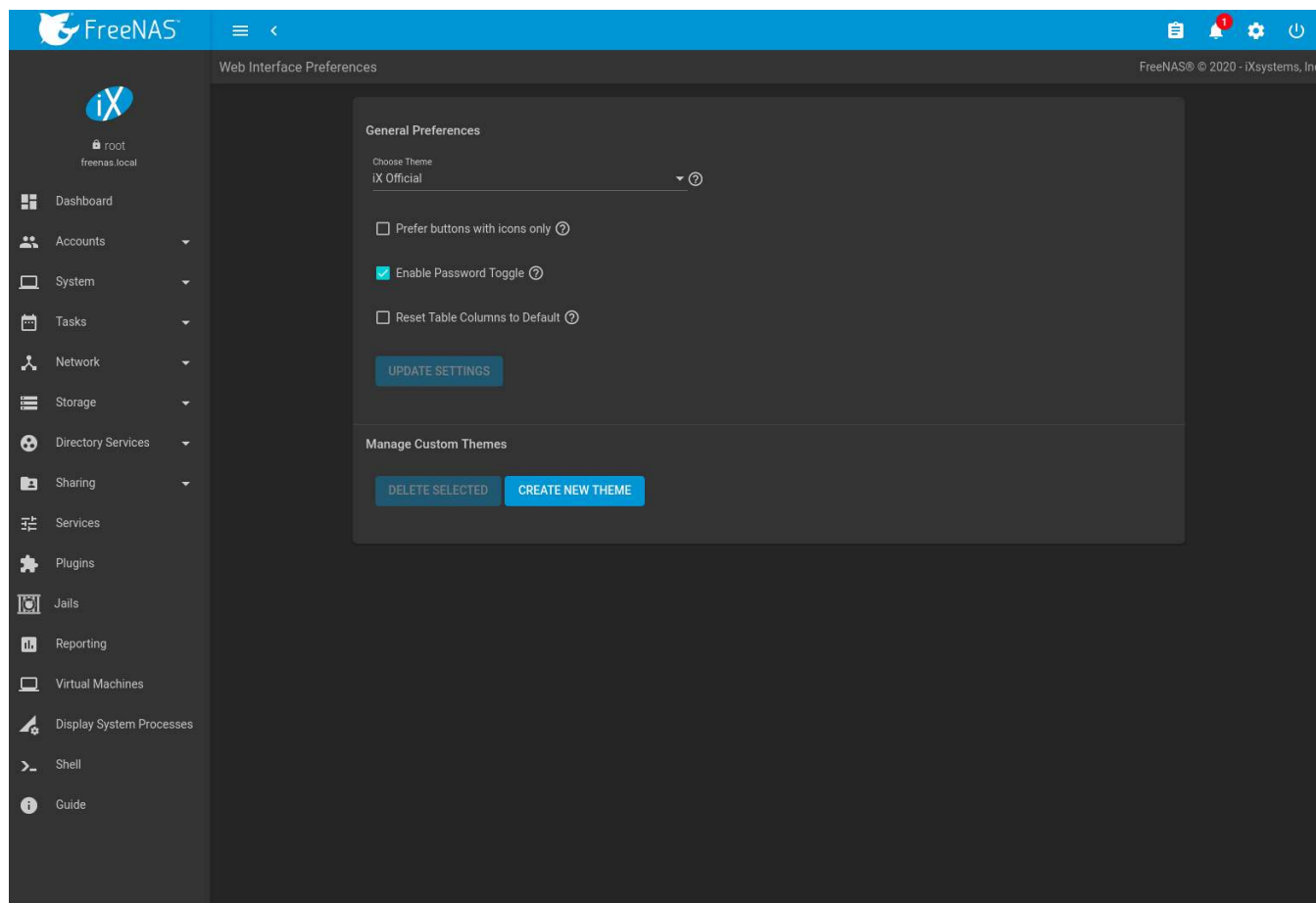


Fig. 5.1: Web Interface Preferences

These options are applied to the entire web interface:

- *Choose Theme*: Change the active theme. Custom themes are added to this list.
- *Prefer buttons with icons only*: Set to preserve screen space and only display icons and tooltips instead of text labels.
- *Enable Password Toggle*: When set, an eye icon appears next to password fields. Clicking the icon reveals the password. Clicking it again hides the password.
- *Reset Table Columns to Default*: Set to reset all tables to display default columns.

Make any changes and click *UPDATE SETTINGS* to save the new selections.

5.2.2 Themes

The FreeNAS® web interface supports dynamically changing the active theme and creating new, fully customizable themes.

5.2.2.1 Create New Themes

This page is used to create and preview custom FreeNAS® themes. [Figure 5.2](#) shows many of the theming and preview options:

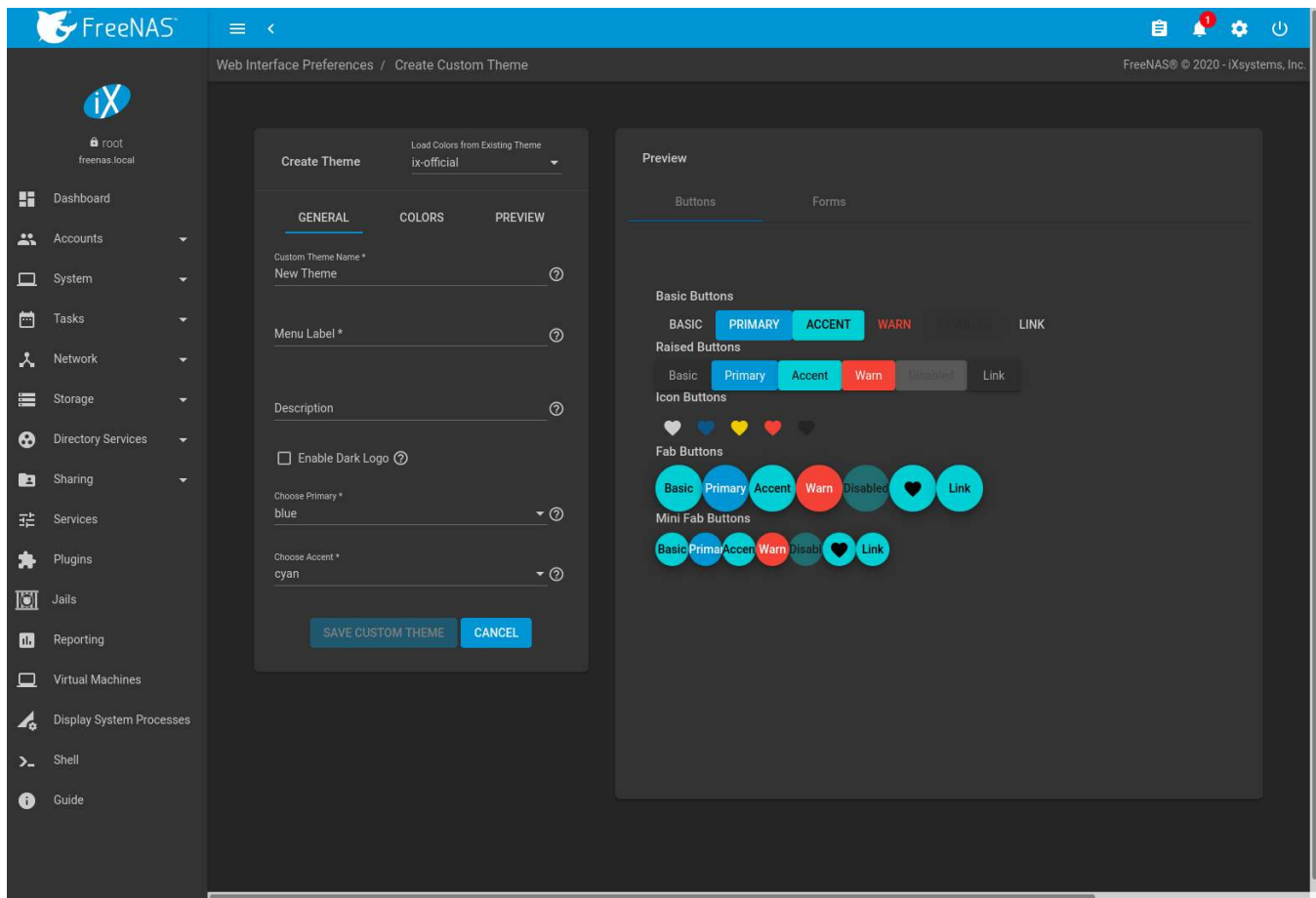


Fig. 5.2: Create and Preview a Custom Theme

To create a new custom theme, click *CREATE NEW THEME*. Colors from an existing theme can be used when creating a new custom theme. Select a theme from the *Load Colors from Theme* drop-down to use the colors from that theme for the new custom theme. Table 5.1 describes each option:

Table 5.1: General Options for a New Theme

Setting	Value	Description
Custom Theme Name	string	Enter a name to identify the new theme.
Menu Label	string	Enter a short name to use for the FreeNAS® menus.
Menu Swatch	drop-down menu	Choose a color from the theme to display next to the menu entry of the custom theme.
Description	string	Enter a short description of the new theme.
Enable Dark Logo	checkbox	Set this to give the FreeNAS Logo a dark fill color.
Choose Primary	drop-down menu	Choose from either a generic color or import a specific color setting to use as the primary theme color. The primary color changes the top bar of the web interface and the color of many of the buttons.
Choose Accent	drop-down menu	Choose from either a generic color or import a specific color setting to use as the accent color for the theme. This color is used for many of the buttons and smaller elements in the web interface.

Choose the different *COLORS* for this new theme after setting these general options. Click the color swatch to open a small popup with sliders to adjust the color. Color values can also be entered as a hexadecimal value.

Changing any color value automatically updates the *Theme Preview* column. This section is completely interactive and shows how the custom theme is applied to all the different elements in the web interface.

Click *SAVE CUSTOM THEME* when finished with all the *GENERAL* and *COLORS* options. The new theme is added to the list of available themes in *Web Interface Preferences*.

Click *PREVIEW* → *Global Preview* to apply the unsaved custom theme to the current session of the FreeNAS® web interface. Activating *Global Preview* allows going to other pages in the web interface and live testing the new custom theme.

Note: Setting a custom theme as a *Global Preview* does **not** save that theme! Be sure to go back to *Preferences* → *Create Custom Theme*, complete any remaining options, and click *SAVE CUSTOM THEME* to save the current settings as a new theme.

5.3 API Documentation

Click *API* to see documentation for the [websocket protocol API](https://en.wikipedia.org/wiki/WebSocket) (<https://en.wikipedia.org/wiki/WebSocket>) used in FreeNAS®.

5.4 About

Click ⚙ (Settings) and *About* to view a popup window with basic system information. This includes system *Version*, *Hostname*, *Uptime*, *IP* address, *Physical Memory*, *CPU Model*, and *Average Load*.

ACCOUNTS

Accounts is used to manage users and groups. This section contains these entries:

- [Groups](#) (page 67): used to manage UNIX-style groups on the FreeNAS® system.
- [Users](#) (page 70): used to manage UNIX-style accounts on the FreeNAS® system.

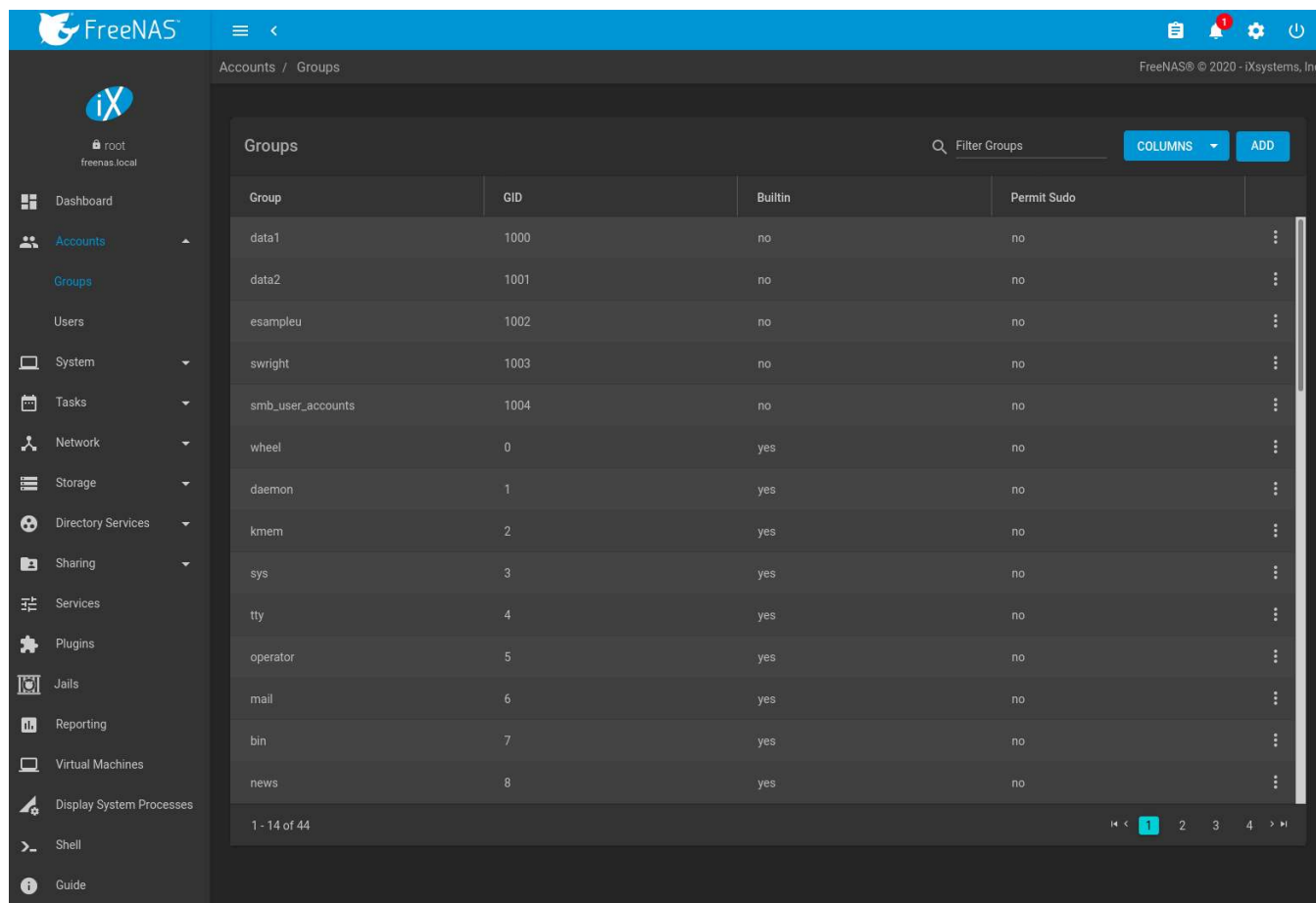
Each entry is described in more detail in this section.

6.1 Groups

The Groups interface provides management of UNIX-style groups on the FreeNAS® system.

Note: It is unnecessary to recreate the network users or groups when a directory service is running on the same network. Instead, import the existing account information into FreeNAS®. Refer to [Directory Services](#) (page 198) for details.

This section describes how to create a group and assign user accounts to it. The *Groups* page lists all groups, including those built in and used by the operating system.



Accounts / Groups

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Groups

Filter Groups

COLUMNS ADD

Group	GID	Builtin	Permit Sudo
data1	1000	no	no
data2	1001	no	no
esampleu	1002	no	no
swright	1003	no	no
smb_user_accounts	1004	no	no
wheel	0	yes	no
daemon	1	yes	no
knmem	2	yes	no
sys	3	yes	no
tty	4	yes	no
operator	5	yes	no
mail	6	yes	no
bin	7	yes	no
news	8	yes	no

1 - 14 of 44

Fig. 6.1: Group Management

The table displays group names, group IDs (GID), built-in groups, and whether `sudo` is permitted. Clicking the `:` (Options) icon on a user-created group entry displays *Members*, *Edit*, and *Delete* options. Click *Members* to view and modify the group membership. Built-in groups are required by the FreeNAS® system and cannot be edited or deleted.

The **ADD** button opens the screen shown in [Figure 6.2](#). [Table 6.1](#) summarizes the available options when creating a group.

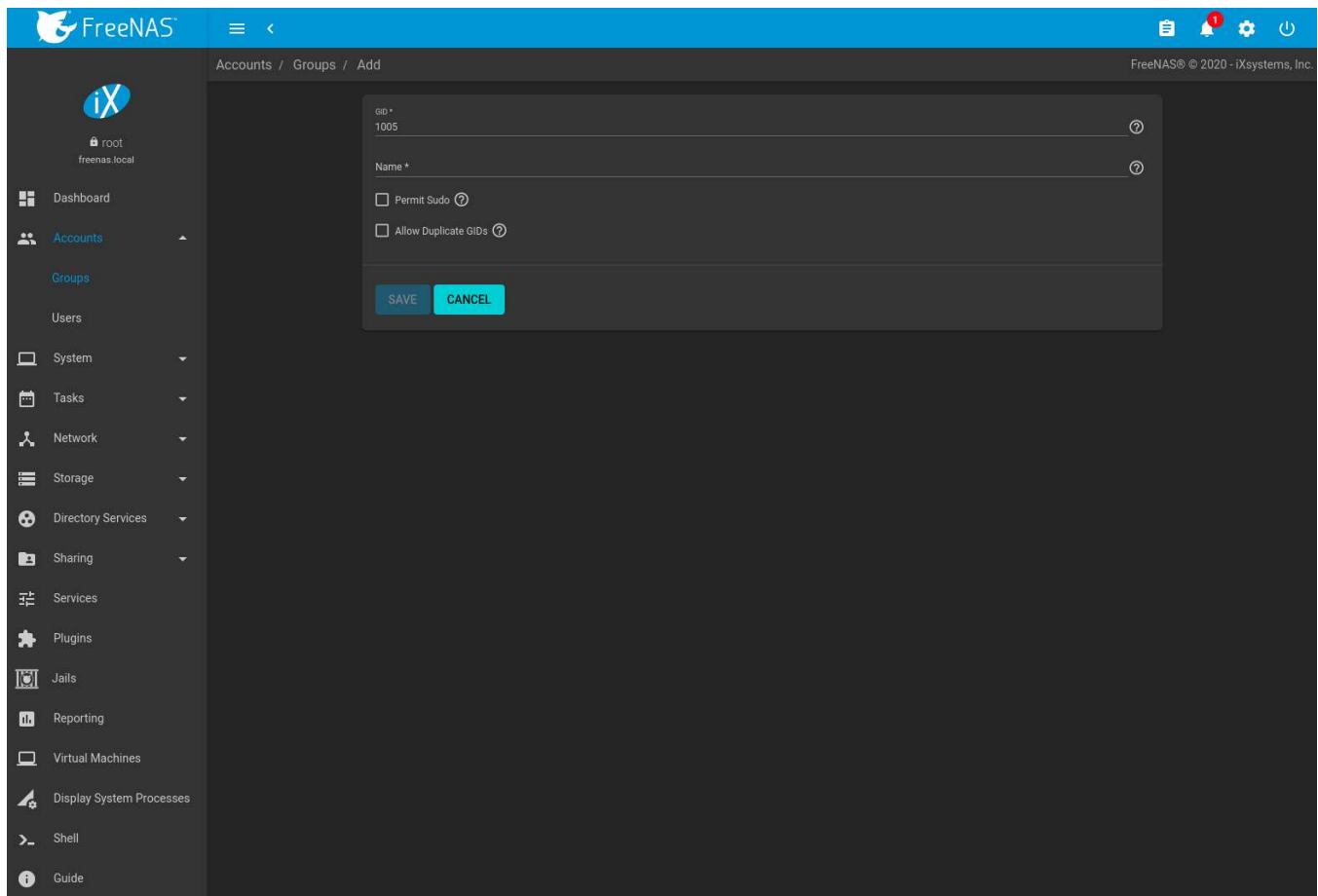


Fig. 6.2: Creating a New Group

Table 6.1: Group Creation Options

Setting	Value	Description
GID	string	The next available group ID is suggested. By convention, UNIX groups containing user accounts have an ID greater than 1000 and groups required by a service have an ID equal to the default port number used by the service. Example: the <code>sshd</code> group has an ID of 22. This setting cannot be edited once the group is created.
Name	string	Enter an alphanumeric name for the new group. Group names cannot begin with a hyphen (-) or contain a space, tab, or these characters: , : + & # % ^ () ! @ ~ * ? < > = . \$ can only be used as the last character of the group name.
Permit Sudo	checkbox	Set to allow group members to use <code>sudo</code> (https://www.sudo.ws/). When using <code>sudo</code> , a user is prompted for their own password.
Allow Duplicate GIDs	checkbox	Not recommended. Allow more than one group to have the same group ID.

To change which users are members of a group, expand the group from the list and click *Members*. To add users to the group, select users in the left frame and click `->`. To remove users from the group, select users in the right frame and click `<-`. Click *SAVE* when finished changing the group members.

Figure 6.3, shows adding a user as a member of a group.

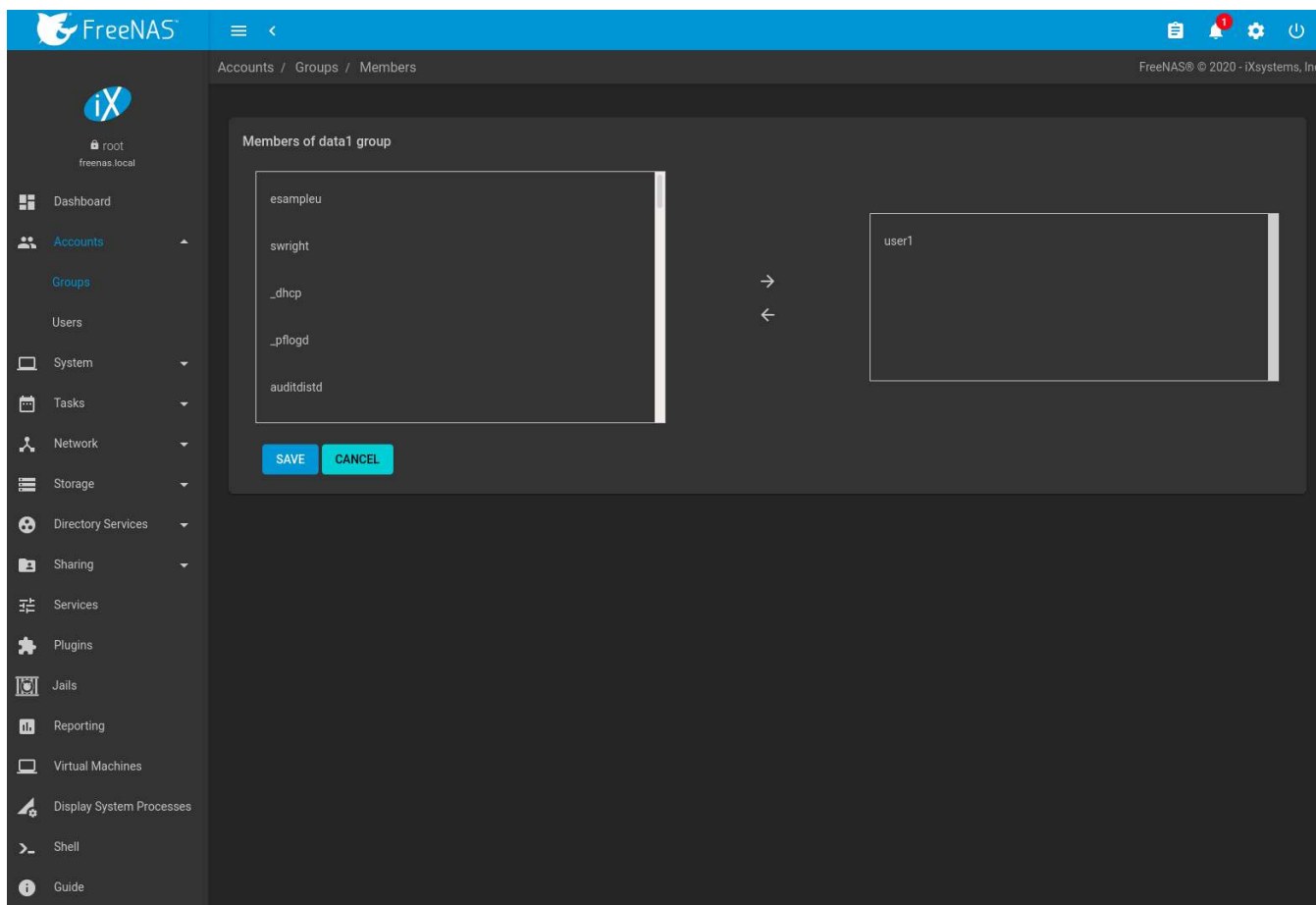


Fig. 6.3: Assigning a User to a Group

The *Delete* button deletes a group. The pop-up message asks if all users with this primary group should also be deleted, and to confirm the action. Note built-in groups do not have a *Delete* button.

6.2 Users

FreeNAS® supports users, groups, and permissions, allowing flexibility in configuring which users have access to the data stored on FreeNAS®. To assign permissions to shares, select one of these options:

1. Create a guest account for all users, or create a user account for every user in the network where the name of each account is the same as a login name used on a computer. For example, if a Windows system has a login name of *bobsmith*, create a user account with the name *bobsmith* on FreeNAS®. A common strategy is to create groups with different sets of permissions on shares, then assign users to those groups.
2. If the network uses a directory service, import the existing account information using the instructions in *Directory Services* (page 198).

Accounts → *Users* lists all system accounts installed with the FreeNAS® operating system, as shown in [Figure 6.4](#).


The screenshot shows the FreeNAS web interface with the 'Users' management page. The sidebar on the left contains navigation links: Dashboard, Accounts, Groups, Users, System, Tasks, Network, Storage, Directory Services, Sharing, Services, Plugins, Jails, Reporting, Virtual Machines, Display System Processes, Shell, and Guide. The main content area is titled 'Users' and contains a table with the following columns: Username, UID, Builtin, and Full Name. The table lists 14 users, including esampleu, swright, user1, root, daemon, operator, bin, tty, kmem, games, news, man, ftp, and sshd. At the bottom of the table, it indicates '1 - 14 of 35' entries. The interface also features a search bar, a 'Filter Users' button, and a 'COLUMNS' dropdown menu.

Username	UID	Builtin	Full Name
esampleu	1000	no	Elton Q. Sampleuser
swright	1001	no	Susan B. Wright
user1	1002	no	user1
root	0	yes	root
daemon	1	yes	Owner of many system processes
operator	2	yes	System &
bin	3	yes	Binaries Commands and Source
tty	4	yes	Tty Sandbox
kmem	5	yes	KMem Sandbox
games	7	yes	Games pseudo-user
news	8	yes	News Subsystem
man	9	yes	Mister Man Pages
ftp	14	yes	
sshd	22	yes	Secure Shell Daemon

Fig. 6.4: Managing User Accounts

By default, each user entry displays the username, User ID (UID), whether the user is built into FreeNAS®, and full name. This table is adjustable by clicking *COLUMNS* and setting the desired columns.

Clicking a column name sorts the list by that value. An arrow indicates which column controls the view sort order. Click the arrow to reverse the sort order.

Click  (Options) on the user created account to display the *Edit* and *Delete* buttons. Note built-in users do not have a *Delete* button.

Note: Setting the email address for the built-in *root* user account is recommended as important system messages are sent to the *root* user. For security reasons, password logins are disabled for the *root* account and changing this setting is highly discouraged.

Except for the *root* user, the accounts that come with FreeNAS® are system accounts. Each system account is used by a service and should not be used as a login account. For this reason, the default shell on system accounts is [nologin\(8\)](https://www.freebsd.org/cgi/man.cgi?query=nologin) (<https://www.freebsd.org/cgi/man.cgi?query=nologin>). For security reasons and to prevent breakage of system services, modifying the system accounts is discouraged.

The *ADD* button opens the screen shown in [Figure 6.5](#). [Table 6.2](#) summarizes the options that are available when user accounts are created or modified.

Warning: When using *Active Directory* (page 198), Windows user passwords must be set from within Windows.

The screenshot shows the FreeNAS web interface for adding a new user. The left sidebar contains navigation links for Dashboard, Accounts, Groups, Users, System, Tasks, Network, Storage, Directory Services, Sharing, Services, Plugins, Jails, Reporting, Virtual Machines, Display System Processes, Shell, and Guide. The main content area is titled 'Accounts / Users / Add'. The form is organized into four main sections:

- Name & Contact:** Contains input fields for 'Full Name', 'Username', 'Email', 'Password', and 'Confirm Password'. There are icons to show or hide the password.
- ID & Groups:** Includes a 'User ID' field (pre-filled with 1003), a checked 'New Primary Group' checkbox, and dropdown menus for 'Primary Group' and 'Auxiliary Groups'.
- Directories & Permissions:** Features a 'Home Directory' dropdown (set to '/nonexistent'), a file browser for '/mnt', and a table for 'Home Directory Permissions'.
- Authentication:** Includes an 'SSH Public Key' field, a checked 'Enable password login' checkbox, a 'Shell' dropdown (set to 'csh'), and checkboxes for 'Lock User', 'Permit Sudo', and 'Microsoft Account'.

Fig. 6.5: Adding or Editing a User Account

Table 6.2: User Account Configuration

Setting	Value	Description
Username	string	Usernames can be up to 16 characters long. When using NIS or other legacy software with limited username lengths, keep usernames to eight characters or less for compatibility. Usernames cannot begin with a hyphen (-) or contain a space, tab, or these characters: , : + & # % ^ () ! @ ~ * ? < > = . \$ can only be used as the last character of the username.
Full Name	string	This field is mandatory and may contain spaces.
Email	string	The email address associated with the account.
Password	string	Mandatory unless <i>Disable Password</i> is Yes. Cannot contain a ?. Click (Show) to view or obscure the password characters.
Confirm Password	string	Required to match the value of <i>Password</i> .
User ID	integer	Grayed out if the user already exists. When creating an account, the next numeric ID is suggested. By convention, user accounts have an ID greater than 1000 and system accounts have an ID equal to the default port number used by the service.
New Primary Group	checkbox	Set by default to create a new a primary group with the same name as the user. Unset to select a different primary group name.

Continued on next page

Table 6.2 – continued from previous page

Setting	Value	Description
Primary Group	drop-down menu	Unset <i>New Primary Group</i> to access this menu. For security reasons, FreeBSD will not give a user <code>su</code> permissions if <i>wheel</i> is their primary group. To give a user <code>su</code> access, add them to the <i>wheel</i> group in <i>Auxiliary groups</i> .
Auxiliary groups	drop-down menu	Select which groups the user will be added to.
Home Directory	browse button	Choose a path to the user's home directory. If the directory exists and matches the username, it is set as the user's home directory. When the path does not end with a subdirectory matching the username, a new subdirectory is created. The full path to the user's home directory is shown here when editing a user.
Home Directory Permissions	checkboxes	Sets default Unix permissions of user's home directory. This is read-only for built-in users.
SSH Public Key	string	Paste the user's public SSH key to be used for key-based authentication. Do not paste the private key!
Disable Password	drop-down	<i>Yes</i> : Disables the <i>Password</i> fields and removes the password from the account. The account cannot use password-based logins for services. For example, disabling the password prevents using account credentials to log in to an SMB share or open an SSH session on the system. The <i>Lock User</i> and <i>Permit Sudo</i> options are also removed. <i>No</i> : Requires adding a <i>Password</i> to the account. The account can use the saved <i>Password</i> to authenticate with password-based services.
Shell	drop-down menu	Select the shell to use for local and SSH logins. The <i>root</i> user shell is used for web interface <i>Shell</i> (page 335) sessions. See Table 6.3 for an overview of available shells.
Lock User	checkbox	Prevent the user from logging in or using password-based services until this option is unset. Locking an account is only possible when <i>Disable Password</i> is <i>No</i> and a <i>Password</i> has been created for the account.
Permit Sudo	checkbox	Give this user permission to use <code>sudo</code> (https://www.sudo.ws/). When using <code>sudo</code> , a user is prompted for their account <i>Password</i> .
Microsoft Account	checkbox	Set if the user is connecting from a Windows 8 or newer system or when using a Microsoft cloud service.

Note: Some fields cannot be changed for built-in users and are grayed out.

Table 6.3: Available Shells

Shell	Description
csh	C shell (https://en.wikipedia.org/wiki/C_shell)
sh	Bourne shell (https://en.wikipedia.org/wiki/Bourne_shell)
tcsh	Enhanced C shell (https://en.wikipedia.org/wiki/Tcsh)
bash	Bourne Again shell (https://en.wikipedia.org/wiki/Bash_%28Unix_shell%29)
ksh93	Korn shell (http://www.kornshell.com/)
mksh	mirBSD Korn shell (https://www.mirbsd.org/mksh.htm)
rbash	Restricted bash (http://www.gnu.org/software/bash/manual/html_node/The-Restricted-Shell.html)
rzsh	Restricted zsh (http://www.csse.uwa.edu.au/programming/linux/zsh-doc/zsh_14.html)

Continued on next page

Table 6.3 – continued from previous page

Shell	Description
scponly	Select scponly (https://github.com/scponly/scponly/wiki) to restrict the user's SSH usage to only the <code>scp</code> and <code>sftp</code> commands.
zsh	Z shell (http://www.zsh.org/)
git-shell	restricted git shell (https://git-scm.com/docs/git-shell)
nologin	Use when creating a system account or to create a user account that can authenticate with shares but which cannot login to the FreeNAS system using <code>ssh</code> .

Built-in user accounts needed by the system cannot be removed. A *Delete* button appears for custom users that were added by the system administrator. Clicking *Delete* opens a popup window to confirm the action and offer an option to keep the user primary group when the user is deleted.

SYSTEM

The System section of the web interface contains these entries:

- [General](#) (page 75) configures general settings such as HTTPS access, the language, and the timezone
- [NTP Servers](#) (page 78) adds, edits, and deletes Network Time Protocol servers
- [Boot](#) (page 80) creates, renames, and deletes boot environments. It also shows the condition of the Boot Pool.
- [Advanced](#) (page 83) configures advanced settings such as the serial console, swap space, and console messages
- [Email](#) (page 88) configures the email address to receive notifications
- [System Dataset](#) (page 90) configures the location where logs and reporting graphs are stored
- [Alert Services](#) (page 91) configures services used to notify the administrator about system events.
- [Alert Settings](#) (page 93) lists the available [Alert](#) (page 339) conditions and provides configuration of the notification frequency for each alert.
- [Cloud Credentials](#) (page 94) is used to enter connection credentials for remote cloud service providers
- [SSH Connections](#) (page 98) manages connecting to a remote system with SSH.
- [SSH Keypairs](#) (page 102) manages all private and public SSH key pairs.
- [Tunables](#) (page 102) provides a front-end for tuning in real-time and to load additional kernel modules at boot time
- [Update](#) (page 105) performs upgrades and checks for system updates
- [CAs](#) (page 110): import or create internal or intermediate CAs (Certificate Authorities)
- [Certificates](#) (page 113): import existing certificates, create self-signed certificates, or configure ACME certificates.
- [ACME DNS](#) (page 119): automate domain authentication for compatible CAs and certificates.
- [Support](#) (page 120): report a bug or request a new feature.

Each of these is described in more detail in this section.

7.1 General

System → *General* contains options for configuring the web interface and other basic system settings.

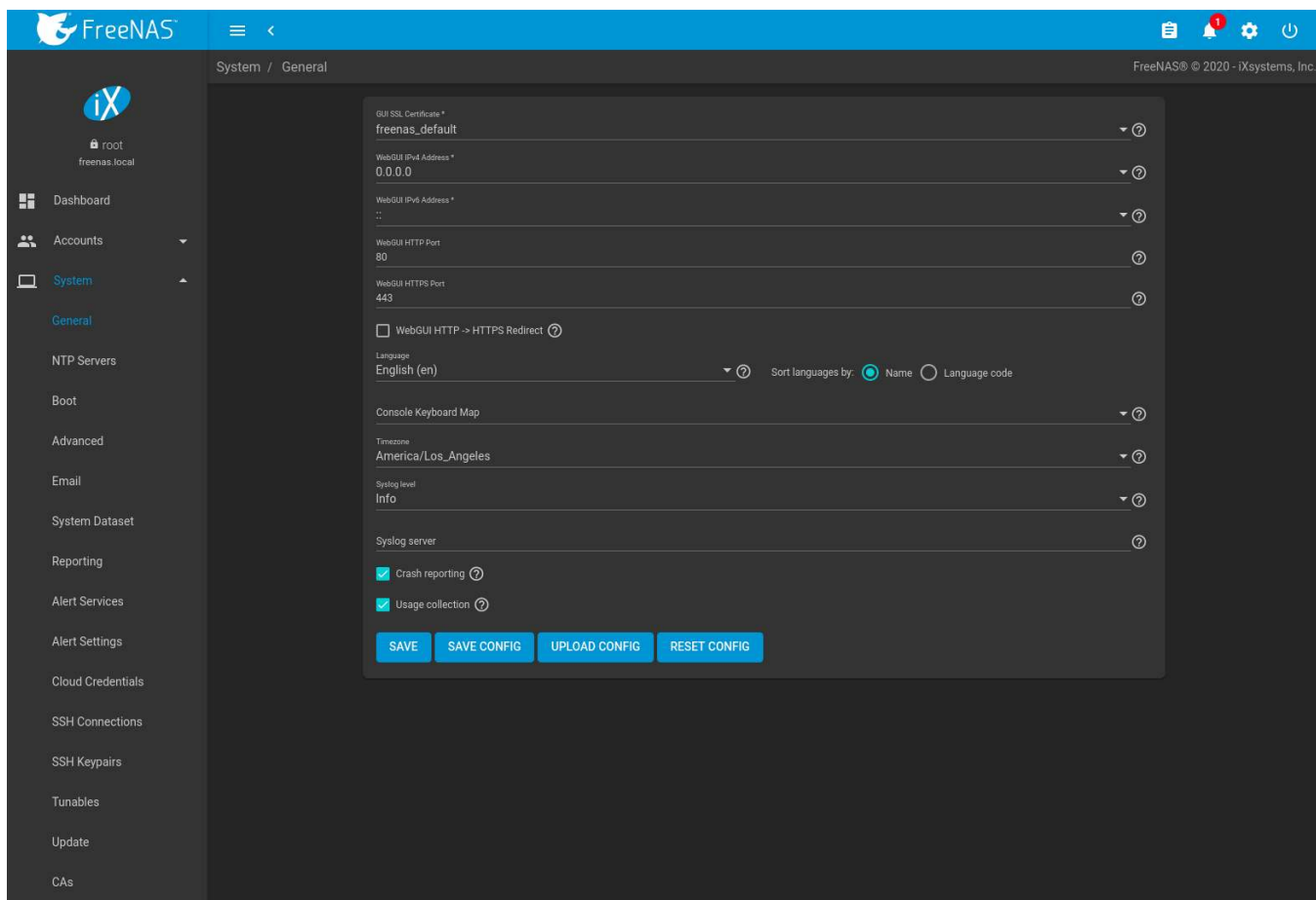


Fig. 7.1: General System Options

Table 7.1: General Configuration Settings

Setting	Value	Description
GUI SSL Certificate	drop-down menu	The system uses a self-signed certificate (page 113) to enable encrypted web interface connections. To change the default certificate, select a different created or imported certificate.
WebGUI IPv4 Address	drop-down menu	Choose a recent IP addresses to limit the usage when accessing the web interface. The built-in HTTP server binds to the wildcard address of <i>0.0.0.0</i> (any address) and issues an alert if the specified address becomes unavailable.
WebGUI IPv6 Address	drop-down menu	Choose a recent IPv6 addresses to limit the usage when accessing the web interface. The built-in HTTP server binds to the wildcard address of <i>0.0.0.0</i> (any address) and issues an alert if the specified address becomes unavailable.
WebGUI HTTP Port	integer	Allow configuring a non-standard port for accessing the web interface over HTTP. Changing this setting might require changing a Firefox configuration setting (https://www.redbrick.dcu.ie/~d_fens/articles/Firefox:_This_Address_is_Restricted).
WebGUI HTTPS Port	integer	Allow configuring a non-standard port to access the web interface over HTTPS.

Continued on next page

Table 7.1 – continued from previous page

Setting	Value	Description
WebGUI HTTP -> HTTPS Redirect	checkbox	Redirect <i>HTTP</i> connections to <i>HTTPS</i> . A <i>GUI SSL Certificate</i> is required for <i>HTTPS</i> . Activating this also sets the HTTP Strict Transport Security (HSTS) (https://en.wikipedia.org/wiki/HTTP_Strict_Transport_Security) maximum age to 31536000 seconds (one year). This means that after a browser connects to the FreeNAS® web interface for the first time, the browser continues to use <i>HTTPS</i> and renews this setting every year.
Language	combo box	Select a language from the drop-down menu. The list can be sorted by <i>Name</i> or Language code (https://en.wikipedia.org/wiki/List_of_ISO_639-1_codes). View the translated status of a language in the webui GitHub repository (https://github.com/freenas/webui/tree/master/src/assets/i18n). Refer to Contributing to FreeNAS® (page 346) for more information about assisting with translations.
Console Keyboard Map	drop-down menu	Select a keyboard layout.
Timezone	drop-down menu	Select a timezone.
Syslog level	drop-down menu	When <i>Syslog server</i> is defined, only logs matching this level are sent.
Syslog server	string	Remote syslog server DNS hostname or IP address. Nonstandard port numbers can be used by adding a colon and the port number to the hostname, like <code>mysyslogserver:1928</code> . Log entries are written to local logs and sent to the remote syslog server.
Crash reporting	checkbox	Send failed HTTP request data which can include client and server IP addresses, failed method call tracebacks, and middleware log file contents to iXsystems.
Usage Collection	checkbox	Enable sending anonymous usage statistics to iXsystems.

After making any changes, click **SAVE**. Changes to any of the *GUI* fields can interrupt web interface connectivity while the new settings are applied.

This screen also contains these buttons:

- **SAVE CONFIG**: save a backup copy of the current configuration database in the format *hostname-version-architecture* to the computer accessing the web interface. Saving the configuration after making any configuration changes is highly recommended. FreeNAS® automatically backs up the configuration database to the system dataset every morning at 3:45. However, this backup does not occur if the system is shut down at that time. If the system dataset is stored on the boot pool and the boot pool becomes unavailable, the backup will also not be available. The location of the system dataset can be viewed or set using *System* → *System Dataset*.

Note: [SSH](#) (page 274) keys are not stored in the configuration database and must be backed up separately. System host keys are files with names beginning with `ssh_host_` in `/usr/local/etc/ssh/`. The root user keys are stored in `/root/.ssh`.

There are two types of passwords. User account passwords for the base operating system are stored as hashed values, do not need to be encrypted to be secure, and are saved in the system configuration backup. Other passwords, like iSCSI CHAP passwords, Active Directory bind credentials, and cloud credentials are stored in an encrypted form to prevent them from being visible as plain text in the saved system configuration. The key or *seed* for this encryption is normally stored only on the operating system device. When *Save Config* is chosen, a dialog gives two options. *Export Password Secret Seed* includes passwords in the config-

uration file which allows the configuration file to be restored to a different operating system device where the decryption seed is not already present. Configuration backups containing the seed must be physically secured to prevent decryption of passwords and unauthorized access.

Warning: The *Export Password Secret Seed* option is off by default and should only be used when making a configuration backup that will be stored securely. After moving a configuration to new hardware, media containing a configuration backup with a decryption seed should be securely erased before reuse.

Export Pool Encryption Keys includes the encryption keys of encrypted pools in the configuration file. The encryption keys are restored if the configuration file is uploaded to the system using *UPLOAD CONFIG*.

- *UPLOAD CONFIG*: allows browsing to the location of a previously saved configuration file to restore that configuration.
- *RESET CONFIG*: reset the configuration database to the default base version. This does not delete user SSH keys or any other data stored in a user home directory. Since configuration changes stored in the configuration database are erased, this option is useful when a mistake has been made or to return a test system to the original configuration.

7.2 NTP Servers

The network time protocol (NTP) is used to synchronize the time on the computers in a network. Accurate time is necessary for the successful operation of time sensitive applications such as Active Directory or other directory services. By default, FreeNAS® is pre-configured to use three public NTP servers. If the network is using a directory service, ensure that the FreeNAS® system and the server running the directory service have been configured to use the same NTP servers.

Available NTP servers can be found at <https://support.ntp.org/bin/view/Servers/NTPPoolServers>. For time accuracy, choose NTP servers that are geographically close to the physical location of the FreeNAS® system.

Click *System* → *NTP Servers* and *ADD* to add an NTP server. [Figure 7.2](#) shows the configuration options. [Table 7.2](#) summarizes the options available when adding or editing an NTP server. [ntp.conf\(5\)](#) (<https://www.freebsd.org/cgi/man.cgi?query=ntp.conf>) explains these options in more detail.

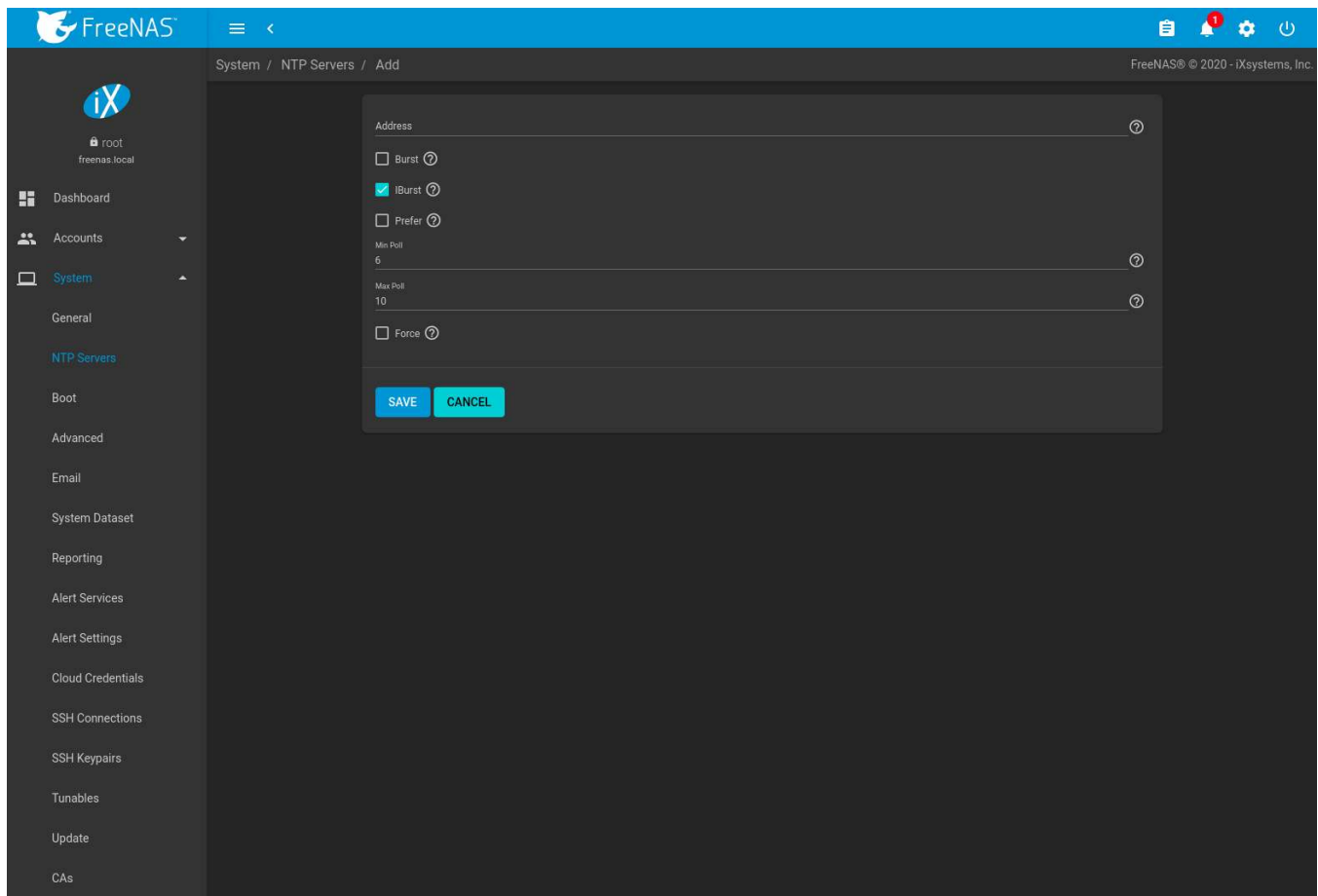


Fig. 7.2: Add an NTP Server

Table 7.2: NTP Servers Configuration Options

Setting	Value	Description
Address	string	Enter the hostname or IP address of the NTP server.
Burst	checkbox	Recommended when <i>Max. Poll</i> is greater than 10. Only use on personal servers. Do not use with a public NTP server.
IBurst	checkbox	Speed up the initial synchronization, taking seconds rather than minutes.
Prefer	checkbox	This option is only recommended for highly accurate NTP servers, such as those with time monitoring hardware.
Min Poll	integer	The minimum polling interval, in seconds, as a power of 2. For example, 6 means 2^6 , or 64 seconds. The default is 6, minimum value is 4.
Max Poll	integer	The maximum polling interval, in seconds, as a power of 2. For example, 10 means 2^{10} , or 1,024 seconds. The default is 10, maximum value is 17.
Force	checkbox	Force the addition of the NTP server, even if it is currently unreachable.

7.3 Boot

FreeNAS® supports a ZFS feature known as multiple boot environments. With multiple boot environments, the process of updating the operating system becomes a low-risk operation. The updater automatically creates a snapshot of the current boot environment and adds it to the boot menu before applying the update.

If an update fails, reboot the system and select the previous boot environment, using the instructions in *If Something Goes Wrong* (page 38), to instruct the system to go back to that system state.

Note: Boot environments are separate from the configuration database. Boot environments are a snapshot of the *operating system* at a specified time. When a FreeNAS® system boots, it loads the specified boot environment, or operating system, then reads the configuration database to load the current configuration values. If the intent is to make configuration changes rather than operating system changes, make a backup of the configuration database first using the instructions in *System -> General* (page 75).


The example shown in [Figure 7.3](#), includes the two boot environments that are created when FreeNAS® is installed. The *Initial-Install* boot environment can be booted into if the system needs to be returned to a non-configured version of the installation.


Name	Active	Created	Space	Keep
default	-	12/9/2019 1:44 AM	6.52 MiB	
Initial-Install	-	12/9/2019 1:48 AM	6.17 MiB	
11.3-MASTER-201912190956	-	12/19/2019 1:08 AM	1.24 GiB	no
11.3-MASTER-201912200956	-	12/20/2019 6:28 AM	1.24 GiB	no
11.3-MASTER-201912220956	-	12/23/2019 1:13 AM	1.24 GiB	no
11.3-MASTER-201912252040	-	12/25/2019 11:04 PM	1.24 GiB	no
11.3-MASTER-201912261819	-	12/26/2019 11:24 PM	1.24 GiB	no
11.3-MASTER-201912270956	-	12/27/2019 1:11 AM	1.24 GiB	no
11.3-MASTER-202001020955	-	1/2/2020 12:19 AM	1.24 GiB	no
11.3-RC2	Now/Reboot	1/3/2020 1:07 AM	1.24 GiB	no

Fig. 7.3: Viewing Boot Environments

Each boot environment entry contains this information:

- **Name:** the name of the boot entry as it will appear in the boot menu. Alphanumeric characters, dashes (-), underscores (_), and periods (.) are allowed.
- **Active:** indicates which entry will boot by default if the user does not select another entry in the boot menu.

- **Created:** indicates the date and time the boot entry was created.
- **Space:** displays the size of the boot environment.
- **Keep:** indicates whether or not this boot environment can be pruned if an update does not have enough space to proceed. Click  (Options) and *Keep* for an entry if that boot environment should not be automatically pruned.

Click  (Options) on an entry to access actions specific to that entry:

- **Activate:** only appears on entries which are not currently set to *Active*. Changes the selected entry to the default boot entry on next boot. The status changes to *Reboot* and the current *Active* entry changes from *Now/Reboot* to *Now*, indicating that it was used on the last boot but will not be used on the next boot.
- **Clone:** makes a new boot environment from the selected boot environment. When prompted for the name of the clone, alphanumeric characters, dashes (-), underscores (_), and periods (.) are allowed.
- **Rename:** used to change the name of the boot environment. Alphanumeric characters, dashes (-), underscores (_), and periods (.) are allowed.
- **Delete:** used to delete the highlighted entry, which also removes that entry from the boot menu. Since an activated entry cannot be deleted, this button does not appear for the active boot environment. To delete an entry that is currently activated, first activate another entry. Note that this button does not appear for the *default* boot environment as this entry is needed to return the system to the original installation state.
- **Keep:** used to toggle whether or not the updater can prune (automatically delete) this boot environment if there is not enough space to proceed with the update.

Click **ACTIONS** to:

- **Add:** make a new boot environment from the active environment. The active boot environment contains the text *Now/Reboot* in the *Active* column. Only alphanumeric characters, underscores, and dashes are allowed in the *Name*.
- **Stats/Settings:** display statistics for the operating system device: condition, total and used size, and date and time of the last scrub. By default, the operating system device is scrubbed every 7 days. To change the default, input a different number in the *Automatic scrub interval (in days)* field and click **UPDATE INTERVAL**.
- **Boot Pool Status:** display the status of each device in the operating system device, including any read, write, or checksum errors.
- **Scrub Boot Pool:** perform a manual scrub of the operating system device.

7.3.1 Operating System Device Mirroring

System → *Boot* → *Boot Pool Status* is used to manage the devices comprising the operating system device. An example is seen in [Figure 7.4](#).

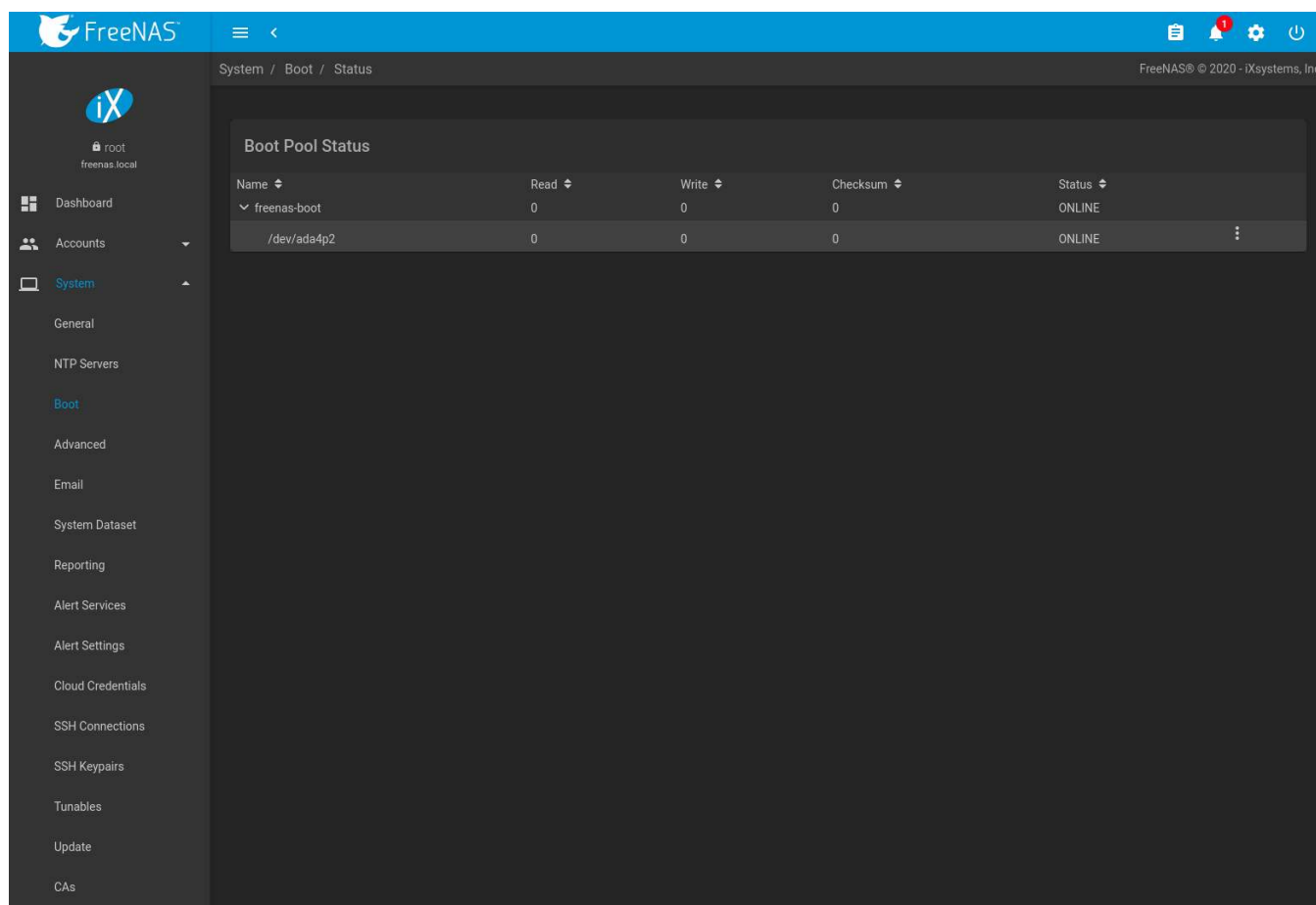



Fig. 7.4: Viewing the Status of the Operating System Device

FreeNAS® supports 2-device mirrors for the operating system device. In a mirrored configuration, a failed device can be detached and replaced.

An additional device can be attached to an existing one-device operating system device, with these caveats:

- The new device must have at least the same capacity as the existing device. Larger capacity devices can be added, but the mirror will only have the capacity of the smallest device. Different models of devices which advertise the same nominal size are not necessarily the same actual size. For this reason, adding another device of the same model of is recommended.
- It is **strongly recommended** to use SSDs rather than USB devices when creating a mirrored operating system device.

Click  (Options) on a device entry to access actions specific to that device:

- **Attach:** use to add a second device to create a mirrored operating system device. If another device is available, it appears in the *Member disk* drop-down menu. Select the desired device. The *Use all disk space* option controls the capacity made available to the operating system device. By default, the new device is partitioned to the same size as the existing device. When *Use all disk space* is enabled, the entire capacity of the new device is used. If the original operating system device fails and is detached, the boot mirror will consist of just the newer drive, and will grow to whatever capacity it provides. However, new devices added to this mirror must now be as large as the new capacity. Click *SAVE* to attach the new disk to the mirror.
- **Detach:** remove the failed device from the mirror so that it can be replaced.
- **Replace:** once the failed device has been detached, select the new replacement device from the *Member disk* drop-down menu to rebuild the mirror.

7.4 Advanced

System → Advanced is shown in Figure 7.5. The configurable settings are summarized in Table 7.3.

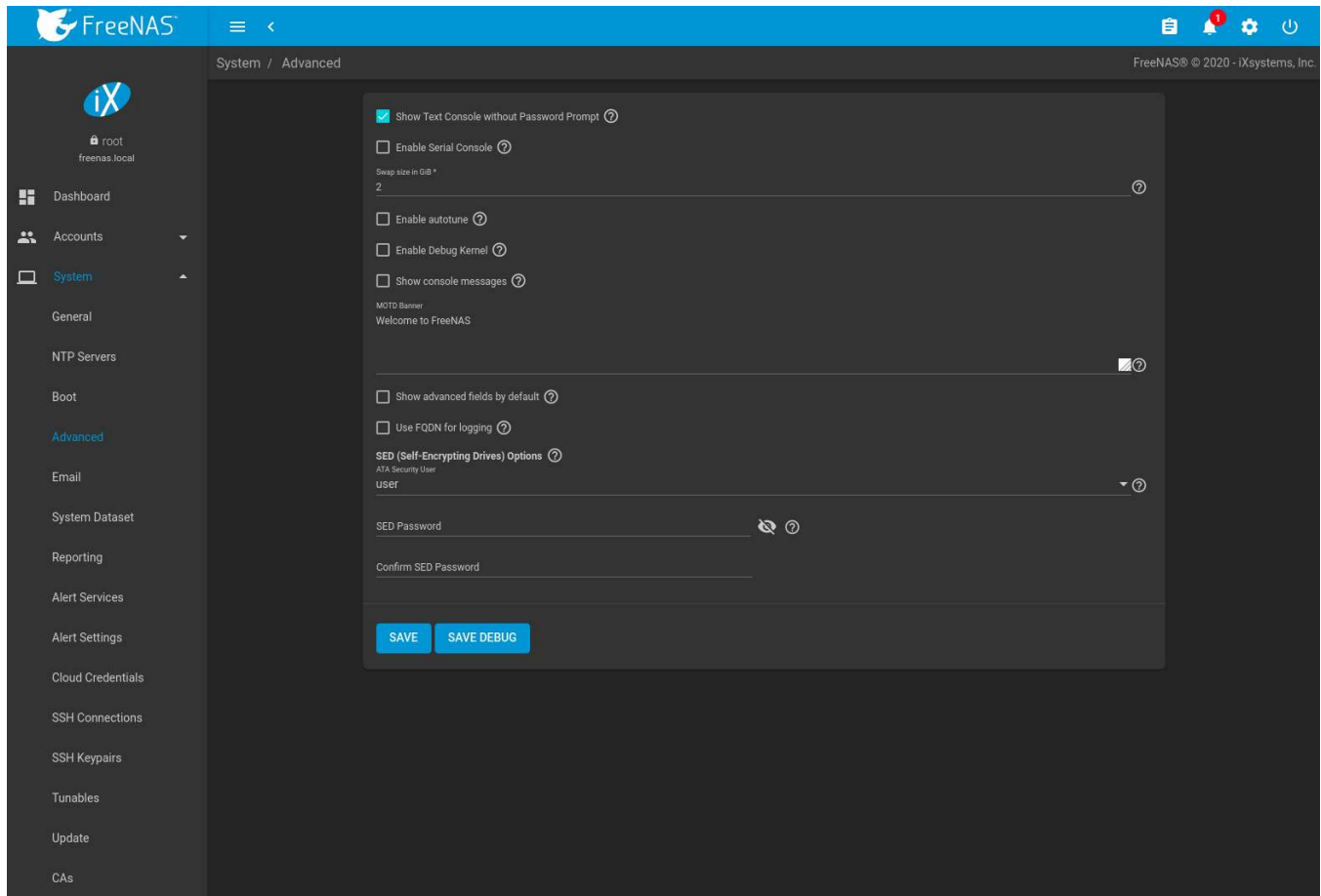


Fig. 7.5: Advanced Screen

Table 7.3: Advanced Configuration Settings

Setting	Value	Description
Show Text Console without Password Prompt	checkbox	Set for the text console to be available without entering a password.
Enable Serial Console	checkbox	Do not enable this option if the serial port is disabled. Adds the <i>Serial Port</i> and <i>Serial Speed</i> fields.
Serial Port	string	Select the serial port address in hex.
Serial Speed	drop-down menu	Select the speed in bps used by the serial port.
Swap size in GiB	non-zero number	By default, all data disks are created with this amount of swap. This setting does not affect log or cache devices as they are created without swap. Setting to 0 disables swap creation completely. This is <i>strongly</i> discouraged.
Enable autotune	checkbox	Enable the <i>Autotune</i> (page 84) script which attempts to optimize the system based on the installed hardware. <i>Warning:</i> Autotuning is only used as a temporary measure and is not a permanent fix for system hardware issues.

Continued on next page

Table 7.3 – continued from previous page

Setting	Value	Description
Enable Debug Kernel	checkbox	Use a debug version of the kernel on the next boot.
Show console messages	checkbox	Display console messages from <code>/var/log/console.log</code> in real time at bottom of browser window. Click the console to bring up a scrollable screen. Set the <i>Stop refresh</i> option in the scrollable screen to pause updates. Unset to continue watching messages as they occur. When this option is set, a button to show the console log appears on busy spinner dialogs.
MOTD banner	string	This message is shown when a user logs in with SSH.
Show advanced fields by default	checkbox	Show <i>Advanced Mode</i> fields by default.
Use FQDN for logging	checkbox	Include the Fully-Qualified Domain Name (FQDN) in logs to precisely identify systems with similar hostnames.
ATA Security User	drop-down menu	User passed to <code>camcontrol security -u</code> for unlocking SEDs. Values are <i>User</i> or <i>Master</i> .
SED Password	string	Global password used to unlock <i>Self-Encrypting Drives</i> (page 84).
Reset SED Password	checkbox	Select to clear the <i>Password for SED</i> column of <i>Storage</i> → <i>Disks</i> .

Click the **SAVE** button after making any changes.

This tab also contains this button:

SAVE DEBUG: used to generate text files that contain diagnostic information. After the debug data is collected, the system prompts for a location to save the compressed .tgz file.

7.4.1 Autotune

FreeNAS® provides an autotune script which optimizes the system depending on the installed hardware. For example, if a pool exists on a system with limited RAM, the autotune script automatically adjusts some ZFS sysctl values in an attempt to minimize memory starvation issues. It should only be used as a temporary measure on a system that hangs until the underlying hardware issue is addressed by adding more RAM. Autotune will always slow such a system, as it caps the ARC.

The *Enable autotune* option in *System* → *Advanced* is off by default. Enable this option to run the autotuner at boot. To run the script immediately, reboot the system.

If the autotune script adjusts any settings, the changed values appear in *System* → *Tunables*. Note that deleting tunables that were created by autotune only affects the current session, as autotune-set tunables are recreated at boot. This means that any autotune-set value that is manually changed will revert back to the value set by autotune on reboot. To permanently change a value set by autotune, change the description of the tunable. For example, changing the description to *manual override* prevents autotune from reverting that tunable back to the autotune default value.

When attempting to increase the performance of the FreeNAS® system, and particularly when the current hardware may be limiting performance, try enabling autotune.

For those who wish to see which checks are performed, the autotune script is located in `/usr/local/bin/autotune`.

7.4.2 Self-Encrypting Drives

FreeNAS® version 11.1-U5 introduced Self-Encrypting Drive (SED) support.

These SED specifications are supported:

- Legacy interface for older ATA devices. **Not recommended for security-critical environments**

- **TCG Opal 1** (https://trustedcomputinggroup.org/wp-content/uploads/Opal_SSC_1.00_rev3.00-Final.pdf) legacy specification
- **TCG OPAL 2** (https://trustedcomputinggroup.org/wp-content/uploads/TCG_Storage-Opal_SSC_v2.01_rev1.00.pdf) standard for newer consumer-grade devices
- **TCG Opalite** (https://trustedcomputinggroup.org/wp-content/uploads/TCG_Storage-Opalite_SSC_FAQ.pdf) is a reduced form of OPAL 2
- TCG Pyrite **Version 1** (https://trustedcomputinggroup.org/wp-content/uploads/TCG_Storage-Pyrite_SSC_v1.00_r1.00.pdf) and **Version 2** (https://trustedcomputinggroup.org/wp-content/uploads/TCG_Storage-Pyrite_SSC_v2.00_r1.00_PUB.pdf) are similar to Opalite, but hardware encryption is removed. Pyrite provides a logical equivalent of the legacy ATA security for non-ATA devices. Only the drive firmware is used to protect the device.

Danger: Pyrite Version 1 SEDs do not have PSID support and **can become unusable if the password is lost.**

- **TCG Enterprise** (https://trustedcomputinggroup.org/wp-content/uploads/TCG_Storage-SSC_Enterprise-v1.01_r1.00.pdf) is designed for systems with many data disks. These SEDs do not have the functionality to be unlocked before the operating system boots.

See this Trusted Computing Group® and NVM Express® [joint white paper](https://nvmexpress.org/wp-content/uploads/TCGandNVMe_Joint_White_Paper-TCG_Storage_Opal_and_NVMe_FINAL.pdf) (https://nvmexpress.org/wp-content/uploads/TCGandNVMe_Joint_White_Paper-TCG_Storage_Opal_and_NVMe_FINAL.pdf) for more details about these specifications.

FreeNAS® implements the security capabilities of [camcontrol](https://www.freebsd.org/cgi/man.cgi?query=camcontrol) (<https://www.freebsd.org/cgi/man.cgi?query=camcontrol>) for legacy devices and [sedutil-cli](https://www.mankier.com/8/sedutil-cli) (<https://www.mankier.com/8/sedutil-cli>) for TCG devices. When managing a SED from the command line, it is recommended to use the `sedhelper` wrapper script for `sedutil-cli` to ease SED administration and unlock the full capabilities of the device. Examples of using these commands to identify and deploy SEDs are provided below.

A SED can be configured before or after assigning the device to a [pool](#) (page 164).

By default, SEDs are not locked until the administrator takes ownership of them. Ownership is taken by explicitly configuring a global or per-device password in the FreeNAS® web interface and adding the password to the SEDs. Adding SED passwords to FreeNAS® also allows FreeNAS® to automatically unlock SEDs.

A password-protected SED protects the data stored on the device when the device is physically removed from the FreeNAS® system. This allows secure disposal of the device without having to first wipe the contents. Repurposing a SED on another system requires the SED password.

7.4.2.1 Deploying SEDs

Run `sedutil-cli --scan` in the [Shell](#) (page 335) to detect and list devices. The second column of the results identifies the drive type:

- **no** indicates a non-SED device
- **1** indicates a legacy TCG OPAL 1 device
- **2** indicates a modern TCG OPAL 2 device
- **L** indicates a TCG Opalite device
- **p** indicates a TCG Pyrite 1 device
- **P** indicates a TCG Pyrite 2 device
- **E** indicates a TCG Enterprise device

Example:

```

root@truenas1:~ # sedutil-cli --scan
Scanning for Opal compliant disks
/dev/ada0  No   32GB SATA Flash Drive SFDK003L
/dev/ada1  No   32GB SATA Flash Drive SFDK003L
/dev/da0   No   HGST      HUS726020AL4210  A7J0
/dev/da1   No   HGST      HUS726020AL4210  A7J0
/dev/da10  E    WDC       WUSTR1519ASS201  B925
/dev/da11  E    WDC       WUSTR1519ASS201  B925

```

FreeNAS® supports setting a global password for all detected SEDs or setting individual passwords for each SED. Using a global password for all SEDs is strongly recommended to simplify deployment and avoid maintaining separate passwords for each SED.

Setting a global password for SEDs

Go to *System* → *Advanced* → *SED Password* and enter the password. **Record this password and store it in a safe place!**

Now the SEDs must be configured with this password. Go to the [Shell](#) (page 335) and enter `sedhelper setup password`, where *password* is the global password entered in *System* → *Advanced* → *SED Password*.

`sedhelper` ensures that all detected SEDs are properly configured to use the provided password:

```

root@truenas1:~ # sedhelper setup abcd1234
da9                [OK]
da10               [OK]
da11               [OK]

```

Rerun `sedhelper setup password` every time a new SED is placed in the system to apply the global password to the new SED.

Creating separate passwords for each SED

Go to *Storage* → *Disks*. Click **:** (Options) for the confirmed SED, then *Edit*. Enter and confirm the password in the *SED Password* and *Confirm SED Password* fields.

The *Storage* → *Disks* screen shows which disks have a configured SED password. The *SED Password* column shows a mark when the disk has a password. Disks that are not a SED or are unlocked using the global password are not marked in this column.

The SED must be configured to use the new password. Go to the [Shell](#) (page 335) and enter `sedhelper setup -disk da1 password`, where *da1* is the SED to configure and *password* is the created password from *Storage* → *Disks* → *Edit Disks* → *SED Password*.

This process must be repeated for each SED and any SEDs added to the system in the future.

Danger: Remember SED passwords! If the SED password is lost, SEDs cannot be unlocked and their data is unavailable. Always record SED passwords whenever they are configured or modified and store them in a secure place!

7.4.2.2 Check SED Functionality

When SED devices are detected during system boot, FreeNAS® checks for configured global and device-specific passwords.

Unlocking SEDs allows a pool to contain a mix of SED and non-SED devices. Devices with individual passwords are unlocked with their password. Devices without a device-specific password are unlocked using the global password.

To verify SED locking is working correctly, go to the [Shell](#) (page 335). Enter `sedutil-cli --listLockingRange 0 password dev/da1`, where *da1* is the SED and *password* is the global or individual password for that SED. The command returns `ReadLockEnabled: 1, WriteLockEnabled: 1, and LockOnReset: 1` for drives with locking enabled:

```
root@truenas1:~ # sedutil-cli --listLockingRange 0 abcd1234 /dev/da9
Band[0]:
  Name:           Global_Range
  CommonName:     Locking
  RangeStart:     0
  RangeLength:    0
  ReadLockEnabled: 1
  WriteLockEnabled: 1
  ReadLocked:     0
  WriteLocked:    0
  LockOnReset:    1
```

7.4.2.3 Managing SED Passwords and Data

This section contains command line instructions to manage SED passwords and data. The command used is [sedutil-cli\(8\)](https://www.mankier.com/8/sedutil-cli) (<https://www.mankier.com/8/sedutil-cli>). Most SEDs are TCG-E (Enterprise) or TCG-Opal ([Opal v2.0](https://trustedcomputinggroup.org/wp-content/uploads/TCG_Storage-Opal_SSC_v2.01_rev1.00.pdf) (https://trustedcomputinggroup.org/wp-content/uploads/TCG_Storage-Opal_SSC_v2.01_rev1.00.pdf)). Commands are different for the different drive types, so the first step is identifying which type is being used.

Warning: These commands can be destructive to data and passwords. Keep backups and use the commands with caution.

Check SED version on a single drive, `/dev/da0` in this example:

```
root@truenas:~ # sedutil-cli --isValidSED /dev/da0
/dev/da0 SED --E--- Micron_5N/A U402
```

All connected disks can be checked at once:

```
root@truenas:~ # sedutil-cli --scan
Scanning for Opal compliant disks
/dev/ada0 No 32GB SATA Flash Drive SFDK003L
/dev/ada1 No 32GB SATA Flash Drive SFDK003L
/dev/da0 E Micron_5N/A U402
/dev/da1 E Micron_5N/A U402
/dev/da12 E SEAGATE XS3840TE70014 0103
/dev/da13 E SEAGATE XS3840TE70014 0103
/dev/da14 E SEAGATE XS3840TE70014 0103
/dev/da2 E Micron_5N/A U402
/dev/da3 E Micron_5N/A U402
/dev/da4 E Micron_5N/A U402
/dev/da5 E Micron_5N/A U402
/dev/da6 E Micron_5N/A U402
/dev/da9 E Micron_5N/A U402
No more disks present ending scan
root@truenas:~ #
```

TCG-Opal Instructions

Reset the password without losing data: `sedutil-cli --revertNoErase oldpassword /dev/device`

Use **both** of these commands to change the password without destroying data:

```
sedutil-cli --setSIDPassword oldpassword newpassword /dev/device
sedutil-cli --setPassword oldpassword Admin1 newpassword /dev/device
```

Wipe data and reset password to default MSID: `sedutil-cli --revertPer oldpassword /dev/device`

Wipe data and reset password using the PSID: `sedutil-cli --yesIreallywanttoERASEALLmydatausingthePSID PSINODASHED /dev/device` where *PSINODASHED* is the PSID located on the physical drive with no dashes (-).

TCG-E Instructions

Use **all** of these commands to reset the password without losing data:

```
sedutil-cli --setSIDPassword oldpassword "" /dev/device
sedutil-cli --setPassword oldpassword EraseMaster "" /dev/device
sedutil-cli --setPassword oldpassword BandMaster0 "" /dev/device
sedutil-cli --setPassword oldpassword BandMaster1 "" /dev/device
```

Use **all** of these commands to change the password without destroying data:

```
sedutil-cli --setSIDPassword oldpassword newpassword /dev/device
sedutil-cli --setPassword oldpassword EraseMaster newpassword /dev/device
sedutil-cli --setPassword oldpassword BandMaster0 newpassword /dev/device
sedutil-cli --setPassword oldpassword BandMaster1 newpassword /dev/device
```

Wipe data and reset password to default MSID:

```
sedutil-cli --eraseLockingRange 0 password /dev/<device>
sedutil-cli --setSIDPassword oldpassword "" /dev/<device>
sedutil-cli --setPassword oldpassword EraseMaster "" /dev/<device>
```

Wipe data and reset password using the PSID: `sedutil-cli --yesIreallywanttoERASEALLmydatausingthePSID PSINODASHED /dev/device` where *PSINODASHED* is the PSID located on the physical drive with no dashes (-).

7.5 Email

An automatic script sends a nightly email to the *root* user account containing important information such as the health of the disks. [Alert](#) (page 339) events are also emailed to the *root* user account. Problems with [Scrub Tasks](#) (page 144) are reported separately in an email sent at 03:00AM.

Note: [S.M.A.R.T.](#) (page 268) reports are mailed separately to the address configured in that service.

The administrator typically does not read email directly on the FreeNAS® system. Instead, these emails are usually sent to an external email address where they can be read more conveniently. It is important to configure the system so it can send these emails to the administrator's remote email account so they are aware of problems or status changes.

The first step is to set the remote address where email will be sent. Go to *Accounts* → *Users*, click **:** (Options) and *Edit* for the *root* user. In the *Email* field, enter the email address on the remote system where email is to be sent, like *admin@example.com*. Click *SAVE* to save the settings.

Additional configuration is performed with *System* → *Email*, shown in Figure 7.6.

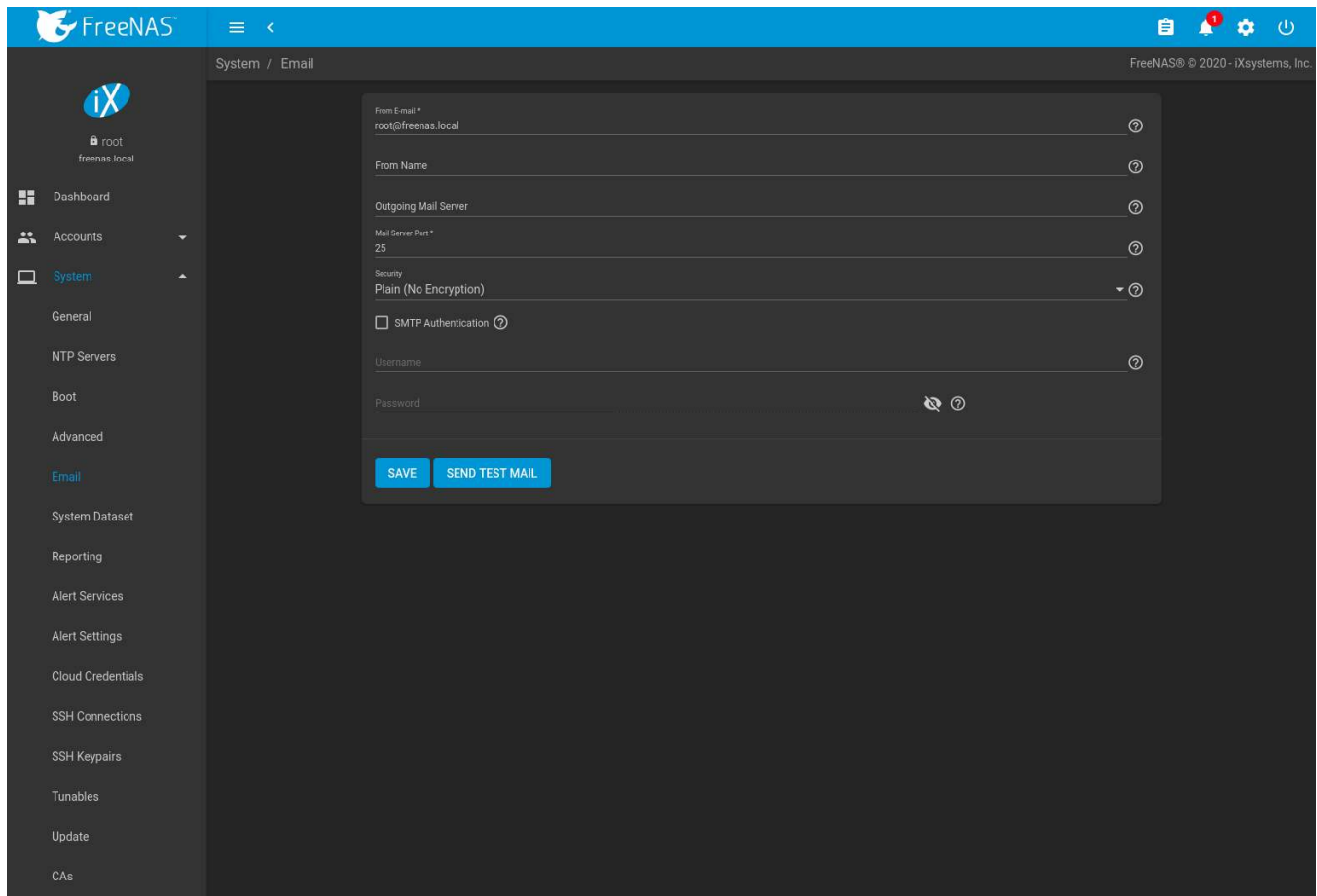


Fig. 7.6: Email Screen

Table 7.4: Email Configuration Settings

Setting	Value	Description
From E-mail	string	The envelope From address shown in the email. This can be set to make filtering mail on the receiving system easier.
From Name	string	The friendly name to show in front of the sending email address.
Outgoing Mail Server	string or IP address	Hostname or IP address of SMTP server used for sending this email.
Mail Server Port	integer	SMTP port number. Typically 25, 465 (secure SMTP), or 587 (submission).
Security	drop-down menu	Choose an encryption type. Choices are <i>Plain (No Encryption)</i> , <i>SSL (Implicit TLS)</i> , or <i>TLS (STARTTLS)</i> .
SMTP Authentication	checkbox	Enable or disable SMTP AUTH (https://en.wikipedia.org/wiki/SMTP_AUTH) using PLAIN SASL. Setting this enables the required <i>Username</i> and optional <i>Password</i> fields.
Username	string	Enter the SMTP username when the SMTP server requires authentication.

Continued on next page

Table 7.4 – continued from previous page

Setting	Value	Description
Password	string	Enter the SMTP account password if needed for authentication. Only plain text characters (7-bit ASCII) are allowed in passwords. UTF or composed characters are not allowed.

Click the *SEND TEST MAIL* button to verify that the configured email settings are working. If the test email fails, double-check that the *Email* field of the *root* user is correctly configured by clicking the *Edit* button for the *root* account in *Accounts* → *Users*.

Configuring email for TLS/SSL email providers is described in [Are you having trouble getting FreeNAS to email you in Gmail?](https://forums.freenas.org/index.php?threads/are-you-having-trouble-getting-freenas-to-email-you-in-gmail.22517/) (<https://forums.freenas.org/index.php?threads/are-you-having-trouble-getting-freenas-to-email-you-in-gmail.22517/>).

7.6 System Dataset

System → *System Dataset*, shown in [Figure 7.7](#), is used to select the pool which contains the persistent system dataset. The system dataset stores debugging core files, [encryption keys](#) (page 169) for encrypted pools, and Samba4 metadata such as the user/group cache and share level permissions.

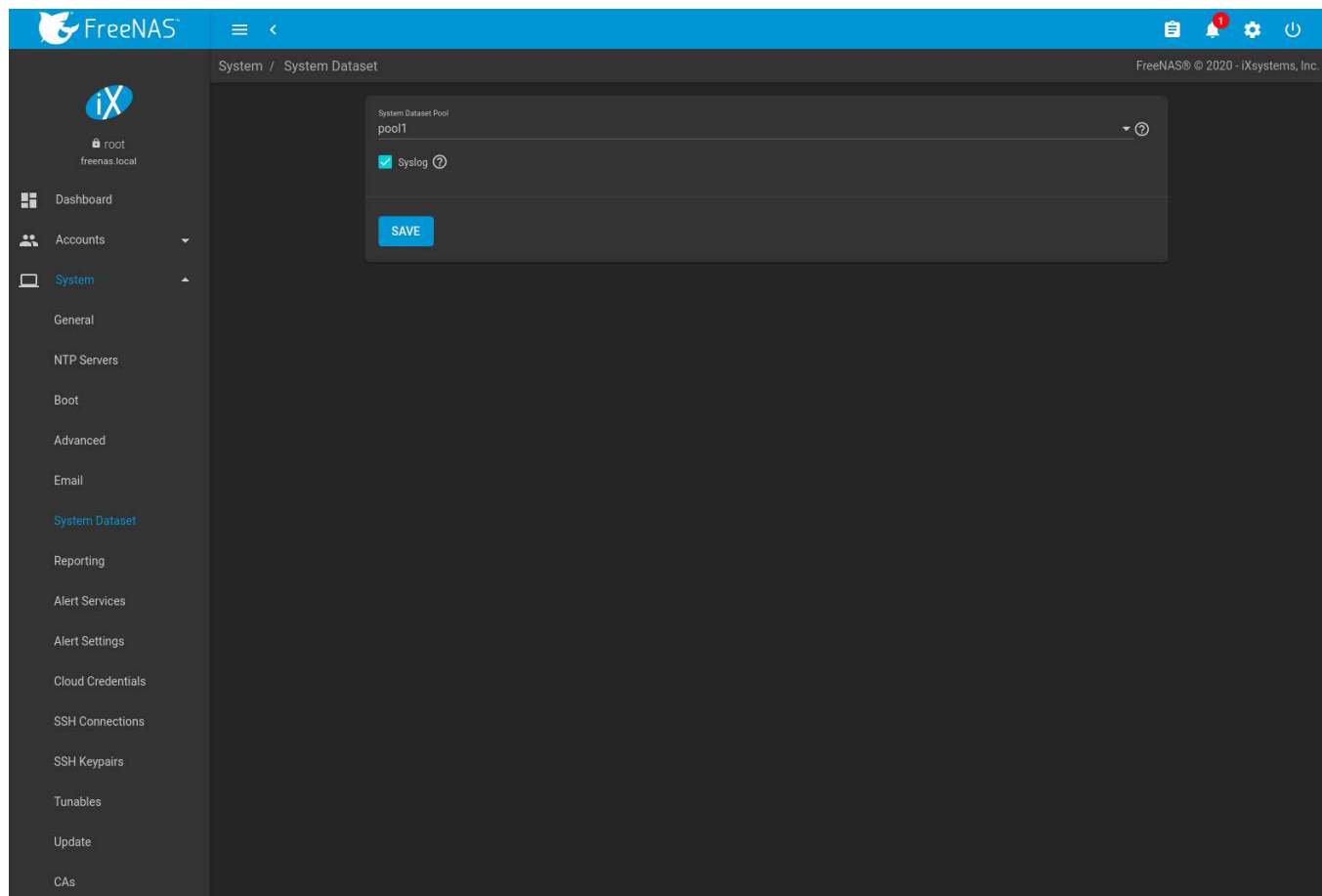


Fig. 7.7: System Dataset Screen

Use the *System Dataset Pool* drop-down menu to select the volume (pool) to contain the system dataset. The system dataset can be moved to unencrypted volumes (pools) or encrypted volumes which do not have passphrases. If the system dataset is moved to an encrypted volume, that volume is no longer allowed to be locked or have a passphrase set.

Moving the system dataset also requires restarting the [SMB](#) (page 270) service. A dialog warns that the SMB service must be restarted, causing a temporary outage of any active SMB connections.

System logs can also be stored on the system dataset. Storing this information on the system dataset is recommended when large amounts of data is being generated and the system has limited memory or a limited capacity operating system device.

Set `Syslog` to store system logs on the system dataset. Leave unset to store system logs in `/var` on the operating system device.

Click **SAVE** to save changes.

If the pool storing the system dataset is changed at a later time, FreeNAS® migrates the existing data in the system dataset to the new location.

Note: Depending on configuration, the system dataset can occupy a large amount of space and receive frequent writes. Do not put the system dataset on a flash drive or other media with limited space or write life.

7.7 Reporting

This section contains settings to customize some of the reporting tools. These settings are described in [Table 7.5](#)

Table 7.5: Reporting Settings

Setting	Value	Description
Report CPU usage in percent	checkbox	Report CPU usage in percent instead of units of kernel time.
Remote Graphite Server Host-name	string	Hostname or IP address of a remote Graphite (http://graphiteapp.org/) server.
Graph Age in Months	integer	Maximum time a graph is stored in months (allowed values are 1 - 60). Changing this value causes the <i>Confirm RRD Destroy</i> dialog to appear. Changes do not take effect until the existing reporting database is destroyed.
Number of Graph Points	integer	Number of points for each hourly, daily, weekly, monthly, or yearly graph (allowed values are 1 - 4096). Changing this value causes the <i>Confirm RRD Destroy</i> checkbox to appear. Changes do not take effect until the existing reporting database is destroyed.

Changes to [Reporting settings](#) (page 91) clear the report history. To keep history with the old settings, cancel the warning dialog. Click **RESET TO DEFAULTS** to restore the original settings.

7.8 Alert Services

FreeNAS® can use a number of methods to notify the administrator of system events that require attention. These events are system [Alerts](#) (page 339).

Available alert services:

- [AWS-SNS](https://aws.amazon.com/sns/) (<https://aws.amazon.com/sns/>)
- E-mail
- [InfluxDB](https://www.influxdata.com/) (<https://www.influxdata.com/>)
- [Mattermost](https://about.mattermost.com/) (<https://about.mattermost.com/>)

- [OpsGenie](https://www.opsgenie.com/) (<https://www.opsgenie.com/>)
- [PagerDuty](https://www.pagerduty.com/) (<https://www.pagerduty.com/>)
- [Slack](https://slack.com/) (<https://slack.com/>)
- [SNMP Trap](http://www.dpstele.com/snmp/trap-basics.php) (<http://www.dpstele.com/snmp/trap-basics.php>)
- [VictorOps](https://victorops.com/) (<https://victorops.com/>)

Warning: These alert services might use a third party commercial vendor not directly affiliated with iXsystems. Please investigate and fully understand that vendor's pricing policies and services before using their alert service. iXsystems is not responsible for any charges incurred from the use of third party vendors with the Alert Services feature.

Select *System* → *Alert Services* to show the Alert Services screen, [Figure 7.8](#).

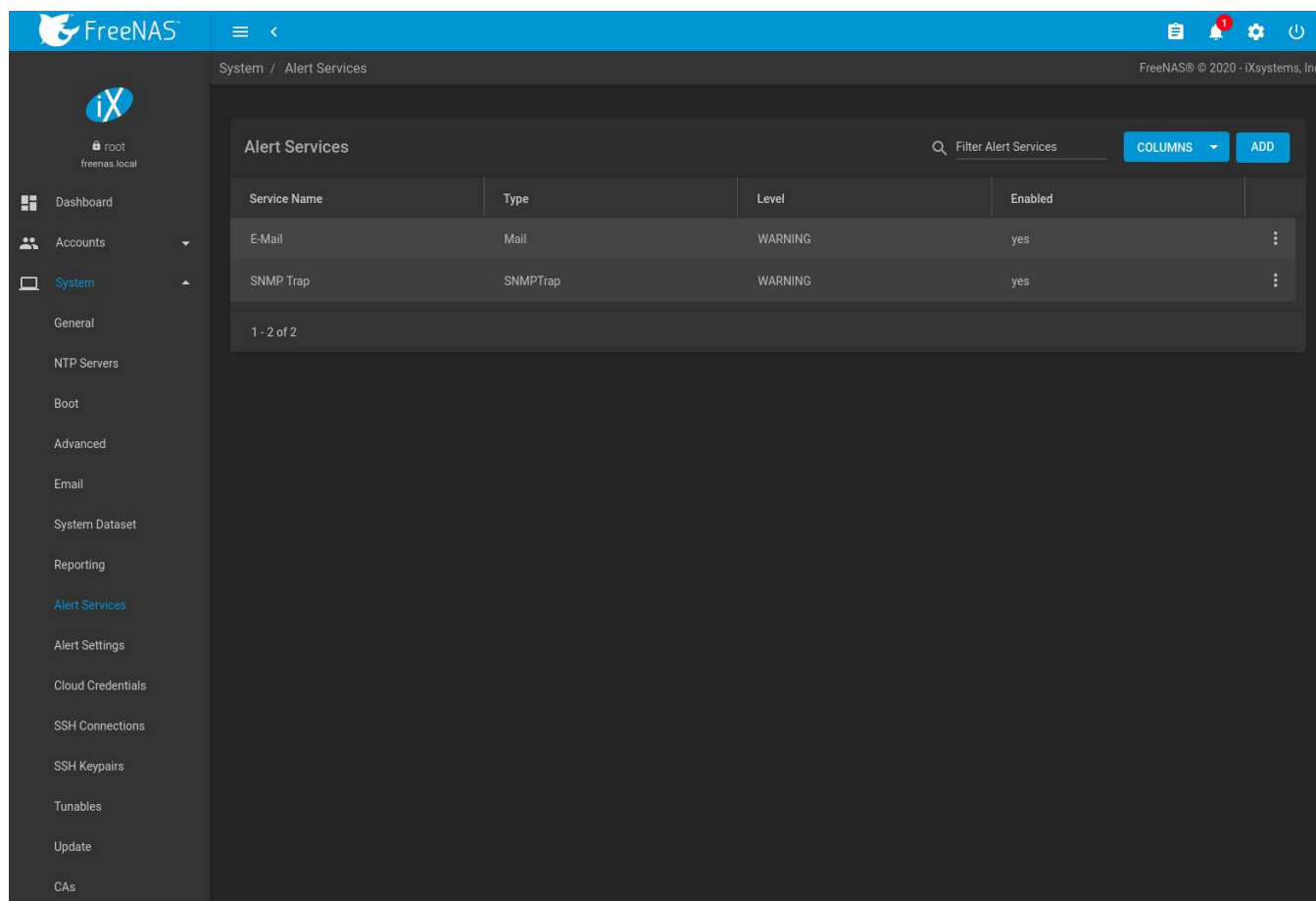


Fig. 7.8: Alert Services

Click *ADD* to display the *Add Alert Service* form, [Figure 7.9](#).

The screenshot shows the FreeNAS web interface with the 'Add Alert Service' form. The left sidebar contains navigation links: Dashboard, Accounts, System (selected), General, NTP Servers, Boot, Advanced, Email, System Dataset, Reporting, Alert Services (highlighted), Alert Settings, Cloud Credentials, SSH Connections, SSH Keypairs, Tunables, Update, and CAs. The main content area shows the 'Add Alert Service' form with the following fields:

- Name *
- ☒ Enabled ⓘ
- Type: AWS SNS ⓘ
- Level: Warning ⓘ
- AWS Region * ⓘ
- ARN * ⓘ
- Key ID * ⓘ
- Secret Key * ⓘ

At the bottom of the form are three buttons: SAVE, CANCEL, and SEND TEST ALERT.

Fig. 7.9: Add Alert Service

Select the *Type* to choose an alert service to configure.

Alert services can be set for a particular severity *Level*. All alerts of that level are then sent out with that alert service. For example, if the *E-Mail* alert service *Level* is set to *Info*, any *Info* level alerts are sent by that service. Multiple alert services can be set to the same level. For instance, *Critical* alerts can be sent both by email and PagerDuty by setting both alert services to the *Critical* level.

The configurable fields and required information differ for each alert service. Set *Enabled* to activate the service. Enter any other required information and click *SAVE*.

Click *SEND TEST ALERT* to test the chosen alert service.

All saved alert services are displayed in *System* → *Alert Services*. To delete an alert service, click ⓘ (Options) and *Delete*. To disable an alert service temporarily, click ⓘ (Options) and *Edit*, then unset the *Enabled* option.

7.9 Alert Settings

System → *Alert Settings* has options to configure each FreeNAS® *Alert* (page 339).

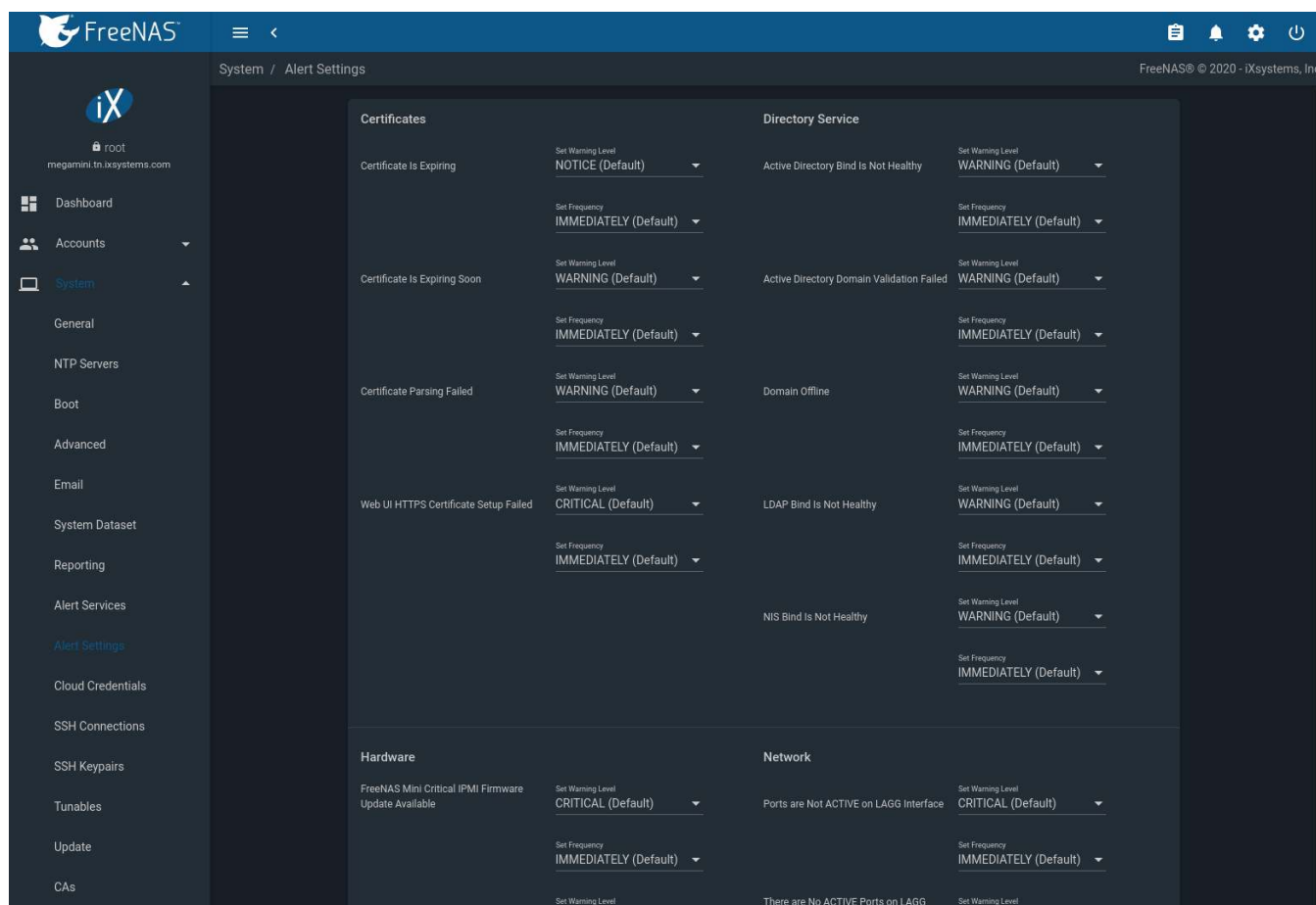


Fig. 7.10: Alert Settings

Alerts are grouped by web interface feature or service monitor. To adjust the alert level or notification frequency, choose an option from the drop-down menus and click **SAVE**.

To configure where alert notifications are sent, use [Alert Services](#) (page 91).

7.10 Cloud Credentials

FreeNAS® can use cloud services for features like [Cloud Sync Tasks](#) (page 146). The [rclone](https://rclone.org/) (https://rclone.org/) credentials to provide secure connections with cloud services are entered here. Amazon S3, Backblaze B2, Box, Dropbox, FTP, Google Cloud Storage, Google Drive, HTTP, hubiC, Mega, Microsoft Azure Blob Storage, Microsoft OneDrive, pCloud, SFTP, WebDAV, and Yandex are available.

Note: The hubiC cloud service has [suspended creation of new accounts](https://www.ovh.co.uk/subscriptions-hubic-ended/) (https://www.ovh.co.uk/subscriptions-hubic-ended/).

Warning: Cloud Credentials are stored in encrypted form. To be able to restore Cloud Credentials from a [saved configuration](#) (page 75), “Export Password Secret Seed” must be set when saving that configuration.

Click *System* → *Cloud Credentials* to see the screen shown in [Figure 7.11](#).

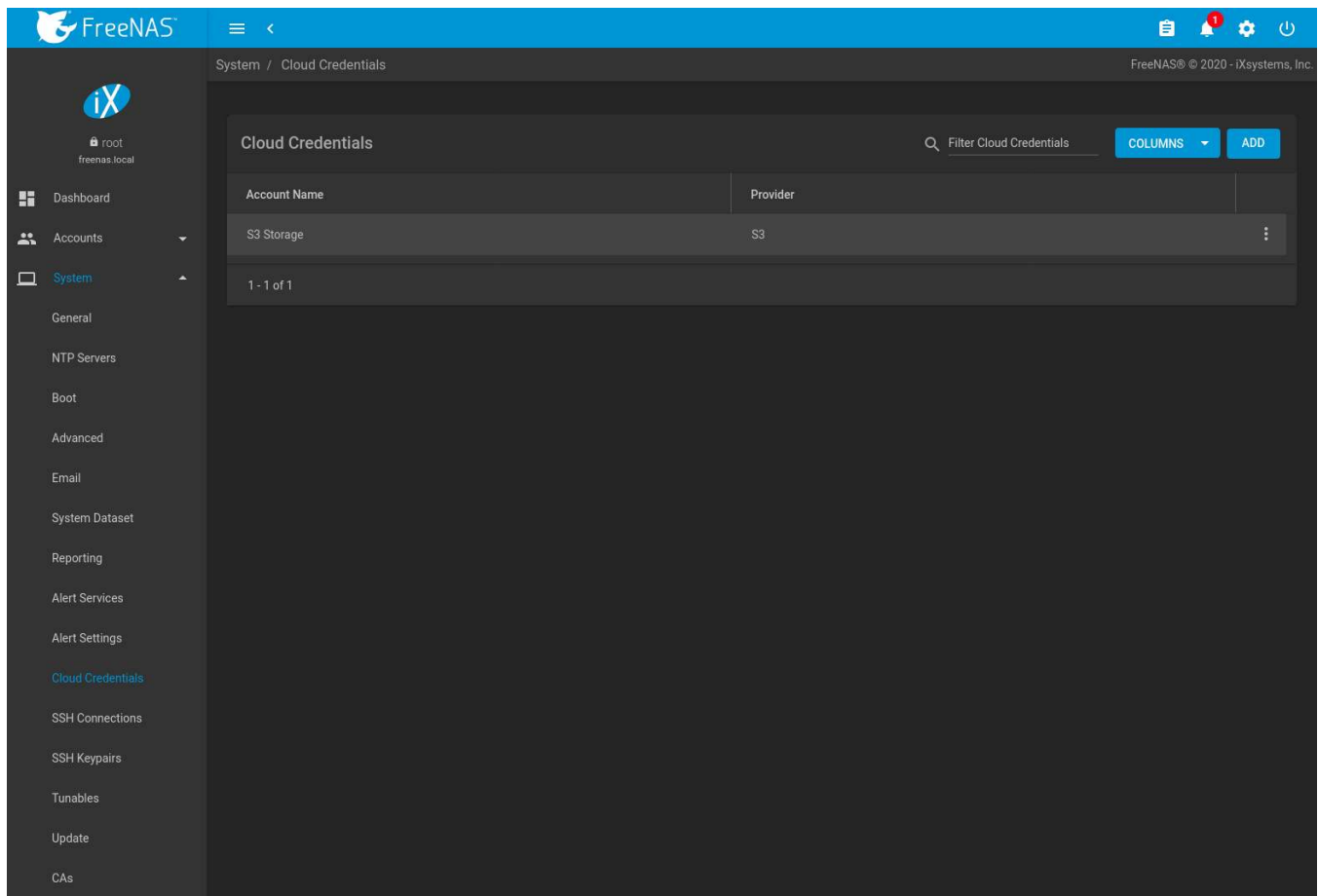



Fig. 7.11: Cloud Credentials List

The list shows the *Account Name* and *Provider* for each credential. There are options to *Edit* and *Delete* a credential after clicking  (Options) for a credential.

Click **ADD** to add a new cloud credential. Choose a *Provider* to display any specific options for that provider. [Figure 7.12](#) shows an example configuration:

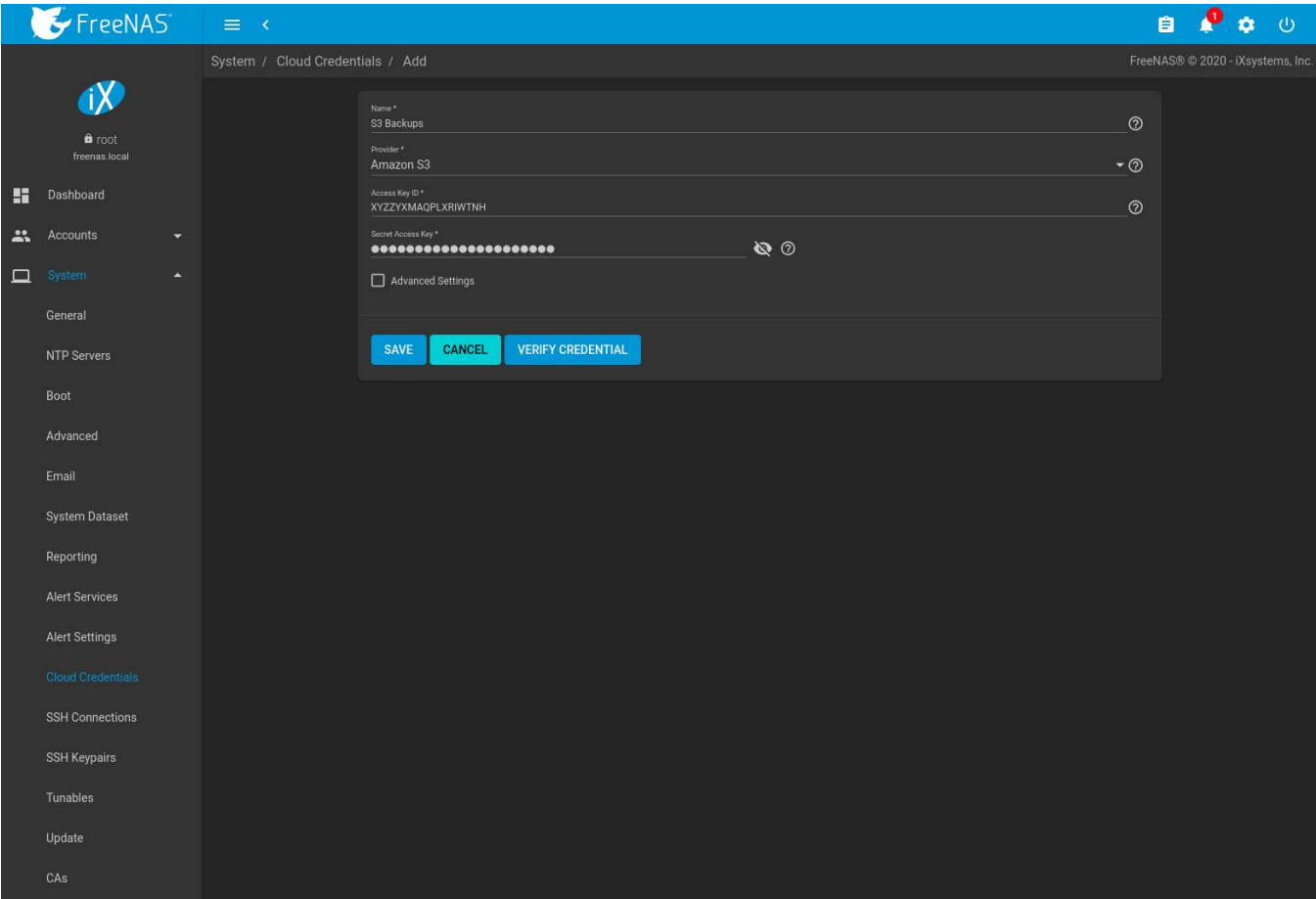


Fig. 7.12: Add Amazon S3 Credential

Enter a descriptive and unique name for the cloud credential in the *Name* field. The remaining options vary by *Provider*, and are shown in [Table 7.6](#). Clicking a provider name opens a new browser tab to the [rclone documentation](https://rclone.org/docs/) (<https://rclone.org/docs/>) for that provider.

Table 7.6: Cloud Credential Options

Provider	Setting	Description
Amazon S3 (https://rclone.org/s3/)	Access Key ID	Enter the Amazon Web Services Key ID. This is found on Amazon AWS (https://aws.amazon.com) by going through <i>My Account</i> -> <i>Security Credentials</i> -> <i>Access Keys</i> . Must be alphanumeric and between 5 and 20 characters.
Amazon S3 (https://rclone.org/s3/)	Secret Access Key	Enter the Amazon Web Services password. If the Secret Access Key cannot be found or remembered, go to <i>My Account</i> -> <i>Security Credentials</i> -> <i>Access Keys</i> and create a new key pair. Must be alphanumeric and between 8 and 40 characters.
Amazon S3 (https://rclone.org/s3/)	Endpoint URL	Set <i>Advanced Settings</i> to access this option. S3 API endpoint URL (https://docs.aws.amazon.com/AmazonS3/latest/dev/WebsiteEndpoints.html). When using AWS, the endpoint field can be empty to use the default endpoint for the region, and available buckets are automatically fetched. Refer to the AWS Documentation for a list of Simple Storage Service Website Endpoints (https://docs.aws.amazon.com/general/latest/gr/rande.html#s3_website_region_end).

Continued on next page

Table 7.6 – continued from previous page

Provider	Setting	Description
Amazon S3 (https://rclone.org/s3/)	Region	AWS resources in a geographic area (https://docs.aws.amazon.com/general/latest/gr/rande-manage.html). Leave empty to automatically detect the correct public region for the bucket. Entering a private region name allows interacting with Amazon buckets created in that region. For example, enter <code>us-gov-east-1</code> to discover buckets created in the eastern AWS GovCloud (https://docs.aws.amazon.com/govcloud-us/latest/UserGuide/whatis.html) region.
Amazon S3 (https://rclone.org/s3/)	Disable Endpoint Region	Set <i>Advanced Settings</i> to access this option. Skip automatic detection of the <i>Endpoint URL</i> region. Set this when configuring a custom <i>Endpoint URL</i> .
Amazon S3 (https://rclone.org/s3/)	Use Signature Version 2	Set <i>Advanced Settings</i> to access this option. Force using <i>Signature Version 2</i> (https://docs.aws.amazon.com/general/latest/gr/signature-version-2.html) to sign API requests. Set this when configuring a custom <i>Endpoint URL</i> .
Backblaze B2 (https://rclone.org/b2/)	Key ID, Application Key	Alphanumeric Backblaze B2 (https://www.backblaze.com/b2/cloud-storage.html) application keys. To generate a new application key, log in to the Backblaze account, go to the <i>App Keys</i> page, and add a new application key. Copy the <code>keyID</code> and <code>applicationKey</code> strings into the FreeNAS® web interface fields.
Box (https://rclone.org/box/)	Access Token	Configured with <i>Open Authentication</i> (page 98).
Dropbox (https://rclone.org/dropbox/)	Access Token	Configured with <i>Open Authentication</i> (page 98). The access token can be manually created by going to the Dropbox <i>App Console</i> (https://www.dropbox.com/developers/apps). After creating an app, go to <i>Settings</i> and click <i>Generate</i> under the Generated access token field.
FTP (https://rclone.org/ftp/)	Host, Port	Enter the FTP host and port.
FTP (https://rclone.org/ftp/)	Username, Password	Enter the FTP username and password.
Google Cloud Storage (https://rclone.org/googlecloudstorage/)	JSON Service Account Key	Upload a Google <i>Service Account credential file</i> (https://rclone.org/googlecloudstorage/#service-account-support). The file is created with the <i>Google Cloud Platform Console</i> (https://console.cloud.google.com/apis/credentials).
Google Drive (https://rclone.org/drive/)	Access Token, Team Drive ID	The <i>Access Token</i> is configured with <i>Open Authentication</i> (page 98). <i>Team Drive ID</i> is only used when connecting to a <i>Team Drive</i> (https://developers.google.com/drive/api/v3/reference/teamdrives). The ID is also the ID of the top level folder of the Team Drive.
HTTP (https://rclone.org/http/)	URL	Enter the HTTP host URL.
hubiC (https://rclone.org/hubic/)	Access Token	Enter the access token. See the <i>HubiC guide</i> (https://api.hubic.com/sandbox/) for instructions to obtain an access token.
Mega (https://rclone.org/mega/)	Username, Password	Enter the Mega (https://mega.nz/) username and password.
Microsoft Azure Blob Storage (https://rclone.org/azureblob/)	Account Name, Account Key	Enter the Azure Blob Storage account name and key.

Continued on next page

Table 7.6 – continued from previous page

Provider	Setting	Description
Microsoft OneDrive (https://rclone.org/onedrive/)	Access Token, Drives List, Drive Account Type, Drive ID	The <i>Access Token</i> is configured with <i>Open Authentication</i> (page 98). Authenticating a Microsoft account adds the <i>Drives List</i> and selects the correct <i>Drive Account Type</i> . The <i>Drives List</i> shows all the drives and IDs registered to the Microsoft account. Selecting a drive automatically fills the <i>Drive ID</i> field.
pCloud (https://rclone.org/pcloud/)	Access Token	Configured with <i>Open Authentication</i> (page 98).
SFTP (https://rclone.org/sftp/)	Host, Port, User-name, Password, Private Key ID	Enter the SFTP host and port. Enter an account user name that has SSH access to the host. Enter the password for that account <i>or</i> import the private key from an existing <i>SSH keypair</i> (page 102). To create a new SSH key for this credential, open the <i>Private Key ID</i> drop-down and select <i>Generate New</i> .
WebDAV (https://rclone.org/webdav/)	URL, WebDAV service	Enter the URL and use the dropdown to select the WebDAV service.
WebDAV (https://rclone.org/webdav/)	Username, Password	Enter the username and password.
Yandex (https://rclone.org/yandex/)	Access Token	Configured with <i>Open Authentication</i> (page 98).

For Amazon S3, *Access Key* and *Secret Key* values are found on the Amazon AWS website by clicking on the account name, then *My Security Credentials* and *Access Keys* (*Access Key ID* and *Secret Access Key*). Copy the *Access Key* value to the FreeNAS® Cloud Credential *Access Key* field, then enter the *Secret Key* value saved when the key pair was created. If the *Secret Key* value is unknown, a new key pair can be created on the same Amazon screen. *Open Authentication* (OAuth) (<https://openauthentication.org/>) is used with some cloud providers. These providers have a *LOGIN TO PROVIDER* button that opens a dialog to log in to that provider and fill the *Access Token* field with valid credentials.

Enter the information and click *VERIFY CREDENTIAL*. The `Credential is valid.` displays when the credential information is verified.

More details about individual *Provider* settings are available in the [rclone documentation](https://rclone.org/about/) (<https://rclone.org/about/>).


7.11 SSH Connections


Secure Socket Shell (SSH) (<https://searchsecurity.techtarget.com/definition/Secure-Shell>) is a network protocol that provides a secure method to access and transfer files between two hosts while using an unsecure network. SSH can use user account credentials to establish secure connections, but often uses key pairs shared between host systems for authentication.

FreeNAS® uses *System* → *SSH Connections* to quickly create SSH connections and show any saved connections. These connections are required when creating a new *replication* (page 142) to back up dataset snapshots.

The remote system must be configured to allow SSH connections. Some situations can also require allowing root account access to the remote system. For FreeNAS® systems, go to *Services* and edit the *SSH* (page 274) service to allow SSH connections and root account access.

To add a new SSH connection, go to *System* → *SSH Connections* and click *ADD*.





root
freenas.local

Dashboard

Accounts

System

General

NTP Servers

Boot

Advanced

Email

System Dataset

Reporting

Alert Services

Alert Settings

Cloud Credentials

SSH Connections

SSH Keypairs

Tunables

Update

CAs

System / SSH Connections / Add

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Name *

Setup Method
Semi-automatic (FreeNAS only)

FreeNAS/TrueNAS URL *

Username *
root

Password *

Private Key *

Cipher
Standard

Connect Timeout
10

SAVE

CANCEL

Table 7.7: SSH Connection Options

Setting	Value	Description
Name	string	Descriptive name of this SSH connection. SSH connection names must be unique.
Setup Method	drop-down menu	How to configure the connection: <i>Manual</i> requires configuring authentication on the remote system. This can require copying SSH keys and modifying the <i>root</i> user account on that system. See Manual Setup (page 100). <i>Semi-automatic</i> is only functional when configuring an SSH connection between FreeNAS® systems. After authenticating the connection, all remaining connection options are automatically configured. See Semi-Automatic Setup (page 101).
Host	string	Enter the hostname or IP address of the remote system. Only available with <i>Manual</i> configurations.
Port	integer	Port number on the remote system to use for the SSH connection. Only available with <i>Manual</i> configurations.
FreeNAS URL	string	Hostname or IP address of the remote FreeNAS® system. Only available with <i>Semi-automatic</i> configurations. A valid URL scheme is required. Example: <code>https://10.231.3.76</code>
Username	string	User account name to use for logging in to the remote system
Password	string	User account password used to log in to the FreeNAS® system. Only available with <i>Semi-automatic</i> configurations.
Private Key	drop-down menu	Choose a saved SSH Keypair (page 102) or select <i>Generate New</i> to create a new keypair and apply it to this connection.
Remote Host Key	string	Remote system SSH key for this system to authenticate the connection. Only available with <i>Manual</i> configurations. When all other fields are properly configured, click <i>DISCOVER REMOTE HOST KEY</i> to query the remote system and automatically populate this field.
Cipher	drop-down menu	Connection security level: <ul style="list-style-type: none"> • <i>Standard</i> is most secure, but has the greatest impact on connection speed. • <i>Fast</i> is less secure than <i>Standard</i> but can give reasonable transfer rates for devices with limited cryptographic speed. • <i>Disabled</i> removes all security in favor of maximizing connection speed. Disabling the security should only be used within a secure, trusted network.
Connect Timeout	integer	Time (in seconds) before the system stops attempting to establish a connection with the remote system.


Saved connections can be edited or deleted. Deleting an SSH connection also deletes or disables paired [SSH Keypairs](#) (page 102), [Replication Tasks](#) (page 142), and [Cloud Credentials](#) (page 94).

7.11.1 Manual Setup

Choosing to manually set up the SSH connection requires copying a public encryption key from the local to remote system. This allows a secure connection without a password prompt.

The examples here and in [Semi-Automatic Setup](#) (page 101) refer to the FreeNAS® system that is configuring a new connection in *System* → *SSH Connections* as *Host 1*. The FreeNAS® system that is receiving the encryption key is *Host 2*.

On *Host 1*, go to *System* → *SSH Keypairs* and create a new [SSH Keypair](#) (page 102). Highlight the entire *Public Key* text, right-click in the highlighted area, and click *Copy*.

Log in to *Host 2* and go to *Accounts* → *Users*. Click  (Options) for the *root* account, then *Edit*. Paste the copied key into the *SSH Public Key* field and click *SAVE* as shown in Figure 7.13.

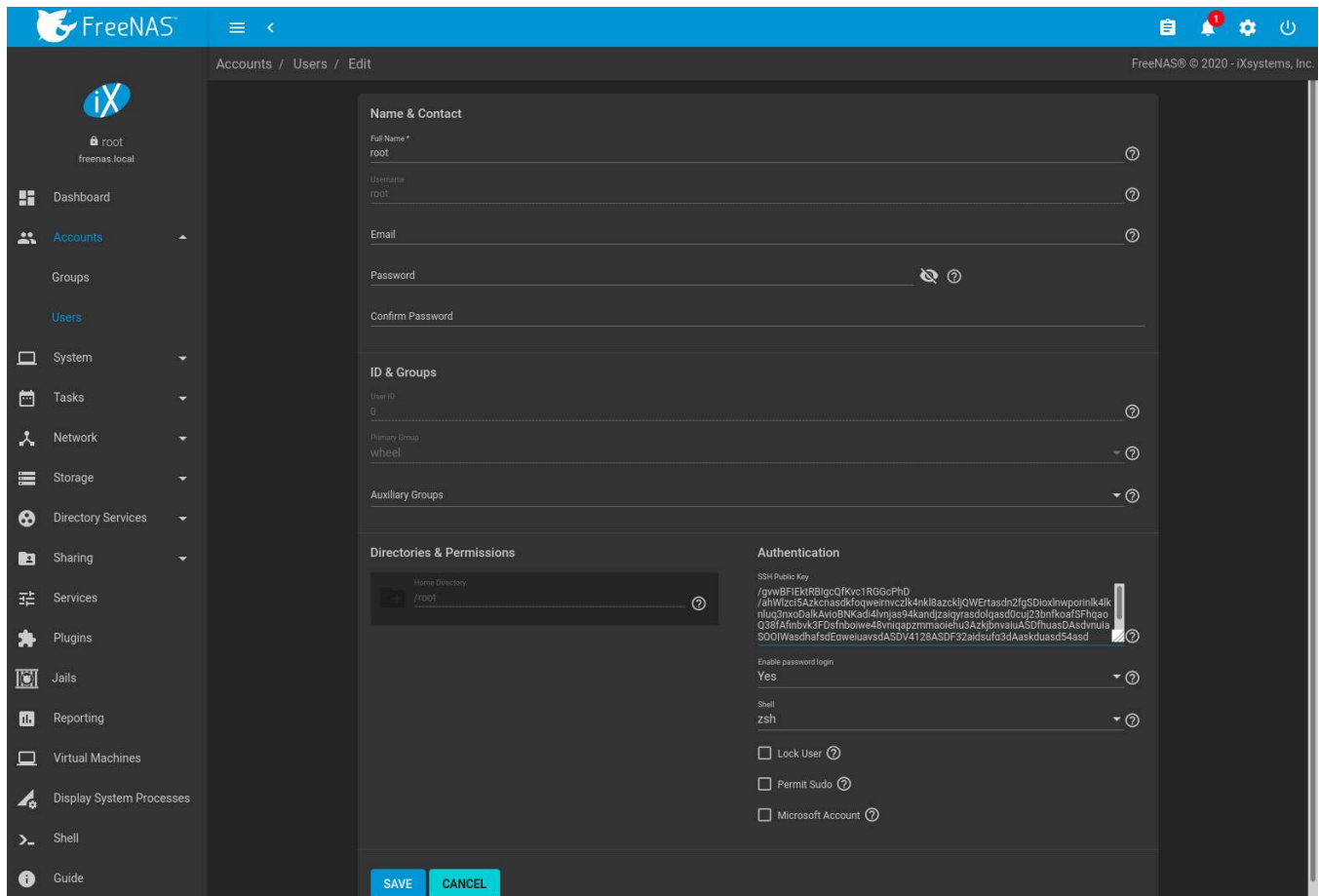


Fig. 7.13: Paste the Replication Key

Switch back to *Host 1* and go to *System* → *SSH Connections* and click *ADD*. Set the *Setup Method* to *Manual*, select the previously created keypair as the *Private Key*, and fill in the rest of the connection details for *Host 2*. Click *DISCOVER REMOTE HOST KEY* to obtain the remote system key. Click *SAVE* to store this SSH connection.

7.11.2 Semi-Automatic Setup

FreeNAS® offers a semi-automatic setup mode that simplifies setting up an SSH connection with another FreeNAS or TrueNAS system. When administrator account credentials are known for *Host 2*, semi-automatic setup allows configuring the SSH connection without logging in to *Host 2* to transfer SSH keys.

In *Host 1*, go to *System* → *SSH Keypairs* and create a new *SSH Keypair* (page 102). Go to *System* → *SSH Connections* and click *ADD*.

Choose *Semi-automatic* as the *Setup Method*. Enter the *Host 2* URL in *FreeNAS URL* using the format `http://freenas.remote`, where *freenas.remote* is the *Host 2* hostname or IP address.

Enter credentials for an *Host 2* user account that can accept SSH connection requests and modify *Host 2*. This is typically the *root* account.

Select the SSH keypair that was just created for the *Private Key*.

Fill in the remaining connection configuration fields and click *SAVE*. *Host 1* can use this saved configuration to establish a connection to *Host 2* and exchange the remaining authentication keys.

7.12 SSH Keypairs

FreeNAS® generates and stores [RSA-encrypted](https://en.wikipedia.org/wiki/RSA_%28cryptosystem%29) (https://en.wikipedia.org/wiki/RSA_%28cryptosystem%29) SSH public and private keypairs in *System* → *SSH Keypairs*. These are generally used when configuring [SSH Connections](#) (page 98) or [SFTP Cloud Credentials](#) (page 94). Encrypted keypairs or keypairs with passphrases are not supported.

To generate a new keypair, click **ADD**, enter a name, and click **GENERATE KEYPAIR**. The *Private Key* and *Public Key* fields fill with the key strings. SSH key pair names must be unique.

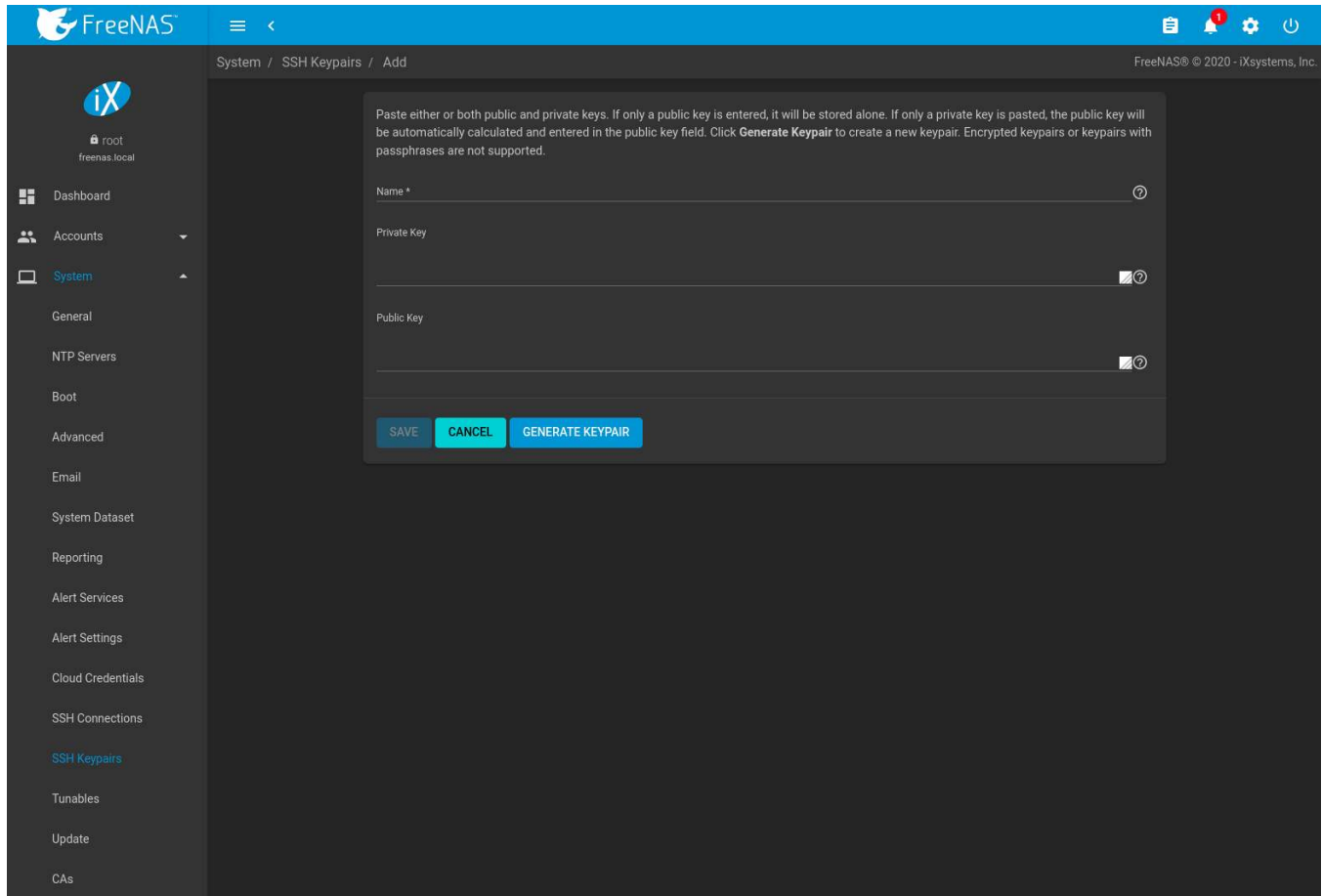


Fig. 7.14: Example Keypair

Click **SAVE** to store the new keypair. These saved keypairs can be selected later in the web interface without having to manually copy the key values.

Keys are viewed or modified by going to *System* → *SSH Keypairs* and clicking **⋮** (Options) and *Edit* for the keypair name.

Deleting an SSH Keypair also deletes any associated [SSH Connections](#) (page 98). [Replication Tasks](#) (page 142) or [SFTP Cloud Credentials](#) (page 94) that use this keypair are disabled but not removed.

7.13 Tunables

System → *Tunables* can be used to manage:

1. **FreeBSD sysctls:** a `sysctl(8)` (<https://www.freebsd.org/cgi/man.cgi?query=sysctl>) makes changes to the FreeBSD kernel running on a FreeNAS® system and can be used to tune the system.

2. **FreeBSD loaders:** a loader is only loaded when a FreeBSD-based system boots and can be used to pass a parameter to the kernel or to load an additional kernel module such as a FreeBSD hardware driver.
3. **FreeBSD rc.conf options:** `rc.conf(5)` (<https://www.freebsd.org/cgi/man.cgi?query=rc.conf>) is used to pass system configuration options to the system startup scripts as the system boots. Since FreeNAS® has been optimized for storage, not all of the services mentioned in `rc.conf(5)` are available for configuration. Note that in FreeNAS®, customized `rc.conf` options are stored in `/tmp/rc.conf.freenas`.

Warning: Adding a `sysctl`, loader, or `rc.conf` option is an advanced feature. A `sysctl` immediately affects the kernel running the FreeNAS® system and a loader could adversely affect the ability of the FreeNAS® system to successfully boot. **Do not create a tunable on a production system before testing the ramifications of that change.**

Since `sysctl`, loader, and `rc.conf` values are specific to the kernel parameter to be tuned, the driver to be loaded, or the service to configure, descriptions and suggested values can be found in the man page for the specific driver and in many sections of the [FreeBSD Handbook](https://www.freebsd.org/doc/en_US.ISO8859-1/books/handbook/) (https://www.freebsd.org/doc/en_US.ISO8859-1/books/handbook/).

To add a loader, `sysctl`, or `rc.conf` option, go to *System* → *Tunables* and click *ADD* to access the screen shown in Figure 7.15.

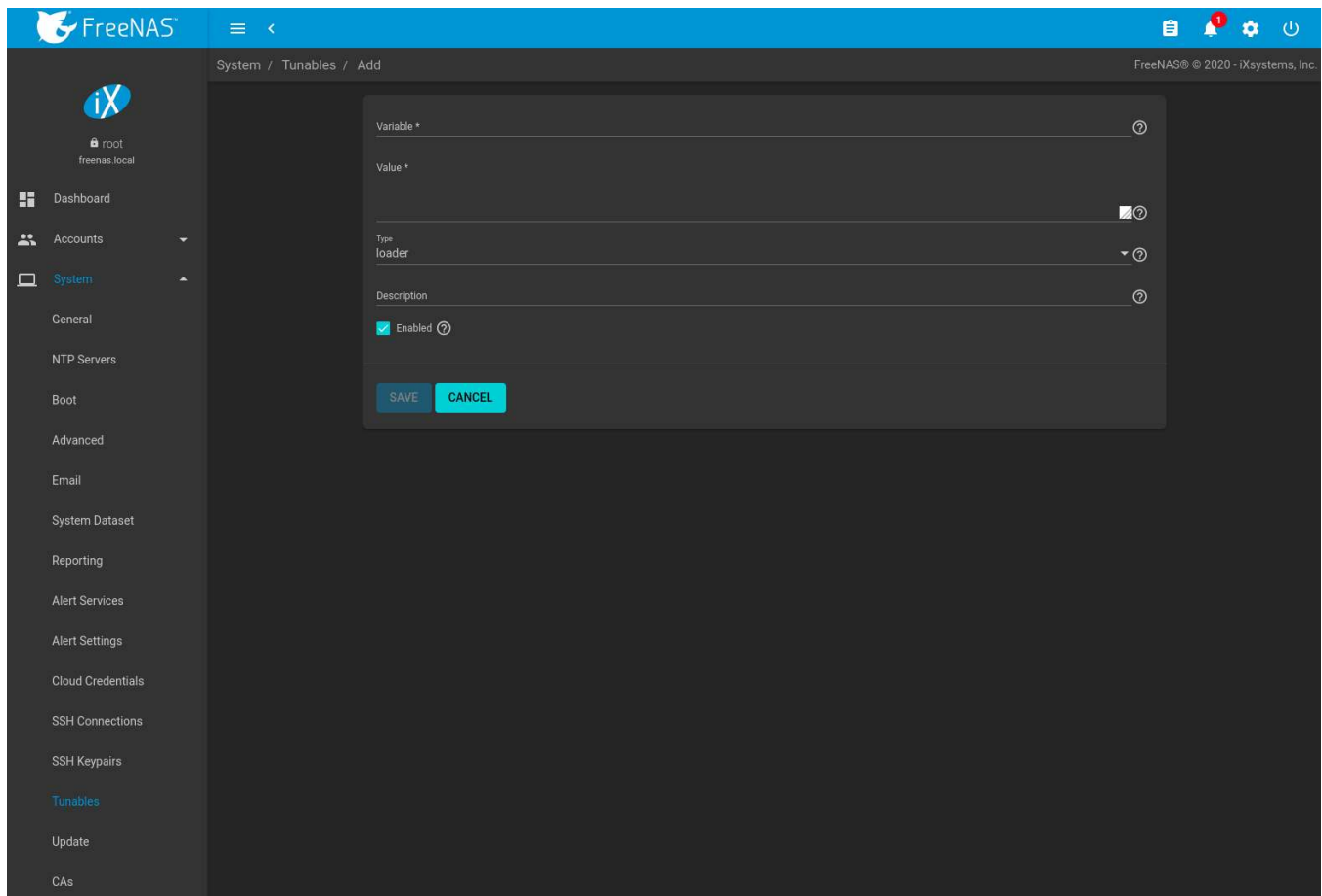



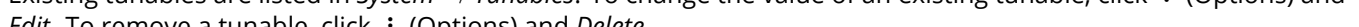
Fig. 7.15: Adding a Tunable

Table 7.8 summarizes the options when adding a tunable.

Table 7.8: Adding a Tunable

Setting	Value	Description
Variable	string	The name of the <i>sysctl</i> or driver to load.
Value	integer or string	Set a value for the <i>Variable</i> . Refer to the man page for the specific driver or the FreeBSD Handbook (https://www.freebsd.org/doc/en_US.ISO08859-1/books/handbook/) for suggested values.
Type	drop-down menu	Choices are <i>Loader</i> , <i>rc.conf</i> , and <i>Sysctl</i> .
Description	string	Optional. Enter a description of this tunable.
Enabled	checkbox	Deselect this option to disable the tunable without deleting it.

Note: As soon as a *Sysctl* is added or edited, the running kernel changes that variable to the value specified. However, when a *Loader* or *rc.conf* value is changed, it does not take effect until the system is rebooted. Regardless of the type of tunable, changes persist at each boot and across upgrades unless the tunable is deleted or the *Enabled* option is deselected.

Existing tunables are listed in *System* → *Tunables*. To change the value of an existing tunable, click  (Options) and *Edit*. To remove a tunable, click  (Options) and *Delete*.

Restarting the FreeNAS® system after making *sysctl* changes is recommended. Some *sysctls* only take effect at system startup, and restarting the system guarantees that the setting values correspond with what is being used by the running system.

The web interface does not display the *sysctls* that are pre-set when FreeNAS® is installed. FreeNAS® 11.3 ships with the *sysctls* set:

```
kern.corefile=/var/tmp/%N.core
kern.metadelays=3
kern.dirdelay=4
kern.filedelay=5
kern.coredump=1
kern.sugid_coredump=1
vfs.timestamp_precision=3
net.link.lagg.lacp.default_strict_mode=0
vfs.zfs.min_auto_ashift=12
```

Do not add or edit these default *sysctls* as doing so may render the system unusable.

The web interface does not display the loaders that are pre-set when FreeNAS® is installed. FreeNAS® 11.3 ships with these loaders set:

```
product="FreeNAS"
autoboot_delay="5"
loader_logo="FreeNAS"
loader_menu_title="Welcome to FreeNAS"
loader_brand="FreeNAS"
loader_version=" "
kern.cam.boot_delay="30000"
debug.debugger_on_panic=1
debug.ddb.textdump.pending=1
hw.hpttr.attach_generic=0
vfs.mountroot.timeout="30"
ispfw_load="YES"
ipmi_load="YES"
freenas_sysctl_load="YES"
hint.isp.0.role=2
hint.isp.1.role=2
hint.isp.2.role=2
hint.isp.3.role=2
```

```

module_path="/boot/kernel;/boot/modules;/usr/local/modules"
net.inet6.ip6.auto_linklocal="0"
vfs.zfs.vol.mode=2
kern.geom.label.disk_ident.enable=0
kern.geom.label.ufs.enable=0
kern.geom.label.ufsid.enable=0
kern.geom.label.reiserfs.enable=0
kern.geom.label.ntfs.enable=0
kern.geom.label.msdfs.enable=0
kern.geom.label.ext2fs.enable=0
hint.ahciem.0.disabled="1"
hint.ahciem.1.disabled="1"
kern.msgbufsize="524288"
hw.mfi.mrsas_enable="1"
hw.usb.no_shutdown_wait=1
vfs.nfsd.fha.write=0
vfs.nfsd.fha.max_nfsds_per_fh=32
vm.lowmem_period=0

```

Do not add or edit the default tunables. Changing the default tunables can make the system unusable.

The ZFS version used in 11.3 deprecates these tunables:

```

kvfs.zfs.write_limit_override
vfs.zfs.write_limit_inflated
vfs.zfs.write_limit_max
vfs.zfs.write_limit_min
vfs.zfs.write_limit_shift
vfs.zfs.no_write_throttle

```

After upgrading from an earlier version of FreeNAS®, these tunables are automatically deleted. Please do not manually add them back.

7.14 Update

FreeNAS® has an integrated update system to make it easy to keep up to date.

7.14.1 Preparing for Updates

It is best to perform updates at times the FreeNAS® system is idle, with no clients connected and no scrubs or other disk activity going on. Most updates require a system reboot. Plan updates around scheduled maintenance times to avoid disrupting user activities.

The update process will not proceed unless there is enough free space in the boot pool for the new update files. If a space warning is shown, go to [Boot](#) (page 80) to remove unneeded boot environments.

7.14.2 Updates and Trains

Cryptographically signed update files are used to update FreeNAS®. Update files provide flexibility in deciding when to upgrade the system. Go to [Boot](#) (page 38) to test an update.

FreeNAS® defines software branches, known as *trains*. There are several trains available for updates, but the web interface only displays trains that can be selected as an upgrade.

Update trains are labeled with a numeric version followed by a short description. The current version receives regular bug fixes and new features. Supported older versions of FreeNAS® only receive maintenance updates. Several specific words are used to describe the type of train:

- **STABLE:** Bug fixes and new features are available from this train. Upgrades available from a *STABLE* train are tested and ready to apply to a production environment.
- **Nightlies:** Experimental train used for testing future versions of FreeNAS®.
- **SDK:** Software Developer Kit train. This has additional tools for testing and debugging FreeNAS®.

Warning: The UI will warn if the currently selected train is not suited for production use. Before using a non-production train, be prepared to experience bugs or problems. Testers are encouraged to submit bug reports at <https://bug.ixsystems.com>.

7.14.3 Checking for Updates

Figure 7.16 shows an example of the *System* → *Update* screen.

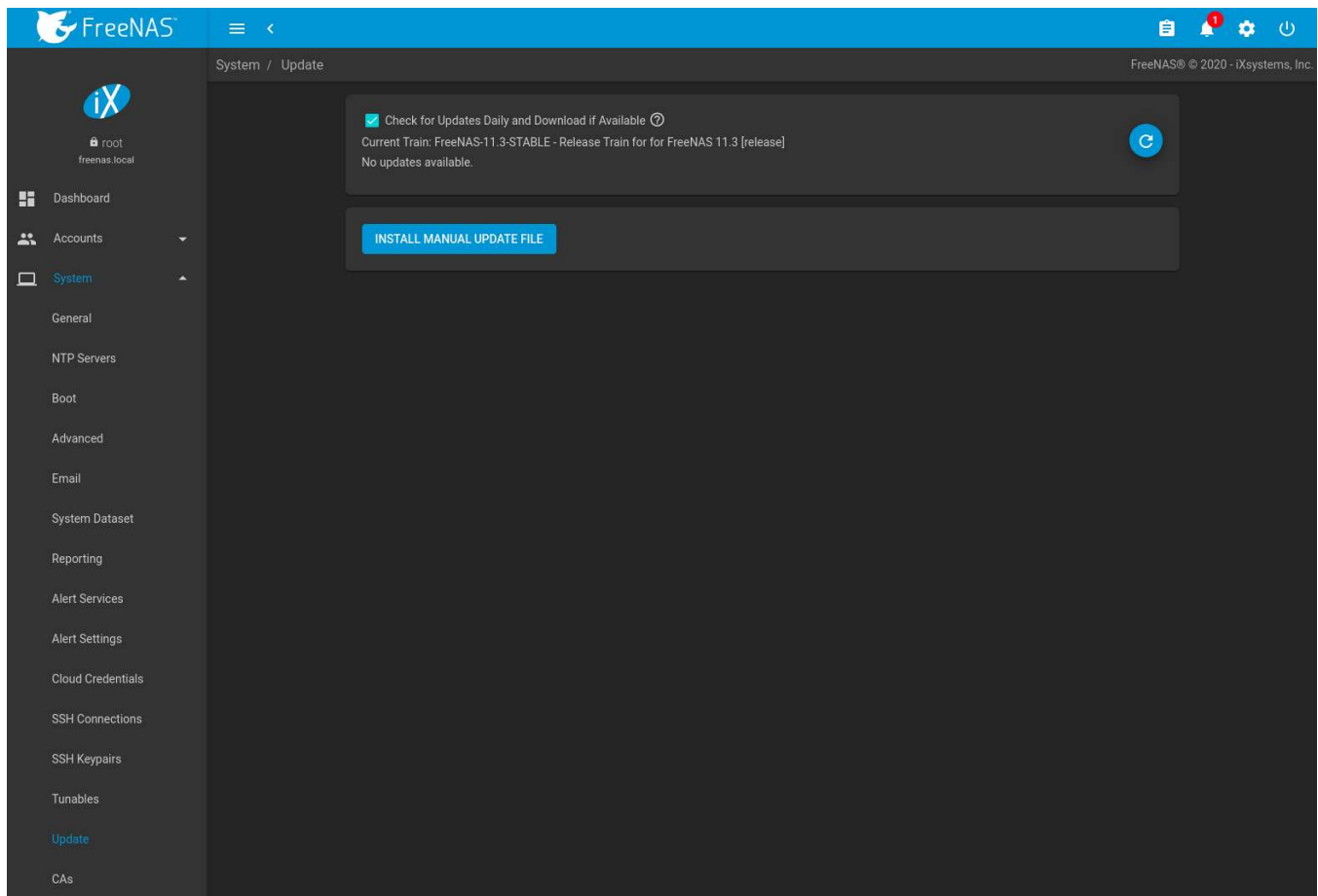



Fig. 7.16: Update Options

The system checks daily for updates and downloads an update if one is available. An alert is issued when a new update becomes available. The automatic check and download of updates is disabled by unsetting *Check for Updates Daily and Download if Available*. Click  (Refresh) to perform another check for updates.

To change the train, use the drop-down menu to make a different selection.

Note: The train selector does not allow downgrades. For example, the STABLE train cannot be selected while booted into a Nightly boot environment, or a 9.10 train cannot be selected while booted into a 11 boot environ-

ment. To go back to an earlier version after testing or running a more recent version, reboot and select a boot environment for that earlier version. This screen can then be used to check for updates that train.

In the example shown in [Figure 7.17](#), information about the update is displayed along with a link to the *release notes*. It is important to read the release notes before updating to determine if any of the changes in that release impact the use of the system.

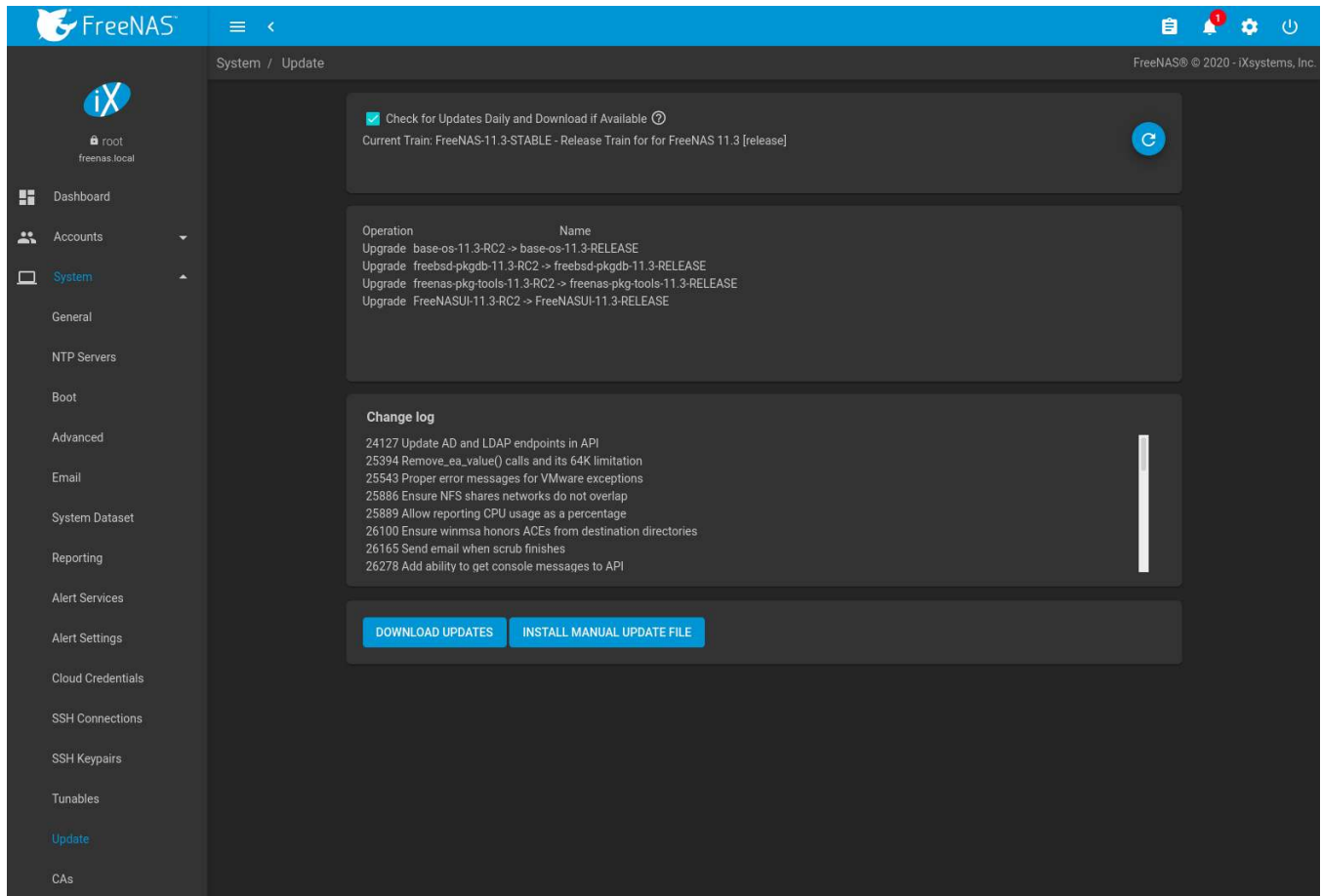
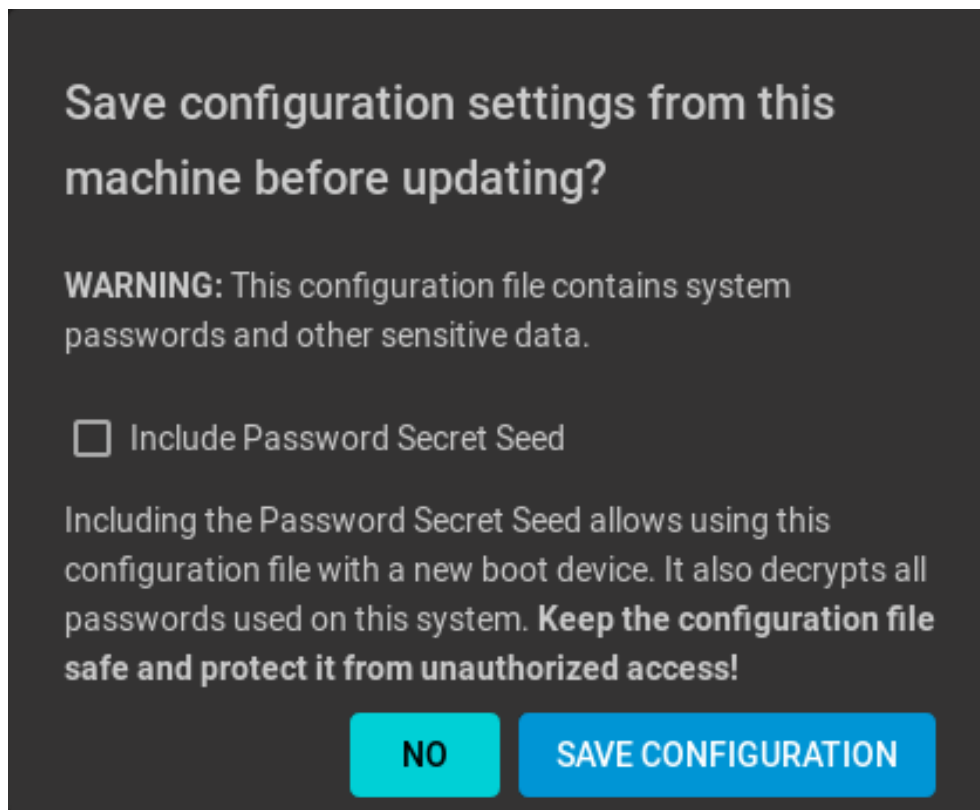


Fig. 7.17: Reviewing Updates

7.14.4 Saving the Configuration File

A dialog to save the system *configuration file* (page 77) appears before installing updates.



Warning: Keep the system configuration file secure after saving it. The security information in the configuration file could be used for unauthorized access to the FreeNAS® system.

7.14.5 Applying Updates

Make sure the system is in a low-usage state as described above in [Preparing for Updates](#) (page 105).

Click **DOWNLOAD UPDATES** to immediately download and install an update.

The [Save Configuration](#) (page 107) dialog appears so the current configuration can be saved to external media.

A confirmation window appears before the update is installed. When *Apply updates and reboot system after downloading* is set and, clicking **CONTINUE** downloads, applies the updates, and then automatically reboots the system. The update can be downloaded for a later manual installation by unsetting the *Apply updates and reboot system after downloading* option.

APPLY PENDING UPDATE is visible when an update is downloaded and ready to install. Click the button to see a confirmation window. Setting *Confirm* and clicking **CONTINUE** installs the update and reboots the system.

Warning: Each update creates a boot environment. If the update process needs more space, it attempts to remove old boot environments. Boot environments marked with the *Keep* attribute as shown in [Boot](#) (page 80) are not removed. If space for a new boot environment is not available, the upgrade fails. Space on the operating system device can be manually freed using *System* → *Boot*. Review the boot environments and remove the *Keep* attribute or delete any boot environments that are no longer needed.

7.14.6 Manual Updates

Updates can also be manually downloaded and applied in *System* → *Update*.

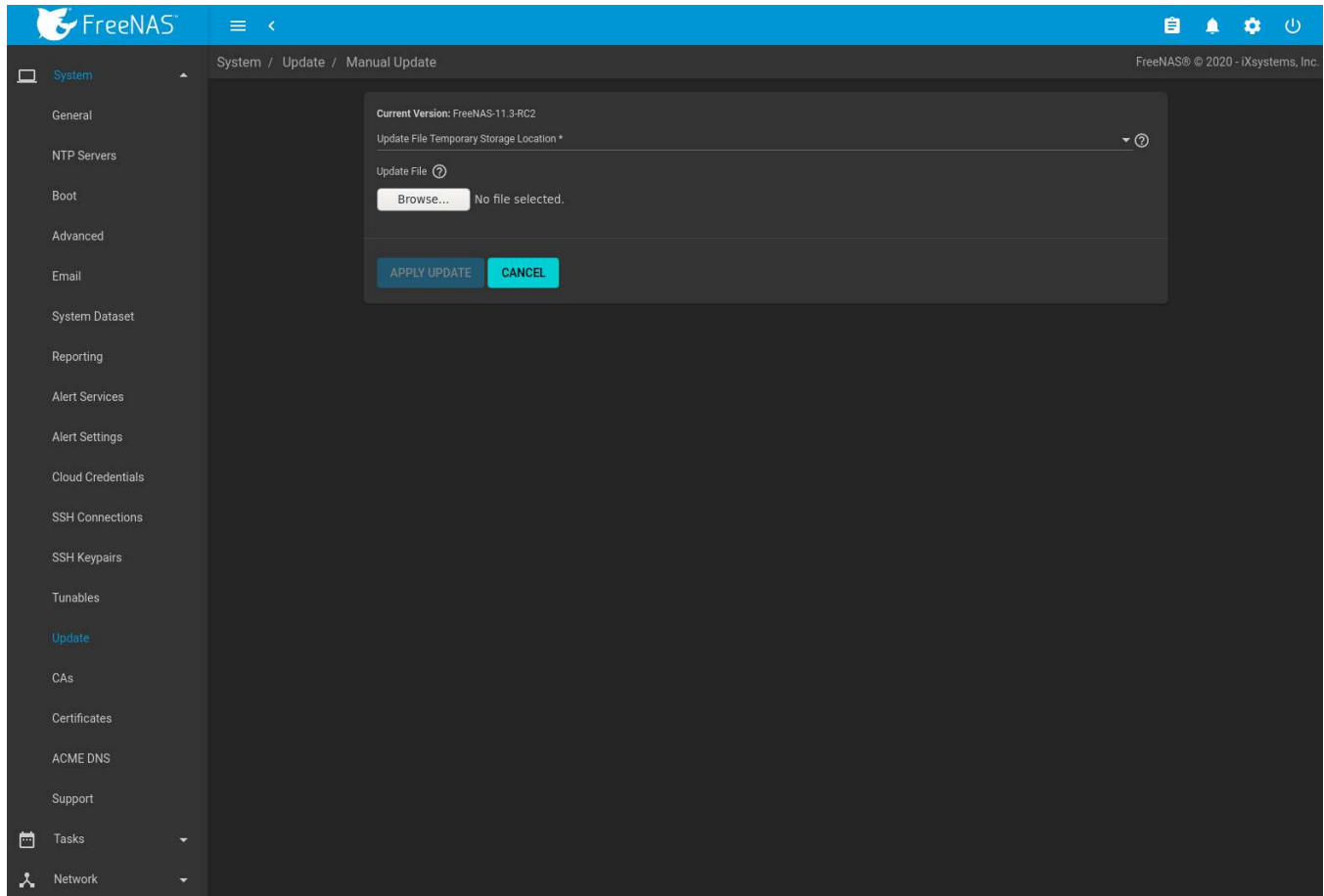
Note: Manual updates cannot be used to upgrade from older major versions.

Go to <https://download.freenas.org/> and find an update file of the desired version. Manual update file names end with `-manual-update-unsigned.tar`.

Download the file to a desktop or laptop computer. Connect to FreeNAS® with a browser and go to *System* → *Update*. Click *INSTALL MANUAL UPDATE FILE*.

The *Save Configuration* (page 107) dialog opens. This makes it possible to save a copy of the current configuration to external media for backup in case of an update problem.


After the dialog closes, the manual update screen is shown:



The current version of FreeNAS® is shown for verification.

Select the manual update file with the *Browse* button. Set *Reboot After Update* to reboot the system after the update has been installed. Click *APPLY UPDATE* to begin the update.

7.14.7 Update in Progress

Starting an update shows a progress dialog. When an update is in progress, the web interface shows an  icon in the top row. Dialogs also appear in every active web interface session to warn that a system update is in progress.

Do not interrupt a system update.

7.15 CAs

FreeNAS® can act as a Certificate Authority (CA). When encrypting SSL or TLS connections to the FreeNAS® system, either import an existing certificate, or create a CA on the FreeNAS® system, then create a certificate. This certificate will appear in the drop-down menus for services that support SSL or TLS.

For secure LDAP, the public key of an existing CA can be imported with *Import CA*, or a new CA created on the FreeNAS® system and used on the LDAP server also.

Figure 7.18 shows the screen after clicking *System* → *CAs*.

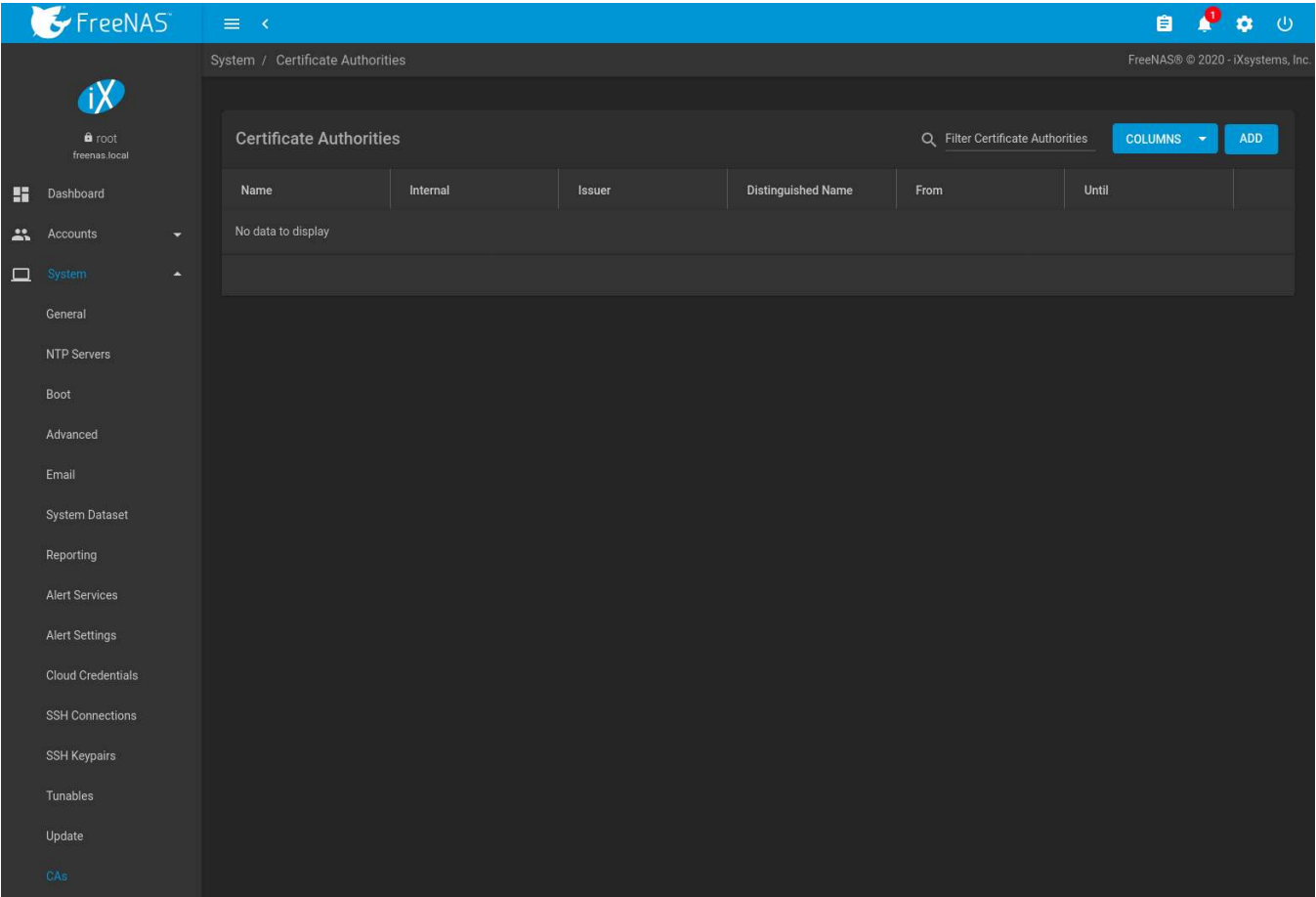


Fig. 7.18: Initial CA Screen

If the organization already has a CA, the CA certificate and key can be imported. Click *ADD* and set the *Type* to *Import CA* to see the configuration options shown in Figure 7.19. The configurable options are summarized in Table 7.9.

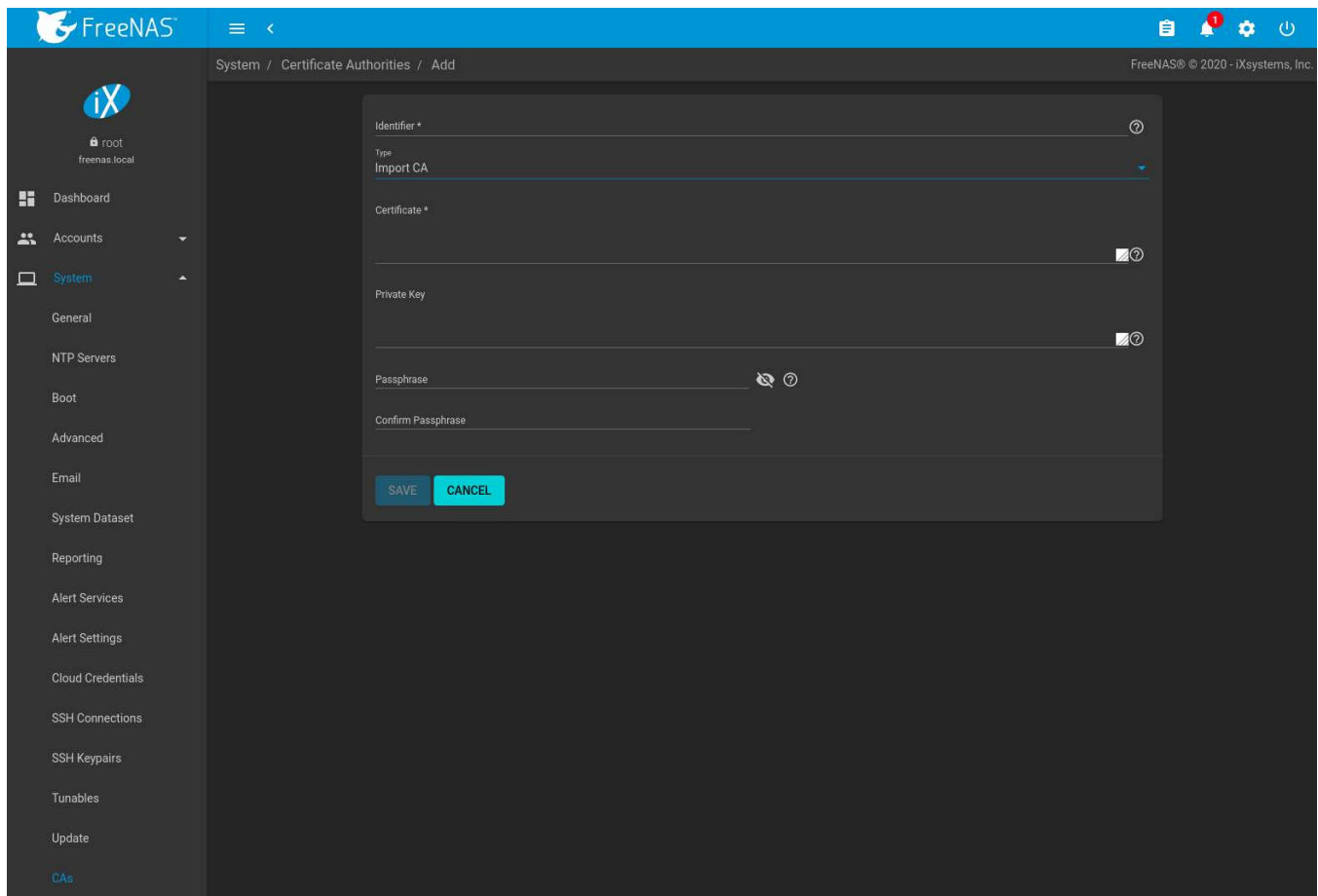


Fig. 7.19: Importing a CA

Table 7.9: Importing a CA Options

Setting	Value	Description
Identifier	string	Enter a descriptive name for the CA using only alphanumeric, underscore (_), and dash (-) characters.
Type	drop-down menu	Choose the type of CA. Choices are <i>Internal CA</i> , <i>Intermediate CA</i> , and <i>Import CA</i> .
Certificate	string	Mandatory. Paste in the certificate for the CA.
Private Key	string	If there is a private key associated with the <i>Certificate</i> , paste it here. Private keys must be at least 1024 bits long.
Passphrase	string	If the <i>Private Key</i> is protected by a passphrase, enter it here and repeat it in the "Confirm Passphrase" field.

To create a new CA, first decide if it will be the only CA which will sign certificates for internal use or if the CA will be part of a [certificate chain](https://en.wikipedia.org/wiki/Root_certificate) (https://en.wikipedia.org/wiki/Root_certificate).

To create a CA for internal use only, click *ADD* and set the *Type* to *Internal CA*. [Figure 7.20](#) shows the available options.

Fig. 7.20: Creating an Internal CA

The configurable options are described in Table 7.10. When completing the fields for the certificate authority, supply the information for the organization.

Table 7.10: Internal CA Options

Setting	Value	Description
Identifier	string	Enter a descriptive name for the CA using only alphanumeric, underscore (<code>_</code>), and dash (<code>-</code>) characters.
Type	drop-down menu	Choose the type of CA. Choices are <i>Internal CA</i> , <i>Intermediate CA</i> , and <i>Import CA</i> .
Key Type	drop-down menu	Cryptosystem for the certificate authority key. Choose between <i>RSA</i> (<i>Rivest-Shamir-Adleman</i> (<i>https://en.wikipedia.org/wiki/RSA_(cryptosystem)</i>)) and <i>EC</i> (<i>Elliptic-curve</i> (<i>https://en.wikipedia.org/wiki/Elliptic-curve_cryptography</i>)) encryption.
EC Curve	drop-down menu	Elliptic curve to apply to the certificate authority key. Choose from different <i>Brainpool</i> or <i>SEC</i> curve parameters. See <i>RFC 5639</i> (<i>https://tools.ietf.org/html/rfc5639</i>) and <i>SEC 2</i> (<i>http://www.secg.org/sec2-v2.pdf</i>) for more details. Applies to <i>EC</i> keys only.
Key Length	drop-down menu	For security reasons, a minimum of <i>2048</i> is recommended. Applies to <i>RSA</i> keys only.
Digest Algorithm	drop-down menu	The default is acceptable unless the organization requires a different algorithm.

Continued on next page


Table 7.10 – continued from previous page

Setting	Value	Description
Lifetime	integer	The lifetime of a CA is specified in days.
Country	drop-down menu	Select the country for the organization.
State	string	Enter the state or province of the organization.
Locality	string	Enter the location of the organization.
Organization	string	Enter the name of the company or organization.
Organizational Unit	string	Organizational unit of the entity.
Email	string	Enter the email address for the person responsible for the CA.
Common Name	string	Enter the fully-qualified hostname (FQDN) of the system. The <i>Common Name</i> must be unique within a certificate chain.
Subject Alternate Names	string	Multi-domain support. Enter additional space separated domain names.

To create an intermediate CA which is part of a certificate chain, set the *Type* to *Intermediate CA*. This screen adds one more option to the screen shown in [Figure 7.20](#):

- **Signing Certificate Authority:** this drop-down menu is used to specify the root CA in the certificate chain. This CA must first be imported or created.

Imported or created CAs are added as entries in *System* → *CAs*. The columns in this screen indicate the name of the CA, whether it is an internal CA, whether the issuer is self-signed, the CA lifetime (in days), the common name of the CA, the date and time the CA was created, and the date and time the CA expires.

Click  (Options) on an existing CA to access these configuration buttons:

- **View:** use this option to view the contents of an existing *Certificate*, *Private Key*, or to edit the *Identifier*.
- **Sign CSR:** used to sign internal Certificate Signing Requests created using *System* → *Certificates* → *Create CSR*. Signing a request adds a new certificate to *System* → *Certificates*.
- **Export Certificate:** prompts to browse to the location to save a copy of the CA's X.509 certificate on the computer being used to access the FreeNAS® system.
- **Export Private Key:** prompts to browse to the location to save a copy of the CA's private key on the computer being used to access the FreeNAS® system. This option only appears if the CA has a private key.
- **Delete:** prompts for confirmation before deleting the CA.

7.16 Certificates

FreeNAS® can import existing certificates or certificate signing requests, create new certificates, and issue certificate signing requests so that created certificates can be signed by the CA which was previously imported or created in [CAs](#) (page 110).

Go to *System* → *Certificates* to add or view certificates.

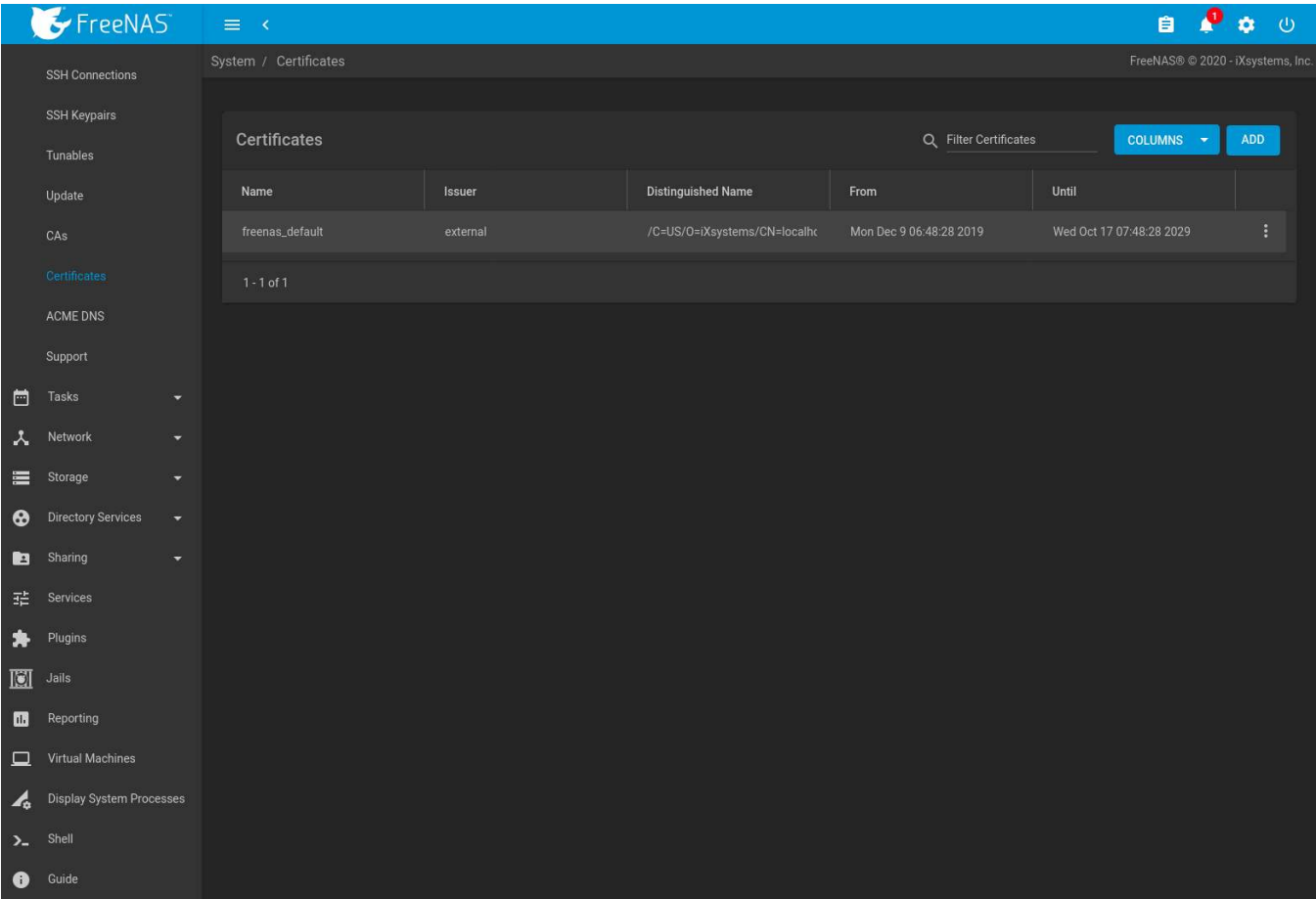


Fig. 7.21: Certificates

FreeNAS® uses a self-signed certificate to enable encrypted access to the web interface. This certificate is generated at boot and cannot be deleted until a different certificate is chosen as the [GUI SSL Certificate](#) (page 76).

To import an existing certificate, click *ADD* and set the *Type* to *Import Certificate*. [Figure 7.22](#) shows the options. When importing a certificate chain, paste the primary certificate, followed by any intermediate certificates, followed by the root CA certificate.

The configurable options are summarized in [Table 7.11](#).

The screenshot shows the FreeNAS web interface with the 'Import Certificate' form. The left sidebar contains a navigation menu with options like SSH Connections, SSH Keypairs, Tunables, Update, CAs, Certificates (highlighted), ACME DNS, Support, Tasks, Network, Storage, Directory Services, Sharing, Services, Plugins, Jails, Reporting, Virtual Machines, Display System Processes, Shell, and Guide. The main content area is titled 'System / Certificates / Add' and contains the following form fields:

- Identifier ***: A text input field.
- Type**: A dropdown menu with 'Import Certificate' selected.
- CSR exists on this system**: A checkbox.
- Signing Certificate Authority**: A dropdown menu.
- Certificate ***: A large text area for pasting the certificate content.
- Private Key**: A large text area for pasting the private key.
- Passphrase**: A text input field with a toggle for visibility.
- Confirm Passphrase**: A text input field for repeating the passphrase.
- SAVE** and **CANCEL** buttons at the bottom.

Fig. 7.22: Importing a Certificate

Table 7.11: Certificate Import Options

Setting	Value	Description
Identifier	string	Enter a descriptive name for the certificate using only alphanumeric, underscore (_), and dash (-) characters.
Type	drop-down menu	Choose the type of certificate. Choices are <i>Internal Certificate</i> , <i>Certificate Signing Request</i> , <i>Import Certificate</i> , and <i>Import Certificate Signing Request</i> .
CSR exists on this system	checkbox	Set when the certificate being imported already has a Certificate Signing Request (CSR) on the system.
Signing Certificate Authority	drop-down menu	Select a previously created or imported CA. Active when <i>CSR exists on this system</i> is set.
Certificate	string	Paste the contents of the certificate.
Private Key	string	Paste the private key associated with the certificate. Private keys must be at least 1024 bits long. Active when <i>CSR exists on this system</i> is unset.
Passphrase	string	If the private key is protected by a passphrase, enter it here and repeat it in the <i>Confirm Passphrase</i> field. Active when <i>CSR exists on this system</i> is unset.

Importing a certificate signing request requires copying the contents of the signing request and key files into the form. Having the signing request `CERTIFICATE REQUEST` and `PRIVATE KEY` strings visible in a separate window simplifies the import process.

Table 7.12: Certificate Signing Request Import Options

Setting	Value	Description
Identifier	string	Enter a descriptive name for the certificate using only alphanumeric, underscore (_), and dash (-) characters.
Type	drop-down menu	Choose the type of certificate. Choices are <i>Internal Certificate</i> , <i>Certificate Signing Request</i> , <i>Import Certificate</i> , and <i>Import Certificate Signing Request</i> .
Signing Request	drop-down menu	Paste the CERTIFICATE REQUEST string from the signing request.
Private Key	string	Paste the private key associated with the certificate signing request. Private keys must be at least 1024 bits long.
Passphrase	string	If the private key is protected by a passphrase, enter it here and repeat it in the <i>Confirm Passphrase</i> field.

To create a new self-signed certificate, set the *Type* to *Internal Certificate* to see the options shown in [Figure 7.23](#). The configurable options are summarized in [Table 7.13](#). When completing the fields for the certificate authority, use the information for the organization. Since this is a self-signed certificate, use the CA that was imported or created with *CAs* (page 110) as the signing authority.

The screenshot shows the FreeNAS web interface with the 'Add Certificate' form. The left sidebar contains navigation links for SSH Connections, SSH Keypairs, Tunables, Update, CAs, Certificates (highlighted), ACME DNS, Support, Tasks, Network, Storage, Directory Services, Sharing, Services, Plugins, Jails, Reporting, Virtual Machines, Display System Processes, Shell, and Guide. The main content area displays the 'Add Certificate' form with the following fields and values:

- Identifier: (empty)
- Type: Internal Certificate
- Signing Certificate Authority: (empty)
- Key Type: RSA
- EC Curve: BrainpoolP384R1
- Key Length: 2048
- Digest Algorithm: SHA256
- Lifetime: 3650
- Country: United States
- State: (empty)
- Locality: (empty)
- Organization: (empty)
- Organizational Unit: (empty)
- Email: (empty)
- Common Name: (empty)
- Subject Alternate Names: (empty)

At the bottom of the form are 'SAVE' and 'CANCEL' buttons.

Fig. 7.23: Creating a New Certificate

Table 7.13: Certificate Creation Options

Setting	Value	Description
Identifier	string	Enter a descriptive name for the certificate using only alphanumeric, underscore (_), and dash (-) characters.
Type	drop-down menu	Choose the type of certificate. Choices are <i>Internal Certificate</i> , <i>Certificate Signing Request</i> , and <i>Import Certificate</i> .
Signing Certificate Authority	drop-down menu	Select the CA which was previously imported or created using <i>CAs</i> (page 110).
Key Type	drop-down menu	Cryptosystem for the certificate key. Choose between <i>RSA</i> (<i>Rivest-Shamir-Adleman</i> (<i>https://en.wikipedia.org/wiki/RSA_(cryptosystem)</i>)) and <i>EC</i> (<i>Elliptic-curve</i> (<i>https://en.wikipedia.org/wiki/Elliptic-curve_cryptography</i>)) encryption.
EC Curve	drop-down menu	Elliptic curve to apply to the certificate key. Choose from different <i>Brainpool</i> or <i>SEC</i> curve parameters. See <i>RFC 5639</i> (<i>https://tools.ietf.org/html/rfc5639</i>) and <i>SEC 2</i> (<i>http://www.secg.org/sec2-v2.pdf</i>) for more details. Applies to <i>EC</i> keys only.
Key Length	drop-down menu	For security reasons, a minimum of 2048 is recommended. Applies to <i>RSA</i> keys only.
Digest Algorithm	drop-down menu	The default is acceptable unless the organization requires a different algorithm.
Lifetime	integer	The lifetime of the certificate is specified in days.
Country	drop-down menu	Select the country for the organization.
State	string	State or province of the organization.
Locality	string	Location of the organization.
Organization	string	Name of the company or organization.
Organizational Unit	string	Organizational unit of the entity.
Email	string	Enter the email address for the person responsible for the CA.
Common Name	string	Enter the fully-qualified hostname (FQDN) of the system. The <i>Common Name</i> must be unique within a certificate chain.
Subject Alternate Names	string	Multi-domain support. Enter additional domain names and separate them with a space.

If the certificate is signed by an external CA, such as Verisign, instead create a certificate signing request. To do so, set the *Type* to *Certificate Signing Request*. The options from [Figure 7.23](#) display, but without the *Signing Certificate Authority* and *Lifetime* fields.

Certificates that are imported, self-signed, or for which a certificate signing request is created are added as entries to *System* → *Certificates*. In the example shown in [Figure 7.24](#), a self-signed certificate and a certificate signing request have been created for the fictional organization *My Company*. The self-signed certificate was issued by the internal CA named *My Company* and the administrator has not yet sent the certificate signing request to Verisign so that it can be signed. Once that certificate is signed and returned by the external CA, it should be imported with a new certificate set to *Import Certificate*. This makes the certificate available as a configurable option for encrypting connections.

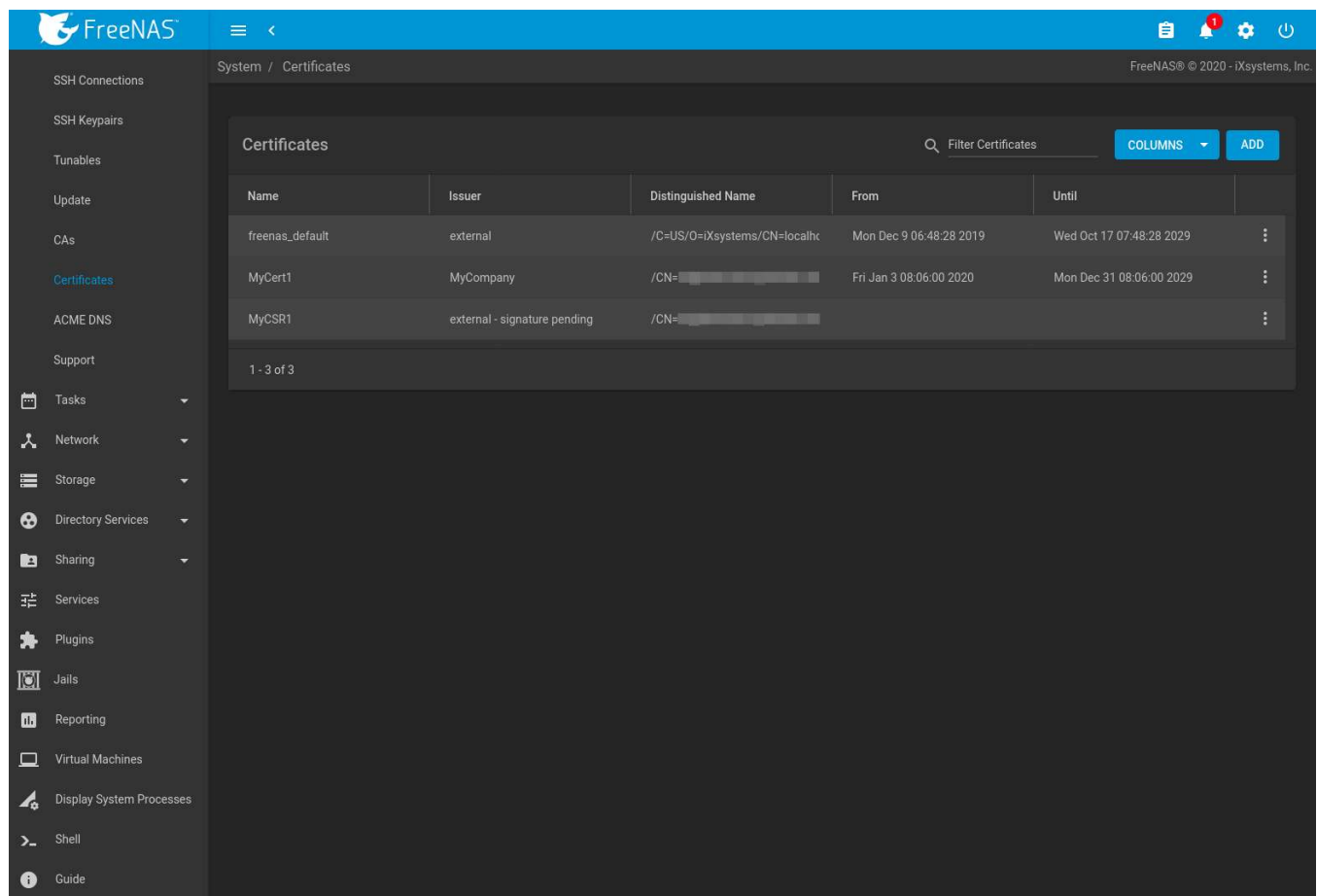




Fig. 7.24: Managing Certificates

Clicking  (Options) for an entry shows these configuration buttons:

- **View:** use this option to view the contents of an existing *Certificate*, *Private Key*, or to edit the *Identifier*.
- **Create ACME Certificate:** use an [ACME DNS](#) (page 119) authenticator to verify, issue, and renew a certificate. Only visible with certificate signing requests.
- **Export Certificate** saves a copy of the certificate or certificate signing request to the system being used to access the FreeNAS® system. For a certificate signing request, send the exported certificate to the external signing authority so that it can be signed.
- **Export Private Key** saves a copy of the private key associated with the certificate or certificate signing request to the system being used to access the FreeNAS® system.
- **Delete** is used to delete a certificate or certificate signing request.

7.16.1 ACME Certificates

[Automatic Certificate Management Environment \(ACME\)](https://ietf-wg-acme.github.io/acme/draft-ietf-acme-acme.html) (<https://ietf-wg-acme.github.io/acme/draft-ietf-acme-acme.html>) is available for automating certificate issuing and renewal. The user must verify ownership of the domain before certificate automation is allowed.

ACME certificates can be created for existing certificate signing requests. These certificates use an [ACME DNS](#) (page 119) authenticator to confirm domain ownership, then are automatically issued and renewed. To create a new ACME certificate, go to *System* → *Certificates*, click  (Options) for an existing certificate signing request, and click *Create ACME Certificate*.

The screenshot shows the FreeNAS web interface. The top navigation bar is blue with the FreeNAS logo and a hamburger menu. The breadcrumb trail is 'System / Certificates / Add ACME Certificate'. The left sidebar is dark grey with various system management options. The main content area is dark grey and contains a form for adding an ACME certificate. The form has the following fields:

- Identifier ***: A text input field with a help icon.
- Terms of Service**: A checkbox with a help icon.
- Renew Certificate Days ***: A text input field with the value '10' and a help icon.
- ACME Server Directory URI ***: A dropdown menu with a help icon.
- Authenticator for**: A dropdown menu with a help icon.

Fig. 7.25: ACME Certificate Options

Table 7.14: ACME Certificate Options

Setting	Value	Description
Identifier	string	Internal identifier of the certificate. Only alphanumeric characters, dash (-), and underline (_) are allowed.
Terms of Service	checkbox	Please accept the terms of service for the given ACME Server.
Renew Certificate Day	integer	Number of days to renew certificate before expiring.
ACME Server Directory URI	drop-down menu	URI of the ACME Server Directory. Choose a preconfigured URI or enter a custom URI.
Authenticator for {Domain Name} ({Domain Name} dynamically changes)	drop-down menu	Authenticator to validate the Domain. Choose a previously configured ACME DNS (page 119) authenticator.

7.17 ACME DNS

Go to *System* → *ACME DNS* and click *ADD* to show options to add a new DNS authenticator to FreeNAS®. This is used to create *ACME Certificates* (page 118) that are automatically issued and renewed after being validated.

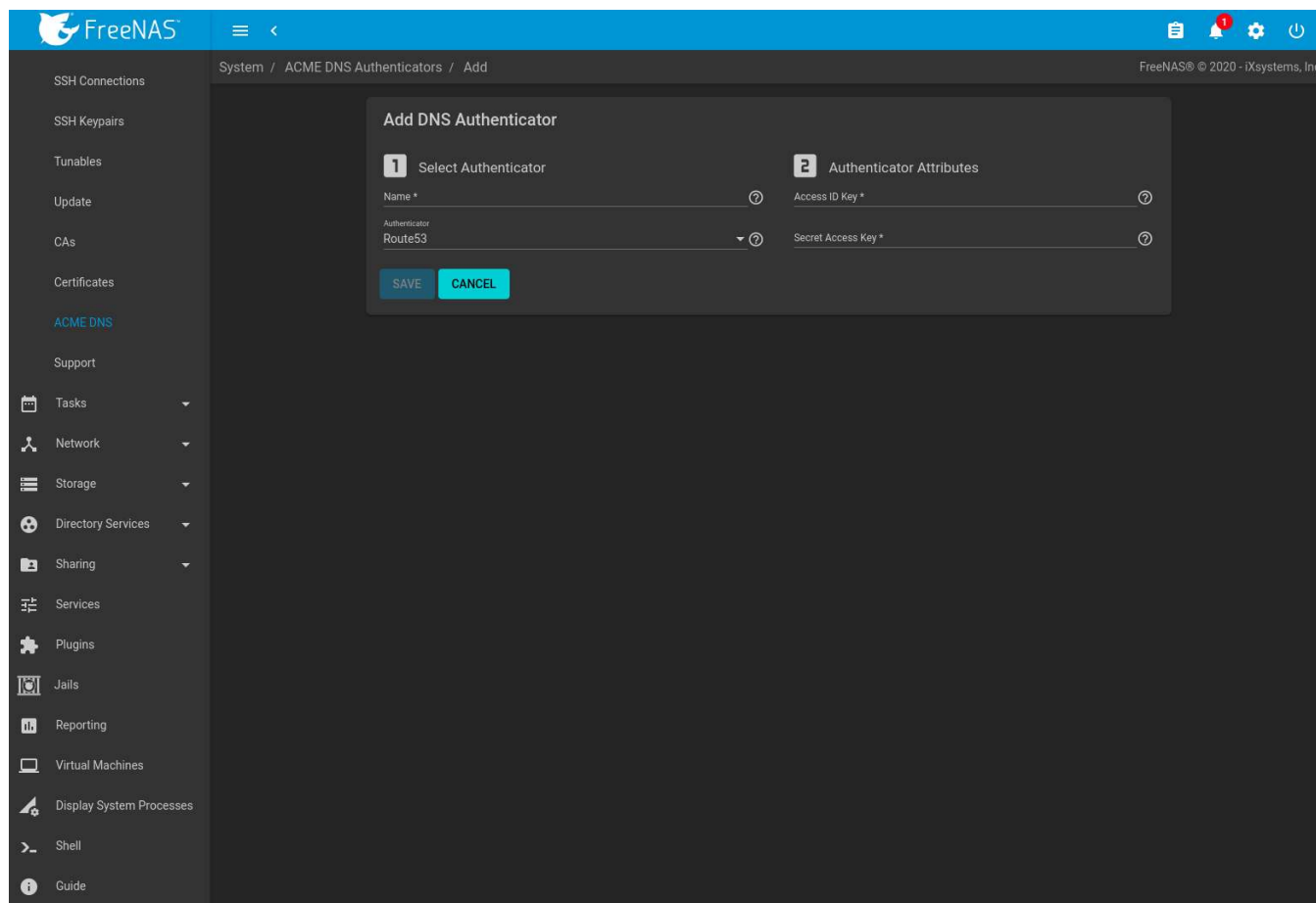


Fig. 7.26: DNS Authenticator Options

Enter a name for the authenticator. This is only used to identify the authenticator in the FreeNAS® web interface. Choose a DNS provider and configure any required *Authenticator Attributes*:

- **Route 53:** Amazon DNS web service. Requires entering an Amazon account *Access ID Key* and *Secret Access Key*. See the [AWS documentation](https://docs.aws.amazon.com/IAM/latest/UserGuide/id_credentials_access-keys.html) (https://docs.aws.amazon.com/IAM/latest/UserGuide/id_credentials_access-keys.html) for more details about generating these keys.

Click *SAVE* to register the DNS Authenticator and add it to the list of authenticator options for *ACME Certificates* (page 118).

7.18 Support

The FreeNAS® *Support* option, shown in [Figure 7.27](#), provides a built-in ticketing system for generating bug reports and feature requests.

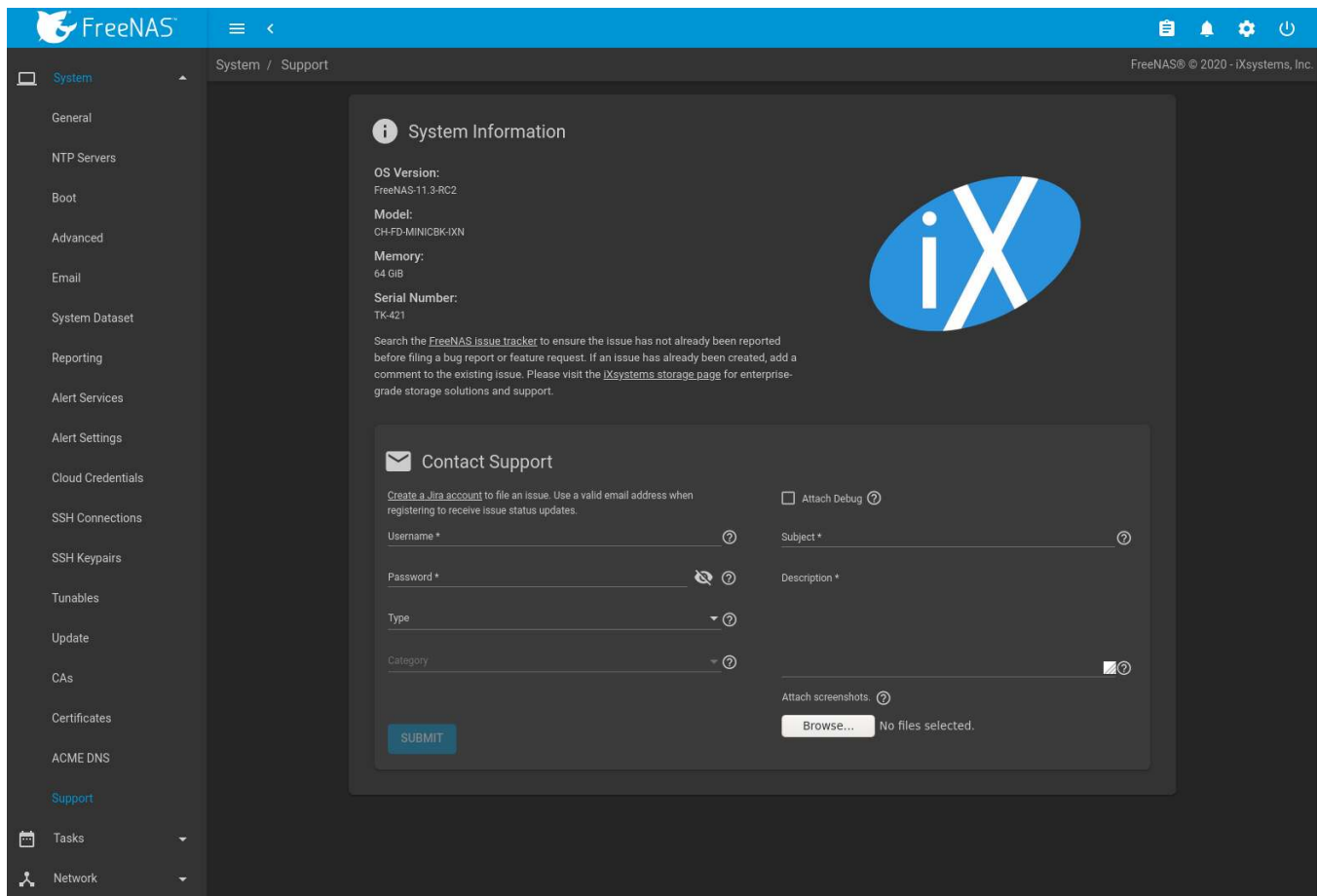


Fig. 7.27: Support Menu

This screen provides a built-in interface to the FreeNAS® issue tracker located at <https://bug.ixsystems.com>.

An account is required to create tickets and receive notifications as issues are addressed.

Log in to an existing account to enter an issue. If you do not have an account yet, go to <https://bug.ixsystems.com>, click *Register*, and fill out the form. Reply to the registration email to validate the account before logging in.

Before creating a bug report or feature request, ensure that an existing report does not already exist at <https://bug.ixsystems.com>. If a similar issue is already present and has not been marked *Closed* or *Resolved*, comment on that issue, adding new information to help solve it. When similar issues are *Closed* or *Resolved*, create a new issue and refer to the previous issue.

Note: Update the system to the latest version of STABLE and retest before reporting an issue. Newer versions of the software might have already fixed the problem.

To generate a report using the built-in *Support* screen, complete these fields:

- **Username:** enter the login name created when registering at <https://bug.ixsystems.com>.
- **Password:** enter the password associated with the registered login name.
- **Type:** select *Bug* when reporting an issue or *Feature* when requesting a new feature.
- **Category:** this drop-down menu is empty until a registered *Username* and *Password* are entered. The field remains empty if either value is incorrect. After the *Username* and *Password* are validated, possible categories are populated to the drop-down menu. Select the one that best describes the bug or feature being reported.

- **Attach Debug:** enabling this option is recommended so an overview of the system hardware, build string, and configuration is automatically generated and included with the ticket. Generating and attaching a debug to the ticket can take some time.

Debug file attachments are limited to 20 MiB. If the debug file is too large to include, unset the option to generate the debug file and let the system create an issue ticket as shown below. Manually create a debug file by going to *System* → *Advanced* and clicking *SAVE DEBUG*.

Go to the ticket at <https://bug.ixsystems.com> and add the debug file as a private attachment.

- **Subject:** enter a descriptive title for the ticket. A good *Subject* makes it easy to find similar reports.
- **Description:** enter a one- to three-paragraph summary of the issue that describes the problem, and if applicable, what steps can be taken to reproduce it.
- **Attach screenshots:** select screenshots on the client system to include with the report.

Click *SUBMIT* to automatically generate and upload the report to the issue tracker (<https://bug.ixsystems.com>). This process can take several minutes while information is collected and sent. All files included with the report are added to the issue tracker ticket as private attachments and can only be accessed by the creator of the ticket and iXsystems.

After the new ticket is created, the ticket URL is shown for viewing or updating with more information.

TASKS

The Tasks section of the web interface is used to configure repetitive tasks:

- [Cron Jobs](#) (page 123) schedules a command or script to automatically execute at a specified time
- [Init/Shutdown Scripts](#) (page 125) configures a command or script to automatically execute during system startup or shutdown
- [Rsync Tasks](#) (page 126) schedules data synchronization to another system
- [S.M.A.R.T. Tests](#) (page 132) schedules disk tests
- [Periodic Snapshot Tasks](#) (page 133) schedules automatic creation of filesystem snapshots
- [Replication Tasks](#) (page 142) automate the replication of snapshots to a remote system
- [Resilver Priority](#) (page 143) controls the priority of resilvers
- [Scrub Tasks](#) (page 144) schedules scrubs as part of ongoing disk maintenance
- [Cloud Sync Tasks](#) (page 146) schedules data synchronization to cloud providers

Each of these tasks is described in more detail in this section.

Note: By default, [Scrub Tasks](#) (page 144) are run once a month by an automatically-created task. [S.M.A.R.T. Tests](#) (page 132) and [Periodic Snapshot Tasks](#) (page 133) must be set up manually.

8.1 Cron Jobs

[cron\(8\)](https://www.freebsd.org/cgi/man.cgi?query=cron) (<https://www.freebsd.org/cgi/man.cgi?query=cron>) is a daemon that runs a command or script on a regular schedule as a specified user.

Navigate to *Tasks* → *Cron Jobs* and click *ADD* to create a cron job. [Figure 8.1](#) shows the configuration screen that appears.

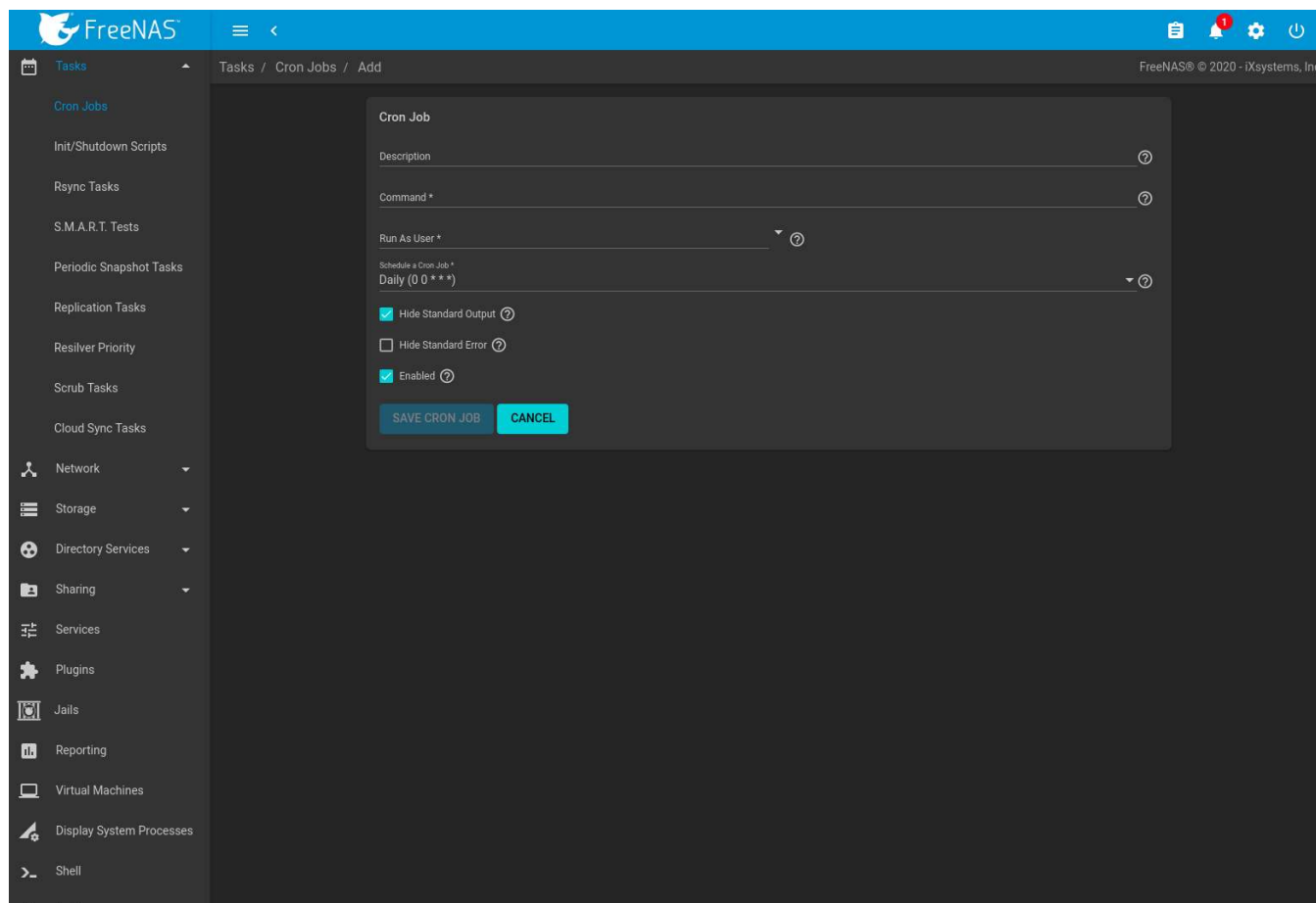


Fig. 8.1: Creating a Cron Job

Table 8.1 lists the configurable options for a cron job.

Table 8.1: Cron Job Options

Setting	Value	Description
Description	string	Enter a description of the cron job.
Command	drop-down menu	Enter the full path to the command or script to be run. If it is a script, testing it at the command line first is recommended.
Run As User	string	Select a user account to run the command. The user must have permissions allowing them to run the command or script. Output from executing a cron task is emailed to this user if <i>Email</i> has been configured for that <i>user account</i> (page 70).
Schedule a Cron Job	drop-down menu	Select how often to run the cron job. Choices are <i>Hourly</i> , <i>Daily</i> , <i>Weekly</i> , <i>Monthly</i> , or <i>Custom</i> . Selecting <i>Custom</i> opens the <i>Advanced Scheduler</i> (page 18).
Hide Standard Output	checkbox	Hide standard output (stdout) from the command. When unset, any standard output is mailed to the user account cron used to run the command.
Hide Standard Error	checkbox	Hide error output (stderr) from the command. When unset, any error output is mailed to the user account cron used to run the command.
Enable	checkbox	Enable this cron job. When unset, disable the cron job without deleting it.

Cron jobs are shown in *Tasks* → *Cron Jobs*. This table displays the user, command, description, schedule, and whether the job is enabled. This table is adjustable by setting the different column checkboxes above it. Set *Tog-*

gle to display all options in the table. Click **:** (Options) for to show the *Run Now*, *Edit*, and *Delete* options.

Note: % symbols are automatically escaped and do not need to be prefixed with backslashes. For example, use `date '+%Y-%m-%d'` in a cron job to generate a filename based on the date.

8.2 Init/Shutdown Scripts

FreeNAS® provides the ability to schedule commands or scripts to run at system startup or shutdown. Go to *Tasks* → *Init/Shutdown Scripts* and click *ADD*.

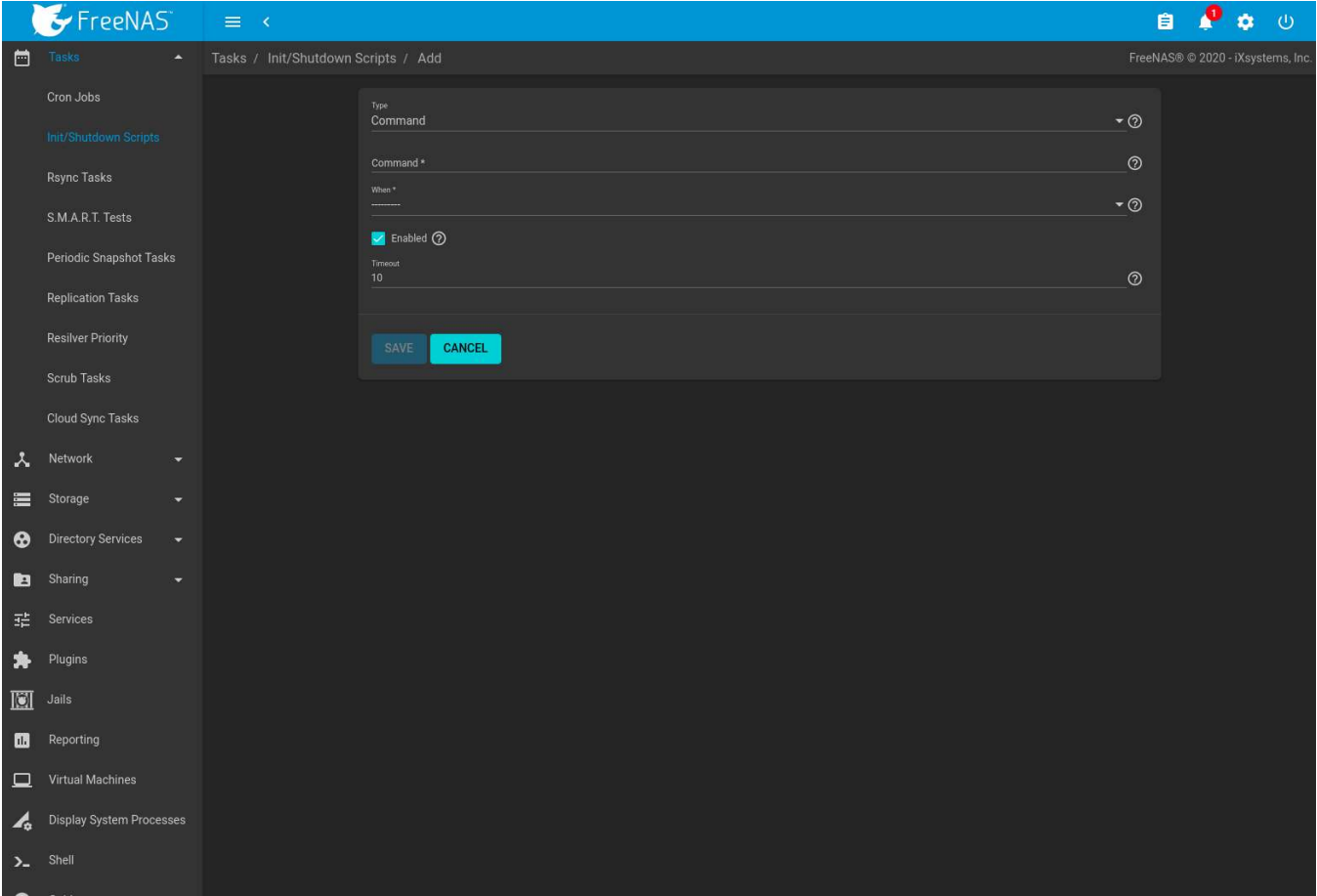



Fig. 8.2: Add an Init/Shutdown Command or Script

Table 8.2: Init/Shutdown Command or Script Options

Setting	Value	Description
Type	drop-down menu	Select <i>Command</i> for an executable or <i>Script</i> for an executable script.
Command or Script	string	If <i>Command</i> is selected, enter the command with any options. When <i>Script</i> is selected, click  (Browse) to select the script from an existing pool.

Continued on next page

Table 8.2 – continued from previous page

Setting	Value	Description
When	drop-down menu	Select when the <i>Command</i> or <i>Script</i> runs: <ul style="list-style-type: none"> • <i>Pre Init</i>: early in the boot process, after mounting filesystems and starting networking • <i>Post Init</i>: at the end of the boot process, before FreeNAS® services start • <i>Shutdown</i>: during the system power off process.
Enabled	checkbox	Enable this task. Unset to disable the task without deleting it.
Timeout	integer	Automatically stop the script or command after the specified number of seconds.

Scheduled commands must be in the default path. The full path to the command can also be included in the entry. The path can be tested with `which {commandname}` in the *Shell* (page 335). When available, the path to the command is shown:

```
[root@freenas ~]# which ls
/bin/ls
```

When scheduling a script, test the script first to verify it is executable and achieves the desired results.

Note: Init/shutdown scripts are run with `sh`.

Init/Shutdown tasks are shown in *Tasks* → *Init/Shutdown Scripts*. Click **:** (Options) for a task to *Edit* or *Delete* that task.

8.3 Rsync Tasks

Rsync (<https://www.samba.org/ftp/rsync/rsync.html>) is a utility that copies specified data from one system to another over a network. Once the initial data is copied, *rsync* reduces the amount of data sent over the network by sending only the differences between the source and destination files. *Rsync* is used for backups, mirroring data on multiple systems, or for copying files between systems.

Rsync is most effective when only a relatively small amount of the data has changed. There are also [some limitations when using rsync with Windows files](https://forums.freenas.org/index.php?threads/impaired-rsync-permissions-support-for-windows-datasets.43973/) (<https://forums.freenas.org/index.php?threads/impaired-rsync-permissions-support-for-windows-datasets.43973/>). For large amounts of data, data that has many changes from the previous copy, or Windows files, *Replication Tasks* (page 142) are often the faster and better solution.

Rsync is single-threaded and gains little from multiple processor cores. To see whether *rsync* is currently running, use `pgrep rsync` from the *Shell* (page 335).

Both ends of an *rsync* connection must be configured:

- **the *rsync* server:** this system pulls (receives) the data. This system is referred to as *PULL* in the configuration examples.
- **the *rsync* client:** this system pushes (sends) the data. This system is referred to as *PUSH* in the configuration examples.

FreeNAS® can be configured as either an *rsync client* or an *rsync server*. The opposite end of the connection can be another FreeNAS® system or any other system running *rsync*. In FreeNAS® terminology, an *rsync task* defines which data is synchronized between the two systems. To synchronize data between two FreeNAS® systems, create the *rsync task* on the *rsync client*.

FreeNAS® supports two modes of *rsync* operation:

- **Module:** exports a directory tree, and the configured settings of the tree as a symbolic name over an unencrypted connection. This mode requires that at least one module be defined on the *rsync* server. It can be

defined in the FreeNAS® web interface under *Services* → *Rsync Configure* → *Rsync Module*. In other operating systems, the module is defined in [rsyncd.conf\(5\)](https://www.samba.org/ftp/rsync/rsyncd.conf.html) (<https://www.samba.org/ftp/rsync/rsyncd.conf.html>).

- **SSH:** synchronizes over an encrypted connection. Requires the configuration of SSH user and host public keys.

This section summarizes the options when creating an rsync task. It then provides a configuration example between two FreeNAS® systems for each mode of rsync operation.

Note: If there is a firewall between the two systems or if the other system has a built-in firewall, make sure that TCP port 873 is allowed.

Figure 8.3 shows the screen that appears after navigating to *Tasks* → *Rsync Tasks* and clicking *ADD*. Table 8.3 summarizes the configuration options available when creating an rsync task.

The screenshot shows the FreeNAS web interface with the 'Rsync Task' configuration form. The form is titled 'Rsync Task' and contains the following fields and options:

- Path ***: A text input field with a browse button icon.
- User ***: A dropdown menu with a help icon.
- Remote Host ***: A text input field with a help icon.
- Rsync Mode**: A dropdown menu with a help icon.
- Remote Module Name ***: A text input field with a help icon.
- Direction ***: A dropdown menu with a help icon.
- Short Description**: A text input field with a help icon.
- Schedule the Rsync Task ***: A dropdown menu with a help icon.
- Recursive**: ☒ with a help icon.
- Times**: ☒ with a help icon.
- Compress**: ☒ with a help icon.
- Archive**: ☐ with a help icon.
- Delete**: ☐ with a help icon.
- Quiet**: ☐ with a help icon.
- Preserve permissions**: ☐ with a help icon.
- Preserve extended attributes**: ☐ with a help icon.
- Delay Updates**: ☒ with a help icon.
- Extra options**: A text input field with a help icon.
- Enabled**: ☒ with a help icon.

Fig. 8.3: Adding an Rsync Task

Table 8.3: Rsync Configuration Options


Setting	Value	Description
Path	browse button	<i>Browse</i> to the path to be copied. FreeNAS® verifies that the remote path exists. <i>FreeBSD path length limits</i> (page 17) apply on the FreeNAS® system. Other operating systems can have different limits which might affect how they can be used as sources or destinations.
User	drop-down menu	Select the user to run the rsync task. The user selected must have permissions to write to the specified directory on the remote host.

Continued on next page

Table 8.3 – continued from previous page

Setting	Value	Description
Remote Host	string	Enter the IP address or hostname of the remote system that will store the copy. Use the format <i>username@remote_host</i> if the user-name differs on the remote host.
Remote SSH Port	integer	Only available in <i>SSH</i> mode. Allows specifying an SSH port other than the default of 22.
Rsync mode	drop-down menu	The choices are <i>Module</i> mode or <i>SSH</i> mode.
Remote Module Name	string	At least one module must be defined in <i>rsyncd.conf(5)</i> (https://www.samba.org/ftp/rsync/rsyncd.conf.html) of the rsync server or in the <i>Rsync Modules</i> of another system.
Remote Path	string	Only appears when using <i>SSH</i> mode. Enter the existing path on the remote host to sync with, for example, <i>/mnt/pool</i> . Note that the path length cannot be greater than 255 characters.
Validate Remote Path	checkbox	Verifies the existence of the <i>Remote Path</i> .
Direction	drop-down menu	Direct the flow of the data to the remote host. Choices are <i>Push</i> or <i>Pull</i> . Default is to push to a remote host.
Short Description	string	Enter a description of the rsync task.
Schedule the Rsync Task	drop-down menu	Choose how often to run the task. Choices are <i>Hourly</i> , <i>Daily</i> , <i>Weekly</i> , <i>Monthly</i> , or <i>Custom</i> . Selecting <i>Custom</i> opens the <i>Advanced Scheduler</i> (page 18).
Recursive	checkbox	Set to include all subdirectories of the specified directory. When unset, only the specified directory is included.
Times	checkbox	Set to preserve the modification times of files.
Compress	checkbox	Set to reduce the size of the data to transmit. Recommended for slow connections.
Archive	checkbox	When set, rsync is run recursively, preserving symlinks, permissions, modification times, group, and special files. When run as root, owner, device files, and special files are also preserved. Equivalent to <code>rsync -rlptgoD</code> .
Delete	checkbox	Set to delete files in the destination directory that do not exist in the source directory.
Quiet	checkbox	Suppress rsync task status <i>alerts</i> (page 339).
Preserve permissions	checkbox	Set to preserve original file permissions. This is useful when the user is set to <i>root</i> .
Preserve extended attributes	checkbox	<i>Extended attributes</i> (https://en.wikipedia.org/wiki/Extended_file_attributes) are preserved, but must be supported by both systems.
Delay Updates	checkbox	Set to save the temporary file from each updated file to a holding directory until the end of the transfer when all transferred files are renamed into place.
Extra options	string	Additional <i>rsync(1)</i> (http://rsync.samba.org/ftp/rsync/rsync.html) options to include. Note: The * character must be escaped with a backslash (<code>*.txt</code>) or used inside single quotes. (<code>'*.txt'</code>)
Enabled	checkbox	Enable this rsync task. Unset to disable this rsync task without deleting it.

If the rsync server requires password authentication, enter `--password-file=/PATHTO/FILENAME` in the *Extra options* field, replacing `/PATHTO/FILENAME` with the appropriate path to the file containing the password.

Created rsync tasks are listed in *Rsync Tasks*. Click  (Options) for an entry to display buttons for *Edit*, *Delete*, or *Run Now*.

The *Status* column shows the status of the rsync task. To view the detailed rsync logs for a task, click the *Status* entry when the task is running or finished.

Rsync tasks also generate an [Alert](#) (page 339) on task completion. The alert shows if the task succeeded or failed.

8.3.1 Rsync Module Mode

This configuration example configures rsync module mode between the two following FreeNAS® systems:

- 192.168.2.2 has existing data in `/mnt/local/images`. It will be the rsync client, meaning that an rsync task needs to be defined. It will be referred to as *PUSH*.
- 192.168.2.6 has an existing pool named `/mnt/remote`. It will be the rsync server, meaning that it will receive the contents of `/mnt/local/images`. An rsync module needs to be defined on this system and the rsyncd service needs to be started. It will be referred to as *PULL*.

On *PUSH*, an rsync task is defined in *Tasks* → *Rsync Tasks*, *ADD*. In this example:

- the *Path* points to `/usr/local/images`, the directory to be copied
- the *Remote Host* points to 192.168.2.6, the IP address of the rsync server
- the *Rsync Mode* is *Module*
- the *Remote Module Name* is *backups*; this will need to be defined on the rsync server
- the *Direction* is *Push*
- the rsync is scheduled to occur every 15 minutes
- the *User* is set to *root* so it has permission to write anywhere
- the *Preserve Permissions* option is enabled so that the original permissions are not overwritten by the *root* user

On *PULL*, an rsync module is defined in *Services* → *Rsync Configure* → *Rsync Module*, *ADD*. In this example:

- the *Module Name* is *backups*; this needs to match the setting on the rsync client
- the *Path* is `/mnt/remote`; a directory called `images` will be created to hold the contents of `/usr/local/images`
- the *User* is set to *root* so it has permission to write anywhere

Descriptions of the configurable options can be found in [Rsync Modules](#) (page 265).

- *Hosts allow* is set to 192.168.2.2, the IP address of the rsync client

To finish the configuration, start the rsync service on *PULL* in *Services*. If the rsync is successful, the contents of `/mnt/local/images/` will be mirrored to `/mnt/remote/images/`.

8.3.2 Rsync over SSH Mode

SSH replication mode does not require the creation of an rsync module or for the rsync service to be running on the rsync server. It does require SSH to be configured before creating the rsync task:

- a public/private key pair for the rsync user account (typically *root*) must be generated on *PUSH* and the public key copied to the same user account on *PULL*
- to mitigate the risk of man-in-the-middle attacks, the public host key of *PULL* must be copied to *PUSH*
- the SSH service must be running on *PULL*

To create the public/private key pair for the rsync user account, open [Shell](#) (page 335) on *PUSH* and run `ssh-keygen`. This example generates an RSA type public/private key pair for the *root* user. When creating the key pair, do not enter the passphrase as the key is meant to be used for an automated task.

```
ssh-keygen -t rsa
Generating public/private rsa key pair.
Enter file in which to save the key (/root/.ssh/id_rsa):
Created directory '/root/.ssh'.
Enter passphrase (empty for no passphrase):
```

```

Enter same passphrase again:
Your identification has been saved in /root/.ssh/id_rsa.
Your public key has been saved in /root/.ssh/id_rsa.pub.
The key fingerprint is:
f5:b0:06:d1:33:e4:95:cf:04:aa:bb:6e:a4:b7:2b:df root@freenas.local
The key's randomart image is:
+--[ RSA 2048]-----+
|      .o. oo      |
|      o+o. .      |
|      . =o +      |
|      + +   o      |
|      S o .        |
|      .o           |
|      o.           |
|      o oo         |
|      **oE         |
|-----|
|
|-----|

```

FreeNAS® supports RSA keys for SSH. When creating the key, use `-t rsa` to specify this type of key. Refer to [Key-based Authentication](https://www.freebsd.org/doc/en_US.ISO8859-1/books/handbook/openssh.html#security-ssh-keygen) (https://www.freebsd.org/doc/en_US.ISO8859-1/books/handbook/openssh.html#security-ssh-keygen) for more information.

Note: If a different user account is used for the rsync task, use the `su -` command after mounting the filesystem but before generating the key. For example, if the rsync task is configured to use the `user1` user account, use this command to become that user:

```
su - user1
```

Next, view and copy the contents of the generated public key:

```

more .ssh/id_rsa.pub
ssh-rsa AAAAB3NzaC1yc2EAAAADAQABAAQAC1lBEXRgw1W8y8k+lXPlVR3xsmVSjtsoyIzV/PlQPoSrWotUQzqILq0SmUpViAAv4Ik3T8NtxXyohKmFNbBczU6tEsVGHo/2BLjvKiSHRPHc/1DX9hofcFti4hdcD7Y5mvU3MAEeDClt02/xoi5xS/RLxgP0R5dNrakw958Yn001sJS9VMf528fknUmasti00qmDDcp/kOxT+S6DFNDBY6IYQN4heqmhTPRXqPhXqcD1G+rWr/nZK4H8Ckzy+l9RaEXMRuTyQgqJB/rsRcmJX5fApdDmNfwrRSxLjDvUzfywnjFh1Kk/+TQIT1gg1QQaj21PJD9pnDVF0AiJrWyWnR root@freenas.local

```

Go to *PULL* and paste (or append) the copied key into the *SSH Public Key* field of *Accounts* → *Users* → *root* → *:* (Options) → *Edit*, or the username of the specified rsync user account. The paste for the above example is shown in [Figure 8.4](#). When pasting the key, ensure that it is pasted as one long line and, if necessary, remove any extra spaces representing line breaks.

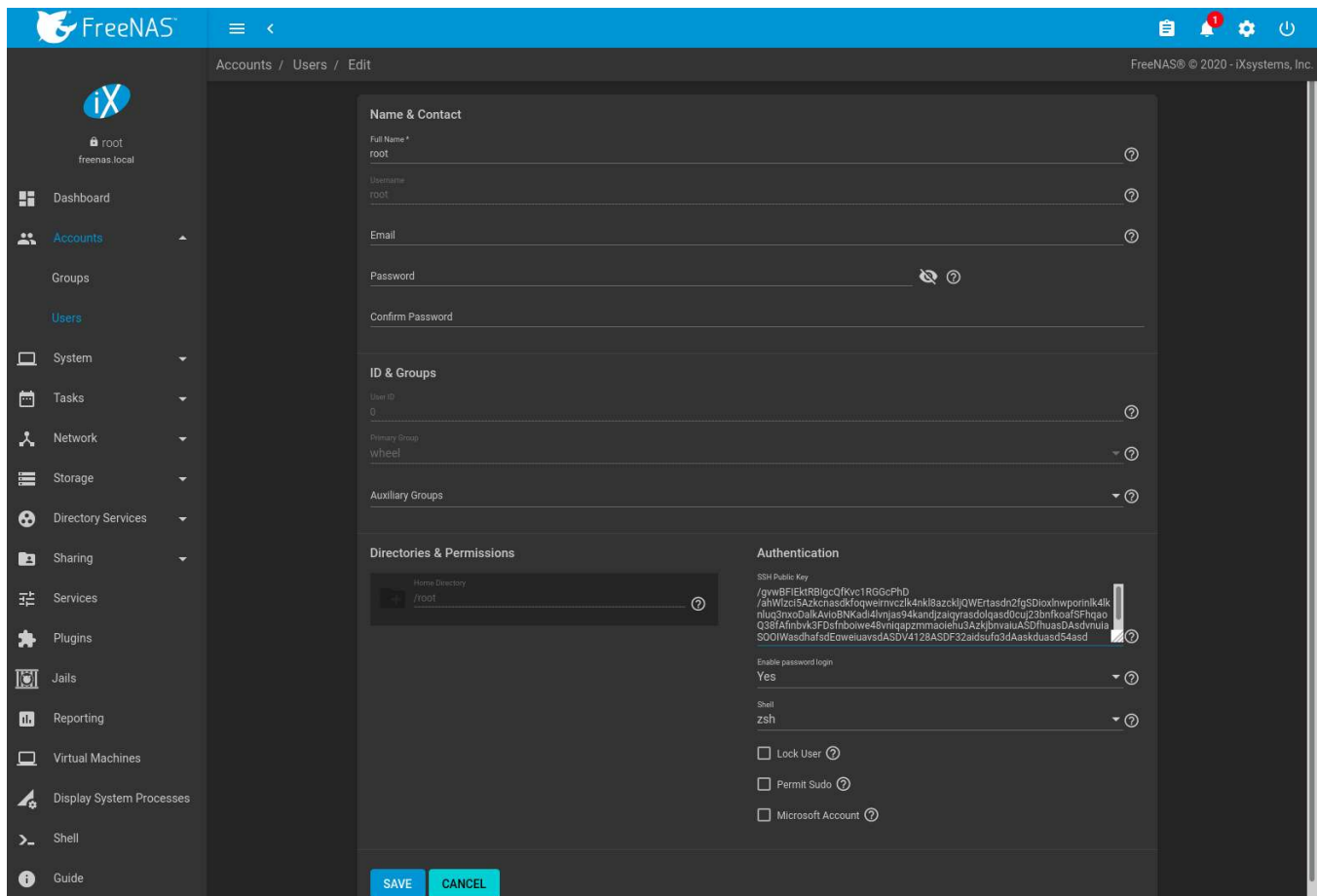


Fig. 8.4: Pasting the User SSH Public Key

While on *PULL*, verify that the SSH service is running in *Services* and start it if it is not.

Next, copy the host key of *PULL* using Shell on *PUSH*. The command copies the RSA host key of the *PULL* server used in our previous example. Be sure to include the double bracket `>>` to prevent overwriting any existing entries in the `known_hosts` file:

```
ssh-keyscan -t rsa 192.168.2.6 >> /root/.ssh/known_hosts
```

Note: If *PUSH* is a Linux system, use this command to copy the RSA key to the Linux system:

```
cat ~/.ssh/id_rsa.pub | ssh user@192.168.2.6 'cat >> .ssh/authorized_keys'
```

The rsync task can now be created on *PUSH*. To configure rsync SSH mode using the systems in our previous example, the configuration is:

- the *Path* points to `/mnt/local/images`, the directory to be copied
- the *Remote Host* points to `192.168.2.6`, the IP address of the rsync server
- the *Rsync Mode* is *SSH*
- the rsync is scheduled to occur every 15 minutes
- the *User* is set to *root* so it has permission to write anywhere; the public key for this user must be generated on *PUSH* and copied to *PULL*
- the *Preserve Permissions* option is enabled so that the original permissions are not overwritten by the *root* user

Save the rsync task and the rsync will automatically occur according to the schedule. In this example, the contents of `/mnt/local/images/` will automatically appear in `/mnt/remote/images/` after 15 minutes. If the content does not appear, use Shell on *PULL* to read `/var/log/messages`. If the message indicates a *n* (newline character) in the key, remove the space in the pasted key—it will be after the character that appears just before the *n* in the error message.

8.4 S.M.A.R.T. Tests

S.M.A.R.T. (<https://en.wikipedia.org/wiki/S.M.A.R.T.>) (Self-Monitoring, Analysis and Reporting Technology) is a monitoring system for computer hard disk drives to detect and report on various indicators of reliability. Replace the drive when a failure is anticipated by S.M.A.R.T. Most modern ATA, IDE, and SCSI-3 hard drives support S.M.A.R.T. – refer to the drive documentation for confirmation.

Click *Tasks* → *S.M.A.R.T. Tests* and *ADD* to add a new scheduled S.M.A.R.T. test. [Figure 8.5](#) shows the configuration screen that appears. Tests are listed under *S.M.A.R.T. Tests*. After creating tests, check the configuration in *Services* → *S.M.A.R.T.*, then click the power button for the S.M.A.R.T. service in *Services* to activate the service. The S.M.A.R.T. service will not start if there are no pools.

Note: To prevent problems, do not enable the S.M.A.R.T. service if the disks are controlled by a RAID controller. It is the job of the controller to monitor S.M.A.R.T. and mark drives as Predictive Failure when they trip.

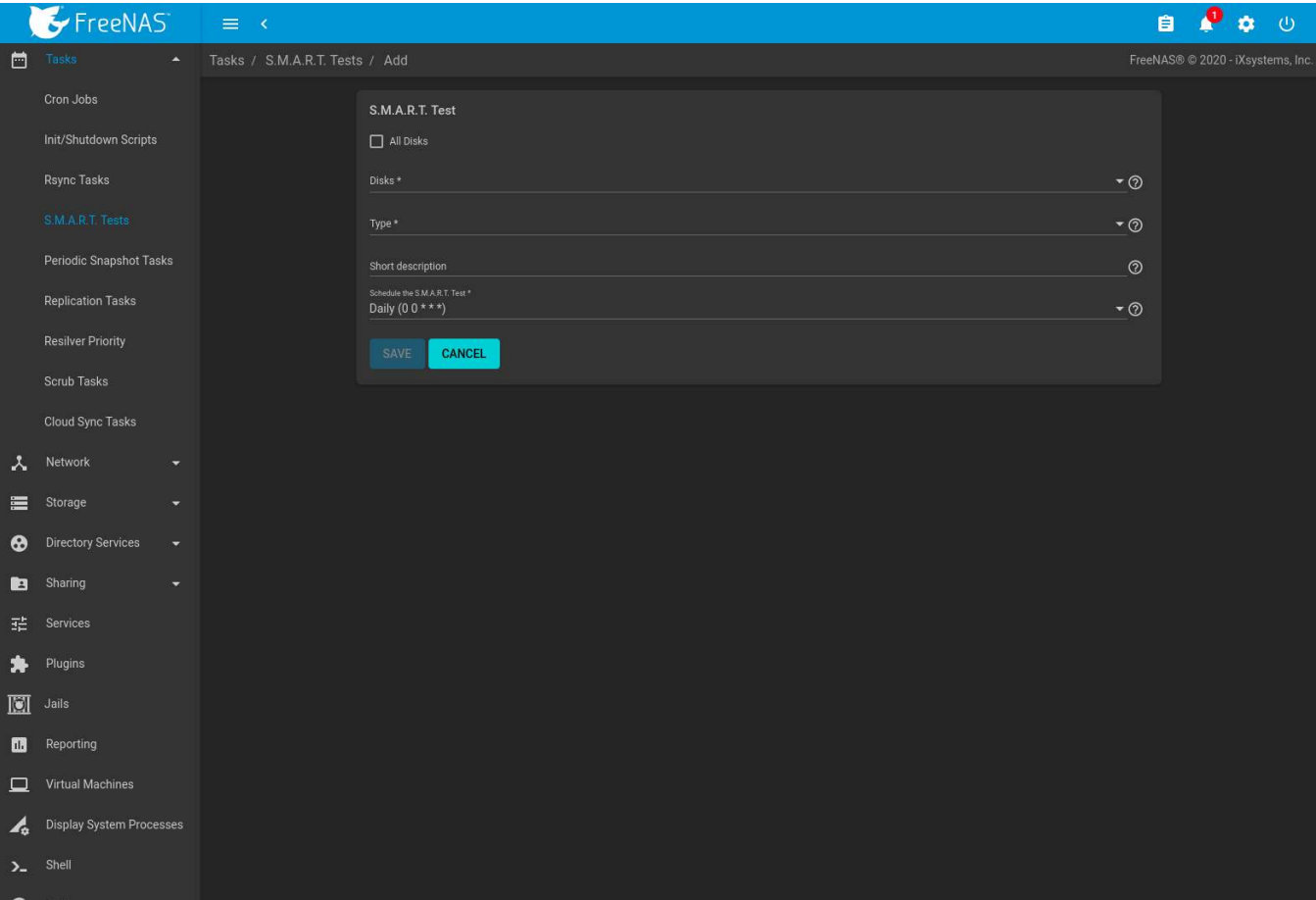


Fig. 8.5: Adding a S.M.A.R.T. Test

[Table 8.4](#) summarizes the configurable options when creating a S.M.A.R.T. test.

Table 8.4: S.M.A.R.T. Test Options

Setting	Value	Description
All Disks	checkbox	Set to monitor all disks.
Disks	drop-down menu	Select the disks to monitor. Available when <i>All Disks</i> is unset.
Type	drop-down menu	Choose the test type. See smartctl(8) (https://www.smartmontools.org/browser/trunk/smartmontools/smartctl.8.in) for descriptions of each type. Some test types will degrade performance or take disks offline. Avoid scheduling S.M.A.R.T. tests simultaneously with scrub or resilver operations.
Short description	string	Optional. Enter a description of the S.M.A.R.T. test.
Schedule the S.M.A.R.T. Test	drop-down menu	Choose how often to run the task. Choices are <i>Hourly</i> , <i>Daily</i> , <i>Weekly</i> , <i>Monthly</i> , or <i>Custom</i> . Selecting <i>Custom</i> opens the Advanced Scheduler (page 18).

An example configuration is to schedule a *Short Self-Test* once a week and a *Long Self-Test* once a month. These tests do not have a performance impact, as the disks prioritize normal I/O over the tests. If a disk fails a test, even if the overall status is *Passed*, consider replacing that disk.

Warning: Some S.M.A.R.T. tests cause heavy disk activity and can drastically reduce disk performance. Do not schedule S.M.A.R.T. tests to run at the same time as scrub or resilver operations or during other periods of intense disk activity.

Which tests will run and when can be verified by typing `smartd -q showtests` within [Shell](#) (page 335).

The results of a test can be checked from [Shell](#) (page 335) by specifying the name of the drive. For example, to see the results for disk *ada0*, type:

```
smartctl -l selftest /dev/ada0
```

8.5 Periodic Snapshot Tasks

A periodic snapshot task allows scheduling the creation of read-only versions of pools and datasets at a given point in time. Snapshots can be created quickly and, if little data changes, new snapshots take up very little space. For example, a snapshot where no files have changed takes 0 MB of storage, but as changes are made to files, the snapshot size changes to reflect the size of the changes.

Snapshots keep a history of files, providing a way to recover an older copy or even a deleted file. For this reason, many administrators take snapshots often, store them for a period of time, and store them on another system, typically using [Replication Tasks](#) (page 142). Such a strategy allows the administrator to roll the system back to a specific point in time. If there is a catastrophic loss, an off-site snapshot can be used to restore the system up to the time of the last snapshot.

A pool must exist before a snapshot can be created. Creating a pool is described in [Pools](#) (page 164).

View the list of periodic snapshot tasks by going to [Tasks](#) → [Periodic Snapshot Tasks](#). If a periodic snapshot task encounters an error, the status column will show *ERROR*. Click the status to view the logs of the task.

To create a periodic snapshot task, navigate to [Tasks](#) → [Periodic Snapshot Tasks](#) and click *ADD*. This opens the screen shown in [Figure 8.6](#). [Table 8.5](#) describes the fields in this screen.

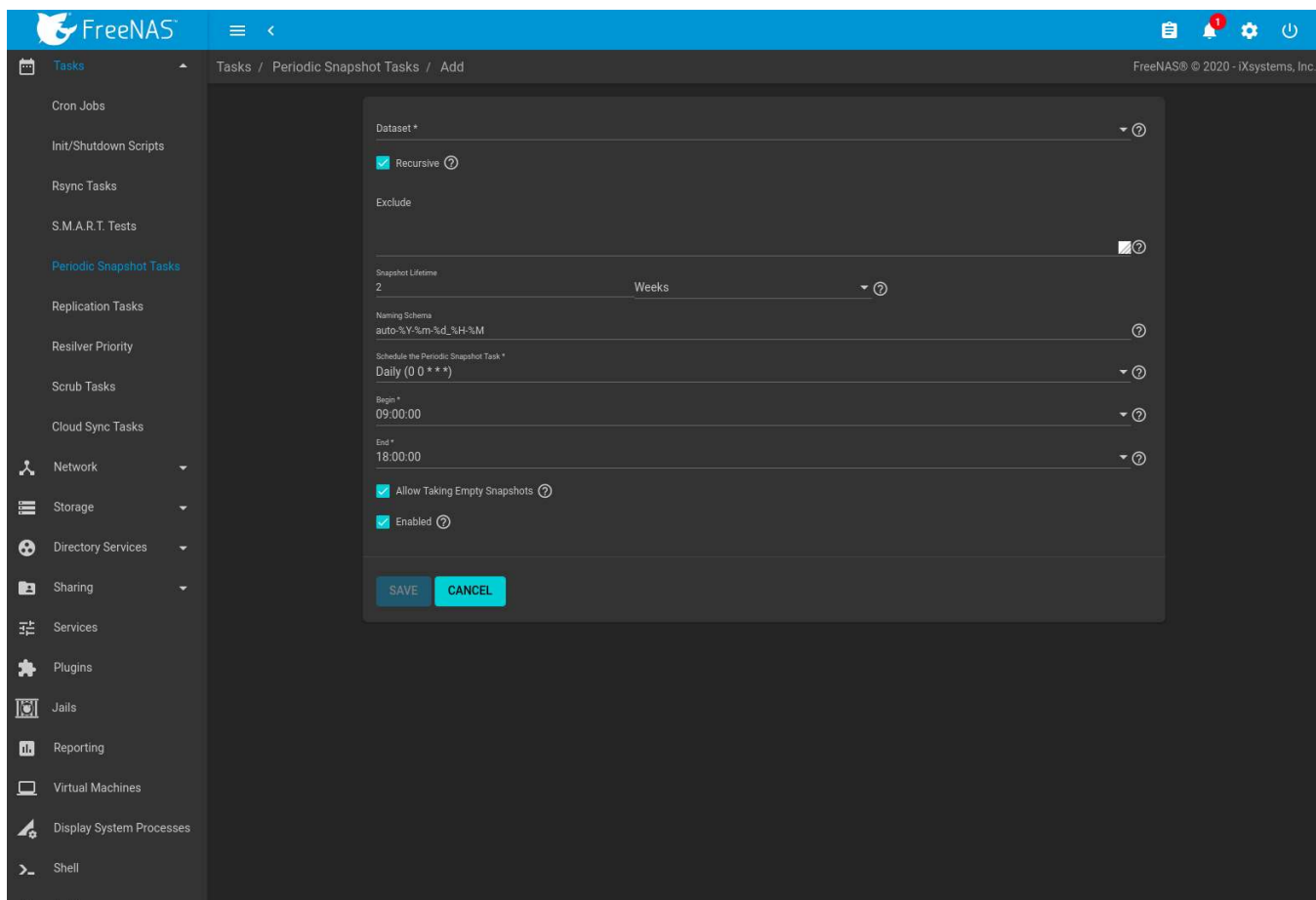


Fig. 8.6: Creating a Periodic Snapshot

Table 8.5: Periodic Snapshot Options

Setting	Value	Description
Dataset	drop-down menu	Select an existing dataset, or zvol.
Recursive	checkbox	Set this option to take separate snapshots of the pool or dataset and each of the child datasets. Deselect to take a single snapshot of the specified pool or dataset with no child datasets.
Exclude	string	Exclude specific child dataset snapshots from the snapshot. Use with <i>Recursive</i> snapshots. Add one child dataset name per line. Example: pool1/dataset1/child1. A recursive snapshot of pool1/dataset1 includes all child dataset snapshots except child1.
Snapshot Lifetime	integer and drop-down menu	Define a length of time to retain the snapshot on this system. After the time expires, the snapshot is removed. Snapshots replicated to other systems are not affected.
Snapshot Lifetime Unit	drop-down	Select a unit of time to retain the snapshot on this system.
Naming Schema	string	Snapshot name format string. The default is <code>auto-%Y-%m-%d_%H-%M</code> . Must include the strings <code>%Y</code> , <code>%m</code> , <code>%d</code> , <code>%H</code> , and <code>%M</code> . These strings are replaced with the four-digit year, month, day of month, hour, and minute as defined in <code>strftime(3)</code> (https://www.freebsd.org/cgi/man.cgi?query=strftime). Example: <code>backups_%Y-%m-%d_%H:%M</code>


Continued on next page

Table 8.5 – continued from previous page

Setting	Value	Description
Schedule the Periodic Snapshot Task	drop-down menu	When the periodic snapshot will run. Choose one of the preset schedules or choose <i>Custom</i> to use the Advanced Scheduler (page 18).
Begin	drop-down menu	Hour and minute when the system can begin taking snapshots.
End	drop-down menu	Hour and minute the system must stop creating snapshots. Snapshots already in progress will continue until complete.
Allow Taking Empty Snapshots	checkbox	Creates dataset snapshots when there are no changes. Set to support periodic snapshot schedules and replications created in FreeNAS® 11.2 and earlier.
Enabled	checkbox	Set to activate this periodic snapshot schedule.

Setting *Recursive* adds child datasets to the snapshot. Creating separate snapshots for each child dataset is not needed.

Click *SAVE* when finished customizing the task. Defined tasks are listed alphabetically in *Tasks* → *Periodic Snapshot Tasks*.

Click  (Options) for a periodic snapshot task to see options to *Edit* or *Delete* the scheduled task.

Deleting a dataset does not delete snapshot tasks for that dataset. To re-use the snapshot task for a different dataset, *Edit* the task and choose the new *Dataset*. The original dataset is shown in the drop-down, but cannot be selected.

Deleting the last periodic snapshot task used by a replication task is not permitted while that replication task remains active. The replication task must be disabled before the related periodic snapshot task can be deleted.

8.6 Replication

Replication is the process of copying [ZFS dataset snapshots](#) (page 366) from one storage pool to another. Replications can be configured to copy snapshots to another pool on the local system or send copies to a remote system that is in a different physical location.

Replication schedules are typically paired with [Periodic Snapshot Tasks](#) (page 133) to generate local copies of important data and replicate these copies to a remote system.

Replications require a source system with dataset snapshots and a destination that can store the copied data. Remote replications require a saved [SSH Connection](#) (page 98) on the source system and the destination system must be configured to allow [SSH](#) (page 274) connections. Local replications do not use SSH.

Snapshots are organized and sent to the destination according to the creation date included in the snapshot name. When replicating manually created snapshots, make sure snapshots are named according to their actual creation date.

First-time replication tasks can take a long time to complete as the entire dataset snapshot must be copied to the destination system. Replicated data is not visible on the receiving system until the replication task is complete.

Later replications only send incremental snapshot changes to the destination system. This reduces both the total space required by replicated data and the network bandwidth required for the replication to complete.

The replication task asks to destroy destination dataset snapshots when those snapshots are not related to the replication snapshots. Verify that the snapshots in the destination dataset are unneeded or are backed up in a different location! Allowing the replication task to continue destroys the current snapshots in the destination dataset and replicates a full copy of the source snapshots.

The target dataset on the destination system is created in *read-only* mode to protect the data. To mount or browse the data on the destination system, use a clone of the snapshot. Clones are created in *read/write* mode, making it possible to browse or mount them. See [Snapshots](#) (page 186) for more details.

Replications run in parallel as long as they do not conflict with each other. Completion time depends on the number and size of snapshots and the bandwidth available between the source and destination computers.

Examples in this section refer to the FreeNAS® system with the original datasets for snapshot and replication as *Primary* and the FreeNAS® system that is storing replicated snapshots as *Secondary*.

8.6.1 Replication Creation Wizard

To create a new replication, go to *Tasks* → *Replication Tasks* and click *ADD*.

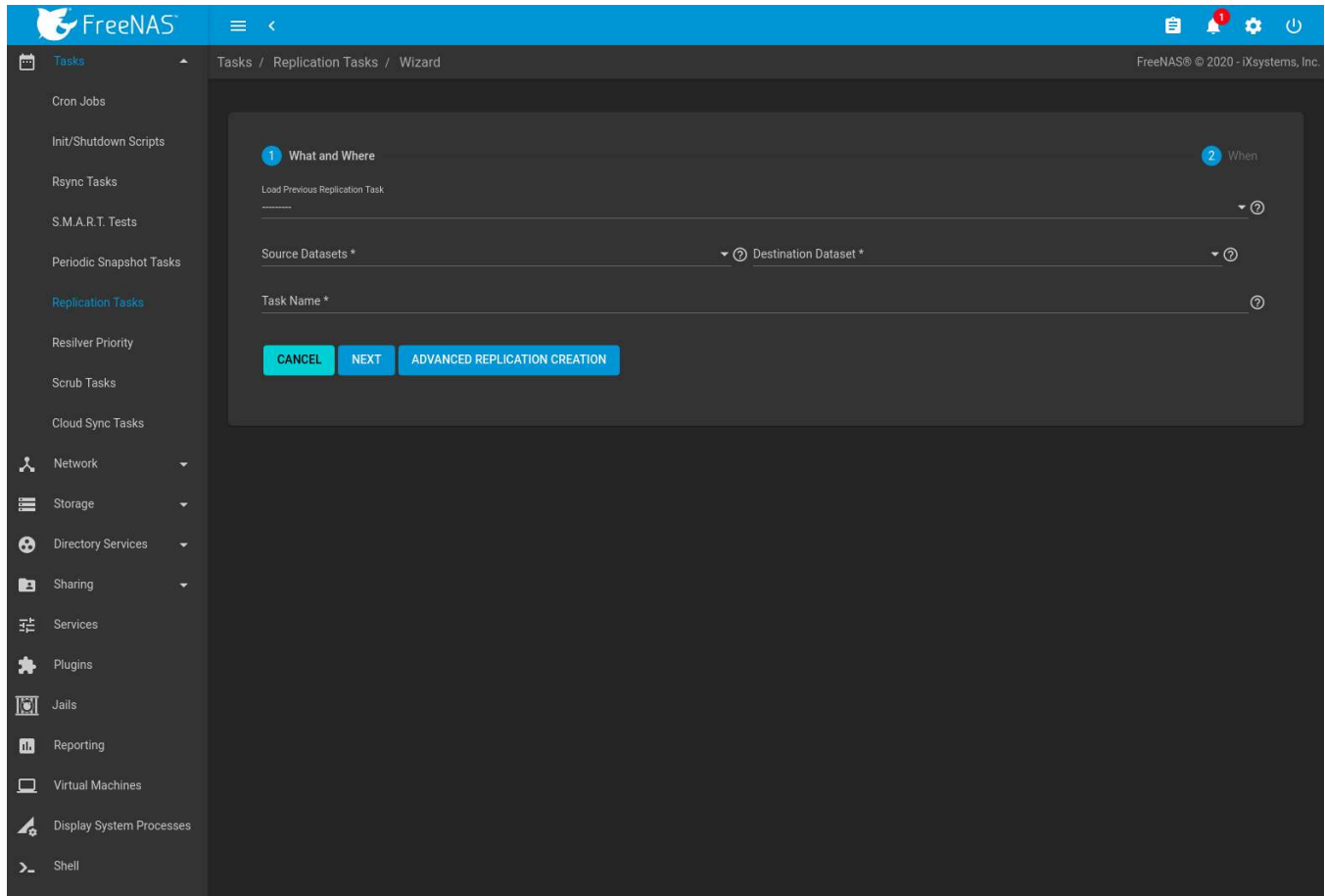



Fig. 8.7: Replication Wizard: What and Where

The wizard allows loading previously saved replication configurations and simplifies many replication settings. To see all possible *replication creation options* (page 138), click *ADVANCED REPLICATION CREATION*.

Using the wizard to create a new replication task begins by defining what is being replicated and where. Choosing *On a Different System* for either the *Sources Datasets* or *Destination Dataset* requires an *SSH Connection* (page 98) to the remote system. Open the drop-down menu to choose an SSH connection or click *Create New* to add a new connection.

To choose a dataset, click  (Browse) and select the dataset from the expandable tree. The path of the dataset can also be typed into the field. Multiple *Source Datasets* can be chosen.

Start by selecting the *Source Datasets* to be replicated. Source datasets on the local system are replicated using existing snapshots of the chosen datasets. When no snapshots exist, FreeNAS® automatically creates snapshots of the chosen datasets before starting the replication. To manually define which dataset snapshots to replicate, set *Replicate Custom Snapshots* and define a snapshot *Naming Schema*.

Source datasets on a remote system are replicated by defining a snapshot *Naming Schema*. The schema is a pattern of the name and *strftime(3)* (<https://www.freebsd.org/cgi/man.cgi?query=strftime>) %Y, %m, %d, %H, and %M strings that match names of the snapshots to include in the replication. For example, to replicate a snapshot

named `auto-2019-12-18.05-20-2w` from a remote source, enter `auto-%Y-%m-%d.%H-%M-2w` as the replication task *Naming Schema*.

The number of snapshots that will be replicated is shown. There is also a *Recursive* option to include child datasets with the selected datasets.

Now choose the *Destination Dataset* to receive the replicated snapshots. Only a single dataset can be chosen.

Using an SSH connection for replication adds the *SSH Transfer Security* option. This sets the data transfer security level. The connection is authenticated with SSH. Data can be encrypted during transfer for security or left unencrypted to maximize transfer speed. **WARNING:** Encryption is recommended, but can be disabled for increased speed on secure networks.

A suggested replication *Task Name* is shown. This can be changed to give a more meaningful name to the task. When the source and destination have been set, click *NEXT* to choose when the replication will run.

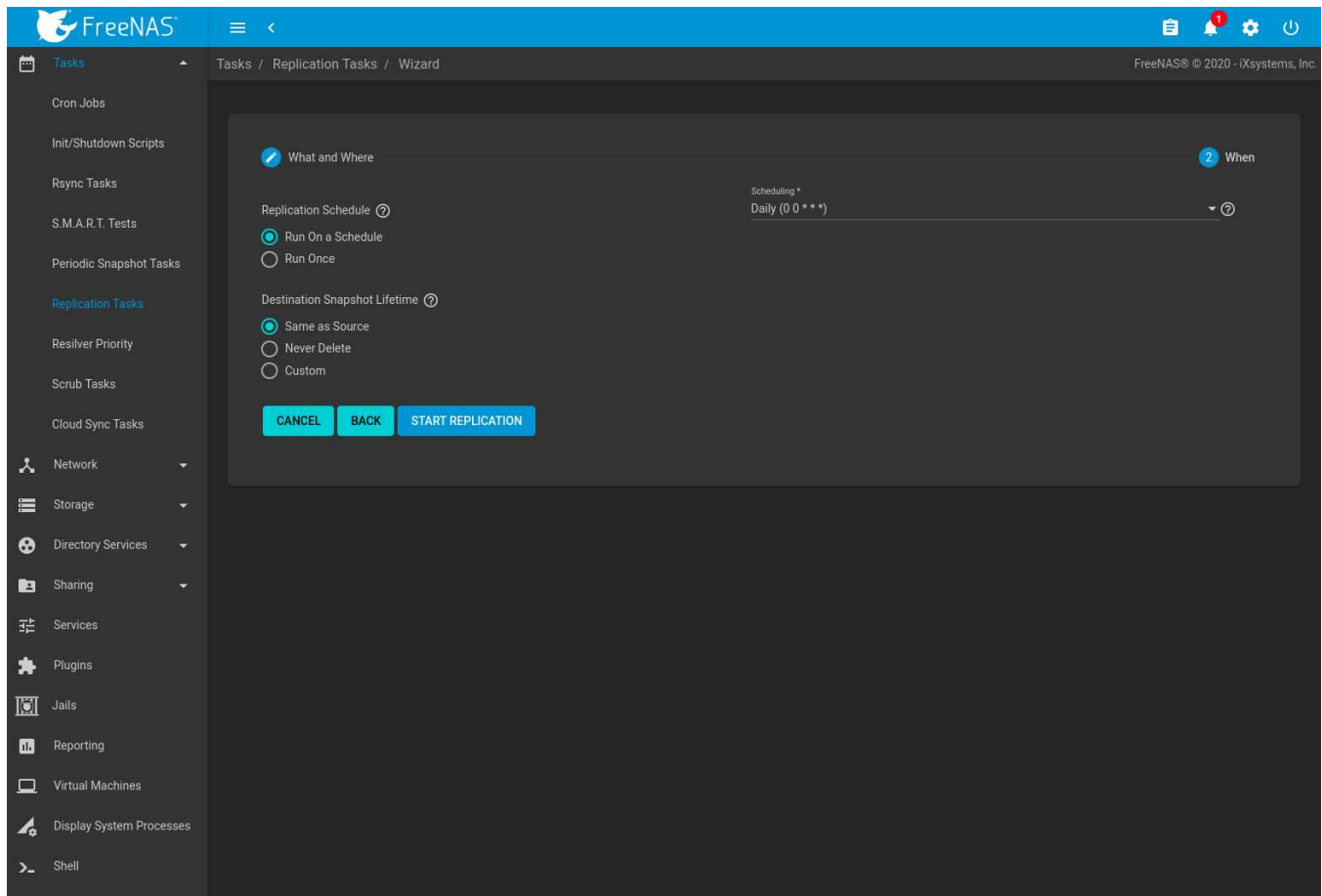


Fig. 8.8: Replication Wizard: When

The replication task can be configured to run on a schedule or left unscheduled and manually activated. Choosing *Run On a Schedule* adds the *Scheduling* drop-down to choose from preset schedules or define a *Custom* replication schedule. Choosing *Run Once* removes all scheduling options.

Destination Snapshot Lifetime determines when replicated snapshots are deleted from the destination system:

- *Same as Source*: duplicate the configured *Snapshot Lifetime* value from the source dataset *periodic snapshot task* (page 133).
- *Never Delete*: never delete snapshots from the destination system.
- *Custom*: define how long a snapshot remains on the destination system. Enter a number and choose a measure of time from the drop-down menus.

Clicking *START REPLICATION* saves the replication configuration and activates the schedule. When the replication configuration includes a source dataset on the local system and has a schedule, a *periodic snapshot task* (page 133) of that dataset is also created.

Tasks set to *Run Once* will start immediately. If a one-time replication has no valid local system source dataset snapshots, FreeNAS® will snapshot the source datasets and immediately replicate those snapshots to the destination dataset.

All replication tasks are displayed in *Tasks* → *Replication Tasks*. The task settings that are shown by default can be adjusted by opening the *COLUMNS* drop-down. To see more details about the last time the replication task ran, click the entry under the *State* column. Tasks can also be expanded by clicking > (Expand) for that task. Expanded tasks show all replication settings and have ► *RUN NOW*, ✎ *EDIT*, and 🗑 *DELETE* buttons.

8.6.2 Advanced Replication Creation

The advanced replication creation screen has more options for fine-tuning a replication. It also allows creating local replications, legacy engine replications from FreeNAS® 11.1 or earlier, or even creating a one-time replication that is not linked to a periodic snapshot task.





Go to *System* → *Replication Tasks*, click *ADD* and *ADVANCED REPLICATION CREATION* to see these options. This screen is also displayed after clicking ⋮ (Options) and *Edit* for an existing replication.

The *Transport* value changes many of the options for replication. Table 8.6 shows abbreviated names of the *Transport* methods in the *Transport* column to identify fields which appear when that method is selected.

- ALL: All *Transport* methods
- SSH: *SSH*

- NCT: *SSH+NETCAT*
- LOC: *LOCAL*
- LEG: *LEGACY*

Table 8.6: Replication Task Options

Setting	Transport	Value	Description
Name	All	string	Descriptive name for the replication.
Direction	SSH, NCT, LEG	drop-down menu	<i>PUSH</i> sends snapshots to a destination system. <i>PULL</i> connects to a remote system and retrieves snapshots matching a <i>Naming Schema</i> .
Transport	All	drop-down menu	Method of snapshot transfer: <ul style="list-style-type: none"> • <i>SSH</i> is supported by most systems. It requires a previously created <i>SSH connection</i> (page 98). • <i>SSH+NETCAT</i> uses <i>SSH</i> to establish a connection to the destination system, then uses <i>py-libzfs</i> (https://github.com/freenas/py-libzfs) to send an unencrypted data stream for higher transfer speeds. By default, this is supported by FreeNAS® systems with 11.2 or later installed (11.3 or later is recommended). Destination systems that do not have FreeNAS® 11.2 or later installed might have to manually install <i>py-libzfs</i>. • <i>LOCAL</i> efficiently replicates snapshots to another dataset on the same system. • <i>LEGACY</i> uses the legacy replication engine from FreeNAS® 11.2 and earlier.
SSH Connection	SSH, NCT, LEG	drop-down menu	Choose the <i>SSH connection</i> (page 98).
Netcat Active Side	NCT	drop-down menu	Establishing a connection requires that one of the connection systems has open TCP ports. Choose which system (<i>LOCAL</i> or <i>REMOTE</i>) will open ports. Consult your IT department to determine which systems are allowed to open ports.
Netcat Active Side Listen Address	NCT	string	IP address on which the connection <i>Active Side</i> listens. Defaults to 0.0.0.0.
Netcat Active Side Min Port	NCT	integer	Lowest port number of the active side listen address that is open to connections.
Netcat Active Side Max Port	NCT	integer	Highest port number of the active side listen address that is open to connections. The first available port between the minimum and maximum is used.
Netcat Active Side Connect Address	NCT	string	Hostname or IP address used to connect to the active side system. When the active side is <i>LOCAL</i> , this defaults to the <i>SSH_CLIENT</i> environment variable. When the active side is <i>REMOTE</i> , this defaults to the <i>SSH connection</i> hostname.
Source Datasets	All	 (Browse)	Choose datasets on the source system to be replicated. Click  (Browse) to see all datasets on the source system. Each dataset must have an associated periodic snapshot task, or previously-created snapshots for a one-time replication.
Target Dataset	All	 (Browse)	Choose a dataset on the destination system where snapshots are stored. Click  (Browse) to see all datasets on the destination system. Click a dataset to set it as the target.

Continued on next page

Table 8.6 – continued from previous page

Setting	Transport	Value	Description
Recursive	All	checkbox	Replicate all child dataset snapshots. When set, <i>Exclude Child Datasets</i> becomes visible.
Exclude Child Datasets	SSH, NCT, LOC	string	Exclude specific child dataset snapshots from the replication. Use with <i>Recursive</i> snapshots. List child dataset names to exclude. Example: <code>pool1/dataset1/child1</code> . A recursive replication of <code>pool1/dataset1</code> snapshots includes all child dataset snapshots except <code>child1</code> .
Properties	SSH, NCT, LOC	checkbox	Include dataset properties with the replicated snapshots.
Periodic Snapshot Tasks	SSH, NCT, LOC	drop-down menu	Snapshot schedule for this replication task. Choose from configured <i>Periodic Snapshot Tasks</i> (page 133). This replication task must have the same <i>Recursive</i> and <i>Exclude Child Datasets</i> values as the chosen periodic snapshot task. Selecting a periodic snapshot schedule removes the <i>Schedule</i> field.
Naming Schema	SSH, NCT, LOC	string	Visible with <i>PULL</i> replications. Pattern of naming custom snapshots to be replicated. Enter the name and <code>strftime(3)</code> (https://www.freebsd.org/cgi/man.cgi?query=strftime) <code>%Y</code> , <code>%m</code> , <code>%d</code> , <code>%H</code> , and <code>%M</code> strings that match the snapshots to include in the replication.
Also Include Naming Schema	SSH, NCT, LOC	string	Visible with <i>PUSH</i> replications. Pattern of naming custom snapshots to include in the replication with the periodic snapshot schedule. Enter the <code>strftime(3)</code> (https://www.freebsd.org/cgi/man.cgi?query=strftime) strings that match the snapshots to include in the replication. When a periodic snapshot is not linked to the replication, enter the naming schema for manually created snapshots. Has the same <code>%Y</code> , <code>%m</code> , <code>%d</code> , <code>%H</code> , and <code>%M</code> string requirements as the <i>Naming Schema</i> in a <i>periodic snapshot task</i> (page 134).
Run Automatically	SSH, NCT, LOC	checkbox	Set to either start this replication task immediately after the linked periodic snapshot task completes or continue to create a separate <i>Schedule</i> for this replication.
Schedule	SSH, NCT, LOC	checkbox and drop-down menu	Start time for the replication task. Select a preset schedule or choose <i>Custom</i> to use the advanced scheduler. Adds the <i>Begin</i> and <i>End</i> fields.
Begin	SSH, NCT, LOC	drop-down menu	Start time for the replication task.
End	SSH, NCT, LOC	drop-down menu	End time for the replication task. A replication that is already in progress can continue to run past this time.
Snapshot Replication Schedule	SSH, NCT, LOC	checkbox and drop-down menu	Schedule which periodic snapshots will be replicated. All snapshots will be replicated by default. To choose which snapshots are replicated, set the checkbox and select a schedule from the drop-down menu. For example, there is a system that takes a snapshot every hour, but the administrator has decided that only every other snapshot is needed for replication. The scheduler is set to even hours and only snapshots taken at those times are replicated.
Begin	SSH, NCT, LOC	drop-down menu	Set a starting time when the replication is not allowed to start. A replication that is already in progress can continue to run past this time.

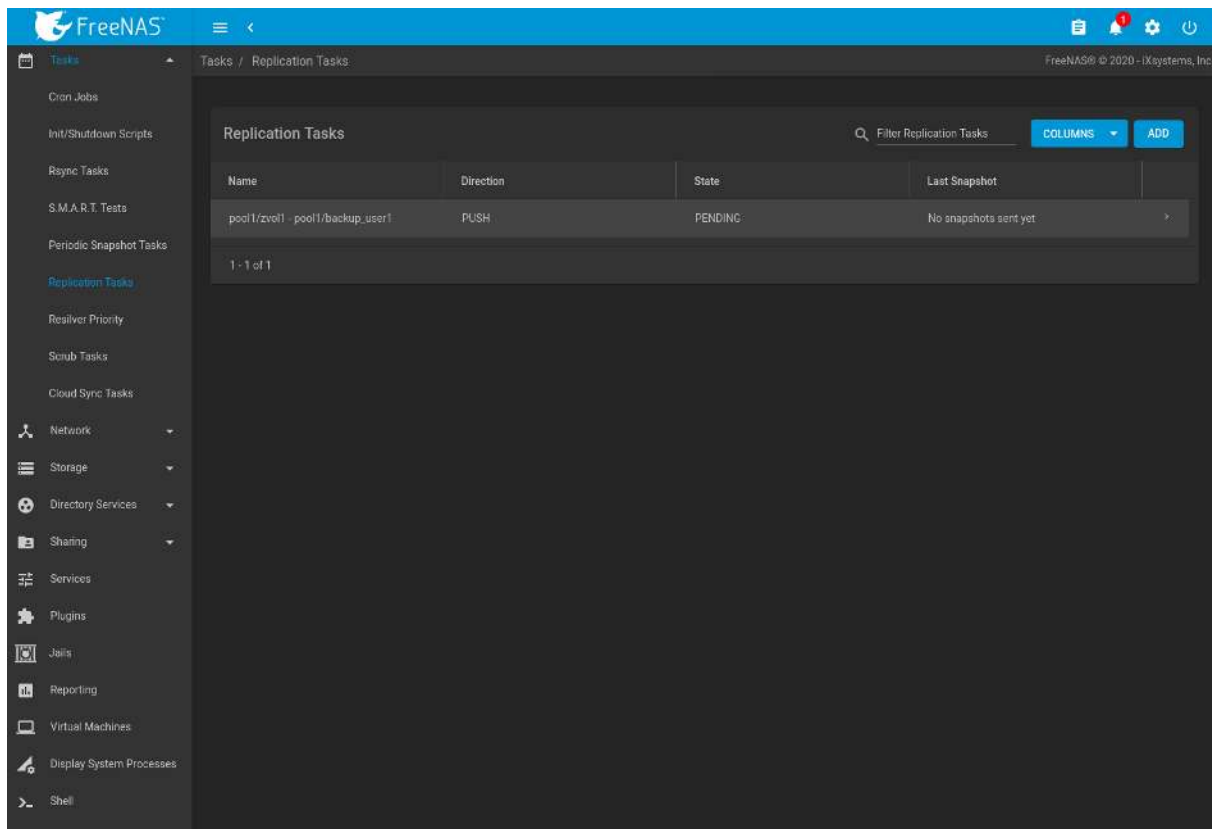
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Table 8.6 – continued from previous page

Setting	Transport	Value	Description
End	SSH, NCT, LOC	drop-down menu	Set an ending time for when replications are not allowed to start.
Only Replicate Snapshots Matching Schedule	SSH, NCT, LOC	checkbox	Set to either use the <i>Schedule</i> in place of the <i>Snapshot Replication Schedule</i> or add the <i>Schedule</i> values to the <i>Snapshot Replication Schedule</i> .
Replicate from scratch if incremental is not possible	SSH, NCT, LOC	checkbox	If the destination system has snapshots but they do not have any data in common with the source snapshots, destroy all destination snapshots and do a full replication. Warning: enabling this option can cause data loss or excessive data transfer if the replication is misconfigured.
Hold Pending Snapshots	SSH, NCT, LOC	checkbox	Prevent source system snapshots that have failed replication from being automatically removed by the <i>Snapshot Retention Policy</i> .
Snapshot Retention Policy	SSH, NCT, LOC	drop-down menu	When replicated snapshots are deleted from the destination system: <ul style="list-style-type: none"> • <i>Same as Source</i>: use <i>Snapshot Lifetime</i> value from the source <i>periodic snapshot task</i> (page 133). • <i>Custom</i>: define a <i>Snapshot Lifetime</i> for the destination system. • <i>None</i>: never delete snapshots from the destination system.
Snapshot Lifetime	All	integer and drop-down menu	Added with a <i>Custom</i> retention policy. How long a snapshot remains on the destination system. Enter a number and choose a measure of time from the drop-down.
Stream Compression	SSH	drop-down menu	Select a compression algorithm to reduce the size of the data being replicated. Only appears when <i>SSH</i> is chosen for <i>Transport</i> .
Limit (Examples: 500 KiB, 500M, 2 TB)	SSH	integer	Limit replication speed to this number of bytes per second. Zero means no limit. This is a <i>humanized field</i> (page 21).
Send Deduplicated Stream	SSH, NCT, LOC	checkbox	Deduplicate the stream to avoid sending redundant data blocks. The destination system must also support deduplicated streams. See zfs(8) (https://www.freebsd.org/cgi/man.cgi?query=zfs).
Allow Blocks Larger than 128KB	SSH, NCT, LOC	checkbox	Allow sending large data blocks. The destination system must also support large blocks. See zfs(8) (https://www.freebsd.org/cgi/man.cgi?query=zfs).
Allow Compressed WRITE Records	SSH, NCT, LOC	checkbox	Use compressed WRITE records to make the stream more efficient. The destination system must also support compressed WRITE records. See zfs(8) (https://www.freebsd.org/cgi/man.cgi?query=zfs).
Number of retries for failed replications	SSH, NCT, LOC	integer	Number of times the replication is attempted before stopping and marking the task as failed.
Logging Level	All	drop-down menu	Message verbosity level in the replication task log.
Enabled	All	checkbox	Activates the replication schedule.

8.6.3 Replication Tasks

Saved replications are shown on the *Replication Tasks* page.



Name	Direction	State	Last Snapshot
pool1/zvol1 - pool1/backup_user1	PUSH	PENDING	No snapshots sent yet

Fig. 8.9: Replication Task List

The replication name and configuration details are shown in the list. To adjust the default table view, open the **COLUMNS** menu and select the replication details to show in the normal table view.

The *State* column shows the status of the replication task. To view the detailed replication logs for a task, click the *State* entry when the task is running or finished.

Expanding an entry shows additional buttons for starting or editing a replication task.

8.6.4 Limiting Replication Times

The *Schedule*, *Begin*, and *End* times in a replication task make it possible to restrict when replication is allowed. These times can be set to only allow replication after business hours, or at other times when disk or network activity will not slow down other operations like snapshots or *Scrub Tasks* (page 144). The default settings allow replication to occur at any time.

These times control when replication task are allowed to start, but will not stop a replication task that is already running. Once a replication task has begun, it will run until finished.

8.6.5 Troubleshooting Replication

Replication depends on SSH, disks, network, compression, and encryption to work. A failure or misconfiguration of any of these can prevent successful replication.

Replication logs are saved in `var/log/zettarepl.log`. Logs of individual replication tasks can be viewed by clicking the replication *State*.

8.6.5.1 SSH

[SSH](#) (page 274) must be able to connect from the source system to the destination system with an encryption key. This is tested from [Shell](#) (page 335) by making an [SSH](#) (page 274) connection from the source system to the destination system. For example, this is a connection from *Alpha* to *Beta* at 10.0.0.118. Start the [Shell](#) (page 335) on the source machine (*Alpha*), then enter this command:

```
ssh -vv 10.0.0.118
```

On the first connection, the system might say

```
No matching host key fingerprint found in DNS.
Are you sure you want to continue connecting (yes/no)?
```

Verify that this is the correct destination computer from the preceding information on the screen and type `yes`. At this point, an [SSH](#) (page 274) shell connection is open to the destination system, *Beta*.

If a password is requested, SSH authentication is not working. An SSH key value must be present in the destination system `/root/.ssh/authorized_keys` file. `/var/log/auth.log` file can show diagnostic errors for login problems on the destination computer also.

8.6.5.2 Compression

Matching compression and decompression programs must be available on both the source and destination computers. This is not a problem when both computers are running FreeNAS®, but other operating systems might not have *lz4*, *pigz*, or *plzip* compression programs installed by default. An easy way to diagnose the problem is to set *Replication Stream Compression* to *Off*. If the replication runs, select the preferred compression method and check `/var/log/debug.log` on the FreeNAS® system for errors.

8.6.5.3 Manual Testing

On *Alpha*, the source computer, the `/var/log/messages` file can also show helpful messages to locate the problem.

On the source computer, *Alpha*, open a [Shell](#) (page 335) and manually send a single snapshot to the destination computer, *Beta*. The snapshot used in this example is named `auto-20161206.1110-2w`. As before, it is located in the *alphapool/alphadata* dataset. A `@` symbol separates the name of the dataset from the name of the snapshot in the command.

```
zfs send alphapool/alphadata@auto-20161206.1110-2w | ssh 10.0.0.118 zfs recv betapool
```

If a snapshot of that name already exists on the destination computer, the system will refuse to overwrite it with the new snapshot. The existing snapshot on the destination computer can be deleted by opening a [Shell](#) (page 335) on *Beta* and running this command:

```
zfs destroy -R betapool/alphadata@auto-20161206.1110-2w
```

Then send the snapshot manually again. Snapshots on the destination system, *Beta*, are listed from the [Shell](#) (page 335) with `zfs list -t snapshot` or from *Storage* → *Snapshots*.

Error messages here can indicate any remaining problems.

8.7 Resilver Priority

Resilvering, or the process of copying data to a replacement disk, is best completed as quickly as possible. Increasing the priority of resilvers can help them to complete more quickly. The *Resilver Priority* menu makes it possible to increase the priority of resilvering at times where the additional I/O or CPU usage will not affect normal usage.

Select *Tasks* → *Resilver Priority* to display the screen shown in Figure 8.10. Table 8.7 describes the fields on this screen.

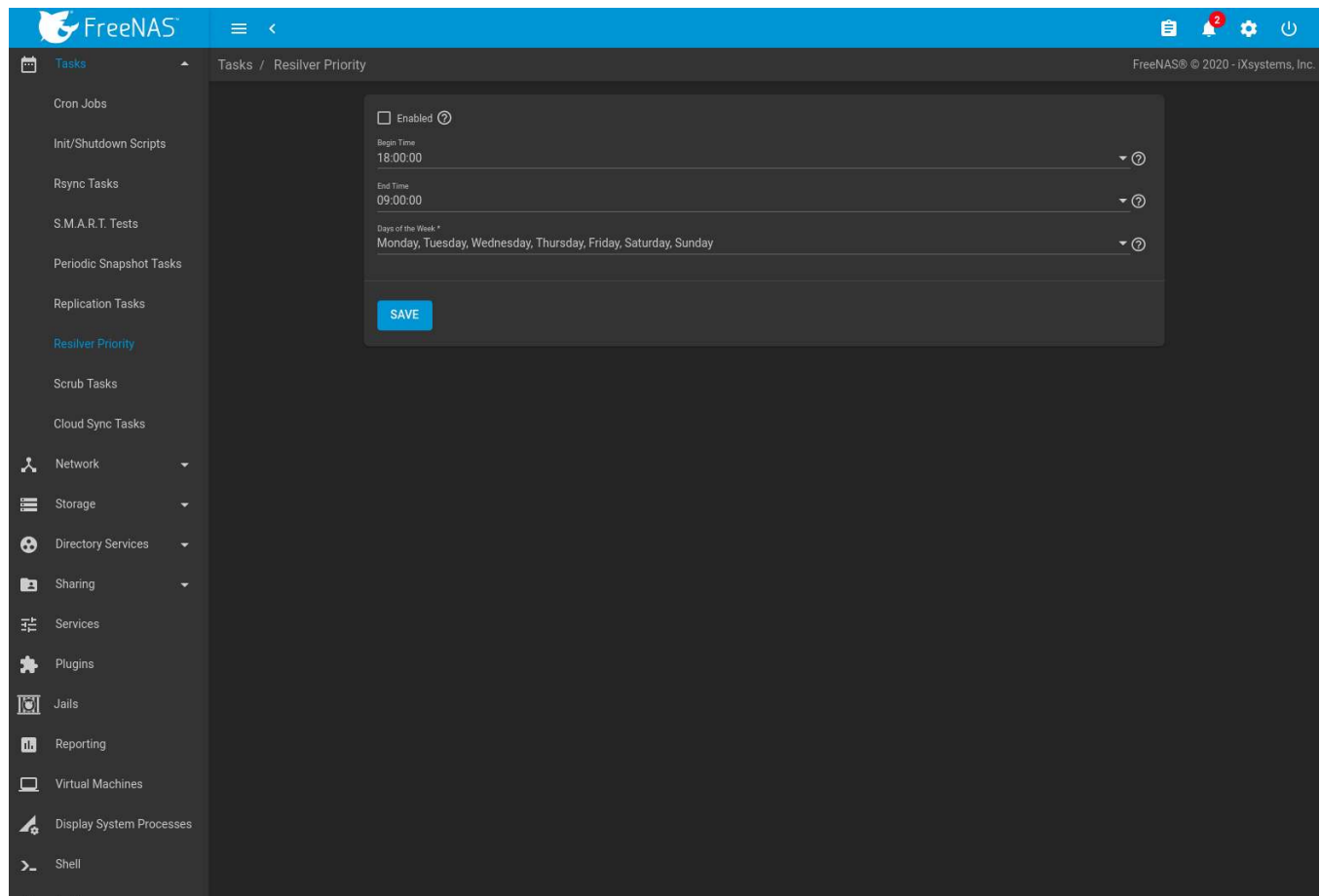


Fig. 8.10: Resilver Priority

Table 8.7: Resilver Priority Options

Setting	Value	Description
Enabled	checkbox	Set to run resilver tasks between the configured times.
Begin Time	drop-down	Choose the hour and minute when resilver tasks can be started.
End Time	drop-down	Choose the hour and minute when new resilver tasks can no longer be started. This does not affect active resilver tasks.
Days of the Week	checkboxes	Select the days to run resilver tasks.

8.8 Scrub Tasks

A scrub is the process of ZFS scanning through the data on a pool. Scrubs help to identify data integrity problems, detect silent data corruptions caused by transient hardware issues, and provide early alerts of impending disk failures. FreeNAS® makes it easy to schedule periodic automatic scrubs.

It is recommended that each pool is scrubbed at least once a month. Bit errors in critical data can be detected by ZFS, but only when that data is read. Scheduled scrubs can find bit errors in rarely-read data. The amount of time

needed for a scrub is proportional to the quantity of data on the pool. Typical scrubs take several hours or longer. The scrub process is I/O intensive and can negatively impact performance. Schedule scrubs for evenings or week-ends to minimize impact to users. Make certain that scrubs and other disk-intensive activity like [S.M.A.R.T. Tests](#) (page 132) are scheduled to run on different days to avoid disk contention and extreme performance impacts. Scrubs only check used disk space. To check unused disk space, schedule [S.M.A.R.T. Tests](#) (page 132) of *Type Long Self-Test* to run once or twice a month.

Scrubs are scheduled and managed with *Tasks* → *Scrub Tasks*.

When a pool is created, a scrub is automatically scheduled. An entry with the same pool name is added to *Tasks* → *Scrub Tasks*. A summary of this entry can be viewed with *Tasks* → *Scrub Tasks*. [Figure 8.11](#) displays the default settings for the pool named `pool1`. In this example, `:` (Options) and *Edit* for a pool is clicked to display the *Edit* screen. [Table 8.8](#) summarizes the options in this screen.

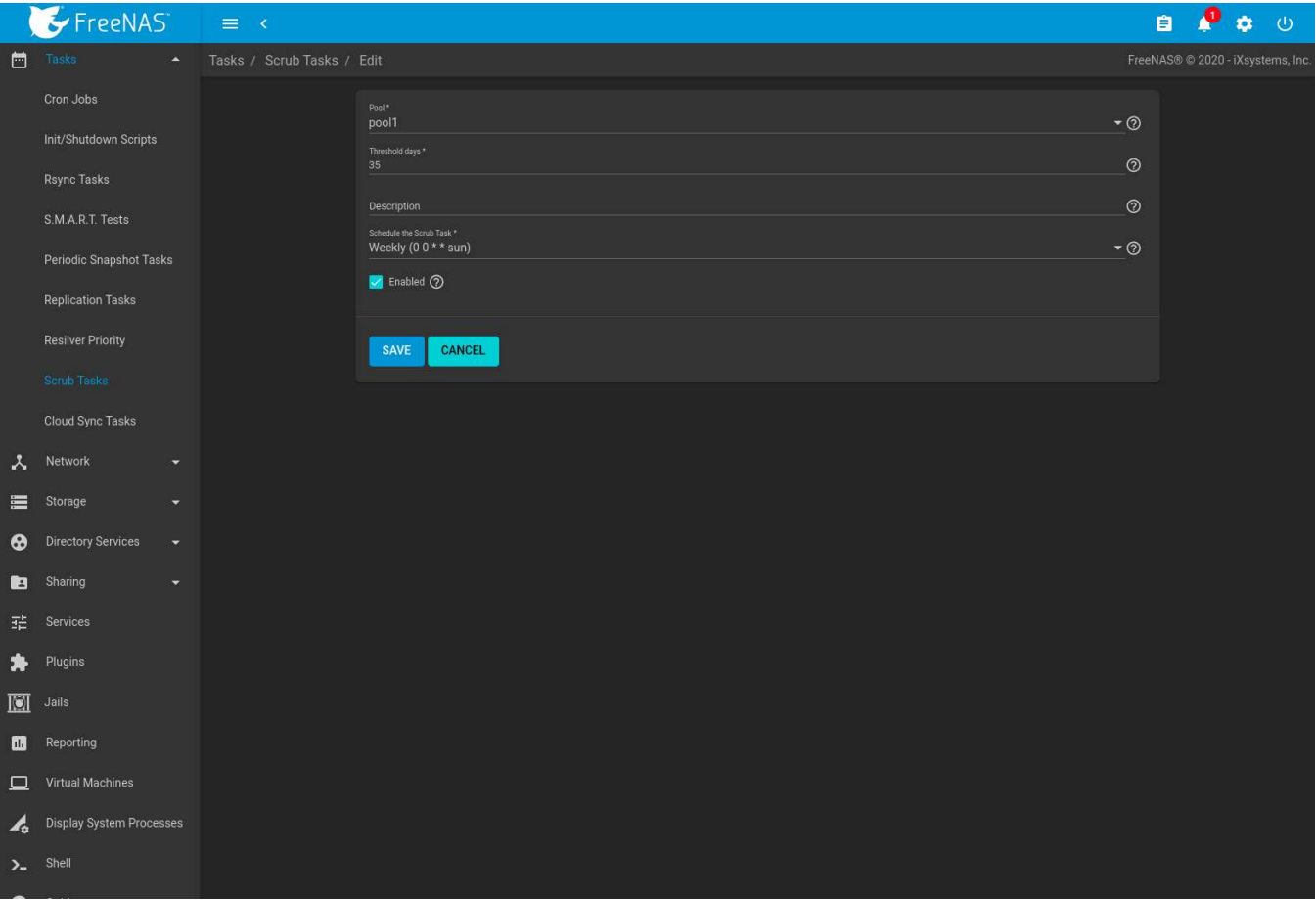


Fig. 8.11: Viewing Pool Default Scrub Settings

Table 8.8: ZFS Scrub Options

Setting	Value	Description
Pool	drop-down menu	Choose a pool to scrub.

Continued on next page

Table 8.8 – continued from previous page

Setting	Value	Description
Threshold days	string	Days before a completed scrub is allowed to run again. This controls the task schedule. For example, scheduling a scrub to run daily and setting <i>Threshold days</i> to 7 means the scrub attempts to run daily. When the scrub is successful, it continues to check daily but does not run again until seven days have elapsed. Using a multiple of seven ensures the scrub always occurs on the same weekday.
Description	string	Describe the scrub task.
Schedule the Scrub Task	drop-down menu	Choose how often to run the scrub task. Choices are <i>Hourly</i> , <i>Daily</i> , <i>Weekly</i> , <i>Monthly</i> , or <i>Custom</i> . Selecting <i>Custom</i> opens the Advanced Scheduler (page 18).
Enabled	checkbox	Unset to disable the scheduled scrub without deleting it.

Review the default selections and, if necessary, modify them to meet the needs of the environment. Scrub tasks cannot run for locked or unmounted pools.

Scheduled scrubs can be deleted with the *Delete* button, but this is not recommended. **Scrubs can provide an early indication of disk issues before a disk failure.** If a scrub is too intensive for the hardware, consider temporarily deselecting the *Enabled* button for the scrub until the hardware can be upgraded.

8.9 Cloud Sync Tasks

Files or directories can be synchronized to remote cloud storage providers with the *Cloud Sync Tasks* feature.

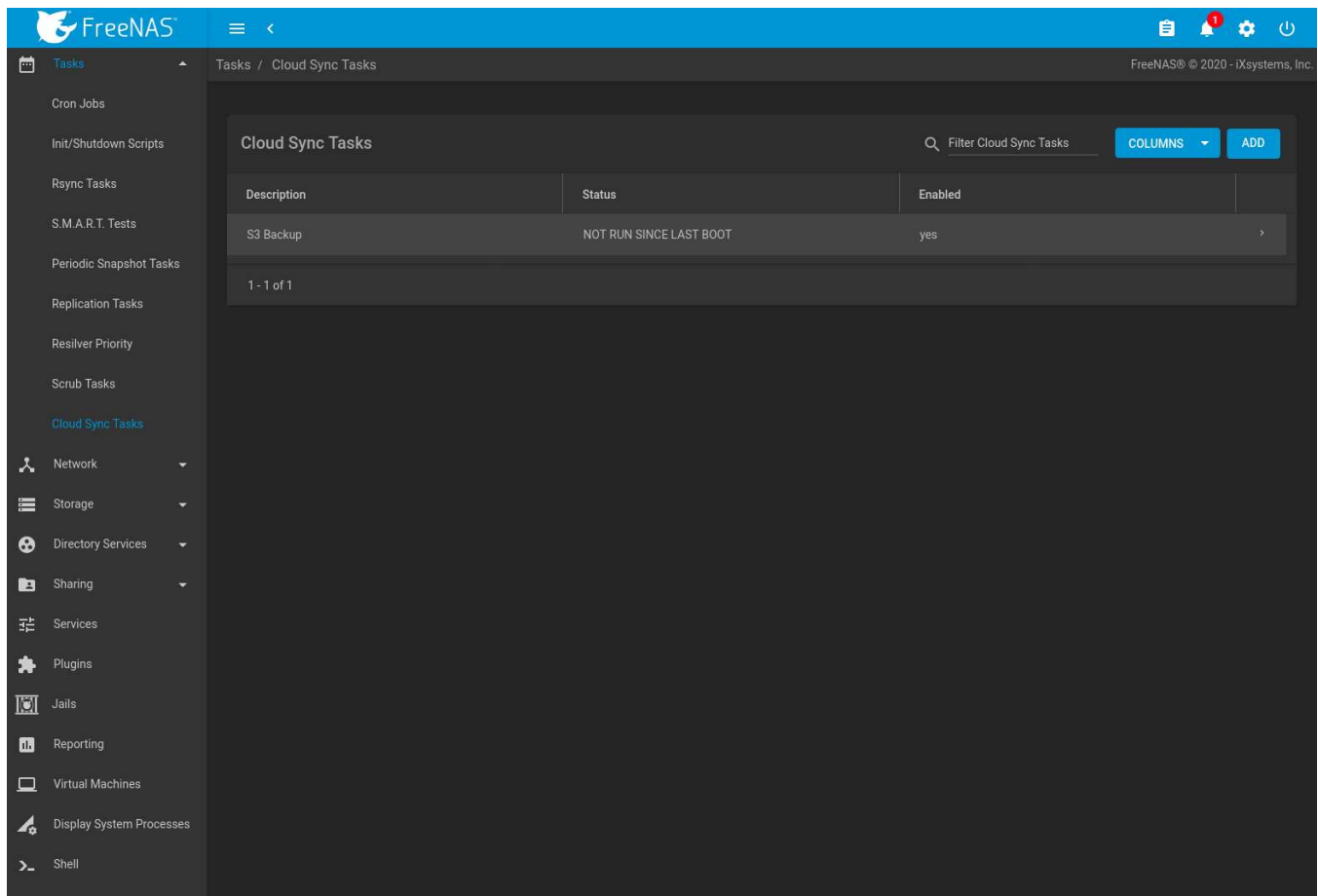
Warning: This Cloud Sync task might go to a third party commercial vendor not directly affiliated with iXsystems. Please investigate and fully understand that vendor's pricing policies and services before creating any Cloud Sync task. iXsystems is not responsible for any charges incurred from the use of third party vendors with the Cloud Sync feature.

[Cloud Credentials](#) (page 94) must be defined before a cloud sync is created. One set of credentials can be used for more than one cloud sync. For example, a single set of credentials for Amazon S3 can be used for separate cloud syncs that push different sets of files or directories.

A cloud storage area must also exist. With Amazon S3, these are called *buckets*. The bucket must be created before a sync task can be created.

After the cloud credentials have been configured, *Tasks* → *Cloud Sync Tasks* is used to define the schedule for running a cloud sync task. The time selected is when the Cloud Sync task is allowed to begin. An in-progress cloud sync must complete before another cloud sync can start. The cloud sync runs until finished, even after the selected ending time. To stop the cloud sync task before it is finished, click ⋮ (Options) → *Stop*.

An example is shown in [Figure 8.12](#).



The screenshot displays the FreeNAS web interface. The top navigation bar is blue with the FreeNAS logo and a hamburger menu. The left sidebar is dark grey with various system management options. The main content area is titled 'Cloud Sync Tasks' and contains a table with the following data:

Description	Status	Enabled
S3 Backup	NOT RUN SINCE LAST BOOT	yes

Below the table, it indicates '1 - 1 of 1'. The right side of the table has a 'COLUMNS' dropdown and an 'ADD' button. The bottom of the sidebar shows a list of system components: Network, Storage, Directory Services, Sharing, Services, Plugins, Jails, Reporting, Virtual Machines, Display System Processes, and Shell.

Fig. 8.12: Cloud Sync Status

The cloud sync *Status* indicates the state of most recent cloud sync. Clicking the *Status* entry shows the task logs and includes an option to download them.

Click *ADD* to display the *Add Cloud Sync* menu shown in [Figure 8.13](#).

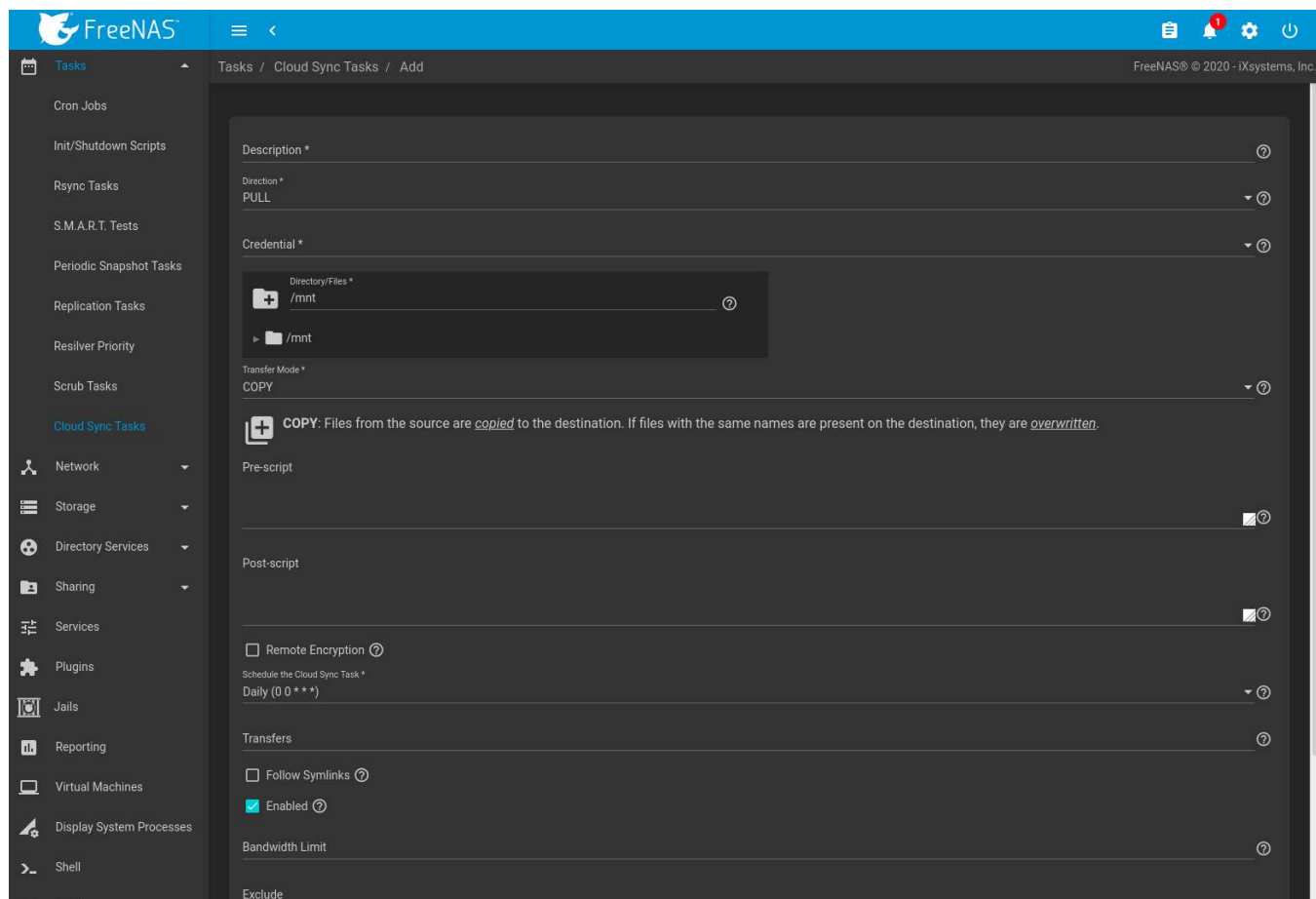



Fig. 8.13: Adding a Cloud Sync

Table 8.9 shows the configuration options for Cloud Syncs.

Table 8.9: Cloud Sync Options

Setting	Value Type	Description
Description	string	A description of the Cloud Sync Task.
Direction	drop-down menu	<i>PUSH</i> sends data to cloud storage. <i>PULL</i> receives data from cloud storage. Changing the direction resets the <i>Transfer Mode</i> to <i>COPY</i> .
Credential	drop-down menu	Select the cloud storage provider credentials from the list of available Cloud Credentials (page 94). The credential is tested and an error is displayed if a connection cannot be made. Click <i>Fix Credential</i> to go to the configuration page for that Cloud Credential (page 94). <i>SAVE</i> is disabled until a valid credential is selected.
Bucket/Container	drop-down menu	<i>Bucket</i> : Only appears when an S3 credential is the <i>Provider</i> . Select the predefined S3 bucket to use. <i>Container</i> : The pre-configured container name. Only appears when a <i>AZUREBLOB</i> or <i>hubic</i> credential is selected as the <i>Credential</i> .
Folder	browse button	The name of the predefined folder within the selected bucket or container. Type the name or click  (Browse) to list the remote filesystem and choose the folder.
Server Side Encryption	drop-down menu	Active encryption on the cloud provider account. Choose <i>None</i> or <i>AES-256</i> . Only visible when the cloud provider supports encryption.

Continued on next page

Table 8.9 – continued from previous page

Setting	Value Type	Description
Storage Class	drop-down menu	Classification for each S3 object. Choose a class based on the specific use case or performance requirements. See Amazon S3 Storage Classes (https://docs.aws.amazon.com/AmazonS3/latest/dev/storage-class-intro.html) for more information on which storage class to choose. <i>Storage Class</i> only appears when an S3 credential is the <i>Provider</i> .
Upload Chunk Size (MiB)	integer	Files are split into chunks of this size before upload. The number of chunks that can be simultaneously transferred is set by the <i>Transfers</i> number. The single largest file being transferred must fit into no more than 10,000 chunks.
Use -fast-list	checkbox	Use fewer transactions in exchange for more RAM (https://rclone.org/docs/#fast-list). Modifying this setting can speed up or slow down the transfer. Only appears with a compatible <i>Credential</i> .
Directory/Files	browse button	Select directories or files to be sent to the cloud for <i>Push</i> syncs, or the destination to be written for <i>Pull</i> syncs. Be cautious about the destination of <i>Pull</i> jobs to avoid overwriting existing files.
Transfer Mode	drop-down menu	SYNC : Files on the destination are changed to match those on the source. If a file does not exist on the source, it is also deleted from the destination. There are exceptions (page 150) to this behavior. COPY : Files from the source are copied to the destination. If files with the same names are present on the destination, they are overwritten . MOVE : After files are copied from the source to the destination, they are deleted from the source. Files with the same names on the destination are overwritten .
Take Snapshot	checkbox	Take a snapshot of the dataset before a <i>PUSH</i> .
Pre-script	string	A script to execute before the Cloud Sync Task is run.
Post-script	string	A script to execute after the Cloud Sync Task is run.
Remote Encryption	checkbox	Use rclone crypt (https://rclone.org/crypt/) to manage data encryption during <i>PUSH</i> or <i>PULL</i> transfers: <i>PUSH</i> : Encrypt files before transfer and store the encrypted files on the remote system. Files are encrypted using the <i>Encryption Password</i> and <i>Encryption Salt</i> values. <i>PULL</i> : Decrypt files that are being stored on the remote system before the transfer. Transferring the encrypted files requires entering the same <i>Encryption Password</i> and <i>Encryption Salt</i> that was used to encrypt the files. Adds the <i>Filename Encryption</i> , <i>Encryption Password</i> , and <i>Encryption Salt</i> options. Additional details about the encryption algorithm and key derivation are available in the rclone crypt File formats documentation (https://rclone.org/crypt/#file-formats).
Filename Encryption	checkbox	Encrypt (<i>PUSH</i>) or decrypt (<i>PULL</i>) file names with the rclone “ Standard ” file name encryption mode (https://rclone.org/crypt/#file-name-encryption-modes). The original directory structure is preserved. A filename with the same name always has the same encrypted filename. <i>PULL</i> tasks that have <i>Filename Encryption</i> enabled and an incorrect <i>Encryption Password</i> or <i>Encryption Salt</i> will not transfer any files but still report that the task was successful. To verify that files were transferred successfully, click the finished task status (page 147) to see a list of transferred files.


Continued on next page

Table 8.9 – continued from previous page

Setting	Value Type	Description
Encryption Password	string	Password to encrypt and decrypt remote data. Warning: Always securely back up this password! Losing the encryption password will result in data loss.
Encryption Salt	string	Enter a long string of random characters for use as salt (https://searchsecurity.techtarget.com/definition/salt) for the encryption password. Warning: Always securely back up the encryption salt value! Losing the salt value will result in data loss.
Schedule the Cloud Sync Task	drop-down menu	Choose how often or at what time to start a sync. Choices are <i>Hourly</i> , <i>Daily</i> , <i>Weekly</i> , <i>Monthly</i> , or <i>Custom</i> . Selecting <i>Custom</i> opens the Advanced Scheduler (page 18).
Transfers	integer	Number of simultaneous file transfers. Enter a number based on the available bandwidth and destination system performance. See rclone -transfers (https://rclone.org/docs/#transfers-n).
Follow Sym-links	checkbox	Include symbolic link targets in the transfer.
Enabled	checkbox	Enable this Cloud Sync Task. Unset to disable this Cloud Sync Task without deleting it.
Bandwidth Limit	string	A single bandwidth limit or bandwidth limit schedule in rclone format. Example: <i>08:00,512 12:00,10MB 13:00,512 18:00,30MB 23:00,off</i> . Units can be specified with the beginning letter: b, k (default), M, or G. See rclone -bwlimit . (https://rclone.org/docs/#bwlimit-bandwidth-spec)
Exclude	string	List of files and directories to exclude from sync, one per line. See https://rclone.org/filtering/ .

There are specific circumstances where a *SYNC* task does not delete files from the destination:

- If [rclone sync](https://rclone.org/commands/rclone_sync/) (https://rclone.org/commands/rclone_sync/) encounters any errors, files are not deleted in the destination. This includes a common error when the Dropbox [copyright detector](https://techcrunch.com/2014/03/30/how-dropbox-knows-when-youre-sharing-copyrighted-stuff-without-actually-looking-at-your-stuff/) (<https://techcrunch.com/2014/03/30/how-dropbox-knows-when-youre-sharing-copyrighted-stuff-without-actually-looking-at-your-stuff/>) flags a file as copyrighted.
- Syncing to a [B2 bucket](#) (page 96) does not delete files from the bucket, even when those files have been deleted locally. Instead, files are tagged with a version number or moved to a hidden state. To automatically delete old or unwanted files from the bucket, adjust the [Backblaze B2 Lifecycle Rules](https://www.backblaze.com/blog/backblaze-b2-lifecycle-rules/) (<https://www.backblaze.com/blog/backblaze-b2-lifecycle-rules/>)
- Files stored in Amazon S3 Glacier or S3 Glacier Deep Archive cannot be deleted by [rclone sync](https://rclone.org/s3/#glacier-and-glacier-deep-archive/) (<https://rclone.org/s3/#glacier-and-glacier-deep-archive/>). These files must first be restored by another means, like the [Amazon S3 console](https://docs.aws.amazon.com/AmazonS3/latest/user-guide/restore-archived-objects.html) (<https://docs.aws.amazon.com/AmazonS3/latest/user-guide/restore-archived-objects.html>).

To modify an existing cloud sync, click  (Options) to access the *Run Now*, *Edit*, and *Delete* options.

8.9.1 Cloud Sync Example

This example shows a *Push* cloud sync that copies files from a FreeNAS® pool to a cloud service provider.

The cloud service provider was configured with a location to store data received from the FreeNAS® system.

In the FreeNAS® web interface, go to *System* → *Cloud Credentials* and click *ADD* to configure the cloud service provider credentials:

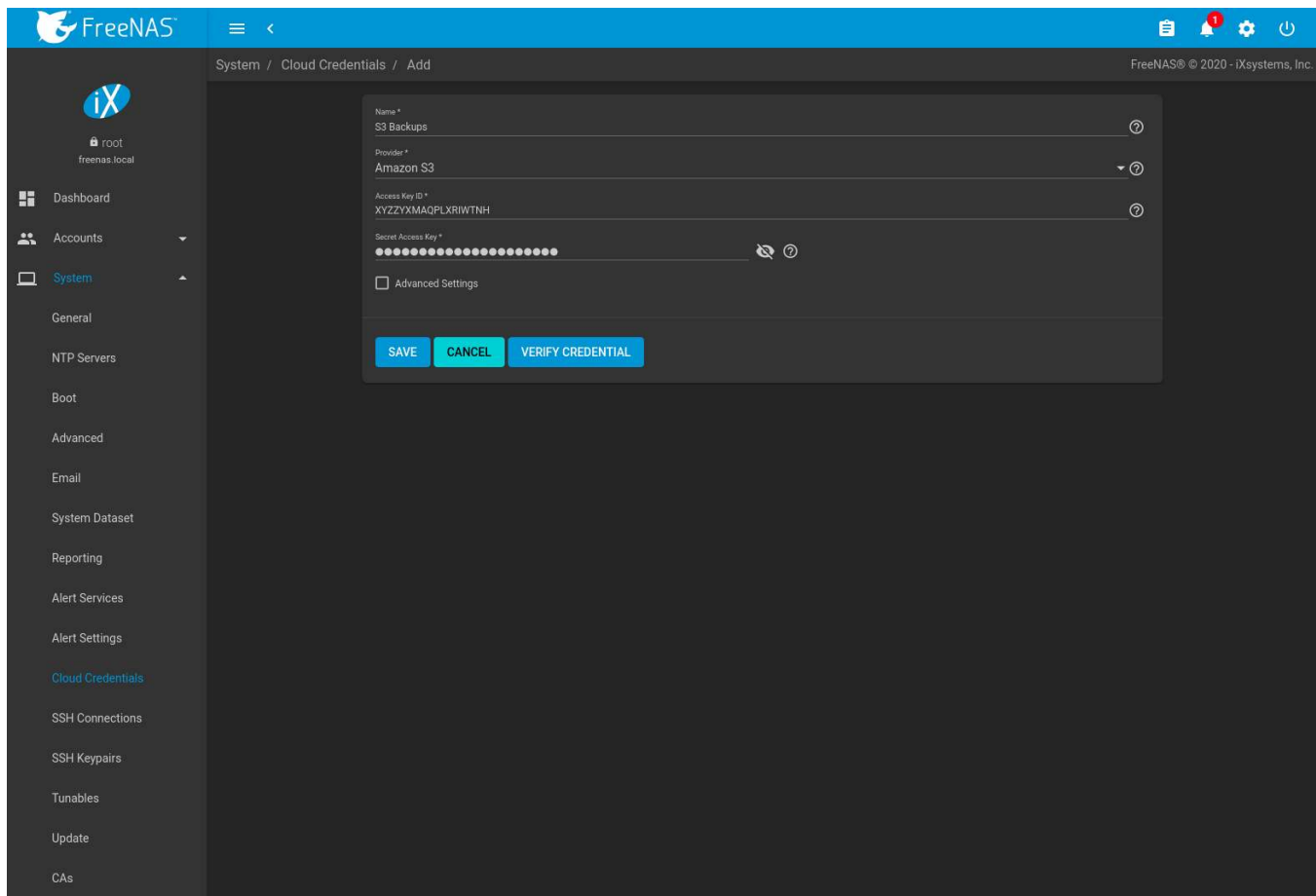


Fig. 8.14: Example: Adding Cloud Credentials

Go to *Tasks* → *Cloud Sync* and click *ADD* to create a cloud sync job. The *Description* is filled with a simple note describing the job. Data is being sent to cloud storage, so this is a *Push*. The provider comes from the cloud credentials defined in the previous step, and the destination folder was configured in the cloud provider account.

The *Directory/Files* is set to the file or directory to copy to the cloud provider.

The *Transfer Mode* is set to *COPY* so that only the files stored by the cloud provider are modified.

The remaining requirement is to schedule the task. The default is to send the data to cloud storage daily, but the schedule can be *customized* (page 18) to fine-tune when the task runs.

The *Enabled* field is enabled by default, so this cloud sync will run at the next scheduled time.

An example of a completed cloud sync task is shown in [Figure 8.15](#):

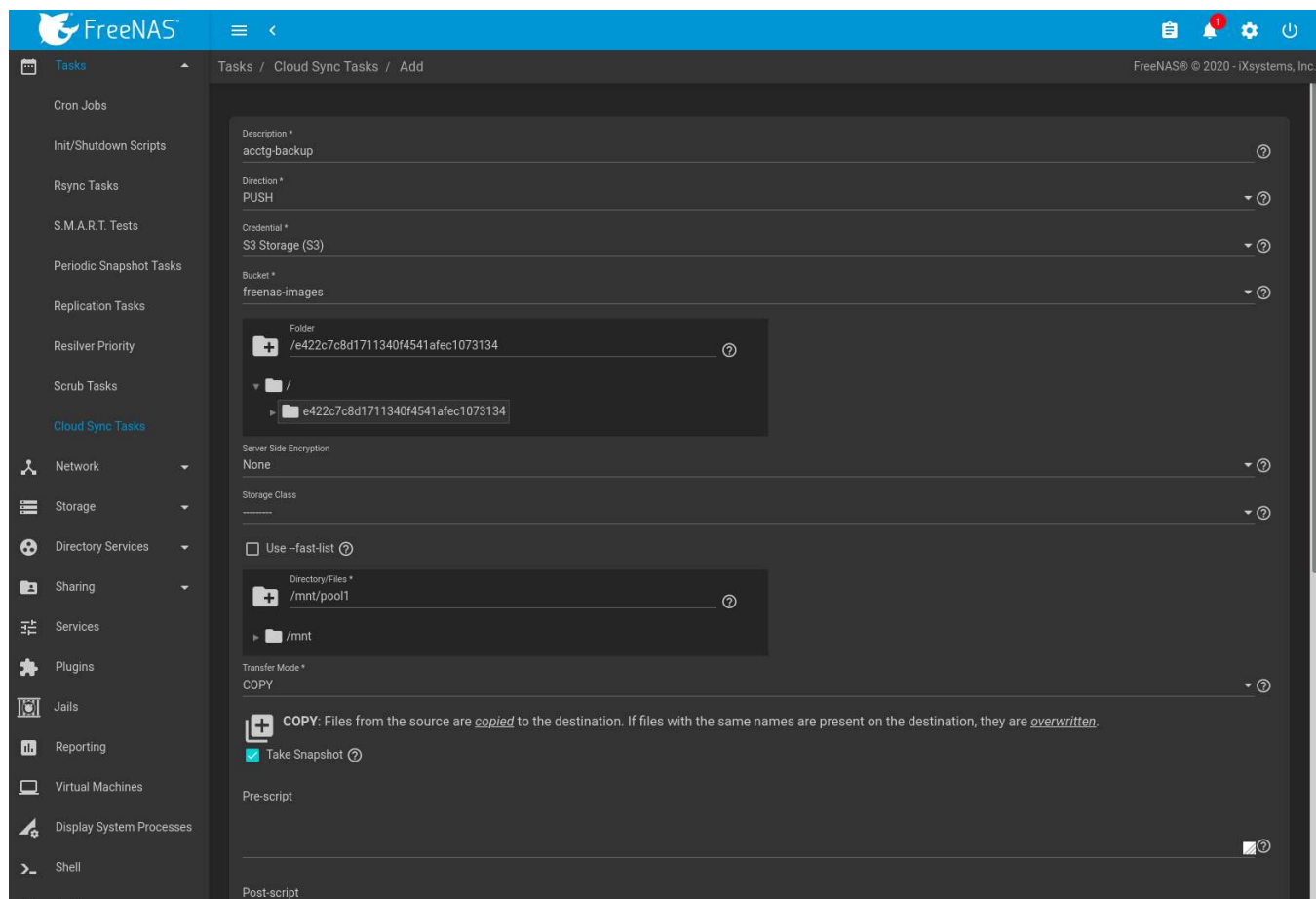


Fig. 8.15: Example: Successful Cloud Sync

NETWORK

The Network section of the web interface contains these components for viewing and configuring network settings on the FreeNAS[®] system:

- [Global Configuration](#) (page 153): general network settings.
- [Interfaces](#) (page 155): settings for each network interface and options to configure [Bridge](#) (page 158), [Link Aggregation](#) (page 158), and [VLAN](#) (page 160) interfaces.
- [IPMI](#) (page 160): settings controlling connection to the appliance through the hardware side-band management interface if the user interface becomes unavailable.
- [Static Routes](#) (page 162): add static routes.

Each of these is described in more detail in this section.

Warning: Making changes to the network interface the web interface uses can result in losing connection to the FreeNAS[®] system! Misconfiguring network settings might require command line knowledge or physical access to the FreeNAS[®] system to fix. Be very careful when configuring [Interfaces](#) (page 155) and [Link Aggregations](#) (page 158).

9.1 Global Configuration

Network → *Global Configuration*, shown in [Figure 9.1](#), is for general network settings that are not unique to any particular network interface.

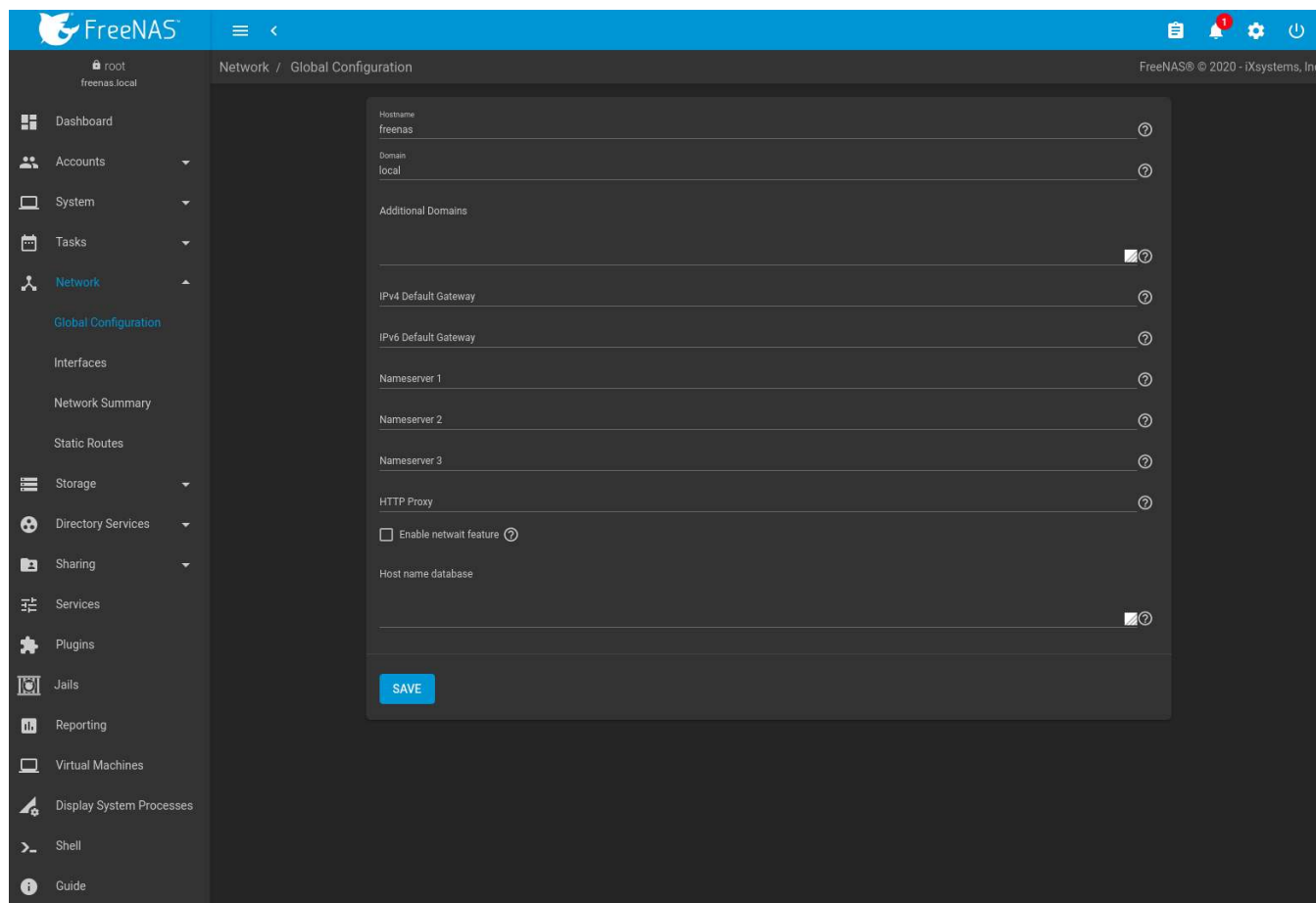


Fig. 9.1: Global Network Configuration

Table 9.1 summarizes the settings on the Global Configuration tab. *Hostname* and *Domain* fields are pre-filled as shown in Figure 9.1, but can be changed to meet requirements of the local network.

Table 9.1: Global Configuration Settings

Setting	Value	Description
Hostname	string	System host name. Upper and lower case alphanumeric, ., and - characters are allowed. The <i>Hostname</i> and <i>Domain</i> are also displayed under the iXsystems logo at the top left of the main screen.
Domain	string	System domain name. The <i>Hostname</i> and <i>Domain</i> are also displayed under the iXsystems logo at the top left of the main screen.
Additional Domains	string	Additional space-delimited domains to search. Adding search domains can cause slow DNS lookups.
IPv4 Default Gateway	IP address	Typically not set. See this note about Gateways (page 155). If set, used instead of the default gateway provided by DHCP.
IPv6 Default Gateway	IP address	Typically not set. See this note about Gateways (page 155).
Nameserver 1	IP address	Primary DNS server.
Nameserver 2	IP address	Secondary DNS server.
Nameserver 3	IP address	Tertiary DNS server.
HTTP Proxy	string	Enter the proxy information for the network in the format <code>http://my.proxy.server:3128</code> or <code>http://user:password@my.proxy.server:3128</code> .

Continued on next page

Table 9.1 – continued from previous page

Setting	Value	Description
Enable netwait feature	checkbox	If enabled, network services do not start at boot until the interface is able to ping the addresses listed in the <i>Netwait IP list</i> .
Netwait IP list	string	Only appears when <i>Enable netwait feature</i> is set. Enter a space-delimited list of IP addresses to ping(8). Each address is tried until one is successful or the list is exhausted. Leave empty to use the default gateway.
Host name database	string	Used to add one entry per line which will be appended to <code>/etc/hosts</code> . Use the format <i>IP_address space hostname</i> where multiple hostnames can be used if separated by a space.

When using Active Directory, set the IP address of the realm DNS server in the *Nameserver 1* field.

If the network does not have a DNS server, or NFS, SSH, or FTP users are receiving “reverse DNS” or timeout errors, add an entry for the IP address of the FreeNAS® system in the *Host name database* field.

Note: In many cases, a FreeNAS® configuration does not include default gateway information as a way to make it more difficult for a remote attacker to communicate with the server. While this is a reasonable precaution, such a configuration does **not** restrict inbound traffic from sources within the local network. However, omitting a default gateway will prevent the FreeNAS® system from communicating with DNS servers, time servers, and mail servers that are located outside of the local network. In this case, it is recommended to add [Static Routes](#) (page 162) to be able to reach external DNS, NTP, and mail servers which are configured with static IP addresses. When a gateway to the Internet is added, make sure the FreeNAS® system is protected by a properly configured firewall.

9.2 Interfaces

Network → *Interfaces* shows all physical Network Interface Controllers (NICs) connected to the FreeNAS® system. These can be edited or new *bridge*, *link aggregation*, or *Virtual LAN (VLAN)* interfaces can be created and added to the interface list.

Be careful when configuring the network interface that controls the FreeNAS® web interface or [web connectivity can be lost](#) (page 153).

To configure a new network interface, go to *Network* → *Interfaces* and click *ADD*.

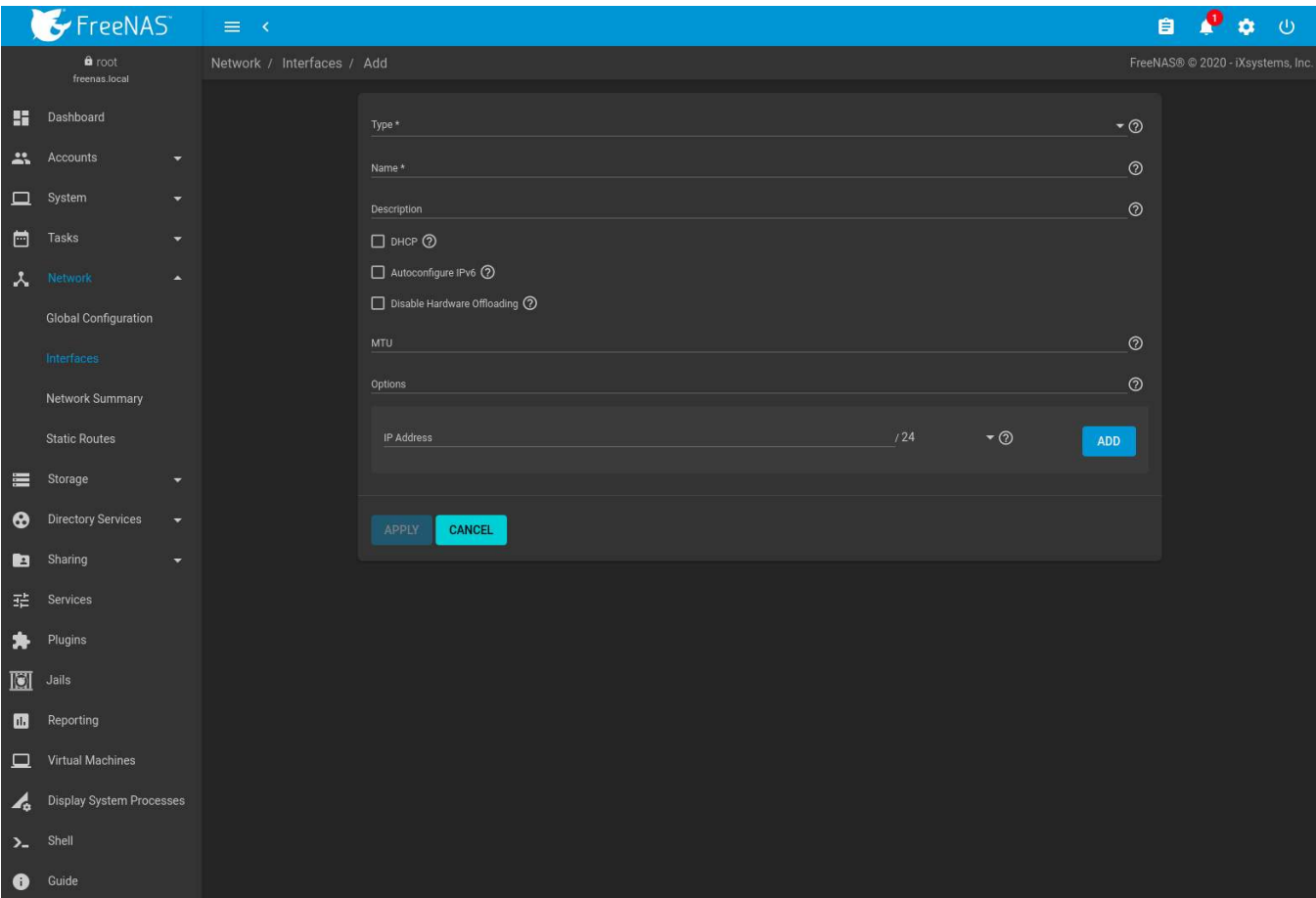


Fig. 9.2: Adding a Network Interface

Each *Type* of configurable network interface changes the available options. Table 9.2 shows which settings are available with each interface type.

Table 9.2: Interface Configuration Options

Setting	Value	Type	Description
Type	drop-down menu	All	Choose the type of interface. <i>Bridge</i> creates a logical link between multiple networks. <i>Link Aggregation</i> combines multiple network connections into a single interface. A virtual LAN (VLAN) partitions and isolates a segment of the connection.
Name	string	All	Enter a name to use for the the interface. Use the format laggX, vlanX, or bridgeX where X is a number representing a non-parent interface.
Description	string	All	Notes or explanatory text about this interface.
DHCP	checkbox	All	Enable DHCP to auto-assign an IPv4 address to this interface. Leave unset to create a static IPv4 or IPv6 configuration. Only one interface can be configured for DHCP.
Autoconfigure IPv6	drop-down menu	All	Automatically configure the IPv6 address with rtol(8) to auto-assign an IPv6 address to this interface. Leave unset to create a static IPv4 or IPv6 configuration. Only one interface can be configured this way.

Continued on next page

Table 9.2 – continued from previous page

Setting	Value	Type	Description
Disable Hardware Offloading	checkbox	All	Turn off hardware offloading for network traffic processing. WARNING: disabling hardware offloading can reduce network performance and is only recommended when the interface is managing <i>jails</i> (page 294), <i>plugins</i> (page 283), or <i>virtual machines (VMs)</i> (page 322).
Bridge Members	drop-down menu	Bridge	Network interfaces to include in the bridge.
Lagg Protocol	drop-down menu	Link Aggregation	Select the <i>Protocol Type</i> (page 158). <i>LACP</i> is the recommended protocol if the network switch is capable of active LACP. <i>Failover</i> is the default protocol choice and should only be used if the network switch does not support active LACP.
Lagg Interfaces	drop-down menu	Link Aggregation	Select the interfaces to use in the aggregation. Warning: Lagg creation fails when the selected interfaces have manually assigned IP addresses.
Parent Interface	drop-down menu	VLAN	Select the VLAN Parent Interface. Usually an Ethernet card connected to a switch port configured for the VLAN. A <i>bridge</i> cannot be selected as a parent interface. New <i>Link Aggregations</i> (page 158) are not available until the system is restarted.
Vlan Tag	integer	VLAN	The numeric tag provided by the switched network.
Priority Code Point	drop-down menu	VLAN	Select the <i>Class of Service</i> (https://en.wikipedia.org/wiki/Class_of_service). The available 802.1p Class of Service ranges from <i>Best effort (default)</i> to <i>Network control (highest)</i> .
MTU	integer	All	Maximum Transmission Unit, the largest protocol data unit that can be communicated. The largest workable MTU size varies with network interfaces and equipment. <i>1500</i> and <i>9000</i> are standard Ethernet MTU sizes. Leaving blank restores the field to the default value of <i>1500</i> .
Options	string	All	Additional parameters from <i>ifconfig(8)</i> (https://www.freebsd.org/cgi/man.cgi?query=ifconfig). Separate multiple parameters with a space. For example: <i>mtu 9000</i> increases the MTU for interfaces which support jumbo frames. See <i>this note</i> (page 159) about MTU and lagg interfaces.
IP Address	integer and drop-down menu	All	Static IPv4 or IPv6 address and subnet mask. Example: <i>10.0.0.3</i> and <i>/24</i> . Click <i>ADD</i> to add another IP address. Clicking <i>DELETE</i> removes that <i>IP Address</i> .

Multiple interfaces **cannot** be members of the same subnet. See [Multiple network interfaces on a single subnet](https://forums.freenas.org/index.php?threads/multiple-network-interfaces-on-a-single-subnet.20204/) (<https://forums.freenas.org/index.php?threads/multiple-network-interfaces-on-a-single-subnet.20204/>) for more information. Check the subnet mask if an error is shown when setting the IP addresses on multiple interfaces.

Saving a new interface adds an entry to the list in *Network* → *Interfaces*. A new animated icon also appears in the upper-right web interface panel to show there are pending network changes.

Network changes must be confirmed before being saved to the FreeNAS® system. A new section is added above the list to confirm the new network settings. To temporarily apply the settings, click *APPLY CHANGES*. Temporary settings revert automatically after 60 seconds or by clicking *DISCARD CHANGES*. To permanently apply the new settings, click *KEEP NETWORK CHANGES PERMANENTLY*.

Expanding an entry in the list shows further details for that interface.

Editing an interface allows changing all the *interface options* (page 156) except the interface *Type* and *Name*.

9.2.1 Network Bridges

A network bridge allows multiple network interfaces to function as a single interface.

To create a bridge, go to *Network* → *Interfaces* and click *ADD*. Choose *Bridge* as the *Type* and continue to configure the interface. See the *Interface Configuration Options table* (page 156) for descriptions of each option.

Enter `bridgeX` for the *Name*, where *X* is a unique interface number. Open the *Bridge Members* drop-down menu and select each interface that will be part of the bridge. Click *SAVE* to add the new bridge to *Network* → *Interfaces* and show options to confirm or revert the new network settings.

9.2.2 Link Aggregations

FreeNAS® uses the FreeBSD `lagg(4)` (<https://www.freebsd.org/cgi/man.cgi?query=lagg>) interface to provide link aggregation and link failover support. A `lagg` interface allows combining multiple network interfaces into a single virtual interface. This provides fault-tolerance and high-speed multi-link throughput. The aggregation protocols supported by `lagg` both determines the ports to use for outgoing traffic and if a specific port accepts incoming traffic. The link state of the `lagg` interface is used to validate whether the port is active.

Aggregation works best on switches supporting LACP, which distributes traffic bi-directionally while responding to failure of individual links. FreeNAS® also supports active/passive failover between pairs of links. The LACP and load-balance modes select the output interface using a hash that includes the Ethernet source and destination address, VLAN tag (if available), IP source and destination address, and flow label (IPv6 only). The benefit can only be observed when multiple clients are transferring files *from* the NAS. The flow entering *into* the NAS depends on the Ethernet switch load-balance algorithm.

The `lagg` driver currently supports several aggregation protocols, although only *Failover* is recommended on network switches that do not support LACP:

Failover: the default protocol. Sends traffic only through the active port. If the master port becomes unavailable, the next active port is used. The first interface added is the master port. Any interfaces added later are used as failover devices. By default, received traffic is only accepted when received through the active port. This constraint can be relaxed, which is useful for certain bridged network setups, by going to *System* → *Tunables* and clicking *ADD* to add a tunable. Set the *Variable* to `net.link.lagg.failover_rx_all`, the *Value* to a non-zero integer, and the *Type* to `sysctl`.

LACP: supports the IEEE 802.3ad Link Aggregation Control Protocol (LACP) and the Marker Protocol. LACP negotiates a set of aggregable links with the peer into one or more link aggregated groups (LAGs). Each LAG is composed of ports of the same speed, set to full-duplex operation. Traffic is balanced across the ports in the LAG with the greatest total speed. In most situations there will be a single LAG which contains all ports. In the event of changes in physical connectivity, link aggregation quickly converges to a new configuration. LACP must be configured on the network switch and LACP does not support mixing interfaces of different speeds. Only interfaces that use the same driver, like two `igb` ports, are recommended for LACP. Using LACP for iSCSI is not recommended as iSCSI has built-in multipath features which are more efficient.

Note: When using LACP, verify the switch is configured for active LACP. Passive LACP is not supported.

Load Balance: balances outgoing traffic across the active ports based on hashed protocol header information and accepts incoming traffic from any active port. This is a static setup and does not negotiate aggregation with the peer or exchange frames to monitor the link. The hash includes the Ethernet source and destination address, VLAN tag (if available), and IP source and destination address. Requires a switch which supports IEEE 802.3ad static link aggregation.

Round Robin: distributes outgoing traffic using a round-robin scheduler through all active ports and accepts incoming traffic from any active port. This mode can cause unordered packet arrival at the client. This has a side effect of limiting throughput as reordering packets can be CPU intensive on the client. Requires a switch which supports IEEE 802.3ad static link aggregation.

None: this protocol disables any traffic without disabling the `lagg` interface itself.

9.2.2.1 LACP, MPIO, NFS, and ESXi

LACP bonds Ethernet connections to improve bandwidth. For example, four physical interfaces can be used to create one mega interface. However, it cannot increase the bandwidth for a single conversation. It is designed to increase bandwidth when multiple clients are simultaneously accessing the same system. It also assumes that quality Ethernet hardware is used and it will not make much difference when using inferior Ethernet chipsets such as a Realtek.

LACP reads the sender and receiver IP addresses and, if they are deemed to belong to the same TCP connection, always sends the packet over the same interface to ensure that TCP does not need to reorder packets. This makes LACP ideal for load balancing many simultaneous TCP connections, but does nothing for increasing the speed over one TCP connection.

MPIO operates at the iSCSI protocol level. For example, if four IP addresses are created and there are four simultaneous TCP connections, MPIO will send the data over all available links. When configuring MPIO, make sure that the IP addresses on the interfaces are configured to be on separate subnets with non-overlapping netmasks, or configure static routes to do point-to-point communication. Otherwise, all packets will pass through one interface.

LACP and other forms of link aggregation generally do not work well with virtualization solutions. In a virtualized environment, consider the use of iSCSI MPIO through the creation of an iSCSI Portal with at least two network cards on different networks. This allows an iSCSI initiator to recognize multiple links to a target, using them for increased bandwidth or redundancy. This [how-to](https://fojta.wordpress.com/2010/04/13/iscsi-and-esxi-multipathing-and-jumbo-frames/) (<https://fojta.wordpress.com/2010/04/13/iscsi-and-esxi-multipathing-and-jumbo-frames/>) contains instructions for configuring MPIO on ESXi.

NFS does not understand MPIO. Therefore, one fast interface is needed, since creating an iSCSI portal will not improve bandwidth when using NFS. LACP does not work well to increase the bandwidth for point-to-point NFS (one server and one client). LACP is a good solution for link redundancy or for one server and many clients.

9.2.2.2 Creating a Link Aggregation

Before creating a link aggregation, see this [warning](#) (page 153) about changing the interface that the web interface uses.

To create a link aggregation, go to *Network* → *Interfaces* and click *ADD*. Choose *Link Aggregation* as the *Type* and continue to fill in the remaining configuration options. See the [Interface Configuration Options table](#) (page 156) for descriptions of each option.

Enter `laggX` for the *Name*, where *X* is a unique interface number. There are several *Lagg Protocol* options, but *LACP* is preferred. Choose *Failover* when the network switch does not support LACP. Open the *Lagg Interfaces* drop-down menu to associate NICs with the lagg device. Click *SAVE* to add the new aggregation to *Network* → *Interfaces* and show options to confirm or revert the new network settings.

Note: If interfaces are installed but do not appear in the *Lagg Interfaces* list, check for a [FreeBSD driver](https://www.freebsd.org/releases/11.2R/hardware.html#ethernet) (<https://www.freebsd.org/releases/11.2R/hardware.html#ethernet>) for the interface.

9.2.2.3 Link Aggregation Options

Options are set at the lagg level from *Network* → *Interfaces*. Find the lagg interface, expand the entry with *>* (Expand), and click *EDIT*. Scroll to the *Options* field. Changes are typically made at the lagg level as each interface member inherits settings from the lagg. Configuring at the interface level requires repeating the configuration for each interface within the lagg. Setting options at the individual interface level is done by editing the parent interface in the same way as the lagg interface. If the MTU settings on the lagg member interfaces are not identical, the smallest value is used for the MTU of the entire lagg.

Note: A reboot is required after changing the MTU to create a jumbo frame lagg.

Link aggregation load balancing can be tested with:

```
systat -ifstat
```

More information about this command can be found at [systat\(1\)](https://www.freebsd.org/cgi/man.cgi?query=systat) (<https://www.freebsd.org/cgi/man.cgi?query=systat>).

9.2.3 VLANs

FreeNAS® uses [vlan\(4\)](https://www.freebsd.org/cgi/man.cgi?query=vlan) (<https://www.freebsd.org/cgi/man.cgi?query=vlan>) to demultiplex frames with IEEE 802.1q tags. This allows nodes on different VLANs to communicate through a layer 3 switch or router. A vlan interface must be assigned a parent interface and a numeric VLAN tag. A single parent can be assigned to multiple vlan interfaces provided they have different tags.

Note: VLAN tagging is the only 802.1q feature that is implemented. Additionally, not all Ethernet interfaces support full VLAN processing. See the HARDWARE section of [vlan\(4\)](https://www.freebsd.org/cgi/man.cgi?query=vlan) (<https://www.freebsd.org/cgi/man.cgi?query=vlan>) for details.

To add a new VLAN interface, go to *Network* → *Interfaces* and click *ADD*. Choose *VLAN* as the *Type* and continue filling in the remaining fields. See the [Interface Configuration Options table](#) (page 156) for descriptions of each option.

The parent interface of a VLAN must be up, but it can either have an IP address or be unconfigured, depending upon the requirements of the VLAN configuration. This makes it difficult for the web interface to do the right thing without trampling the configuration. To remedy this, add the VLAN interface, then select *Network* → *Interfaces*, and click *:* (Options) and *Edit* for the parent interface. Enter `up` in the *Options* field and click *SAVE*. This brings up the parent interface. If an IP address is required, configure it using the rest of the options in the edit screen.

Warning: Creating a VLAN causes an interruption to network connectivity. The web interface requires confirming the new network configuration before it is permanently applied to the FreeNAS® system.

9.3 IPMI

Beginning with version 9.2.1, FreeNAS® provides a graphical screen for configuring an IPMI interface. This screen will only appear if the system hardware includes a Baseboard Management Controller (BMC).

IPMI provides side-band management if the graphical administrative interface becomes unresponsive. This allows for a few vital functions, such as checking the log, accessing the BIOS setup, and powering on the system without requiring physical access to the system. IPMI is also used to give another person remote access to the system to assist with a configuration or troubleshooting issue. Before configuring IPMI, ensure that the management interface is physically connected to the network. The IPMI device may share the primary Ethernet interface, or it may be a dedicated separate IPMI interface.

Warning: It is recommended to first ensure that the IPMI has been patched against the Remote Management Vulnerability before enabling IPMI. This [article](https://www.ixsystems.com/blog/how-to-fix-the-ipmi-remote-management-vulnerability/) (<https://www.ixsystems.com/blog/how-to-fix-the-ipmi-remote-management-vulnerability/>) provides more information about the vulnerability and how to fix it.

Note: Some IPMI implementations require updates to work with newer versions of Java. See [PSA: Java 8 Update 131 breaks ASRock's IPMI Virtual console](https://forums.freenas.org/index.php?threads/psa-java-8-update-131-breaks-asrocks-ipmi-virtual-console.53911/) (<https://forums.freenas.org/index.php?threads/psa-java-8-update-131-breaks-asrocks-ipmi-virtual-console.53911/>) for more information.

IPMI is configured from *Network* → *IPMI*. The IPMI configuration screen, shown in [Figure 9.3](#), provides a shortcut to the most basic IPMI configuration. Those already familiar with IPMI management tools can use them instead. [Table 9.3](#) summarizes the options available when configuring IPMI with the FreeNAS® web interface.

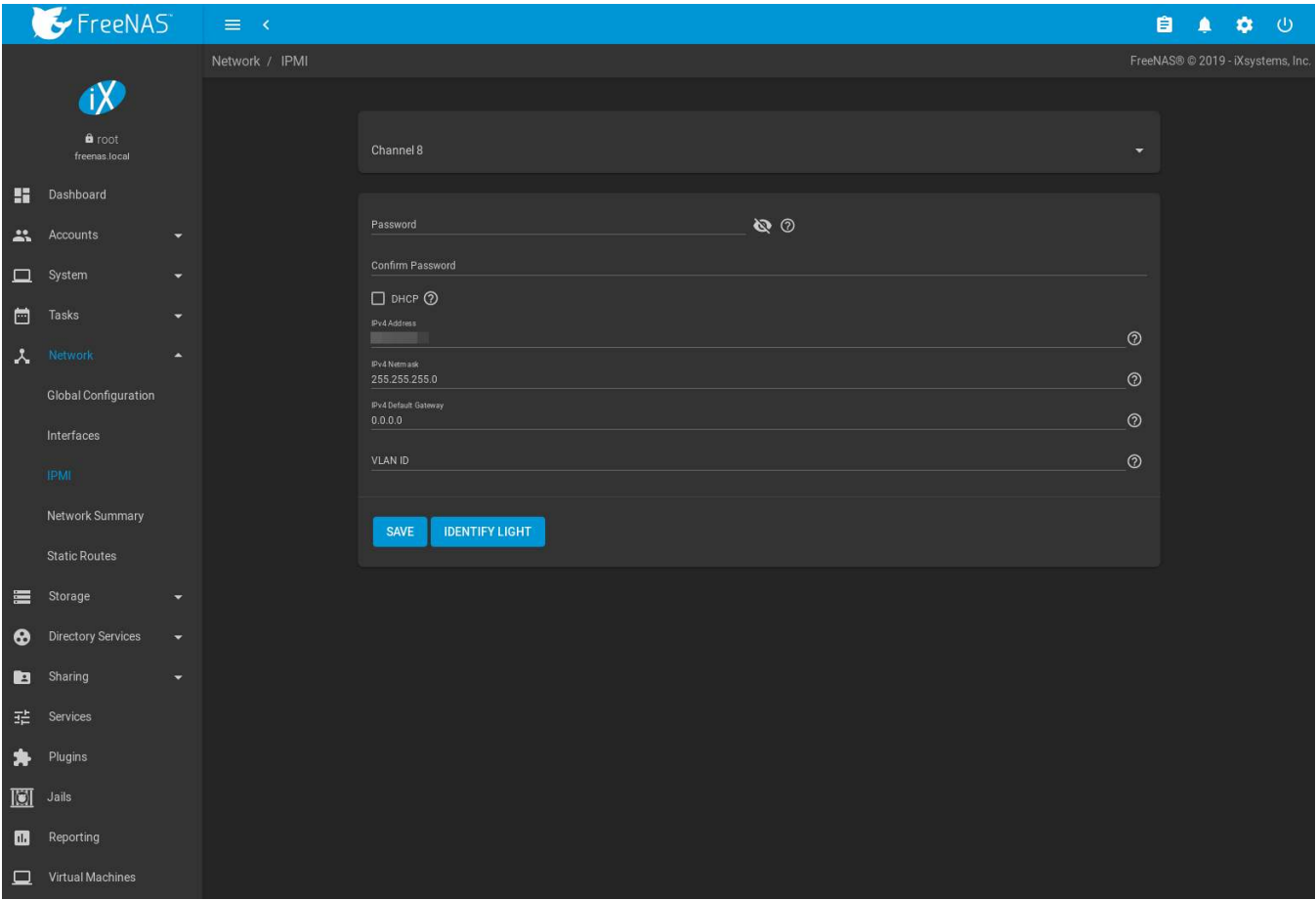


Fig. 9.3: IPMI Configuration

Table 9.3: IPMI Options

Setting	Value	Description
Channel	drop-down menu	Select the communications channel (https://www.thomas-krenn.com/en/wiki/IPMI_Basics#Channel_Model) to use. Available channel numbers vary by hardware.
Password	string	Enter the password used to connect to the IPMI interface from a web browser. The maximum length accepted in the UI is 20 characters, but different hardware might require shorter passwords.
DHCP	checkbox	If left unset, <i>IPv4 Address</i> , <i>IPv4 Netmask</i> , and <i>IPv4 Default Gateway</i> must be set.
IPv4 Address	string	IP address used to connect to the IPMI web interface.
IPv4 Netmask	drop-down menu	Subnet mask associated with the IP address.
IPv4 Default Gateway	string	Default gateway associated with the IP address.
VLAN ID	string	Enter the VLAN identifier if the IPMI out-of-band management interface is not on the same VLAN as management networking.
IDENTIFY LIGHT	button	Show a dialog to activate an IPMI identify light on the compatible connected hardware.

After configuration, the IPMI interface is accessed using a web browser and the IP address specified in the configuration. The management interface prompts for a username and the configured password. Refer to the IPMI device documentation to determine the default administrative username.

After logging in to the management interface, the default administrative username can be changed, and additional

users created. The appearance of the IPMI utility and the functions that are available vary depending on the hardware.

9.4 Network Summary

Network → *Network Summary* shows a quick summary of the addressing information of every configured interface. For each interface name, the configured IPv4 and IPv6 addresses, default routes, and DNS namerservers are displayed.

9.5 Static Routes

No static routes are defined on a default FreeNAS® system. If a static route is required to reach portions of the network, add the route by going to *Network* → *Static Routes*, and clicking *ADD*. This is shown in [Figure 9.4](#).

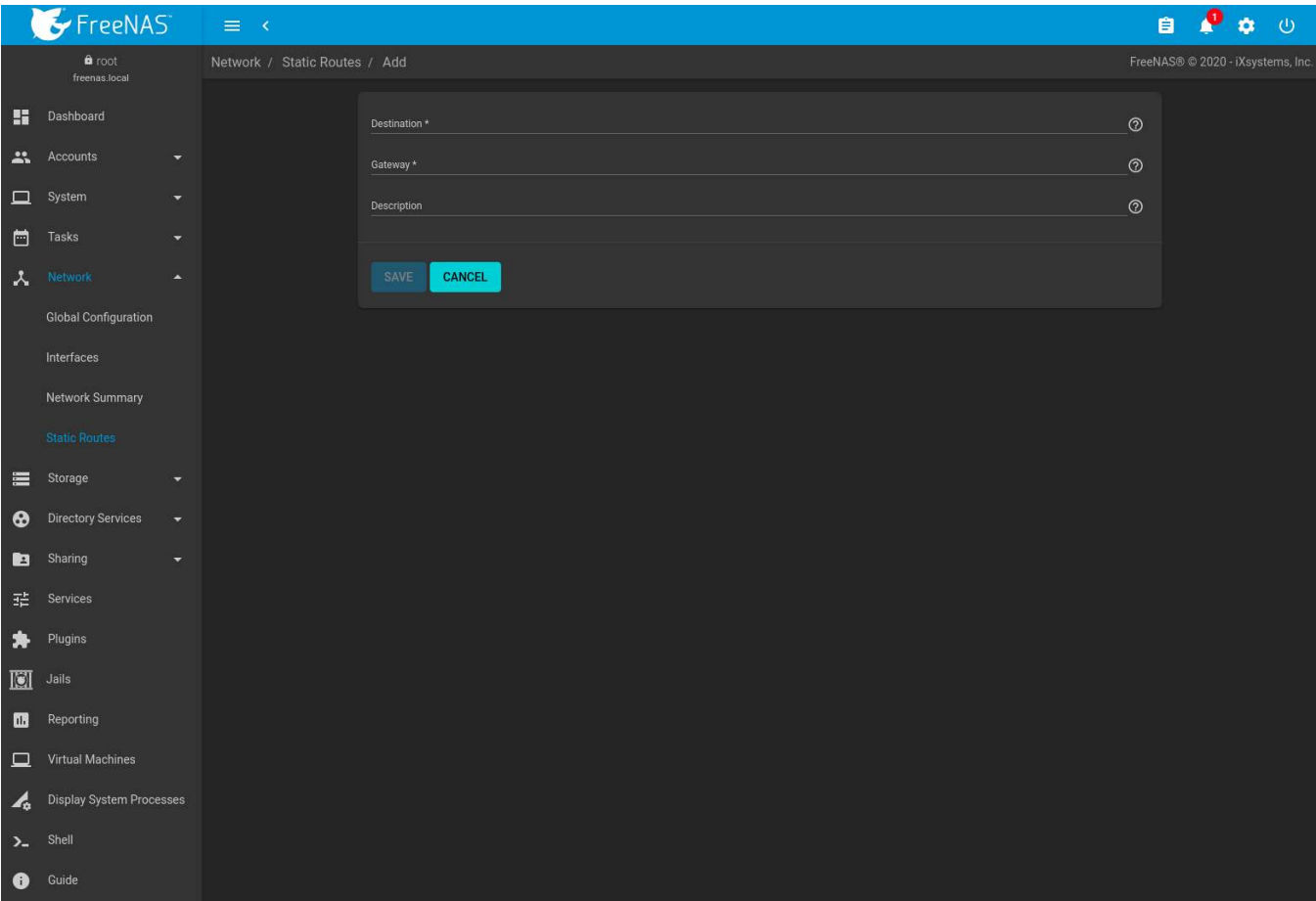


Fig. 9.4: Adding a Static Route

The available options are summarized in [Table 9.4](#).

Table 9.4: Static Route Options

Setting	Value	Description
Destination	integer	Use the format <i>A.B.C.D/E</i> where <i>E</i> is the CIDR mask.
Gateway	integer	Enter the IP address of the gateway.

Continued on next page

Table 9.4 – continued from previous page

Setting	Value	Description
Description	string	Optional. Add any notes about the route.

Added static routes are shown in *Network* → *Static Routes*. Click ⋮ (Options) on a route entry to access the *Edit* and *Delete* buttons.

STORAGE

The Storage section of the web interface allows configuration of these options:

- [Swap Space](#) (page 164): Change the swap space size.
- [Pools](#) (page 164): create and manage storage pools.
- [Snapshots](#) (page 186): manage local snapshots.
- [VMware-Snapshots](#) (page 190): coordinate OpenZFS snapshots with a VMware datastore.
- [Disks](#) (page 191): view and manage disk options.
- [Importing a Disk](#) (page 196): import a **single** disk that is formatted with the UFS, NTFS, MSDOS, or EXT2 filesystem.
- [Multipaths](#) (page 197): View multipath information for systems with compatible hardware.

10.1 Swap Space

Swap is space on a disk set aside to be used as memory. When the FreeNAS® system runs low on memory, less-used data can be “swapped” onto the disk, freeing up main memory.

For reliability, FreeNAS® creates swap space as mirrors of swap partitions on pairs of individual disks. For example, if the system has three hard disks, a swap mirror is created from the swap partitions on two of the drives. The third drive is not used, because it does not have redundancy. On a system with four drives, two swap mirrors are created.

Swap space is allocated when drives are partitioned before being added to a [vdev](#) (page 366). A 2 GiB partition for swap space is created on each data drive by default. The size of space to allocate can be changed in *System* → *Advanced* in the *Swap size in Gib* field. Changing the value does not affect the amount of swap on existing disks, only disks added after the change. This does not affect log or cache devices, which are created without swap. Swap can be disabled by entering 0, but that is **strongly discouraged**.

10.2 Pools

Storage → *Pools* is used to create and manage ZFS pools, datasets, and zvols.

Proper storage design is important for any NAS. **Please read through this entire chapter before configuring storage disks. Features are described to help make it clear which are beneficial for particular uses, and caveats or hardware restrictions which limit usefulness.**

10.2.1 Creating Pools

Before creating a pool, determine the level of required redundancy, how many disks will be added, and if any data exists on those disks. Creating a pool overwrites disk data, so save any required data to different media before adding disks to a pool.

Go to *Storage* → *Pools* and click *ADD*. Select *Create new pool* and click *CREATE POOL* to open the screen shown in Figure 10.1.

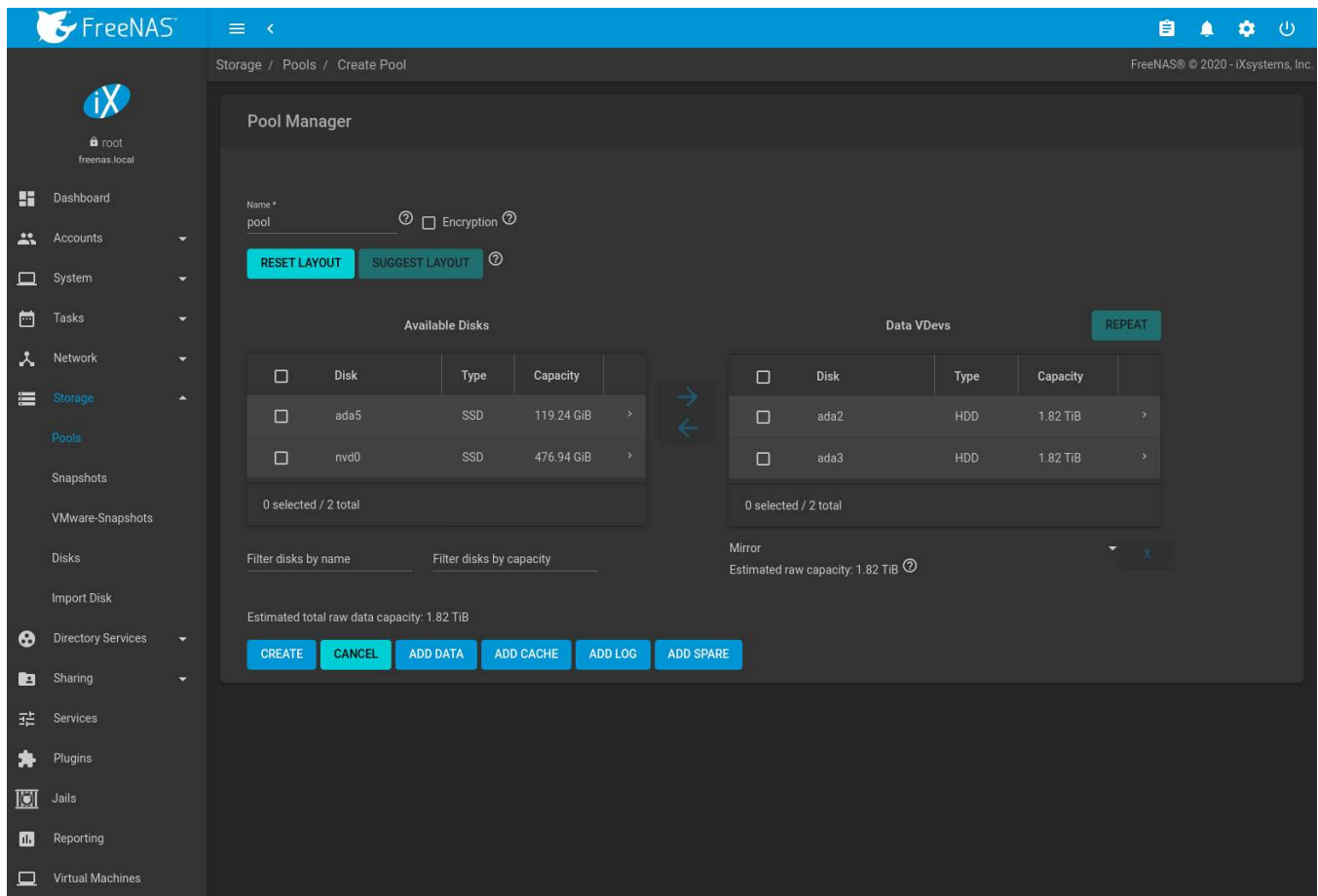


Fig. 10.1: Creating a Pool

Enter a name for the pool in the *Name* field. Ensure that the chosen name conforms to these [naming conventions](https://docs.oracle.com/cd/E23824_01/html/821-1448/gbcpt.html) (https://docs.oracle.com/cd/E23824_01/html/821-1448/gbcpt.html). Choosing a name that will stick out in the logs is recommended, rather than generic names like “data” or “freenas”.

To encrypt data on the underlying disks as a protection against physical theft, set the *Encryption* option. A dialog displays a reminder to back up the *encryption key* (page 169). The data on the disks is inaccessible without the key. Select *Confirm* then click *I UNDERSTAND*.

Warning: Refer to the warnings in [Managing Encrypted Pools](#) (page 167) before enabling encryption!

From the *Available Disks* section, select disks to add to the pool. Enter a value in *Filter disks by name* or *Filter disks by capacity* to change the displayed disk order. These fields support [PCRE regular expressions](http://php.net/manual/en/reference.pcre.pattern.syntax.php) (<http://php.net/manual/en/reference.pcre.pattern.syntax.php>) for filtering. For example, to show only *da* and *nvd* disks in *Available Disks*, type `^(da)|(nvd)` in *Filter disks by name*.

Type and maximum capacity is displayed for available disks. To show the disk *Rotation Rate*, *Model*, and *Serial*, click `>` (Expand).

After selecting disks, click the right arrow to add them to the *Data VDevs* section. The usable space of each disk in a vdev is limited to the size of the smallest disk in the vdev. Additional data vdevs must have the same configuration as the initial vdev.

Any disks that appear in *Data VDevs* are used to create the pool. To remove a disk from that section, select the disk and click the left arrow to return it to the *Available Disks* section.

After adding one data vdev, additional data vdevs can be added with *REPEAT*. This creates additional vdevs of the same layout as the initial vdev. Select the number of additional vdevs and click *REPEAT VDEV*.

RESET LAYOUT returns all disks to the *Available Disks* area and closes all but one *Data VDevs* table.

SUGGEST LAYOUT arranges all disks in an optimal layout for both redundancy and capacity.

The pool layout is dependent upon the number of disks added to *Data VDevs* and the number of available layouts increases as disks are added. To view the available layouts, ensure that at least one disk appears in *Data VDevs* and select the drop-down menu under this section. The web interface will automatically update the *Estimated total raw data capacity* when a layout is selected. These layouts are supported:

- **Stripe:** requires at least one disk
- **Mirror:** requires at least two disks
- **RAIDZ1:** requires at least three disks
- **RAIDZ2:** requires at least four disks
- **RAIDZ3:** requires at least five disks

Warning: Refer to the [ZFS Primer](#) (page 366) for more information on redundancy and disk layouts. When more than five disks are used, consideration must be given to the optimal layout for the best performance and scalability. It is important to realize that different layouts of virtual devices (*vdevs*) affect which operations can be performed on that pool later. For example, drives can be added to a mirror to increase redundancy, but that is not possible with RAIDZ arrays.

After the desired layout is configured, click *CREATE*. A dialog shows a reminder that all disk contents will be erased. Click *Confirm*, then *CREATE POOL* to create the pool.

Note: To instead preserve existing data, click the *CANCEL* button and refer to [Importing a Disk](#) (page 196) and [Importing a Pool](#) (page 173) to see if the existing format is supported. If so, perform that action instead. If the current storage format is not supported, it is necessary to back up the data to external media, create the pool, then re-store the data to the new pool.

Depending on the size and number of disks, the type of controller, and whether encryption is selected, creating the pool may take some time. If the *Encryption* option was selected, a dialog provides a link to *Download Recovery Key*. Click the link and save the key to a safe location. When finished, click *DONE*.

[Figure 10.2](#) shows the new *pool1*. Select the pool to see more information. The first entry in the list represents the root dataset and has the same name as the pool.

The *Available* column shows the estimated storage space before [compression](#) (https://en.wikipedia.org/wiki/Data_compression). The *Used* column shows the estimated space used after compression. These numbers come from `zfs list`.

Other utilities can report different storage estimates. For example, the available space shown in `zpool status` is the cumulative space of all drives in the pool, regardless of pool configuration or compression.

Other information shown is the type of compression, the compression ratio, whether it is mounted as read-only, whether deduplication has been enabled, the mountpoint path, and any comments entered for the pool.

Pool status is indicated by one of these symbols:

Table 10.1: Pool Status

Symbol	Color	Meaning
☑ HEALTHY	Green	The pool is healthy.
⚠ DEGRADED	Orange	The pool is in a degraded state.

Continued on next page

Table 10.1 – continued from previous page

Symbol	Color	Meaning
❓ UNKNOWN	Blue	Pool status cannot be determined.
🔒 LOCKED	Yellow	The pool is locked.
✖ Pool Fault	Red	The pool has a critical error.

There is an option to *Upgrade Pool*. This upgrades the pool to the latest *ZFS Feature Flags* (page 369). See the warnings in *Upgrading a ZFS Pool* (page 40) before selecting this option. This button does not appear when the pool is running the latest version of the feature flags.

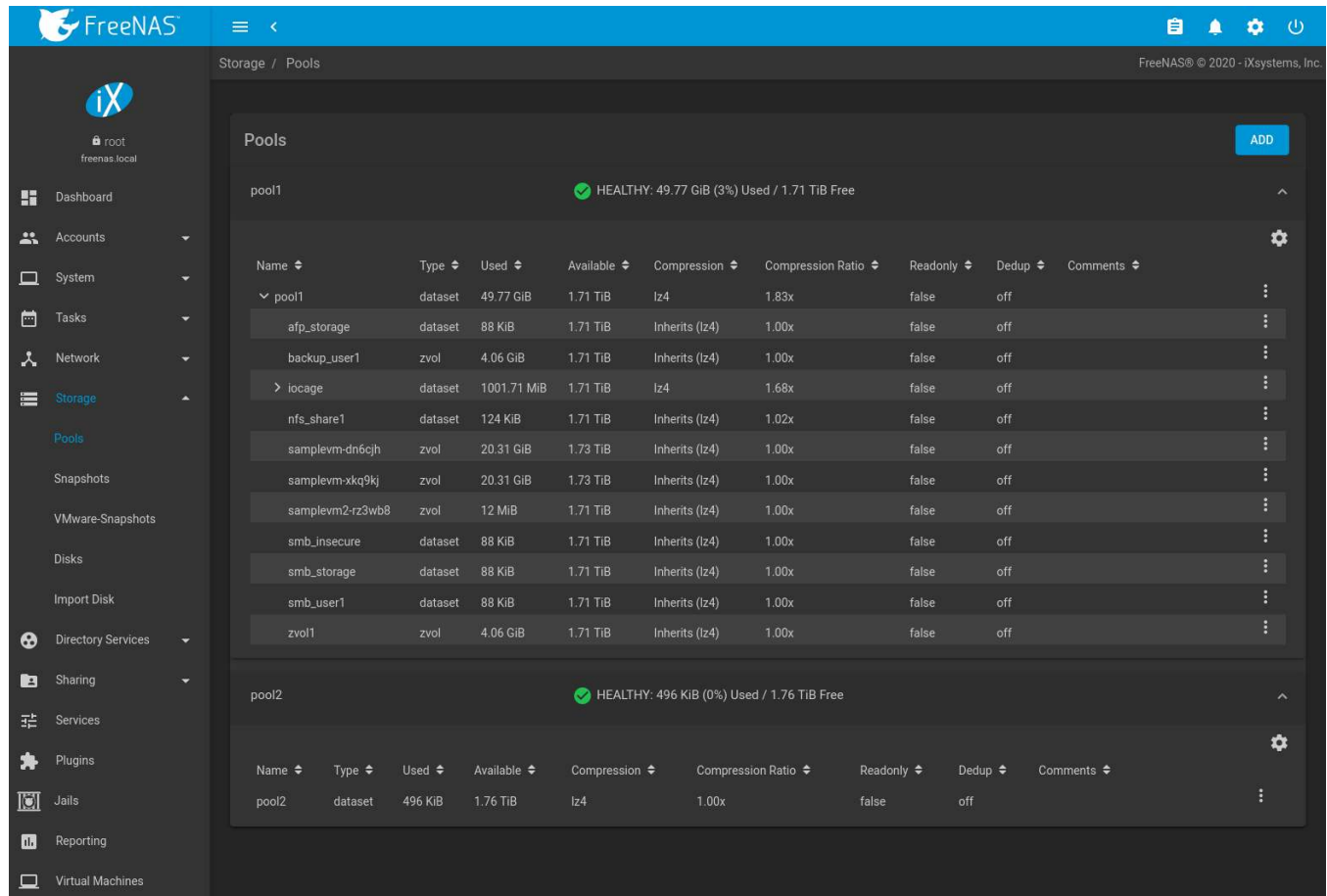


Fig. 10.2: Viewing Pools

Creating a pool adds a card to the *Dashboard*. Available space, disk details, and pool status is shown on the card. The background color of the card indicates the pool status:

- Green: healthy or locked
- Yellow: unknown, offline, or degraded
- Red: faulted or removed

10.2.2 Managing Encrypted Pools

FreeNAS® uses **GELI** (<https://www.freebsd.org/cgi/man.cgi?query=geli>) full disk encryption for ZFS pools. This type of encryption is intended to protect against the risks of data being read or copied when the system is powered down, when the pool is locked, or when disks are physically stolen.

FreeNAS® encrypts disks and pools, not individual filesystems. The partition table on each disk is not encrypted, but only identifies the location of partitions on the disk. On an encrypted pool, the data in each partition is encrypted. These are generally called “encrypted drives”, even though the partition table is not encrypted. To use drive firmware to completely encrypt the drive, see [Self-Encrypting Drives](#) (page 84).

Note: Processors with support for the [AES-NI](https://en.wikipedia.org/wiki/AES_instruction_set) (https://en.wikipedia.org/wiki/AES_instruction_set) instruction set are strongly recommended. These processors can handle encryption of a small number of disks with negligible performance impact. They also retain performance better as the number of disks increases. Older processors without the AES-NI instructions see significant performance impact with even a single encrypted disk. This [forum post](https://forums.freenas.org/index.php?threads/encryption-performance-benchmarks.12157/) (<https://forums.freenas.org/index.php?threads/encryption-performance-benchmarks.12157/>) compares the performance of various processors.

All drives in an encrypted pool are encrypted, including L2ARC (read cache) and SLOG (write cache). Drives added to an existing encrypted pool are encrypted with the same method specified when the pool was created. Data in memory, including ARC, is not encrypted. ZFS data on disk, including L2ARC and SLOG, are encrypted if the underlying disks are encrypted. Swap data on disk is always encrypted.

Encryption performance depends upon the number of disks encrypted. The more drives in an encrypted pool, the more encryption and decryption overhead, and the greater the impact on performance. **Encrypted pools composed of more than eight drives can suffer severe performance penalties.** Please benchmark encrypted pools before using them in production.

Creating an encrypted pool means GELI encrypts the data on the disk and generates a *master key* to decrypt this data. This master key is also encrypted. Loss of a disk master key due to disk corruption is equivalent to any other disk failure, and in a redundant pool, other disks will contain accessible copies of the uncorrupted data. While it is *possible* to separately back up disk master keys, it is usually not necessary or useful.

There are two *user keys* that can be used to unlock the master key and then decrypt the disks. In FreeNAS®, these user keys are named the **encryption key** and the **recovery key**. Because data cannot be read without first providing a key, encrypted disks containing sensitive data can be safely removed, reused, or discarded without secure wiping or physical destruction of the media.

When discarding disks that still contain encrypted sensitive data, the encryption and recovery keys should also be destroyed or securely deleted. Keys that are not destroyed must be stored securely and kept physically separate from the discarded disks. Data is vulnerable to decryption when the encryption key is present with the discarded disks or can be obtained by the same person who gains access to the disks.

This encryption method is **not** designed to protect against unauthorized access when the pool is already unlocked. Before sensitive data is stored on the system, ensure that only authorized users have access to the web interface and that permissions with appropriate restrictions are set on shares.

Here are some important points about FreeNAS® behavior to remember when creating or using an encrypted pool:

- At present, there is no one-step way to encrypt an existing pool. The data must be copied to an existing or new encrypted pool. After that, the original pool and any unencrypted backup should be destroyed to prevent unauthorized access and any disks that contained unencrypted data should be wiped.
- Hybrid pools are not supported. Added vdevs must match the existing encryption scheme. [Extending a Pool](#) (page 171) automatically encrypts a new vdev being added to an existing encrypted pool.
- FreeNAS® encryption differs from the encryption used in the Oracle proprietary version of ZFS. To convert between these formats, both pools must be unlocked, and the data copied between them.
- Each pool has a separate encryption key. Pools can also add a unique recovery key to use if the passphrase is forgotten or encryption key invalidated.
- Encryption applies to a pool, not individual users. The data from an unlocked pool is accessible to all users with permissions to access it. Encrypted pools with a passphrase can be locked on demand by users that know the passphrase. Pools are automatically locked when the system is shut down.
- Encrypted data cannot be accessed when the disks are removed or the system has been shut down. On a running system, encrypted data cannot be accessed when the pool is locked.

- Encrypted pools that have no passphrase are unlocked at startup. Pools with a passphrase remain locked until a user enters the passphrase to unlock them.

10.2.2.1 Encryption and Recovery Keys

FreeNAS® generates a randomized *encryption key* whenever a new encrypted pool is created. This key is stored in the *system dataset* (page 90). It is the primary key used to unlock the pool each time the system boots. Creating a passphrase for the pool adds a passphrase component to the encryption key and allows the pool to be locked.

A pool encryption key backup can be downloaded to allow disk decryption on a different system in the event of failure or to allow the FreeNAS® stored key to be deleted for extra security. The combination of encryption key location and passphrase usage provide several different security scenarios:

- *Key stored locally, no passphrase*: the encrypted pool is decrypted and accessible when the system running. Protects “data at rest” only.
- *Key stored locally, with passphrase*: the encrypted pool is not accessible until the passphrase is entered by the FreeNAS® administrator.
- *Key not stored locally*: the encrypted pool is not accessible until the FreeNAS® administrator uploads the key file. When the key also has a passphrase, it must be provided with the key file.

Encrypted pools cannot be locked in the web interface until a passphrase is created for the encryption key.


The recovery key is an optional keyfile that is generated by FreeNAS®, provided for download, and wiped from the system. It is designed as an emergency backup to unlock or import an encrypted pool if the passphrase is forgotten or the encryption key is somehow invalidated. This file is not stored anywhere on the FreeNAS® system and only one recovery key can exist for each encrypted pool. Adding a new recovery key invalidates any previously downloaded recovery key file for that pool.




Existing encryption or recovery keys can be invalidated in several situations:

- An encryption re-key invalidates all encryption and recovery keys as well as an existing passphrase.
- Using a recovery key file to import an encrypted pool invalidates the existing encryption key and passphrase for that pool. FreeNAS® generates a new encryption key for the imported pool, but a new passphrase must be created before the pool can be locked.
- Creating or changing a passphrase invalidates any existing recovery key.
- Adding a new recovery key invalidates any existing recovery key files for the pool.
- *Extending a Pool* (page 171) invalidates all encryption and recovery keys as well as an existing passphrase.

Be sure to download and securely store copies of the most current encryption and recovery keys. Protect and backup encryption key passphrases. **Losing the encryption and recovery keys or the passphrase can result in irrevocably losing all access to the data stored in the encrypted pool!**

10.2.2.2 Encryption Operations

Encryption operations are seen by clicking  (Encryption Options) for the encrypted pool in *Storage* → *Pools*. These options are available:

- *Lock*: Only appears after a passphrase is created. Locking a pool restricts data accessibility in FreeNAS® until the pool is unlocked. Selecting this action requires entering the passphrase. The pool status changes to **LOCKED**, *Pool Operations* are limited to *Export/Disconnect*, and  (Encryption Options) changes to  (Unlock).
- *Unlock*: Decrypt the pool by clicking  (Unlock) and entering the passphrase *or* uploading the recovery key file. Only the passphrase is used when both a passphrase and a recovery key are entered. The services listed in *Restart Services* restart when the pool is unlocked. This enables FreeNAS® to begin accessing the decrypted data. Individual services can be prevented from restarting by opening *Restart Services* and deselecting them. Deselecting services can prevent them from properly accessing the unlocked pool.

- *Encryption Key/Passphrase*: Create or change the encryption key passphrase and download a backup of the encryption key. Unlike a password, a passphrase can contain spaces and is typically a series of words. A good passphrase is easy to remember but hard to guess.

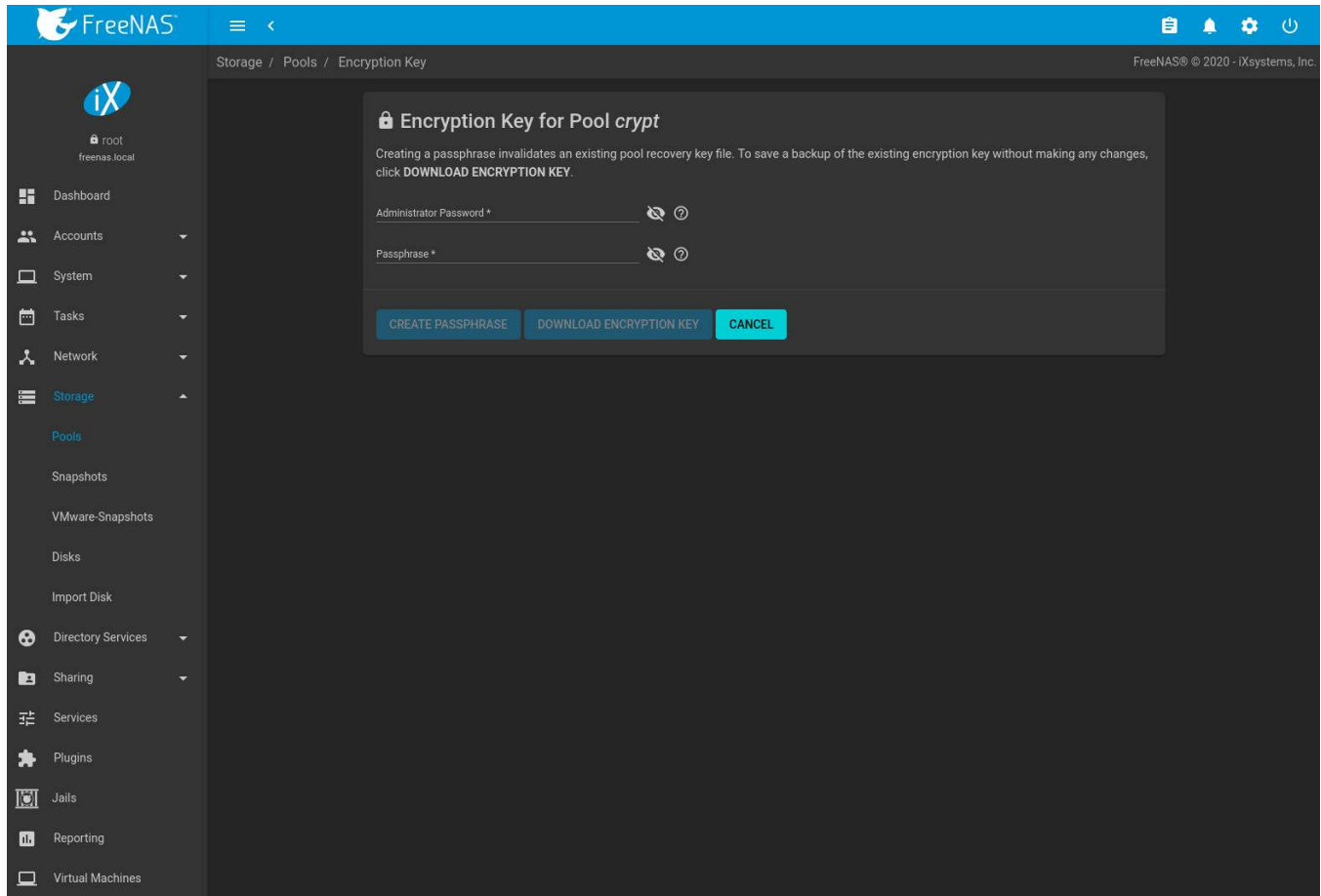


Fig. 10.3: Encryption Key/Passphrase Options

The administrator password is required for encryption key changes. Setting *Remove Passphrase* invalidates the current pool passphrase. Creating or changing a passphrase invalidates the pool recovery key.

- *Recovery Key*: Generate and download a new recovery key file or invalidate an existing recovery key. The FreeNAS® administrative password is required. Generating a new recovery key file invalidates previously downloaded recovery key files for the pool.
- *Reset Keys*: Reset the encryption on the pool GELI master key and invalidate all encryption keys, recovery keys, and any passphrase for the pool. A dialog opens to save a backup of the new encryption key. A new passphrase can be created and a new pool recovery key file can be downloaded. The administrator password is required to reset pool encryption.

If a key reset fails on a multi-disk system, an alert is generated. **Do not ignore this alert** as doing so may result in the loss of data.

10.2.3 Adding Cache or Log Devices

Pools (page 164) can be used either during or after pool creation to add an SSD as a cache or log device to improve performance of the pool under specific use cases. Before adding a cache or log device, refer to the [ZFS Primer](#) (page 366) to determine if the system will benefit or suffer from the addition of the device.

To add a Cache or Log device during pool creation, click the *Add Cache* or *Add Log* button. Select the disk from *Available Disks* and use the *right arrow* next to *Cache VDev* or *Log VDev* to add it to that section.

To add a device to an existing pool, *Extend* (page 171) that pool.

10.2.4 Removing Cache or Log Devices

Cache or log devices can be removed by going to *Storage* → *Pools*. Choose the desired pool and click ⚙ (Settings) → *Status*. Choose the log or cache device to remove, then click ⋮ (Options) → *Remove*.

10.2.5 Adding Spare Devices

ZFS provides the ability to have “hot” *spares*. These are drives that are connected to a pool, but not in use. If the pool experiences the failure of a data drive, the system uses the hot spare as a temporary replacement. If the failed drive is replaced with a new drive, the hot spare drive is no longer needed and reverts to being a hot spare. If the failed drive is detached from the pool, the spare is promoted to a full member of the pool.

Hot spares can be added to a pool during or after creation. On FreeNAS®, hot spare actions are implemented by *zfsd(8)* (<https://www.freebsd.org/cgi/man.cgi?query=zfsd>).

To add a spare during pool creation, click the *Add Spare* button. Select the disk from *Available Disks* and use the *right arrow* next to *Spare VDev* to add it to the section.

To add a device to an existing pool, *Extend* (page 171) that pool.

10.2.6 Extending a Pool

To increase the capacity of an existing pool, click the pool name, ⚙ (Settings), then *Extend*.

If the existing pool is *encrypted* (page 167), an additional warning message shows a reminder that **extending a pool resets the passphrase and recovery key**. Extending an encrypted pool opens a dialog to download the new encryption key file. Remember to use the *Encryption Operations* (page 169) to set a new passphrase and create a new recovery key file.

When adding disks to increase the capacity of a pool, ZFS supports the addition of virtual devices, or *vdevs*, to an existing ZFS pool. **After a vdev is created, more drives cannot be added to that vdev**, but a new vdev can be striped with another of the **same type** to increase the overall size of the pool. To extend a pool, the vdev being added must be the same type as existing vdevs. The *EXTEND* button is only enabled when the vdev being added is the same type as the existing vdevs. Some vdev extending examples:

- to extend a ZFS mirror, add the same number of drives. The result is a striped mirror. For example, if ten new drives are available, a mirror of two drives could be created initially, then extended by adding another mirror of two drives, and repeating three more times until all ten drives have been added.
- to extend a three-drive RAIDZ1, add another three drives. The resulting pool is a stripe of two RAIDZ1 vdevs, similar to RAID 50 on a hardware controller.
- to extend a four-drive RAIDZ2, add another four drives. The result is a stripe of RAIDZ2 vdevs, similar to RAID 60 on a hardware controller.

10.2.7 Export/Disconnect a Pool

Export/Disconnect is used to cleanly disconnect a pool from the system. This is used before physically disconnecting the pool so it can be imported on another system, or to optionally detach and erase the pool so the disks can be reused.

To export or destroy an existing pool, click the pool name, ⚙ (Settings), then *Export/Disconnect*. A dialog shows which system *Services* (page 252) will be disrupted by exporting the pool and additional warnings for encrypted pools. Keep or erase the contents of the pool by setting the options shown in *Figure 10.4*.

Export/disconnect pool: 'crypt'

WARNING: Exporting/disconnecting pool *crypt*. Data on the pool will not be available after export. Data on the pool disks can be destroyed by setting the **Destroy data** option. Back up critical data **before** exporting/disconnecting the pool.

These services depend on pool *crypt* and will be disrupted if the pool is detached:

NFS Share:
- /mnt/crypt

SMB Share:
- crypt

'crypt' is encrypted! If the passphrase for this encrypted pool has been lost, the data will be PERMANENTLY UNRECOVERABLE! Before exporting/disconnecting encrypted pools, download and safely store the encryption key and any passphrase for it.

☐ Destroy data on this pool?

☒ Delete configuration of shares that used this pool?

☐ Confirm Export/Disconnect

DOWNLOAD KEY **CANCEL** EXPORT/DISCONNECT

Fig. 10.4: Export/Disconnect a Pool

Warning: Do not export/disconnect an encrypted pool if the passphrase has not been set! **An encrypted pool cannot be reimported without a passphrase!** When in doubt, use the instructions in [Managing En-](#)

encrypted Pools

The *Export/Disconnect Pool* screen provides these options:

Table 10.2: Export/Disconnect Pool Options

Setting	Description
Destroy data on this pool?	Destroy all data on the disks in the pool. This action cannot be undone.
Delete configuration of shares	Delete any share configurations set up on the pool.
Confirm export/disconnect	Confirm the export/disconnect operation.

If the pool is encrypted, *DOWNLOAD KEY* is also shown to download the [encryption key](#) (page 169) for that pool.

To *Export/Disconnect* the pool and keep the data and configurations of shares, set **only** *Confirm export/disconnect* and click *EXPORT/DISCONNECT*.

To instead destroy the data and share configurations on the pool, also set the *Destroy data on this pool?* option. To verify that data on the pool is to be destroyed, type the name of the pool and click *EXPORT/DISCONNECT*. Data on the pool is destroyed, including share configuration, zvols, datasets, and the pool itself. The disk is returned to a raw state.

Danger: Before destroying a pool, ensure that any needed data has been backed up to a different pool or system.

10.2.8 Importing a Pool

A pool that has been exported and disconnected from the system can be reconnected with *Storage* → *Pools* → *Add*, then selecting *Import an existing pool*. This works for pools that were exported/disconnected from the current system, created on another system, or to reconnect a pool after reinstalling the FreeNAS® system.

When physically installing ZFS pool disks from another system, use the `zpool export poolname` command or a web interface equivalent to export the pool on that system. Then shut it down and connect the drives to the FreeNAS® system. This prevents an “in use by another machine” error during the import to FreeNAS®.

Existing ZFS pools can be imported by clicking *Storage* → *Pools* and *ADD*. Select *Import an existing pool*, then click *NEXT* as shown in [Figure 10.5](#).

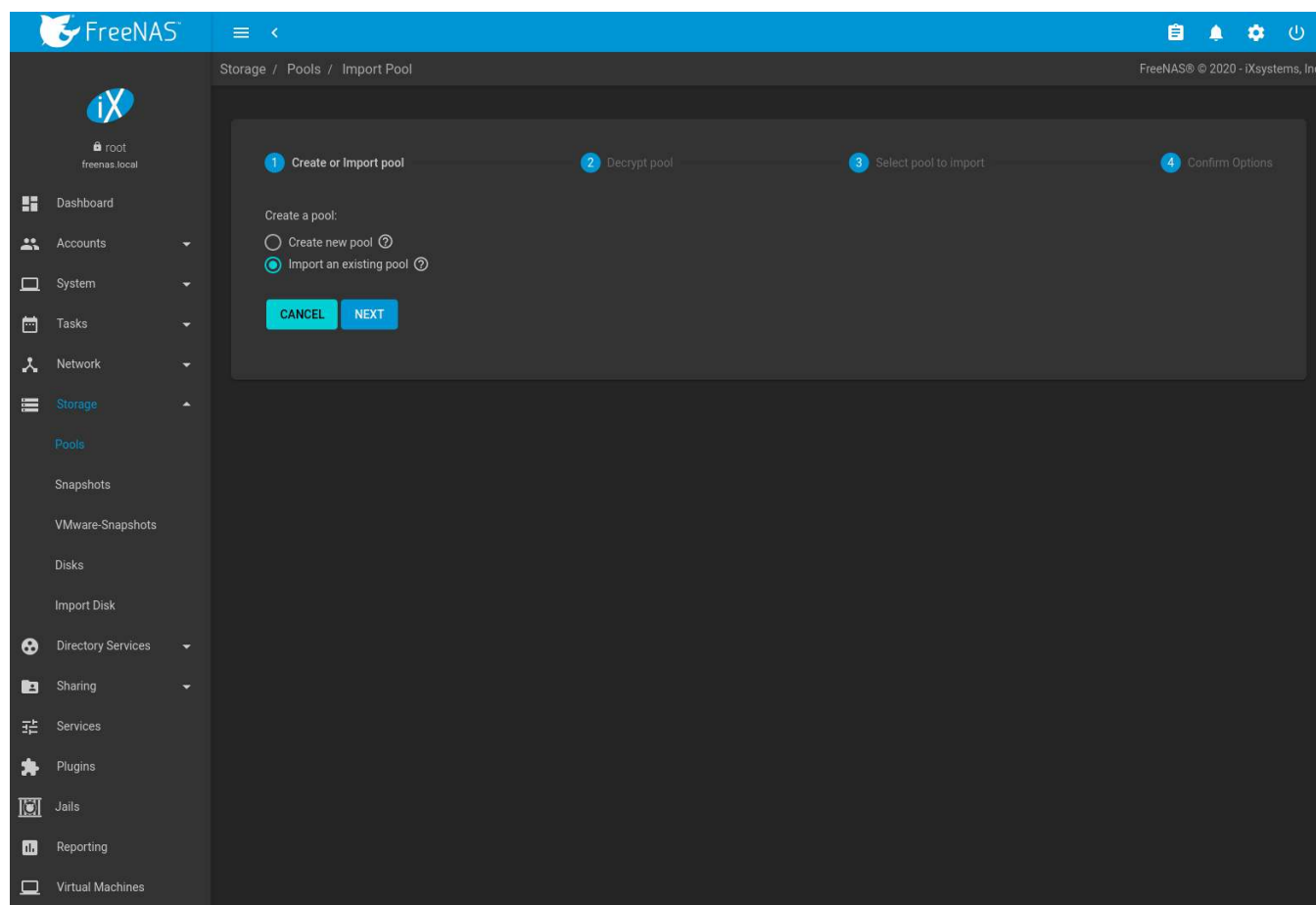


Fig. 10.5: Pool Import

To import a pool, click *No, continue with import* then *NEXT* as shown in [Figure 10.6](#).

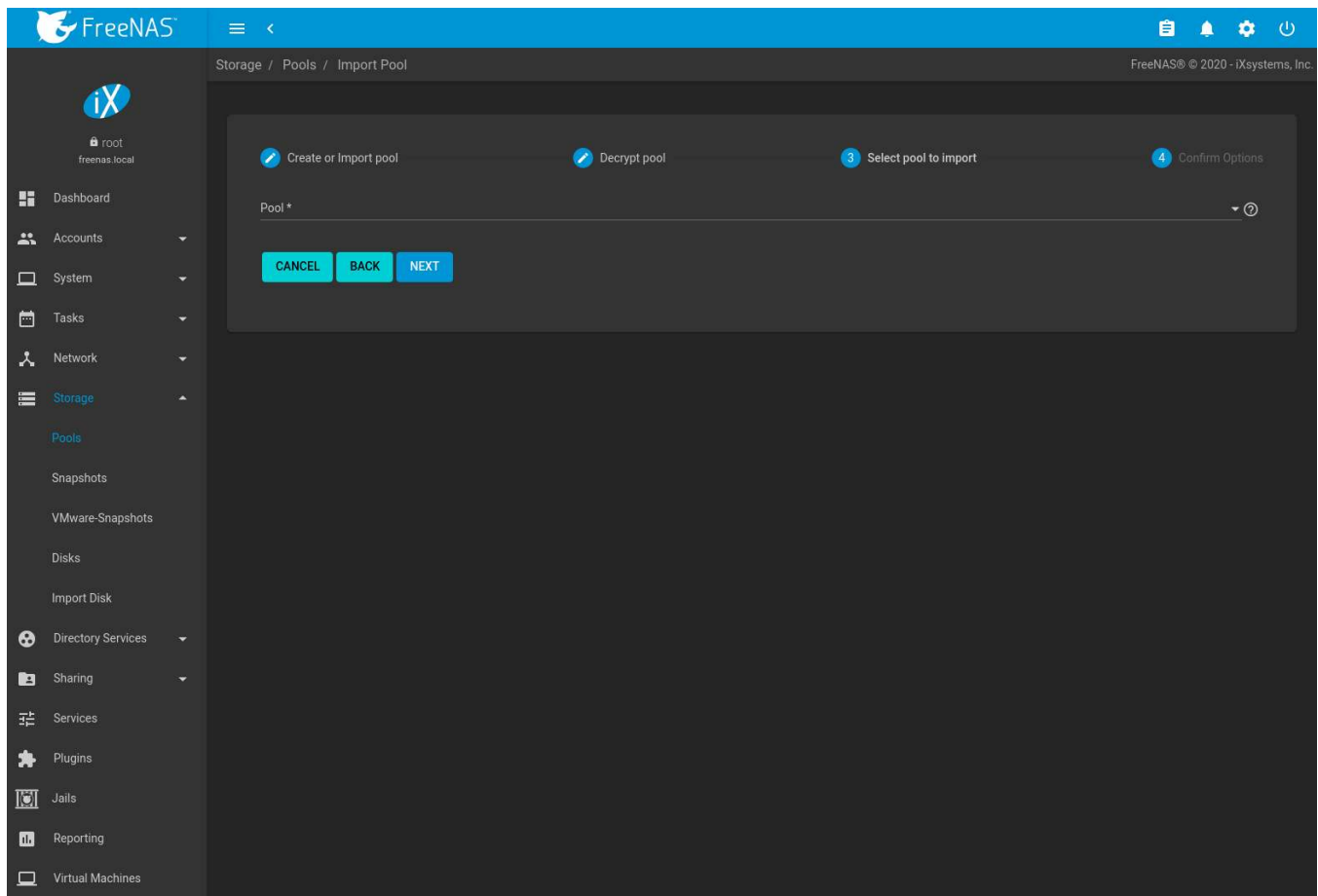


Fig. 10.6: Importing a Pool

Select the pool from the *Pool ** drop-down menu and click *NEXT* to confirm the options and *IMPORT* it.

If hardware is not being detected, run `camcontrol devlist` from [Shell](#) (page 335). If the disk does not appear in the output, check to see if the controller driver is supported or if it needs to be loaded using [Tunables](#) (page 102).

Before importing an [encrypted pool](#) (page 167), disks must first be decrypted. Click *Yes, decrypt the disks*. This is shown in [Figure 10.7](#).

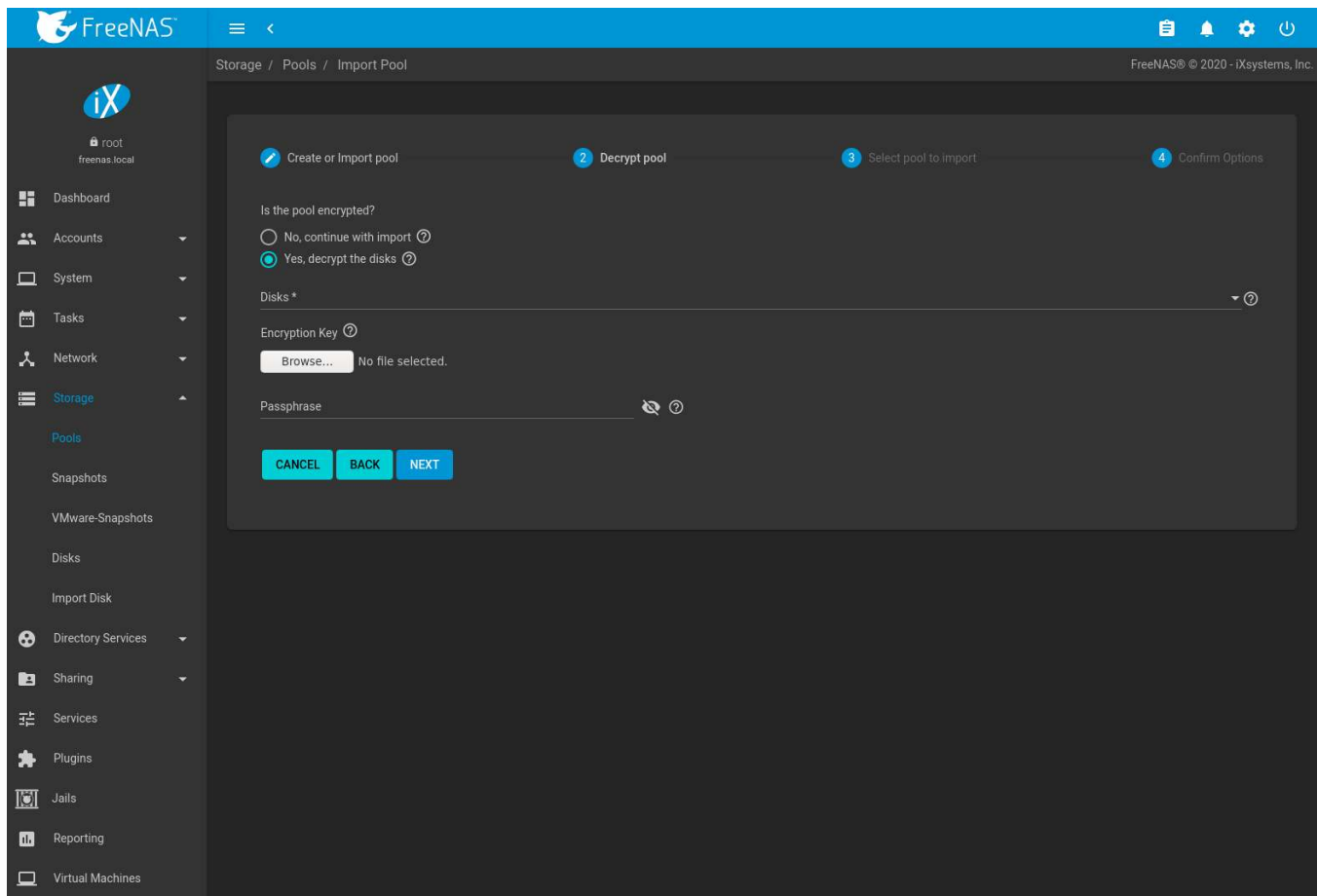


Fig. 10.7: Decrypting Disks Before Importing a Pool

Use the *Disks* dropdown menu to select the disks to decrypt. Click *Browse* to select the encryption key file stored on the client system. Enter the *Passphrase* associated with the encryption key, then click *NEXT* to continue importing the pool.

Danger: The encryption key file and passphrase are required to decrypt the pool. If the pool cannot be decrypted, it cannot be re-imported after a failed upgrade or lost configuration. This means it is **very important** to save a copy of the key and to remember the passphrase that was configured for the key. Refer to [Managing Encrypted Pools](#) (page 167) for instructions on managing keys.

Select the pool to import and confirm the settings. Click *IMPORT* to finish the process.

Note: For security reasons, encrypted pool keys are not saved in a configuration backup file. When FreeNAS® has been installed to a new device and a saved configuration file restored to it, the keys for encrypted disks will not be present, and the system will not request them. To correct this, export the encrypted pool with (Configure) → *Export/Disconnect*, making sure that *Destroy data on this pool?* is **not** set. Then import the pool again. During the import, the encryption keys can be entered as described above.

10.2.9 Viewing Pool Scrub Status

Scrubs and how to set their schedule are described in more detail in [Scrub Tasks](#) (page 144).

To view the scrub status of a pool, click the pool name, ⚙ (Settings), then *Status*. The resulting screen will display the status and estimated time remaining for a running scrub or the statistics from the last completed scrub.

A *CANCEL* button is provided to cancel a scrub in progress. When a scrub is cancelled, it is abandoned. The next scrub to run starts from the beginning, not where the cancelled scrub left off.

10.2.10 Adding Datasets

An existing pool can be divided into datasets. Permissions, compression, deduplication, and quotas can be set on a per-dataset basis, allowing more granular control over access to storage data. Like a folder or directory, permissions can be set on dataset. Datasets are also similar to filesystems in that properties such as quotas and compression can be set, and snapshots created.

Note: ZFS provides thick provisioning using quotas and thin provisioning using reserved space.

To create a dataset, select an existing pool in *Storage* → *Pools*, click ⋮ (Options), then select *Add Dataset*. This will display the screen shown in [Figure 10.8](#).

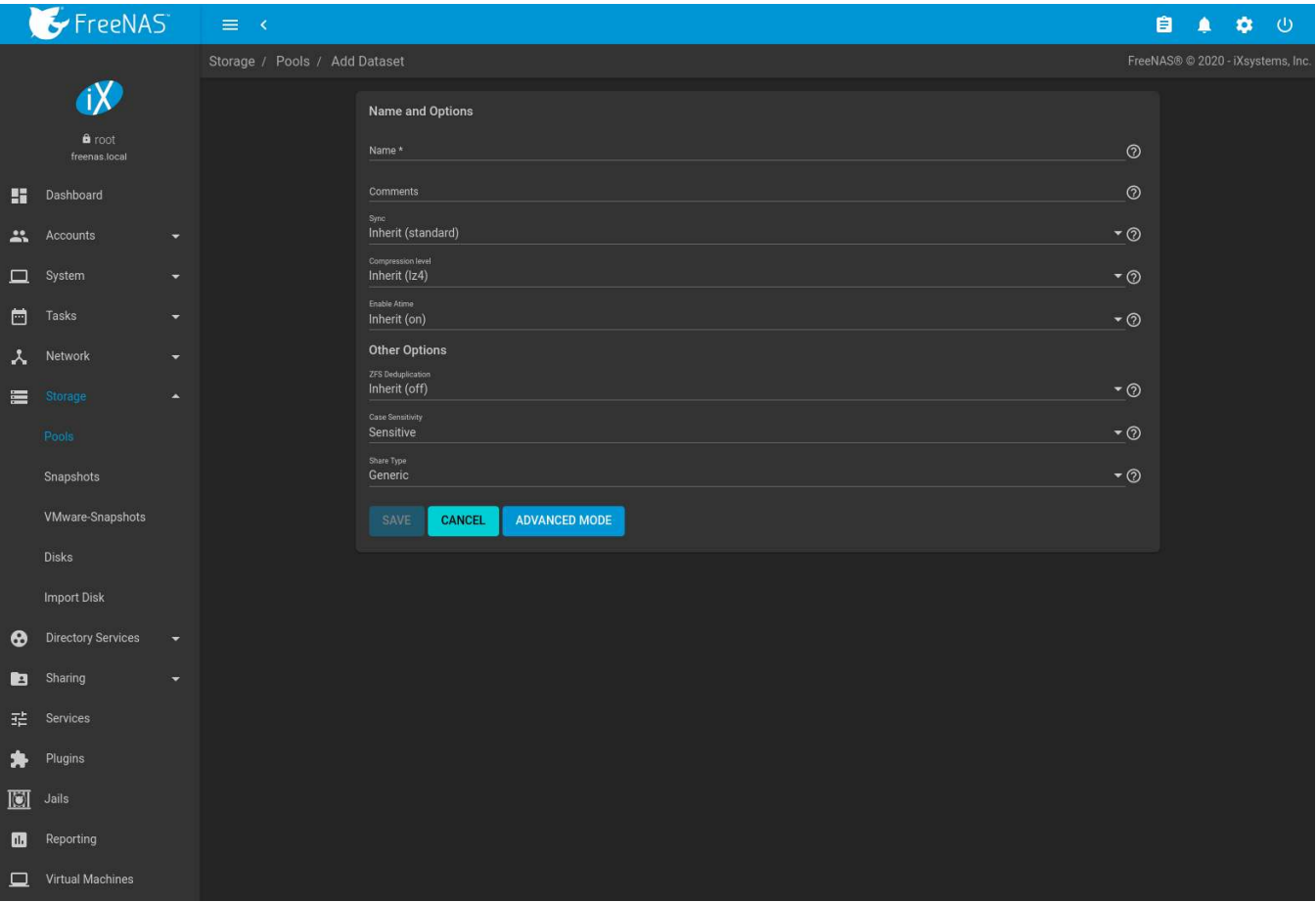


Fig. 10.8: Creating a ZFS Dataset

Table 10.3 shows the options available when creating a dataset.

Some settings are only available in *ADVANCED MODE*. To see these settings, either click the *ADVANCED MODE* button, or configure the system to always display advanced settings by enabling the *Show advanced fields by default* option in *System* → *Advanced*.


Table 10.3: Dataset Options

Setting	Value	Advanced Mode	Description
Name	string		Required. Enter a unique name for the dataset.
Comments	string		Enter any additional comments or user notes about this dataset.
Sync	drop-down menu		Set the data write synchronization. <i>Inherit</i> inherits the sync settings from the parent dataset, <i>Standard</i> uses the sync settings that have been requested by the client software, <i>Always</i> waits for data writes to complete, and <i>Disabled</i> never waits for writes to complete.
Compression Level	drop-down menu		Refer to the section on Compression (page 180) for a description of the available algorithms.
Enable atime	Inherit, On, or Off		Choose <i>On</i> to update the access time for files when they are read. Choose <i>Off</i> to prevent producing log traffic when reading files. This can result in significant performance gains.
Quota for this dataset	integer	✓	Default of 0 disables quotas. Specifying a value means to use no more than the specified size and is suitable for user datasets to prevent users from hogging available space.
Quota warning alert at, %	integer	✓	Set Inherit to apply the same quota warning alert settings as the parent dataset.
Quota critical alert at, %	integer	✓	Set Inherit to apply the same quota critical alert settings as the parent dataset.
Quota for this dataset and all children	integer	✓	A specified value applies to both this dataset and any child datasets.
Quota warning alert at, %	integer	✓	Set Inherit to apply the same quota warning alert settings as the parent dataset.
Quota critical alert at, %	integer	✓	Set Inherit to apply the same quota critical alert settings as the parent dataset.
Reserved space for this dataset	integer	✓	Default of 0 is unlimited. Specifying a value means to keep at least this much space free and is suitable for datasets containing logs which could otherwise take up all available free space.
Reserved space for this dataset and all children	integer	✓	A specified value applies to both this dataset and any child datasets.
ZFS Deduplication	drop-down menu		Read the section on Deduplication (page 180) before making a change to this setting.
Read-only	drop-down menu	✓	Choices are <i>Inherit</i> , <i>On</i> , or <i>Off</i> .
Exec	drop-down menu	✓	Choices are <i>Inherit</i> , <i>On</i> , or <i>Off</i> . Setting to <i>Off</i> prevents the installation of Plugins (page 283) or Jails (page 294).
Snapshot directory	drop-down menu	✓	Choose if the <code>.zfs</code> snapshot directory is Visible or Invisible on this dataset.
Copies	drop-down menu	✓	Set the number of data copies on this dataset.

Continued on next page

Table 10.3 – continued from previous page

Setting	Value	Advanced Mode	Description
Record Size	drop-down menu	✓	While ZFS automatically adapts the record size dynamically to adapt to data, if the data has a fixed size (such as database records), matching its size might result in better performance. Warning: choosing a smaller record size than the suggested value can reduce disk performance and space efficiency.
ACL Mode	drop-down menu	✓	Determine how <code>chmod(2)</code> (https://www.freebsd.org/cgi/man.cgi?query=chmod) behaves when adjusting file ACLs. See the zfs(8) aclmode property (https://www.freebsd.org/cgi/man.cgi?query=zfs). <i>Passthrough</i> only updates ACL entries that are related to the file or directory mode. <i>Restricted</i> does not allow <code>chmod</code> to make changes to files or directories with a non-trivial ACL. An ACL is trivial if it can be fully expressed as a file mode without losing any access rules. Setting the <i>ACL Mode</i> to <i>Restricted</i> is typically used to optimize a dataset for <i>SMB sharing</i> (page 239), but can require further optimizations. For example, configuring an <i>rsync</i> (page 126) with this dataset could require adding <code>--no-perms</code> in the task <i>Extra options</i> field.
Case Sensitivity	drop-down menu		Choices are <i>sensitive</i> (default, assumes filenames are case sensitive), <i>insensitive</i> (assumes filenames are not case sensitive), or <i>mixed</i> (understands both types of filenames). This can only be set when creating a new dataset.
Share Type	drop-down menu		Select the type of share that will be used on the dataset. Choose between <i>Generic</i> for most sharing options or <i>SMB</i> for a <i>SMB share</i> (page 239). Choosing <i>SMB</i> sets the <i>ACL Mode</i> to <i>Restricted</i> and <i>Case Sensitivity</i> to <i>Insensitive</i> . This field is only available when creating a new dataset.

After a dataset is created it appears in *Storage* → *Pools*. Click  (Options) on an existing dataset to configure these options: **Add Dataset:** create a nested dataset, or a dataset within a dataset.

Add Zvol: add a zvol to the dataset. Refer to [Adding Zvols](#) (page 181) for more information about zvols.

Edit Options: edit the pool properties described in [Table 10.8](#). Note that *Dataset Name* and *Case Sensitivity* are read-only as they cannot be edited after dataset creation.

Edit Permissions: refer to [Setting Permissions](#) (page 182) for more information about permissions.

Danger: Removing a dataset is a permanent action and results in data loss!

Edit ACL: see [ACL Management](#) (page 183) for details about modifying an Access Control List (ACL).

Delete Dataset: removes the dataset, snapshots of that dataset, and any objects stored within the dataset. To remove the dataset, set *Confirm*, click *DELETE DATASET*, verify that the correct dataset to be deleted has been chosen by entering the dataset name, and click *DELETE*. When the dataset has active shares or is still being used by other parts of the system, the dialog shows what is still using it and allows forcing the deletion anyway. **Caution:** forcing the deletion of an in-use dataset can cause data loss or other problems.

Promote Dataset: only appears on clones. When a clone is promoted, the origin filesystem becomes a clone of the clone making it possible to destroy the filesystem that the clone was created from. Otherwise, a clone cannot be deleted while the origin filesystem exists.

Create Snapshot: create a one-time snapshot. A dialog opens to name the snapshot. Options to include child datasets in the snapshot and synchronize with VMware can also be shown. To schedule snapshot creation, use [Periodic Snapshot Tasks](#) (page 133).

10.2.10.1 Deduplication

Deduplication is the process of ZFS transparently reusing a single copy of duplicated data to save space. Depending on the amount of duplicate data, deduplication can improve storage capacity, as less data is written and stored. However, deduplication is RAM intensive. A general rule of thumb is 5 GiB of RAM per terabyte of deduplicated storage. **In most cases, compression provides storage gains comparable to deduplication with less impact on performance.**

In FreeNAS®, deduplication can be enabled during dataset creation. Be forewarned that **there is no way to undedup the data within a dataset once deduplication is enabled**, as disabling deduplication has **NO EFFECT** on existing data. The more data written to a deduplicated dataset, the more RAM it requires. When the system starts storing the DDTs (dedup tables) on disk because they no longer fit into RAM, performance craters. Further, importing an unclean pool can require between 3-5 GiB of RAM per terabyte of deduped data, and if the system does not have the needed RAM, it will panic. The only solution is to add more RAM or recreate the pool. **Think carefully before enabling dedup!** This [article](https://constantin.glez.de/2011/07/27/zfs-to-dedupe-or-not-dedupe/) (<https://constantin.glez.de/2011/07/27/zfs-to-dedupe-or-not-dedupe/>) provides a good description of the value versus cost considerations for deduplication.

Unless a lot of RAM and a lot of duplicate data is available, do not change the default deduplication setting of "Off". For performance reasons, consider using compression rather than turning this option on.

If deduplication is changed to *On*, duplicate data blocks are removed synchronously. The result is that only unique data is stored and common components are shared among files. If deduplication is changed to *Verify*, ZFS will do a byte-to-byte comparison when two blocks have the same signature to make sure that the block contents are identical. Since hash collisions are extremely rare, *Verify* is usually not worth the performance hit.

Note: After deduplication is enabled, the only way to disable it is to use the `zfs set dedup=off dataset_name` command from *Shell* (page 335). However, any data that has already been deduplicated will not be un-deduplicated. Only newly stored data after the property change will not be deduplicated. The only way to remove existing deduplicated data is to copy all of the data off of the dataset, set the property to off, then copy the data back in again. Alternately, create a new dataset with *ZFS Deduplication* left at *Off*, copy the data to the new dataset, and destroy the original dataset.

Tip: Deduplication is often considered when using a group of very similar virtual machine images. However, other features of ZFS can provide dedup-like functionality more efficiently. For example, create a dataset for a standard VM, then clone a snapshot of that dataset for other VMs. Only the difference between each created VM and the main dataset are saved, giving the effect of deduplication without the overhead.

10.2.10.2 Compression

When selecting a compression type, balancing performance with the amount of disk space saved by compression is recommended. Compression is transparent to the client and applications as ZFS automatically compresses data as it is written to a compressed dataset or zvol and automatically decompresses that data as it is read. These compression algorithms are supported:

- **LZ4:** default and recommended compression method as it allows compressed datasets to operate at near real-time speed. This algorithm only compresses files that will benefit from compression.
- **GZIP:** levels 1, 6, and 9 where *gzip fastest* (level 1) gives the least compression and *gzip maximum* (level 9) provides the best compression but is discouraged due to its performance impact.
- **ZLE:** fast but simple algorithm which eliminates runs of zeroes.

If *OFF* is selected as the *Compression level* when creating a dataset or zvol, compression will not be used on that dataset/zvol. This is not recommended as using *LZ4* has a negligible performance impact and allows for more storage capacity.

10.2.11 Adding Zvols

A zvol is a feature of ZFS that creates a raw block device over ZFS. The zvol can be used as an *iSCSI* (page 261) device extent.

To create a zvol, select an existing ZFS pool or dataset, click **⋮** (Options), then *Add Zvol* to open the screen shown in Figure 10.9.

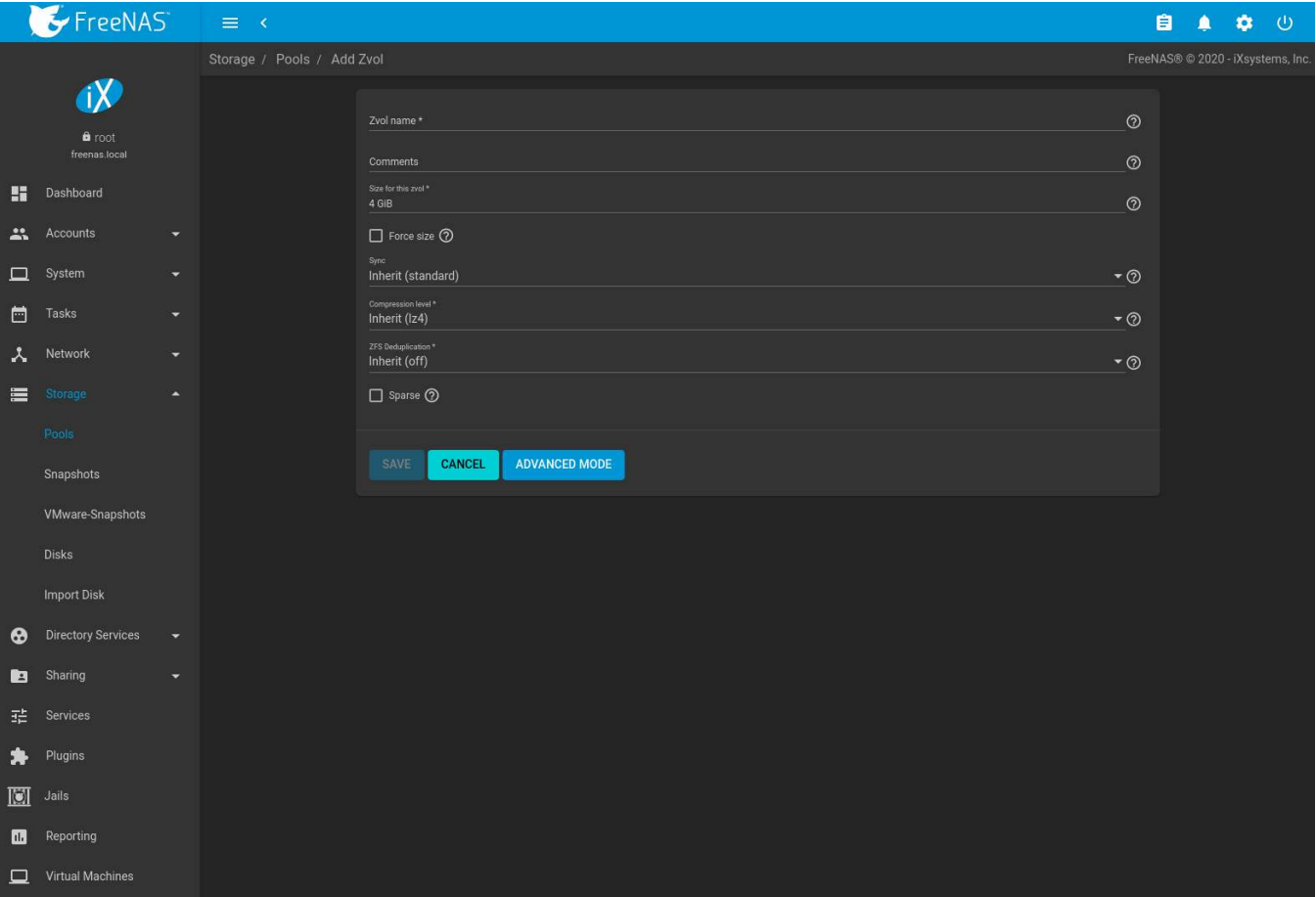


Fig. 10.9: Adding a Zvol

The configuration options are described in Table 10.4.


Table 10.4: zvol Configuration Options

Setting	Value	Advanced Mode	Description
zvol name	string		Enter a short name for the zvol. Using a zvol name longer than 63-characters can prevent accessing zvols as devices. For example, a zvol with a 70-character filename or path cannot be used as an iSCSI extent. This setting is mandatory.
Comments	string		Enter any notes about this zvol.
Size for this zvol	integer		Specify size and value. Units like t , TiB , and G can be used. The size of the zvol can be increased later, but cannot be reduced. If the size is more than 80% of the available capacity, the creation will fail with an “out of space” error unless <i>Force size</i> is also enabled.

Continued on next page

Table 10.4 – continued from previous page

Setting	Value	Advanced Mode	Description
Force size	checkbox		By default, the system will not create a zvol if that operation will bring the pool to over 80% capacity. While NOT recommended , enabling this option will force the creation of the zvol.
Sync	drop-down menu		Sets the data write synchronization. <i>Inherit</i> inherits the sync settings from the parent dataset, <i>Standard</i> uses the sync settings that have been requested by the client software, <i>Always</i> waits for data writes to complete, and <i>Disabled</i> never waits for writes to complete.
Compression level	drop-down menu		Compress data to save space. Refer to Compression (page 180) for a description of the available algorithms.
ZFS Deduplication	drop-down menu		ZFS feature to transparently reuse a single copy of duplicated data to save space. Warning: this option is RAM intensive. Read the section on Deduplication (page 180) before making a change to this setting.
Sparse	checkbox		Used to provide thin provisioning. Use with caution as writes will fail when the pool is low on space.
Block size	drop-down menu	✓	The default is based on the number of disks in the pool. This can be set to match the block size of the filesystem which will be formatted onto the iSCSI target. Warning: Choosing a smaller record size than the suggested value can reduce disk performance and space efficiency.

Click  (Options) next to the desired zvol in *Storage* → *Pools* to access the *Delete zvol*, *Edit Zvol*, *Create Snapshot*, and, for an existing zvol snapshot, *Promote Dataset* options.

Similar to datasets, a zvol name cannot be changed.


Choosing a zvol for deletion shows a warning that all snapshots of that zvol will also be deleted.

10.2.12 Setting Permissions

Setting permissions is an important aspect of managing data access. The web interface is meant to set the **initial** permissions for a pool or dataset to make it available as a share. When a share is made available, the client operating system and [ACL manager](#) (page 183) is used to fine-tune the permissions of the files and directories that are created by the client.

[Sharing](#) (page 210) contains configuration examples for several types of permission scenarios. This section provides an overview of the options available for configuring the initial set of permissions.

Note: For users and groups to be available, they must either be first created using the instructions in [Accounts](#) (page 67) or imported from a directory service using the instructions in [Directory Services](#) (page 198). The drop-down menus described in this section are automatically truncated to 50 entries for performance reasons. To find an unlisted entry, begin typing the desired user or group name for the drop-down menu to show matching results.

To set the permissions on a dataset, select it in *Storage* → *Pools*, click  (Options), then *Edit Permissions*. [Table 10.5](#) describes the options in this screen.

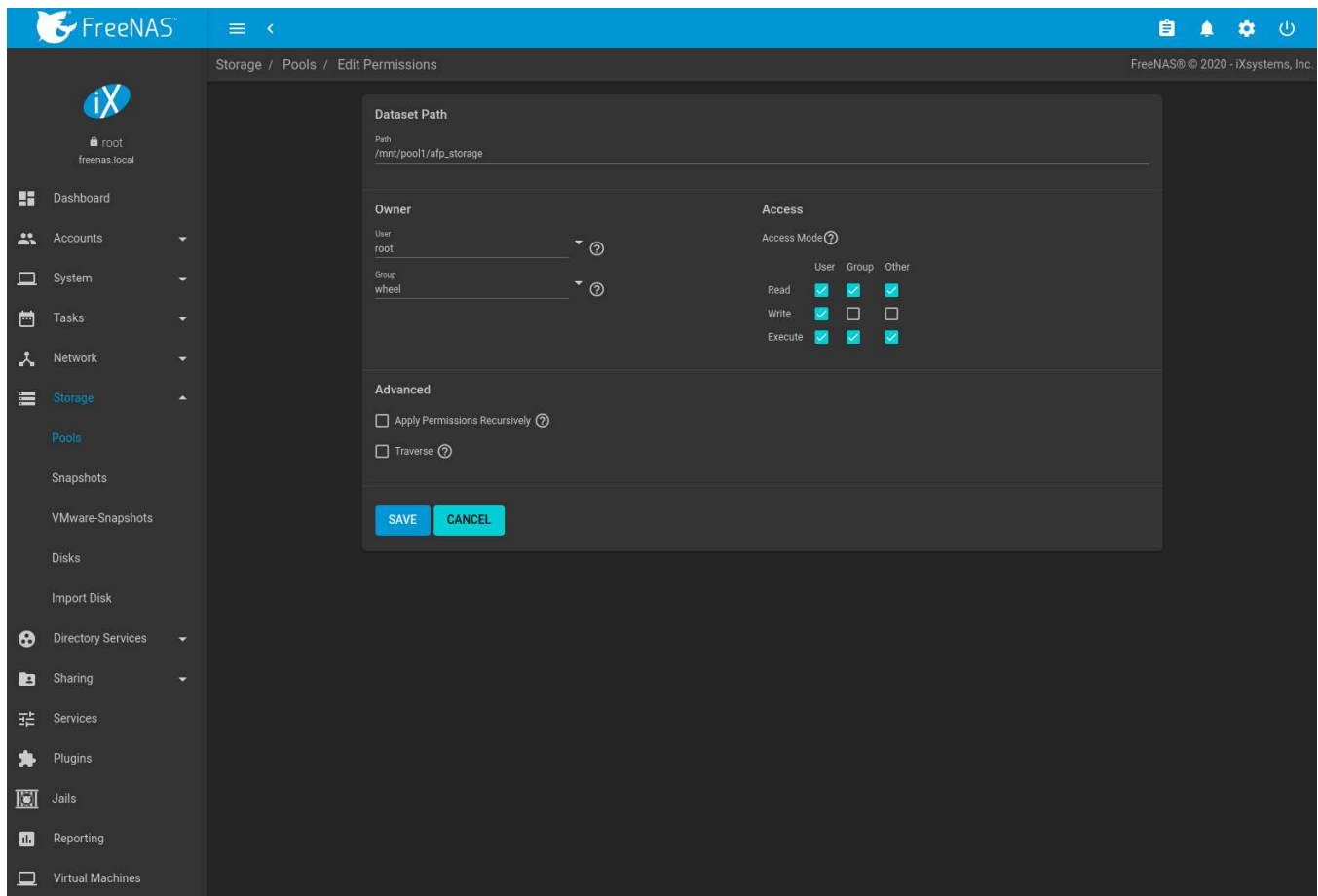


Fig. 10.10: Editing Dataset Permissions

Table 10.5: Permission Options

Setting	Value	Description
Path	string	Displays the path to the dataset or zvol directory.
User	drop-down menu	Select the user to control the dataset. Users created manually or imported from a directory service appear in the drop-down menu.
Group	drop-down menu	Select the group to control the dataset. Groups created manually or imported from a directory service appear in the drop-down menu.
Access Mode	checkboxes	Set the read, write, and execute permissions for the dataset.
Apply Permissions Recursively	checkbox	Apply permissions recursively to all directories and files within the current dataset.
Traverse	checkbox	Movement permission for this dataset. Allows users to view or interact with child datasets even when those users do not have permission to view or manage the contents of this dataset.

10.2.13 ACL Management

An Access Control List (ACL) is a set of account permissions associated with a dataset and applied to directories or files within that dataset. These permissions control the actions users can perform on the dataset contents. ACLs are typically used to manage user interactions with *shared datasets* (page 210). Datasets with an ACL have (ACL) appended to their name in the directory browser.

The ACL for a new file or directory is typically determined by the parent directory ACL. An exception is when there are no *File Inherit* or *Directory Inherit* *flags* (page 186) in the parent ACL `owner@`, `group@`, or `everyone@` entries. These non-inheriting entries are appended to the ACL of the newly created file or directory based on the [Samba create and directory masks](https://www.samba.org/samba/docs/using_samba/ch08.html) (https://www.samba.org/samba/docs/using_samba/ch08.html) or the `umask` (https://www.freebsd.org/cgi/man.cgi?query=umask&sektion=2) value.

By default, a file ACL is preserved when it is moved or renamed within the same dataset. The *SMB winmsa module* (page 243) can override this behavior to force an ACL to be recalculated whenever the file moves, even within the same dataset.

Datasets optimized for SMB sharing can restrict ACL changes. See *ACL Mode* in the *Dataset Options table* (page 178).

ACLs are modified by adding or removing Access Control Entries (ACEs) in *Storage* → *Pools*. Find the desired dataset, click *:* (Options), and select *Edit ACL*. The *ACL Manager* opens. The ACL manager must be used to modify permissions on a dataset with an ACL.

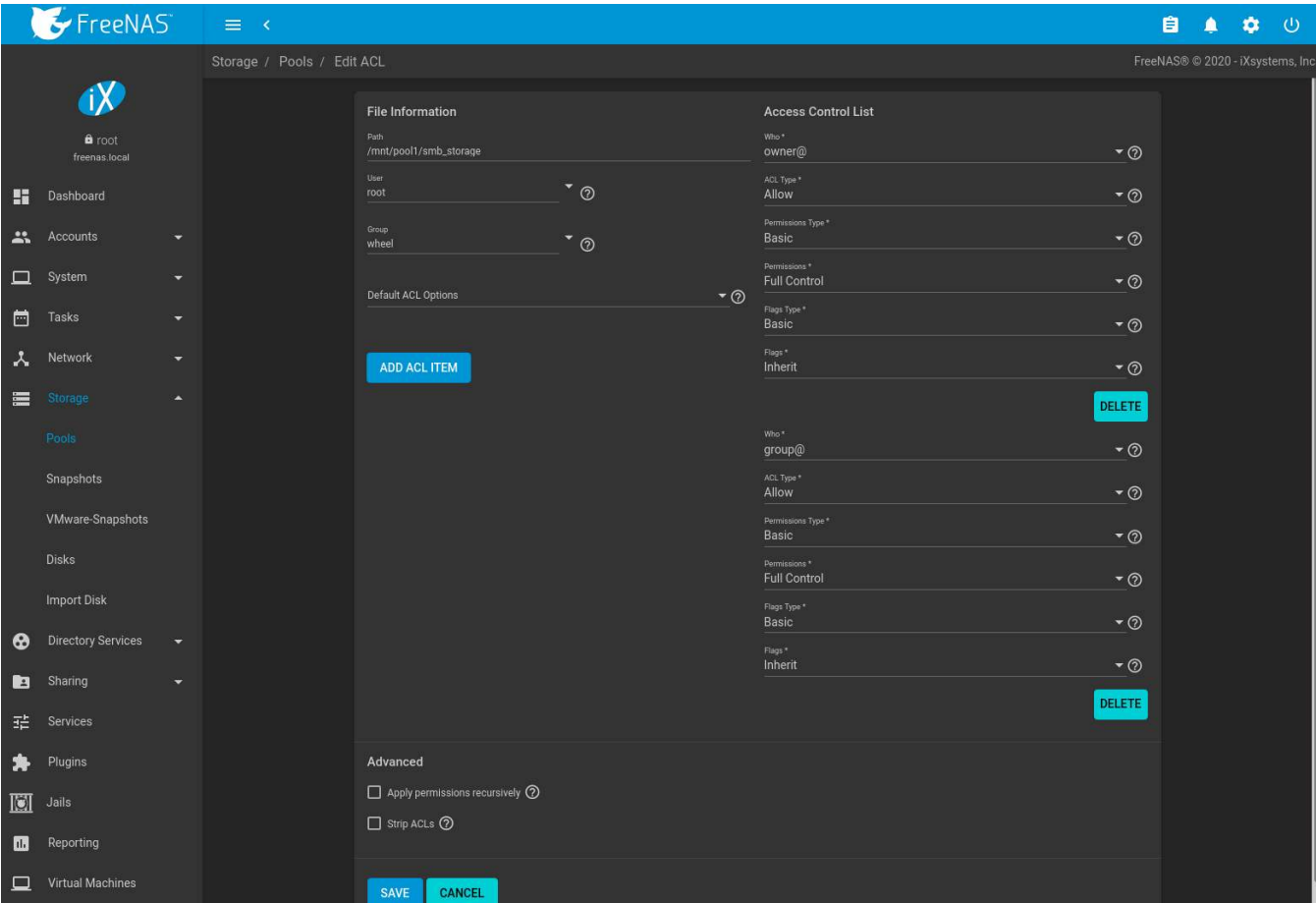


Fig. 10.11: ACL Manager

The ACL Manager options are split into the *File Information*, *Access Control List*, and *Advanced* sections. [Table 10.6](#) sorts these options by their section.

Table 10.6: ACL Options

Setting	Section	Value	Description
Path	File Information	string	Location of the dataset that is being modified. Read-only.

Continued on next page

Table 10.6 – continued from previous page

Setting	Section	Value	Description
User	File Information	drop-down menu	User who controls the dataset. This user always has permissions to read or write the ACL and read or write attributes. Users created manually or imported from a directory service (page 198) appear in the drop-down menu.
Group	File Information	drop-down menu	The group which controls the dataset. This group has all permissions that are granted to the <i>@group Tag</i> . Groups created manually or imported from a directory service (page 198) appear in the drop-down menu.
Default ACL Options	File Information	drop-down menu	Default ACLs. Choosing an entry loads a preset ACL that is configured to match general permissions situations.
Who	Access Control List	drop-down menu	Access Control Entry (ACE) user or group. Select a specific <i>User</i> or <i>Group</i> for this entry, <i>owner@</i> to apply this entry to the selected <i>User</i> , <i>group@</i> to apply this entry to the selected <i>Group</i> , or <i>everyone@</i> to apply this entry to all users and groups. See setfacl(1) NFSv4 ACL ENTRIES (https://www.freebsd.org/cgi/man.cgi?query=setfacl).
User	Access Control List	drop-down menu	User account to which this ACL entry applies. Only visible when <i>User</i> is the chosen <i>Tag</i> .
Group	Access Control List	drop-down menu	Group to which this ACL entry applies. Only visible when <i>Group</i> is the chosen <i>Tag</i> .
ACL Type	Access Control List	drop-down menu	How the <i>Permissions</i> are applied to the chosen <i>Who</i> . Choose <i>Allow</i> to grant the specified permissions and <i>Deny</i> to restrict the specified permissions.
Permissions Type	Access Control List	drop-down menu	Choose the type of permissions. <i>Basic</i> shows general permissions. <i>Advanced</i> shows each specific type of permission for finer control.
Permissions	Access Control List	drop-down menu	Select permissions to apply to the chosen <i>Tag</i> . Choices change depending on the <i>Permissions Type</i> . See the permissions list (page 186) for descriptions of each permission.
Flags Type	Access Control List	drop-down menu	Select the set of ACE inheritance <i>Flags</i> to display. <i>Basic</i> shows un-specific inheritance options. <i>Advanced</i> shows specific inheritance settings for finer control.
Flags	Access Control List	drop-down menu	How this ACE is applied to newly created directories and files within the dataset. <i>Basic</i> flags enable or disable ACE inheritance. <i>Advanced</i> flags allow further control of how the ACE is applied to files and directories in the dataset. See the inheritance flags list (page 186) for descriptions of <i>Advanced</i> inheritance flags.
Apply permissions recursively	Advanced	checkbox	Apply permissions recursively to all directories and files in the current dataset.
Apply permissions to child datasets	Advanced	checkbox	Apply permissions recursively to all child datasets of the current dataset. Only visible when <i>Apply permissions recursively</i> is set.
Strip ACLs	Advanced	checkbox	Set to remove all ACLs from the current dataset. ACLs are also recursively stripped from directories and child datasets when <i>Apply permissions recursively</i> and <i>Apply permissions to child datasets</i> are set.

Additional ACEs are created by clicking *ADD ACL ITEM* and configuring the added fields. One ACE is required in the ACL.

See [setfacl\(1\)](#) (<https://www.freebsd.org/cgi/man.cgi?query=setfacl>), [nfs4_acl\(5\)](#)

(https://linux.die.net/man/5/nfs4_acl), and [NFS Version 4 ACLs memo](https://tools.ietf.org/html/draft-falkner-nfsv4-acls-00) (<https://tools.ietf.org/html/draft-falkner-nfsv4-acls-00>) for more details about Access Control Lists, permissions, and inheritance flags. The following lists show each permission or flag that can be applied to an ACE with a brief description. An ACE can have a variety of basic or advanced permissions:

Basic Permissions

- *Read* : view file or directory contents, attributes, named attributes, and ACL. Includes the *Traverse* permission.
- *Write* : adjust file or directory contents, attributes, and named attributes. Create new files or subdirectories. Includes the *Traverse* permission.
- *Modify* : All permissions are applied except changing the ACL contents or owner.
- *Traverse* : Execute a file or move through a directory. Directory contents are restricted from view unless the *Read* permission is also applied. To traverse and view files in a directory, but not be able to open individual files, set the *Traverse* and *Read* permissions, then add the advanced *Directory Inherit* flag.
- *Full Control* : Apply all permissions.

Advanced Permissions

- *Read Data* : View file contents or list directory contents.
- *Write Data* : Create new files or modify any part of a file.
- *Append Data* : Add new data to the end of a file.
- *Read Named Attributes* : view the named attributes directory.
- *Write Named Attributes* : create a named attribute directory. Must be paired with the *Read Named Attributes* permission.
- *Execute* : Execute a file, move through, or search a directory.
- *Delete Children* : delete files or subdirectories from inside a directory.
- *Read Attributes* : view file or directory non-ACL attributes.
- *Write Attributes* : change file or directory non-ACL attributes.
- *Delete* : remove the file or directory.
- *Read ACL* : view the ACL.
- *Write ACL* : change the ACL and the ACL mode.
- *Write Owner* : change the user and group owners of the file or directory.
- *Synchronize* : synchronous file read/write with the server. This permission does not apply to FreeBSD clients.

Basic inheritance flags only enable or disable ACE inheritance. Advanced flags offer finer control for applying an ACE to new files or directories.

- *File Inherit* : The ACE is inherited with subdirectories and files. It applies to new files.
- *Directory Inherit* : new subdirectories inherit the full ACE.
- *No Propagate Inherit* : The ACE can only be inherited once.
- *Inherit Only* : Remove the ACE from permission checks but allow it to be inherited by new files or subdirectories. *Inherit Only* is removed from these new objects.
- *Inherited* : set when the ACE has been inherited from another dataset.

10.3 Snapshots

To view and manage the listing of created snapshots, use *Storage* → *Snapshots*. An example is shown in [Figure 10.12](#).

Note: If snapshots do not appear, check that the current time configured in [Periodic Snapshot Tasks](#) (page 133) does not conflict with the *Begin*, *End*, and *Interval* settings. If the snapshot was attempted but failed, an entry is added to `/var/log/messages`. This log file can be viewed in [Shell](#) (page 335).

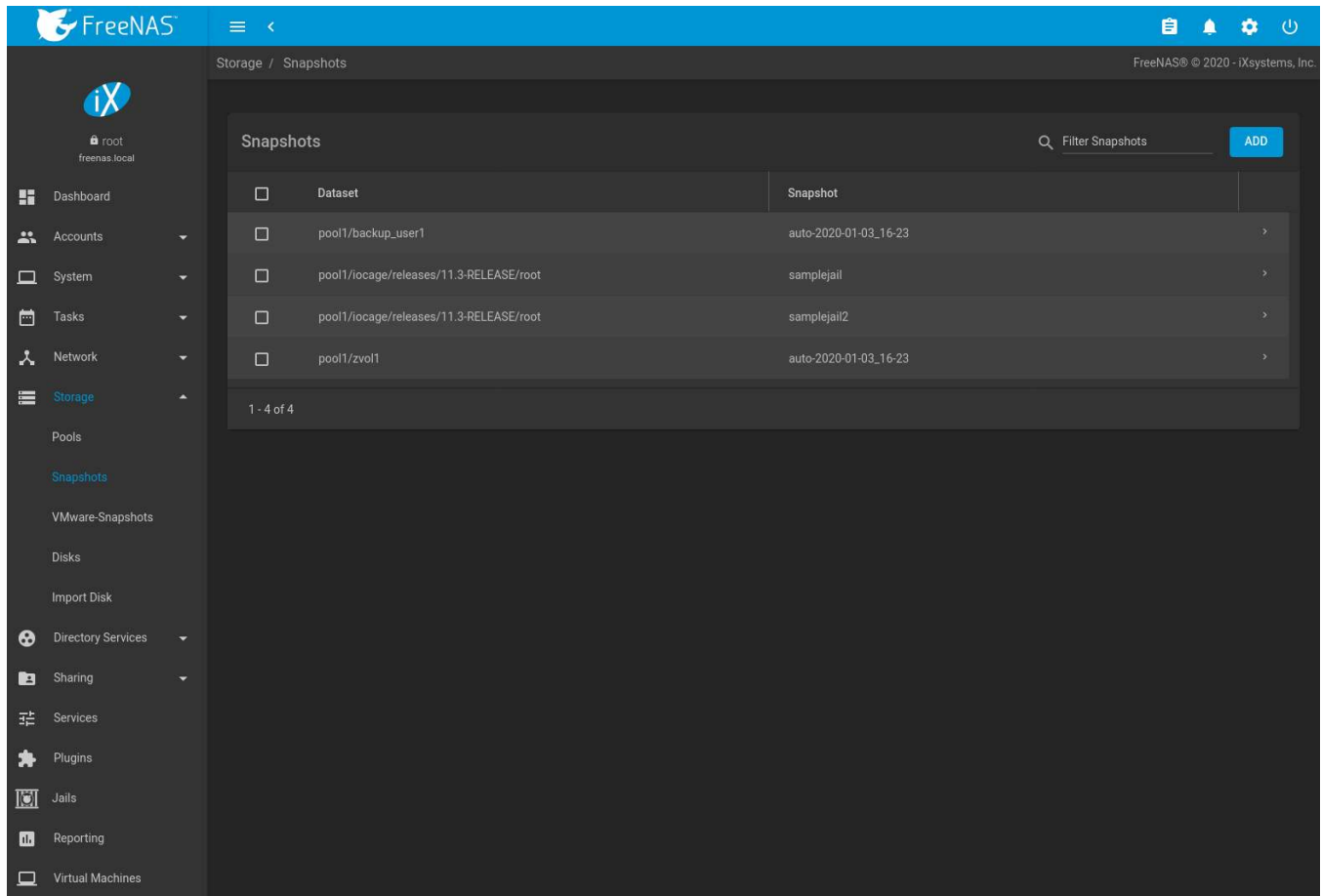


Fig. 10.12: Viewing Available Snapshots

Each entry in the list includes the name of the dataset and snapshot. Click **>** (Expand) to view these options:

DATE CREATED shows the exact time and date of the snapshot creation.

USED is the amount of space consumed by this dataset and all of its descendants. This value is checked against the dataset quota and reservation. The space used does not include the dataset reservation, but does take into account the reservations of any descendent datasets. The amount of space that a dataset consumes from its parent, as well as the amount of space freed if this dataset is recursively deleted, is the greater of its space used and its reservation. When a snapshot is created, the space is initially shared between the snapshot and the filesystem, and possibly with previous snapshots. As the filesystem changes, space that was previously shared becomes unique to the snapshot, and is counted in the used space of the snapshot. Deleting a snapshot can increase the amount of space unique to, and used by, other snapshots. The amount of space used, available, or referenced does not take into account pending changes. While pending changes are generally accounted for within a few seconds, disk changes do not necessarily guarantee that the space usage information is updated immediately.

Tip: Space used by individual snapshots can be seen by running `zfs list -t snapshot` from [Shell](#) (page 335).

REFERENCED indicates the amount of data accessible by this dataset, which may or may not be shared with other datasets in the pool. When a snapshot or clone is created, it initially references the same amount of space as the

filesystem or snapshot it was created from, since its contents are identical.

DELETE shows a confirmation dialog. Child clones must be deleted before their parent snapshot can be deleted. While creating a snapshot is instantaneous, deleting a snapshot can be I/O intensive and can take a long time, especially when deduplication is enabled. In order to delete a block in a snapshot, ZFS has to walk all the allocated blocks to see if that block is used anywhere else; if it is not, it can be freed.

CLONE TO NEW DATASET prompts for the name of the new dataset created from the cloned snapshot. A default name is provided based on the name of the original snapshot. Click the *SAVE* button to finish cloning the snapshot.

A clone is a writable copy of the snapshot. Since a clone is actually a dataset which can be mounted, it appears in the *Pools* screen rather than the *Snapshots* screen. By default, `-clone` is added to the name of a snapshot when a clone is created.

Rollback: Clicking `:` (Options) → *Rollback* asks for confirmation before rolling back to the chosen snapshot state. Clicking *Yes* causes all files in the dataset to revert to the state they were in when the snapshot was created.

Note: Rollback is a potentially dangerous operation and causes any configured replication tasks to fail as the replication system uses the existing snapshot when doing an incremental backup. To restore the data within a snapshot, the recommended steps are:

1. Clone the desired snapshot.
2. Share the clone with the share type or service running on the FreeNAS® system.
3. After users have recovered the needed data, delete the clone in the *Active Pools* tab.

This approach does not destroy any on-disk data and has no impact on replication.

A range of snapshots can be deleted. Set the left column checkboxes for each snapshot and click the *Delete* icon above the table. Be careful when deleting multiple snapshots.

Periodic snapshots can be configured to appear as shadow copies in newer versions of Windows Explorer, as described in [Configuring Shadow Copies](#) (page 247). Users can access the files in the shadow copy using Explorer without requiring any interaction with the FreeNAS® web interface.

To quickly search through the snapshots list by name, type a matching criteria into the *Filter Snapshots* text area. The listing will change to only display the snapshot names that match the filter text.

Warning: A snapshot and any files it contains will not be accessible or searchable if the mount path of the snapshot is longer than 88 characters. The data within the snapshot will be safe, and the snapshot will become accessible again when the mount path is shortened. For details of this limitation, and how to shorten a long mount path, see [Path and Name Lengths](#) (page 17).

10.3.1 Browsing a Snapshot Collection

All snapshots for a dataset are accessible as an ordinary hierarchical filesystem, which can be reached from a hidden `.zfs` file located at the root of every dataset. A user with permission to access that file can view and explore all snapshots for a dataset like any other files - from the CLI or via *File Sharing* services such as *Samba*, *NFS* and *FTP*. This is an advanced capability which requires some command line actions to achieve. In summary, the main changes to settings that are required are:

- Snapshot visibility must be manually enabled in the ZFS properties of the dataset.
- In Samba auxillary settings, the `veto files` command must be modified to not hide the `.zfs` file, and the setting `zfsacl:expose_snapdir=true` must be added.

The effect will be that any user who can access the dataset contents will be able to view the list of snapshots by navigating to the `.zfs` directory of the dataset. They will also be able to browse and search any files they have permission to access throughout the entire snapshot collection of the dataset.

A user's ability to view files within a snapshot will be limited by any permissions or ACLs set on the files when the snapshot was taken. Snapshots are fixed as "read-only", so this access does not permit the user to change any files in the snapshots, or to modify or delete any snapshot, even if they had write permission at the time when the snapshot was taken.

Note: ZFS has a `zfs diff` command which can list the files that have changed between any two snapshot versions within a dataset, or between any snapshot and the current data.

10.3.2 Creating a Single Snapshot

To create a snapshot separately from a *periodic snapshot schedule* (page 133), go to *Storage* → *Snapshots* and click *ADD*.

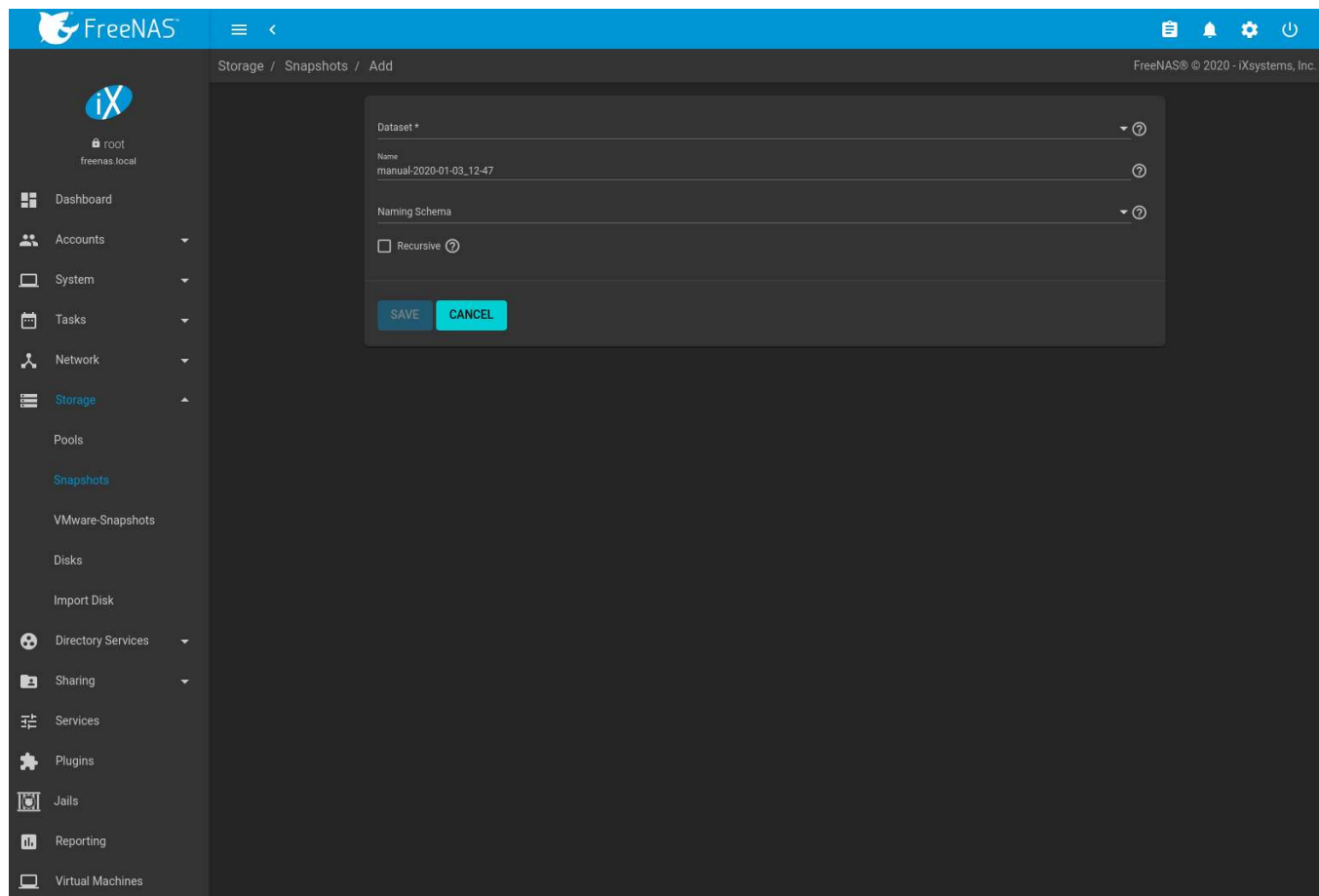


Fig. 10.13: Single Snapshot Options

Select an existing ZFS pool, dataset, or zvol to snapshot. To include child datasets with the snapshot, set *Recursive*. The snapshot can have a custom *Name* or be automatically named by a *Naming Schema*. Using a *Naming Schema* allows the snapshot to be included in *Replication Tasks* (page 142). The *Naming Schema* drop-down is populated with previously created schemas from *Periodic Snapshot Tasks* (page 133).

10.4 VMware-Snapshots

Storage → *VMware-Snapshots* is used to coordinate ZFS snapshots when using FreeNAS® as a VMware datastore. When a ZFS snapshot is created, FreeNAS® automatically snapshots any running VMware virtual machines before taking a scheduled or manual ZFS snapshot of the dataset or zvol backing that VMware datastore. Virtual machines **must be powered on** for FreeNAS® snapshots to be copied to VMware. The temporary VMware snapshots are then deleted on the VMware side but still exist in the ZFS snapshot and can be used as stable resurrection points in that snapshot. These coordinated snapshots are listed in [Snapshots](#) (page 186).

Figure 10.14 shows the menu for adding a VMware snapshot and Table 10.7 summarizes the available options.

The screenshot shows the FreeNAS web interface. The left sidebar contains a navigation menu with items like Dashboard, Accounts, System, Tasks, Network, Storage (highlighted), Pools, Snapshots, VMware-Snapshots, Disks, Import Disk, Directory Services, Sharing, Services, Plugins, Jails, Reporting, and Virtual Machines. The main content area is titled 'Storage / VMware Snapshots / Add'. It features a form with the following fields: 'Hostname *', 'Username *', 'Password *' (with a toggle for visibility), 'ZFS Filesystem *', and 'Datastore *'. At the bottom of the form are three buttons: 'SAVE' (blue), 'CANCEL' (red), and 'FETCH DATASTORES' (blue). The top of the interface shows the FreeNAS logo and a status bar with 'FreeNAS® © 2020 - iXsystems, Inc.'.

Fig. 10.14: Adding a VMware Snapshot

Table 10.7: VMware Snapshot Options

Setting	Value	Description
Hostname	string	Enter the IP address or hostname of the VMware host. When clustering, use the IP address or hostname of the vCenter server for the cluster.
Username	string	Enter a user account name created on the VMware host. The account must have permission to snapshot virtual machines.
Password	string	Enter the password associated with <i>Username</i> .
ZFS Filesystem	browse button	<i>Browse</i> to the filesystem to snapshot.
Datastore	drop-down menu	After entering the <i>Hostname</i> , <i>Username</i> , and <i>Password</i> , click <i>FETCH DATASTORES</i> to populate the menu, then select the datastore to be synchronized.

FreeNAS® connects to the VMware host after the credentials are entered. The *ZFS Filesystem* and *Datastore* drop-down menus are populated with information from the VMware host. Choosing a datastore also selects any previously mapped dataset.

10.5 Disks

To view all of the disks recognized by the FreeNAS® system, use *Storage* → *Disks*. As seen in the example in [Figure 10.15](#), each disk entry displays its device name, serial number, size, advanced power management settings, acoustic level settings, and whether *S.M.A.R.T.* (page 268) tests are enabled. The pool associated with the disk is displayed in the *Pool* column. *Unused* is displayed if the disk is not being used in a pool. Click *COLUMNS* and select additional information to be shown as columns in the table. Additional information not shown in the table can be seen by clicking > (Expand).

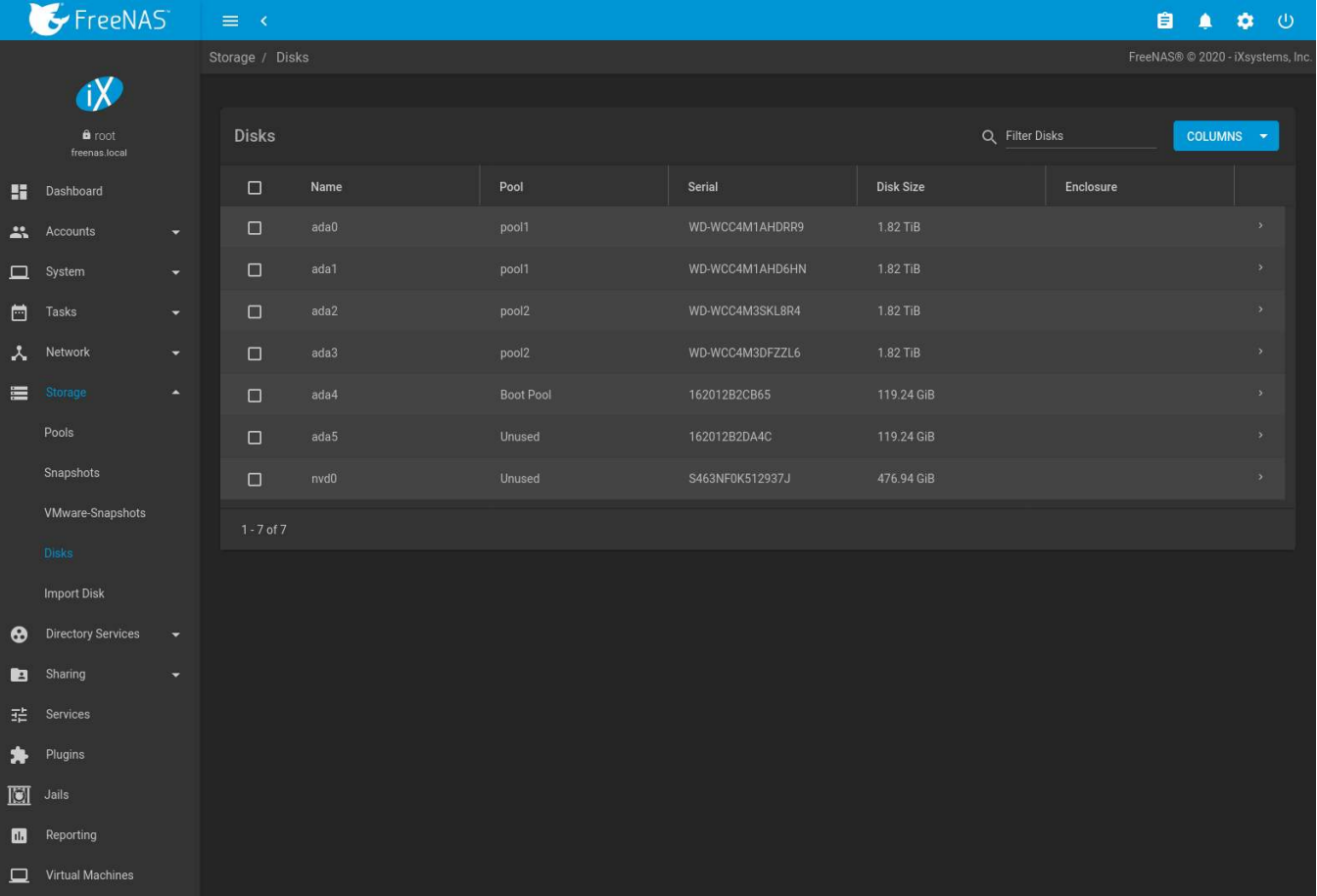


Fig. 10.15: Viewing Disks

To edit the options for a disk, click ⚙ (Options) on a disk, then *Edit* to open the screen shown in [Figure 10.16](#). [Table 10.8](#) lists the configurable options.

To bulk edit disks, set the checkbox for each disk in the table then click ✎ (Edit Disks). The *Bulk Edit Disks* page displays which disks are being edited and a short list of configurable options. The [Disk Options table](#) (page 192) indicates the options available when editing multiple disks.

To offline, online, or replace the device, see [Replacing a Failed Disk](#) (page 193).

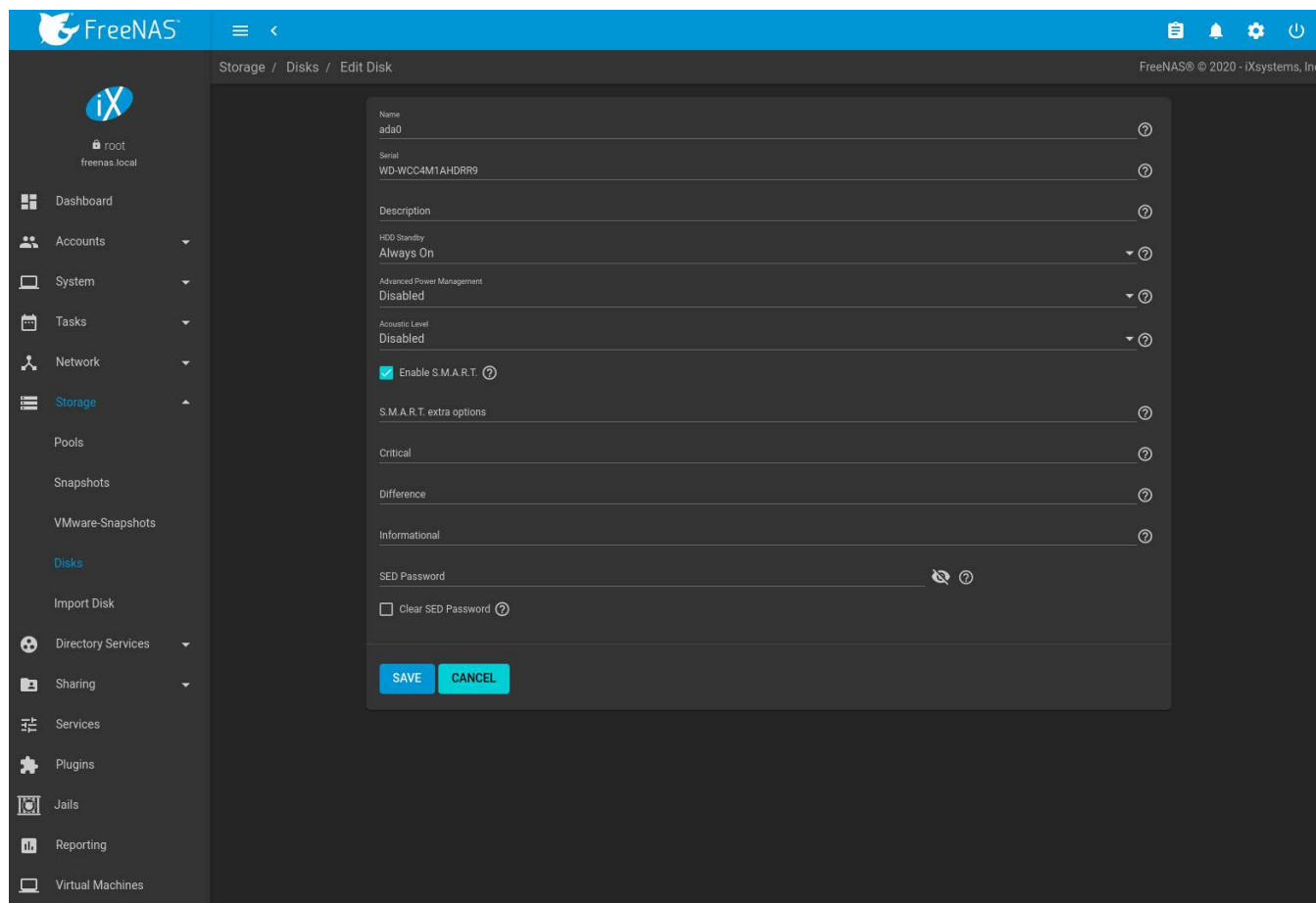


Fig. 10.16: Editing a Disk

Table 10.8: Disk Options

Setting	Value	Bulk Edit	Description
Name	string		This is the FreeBSD device name for the disk.
Serial	string		This is the serial number of the disk.
Description	string		Enter any notes about this disk.
HDD Standby	drop-down menu	✓	Time of inactivity in minutes before the drive enters standby mode to conserve energy. This forum post (https://forums.freenas.org/index.php?threads/how-to-find-out-if-a-drive-is-spinning-down-properly.2068/) shows how to determine if a drive has spun down. Temperature monitoring is disabled if the disk is set to enter standby.
Advanced Power Management	drop-down menu	✓	Select a power management profile from the menu. The default value is <i>Disabled</i> .
Acoustic Level	drop-down menu	✓	Default is <i>Disabled</i> . Other values can be selected for disks that understand AAM (https://en.wikipedia.org/wiki/Automatic_acoustic_management).
Enable S.M.A.R.T.	checkbox	✓	Enabled by default when the disk supports S.M.A.R.T. Disabling S.M.A.R.T. tests prevents collecting new temperature data for this disk. Historical temperature data is still displayed in Reporting (page 320).

Continued on next page

Table 10.8 – continued from previous page

Setting	Value	Bulk Edit	Description
S.M.A.R.T. extra options	string	✓	Enter additional smartctl(8) (https://www.smartmontools.org/browser/trunk/smartmontools/smartctl.8.in) options.
Critical	string		Threshold temperature in Celsius. If the drive temperature is higher than this value, a <code>LOG_CRIT</code> level log entry is created and an email is sent. 0 disables this check.
Difference	string		Report if the temperature of a drive has changed by this many degrees Celsius since the last report. 0 disables the report.
Informational	string		Report if drive temperature is at or above this temperature in Celsius. 0 disables the report.
SED Password	string		Set or change the password of this SED. This password is used instead of the global SED password in <i>System</i> → <i>Advanced</i> . See Self-Encrypting Drives (page 84).
Clear SED Password	checkbox		Clear the SED password for this disk.

Tip: If the serial number for a disk is not displayed in this screen, use the `smartctl` command from [Shell](#) (page 335). For example, to determine the serial number of disk `ada0`, type `smartctl -a /dev/ada0 | grep Serial`.

The *Wipe* function is used to discard an unused disk.

Warning: Ensure all data is backed up and the disk is no longer in use. Triple-check that the correct disk is being selected to be wiped, as recovering data from a wiped disk is usually impossible. If there is any doubt, physically remove the disk, verify that all data is still present on the FreeNAS® system, and wipe the disk in a separate computer.

Clicking *Wipe* offers several choices. *Quick* erases only the partitioning information on a disk, making it easy to reuse but without clearing other old data. For more security, *Full with zeros* overwrites the entire disk with zeros, while *Full with random data* overwrites the entire disk with random binary data.

Quick wipes take only a few seconds. A *Full with zeros* wipe of a large disk can take several hours, and a *Full with random data* takes longer. A progress bar is displayed during the wipe to track status.

10.5.1 Replacing a Failed Disk

With any form of redundant RAID, failed drives must be replaced as soon as possible to repair the degraded state of the RAID. Depending on the hardware capabilities, it might be necessary to reboot to replace the failed drive. Hardware that supports AHCI does not require a reboot.

Striping (RAID0) does not provide redundancy. Disk failure in a stripe results in losing the pool. The pool must be recreated and data stored in the failed stripe will have to be restored from backups.

Warning: Encrypted pools must have a valid passphrase to replace a failed disk. Set a passphrase and back up the encryption key using the pool [Encryption Operations](#) (page 169) **before** attempting to replace the failed drive.

Before physically removing the failed device, go to *Storage* → *Pools*. Select the pool name then click ⚙ (Settings). Select *Status* and locate the failed disk. Then perform these steps:

1. Click ⋮ (Options) on the disk entry, then *Offline* to change the disk status to OFFLINE. This step removes the device from the pool and prevents swap issues. *Warning:* encrypted disks that are set *OFFLINE* cannot

be set back *ONLINE*. If the hardware supports hot-pluggable disks, click the disk *Offline* button and pull the disk, then skip to step 3. If there is no *Offline* but only *Replace*, the disk is already offlined and this step can be skipped.

Note: If the process of changing the disk status to OFFLINE fails with a “disk offline failed - no valid replicas” message, the pool must be scrubbed first with the *Scrub Pool* button in *Storage* → *Pools*. After the scrub completes, try *Offline* again before proceeding.

- After the disk is replaced and is showing as OFFLINE, click ⋮ (Options) on the disk again and then *Replace*. Select the replacement disk from the drop-down menu and click the *REPLACE DISK* button. After clicking the *REPLACE DISK* button, the pool begins resilvering. Encrypted pools require entering the [encryption key passphrase](#) (page 169) when choosing a replacement disk. Clicking *REPLACE DISK* begins the process to reformat the replacement, apply the current pool encryption algorithm, and resilver the pool. The current pool encryption key and passphrase remains valid, but any pool recovery key file is invalidated by the replacement process. To maximize pool security, it is recommended to [reset pool encryption](#) (page 170).
- After the drive replacement process is complete, re-add the replaced disk in the [S.M.A.R.T. Tests](#) (page 132) screen.

To refresh the screen with updated entries, click *REFRESH*. If any problems occur during a disk replacement process, one of the disks can be detached. To detach a disk in the replacement process, find the disk to be replaced and click ⋮ (Options) → *Detach*.

Figure 10.17 shows an example of going to *Storage* → *Pools* → *Status* and replacing a disk in an active pool.

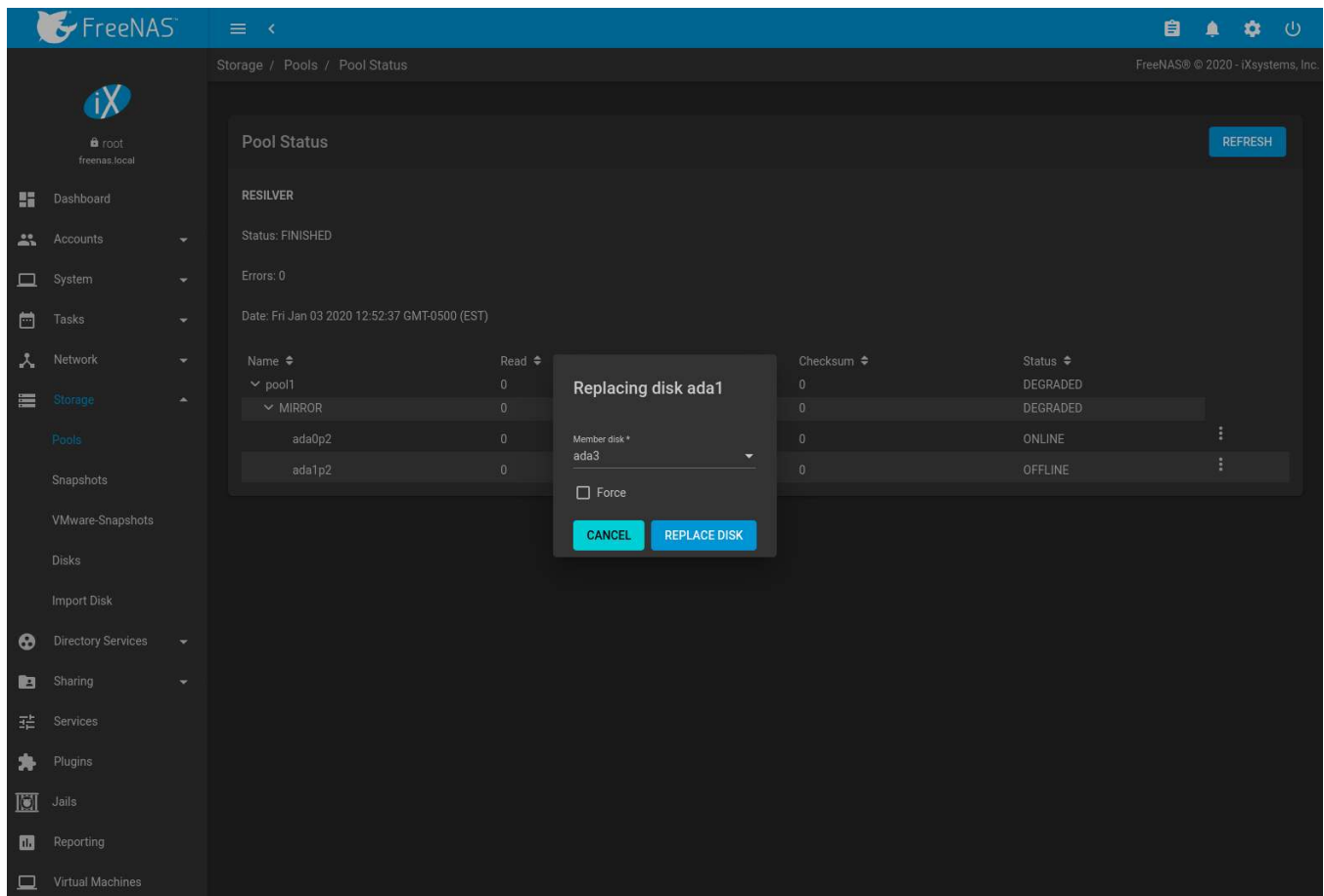


Fig. 10.17: Replacing a Failed Disk

After the resilver is complete, the pool status shows a *Completed* resilver status and indicates any errors. [Figure](#)

10.18 indicates that the disk replacement was successful in this example.

Note: A disk that is failing but has not completely failed can be replaced in place, without first removing it. Whether this is a good idea depends on the overall condition of the failing disk. A disk with a few newly-bad blocks that is otherwise functional can be left in place during the replacement to provide data redundancy. A drive that is experiencing continuous errors can actually slow down the replacement. In extreme cases, a disk with serious problems might spend so much time retrying failures that it could prevent the replacement resilvering from completing before another drive fails.

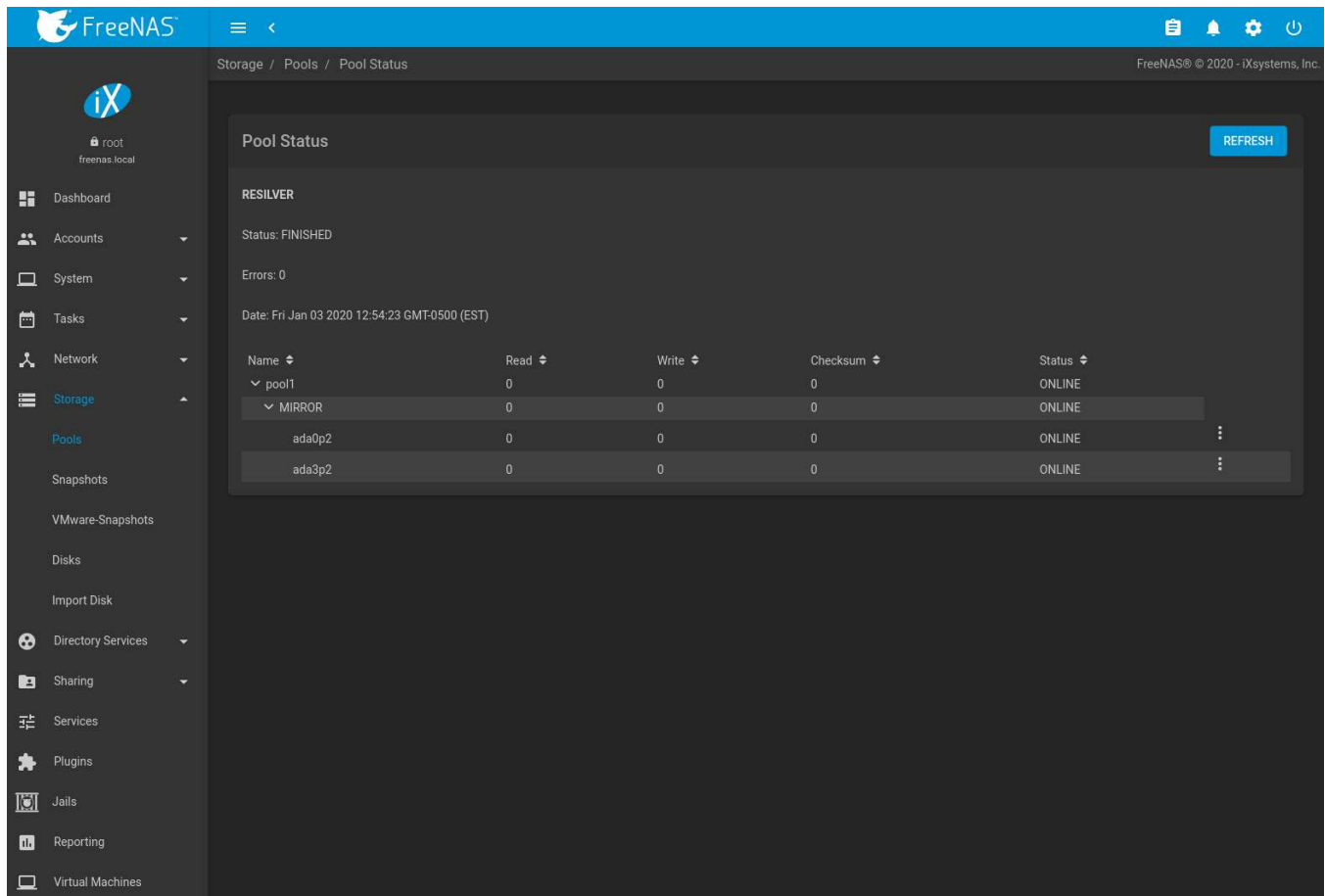


Fig. 10.18: Disk Replacement is Complete

10.5.1.1 Removing a Log or Cache Device

Added log or cache devices appear in *Storage* → *Pools* → *Pool Status*. Clicking the device enables the *Replace* and *Remove* buttons.

Log and cache devices can be safely removed or replaced with these buttons. Both types of devices improve performance, and throughput can be impacted by their removal.

10.5.2 Replacing Disks to Grow a Pool

The recommended method for expanding the size of a ZFS pool is to pre-plan the number of disks in a vdev and to stripe additional vdevs from *Pools* (page 164) as additional capacity is needed.

But adding vdevs is not an option if there are not enough unused disk ports. If there is at least one unused disk port or drive bay, a single disk at a time can be replaced with a larger disk, waiting for the resilvering process to

include the new disk into the pool, removing the old disk, then repeating with another disk until all of the original disks have been replaced. At that point, the pool capacity automatically increases to include the new space.

One advantage of this method is that disk redundancy is present during the process.

Note: A pool that is configured as a [stripe](https://en.wikipedia.org/wiki/Standard_RAID_levels#RAID_0) (https://en.wikipedia.org/wiki/Standard_RAID_levels#RAID_0) can only be increased by following the steps in [Extending a Pool](#) (page 171).

1. Connect the new, larger disk to the unused disk port or drive bay.
2. Go to *Storage* → *Pools*.
3. Select the pool and click ⚙ (Settings) → *Status*.
4. Select one of the old, smaller disks in the pool. Click ⋮ (Options) → *Replace*. Choose the new disk as the replacement.

The status of the resilver process is shown on the screen, or can be viewed with `zpool status`. When the new disk has resilvered, the old one is automatically offlined. It can then be removed from the system, and that port or bay used to hold the next new disk.

If a unused disk port or bay is not available, a drive can be replaced with a larger one as shown in [Replacing a Failed Disk](#) (page 193). This process is slow and places the system in a degraded state. Since a failure at this point could be disastrous, **do not attempt this method unless the system has a reliable backup**. Replace one drive at a time and wait for the resilver process to complete on the replaced drive before replacing the next drive. After all the drives are replaced and the final resilver completes, the added space appears in the pool.

10.6 Importing a Disk

The *Storage* → *Import Disk* screen, shown in [Figure 10.19](#), is used to import disks that are formatted with UFS (BSD Unix), FAT(MSDOS) or NTFS (Windows), or EXT2 (Linux) filesystems. This is a designed to be used as a one-time import, copying the data from that disk into a dataset on the FreeNAS® system. Only one disk can be imported at a time.

Note: Imports of EXT3 or EXT4 filesystems are possible in some cases, although neither is fully supported. EXT3 journaling is not supported, so those filesystems must have an external *fsck* utility, like the one provided by [E2fsprogs utilities](http://e2fsprogs.sourceforge.net/) (<http://e2fsprogs.sourceforge.net/>), run on them before import. EXT4 filesystems with extended attributes or inodes greater than 128 bytes are not supported. EXT4 filesystems with EXT3 journaling must have an *fsck* run on them before import, as described above.

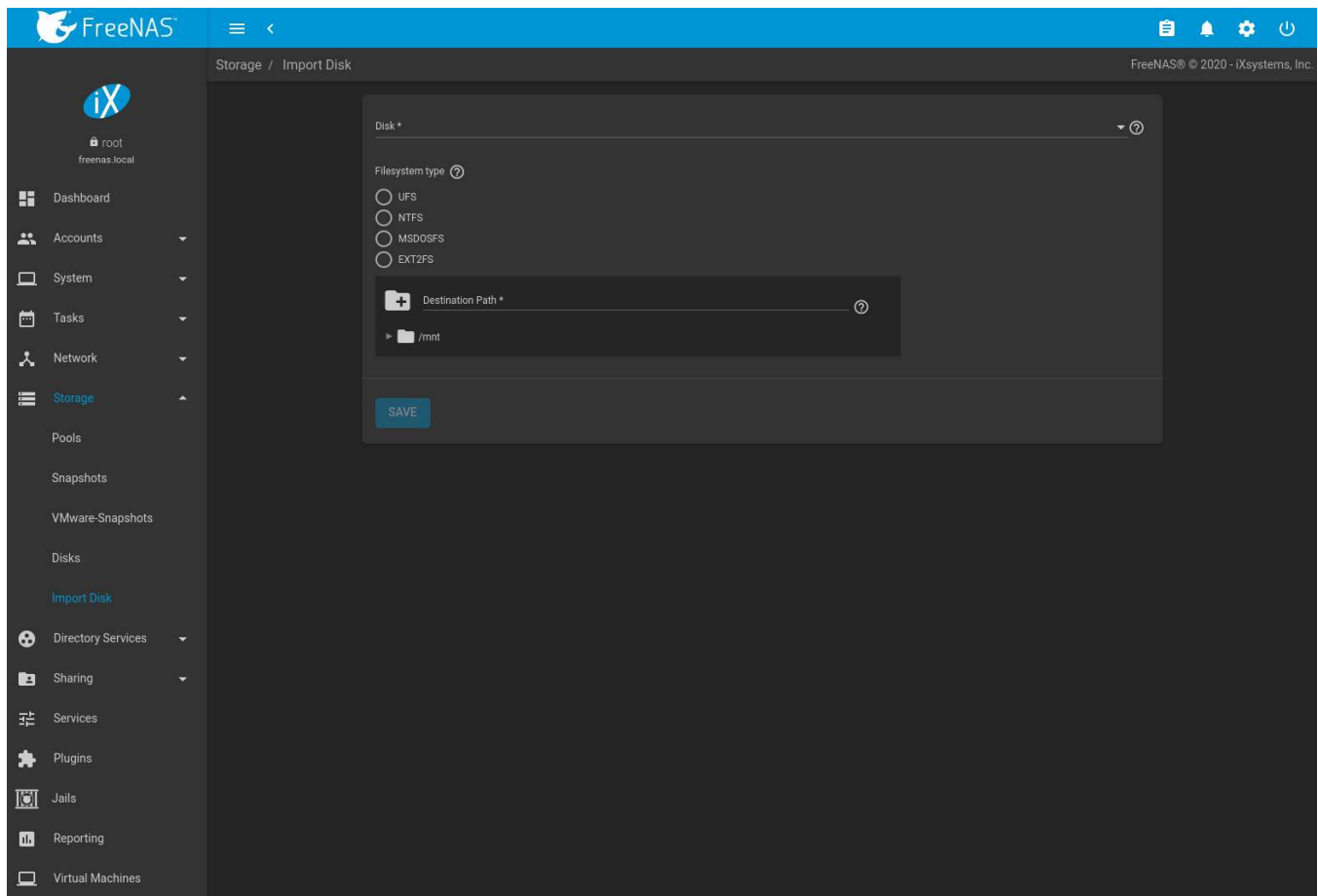


Fig. 10.19: Importing a Disk

Use the drop-down menu to select the disk to import, confirm the detected filesystem is correct, and browse to the ZFS dataset that will hold the copied data. If the *MSDOSFS* filesystem is selected, an additional *MSDOSFS locale* drop-down menu is displayed. Use this menu to select the locale if non-ASCII characters are present on the disk.

After clicking *SAVE*, the disk is mounted and its contents are copied to the specified dataset. The disk is unmounted after the copy operation completes.

After importing a disk, a dialog allows viewing or downloading the disk import log.

10.7 Multipaths

This option is only displayed on systems that contain multipath-capable hardware like a chassis equipped with a dual SAS expander backplane or an external JBOD that is wired for multipath.

FreeNAS® uses [gmultipath\(8\)](https://www.freebsd.org/cgi/man.cgi?query=gmultipath) (<https://www.freebsd.org/cgi/man.cgi?query=gmultipath>) to provide [multipath I/O](https://en.wikipedia.org/wiki/Multipath_I/O) (https://en.wikipedia.org/wiki/Multipath_I/O) support on systems containing multipath-capable hardware.

Multipath hardware adds fault tolerance to a NAS as the data is still available even if one disk I/O path has a failure.



FreeNAS® automatically detects active/active and active/passive multipath-capable hardware. Discovered multipath-capable devices are placed in multipath units with the parent devices hidden. The configuration is displayed in *Storage* → *Multipaths*.

DIRECTORY SERVICES

FreeNAS® supports integration with these directory services:

- [Active Directory](#) (page 198) (for Windows 2000 and higher networks)
- [LDAP](#) (page 203)
- [NIS](#) (page 206)

FreeNAS® also supports [Kerberos Realms](#) (page 207), [Kerberos Keytabs](#) (page 208), and the ability to add more parameters to [Kerberos Settings](#) (page 209).

This section summarizes each of these services and the available configuration options within the FreeNAS® web interface. After successfully enabling a directory service,  appears in the top toolbar row. Click  to show the *Directory Services Monitor* menu. This menu shows the name and status of each directory service.

11.1 Active Directory

Active Directory (AD) is a service for sharing resources in a Windows network.

AD can be configured on a Windows server that is running Windows Server 2000

or higher or on a Unix-like operating system that is running [Samba version 4](#)

(https://wiki.samba.org/index.php/Setting_up_Samba_as_an_Active_Directory_Domain_Controller#Provisioning_a_Samba_Active_Directory_Domain_Controller)

Since AD provides authentication and authorization services for the users in a network, it is not necessary to recreate the same user accounts on the FreeNAS® system. Instead, configure the Active Directory service so account information and imported users can be authorized to access the SMB shares on the FreeNAS® system.

Many changes and improvements have been made to Active Directory support within FreeNAS®. It is strongly recommended to update the system to the latest FreeNAS® 11.3 before attempting Active Directory integration.

Ensure name resolution is properly configured before configuring the Active Directory service. `ping` the domain name of the Active Directory domain controller from [Shell](#) (page 335) on the FreeNAS® system. If the `ping` fails, check the DNS server and default gateway settings in *Network* → *Global Configuration* on the FreeNAS® system.

By default, *Allow DNS updates* in the [Active Directory options](#) (page 199) is enabled. This adds FreeNAS® *SMB 'Bind IP Addresses'* (page 270) DNS records to the Active Directory DNS when the domain is joined. Disabling *Allow DNS updates* means that the Active Directory DNS records must be updated manually.

Active Directory relies on Kerberos, a time-sensitive protocol. During the domain join process the [PDC emulator FSMO role](#) (https://docs.microsoft.com/en-us/openspecs/windows_protocols/ms-adts/f96ff8ec-c660-4d6c-924f-c0dbbcac1527) server is added as the preferred NTP server. The time on the FreeNAS® system and the Active Directory Domain Controller cannot be out of sync by more than five minutes in a default Active Directory environment. An [Alert](#) (page 339) is sent when the time is out of sync.

To ensure both systems are set to the same time:

- use the same NTP server (set in *System* → *NTP Servers* on the FreeNAS® system)
- set the same timezone
- set either localtime or universal time at the BIOS level

Figure 11.1 shows *Directory Services* → *Active Directory* settings.

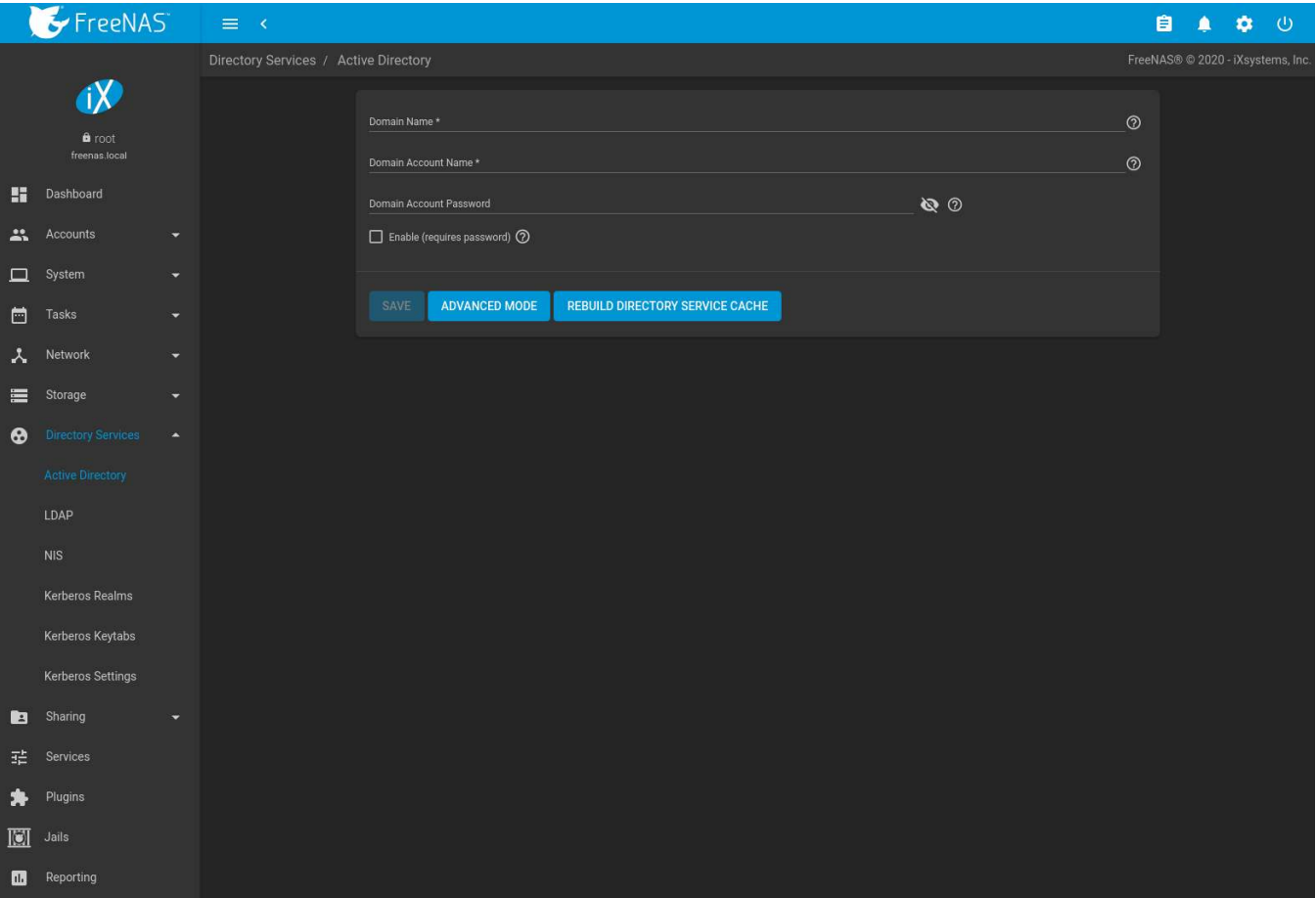


Fig. 11.1: Configuring Active Directory

Table 11.1 describes the configurable options. Some settings are only available in Advanced Mode. Click the *ADVANCED MODE* button to show the Advanced Mode settings. Go to *System* → *Advanced* and set the *Show advanced fields by default* option to always show advanced options.

Table 11.1: Active Directory Configuration Options

Setting	Value	Advanced Mode	Description
Domain Name	string		Name of the Active Directory domain (<i>example.com</i>) or child domain (<i>sales.example.com</i>). This field is mandatory. <i>Save</i> will be inactive until valid input is entered. Hidden when a <i>Kerberos Principal</i> is selected.
Domain Account Name	string		Name of the Active Directory administrator account. This field is mandatory. <i>Save</i> will be inactive until valid input is entered. Hidden when a <i>Kerberos Principal</i> is selected.
Domain Account Password	string		Password for the Active Directory administrator account. Required the first time a domain is configured. After initial configuration, the password is not needed to edit, start, or stop the service.

Continued on next page

Table 11.1 – continued from previous page

Setting	Value	Advanced Mode	Description
Encryption Mode	drop-down	✓	Choices are <i>Off</i> , <i>SSL (LDAPS protocol port 636)</i> , or <i>TLS (LDAP protocol port 389)</i> . See http://info.ssl.com/article.aspx?id=10241 and https://hpbn.co/transport-layer-security-tls/ for more information about SSL and TLS.
Certificate	drop-down menu	✓	Select the Active Directory server certificate if SSL connections are used. If a certificate does not exist, create a <i>Certificate Authority</i> (page 110), then create a certificate on the Active Directory server. Import the certificate to the FreeNAS® system using the <i>Certificates</i> (page 113) menu. To clear a saved certificate, choose the blank entry and click <i>SAVE</i> .
Validate Certificate	checkbox	✓	Check server certificates in a TLS session.
Verbose logging	checkbox	✓	Set to log attempts to join the domain to <code>/var/log/messages</code> .
Allow Trusted Domains	checkbox	✓	Do not set this unless the network has active <i>domain/forest trusts</i> (https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2003/cc757352(v=ws.10)) and managing files on multiple domains is required. Setting this option generates more winbindd traffic and slows down filtering with user and group information. If enabled, also configuring the idmap ranges and a backend for each trusted domain in the environment is recommended.
Use Default Domain	checkbox	✓	Unset to prepend the domain name to the username. Unset to prevent name collisions when <i>Allow Trusted Domains</i> is set and multiple domains use the same username.
Allow DNS updates	checkbox	✓	Set to enable Samba to do DNS updates when joining a domain.
Disable FreeNAS Cache	checkbox	✓	Disable caching AD users and groups. Setting this hides all AD users and groups from web interface drop-down menus and auto-completion suggestions, but manually entering names is still allowed. This can help when unable to bind to a domain with a large number of users or groups.
Site Name	string	✓	Auto-detected site name. Do not change this unless the detected site name is incorrect for the particular AD environment.
Kerberos Realm	drop-down menu	✓	Select the realm created using the instructions in <i>Kerberos Realms</i> (page 207).
Kerberos Principal	drop-down menu	✓	Select a keytab created using the instructions in <i>Kerberos Keytabs</i> (page 208). Selecting a principal hides the <i>Domain Account Name</i> and <i>Domain Account Password</i> fields. An existing account name is not overwritten by the principal.
Computer Account OU	string	✓	The OU in which new computer accounts are created. The OU string is read from top to bottom without RDNs. Slashes (/) are used as delimiters, like <i>Computers/Servers/NAS</i> . The backslash (\) is used to escape characters but not as a separator. Backslashes are interpreted at multiple levels and might require doubling or even quadrupling to take effect. When this field is blank, new computer accounts are created in the Active Directory default OU.

Continued on next page

Table 11.1 – continued from previous page

Setting	Value	Advanced Mode	Description
AD Timeout	integer	✓	Increase the number of seconds before timeout if the AD service does not immediately start after connecting to the domain.
DNS Timeout	integer	✓	Increase the number of seconds before a timeout occurs if AD DNS queries timeout.
Idmap backend	drop-down menu and Edit Idmap button	✓	Choose the backend to map Windows security identifiers (SIDs) to UNIX UIDs and GIDs. See Table 11.2 for a summary of the available backends. Click <i>Edit Idmap</i> to configure the selected backend.
Windbind NSS Info	drop-down menu	✓	Choose the schema to use when querying AD for user/group information. <i>rfc2307</i> uses the RFC2307 schema support included in Windows 2003 R2, <i>sfu</i> is for Services For Unix 3.0 or 3.5, and <i>sfu20</i> is for Services For Unix 2.0.
SASL wrapping	drop-down menu	✓	Choose how LDAP traffic is transmitted. Choices are <i>plain</i> (plain text), <i>sign</i> (signed only), or <i>seal</i> (signed and encrypted). Windows 2000 SP3 and newer can be configured to enforce signed LDAP connections.
Enable (requires password or Kerberos principal)	checkbox		Activate the Active Directory service.
Netbios Name	string	✓	Name for the computer object generated in AD. Limited to 15 characters. Automatically populated with the original hostname of the system. This must be different from the <i>Workgroup</i> name.
NetBIOS alias	string	✓	Limited to 15 characters.

[Table 11.2](#) summarizes the backends which are available in the *Idmap backend* drop-down menu. Each backend has its own [man page](http://samba.org.ru/samba/docs/man/manpages/) (<http://samba.org.ru/samba/docs/man/manpages/>) that gives implementation details.

Changing idmap backends automatically refreshes the *windbind* resolver cache by sending SIGHUP (signal hang up) to the parent *windbindd* process. To find this parent process, start an [SSH](#) (page 274) session with the FreeNAS® system and enter `service samba_server status`. To manually send the SIGHUP, enter `kill -HUP pid`, where *pid* is the parent process ID.

Table 11.2: ID Mapping Backends

Value	Description
ad	AD server uses RFC2307 or Services For Unix schema extensions. Mappings must be provided in advance by adding the <code>uidNumber</code> attributes for users and <code>gidNumber</code> attributes for groups in the AD.
autorid	Similar to <i>rid</i> , but automatically configures the range to be used for each domain, so there is no need to specify a specific range for each domain in the forest. The only needed configuration is the range of UID or GIDs to use for user and group mappings and an optional size for the ranges.
ldap	Stores and retrieves mapping tables in an LDAP directory service. Default for LDAP directory service.
nss	Provides a simple means of ensuring that the SID for a Unix user is reported as the one assigned to the corresponding domain user.
rfc2307	IDs for AD users stored as RFC2307 (https://tools.ietf.org/html/rfc2307) ldap schema extensions. This module can either look up the IDs in the AD LDAP servers or an external (non-AD) LDAP server.
rid	Default for AD. Requires an explicit idmap configuration for each domain, using disjoint ranges where a writeable default idmap range is to be defined, using a backend like <i>tdb</i> or <i>ldap</i> .

Continued on next page

Table 11.2 – continued from previous page

Value	Description
script	Stores mapping tables for clustered environments in the winbind_cache tdb.
tdb	Default backend used by winbindd for storing mapping tables.

REBUILD DIRECTORY SERVICE CACHE immediately refreshes the web interface directory service cache. This occurs automatically once a day as a cron job.

If there are problems connecting to the realm, [verify](https://support.microsoft.com/en-us/help/909264/naming-conventions-in-active-directory-for-computers-domains-sites-and) (https://support.microsoft.com/en-us/help/909264/naming-conventions-in-active-directory-for-computers-domains-sites-and) the settings do not include any disallowed characters. Active Directory does not allow \$ characters in Domain or NetBIOS names. The length of those names is also limited to 15 characters. The Administrator account password cannot contain the \$ character. If a \$ exists in the domain administrator password, `kinit` reports a “Password Incorrect” error and `ldap_bind` reports an “Invalid credentials (49)” error.

It can take a few minutes after configuring the Active Directory service for the AD information to be populated to the FreeNAS® system. Once populated, the AD users and groups will be available in the drop-down menus of the *Permissions* screen of a dataset.

The Active Directory users and groups that are imported to the FreeNAS® system are shown by typing commands in the FreeNAS® *Shell* (page 335):

- View users: `wbinfo -u`
- View groups: `wbinfo -g`

In addition, `wbinfo -m` shows the domains and `wbinfo -t` tests the connection. When successful, `wbinfo -t` shows a message similar to:

```
checking the trust secret for domain YOURDOMAIN via RPC calls succeeded
```

To manually check that a specified user can authenticate, open the *Shell* (page 335) and enter `smbclient//127.0.0.1/SHARE -U DOMAIN\username`, where *SHARE* is the SMB share name, *DOMAIN* is the name of the trusted domain, and *username* is the user account for authentication testing.

`getent passwd` and `getent group` can provide more troubleshooting information if no users or groups are listed in the output.

Tip: Sometimes network users do not appear in the drop-down menu of a *Permissions* screen but the `wbinfo` commands display these users. This is typically due to the FreeNAS® system taking longer than the default ten seconds to join Active Directory. Increase the value of *AD timeout* to 60 seconds.

To change a certificate, enable Advanced Mode, set the *Encryption Mode* to *Off*, then disable AD by unchecking *Enable*. Click *SAVE*. Select the new *Certificate*, set the *Encryption Mode* as desired, check *Enable* to re-enable AD, and click *SAVE* to restart AD.

11.1.1 Leaving the Domain

A *Leave Domain* button appears on the service dialog when a domain is connected. To leave the domain, click the button and enter credentials with privileges sufficient to permit leaving.

11.1.2 Troubleshooting Tips

When running AD in a 2003/2008 mixed domain, [this forum post](https://forums.freenas.org/index.php?threads/2008r2-2003-mixed-domain.1931/) (https://forums.freenas.org/index.php?threads/2008r2-2003-mixed-domain.1931/) has instructions to prevent the secure channel key from becoming corrupt.

Active Directory uses DNS to determine the location of the domain controllers and global catalog servers in the network. Use `host -t srv _ldap._tcp.domainname.com` to determine the SRV records of the network and change the weight and/or priority of the SRV record to reflect the fastest server. More information about SRV records can be found in the Technet article [How DNS Support for Active Directory Works](https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2003/cc759550(v=ws.10)) ([https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2003/cc759550\(v=ws.10\)](https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2003/cc759550(v=ws.10))).

The realm used depends on the priority in the SRV DNS record. DNS can override the system Active Directory settings. When unable to connect to the correct realm, check the SRV records on the DNS server.

An expired password for the administrator account will cause `kinit` to fail. Ensure the password is still valid and double-check the password on the AD account being used does not include any spaces, special symbols, and is not unusually long.

If the Windows server version is lower than 2008 R2, try creating a *Computer* entry on the Windows server Organizational Unit (OU). When creating this entry, enter the FreeNAS® hostname in the *name* field. Make sure it is under 15 characters, the same name as the one set in the *Hostname* field in *Network* → *Global Configuration*, and the same *NetBIOS alias* in *Directory Service* → *Active Directory* → *Advanced* settings.

If the cache becomes out of sync due to an AD server being taken off and back online, resync the cache using *Directory Service* → *Active Directory* → *REBUILD DIRECTORY SERVICE CACHE*.

If any of the commands fail or result in a traceback, create a bug report at <https://bug.ixsystems.com>. Include the commands in the order in which they were run and the exact wording of the error message or traceback.

11.2 LDAP

FreeNAS® includes an [OpenLDAP](http://www.openldap.org/) (<http://www.openldap.org/>) client for accessing information from an LDAP server. An LDAP server provides directory services for finding network resources such as users and their associated permissions. Examples of LDAP servers include Microsoft Server (2000 and newer), Mac OS X Server, Novell eDirectory, and OpenLDAP running on a BSD or Linux system. If an LDAP server is running on the network, configure the FreeNAS® LDAP service so network users can authenticate to the LDAP server and have authorized access to the data stored on the FreeNAS® system.

Note: LDAP authentication for SMB shares is disabled unless the LDAP directory has been configured for and populated with Samba attributes. The most popular script for performing this task is [smbldap-tools](https://wiki.samba.org/index.php/4.1_smbldap-tools) (https://wiki.samba.org/index.php/4.1_smbldap-tools). The LDAP server must support SSL/TLS and the certificate for the LDAP server CA must be imported with *System* → *CAs* → *Import CA*. Non-CA certificates are not currently supported.

Tip: Apple's [Open Directory](https://manuals.info.apple.com/MANUALS/0/MA954/en_US/Open_Directory_Admin_v10.5_3rd_Ed) (https://manuals.info.apple.com/MANUALS/0/MA954/en_US/Open_Directory_Admin_v10.5_3rd_Ed) is an LDAP-compatible directory service into which FreeNAS® can be integrated. The forum post [FreeNAS with Open Directory in Mac OS X environments](https://forums.freenas.org/index.php?threads/howto-freenas-with-open-directory-in-mac-os-x-environments.46493/) (<https://forums.freenas.org/index.php?threads/howto-freenas-with-open-directory-in-mac-os-x-environments.46493/>) has more information.

Figure 11.2 shows the LDAP Configuration section from *Directory Services* → *LDAP*.

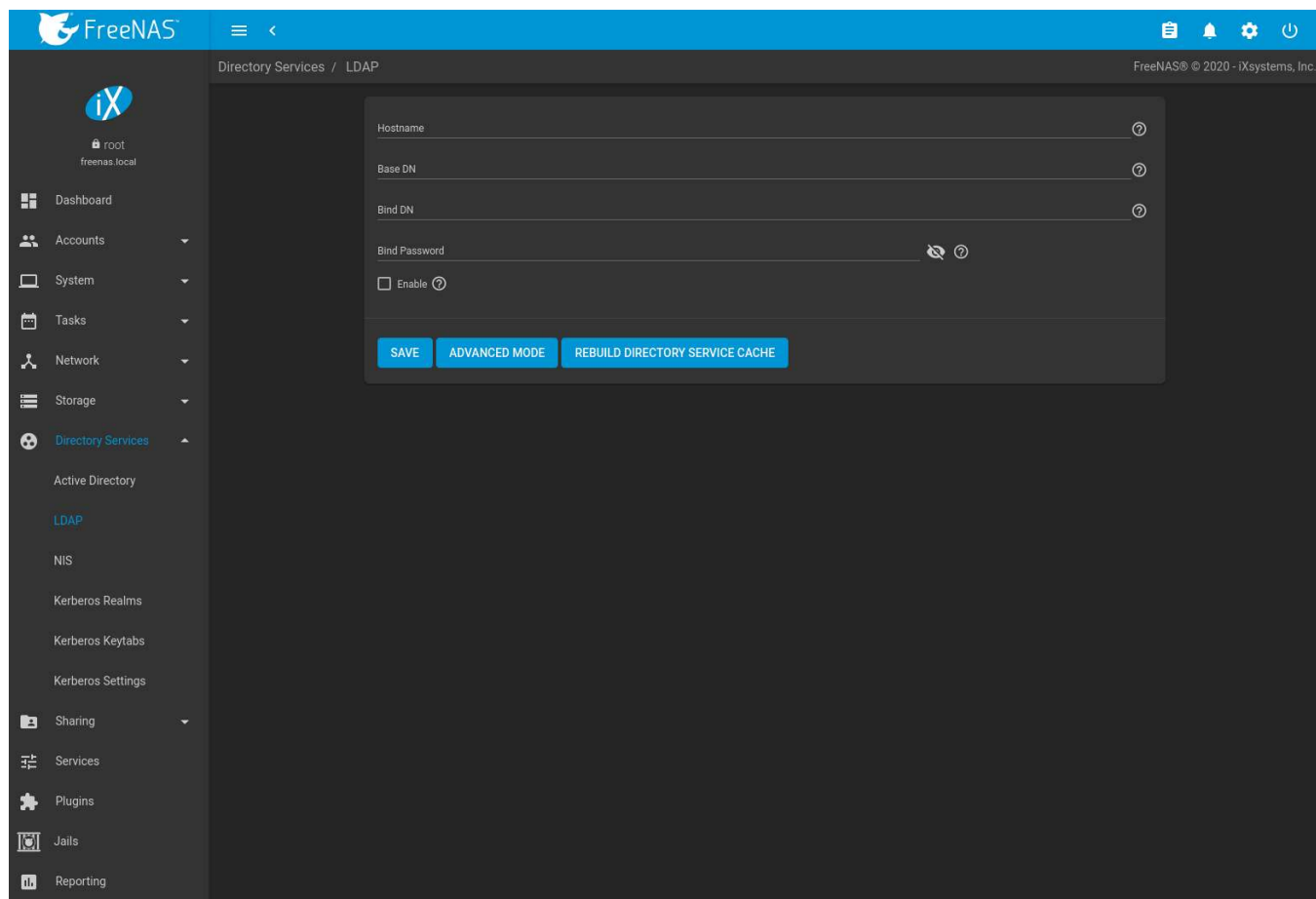


Fig. 11.2: Configuring LDAP

Table 11.3 summarizes the available configuration options. Some settings are only available in Advanced Mode. Click the *ADVANCED MODE* button to show the Advanced Mode settings. Go to *System* → *Advanced* and set the *Show advanced fields by default* option to always show advanced options.

Those new to LDAP terminology should read the [OpenLDAP Software 2.4 Administrator's Guide](http://www.openldap.org/doc/admin24/) (<http://www.openldap.org/doc/admin24/>).

Table 11.3: LDAP Configuration Options

Setting	Value	Advanced Mode	Description
Hostname	string		LDAP server hostnames or IP addresses. Separate entries with an empty space. Multiple hostnames or IP addresses can be entered to create an LDAP failover priority list. If a host does not respond, the next host in the list is tried until a new connection is established.
Base DN	string		Top level of the LDAP directory tree to be used when searching for resources (Example: <i>dc=test,dc=org</i>).
Bind DN	string		Administrative account name on the LDAP server (Example: <i>cn=Manager,dc=test,dc=org</i>).
Bind Password	string		Password for the <i>Bind DN</i> . Click <i>SHOW/HIDE PASSWORDS</i> to view or obscure the password characters.
Allow Anonymous Binding	checkbox	✓	Instruct the LDAP server to disable authentication and allow read and write access to any client.

Continued on next page

Table 11.3 – continued from previous page

Setting	Value	Advanced Mode	Description
Kerberos Realm	drop-down menu	✓	The realm created using the instructions in Kerberos Realms (page 207).
Kerberos Principal	drop-down menu	✓	The location of the principal in the keytab created as described in Kerberos Keytabs (page 208).
Encryption Mode	drop-down menu	✓	Options for encrypting the LDAP connection: <ul style="list-style-type: none"> • <i>OFF</i>: do not encrypt the LDAP connection. • <i>ON</i>: encrypt the LDAP connection with SSL on port 636. • <i>START_TLS</i>: encrypt the LDAP connection with START-TLS on the default LDAP port 389.
Certificate	drop-down menu	✓	Certificate (page 113) to use when performing LDAP certificate-based authentication. To configure LDAP certificate-based authentication, create a Certificate Signing Request for the LDAP provider to sign. A certificate is not required when using username/password or Kerberos authentication.
Validate Certificate	checkbox	✓	Verify certificate authenticity.
Disable LDAP User/Group Cache	checkbox	✓	Disable caching LDAP users and groups in large LDAP environments. When caching is disabled, LDAP users and groups do not appear in dropdown menus, but are still accepted when manually entered.
LDAP timeout	integer	✓	Increase this value in seconds if obtaining a Kerberos ticket times out.
DNS timeout	integer	✓	Increase this value in seconds if DNS queries timeout.
Idmap Backend	drop-down menu	✓	Backend used to map Windows security identifiers (SIDs) to UNIX UIDs and GIDs. See Table 11.2 for a summary of the available backends. To configure the selected backend, click <i>EDIT IDMAP</i> .
Samba Schema	checkbox	✓	Set if LDAP authentication for SMB shares is required and the LDAP server is already configured with Samba attributes.
Auxiliary Parameters	string	✓	Additional options for sssds.conf(5) (https://jhrozek.fedorapeople.org/sssds/1.11.6/man/sssds.conf.5.html).
Schema	drop-down menu	✓	If <i>Samba Schema</i> is set, select the schema to use. Choices are <i>rfc2307</i> and <i>rfc2307bis</i> .
Enable	checkbox		Unset to disable the configuration without deleting it.

LDAP users and groups appear in the drop-down menus of the *Permissions* screen of a dataset after configuring the LDAP service. Type `getent passwd` in the FreeNAS® *Shell* (page 335) to verify the users have been imported. Type `getent group` to verify the groups have been imported.

If the users and groups are not listed, refer to [Common errors encountered when using OpenLDAP Software](http://www.openldap.org/doc/admin24/appendix-common-errors.html) (<http://www.openldap.org/doc/admin24/appendix-common-errors.html>) for common errors and how to fix them. When troubleshooting LDAP, open the FreeNAS® *Shell* (page 335) and look for error messages in `/var/log/auth.log`.

To clear LDAP users and groups from FreeNAS®, go to *Directory Services* → *LDAP*, clear the *Hostname* field, unset *Enable*, and click *SAVE*. Confirm LDAP users and groups are cleared by going to the *Shell* and viewing the output of the `getent passwd` and `getent group` commands.

11.3 NIS

The Network Information Service (NIS) maintains and distributes a central directory of Unix user and group information, hostnames, email aliases, and other text-based tables of information. If an NIS server is running on the network, the FreeNAS® system can be configured to import the users and groups from the NIS directory.

Click the *Rebuild Directory Service Cache* button if a new NIS user needs immediate access to FreeNAS®. This occurs automatically once a day as a cron job.

Note: In Windows Server 2016, Microsoft removed the Identity Management for Unix (IDMU) and NIS Server Role. See [Clarification regarding the status of Identity Management for Unix \(IDMU\) & NIS Server Role in Windows Server 2016 Technical Preview and beyond](https://blogs.technet.microsoft.com/activedirectoryua/2016/02/09/identity-management-for-unix-idmu-is-deprecated-in-windows-server/) (<https://blogs.technet.microsoft.com/activedirectoryua/2016/02/09/identity-management-for-unix-idmu-is-deprecated-in-windows-server/>).

Figure 11.3 shows the *Directory Services* → *NIS* section. Table 11.4 summarizes the configuration options.

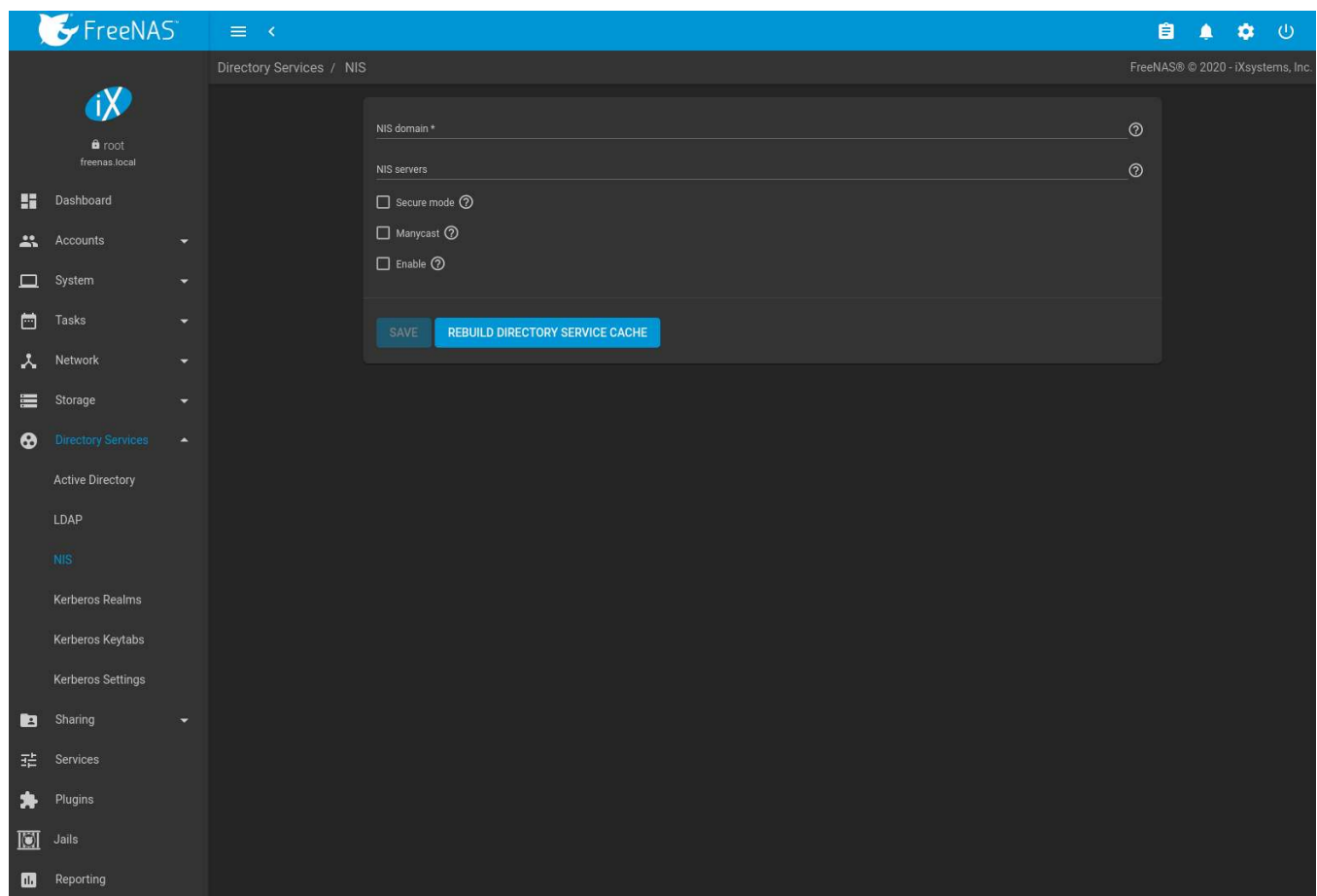


Fig. 11.3: NIS Configuration

Table 11.4: NIS Configuration Options

Setting	Value	Description
NIS domain	string	Name of NIS domain.
NIS servers	string	Comma-delimited list of hostnames or IP addresses.

Continued on next page

Table 11.4 – continued from previous page

Setting	Value	Description
Secure mode	checkbox	Set to have <code>ypbind(8)</code> (https://www.freebsd.org/cgi/man.cgi?query=ypbind) refuse to bind to any NIS server not running as root on a TCP port over 1024.
Manycast	checkbox	Set to have <code>ypbind</code> to bind to the server that responds the fastest. This is useful when no local NIS server is available on the same sub-net.
Enable	checkbox	Unset to disable the configuration without deleting it.

11.4 Kerberos Realms

A default Kerberos realm is created for the local system in FreeNAS®. *Directory Services* → *Kerberos Realms* can be used to view and add Kerberos realms. If the network contains a Key Distribution Center (KDC), click **ADD** to add the realm. The configuration screen is shown in [Figure 11.4](#).

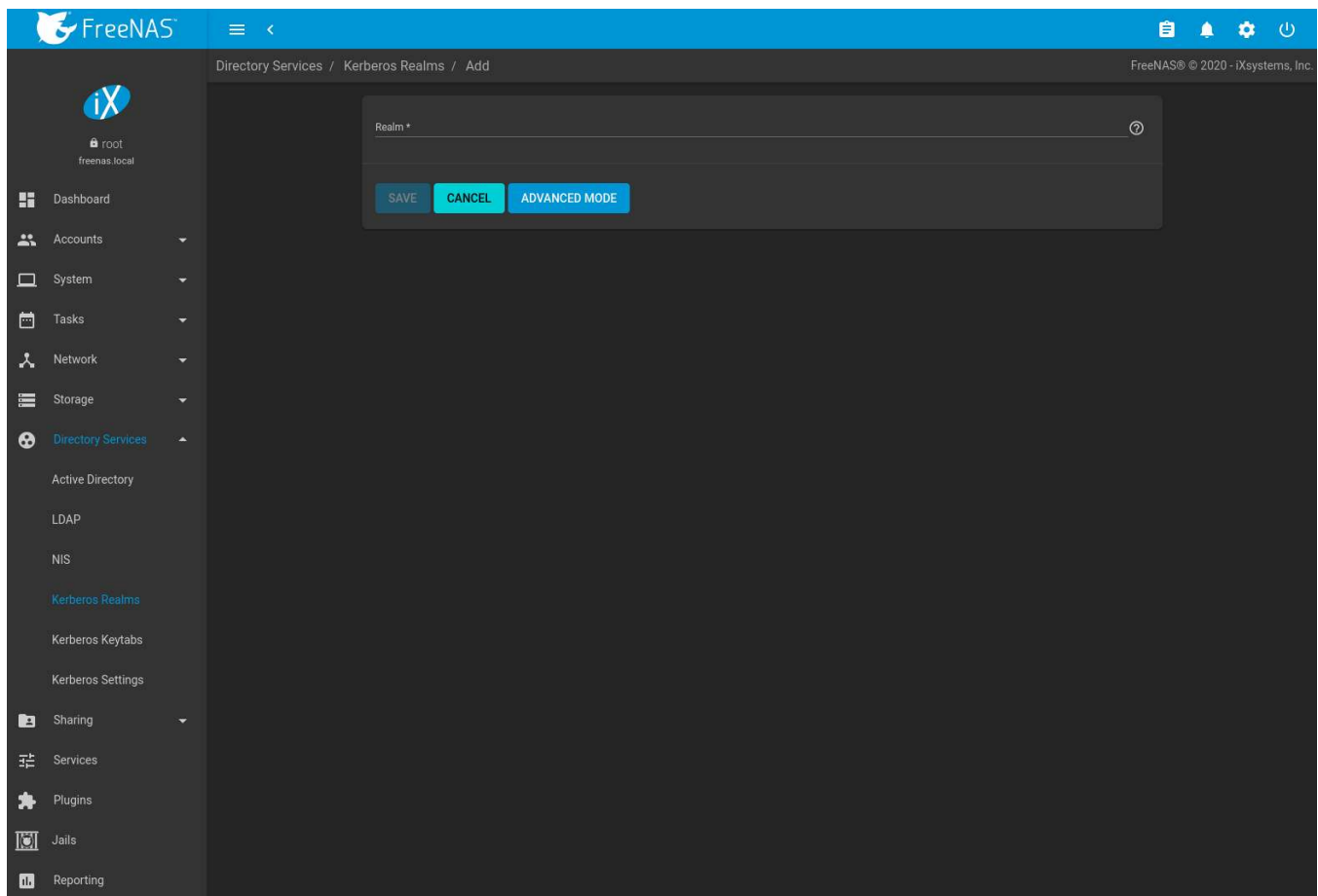


Fig. 11.4: Adding a Kerberos Realm

[Table 11.5](#) summarizes the configurable options. Some settings are only available in Advanced Mode. To see these settings, either click **ADVANCED MODE** or configure the system to always display these settings by setting *Show advanced fields by default* in *System* → *Advanced*.

Table 11.5: Kerberos Realm Options

Setting	Value	Advanced Mode	Description
Realm	string		Name of the realm.
KDC	string	✓	Name of the Key Distribution Center.
Admin Server	string	✓	Server where all changes to the database are performed.
Password Server	string	✓	Server where all password changes are performed.

11.5 Kerberos Keytabs

Kerberos keytabs are used to do Active Directory or LDAP joins without a password. This means the password for the Active Directory or LDAP administrator account does not need to be saved into the FreeNAS® configuration database, which is a security risk in some environments.

When using a keytab, it is recommended to create and use a less privileged account for performing the required queries as the password for that account will be stored in the FreeNAS® configuration database. To create the keytab on a Windows system, use the `ktpass` (<https://docs.microsoft.com/en-us/windows-server/administration/windows-commands/ktpass>) command:

```
ktpass.exe /out freenas.keytab /princ http/useraccount@EXAMPLE.COM /mapuser useraccount /ptype_
↪KRB5_NT_PRINCIPAL /crypto ALL /pass userpass
```

where:

- `freenas.keytab` is the file to upload to the FreeNAS® server.
- `useraccount` is the name of the user account for the FreeNAS® server generated in [Active Directory Users and Computers](https://technet.microsoft.com/en-us/library/aa998508(v=exchg.65).aspx) ([https://technet.microsoft.com/en-us/library/aa998508\(v=exchg.65\).aspx](https://technet.microsoft.com/en-us/library/aa998508(v=exchg.65).aspx)).
- `http/useraccount@EXAMPLE.COM` is the principal name written in the format `host/user.account@KERBEROS.REALM`. By convention, the kerberos realm is written in all caps, but make sure the case used for the [Kerberos Realm](#) (page 207) matches the realm name. See [this note](https://docs.microsoft.com/en-us/windows-server/administration/windows-commands/ktpass#BKMK_remarks) (https://docs.microsoft.com/en-us/windows-server/administration/windows-commands/ktpass#BKMK_remarks) about using `/princ` for more details.
- `userpass` is the password associated with `useraccount`.

Setting `/crypto` to `ALL` allows using all supported cryptographic types. These keys can be specified instead of `ALL`:

- `DES-CBC-CRC` is used for compatibility.
- `DES-CBC-MD5` adheres more closely to the MIT implementation and is used for compatibility.
- `RC4-HMAC-NT` uses 128-bit encryption.
- `AES256-SHA1` uses AES256-CTS-HMAC-SHA1-96 encryption.
- `AES128-SHA1` uses AES128-CTS-HMAC-SHA1-96 encryption.

This will create a keytab with sufficient privileges to grant tickets.

After the keytab is generated, add it to the FreeNAS® system using *Directory Services* → *Kerberos Keytabs* → *Add Kerberos Keytab*.

To instruct the Active Directory service to use the keytab, select the installed keytab using the drop-down *Kerberos Principal* menu in *Directory Services* → *Active Directory* Advanced Mode. When using a keytab with Active Directory, make sure that username and userpass in the keytab matches the Domain Account Name and Domain Account Password fields in *Directory Services* → *Active Directory*.

To instruct LDAP to use a principal from the keytab, select the principal from the drop-down *Kerberos Principal* menu in *Directory Services* → *LDAP* Advanced Mode.

11.6 Kerberos Settings

Configure additional Kerberos parameters in the *Directory Services* → *Kerberos Settings* section. Figure 11.5 shows the fields available:

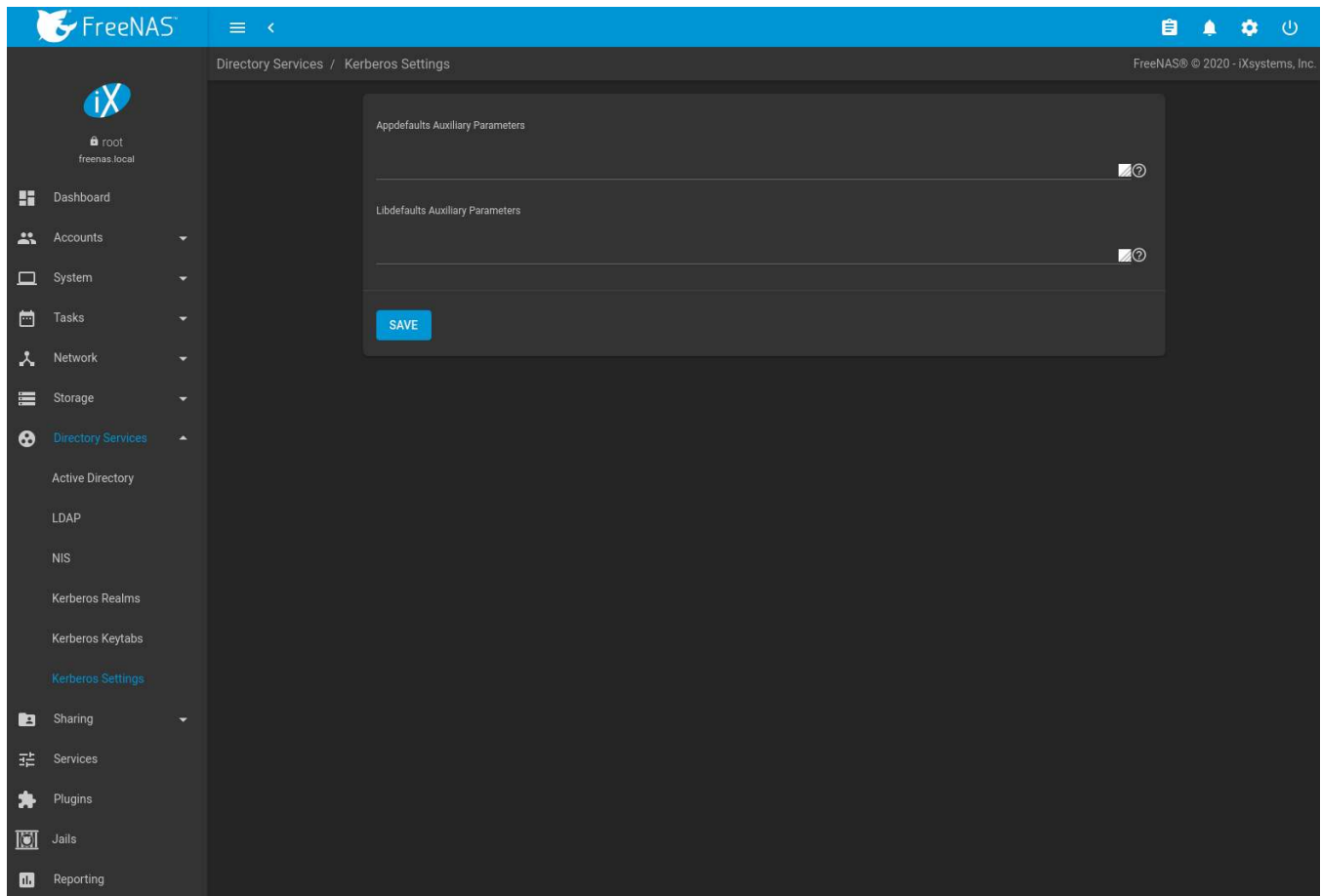


Fig. 11.5: Additional Kerberos Settings

- **Appdefaults Auxiliary Parameters:** Define any additional settings for use by some Kerberos applications. The available settings and syntax is listed in the [\[appdefaults\] section of krb.conf\(5\)](http://web.mit.edu/kerberos/krb5-1.12/doc/admin/conf_files/krb5_conf.html#appdefaults) (http://web.mit.edu/kerberos/krb5-1.12/doc/admin/conf_files/krb5_conf.html#appdefaults).
- **Libdefaults Auxiliary Parameters:** Define any settings used by the Kerberos library. The available settings and their syntax are listed in the [\[libdefaults\] section of krb.conf\(5\)](http://web.mit.edu/kerberos/krb5-1.12/doc/admin/conf_files/krb5_conf.html#libdefaults) (http://web.mit.edu/kerberos/krb5-1.12/doc/admin/conf_files/krb5_conf.html#libdefaults).

SHARING

Shares provide and control access to an area of storage. Consider factors like operating system, security, transfer speed, and user access before creating a new share. This information can help determine the type of share, if multiple datasets are needed to divide the storage into areas with different access and permissions, and the complexity of setting up permissions.

Note that shares are only used to provide access to data. Deleting a share configuration does not affect the data that was being shared.

These types of shares and services are available:

- **AFP** (page 211): Apple Filing Protocol shares are used when the client computers all run macOS. Apple has deprecated AFP in favor of **SMB** (page 239). Using AFP in modern networks is no longer recommended.
- **Unix (NFS)** (page 230): Network File System shares are accessible from macOS, Linux, BSD, and the professional and enterprise versions (but not the home editions) of Windows. This can be a good choice when the client computers do not all run the same operating system but NFS client software is available for all of them.
- **WebDAV** (page 237): WebDAV shares are accessible using an authenticated web browser (read-only) or **WebDAV client** (https://en.wikipedia.org/wiki/WebDAV#Client_support) running on any operating system.
- **SMB** (page 239): Server Message Block shares, also known as Common Internet File System (CIFS) shares, are accessible by Windows, macOS, Linux, and BSD computers. Access is slower than an NFS share due to the single-threaded design of Samba. SMB provides more configuration options than NFS and is a good choice on a network for Windows or Mac systems. However, it is a poor choice if the CPU on the FreeNAS® system is limited. If it is maxed out, upgrade the CPU or consider a different type of share.
- **Block (iSCSI)** (page 215): Block or iSCSI shares appear as an unformatted disk to clients running iSCSI initiator software or a virtualization solution such as VMware. These are usually used as virtual drives.

Fast access from any operating system can be obtained by configuring the **FTP** (page 256) service instead of a share and using a cross-platform FTP file manager application such as **Filezilla** (<https://filezilla-project.org/>). Secure FTP can be configured if the data needs to be encrypted.

When data security is a concern and the network users are familiar with SSH command line utilities or **WinSCP** (<https://winscp.net/eng/index.php>), consider using the **SSH** (page 274) service instead of a share. It is slower than unencrypted FTP due to the encryption overhead, but the data passing through the network is encrypted.

Note: It is generally a mistake to share a pool or dataset with more than one share type or access method. Different types of shares and services use different file locking methods. For example, if the same pool is configured to use both NFS and FTP, NFS will lock a file for editing by an NFS user, but an FTP user can simultaneously edit or delete that file. This results in lost edits and confused users. Another example: if a pool is configured for both AFP and SMB, Windows users can be confused by the “extra” filenames used by Mac files and delete them. This corrupts the files on the AFP share. Pick the one type of share or service that makes the most sense for the types of clients accessing that pool, and use that single type of share or service. To support multiple types of shares, divide the pool into datasets and use one dataset per share.

This section demonstrates configuration and fine-tuning of AFP, NFS, SMB, WebDAV, and iSCSI shares. FTP and SSH configurations are described in **Services** (page 252).

12.1 Apple (AFP) Shares

FreeNAS® uses the [Netatalk](http://netatalk.sourceforge.net/) (<http://netatalk.sourceforge.net/>) AFP server to share data with Apple systems. This section describes the configuration screen for fine-tuning AFP shares. It then provides configuration examples for configuring Time Machine to back up to a dataset on the FreeNAS® system and for connecting to the share from a macOS client.

Create a share by clicking *Sharing* → *Apple (AFP)*, then *ADD*.

New AFP shares are visible in the *Sharing* → *Apple (AFP)* menu.

The configuration options shown in [Figure 12.1](#) appear after clicking ⓘ (Options) on an existing share, and selecting the *Edit* option. The values showing for these options will vary, depending upon the information given when the share was created.

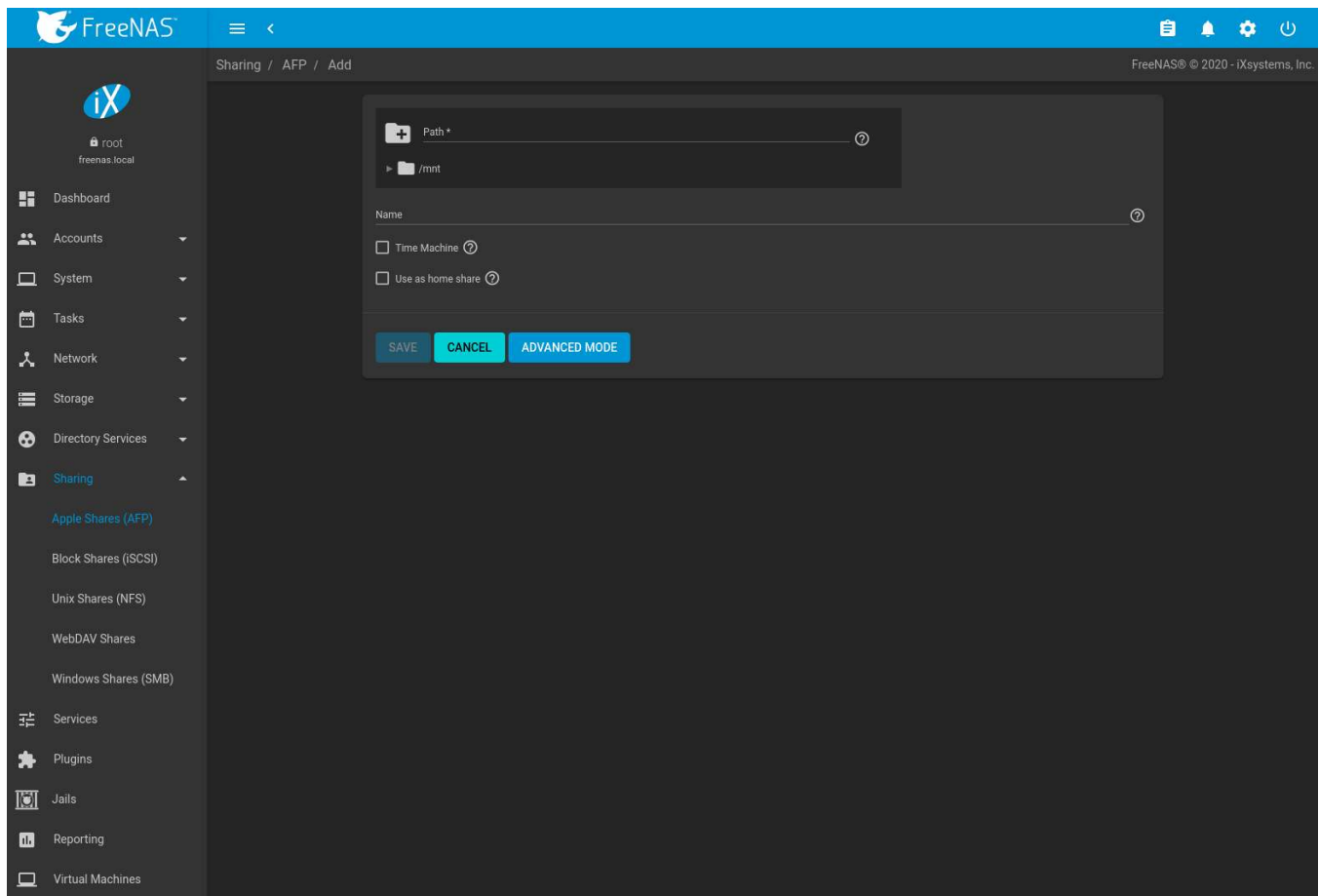


Fig. 12.1: Creating an AFP Share

Note: [Table 12.1](#) summarizes the options available to fine-tune an AFP share. Leaving these options at the default settings is recommended as changing them can cause unexpected behavior. Most settings are only available with *Advanced Mode*. Do **not** change an advanced option without fully understanding the function of that option. Refer to [Setting up Netatalk](http://netatalk.sourceforge.net/2.2/htmldocs/configuration.html) (<http://netatalk.sourceforge.net/2.2/htmldocs/configuration.html>) for a more detailed explanation of these options.

Table 12.1: AFP Share Configuration Options

Setting	Value	Advanced Mode	Description
Path	browse button		Browse to the pool or dataset to share. Do not nest additional pools, datasets, or symbolic links beneath this path because Netatalk does not fully support that.
Name	string		Enter the pool name that appears in macOS after selecting <i>Go → Connect to server</i> in the Finder menu. Limited to 27 characters and cannot contain a period.
Comment	string	✓	Optional comment.
Allow list	string	✓	Comma-delimited list of allowed users and/or groups where groupname begins with a @. Note that adding an entry will deny any user/group that is not specified.
Deny list	string	✓	Comma-delimited list of denied users and/or groups where groupname begins with a @. Note that adding an entry will allow all users/groups that are not specified.
Read Only Access	string	✓	Comma-delimited list of users and/or groups who only have read access where groupname begins with a @.
Read/Write Access	string	✓	Comma-delimited list of users and/or groups who have read and write access where groupname begins with a @.
Time Machine	checkbox		Set to advertise FreeNAS® as a Time Machine disk so it can be found by Macs. Setting multiple shares for Time Machine use is not recommended. When multiple Macs share the same pool, low disk space issues and intermittently failed backups can occur.
Time Machine Quota	integer		Appears when <i>Time Machine</i> is set. Enter a storage quota for each Time Machine backup on this share. The share must be remounted for any changes to this value to take effect.
Use as home share	checkbox		Allows the share to host user home directories. Each user is given a personal home directory when connecting to the share which is not accessible by other users. This allows for a personal, dynamic share. Only one share can be used as the home share.
Zero Device Numbers	checkbox	✓	Enable when the device number is not constant across a reboot.
No Stat	checkbox	✓	If set, AFP does not stat the pool path when enumerating the pools list. Useful for automounting or pools created by a preexec script.
AFP3 UNIX Privs	checkbox	✓	Set to enable Unix privileges supported by Mac OS X 10.5 and higher. Do not enable if the network has Mac OS X 10.4 or lower clients. Those systems do not support this feature.
Default file permissions	checkboxes	✓	Only works with Unix ACLs. New files created on the share are set with the selected permissions.
Default directory permissions	checkboxes	✓	Only works with Unix ACLs. New directories created on the share are set with the selected permissions.
Default umask	integer	✓	Umask is used for newly created files. Default is 000 (anyone can read, write, and execute).
Hosts Allow	string	✓	Enter a list of allowed hostnames or IP addresses. Separate entries with a comma, space, or tab.
Hosts Deny	string	✓	Enter a list of denied hostnames or IP addresses. Separate entries with a comma, space, or tab.

Continued on next page


Table 12.1 – continued from previous page

Setting	Value	Advanced Mode	Description
Auxiliary Parameters	string	✓	Enter any additional afp.conf (https://www.freebsd.org/cgi/man.cgi?query=afp.conf) parameters not covered by other option fields.

12.1.1 Creating AFP Guest Shares

AFP supports guest logins, meaning that macOS users can access the AFP share without requiring their user accounts to first be created on or imported into the FreeNAS® system.

Note: When a guest share is created along with a share that requires authentication, AFP only maps users who log in as *guest* to the guest share. If a user logs in to the share that requires authentication, permissions on the guest share can prevent that user from writing to the guest share. The only way to allow both guest and authenticated users to write to a guest share is to set the permissions on the guest share to 777 or to add the authenticated users to a guest group and set the permissions to 77x.

Before creating a guest share, go to *Services* → *AFP* and click the sliding button to turn on the service. Click  (Configure) to open the screen shown in [Figure 12.2](#). For *Guest Account*, use the drop-down to select *Nobody*, set *Guest Access*, and click *SAVE*.

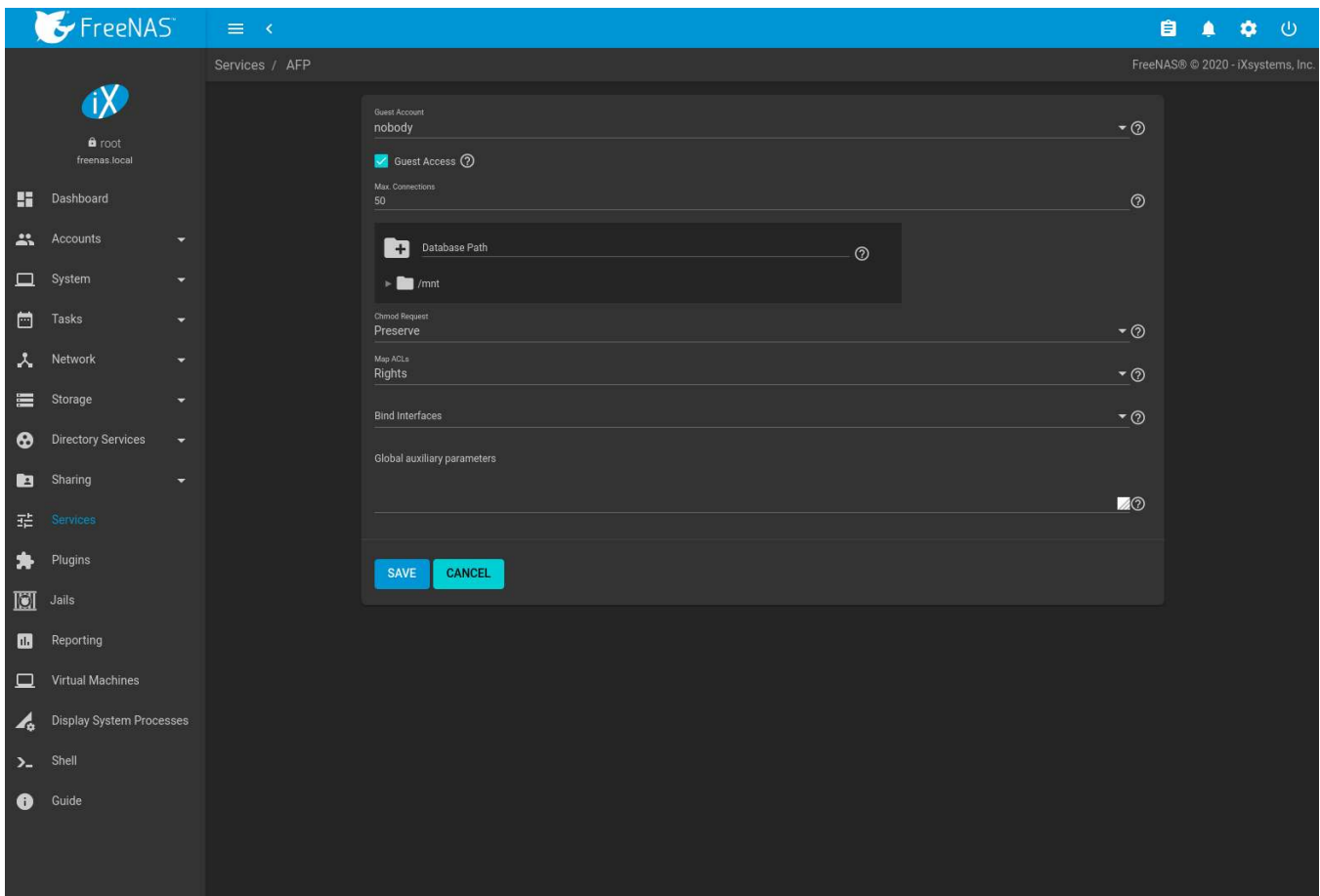


Fig. 12.2: Creating a Guest AFP Share

Next, create a dataset for the guest share. Refer to [Adding Datasets](#) (page 177) for more information about dataset

creation.

After creating the dataset for the guest share, go to *Storage* → *Pools*, click the **:** (Options) button for the dataset, then click *Edit Permissions*. Complete the fields shown in [Figure 12.3](#).

1. **User:** Use the drop-down to select *Nobody*.
2. Click *SAVE*.

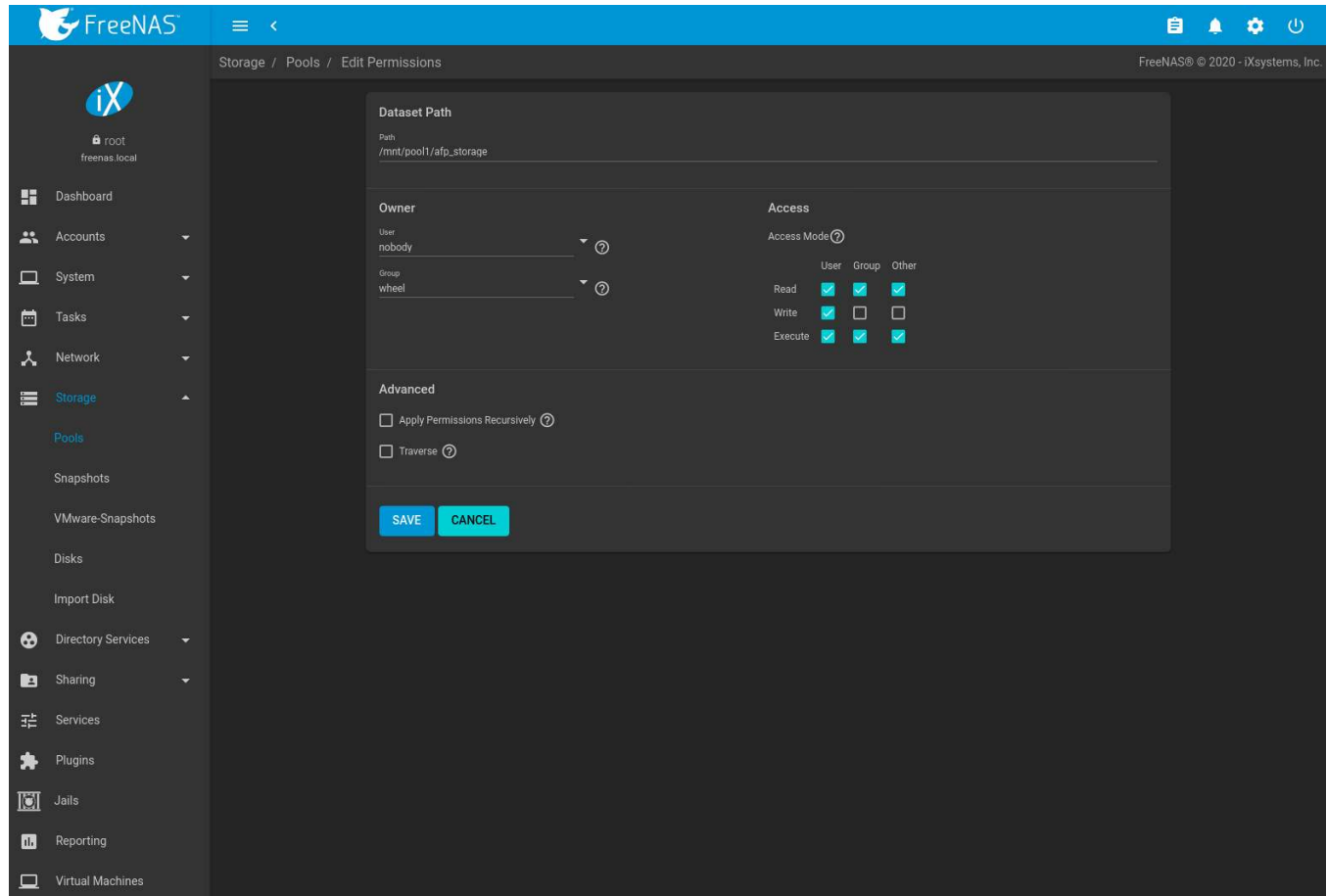


Fig. 12.3: Editing Dataset Permissions for Guest AFP Share

To create a guest AFP share:

1. Go to *Sharing* → *Apple (AFP) Shares* and click *ADD*.
2. *Browse* to the dataset created for the guest share.
3. Fill out the other required fields, then press *SAVE*.

macOS users can use Finder to connect to the guest AFP share by clicking *Go* → *Connect to Server*. In the example shown in [Figure 12.4](#), the user entered `afp://` followed by the IP address of the FreeNAS® system.

Click the *Connect* button. Once connected, Finder opens automatically. The name of the AFP share is displayed in the SHARED section in the left frame and the contents of any data saved in the share is displayed in the right frame.

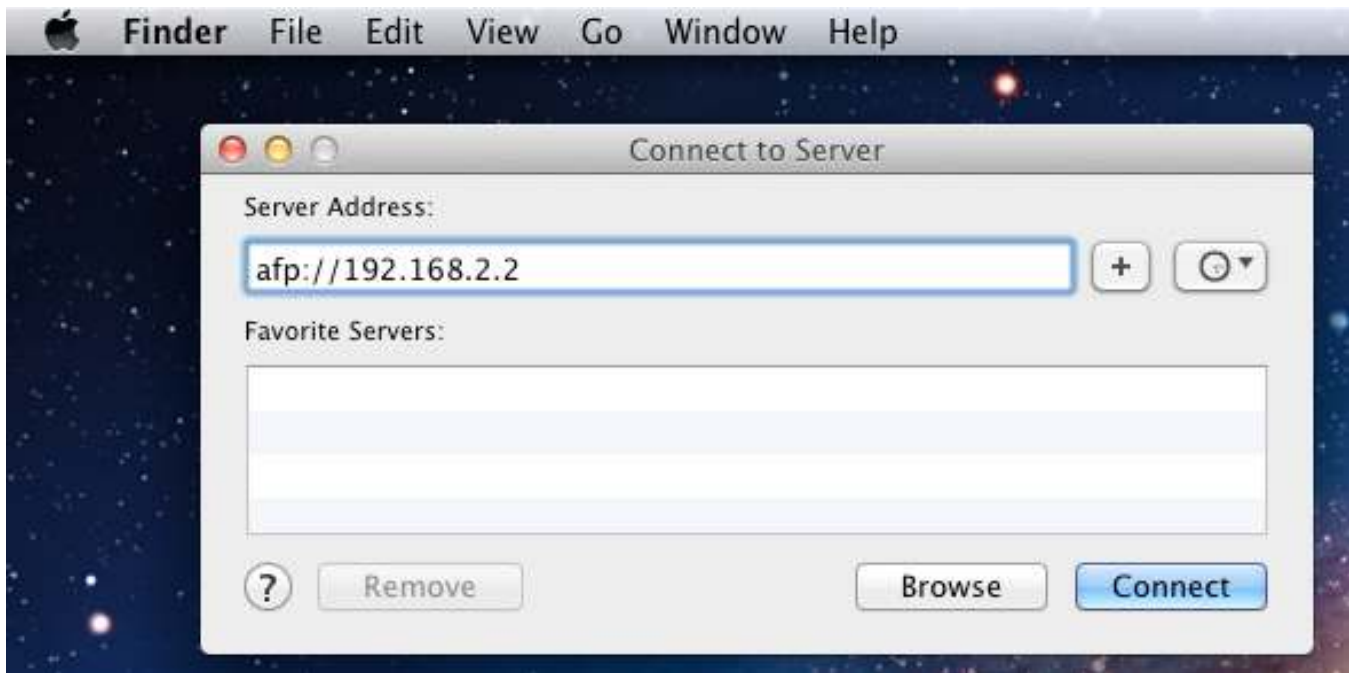


Fig. 12.4: Connect to Server Dialog

To disconnect from the pool, click the *eject* button in the *Shared* sidebar.

12.2 Block (iSCSI)

iSCSI is a protocol standard for the consolidation of storage data. iSCSI allows FreeNAS® to act like a storage area network (SAN) over an existing Ethernet network. Specifically, it exports disk devices over an Ethernet network that iSCSI clients (called initiators) can attach to and mount. Traditional SANs operate over fibre channel networks which require a fibre channel infrastructure such as fibre channel HBAs, fibre channel switches, and discrete cabling. iSCSI can be used over an existing Ethernet network, although dedicated networks can be built for iSCSI traffic in an effort to boost performance. iSCSI also provides an advantage in an environment that uses Windows shell programs; these programs tend to filter “Network Location” but iSCSI mounts are not filtered.

Before configuring the iSCSI service, be familiar with this iSCSI terminology:

CHAP: an authentication method which uses a shared secret and three-way authentication to determine if a system is authorized to access the storage device and to periodically confirm that the session has not been hijacked by another system. In iSCSI, the initiator (client) performs the CHAP authentication.

Mutual CHAP: a superset of CHAP in that both ends of the communication authenticate to each other.

Initiator: a client which has authorized access to the storage data on the FreeNAS® system. The client requires initiator software to initiate the connection to the iSCSI share.

Target: a storage resource on the FreeNAS® system. Every target has a unique name known as an iSCSI Qualified Name (IQN).

Internet Storage Name Service (iSNS): protocol for the automated discovery of iSCSI devices on a TCP/IP network.

Extent: the storage unit to be shared. It can either be a file or a device.

Portal: indicates which IP addresses and ports to listen on for connection requests.

LUN: *Logical Unit Number* representing a logical SCSI device. An initiator negotiates with a target to establish connectivity to a LUN. The result is an iSCSI connection that emulates a connection to a SCSI hard disk. Initiators treat

iSCSI LUNs as if they were a raw SCSI or SATA hard drive. Rather than mounting remote directories, initiators format and directly manage filesystems on iSCSI LUNs. When configuring multiple iSCSI LUNs, create a new target for each LUN. Since iSCSI multiplexes a target with multiple LUNs over the same TCP connection, there can be TCP contention when more than one target accesses the same LUN. FreeNAS® supports up to 1024 LUNs.

In FreeNAS®, iSCSI is built into the kernel. This version of iSCSI supports [Microsoft Offloaded Data Transfer \(ODX\)](https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/hh831628(v=ws.11)) ([https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/hh831628\(v=ws.11\)](https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/hh831628(v=ws.11))), meaning that file copies happen locally, rather than over the network. It also supports the [VAAI](#) (page 371) (vStorage APIs for Array Integration) primitives for efficient operation of storage tasks directly on the NAS. To take advantage of the VAAI primitives, [create a zvol](#) (page 181) and use it to [create a device extent](#) (page 224).

12.2.1 iSCSI Wizard

To configure iSCSI, click *WIZARD* and follow each step:

1. Create or Choose Block Device:

- *Name*: Enter a name for the block device. Keeping the name short is recommended. Using a name longer than 63 characters can prevent access to the block device.
- *Type*: Select *File* or *Device* as the type of block device. *Device* provides virtual storage access to zvols, zvol snapshots, or physical devices. *File* provides virtual storage access to an individual file.
- *Device*: Select the unformatted disk, controller, zvol, or zvol snapshot. Select *Create New* for options to create a new zvol. If *Create New* is selected, use the browser to select an existing pool or dataset to store the new zvol. Enter the desired size of the zvol in *Size*. Only displayed when *Type* is set to *Device*.
- *File*: Browse to an existing file. Create a new file by browsing to a dataset and appending the file name to the path. When the file already exists, enter a size of *0* to use the actual file size. For new files, enter the size of the file to create. Only displayed when *Type* is set to *File*.
- *What are you using this for*: Choose the platform that will use this share. The associated options are applied to this share.

2. Portal

- *Portal*: Select an existing portal or choose *Create New* to configure a new portal.
- *Discovery Auth Method*: *NONE* allows anonymous discovery while *CHAP* and *Mutual CHAP* require authentication.
- *Discovery Auth Group*: Choose an existing [Authorized Access](#) (page 220) group ID or create a new authorized access. This is required when the *Discovery Auth Method* is set to *CHAP* or *Mutual CHAP*.
- *IP*: Select IP addresses to be listened on by the portal. Click *ADD* to add IP addresses with a different network port. The address *0.0.0.0* can be selected to listen on all IPv4 addresses, or *:::* to listen on all IPv6 addresses.
- *Port*: TCP port used to access the iSCSI target. Default is 3260.

3. Initiator

- *Initiators*: Leave blank to allow all or enter a list of initiator hostnames separated by spaces.
- *Authorized Networks*: Network addresses allowed to use this initiator. Leave blank to allow all networks or list network addresses with a CIDR mask. Separate multiple addresses with a space: *192.168.2.0/24 192.168.2.1/12*.

4. Confirm Options

- Review the configuration and click *SUBMIT* to set up the iSCSI share.

The rest of this section describes iSCSI configuration in more detail.

12.2.2 Target Global Configuration

Sharing → *Block (iSCSI)* → *Target Global Configuration* contains settings that apply to all iSCSI shares. [Table 12.2](#) describes each option.

Some built-in values affect iSNS usage. Fetching of allowed initiators from iSNS is not implemented, so target ACLs must be configured manually. To make iSNS registration useful, iSCSI targets should have explicitly configured port IP addresses. This avoids initiators attempting to discover unconfigured target portal addresses like `0.0.0.0`.

The iSNS registration period is *900* seconds. Registered Network Entities not updated during this period are unregistered. The timeout for iSNS requests is *5* seconds.

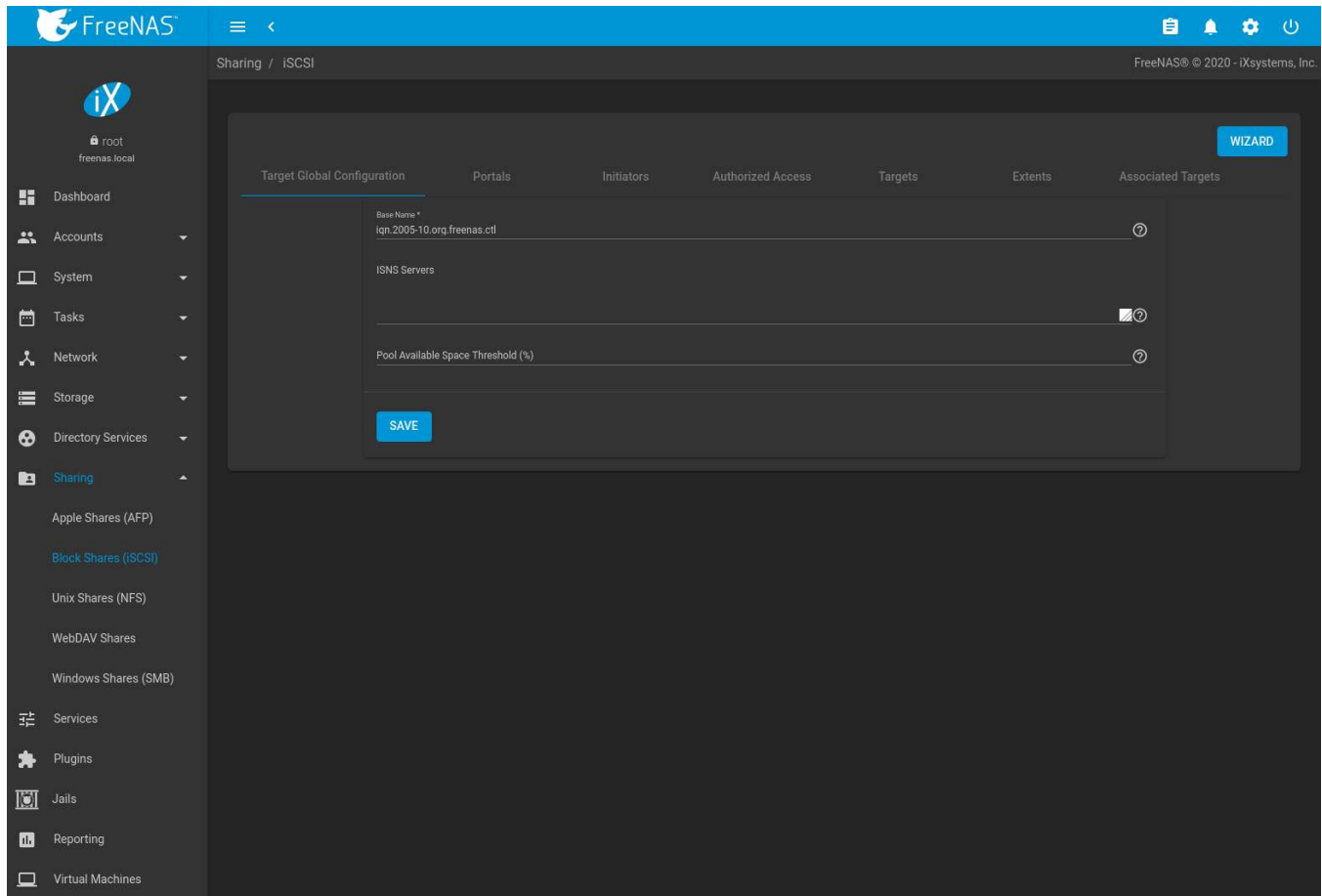


Fig. 12.5: iSCSI Target Global Configuration Variables

Table 12.2: Target Global Configuration Settings

Setting	Value	Description
Base Name	string	Lowercase alphanumeric characters plus dot (.), dash (-), and colon (:) are allowed. See the “Constructing iSCSI names using the iqn. format” section of RFC 3721 (https://tools.ietf.org/html/rfc3721).
iSNS Servers	string	Enter the hostnames or IP addresses of iSNS servers to be registered with iSCSI targets and portals of the system. Separate each entry with a space.
Pool Available Space Threshold	integer	Enter the percentage of free space to remain in the pool. When this percentage is reached, the system issues an alert, but only if zvols are used. See VAAI (page 371) Threshold Warning for more information.

12.2.3 Portals

A portal specifies the IP address and port number to be used for iSCSI connections. Go to *Sharing* → *Block (iSCSI)* → *Portals* and click *ADD* to display the screen shown in [Figure 12.6](#).

Table 12.6 summarizes the settings that can be configured when adding a portal.

The screenshot shows the FreeNAS web interface. The breadcrumb navigation is 'Sharing / iSCSI / Portals / Add'. The left sidebar shows the 'Sharing' menu expanded, with 'Block Shares (iSCSI)' selected. The main content area displays the 'Add iSCSI Portal' form. The form has the following fields: 'Description' (text input), 'Discovery Auth Method' (dropdown menu set to 'NONE'), 'Discovery Auth Group' (dropdown menu), 'IP Address *' (dropdown menu), and 'Port' (set to '3260'). There are 'SAVE' and 'CANCEL' buttons at the bottom of the form.

Fig. 12.6: Adding an iSCSI Portal

Table 12.3: Portal Configuration Settings

Setting	Value	Description
Description	string	Optional description. Portals are automatically assigned a numeric group.
Discovery Auth Method	drop-down menu	<i>iSCSI</i> (page 261) supports multiple authentication methods that are used by the target to discover valid devices. <i>None</i> allows anonymous discovery while <i>CHAP</i> and <i>Mutual CHAP</i> both require authentication.
Discovery Auth Group	drop-down menu	Select a Group ID created in <i>Authorized Access</i> if the <i>Discovery Auth Method</i> is set to <i>CHAP</i> or <i>Mutual CHAP</i> .
IP address	drop-down menu	Select IP addresses to be listened on by the portal. Click <i>ADD</i> to add IP addresses with a different network port. The address <code>0.0.0.0</code> can be selected to listen on all IPv4 addresses, or <code>::</code> to listen on all IPv6 addresses.
Port	integer	TCP port used to access the iSCSI target. Default is <code>3260</code> .

FreeNAS® systems with multiple IP addresses or interfaces can use a portal to provide services on different inter-

faces or subnets. This can be used to configure multi-path I/O (MPIO). MPIO is more efficient than a link aggregation.

If the FreeNAS® system has multiple configured interfaces, portals can also be used to provide network access control. For example, consider a system with four interfaces configured with these addresses:

192.168.1.1/24

192.168.2.1/24

192.168.3.1/24

192.168.4.1/24

A portal containing the first two IP addresses (group ID 1) and a portal containing the remaining two IP addresses (group ID 2) could be created. Then, a target named A with a Portal Group ID of 1 and a second target named B with a Portal Group ID of 2 could be created. In this scenario, the iSCSI service would listen on all four interfaces, but connections to target A would be limited to the first two networks and connections to target B would be limited to the last two networks.

Another scenario would be to create a portal which includes every IP address **except** for the one used by a management interface. This would prevent iSCSI connections to the management interface.

12.2.4 Initiators

The next step is to configure authorized initiators, or the systems which are allowed to connect to the iSCSI targets on the FreeNAS® system. To configure which systems can connect, go to *Sharing* → *Block (iSCSI)* → *Initiators* and click *ADD* as shown in Figure 12.7.

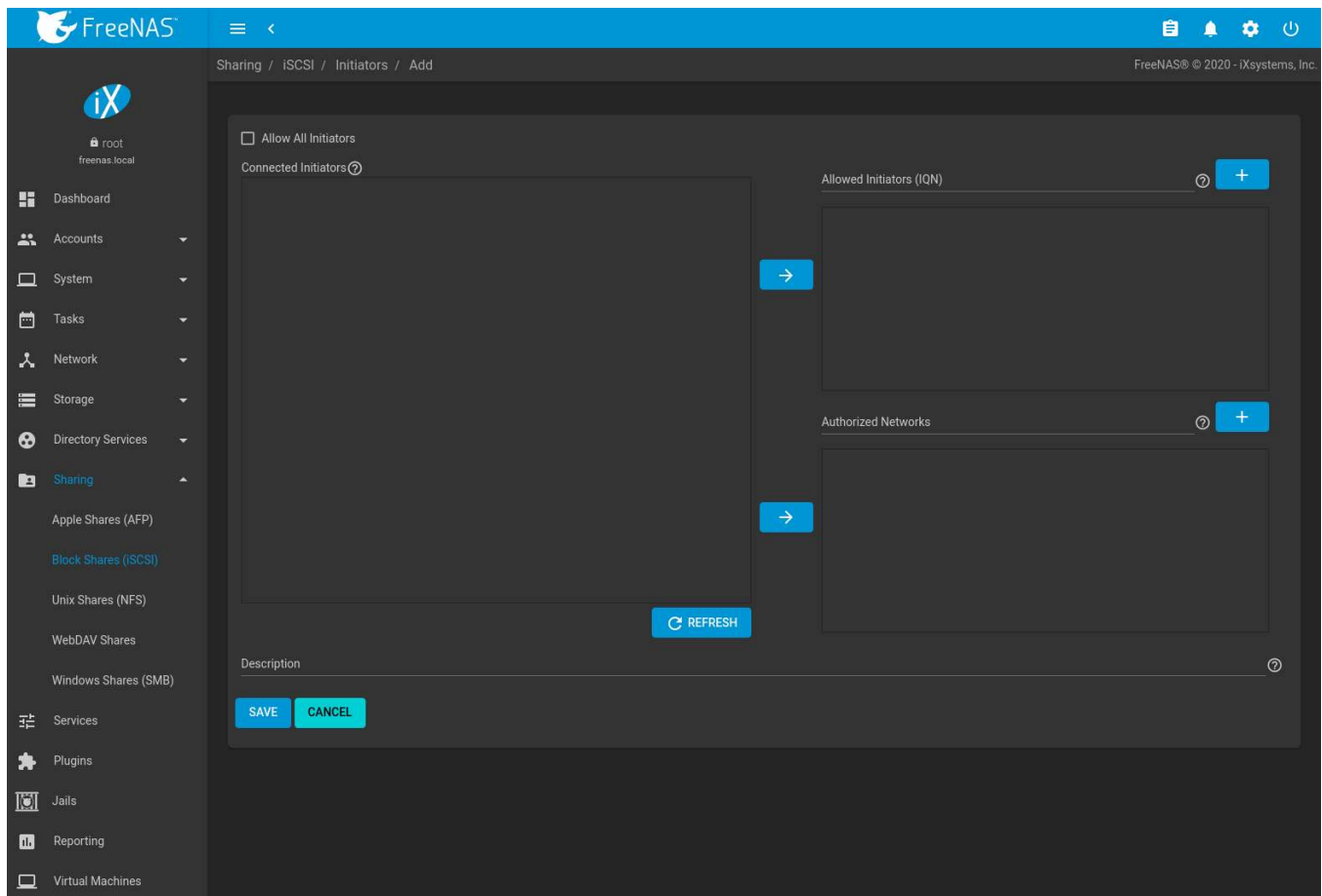




Fig. 12.7: Adding an iSCSI Initiator

Table 12.4 summarizes the settings that can be configured when adding an initiator.

Table 12.4: Initiator Configuration Settings

Setting	Value	Description
Allow All Initiators	checkbox	Accept all detected initiators. When set, all other initiator fields are disabled.
Connected Initiators	string	Initiators currently connected to the system. Shown in IQN format with an IP address. Set initiators and click an  to add the initiators to either the <i>Allowed Initiators</i> or <i>Authorized Networks</i> lists. Clicking <i>REFRESH</i> updates the <i>Connected Initiators</i> list.
Allowed Initiators (IQN)	string	Initiators allowed access to this system. Enter an iSCSI Qualified Name (IQN) (https://tools.ietf.org/html/rfc3720#section-3.2.6) and click + to add it to the list. Example: <code>iqn.1994-09.org.freebsd:freenas.local</code>
Authorized Networks	string	Network addresses allowed to use this initiator. Each address can include an optional CIDR (https://en.wikipedia.org/wiki/Classless_Inter-Domain_Routing) netmask. Click + to add the network address to the list. Example: <code>192.168.2.0/24</code>
Description	string	Any notes about initiators.

Click  (Options) on an initiator entry for options to *Edit* or *Delete* it.

12.2.5 Authorized Access

When using CHAP or mutual CHAP to provide authentication, creating authorized access is recommended. Do this by going to *Sharing* → *Block (iSCSI)* → *Authorized Access* and clicking *ADD*. The screen is shown in [Figure 12.8](#).

Note: This screen sets login authentication. This is different from discovery authentication which is set in [Global Configuration](#) (page 153).

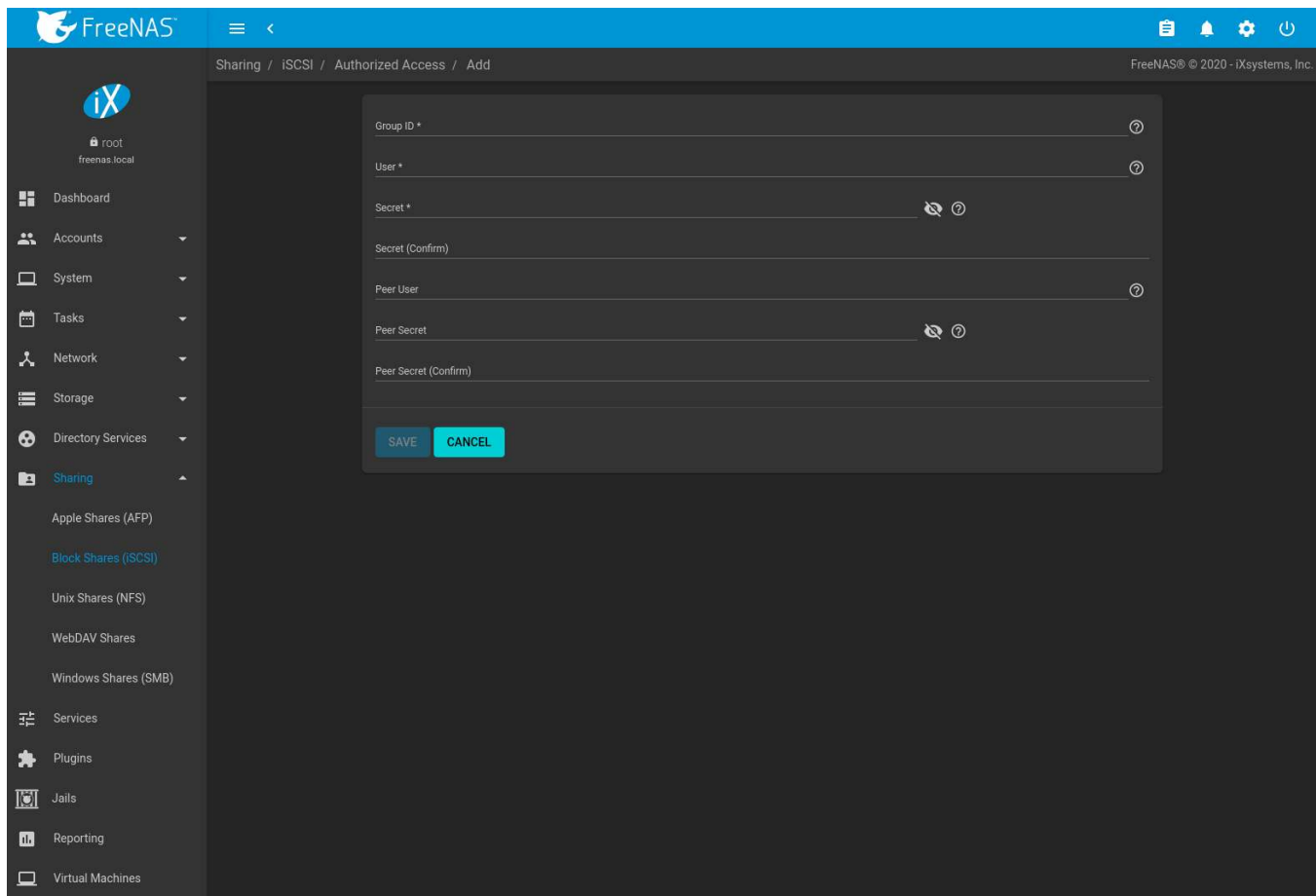


Fig. 12.8: Adding an iSCSI Authorized Access

Table 12.5 summarizes the settings that can be configured when adding an authorized access:

Table 12.5: Authorized Access Configuration Settings

Setting	Value	Description
Group ID	integer	Allow different groups to be configured with different authentication profiles. Example: enter <i>1</i> for all users in Group <i>1</i> to inherit the Group <i>1</i> authentication profile. Group IDs that are already configured with authorized access cannot be reused.
User	string	User account to create for CHAP authentication with the user on the remote system. Many initiators use the initiator name as the user name.
Secret	string	<i>User</i> password. Must be at least <i>12</i> and no more than <i>16</i> characters long.
Peer User	string	Only entered when configuring mutual CHAP. Usually the same value as <i>User</i> .
Peer Secret	string	Mutual secret password. Required when <i>Peer User</i> is set. Must be different than the <i>Secret</i> . Must be at least <i>12</i> and no more than <i>16</i> characters long.

Note: CHAP does not work with GlobalSAN initiators on macOS.

New authorized accesses are visible from the *Sharing* → *Block (iSCSI)* → *Authorized Access* menu. In the example

shown in [Figure 12.9](#), three users (*test1*, *test2*, and *test3*) and two groups (1 and 2) have been created, with group 1 consisting of one CHAP user and group 2 consisting of one mutual CHAP user and one CHAP user. Click an authorized access entry to display its *Edit* and *Delete* buttons.

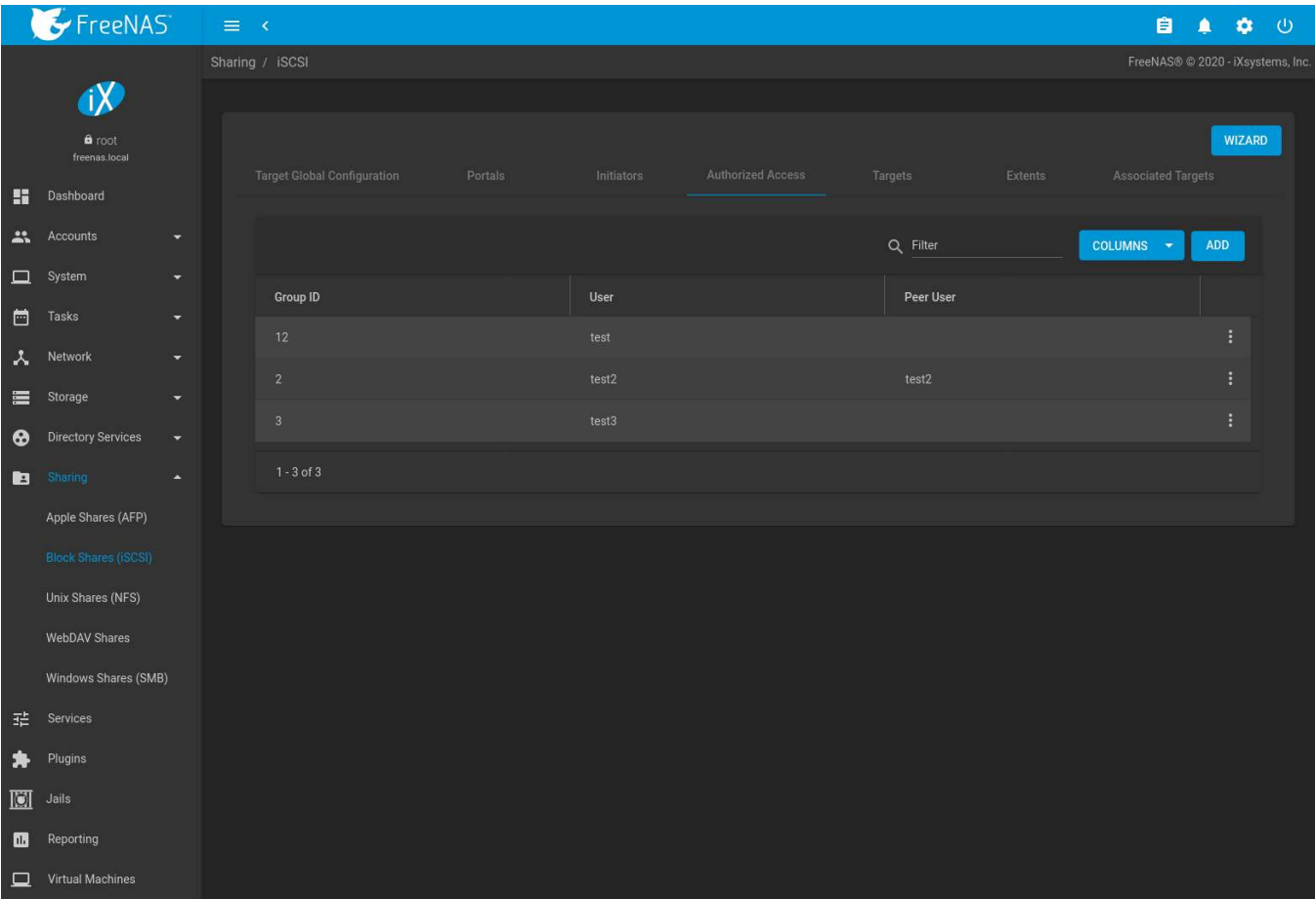


Fig. 12.9: Viewing Authorized Accesses

12.2.6 Targets

Next, create a Target by going to *Sharing* → *Block (iSCSI)* → *Targets* and clicking *ADD* as shown in [Figure 12.10](#). A target combines a portal ID, allowed initiator ID, and an authentication method. [Table 12.6](#) summarizes the settings that can be configured when creating a Target.

Note: An iSCSI target creates a block device that may be accessible to multiple initiators. A clustered filesystem is required on the block device, such as VMFS used by VMware ESX/ESXi, in order for multiple initiators to mount the block device read/write. If a traditional filesystem such as EXT, XFS, FAT, NTFS, UFS, or ZFS is placed on the block device, care must be taken that only one initiator at a time has read/write access or the result will be filesystem corruption. If multiple clients need access to the same data on a non-clustered filesystem, use SMB or NFS instead of iSCSI, or create multiple iSCSI targets (one per client).

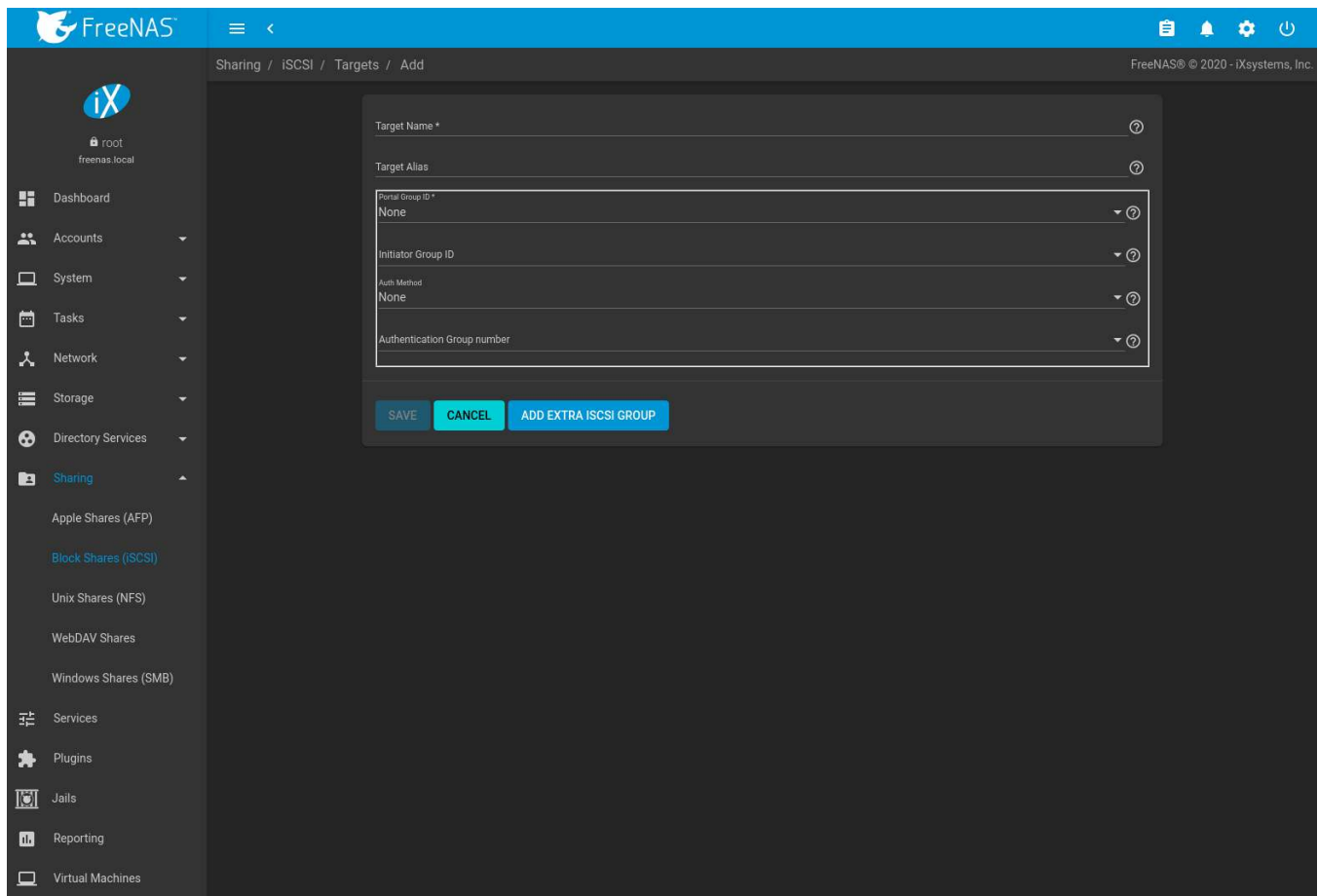


Fig. 12.10: Adding an iSCSI Target

Table 12.6: Target Settings

Setting	Value	Description
Target Name	string	Required. The base name is automatically prepended if the target name does not start with <i>iqn</i> . Lowercase alphanumeric characters plus dot (.), dash (-), and colon (:) are allowed. See the “Constructing iSCSI names using the iqn. format” section of RFC 3721 (https://tools.ietf.org/html/rfc3721.html).
Target Alias	string	Enter an optional user-friendly name.
Portal Group ID	drop-down menu	Leave empty or select number of existing portal to use.
Initiator Group ID	drop-down menu	Select which existing initiator group has access to the target.
Auth Method	drop-down menu	<i>None</i> , <i>Auto</i> , <i>CHAP</i> , or <i>Mutual CHAP</i> .
Authentication Group number	drop-down menu	Select <i>None</i> or an integer. This number represents the number of existing authorized accesses.

12.2.7 Extents

iSCSI targets provide virtual access to resources on the FreeNAS® system. *Extents* are used to define resources to share with clients. There are two types of extents: *device* and *file*.

Device extents provide virtual storage access to zvols, zvol snapshots, or physical devices like a disk, an SSD, or a hardware RAID volume.

File extents provide virtual storage access to an individual file.

Tip: For typical use as storage for virtual machines where the virtualization software is the iSCSI initiator, device extents with zvols provide the best performance and most features. For other applications, device extents sharing a raw device can be appropriate. File extents do not have the performance or features of device extents, but do allow creating multiple extents on a single filesystem.

Virtualized zvols support all the FreeNAS® [VAAI](#) (page 371) primitives and are recommended for use with virtualization software as the iSCSI initiator.

The ATS, WRITE SAME, XCOPY and STUN, primitives are supported by both file and device extents. The UNMAP primitive is supported by zvols and raw SSDs. The threshold warnings primitive is fully supported by zvols and partially supported by file extents.

Virtualizing a raw device like a single disk or hardware RAID volume limits performance to the abilities of the device. Because this bypasses ZFS, such devices do not benefit from ZFS caching or provide features like block checksums or snapshots.

Virtualizing a zvol adds the benefits of ZFS, such as read and write cache. Even if the client formats a device extent with a different filesystem, the data still resides on a ZFS pool and benefits from ZFS features like block checksums and snapshots.

Warning: For performance reasons and to avoid excessive fragmentation, keep the used space of the pool below 80% when using iSCSI. The capacity of an existing extent can be increased as shown in [Growing LUNs](#) (page 228).

To add an extent, go to *Sharing* → *Block (iSCSI)* → *Extents* and click *ADD*. In the example shown in [Figure 12.11](#), the device extent is using the `export` zvol that was previously created from the `/mnt/pool11` pool.

[Table 12.7](#) summarizes the settings that can be configured when creating an extent. Note that **file extent creation fails unless the name of the file to be created is appended to the pool or dataset name.**

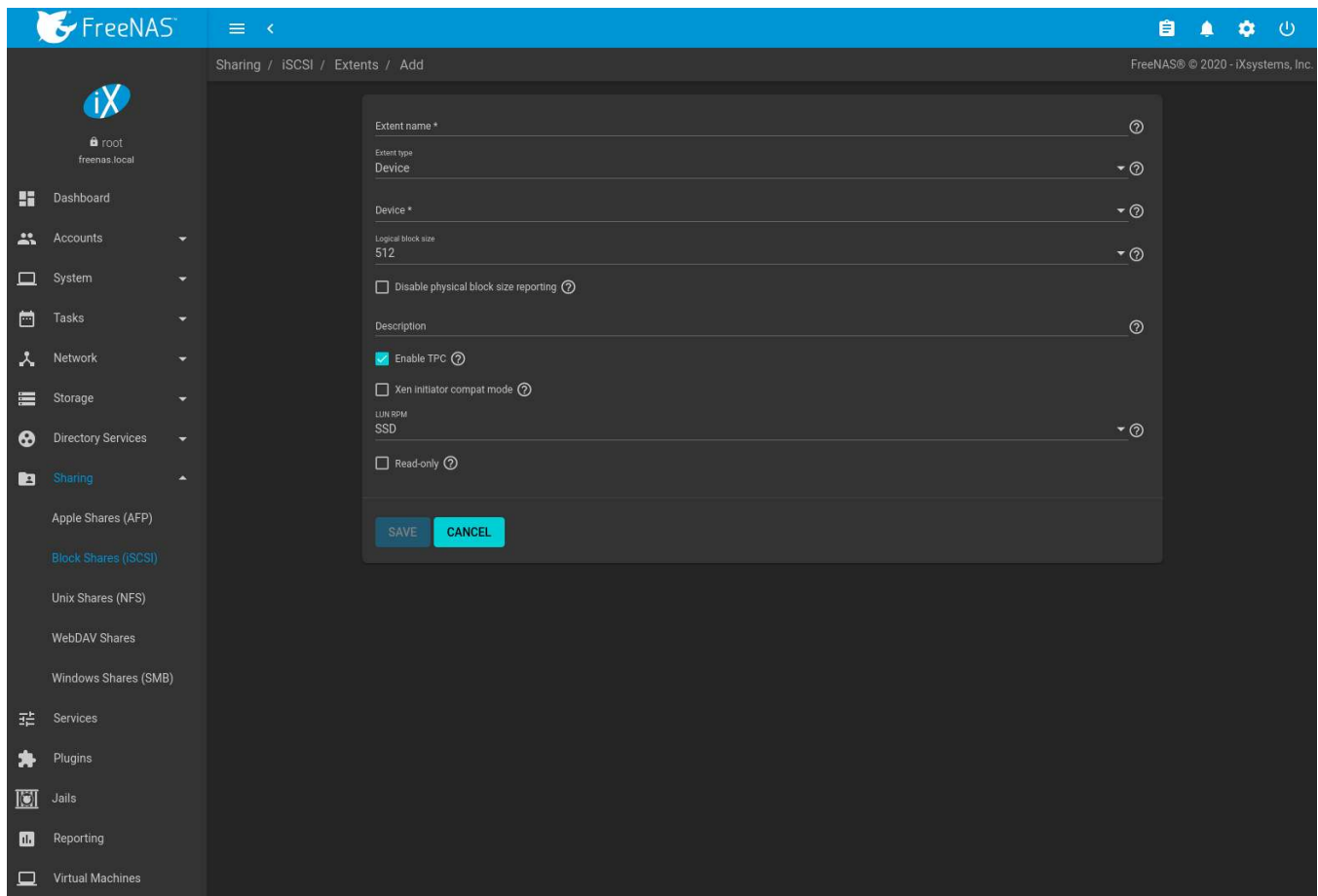


Fig. 12.11: Adding an iSCSI Extent

Table 12.7: Extent Configuration Settings

Setting	Value	Description
Extent name	string	Enter the extent name. If the <i>Extent size</i> is not 0, it cannot be an existing file within the pool or dataset.
Extent type	drop-down menu	<i>File</i> shares the contents of an individual file. <i>Device</i> shares an entire device.
Path to the extent	browse button	Only appears when <i>File</i> is selected. Browse to an existing file. Create a new file by browsing to a dataset and appending the file name to the path. Extents cannot be created inside a jail root directory.
Extent size	integer	Only appears when <i>File</i> is selected. Entering 0 uses the actual file size and requires that the file already exists. Otherwise, specify the file size for the new file.
Device	drop-down menu	Only appears when <i>Device</i> is selected. Select the unformatted disk, controller, zvol, or zvol snapshot.
Logical block size	drop-down menu	Leave at the default of 512 unless the initiator requires a different block size.

Continued on next page

Table 12.7 – continued from previous page

Setting	Value	Description
Disable physical block size reporting	checkbox	Set if the initiator does not support physical block size values over 4K (MS SQL). Setting can also prevent constant block size warnings (https://www.virtten.net/2016/12/the-physical-block-size-reported-by-the-device-is-not-supported/) when using this share with ESXi.
Available space threshold	string	Only appears if <i>File</i> or a zvol is selected. When the specified percentage of free space is reached, the system issues an alert. See VAAI (page 371) Threshold Warning.
Description	string	Notes about this extent.
Enable TPC	checkbox	Set to allow an initiator to bypass normal access control and access any scannable target. This allows xcopy (https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/cc771254(v=ws.11)) operations which are otherwise blocked by access control.
Xen initiator compat mode	checkbox	Set when using Xen as the iSCSI initiator.
LUN RPM	drop-down menu	Do NOT change this setting when using Windows as the initiator. Only needs to be changed in large environments where the number of systems using a specific RPM is needed for accurate reporting statistics.
Read-only	checkbox	Set to prevent the initiator from initializing this LUN.

New extents have been added to *Sharing* → *Block (iSCSI)* → *Extents*. The associated *Serial* and Network Address Authority (NAA) are shown along with the extent name.

12.2.8 Associated Targets

The last step is associating an extent to a target by going to *Sharing* → *Block (iSCSI)* → *Associated Targets* and clicking *ADD*. The screen is shown in [Figure 12.12](#). Use the drop-down menus to select the existing target and extent. Click *SAVE* to add an entry for the LUN.

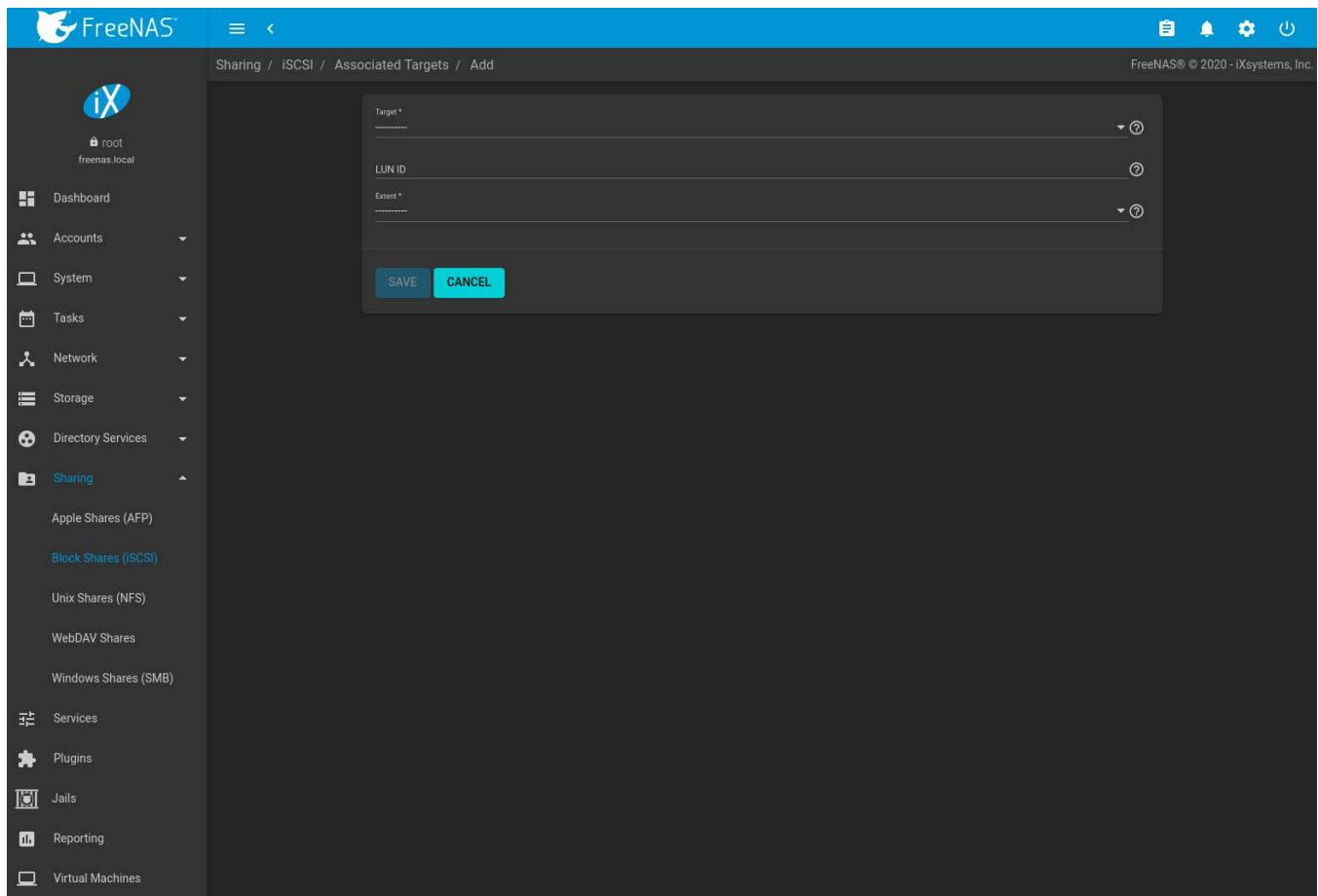


Fig. 12.12: Associating a Target With an Extent

Table 12.8 summarizes the settings that can be configured when associating targets and extents.

Table 12.8: Associated Target Configuration Settings

Setting	Value	Description
Target	drop-down menu	Select an existing target.
LUN ID	integer	Select or enter a value between 0 and 1023. Some initiators expect a value less than 256. Leave this field blank to automatically assign the next available ID.
Extent	drop-down menu	Select an existing extent.

Always associating extents to targets in a one-to-one manner is recommended, even though the web interface will allow multiple extents to be associated with the same target.

Note: Each LUN entry has *Edit* and *Delete* buttons for modifying the settings or deleting the LUN entirely. A verification popup appears when the *Delete* button is clicked. If an initiator has an active connection to the LUN, it is indicated in red text. Clearing the initiator connections to a LUN before deleting it is recommended.

After iSCSI has been configured, remember to start the service in *Services* → *iSCSI* by clicking the ⏻ (Power) button.

12.2.9 Connecting to iSCSI

To access the iSCSI target, clients must use iSCSI initiator software.

An iSCSI Initiator client is pre-installed with Windows 7. A detailed how-to for this client can be found [here](http://techgenix.com/Connecting-Windows-7-iSCSI-SAN/) (<http://techgenix.com/Connecting-Windows-7-iSCSI-SAN/>). A client for Windows 2000, XP, and 2003 can be found [here](http://www.microsoft.com/en-us/download/details.aspx?id=18986) (<http://www.microsoft.com/en-us/download/details.aspx?id=18986>). This [How-to](https://www.pluralsight.com/blog/software-development/freenas-8-iscsi-target-windows-7) (<https://www.pluralsight.com/blog/software-development/freenas-8-iscsi-target-windows-7>) shows how to create an iSCSI target for a Windows 7 system.

macOS does not include an initiator. [globalSAN](http://www.studionetworksolutions.com/globalsan-iscsi-initiator/) (<http://www.studionetworksolutions.com/globalsan-iscsi-initiator/>) is a commercial, easy-to-use Mac initiator.

BSD systems provide command line initiators: `iscontrol(8)` (<https://www.freebsd.org/cgi/man.cgi?query=iscontrol>) comes with FreeBSD versions 9.x and lower, `iscsictl(8)` (<https://www.freebsd.org/cgi/man.cgi?query=iscsictl>) comes with FreeBSD versions 10.0 and higher, `iscsi-initiator(8)` (<http://netbsd.gw.com/cgi-bin/man-cgi?iscsi-initiator++NetBSD-current>) comes with NetBSD, and `iscsid(8)` (<http://man.openbsd.org/cgi-bin/man.cgi/OpenBSD-current/man8/iscsid.8?query=iscsid>) comes with OpenBSD.

Some Linux distros provide the command line utility `iscsiadm` from [Open-iSCSI](http://www.open-iscsi.com/) (<http://www.open-iscsi.com/>). Use a web search to see if a package exists for the distribution should the command not exist on the Linux system.

If a LUN is added while `iscsiadm` is already connected, it will not see the new LUN until rescanned with `iscsiadm -m node -R`. Alternately, use `iscsiadm -m discovery -t st -p portal_IP` to find the new LUN and `iscsiadm -m node -T LUN_Name -l` to log into the LUN.

Instructions for connecting from a VMware ESXi Server can be found at [How to configure FreeNAS 8 for iSCSI and connect to ESXi\(i\)](https://www.vladan.fr/how-to-configure-freenas-8-for-iscsi-and-connect-to-esxi/) (<https://www.vladan.fr/how-to-configure-freenas-8-for-iscsi-and-connect-to-esxi/>). Note that the requirements for booting vSphere 4.x off iSCSI differ between ESX and ESXi. ESX requires a hardware iSCSI adapter while ESXi requires specific iSCSI boot firmware support. The magic is on the booting host side, meaning that there is no difference to the FreeNAS® configuration. See the [iSCSI SAN Configuration Guide](https://www.vmware.com/pdf/vsphere4/r41/vsp_41_iscsi_san_cfg.pdf) (https://www.vmware.com/pdf/vsphere4/r41/vsp_41_iscsi_san_cfg.pdf) for details.

The VMware firewall only allows iSCSI connections on port 3260 by default. If a different port has been selected, outgoing connections to that port must be manually added to the firewall before those connections will work.

If the target can be seen but does not connect, check the *Discovery Auth* settings in *Target Global Configuration*.


If the LUN is not discovered by ESXi, make sure that promiscuous mode is set to *Accept* in the vSwitch.

12.2.10 Growing LUNs

The method used to grow the size of an existing iSCSI LUN depends on whether the LUN is backed by a file extent or a zvol. Both methods are described in this section.

Enlarging a LUN with one of the methods below gives it more unallocated space, but does not automatically re-size filesystems or other data on the LUN. This is the same as binary-copying a smaller disk onto a larger one. More space is available on the new disk, but the partitions and filesystems on it must be expanded to use this new space. Resizing virtual disk images is usually done from virtual machine management software. Application software to resize filesystems is dependent on the type of filesystem and client, but is often run from within the virtual machine. For instance, consider a Windows VM with the last partition on the disk holding an NTFS filesystem. The LUN is expanded and the partition table edited to add the new space to the last partition. The Windows disk manager must still be used to resize the NTFS filesystem on that last partition to use the new space.

12.2.10.1 Zvol Based LUN

To grow a zvol-based LUN, go to *Storage* → *Pools*, click  (Options) on the zvol to be grown, then click *Edit zvol*. In the example shown in [Figure 12.13](#), the current size of the zvol named *zvol1* is 4 GiB.

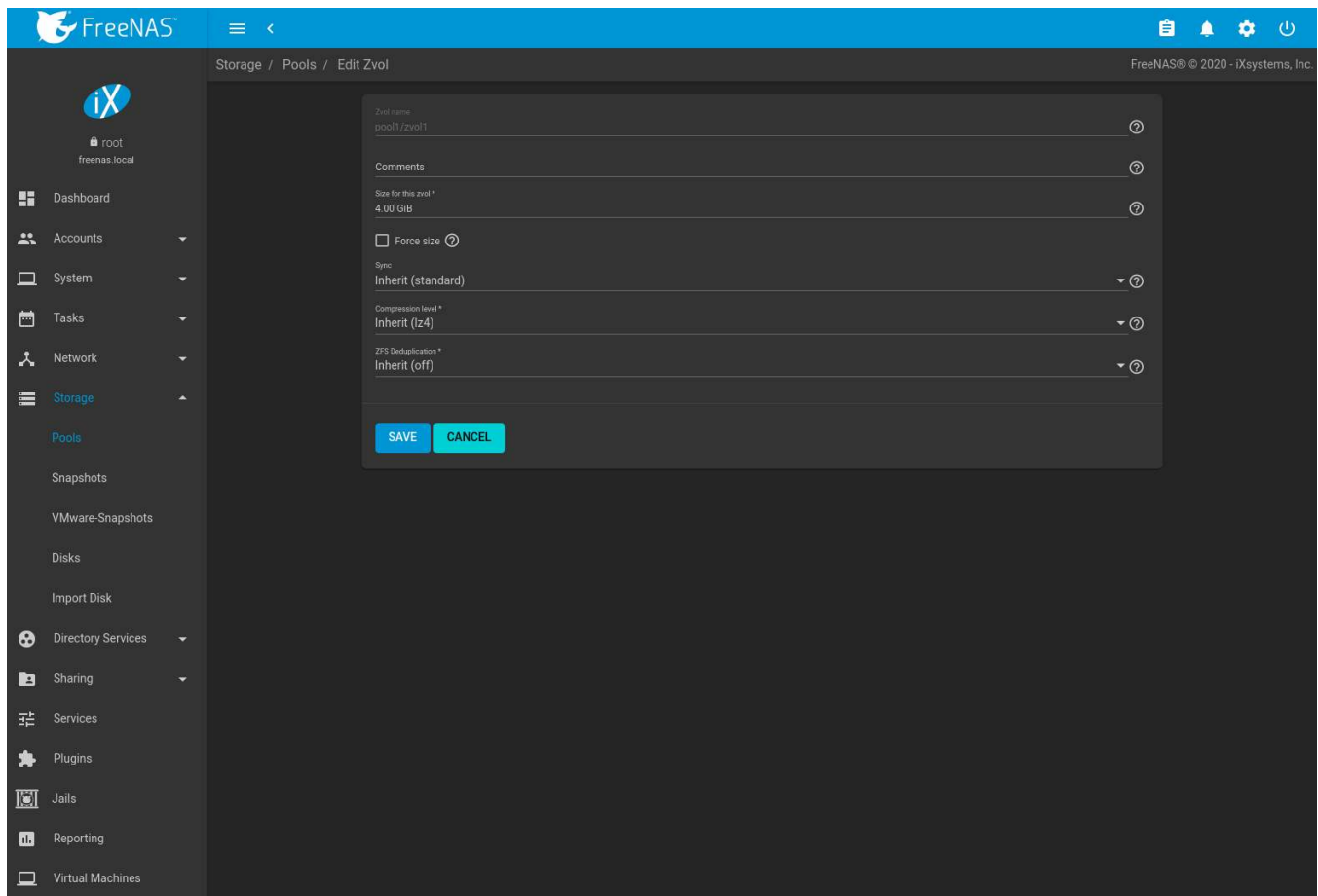


Fig. 12.13: Editing an Existing Zvol

Enter the new size for the zvol in the *Size for this zvol* field and click **SAVE**. The new size for the zvol is immediately shown in the *Used* column of the *Storage* → *Pools* table.

Note: The web interface does not allow reducing the size of the zvol, as doing so could result in loss of data. It also does not allow increasing the size of the zvol past 80% of the pool size.

12.2.10.2 File Extent Based LUN

To grow a file extent-based LUN:

Go to *Services* → *iSCSI* → *CONFIGURE* → *Extents*. Click **:** (Options), then *Edit*. Ensure the *Extent Type* is set to file and enter the *Path to the extent*. Open the *Shell* (page 335) to grow the file extent. This example grows `/mnt/pool1/data` by 2 GiB:

```
truncate -s +2g /mnt/pool1/data
```

Return to *Services* → *iSCSI* → *CONFIGURE* → *Extents*, click **:** (Options) on the desired file extent, then click *Edit*. Set the size to 0 as this causes the iSCSI target to use the new size of the file.

12.3 Unix (NFS) Shares

FreeNAS® supports sharing pools, datasets, and directories over the Network File System (NFS). Clients use the `mount` command to mount the share. Mounted NFS shares appear as another directory on the client system. Some Linux distros require the installation of additional software to mount an NFS share. Windows systems must enable Services for NFS in the Ultimate or Enterprise editions or install an NFS client application.

Note: For performance reasons, iSCSI is preferred to NFS shares when FreeNAS® is installed on ESXi. When considering creating NFS shares on ESXi, read through the performance analysis presented in [Running ZFS over NFS as a VMware Store](https://tinyurl.com/archive-zfs-over-nfs-vmware) (<https://tinyurl.com/archive-zfs-over-nfs-vmware>).

Create an NFS share by going to *Sharing* → *Unix (NFS) Shares* and clicking *ADD*. Figure 12.14 shows an example of creating an NFS share.

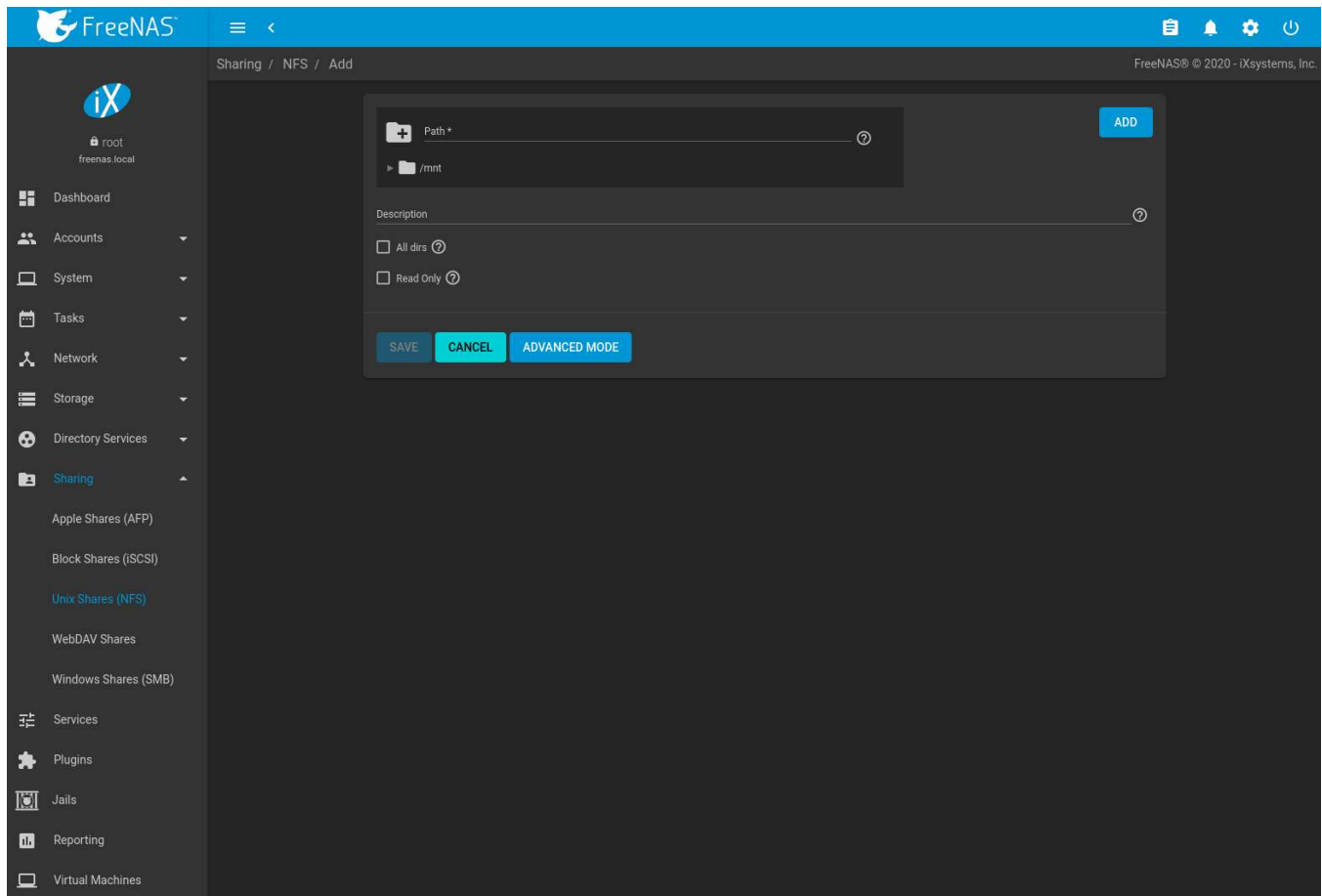


Fig. 12.14: NFS Share Creation

Remember these points when creating NFS shares:

1. Clients specify the *Path* when mounting the share.
2. The *Maproot* and *Mapall* options cannot both be enabled. The *Mapall* options supersede the *Maproot* options. To restrict only the *root* user permissions, set the *Maproot* option. To restrict permissions of all users, set the *Mapall* options.
3. Each pool or dataset is considered to be a unique filesystem. Individual NFS shares cannot cross filesystem boundaries. Adding paths to share more directories only works if those directories are within the same filesystem.

4. The network and host must be unique to both each created share and the filesystem or directory included in that share. Because `/etc/exports` is not an access control list (ACL), the rules contained in `/etc/exports` become undefined with overlapping networks or when using the same share with multiple hosts.
5. The *All dirs* option can only be used once per share per filesystem.

To better understand these restrictions, consider scenarios where there are:

- two networks, `10.0.0.0/8` and `20.0.0.0/8`
- a ZFS pool named `pool1` with a dataset named `dataset1`
- `dataset1` contains directories named `directory1`, `directory2`, and `directory3`

Because of restriction #3, an error is shown when trying to create one NFS share like this:

- *Authorized Networks* set to `10.0.0.0/8 20.0.0.0/8`
- *Path* set to the dataset `/mnt/pool1/dataset1`. An additional path to directory `/mnt/pool1/dataset1/directory1` is added.

The correct method to configure this share is to set the *Path* to `/mnt/pool1/dataset1` and set the *All dirs* box. This allows the client to also mount `/mnt/pool1/dataset1/directory1` when `/mnt/pool1/dataset1` is mounted.

Additional paths are used to define specific directories to be shared. For example, `dataset1` has three directories. To share only `/mnt/pool1/dataset1/directory1` and `/mnt/pool1/dataset1/directory2`, create paths for `directory1` and `directory2` within the share. This excludes `directory3` from the share.

Restricting a specific directory to a single network is done by creating a share for the volume or dataset and a share for the directory within that volume or dataset. Define the authorized networks for both shares.

First NFS share:

- *Authorized Networks* set to `10.0.0.0/8`
- *Path* set to `/mnt/pool1/dataset1`

Second NFS share:

- *Authorized Networks* set to `20.0.0.0/8`
- *Path* set to `/mnt/pool1/dataset1/directory1`

This requires the creation of two shares. It cannot be done with only one share.

Table 12.9 summarizes the available configuration options in the *Sharing/NFS/Add* screen. Click *ADVANCED MODE* to see all settings.


Table 12.9: NFS Share Options

Setting	Value	Advanced Mode	Description
Path	browse button		Browse to the dataset or directory to be shared. Click <i>ADD</i> to specify multiple paths.
Comment	string		Text describing the share. Typically used to name the share. If left empty, this shows the <i>Path</i> entries of the share.
All dirs	checkbox		Allow the client to also mount any subdirectories of the selected pool or dataset.
Read only	checkbox		Prohibit writing to the share.
Quiet	checkbox	✓	Restrict some syslog diagnostics to avoid some error messages. See exports(5) (https://www.freebsd.org/cgi/man.cgi?query=exports) for examples.

Continued on next page

Table 12.9 – continued from previous page

Setting	Value	Advanced Mode	Description
Authorized networks	string	✓	Space-delimited list of allowed networks in network/mask CIDR notation. Example: <i>1.2.3.0/24</i> . Leave empty to allow all.
Authorized Hosts and IP addresses	string	✓	Space-delimited list of allowed IP addresses or hostnames. Leave empty to allow all.
Maproot User	drop-down menu	✓	When a user is selected, the <i>root</i> user is limited to permissions of that user.
Maproot Group	drop-down menu	✓	When a group is selected, the <i>root</i> user is also limited to permissions of that group.
Mapall User	drop-down menu	✓	FreeNAS® user or user imported with Active Directory (page 198). The specified permissions of that user are used by all clients.
Mapall Group	drop-down menu	✓	FreeNAS® group or group imported with Active Directory (page 198). The specified permissions of that group are used by all clients.
Security	selection	✓	Only appears if <i>Enable NFSv4</i> is enabled in <i>Services</i> → <i>NFS</i> . Choices are <i>sys</i> or these Kerberos options: <i>krb5</i> (authentication only), <i>krb5i</i> (authentication and integrity), or <i>krb5p</i> (authentication and privacy). If multiple security mechanisms are added to the <i>Selected</i> column using the arrows, use the <i>Up</i> or <i>Down</i> buttons to list in order of preference.

Go to *Sharing* → *Unix (NFS)* and click  (Options) and *Edit* to edit an existing share. [Figure 12.15](#) shows the configuration screen for the existing *nfs_share1* share. Options are the same as described in [NFS Share Options](#) (page 231).

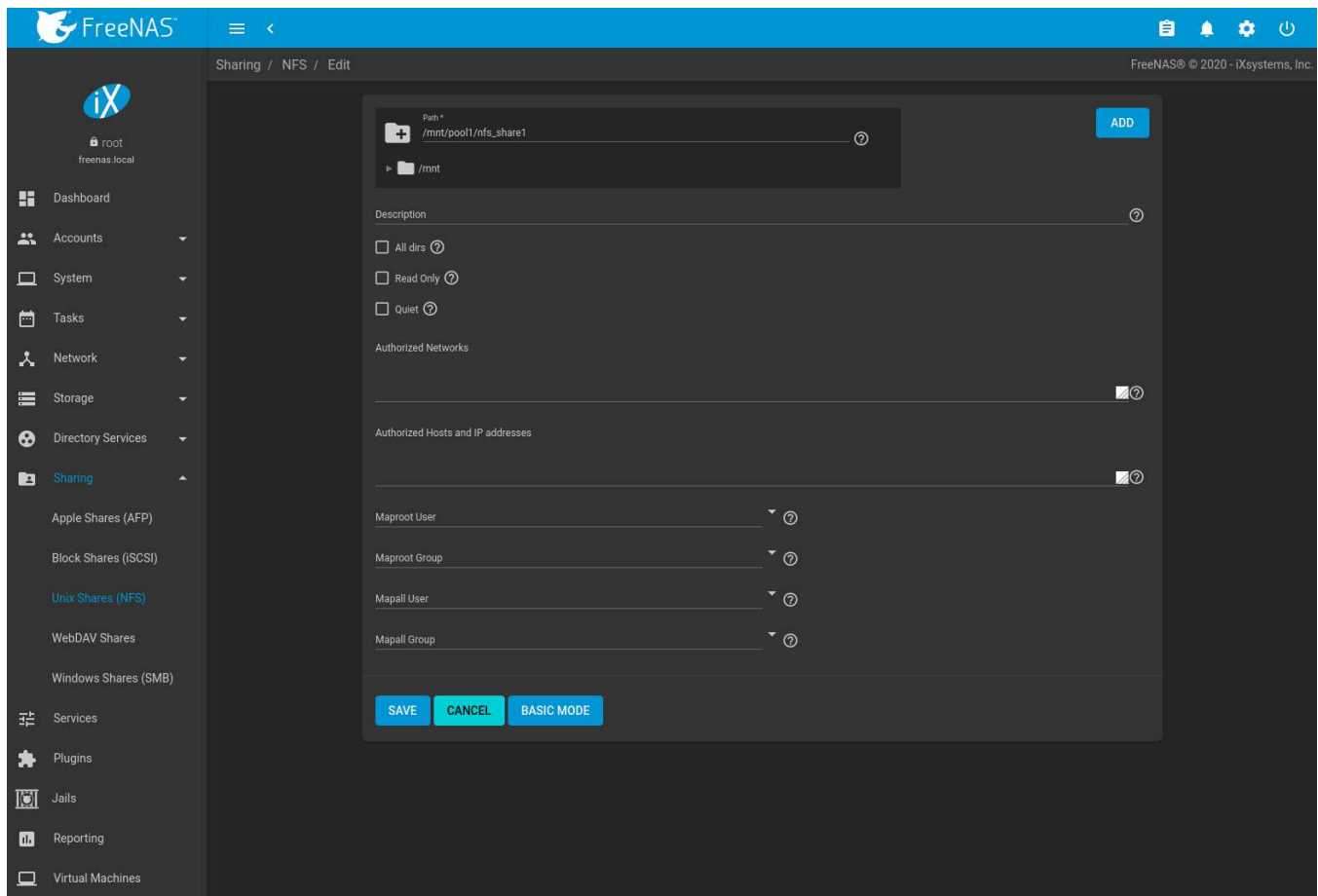


Fig. 12.15: NFS Share Settings

12.3.1 Example Configuration

By default, the *Mapall* fields are not set. This means that when a user connects to the NFS share, the user has the permissions associated with their user account. This is a security risk if a user is able to connect as *root* as they will have complete access to the share.

A better option is to do this:

1. Specify the built-in *nobody* account to be used for NFS access.
2. In the *Change Permissions* screen of the pool or dataset that is being shared, change the owner and group to *nobody* and set the permissions according to the desired requirements.
3. Select *nobody* in the *Mapall User* and *Mapall Group* drop-down menus for the share in *Sharing* → *Unix (NFS) Shares*.

With this configuration, it does not matter which user account connects to the NFS share, as it will be mapped to the *nobody* user account and will only have the permissions that were specified on the pool or dataset. For example, even if the *root* user is able to connect, it will not gain *root* access to the share.

12.3.2 Connecting to the Share

The following examples share this configuration:

1. The FreeNAS® system is at IP address *192.168.2.2*.
2. A dataset named `/mnt/pool1/nfs_share1` is created and the permissions set to the *nobody* user account and the *nobody* group.

3. An NFS share is created with these attributes:

- *Path:* `/mnt/pool1/nfs_share1`
- *Authorized Networks:* `192.168.2.0/24`
- *All dirs* option is enabled
- *MapAll User* is set to *nobody*
- *MapAll Group* is set to *nobody*

12.3.2.1 From BSD or Linux

NFS shares are mounted on BSD or Linux clients with this command executed as the superuser (*root*) or with `sudo`:

```
mount -t nfs 192.168.2.2:/mnt/pool1/nfs_share1 /mnt
```

- **-t nfs** specifies the filesystem type of the share
- **192.168.2.2** is the IP address of the FreeNAS® system
- **/mnt/pool/nfs_share1** is the name of the directory to be shared, a dataset in this case
- **/mnt** is the mountpoint on the client system. This must be an existing, *empty* directory. The data in the NFS share appears in this directory on the client computer.

Successfully mounting the share returns to the command prompt without any status or error messages.

Note: If this command fails on a Linux system, make sure that the [nfs-utils](https://sourceforge.net/projects/nfs/files/nfs-utils/) (<https://sourceforge.net/projects/nfs/files/nfs-utils/>) package is installed.

This configuration allows users on the client system to copy files to and from `/mnt` (the mount point). All files are owned by *nobody:nobody*. Changes to any files or directories in `/mnt` write to the FreeNAS® system `/mnt/pool1/nfs_share1` dataset.

NFS share settings cannot be changed when the share is mounted on a client computer. The `umount` command is used to unmount the share on BSD and Linux clients. Run it as the superuser or with `sudo` on each client computer:

```
umount /mnt
```

12.3.2.2 From Microsoft

Windows NFS client support varies with versions and releases. For best results, use [Windows \(SMB\) Shares](#) (page 239).

12.3.2.3 From macOS

A macOS client uses Finder to mount the NFS volume. Go to *Go → Connect to Server*. In the *Server Address* field, enter *nfs://* followed by the IP address of the FreeNAS® system, and the name of the pool or dataset being shared by NFS. The example shown in [Figure 12.16](#) continues with the example of `192.168.2.2:/mnt/pool1/nfs_share1`.

Finder opens automatically after connecting. The IP address of the FreeNAS® system displays in the SHARED section of the left frame and the contents of the share display in the right frame. [Figure 12.17](#) shows an example where `/mnt/data` has one folder named `images`. The user can now copy files to and from the share.

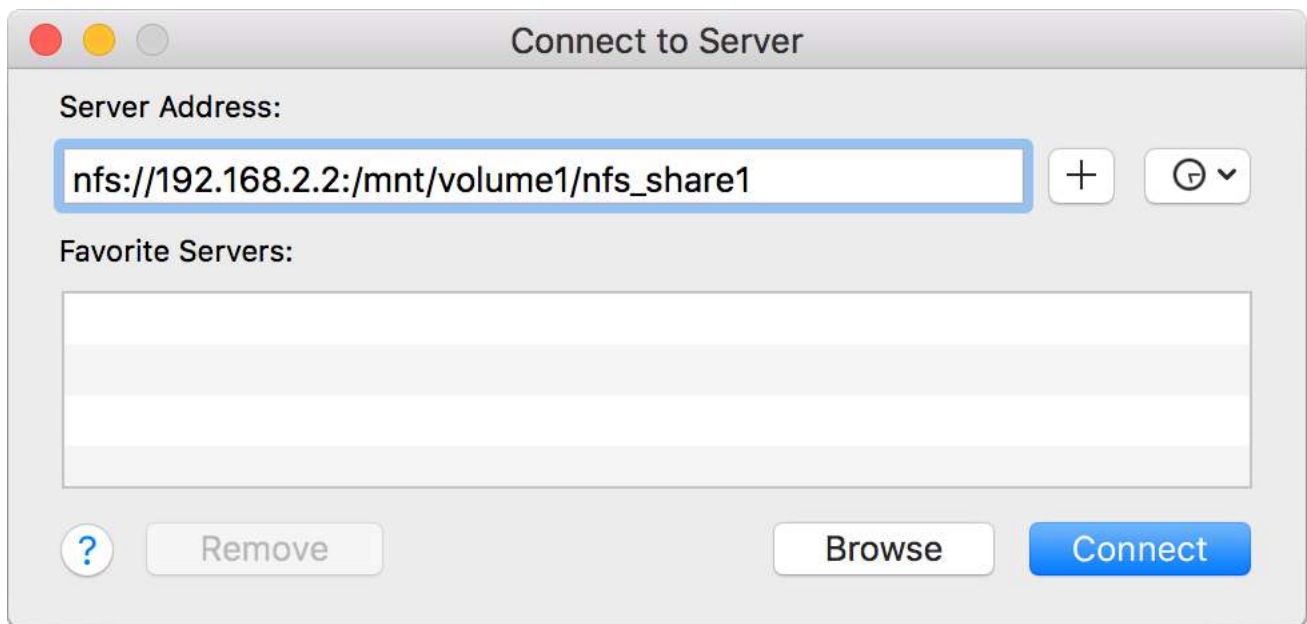


Fig. 12.16: Mounting the NFS Share from macOS

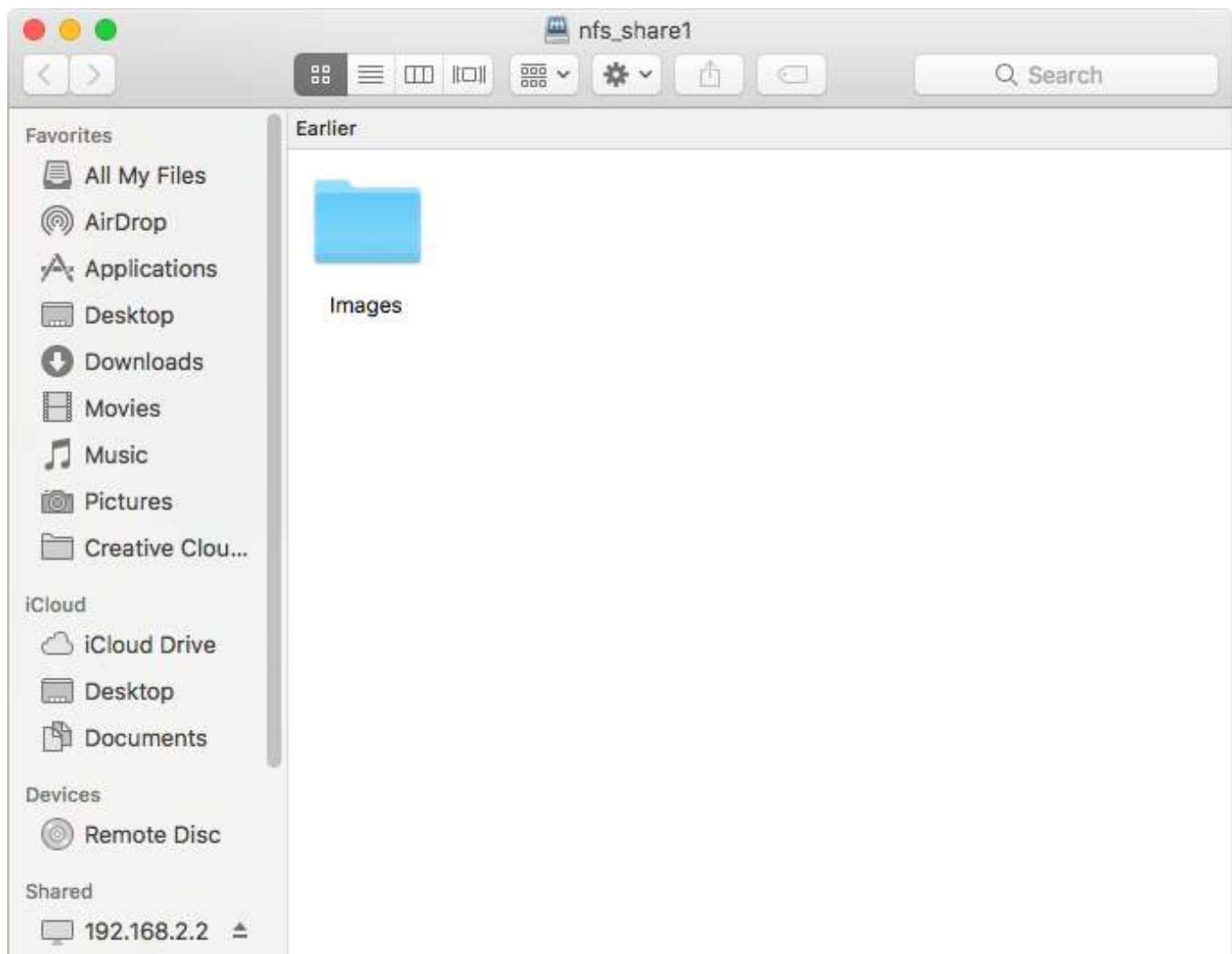


Fig. 12.17: Viewing the NFS Share in Finder

12.3.3 Troubleshooting NFS

Some NFS clients do not support the NLM (Network Lock Manager) protocol used by NFS. This is the case if the client receives an error that all or part of the file may be locked when a file transfer is attempted. To resolve this error, add the option `-o nolock` when running the `mount` command on the client to allow write access to the NFS share.

If a “time out giving up” error is shown when trying to mount the share from a Linux system, make sure that the portmapper service is running on the Linux client. If portmapper is running and timeouts are still shown, force the use of TCP by including `-o tcp` in the `mount` command.

If a `RPC: Program not registered` error is shown, upgrade to the latest version of FreeNAS® and restart the NFS service after the upgrade to clear the NFS cache.

If clients see “reverse DNS” errors, add the FreeNAS® IP address in the *Host name database* field of *Network* → *Global Configuration*.

If clients receive timeout errors when trying to mount the share, add the client IP address and hostname to the *Host name database* field in *Network* → *Global Configuration*.

Some older versions of NFS clients default to UDP instead of TCP and do not auto-negotiate for TCP. By default, FreeNAS® uses TCP. To support UDP connections, go to *Services* → *NFS* → *Configure* and enable the *Serve UDP NFS clients* option.

The `nfsstat -c` or `nfsstat -s` commands can be helpful to detect problems from the [Shell](#) (page 335). A high proportion of retries and timeouts compared to reads usually indicates network problems.

12.4 WebDAV Shares

In FreeNAS®, WebDAV shares can be created so that authenticated users can browse the contents of the specified pool, dataset, or directory from a web browser.

Configuring WebDAV shares is a two step process. First, create the WebDAV shares to specify which data can be accessed. Then, configure the WebDAV service by specifying the port, authentication type, and authentication password. Once the configuration is complete, the share can be accessed using a URL in the format:

```
protocol://IP_address:port_number/share_name
```

where:

- **protocol:** is either *http* or *https*, depending upon the *Protocol* configured in *Services* → *WebDAV* → *CONFIGURE*.
- **IP address:** is the IP address or hostname of the FreeNAS® system. Take care when configuring a public IP address to ensure that the network firewall only allows access to authorized systems.
- **port_number:** is configured in *Services* → *WebDAV* → *CONFIGURE*. If the FreeNAS® system is to be accessed using a public IP address, consider changing the default port number and ensure that the network firewall only allows access to authorized systems.
- **share_name:** is configured by clicking *Sharing* → *WebDAV Shares*, then *ADD*.

Entering the URL in a web browser brings up an authentication pop-up message. Enter a username of *webdav* and the password configured in *Services* → *WebDAV* → *CONFIGURE*.

Warning: At this time, only the *webdav* user is supported. For this reason, it is important to set a good password for this account and to only give the password to users which should have access to the WebDAV share.

To create a WebDAV share, go to *Sharing* → *WebDAV Shares* and click *ADD*, which will open the screen shown in [Figure 12.18](#).

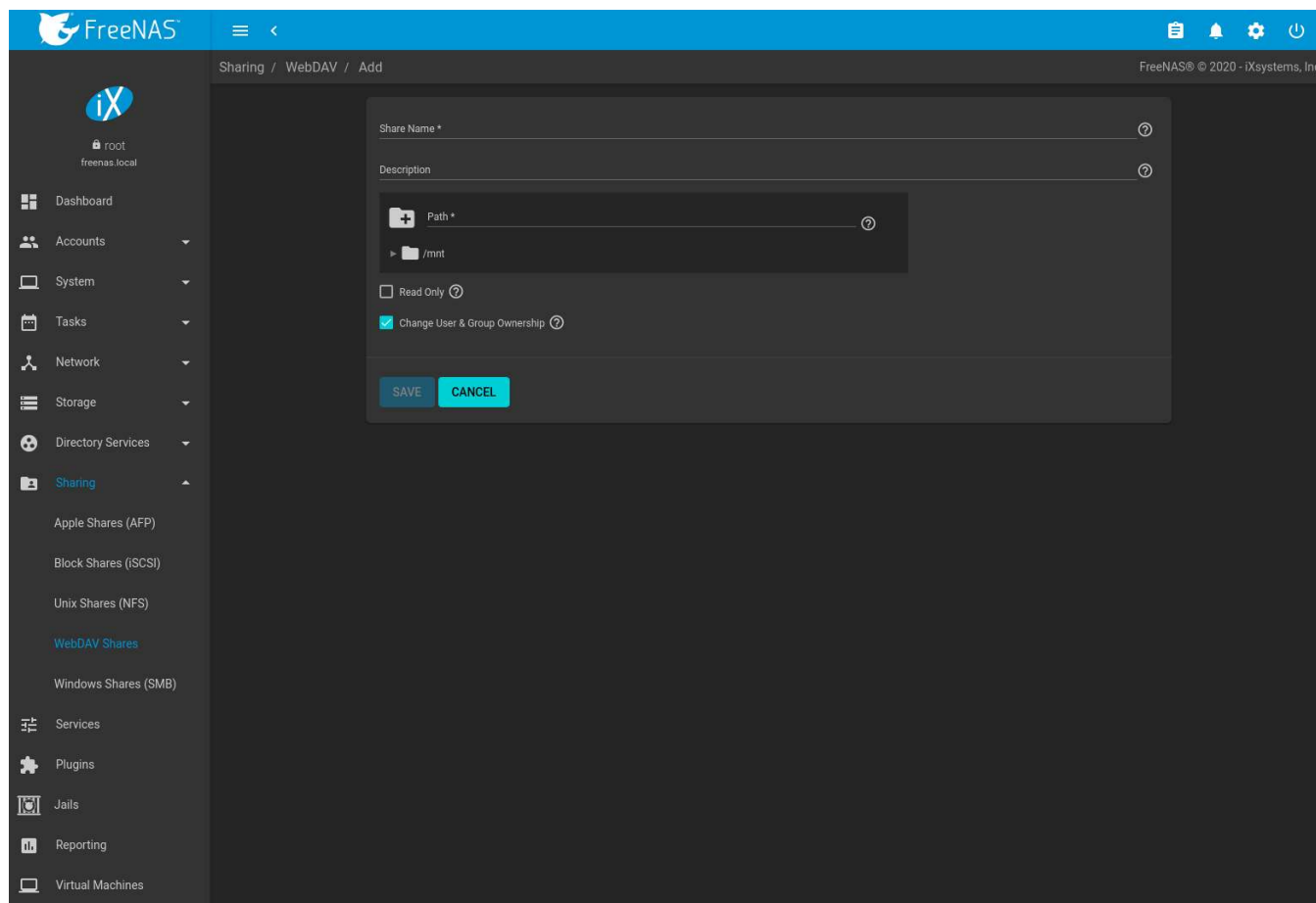



Fig. 12.18: Adding a WebDAV Share

Table 12.10 summarizes the available options.

Table 12.10: WebDAV Share Options

Setting	Value	Description
Share Path Name	string	Enter a name for the share.
Comment	string	Optional.
Path	browse button	Enter the path or <i>Browse</i> to the pool or dataset to share. Appending a new name to the path creates a new dataset. Example: <i>/mnt/pool1/newdataset</i> .
Read Only	checkbox	Set to prohibit users from writing to the share.
Change User & Group	checkbox	Ownership of all files in the share will be changed to user <code>webdav</code> and group <code>webdav</code> . Existing permissions will not be changed, but the ownership change might make files inaccessible to their original owners. This operation cannot be undone! If unset, ownership of files to be accessed through WebDAV must be manually set to the <code>webdav</code> or <code>www</code> user/group.

Click **SAVE** to create the share. Then, go to *Services* → *WebDAV* and click the  (Power) button to turn on the service.

After the service starts, review the settings in *Services* → *WebDAV* → *CONFIGURE* as they are used to determine which URL is used to access the WebDAV share and whether or not authentication is required to access the share. These settings are described in [WebDAV](#) (page 281).

12.5 Windows (SMB) Shares

FreeNAS® uses [Samba](https://www.samba.org/) (<https://www.samba.org/>) to share pools using Microsoft's SMB protocol. SMB is built into the Windows and macOS operating systems and most Linux and BSD systems pre-install the Samba client in order to provide support for SMB. If the distro did not, install the Samba client using the distro software repository.

The SMB protocol supports many different types of configuration scenarios, ranging from the simple to complex. The complexity of the scenario depends upon the types and versions of the client operating systems that will connect to the share, whether the network has a Windows server, and whether Active Directory is being used. Depending on the authentication requirements, it might be necessary to create or import users and groups.

Samba supports server-side copy of files on the same share with clients from Windows 8 and higher. Copying between two different shares is not server-side. Windows 7 clients support server-side copying with [Robo-copy](https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/cc733145(v=ws.11)) ([https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/cc733145\(v=ws.11\)](https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/cc733145(v=ws.11))).

This chapter starts by summarizing the available configuration options. It demonstrates some common configuration scenarios as well as offering some troubleshooting tips. Reading through this entire chapter before creating any SMB shares is recommended to gain a better understanding of the configuration scenario that meets the specific network requirements.

[SMB Tips and Tricks](https://forums.freenas.org/index.php?resources/smb-tips-and-tricks.15/) (<https://forums.freenas.org/index.php?resources/smb-tips-and-tricks.15/>) shows helpful hints for configuring and managing SMB networking. The [FreeNAS and Samba \(CIFS\) permissions](https://www.youtube.com/watch?v=RxggaE935PM) (<https://www.youtube.com/watch?v=RxggaE935PM>) and [Advanced Samba \(CIFS\) permissions on FreeNAS](https://www.youtube.com/watch?v=QhwOyLtArw0) (<https://www.youtube.com/watch?v=QhwOyLtArw0>) videos clarify setting up permissions on SMB shares. Another helpful reference is [Methods For Fine-Tuning Samba Permissions](https://forums.freenas.org/index.php?threads/methods-for-fine-tuning-samba-permissions.50739/) (<https://forums.freenas.org/index.php?threads/methods-for-fine-tuning-samba-permissions.50739/>).

Warning: SMB1 is disabled by default for security (<https://www.ixsystems.com/blog/library/do-not-use-smb1/>). If necessary, SMB1 can be enabled in *Services* → *SMB Configure*.

Figure 12.19 shows the configuration screen that appears after clicking *Sharing* → *Windows (SMB Shares)*, then *ADD*.

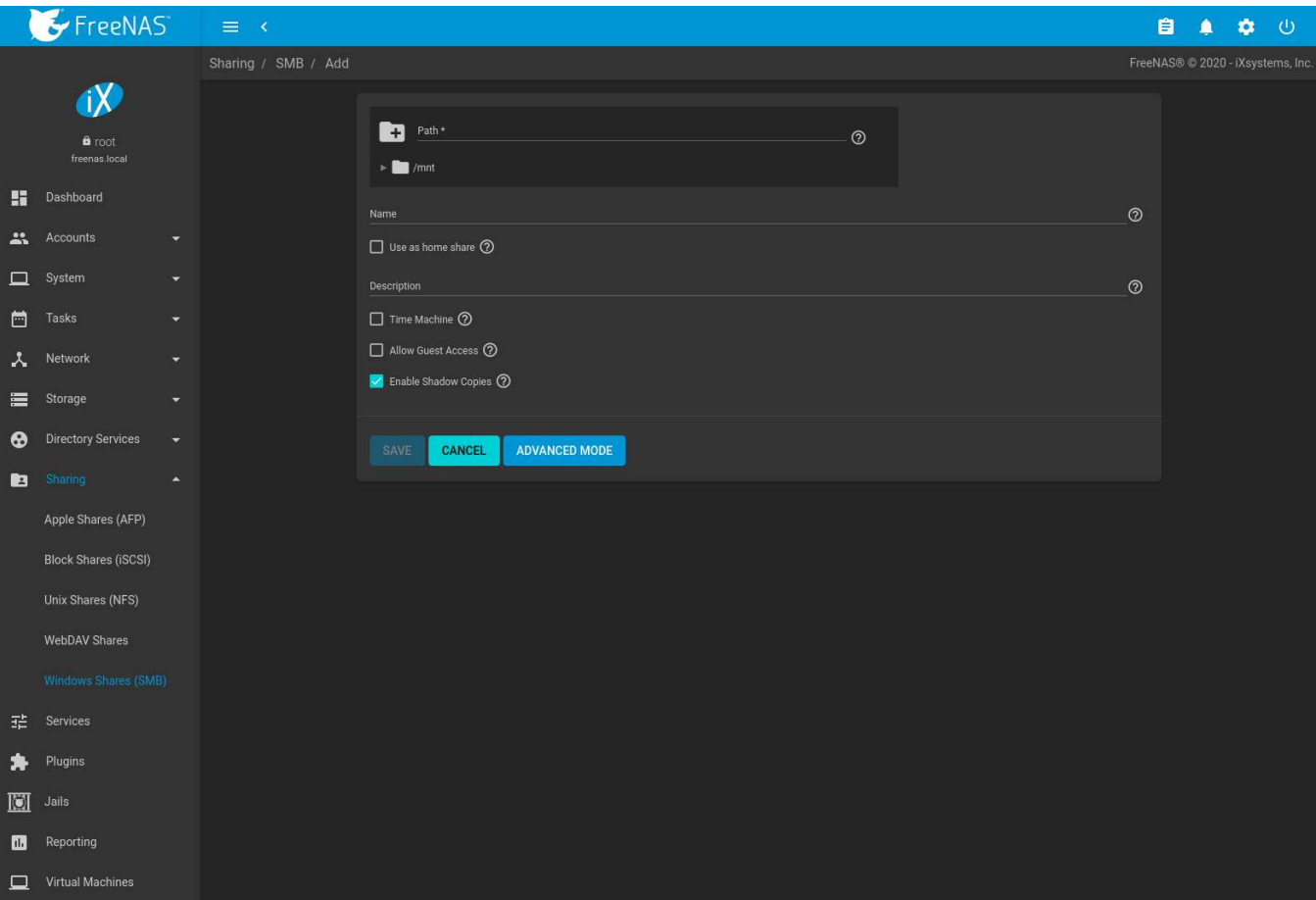


Fig. 12.19: Adding an SMB Share

Table 12.11 summarizes the options available when creating a SMB share. Some settings are only configurable after clicking the *ADVANCED MODE* button. For simple sharing scenarios, *ADVANCED MODE* options are not needed. For more complex sharing scenarios, only change an *ADVANCED MODE* option after fully understanding the function of that option. [smb.conf\(5\)](https://www.freebsd.org/cgi/man.cgi?query=smb.conf) (<https://www.freebsd.org/cgi/man.cgi?query=smb.conf>) provides more details for each configurable option.

Table 12.11: SMB Share Options

Setting	Value	Advanced Mode	Description
Path	browse button		Select the pool, dataset, or directory to share. The same path can be used by more than one share.
Name	string		Name the new share. Each share name must be unique. The names <i>global</i> , <i>homes</i> , and <i>printers</i> are reserved and cannot be used.

Continued on next page

Table 12.11 – continued from previous page


Setting	Value	Advanced Mode	Description
Use as home share	checkbox		Set to allow this share to hold user home directories. Only one share can be the home share. Note that lower case names for user home directories are strongly recommended, as Samba maps usernames to all lower case. For example, the username John will be mapped to a home directory named <code>john</code> . If the <i>Path</i> to the home share includes an upper case username, delete the existing user and recreate it in <i>Accounts</i> → <i>Users</i> with an all lower case <i>Username</i> . Return to <i>Sharing</i> → <i>SMB</i> to create the home share, and select the <i>Path</i> that contains the new lower case username.
Time Machine	checkbox		Enable Time Machine (https://developer.apple.com/library/archive/releasenotes/Networking/CH1-SW1) backups for this share. The process to configure a Time Machine backup is shown in Creating Authenticated and Time Machine Shares (page 248). Changing this setting on an existing share requires an <i>SMB</i> (page 270) service restart.
Export Read Only	checkbox	✓	Prohibit write access to this share.
Browsable to Network Clients	checkbox	✓	Determine whether this share name is included when browsing shares. Home shares are only visible to the owner regardless of this setting.
Export Recycle Bin	checkbox	✓	Files that are deleted from the same dataset are moved to the Recycle Bin and do not take any additional space. When the files are in a different dataset or a child dataset, they are copied to the dataset where the Recycle Bin is located. To prevent excessive space usage, files larger than 20 MiB are deleted rather than moved. Adjust the <i>Auxiliary Parameter</i> <code>crossrename:sizelimit=</code> setting to allow larger files. For example, <code>crossrename:sizelimit=50</code> allows moves of files up to 50 MiB in size.
Show Hidden Files	checkbox	✓	Disable the Windows <i>hidden</i> attribute on a new Unix hidden file. Unix hidden filenames start with a dot: <code>.foo</code> . Existing files are not affected.
Allow Guest Access	checkbox		Privileges are the same as the guest account. Guest access is disabled by default in Windows 10 version 1709 and Windows Server version 1903. Additional client-side configuration is required to provide guest access to these clients. MacOS clients: Attempting to connect as a user that does not exist in FreeNAS® <i>does not</i> automatically connect as the guest account. The <i>Connect As: Guest</i> option must be specifically chosen in MacOS to log in as the guest account. See the Apple documentation (https://support.apple.com/guide/mac-help/connect-mac-shared-computers-servers-mchlp1140/) for more details.
Only Allow Guest Access	checkbox	✓	Requires <i>Allow guest access</i> to also be enabled. Forces guest access for all connections.
Access Based Share Enumeration	checkbox	✓	Restrict share visibility to users with a current Windows Share ACL access of read or write. Use Windows administration tools to adjust the share permissions. See smb.conf(5) (https://www.freebsd.org/cgi/man.cgi?query=smb.conf).


Continued on next page

Table 12.11 – continued from previous page

Setting	Value	Advanced Mode	Description
Hosts Allow	string	✓	Enter a list of allowed hostnames or IP addresses. Separate entries with a comma (,), space, or tab.
Hosts Deny	string	✓	Enter a list of denied hostnames or IP addresses. Specify <code>ALL</code> and list any hosts from <i>Hosts Allow</i> to have those hosts take precedence. Separate entries with a comma (,), space, or tab.
VFS Objects	selection	✓	Add virtual file system objects to enhance functionality. Table 12.12 summarizes the available objects.
Enable Shadow Copies	checkbox	✓	Expose ZFS snapshots as Windows Shadow Copies (https://docs.microsoft.com/en-us/windows/desktop/vss/shadow-copies-and-shadow-copy-sets).
Auxiliary Parameters	string	✓	Additional smb4.conf (https://www.freebsd.org/cgi/man.cgi?query=smb.conf) parameters not covered by other option fields.

Here are some notes about *ADVANCED MODE* settings:

- Hostname lookups add some time to accessing the SMB share. If only using IP addresses, unset the *Hostnames Lookups* setting in *Services* → *SMB* →  (Configure).
- When the *Browsable to Network Clients* option is selected, the share is visible through Windows File Explorer or through `net view`. When the *Use as home share* option is selected, deselecting the *Browsable to Network Clients* option hides the share named *homes* so that only the dynamically generated share containing the authenticated user home directory will be visible. By default, the *homes* share and the user home directory are both visible. Users are not automatically granted read or write permissions on browsable shares. This option provides no real security because shares that are not visible in Windows File Explorer can still be accessed with a *UNC* path.
- If some files on a shared pool should be hidden and inaccessible to users, put a *veto files=* line in the *Auxiliary Parameters* field. The syntax for the *veto files* option and some examples can be found in the [smb.conf manual page](#) (<https://www.freebsd.org/cgi/man.cgi?query=smb.conf>).

Samba disables NTLMv1 authentication by default for security. Standard configurations of Windows XP and some configurations of later clients like Windows 7 will not be able to connect with NTLMv1 disabled. [Security guidance for NTLMv1 and LM network authentication](#) (<https://support.microsoft.com/en-us/help/2793313/security-guidance-for-ntlmv1-and-lm-network-authentication>) has information about the security implications and ways to enable NTLMv2 on those clients. If changing the client configuration is not possible, NTLMv1 authentication can be enabled by selecting the *NTLMv1 auth* option in *Services* → *SMB* →  (Configure).

[Table 12.12](#) provides an overview of the available VFS objects. Be sure to research each object **before** adding or deleting it from the *Selected* column of the *VFS Objects* field of the share. Some objects need additional configuration after they are added. Refer to [Stackable VFS modules](#) (<https://www.samba.org/samba/docs/old/Samba3-HOWTO/VFS.html>) and the [vfs_* man pages](#) (<https://www.samba.org/samba/docs/current/man-html/>) for more details.

Table 12.12: Available VFS Objects

Value	Description
audit	Log share access, connects/disconnects, directory opens/creates/removes, and file opens/closes/renames/unlinks/chmods to syslog.
catia	Improve Mac interoperability by translating characters that are unsupported by Windows.
crossrename	Allow server side rename operations even if source and target are on different physical devices. Required for the recycle bin to work across dataset boundaries. Automatically added when <i>Export Recycle Bin</i> is enabled.
dirsort	Sort directory entries alphabetically before sending them to the client.
fruit	Enhance macOS support by providing the SMB2 AAPL extension and Netatalk interoperability. Automatically loads <i>catia</i> and <i>streams_xattr</i> , but see the warning (page 244) below.
full_audit	Record selected client operations to the system log.
ixnas	<p>Experimental object to improve ACL compatibility with Windows, store DOS attributes as file flags, optimize share case sensitivity to improve performance, and enable User Quota Administration (page 246) from Windows. Several <i>Auxiliary Parameters</i> are available with <i>ixnas</i>.</p> <p>Userspace Quota Settings:</p> <ul style="list-style-type: none"> <i>ixnas:base_user_quota</i> = sets a ZFS user quota on every user that connects to the share. Example: <i>ixnas:base_user_quota</i> = 80G sets the quota to 80 GiB. <i>ixnas:zfs_quota_enabled</i> = enables support for userspace quotas. Choices are <i>True</i> or <i>False</i>. Default is <i>True</i>. Example: <i>ixnas:zfs_quota_enabled</i> = <i>True</i>. <p>Home Dataset Settings:</p> <ul style="list-style-type: none"> <i>ixnas:chown_homedir</i> = changes the owner of a created home dataset to the currently authenticated user. <i>ixnas:zfs_auto_homedir</i> must be set to <i>True</i>. Choices are <i>True</i> or <i>False</i>. Example: <i>ixnas:chown_homedir</i> = <i>True</i>. <i>ixnas:homedir_quota</i> = sets a quota on new ZFS datasets. <i>ixnas:zfs_auto_homedir</i> must be set to <i>True</i>. Example: <i>ixnas:homedir_quota</i> = 20G sets the quota to 20 GiB. <i>ixnas:zfs_auto_homedir</i> = creates new ZFS datasets for users connecting to home shares instead of folders. Choices are <i>True</i> or <i>False</i>. Default is <i>False</i>. Example: <i>ixnas:zfs_auto_homedir</i> = <i>False</i>.
media_harmony	Allow Avid editing workstations to share a network drive.
noacl	Disable NT ACL support. If an extended ACL is present in the share connection

path, all access to this share will be denied. When the [Read-only attribute](#) (https://www.oreilly.com/openbook/samba/book/ch05_03.html)

Warning: Be careful when using multiple SMB shares, some with and some without *fruit*. macOS clients negotiate SMB2 AAPL protocol extensions on the first connection to the server, so mixing shares with and without fruit will globally disable AAPL if the first connection occurs without fruit. To resolve this, all macOS clients need to disconnect from all SMB shares and the first reconnection to the server has to be to a fruit-enabled share.

These VFS objects do not appear in the drop-down menu:

- **recycle:** moves deleted files to the recycle directory instead of deleting them. Controlled by *Export Recycle Bin* in the *SMB share options* (page 240).
- **shadow_copy2:** a more recent implementation of *shadow_copy* with some additional features. *shadow_copy2* and the associated parameters are automatically added to the `smb4.conf` when a *Periodic Snapshot Task* is selected.

Creating or editing an SMB share on a dataset with a [trivial Access Control List \(ACL\)](#) (<https://www.ixsystems.com/community/threads/methods-for-fine-tuning-samba-permissions.50739/>) prompts to [configure the ACL](#) (page 183) for the dataset.

To view all active SMB connections and users, enter `smbstatus` in the *Shell* (page 335).

12.5.1 Configuring Unauthenticated Access

SMB supports guest logins, meaning that users can access the SMB share without needing to provide a username or password. This type of share is convenient as it is easy to configure, easy to access, and does not require any users to be configured on the FreeNAS® system. This type of configuration is also the least secure as anyone on the network can access the contents of the share. Additionally, since all access is as the guest user, even if the user inputs a username or password, there is no way to differentiate which users accessed or modified the data on the share. This type of configuration is best suited for small networks where quick and easy access to the share is more important than the security of the data on the share.

Note: Windows 10, Windows Server 2016 version 1709, and Windows Server 2019 disable SMB2 guest access. Read the [Microsoft security notice](#) (<https://support.microsoft.com/en-hk/help/4046019/guest-access-in-smb2-disabled-by-default-in-windows-10-and-windows-ser>) for details about security vulnerabilities with SMB2 guest access and instructions to re-enable guest logins on these Microsoft systems.

To configure an unauthenticated SMB share:

1. Go to *Sharing* → *Windows (SMB) Shares* and click *ADD*.
2. Fill out the the fields as shown in [Figure 12.20](#).
3. Enable *Allow Guest Access*.
4. Press *SAVE*.

Note: If a dataset for the share has not been created, refer to [Adding Datasets](#) (page 177) to find out more about dataset creation.

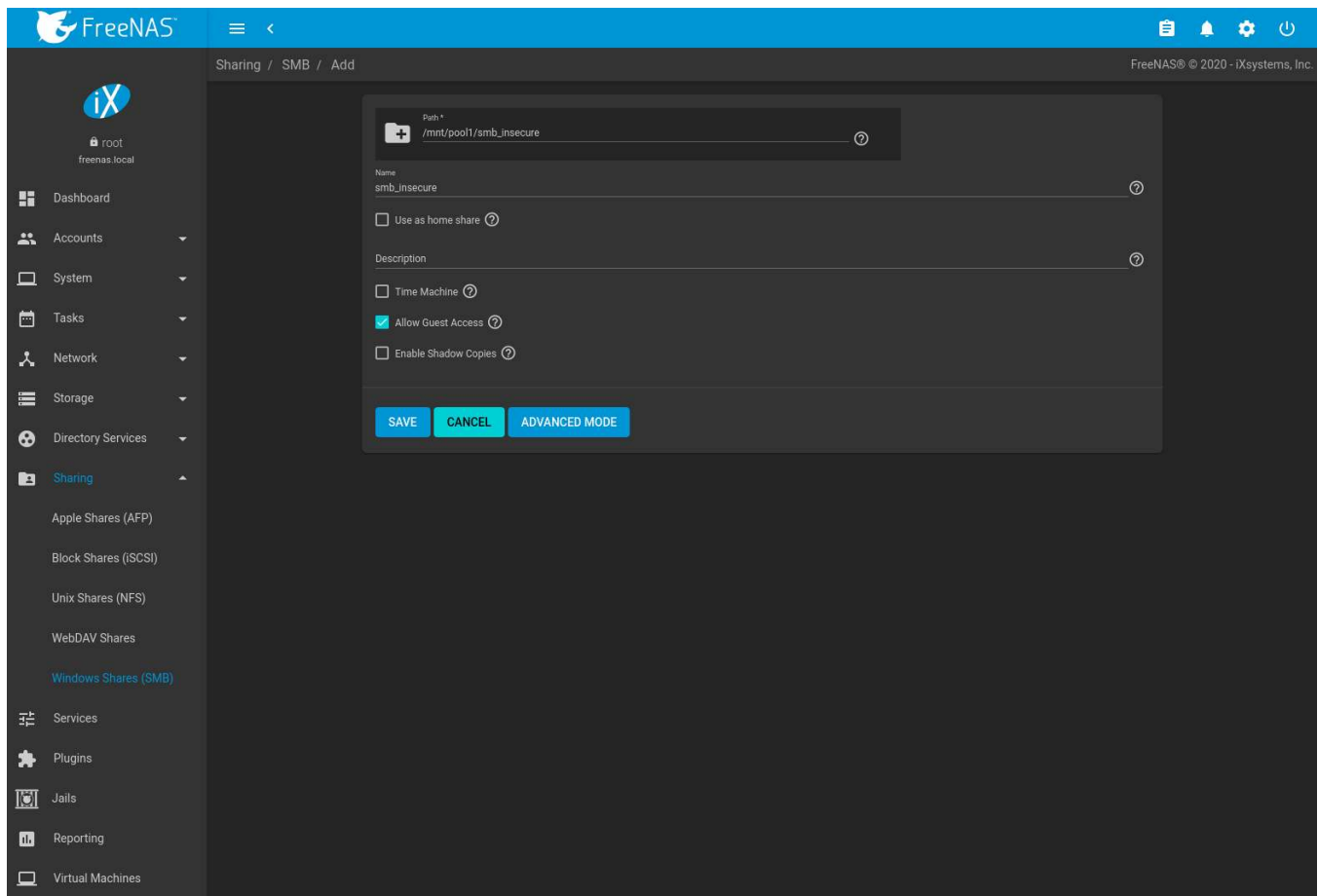


Fig. 12.20: Creating an Unauthenticated SMB Share

The new share appears in *Sharing* → *Windows (SMB) Shares*.

Users can now access the share from any SMB client and will not be prompted for their username or password. For example, to access the share from a Windows system, open Explorer and click on *Network*. For this configuration example, a system named *FREENAS* appears with a share named *insecure_smb*. The user can copy data to and from the unauthenticated SMB share.

12.5.2 Configuring Authenticated Access With Local Users

Most configuration scenarios require each user to have their own user account and to authenticate before accessing the share. This allows the administrator to control access to data, provide appropriate permissions to that data, and to determine who accesses and modifies stored data. A Windows domain controller is not needed for authenticated SMB shares, which means that additional licensing costs are not required. However, because there is no domain controller to provide authentication for the network, each user account must be created on the FreeNAS® system. This type of configuration scenario is often used in home and small networks as it does not scale well if many user accounts are needed.

To configure authenticated access for an SMB share, first create a [group](#) (page 67) for all the SMB user accounts in FreeNAS®. Go to *Accounts* → *Groups* and click *ADD*. Use a descriptive name for the group like `local_smb_users`.

Configure the SMB share dataset with permissions for this new group. When [creating a new dataset](#) (page 177), set the *Share Type* to *SMB*. After the dataset is created, open the dataset [Access Control List \(ACL\)](#) (page 183) and add a new entry. Set *Who* to *Group* and select the SMB group for the *Group*. Finish [defining the permissions](#) (page 186) for the SMB group. Any [members of this group](#) (page 67) now have access to the dataset.

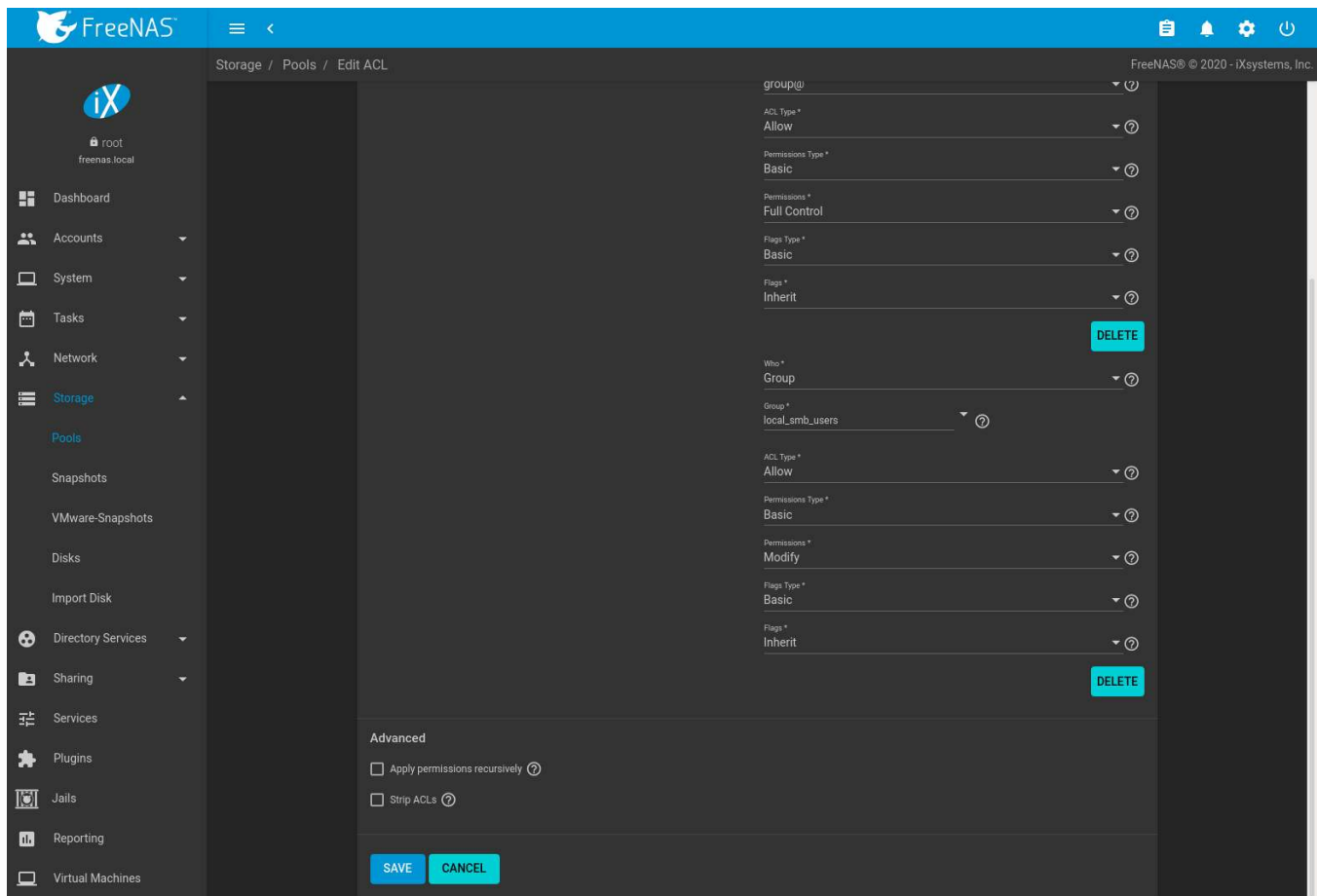


Fig. 12.21: Defining Permissions for a Group

Determine which users need authenticated access to the dataset and [create new accounts](#) (page 70) in FreeNAS®. It is recommended to use the same username and password from the client system for the associated FreeNAS® user account. Add the SMB group to the *Auxiliary Groups* list during account creation.

Finally, [create the SMB share](#) (page 239). Make sure the *Path* is pointed to the dataset that has defined permissions for the SMB group and that the [SMB](#) (page 270) service is active.

Testing the Share

The authenticated share can be tested from any SMB client. For example, to test an authenticated share from a Windows system with network discovery enabled, open Explorer and click on *Network*. If network discovery is disabled, open Explorer and enter `\HOST` in the address bar, where *HOST* is the IP address or hostname of the share system. This example shows a system named *FREENAS* with a share named *smb_share*.

After clicking *smb_share*, a Windows Security dialog prompts for the username and password of the user associated with *smb_share*. After authenticating, the user can copy data to and from the SMB share.

Map the share as a network drive to prevent Windows Explorer from hanging when accessing the share. Right-click the share and select *Map network drive....* Choose a drive letter from the drop-down menu and click *Finish*.

Windows caches user account credentials with the authenticated share. This sometimes prevents connection to a share, even when the correct username and password are provided. Logging out of Windows clears the cache. The authentication dialog reappears the next time the user connects to an authenticated share.

12.5.3 User Quota Administration

File Explorer can manage quotas on SMB shares connected to an [Active Directory](#) (page 198) server. Both the share and dataset being shared must be configured to allow this feature:

- Create an authenticated share with `domain admins` as both the user and group name in *Ownership*.
- Edit the SMB share and add *ixnas* to the list of selected *VFS Object* (page 243).
- In Windows Explorer, connect to and map the share with a user account which is a member of the `domain admins` group. The *Quotas* tab becomes active.

12.5.4 Configuring Shadow Copies

Shadow Copies (https://en.wikipedia.org/wiki/Shadow_copy), also known as the Volume Shadow Copy Service (VSS) or Previous Versions, is a Microsoft service for creating volume snapshots. Shadow copies can be used to restore previous versions of files from within Windows Explorer. Shadow Copy support is built into Vista and Windows 7. Windows XP or 2000 users need to install the **Shadow Copy client** (<http://www.microsoft.com/en-us/download/details.aspx?displaylang=en&id=16220>).

When a periodic snapshot task is created on a ZFS pool that is configured as a SMB share in FreeNAS®, it is automatically configured to support shadow copies.

Before using shadow copies with FreeNAS®, be aware of the following caveats:

- If the Windows system is not fully patched to the latest service pack, Shadow Copies may not work. If no previous versions of files to restore are visible, use Windows Update to ensure the system is fully up-to-date.
- Shadow copy support only works for ZFS pools or datasets. This means that the SMB share must be configured on a pool or dataset, not on a directory.
- Datasets are filesystems and shadow copies cannot traverse filesystems. To see the shadow copies in the child datasets, create separate shares for them.
- Shadow copies will not work with a manual snapshot. Creating a periodic snapshot task for the pool or dataset being shared by SMB or a recursive task for a parent dataset is recommended.
- The periodic snapshot task should be created and at least one snapshot should exist **before** creating the SMB share. If the SMB share was created first, restart the SMB service in *Services*.
- Appropriate permissions must be configured on the pool or dataset being shared by SMB.
- Users cannot delete shadow copies on the Windows system due to the way Samba works. Instead, the administrator can remove snapshots from the FreeNAS® web interface. The only way to disable shadow copies completely is to remove the periodic snapshot task and delete all snapshots associated with the SMB share.

To configure shadow copy support, use the instructions in *Configuring Authenticated Access With Local Users* (page 245) to create the desired number of shares. In this configuration example, a Windows 7 computer has two users: *user1* and *user2*. For this example, two authenticated shares are created so that each user account has their own share. The first share is named *user1* and the second share is named *user2*. Then:

1. Go to *Tasks* → *Periodic Snapshot Tasks* and click *ADD* to create at least one periodic snapshot task. There are two options for snapshot tasks. One is to create a snapshot task for each user's dataset. In this example the datasets are `/mnt/volume1/user1` and `/mnt/volume1/user2`. Another option is to create one periodic snapshot task for the entire volume, `/mnt/volume1` in this case. **Before continuing to the next step**, confirm that at least one snapshot for each defined task is displayed in the *Storage* → *Snapshots* tab. When creating the schedule for the periodic snapshot tasks, keep in mind how often the users need to access modified files and during which days and time of day they are likely to make changes.
2. Go to *Sharing* → *Windows (SMB) Shares* and click *:* (Options) on an existing share. Click *Edit* then *ADVANCED MODE*. Use the *Periodic Snapshot Task* drop-down menu to select the periodic snapshot task to use for that share. Repeat for each share being configured as a shadow copy. For this example, the share named `/mnt/pool1/user1` is configured to use a periodic snapshot task that was configured to take snapshots of the `/mnt/pool1/user1` dataset and the share named `/mnt/pool1/user2` is configured to use a periodic snapshot task that was configured to take snapshots of the `/mnt/pool1/user2` dataset.
3. Verify that the SMB service is running in *Services*.

Figure 12.22 provides an example of using shadow copies while logged in as *user1* on the Windows system. In this example, the user right-clicked *modified file* and selected *Restore previous versions* from the menu. This particular file has three versions: the current version, plus two previous versions stored on the FreeNAS® system. The user

can choose to open one of the previous versions, copy a previous version to the current folder, or restore one of the previous versions, overwriting the existing file on the Windows system.

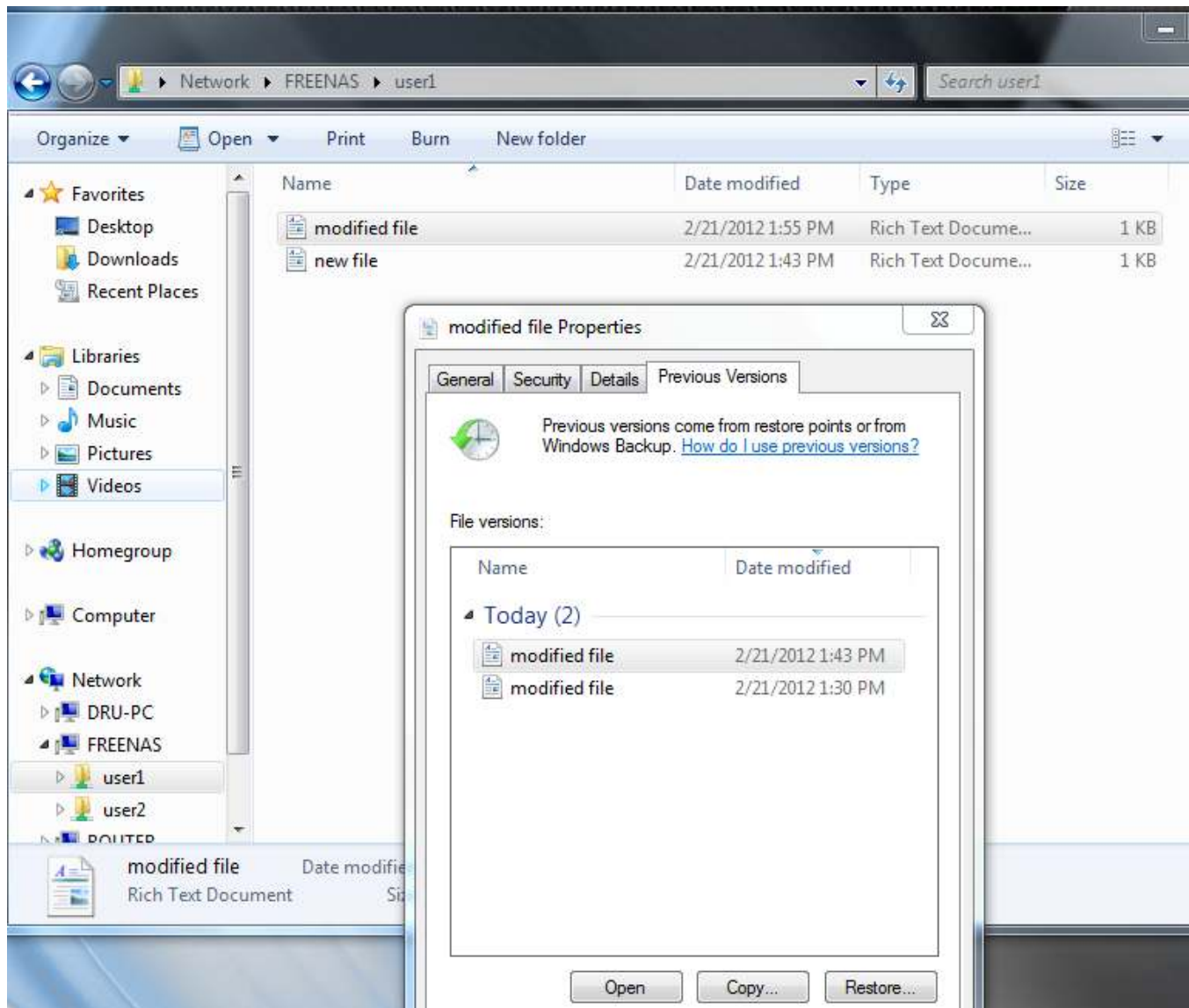


Fig. 12.22: Viewing Previous Versions within Explorer

12.6 Creating Authenticated and Time Machine Shares

macOS includes the [Time Machine](https://support.apple.com/en-us/HT201250) (<https://support.apple.com/en-us/HT201250>) feature which performs automatic backups. FreeNAS® supports Time Machine backups for both [SMB](#) (page 239) and [AFP](#) (page 211) shares. The process for creating an authenticated share for a user is the same as creating a Time Machine share for that user.

Create Time Machine or authenticated shares on a [new dataset](#) (page 177).

Change permissions on the new dataset by going to *Storage* → *Pools*. Select the dataset, click **:** (Options), *Change Permissions*.

Enter these settings:

1. **User:** Use the drop-down to select the desired user account. If the user does not yet exist on the FreeNAS® system, create one with *Accounts* → *Users*. See *users* (page 70) for more information.
2. **Group:** Select the desired group name. If the group does not yet exist on the FreeNAS® system, create one with *Accounts* → *Groups*. See *groups* (page 67) for more information.
3. Click *SAVE*.

Create the authenticated or Time Machine share:

1. Go to *Sharing* → *Windows (SMB) Shares* or *Sharing* → *Apple (AFP) Shares* and click *ADD*. Apple deprecated the *AFP protocol* (<https://support.apple.com/en-us/HT207828>) and recommends using SMB.
2. *Browse* to the dataset created for the share.
3. When creating a Time Machine share, set the *Time Machine* option.
4. Fill out the other required fields.
5. Click *SAVE*.

When creating multiple authenticated or Time Machine shares, repeat this process for each user. Figure 12.23 shows creating a Time Machine Share in *Sharing* → *Apple (AFP) Shares*.

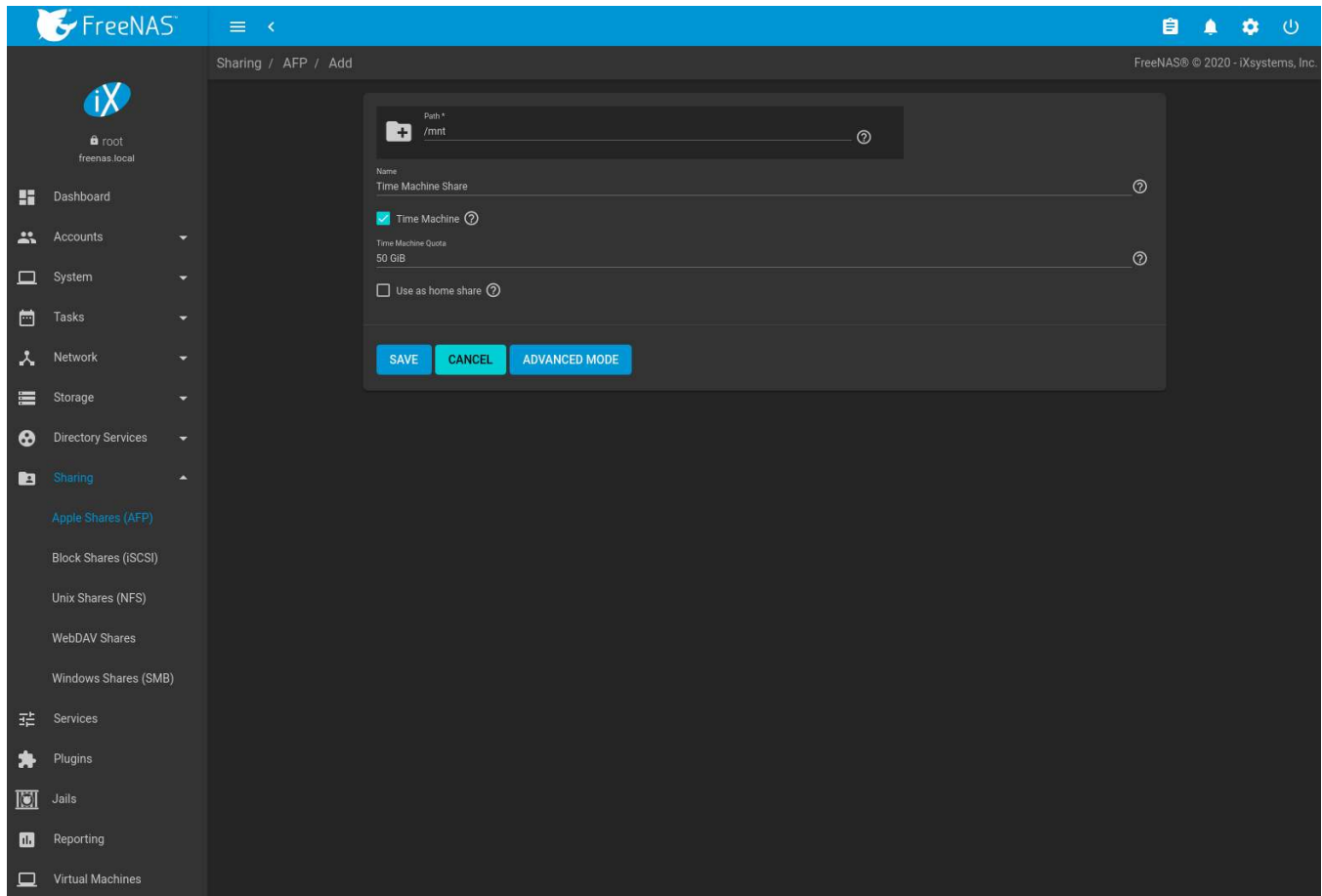


Fig. 12.23: Creating an Authenticated or Time Machine Share

Configuring a quota for each Time Machine share helps prevent backups from using all available space on the FreeNAS® system. Time Machine waits two minutes before creating a full backup. It then creates ongoing hourly, daily, weekly, and monthly backups. **The oldest backups are deleted when a Time Machine share fills up, so make sure that the quota size is large enough to hold the desired number of backups.** Note that a default installation of macOS is over 20 GiB.

Configure a global quota using the instructions in [Set up Time Machine for multiple machines with OSX Server-Style Quotas](https://forums.freenas.org/index.php?threads/how-to-set-up-time-machine-for-multiple-machines-with-osx-server-style-quotas.47173/) (<https://forums.freenas.org/index.php?threads/how-to-set-up-time-machine-for-multiple-machines-with-osx-server-style-quotas.47173/>) or create individual share quotas.

12.6.1 Setting SMB and AFP Share Quotas

SMB Quota

Go to *Sharing* → *Windows (SMB) Shares*, click **⋮** (Options) on the Time Machine share, and *Edit*. Click *Advanced Mode* and enter a `vfs_fruit(8)` (https://www.samba.org/samba/docs/current/man-html/vfs_fruit.8.html) parameter in the *Auxiliary Parameters*. Time Machine quotas use the `fruit:time machine max size` parameter. For example, to set a quota of 500 GiB, enter `fruit:time machine max size = 500 G`.

AFP Quota

Go to *Sharing* → *Apple (AFP) Shares*, click **⋮** (Options) on the Time Machine share, and *Edit*. In the example shown in [Figure 12.24](#), the Time Machine share name is `backup_user1`. Enter a value in the *Time Machine Quota* field, and click *SAVE*. In this example, the Time Machine share is restricted to 200 GiB.

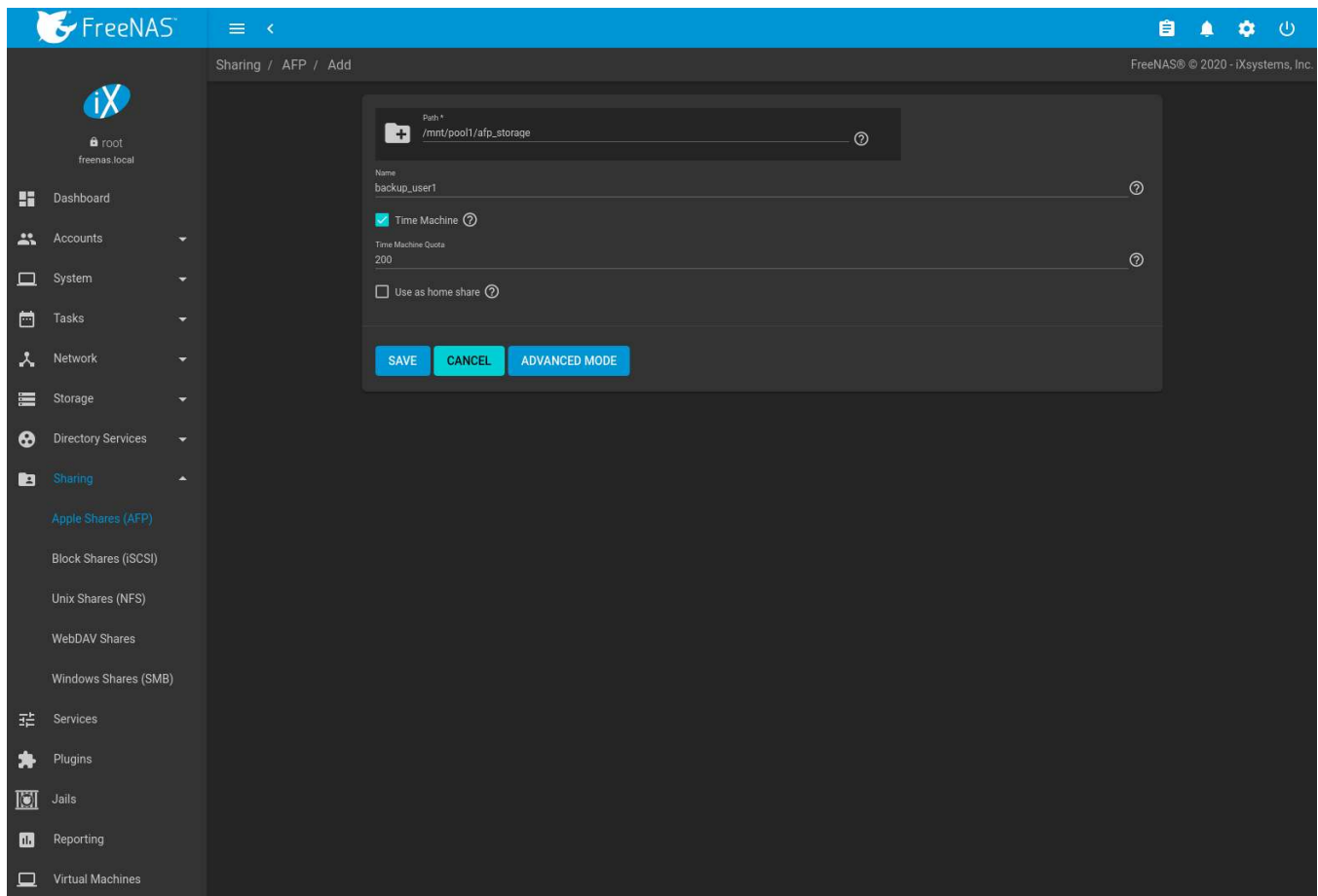


Fig. 12.24: Setting an AFP Share Quota

12.6.2 Client Time Machine Configuration

Note: The example shown here is intended to show the general process of adding a FreeNAS® share in Time Machine. The example might not reflect the exact process to configure Time Machine on a specific version of macOS.

See the [Apple documentation](https://support.apple.com/en-us/HT201250) (<https://support.apple.com/en-us/HT201250>) for detailed Time Machine configuration instructions.

To configure Time Machine on the macOS client, go to *System Preferences* → *Time Machine*, and click *ON* in the left panel.



Fig. 12.25: Configuring Time Machine on macOS

Click *Select Disk...* in the right panel to find the FreeNAS® system with the share. Highlight the share and click *Use Backup Disk*. A connection dialog prompts to log in to the FreeNAS® system.

If Time Machine could not complete the backup. The backup disk image could not be created (error 45) is shown when backing up to the FreeNAS® system, a sparsebundle image must be created using [these instructions](https://community.netgear.com/t5/Stora-Legacy/Solution-to-quot-Time-Machine-could-not-complete-the-backup/td-p/294697) (<https://community.netgear.com/t5/Stora-Legacy/Solution-to-quot-Time-Machine-could-not-complete-the-backup/td-p/294697>).

If Time Machine completed a verification of your backups. To improve reliability, Time Machine must create a new backup for you. is shown, follow the instructions in [this post](http://www.garth.org/archives/2011,08,27,169,fix-time-machine-sparsebundle-nas-based-backup-errors.html) (<http://www.garth.org/archives/2011,08,27,169,fix-time-machine-sparsebundle-nas-based-backup-errors.html>) to avoid making another backup or losing past backups.

SERVICES

Services that ship with FreeNAS® are configured, started, or stopped in *Services*. FreeNAS® includes these built-in services:

- [AFP](#) (page 253)
- [Dynamic DNS](#) (page 255)
- [FTP](#) (page 256)
- [iSCSI](#) (page 261)
- [LLDP](#) (page 261)
- [NFS](#) (page 262)
- [Rsync](#) (page 264)
- [S3](#) (page 267)
- [S.M.A.R.T.](#) (page 268)
- [SMB](#) (page 270)
- [SNMP](#) (page 273)
- [SSH](#) (page 274)
- [TFTP](#) (page 277)
- [UPS](#) (page 278)
- [WebDAV](#) (page 281)

This section demonstrates starting a FreeNAS® service and the available configuration options for each FreeNAS® service.

13.1 Configure Services

The *Services* page, shown in [Figure 13.1](#), lists all services. The list has options to activate the service, set a service to *Start Automatically* at system boot, and configure a service. The S.M.A.R.T. service is enabled by default, but only runs if the storage devices support [S.M.A.R.T. data](https://en.wikipedia.org/wiki/S.M.A.R.T.) (<https://en.wikipedia.org/wiki/S.M.A.R.T.>). Other services default to *off* until started.

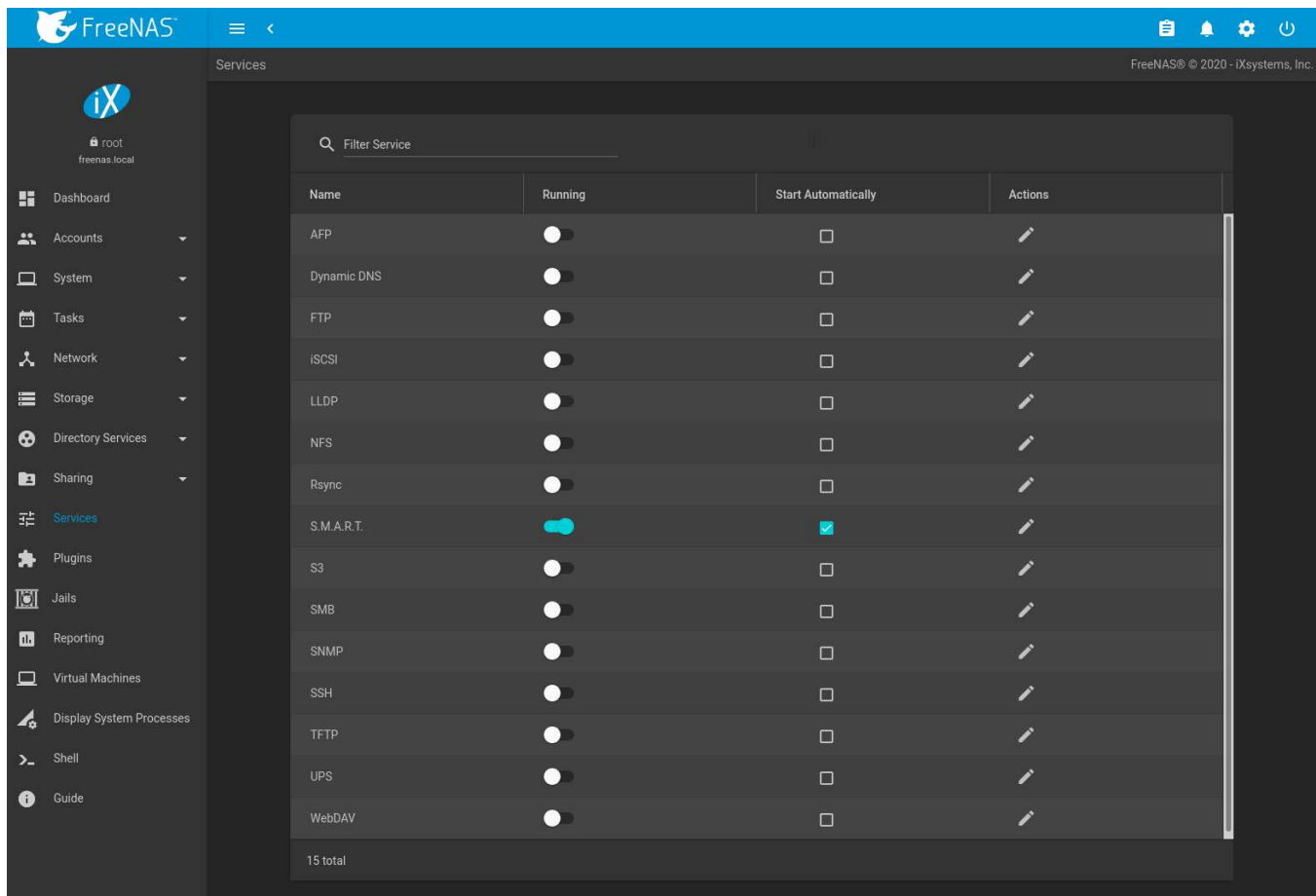


Fig. 13.1: Configure Services

Stopped services show the sliding button on the left. Active services show the sliding button on the right. Click the slider to start or stop a service. Stopping a service shows a confirmation dialog.

Tip: Using a proxy server can prevent the list of services from being displayed. If a proxy server is used, do not configure it to proxy local network or websocket connections. VPN software can also cause problems. If the list of services is displayed when connecting on the local network but not when connecting through the VPN, check the VPN software configuration.

Services are configured by clicking (Configure).

If a service does not start, go to *System* → *Advanced* and enable *Show console messages*. Console messages appear at the bottom of the browser. Clicking the console message area makes it into a pop-up window, allowing scrolling through or copying the messages. Watch these messages for errors when stopping or starting the problematic service.

To read the system logs for more information about a service failure, open [Shell](#) (page 335) and type `more /var/log/messages`.

13.2 AFP

The settings that are configured when creating AFP shares are specific to each configured AFP share. An AFP share is created by navigating to *Sharing* → *Apple (AFP)*, and clicking *ADD*. In contrast, global settings which apply to all AFP shares are configured in *Services* → *AFP* → *Configure*.

Figure 13.2 shows the available global AFP configuration options which are described in Table 13.1.

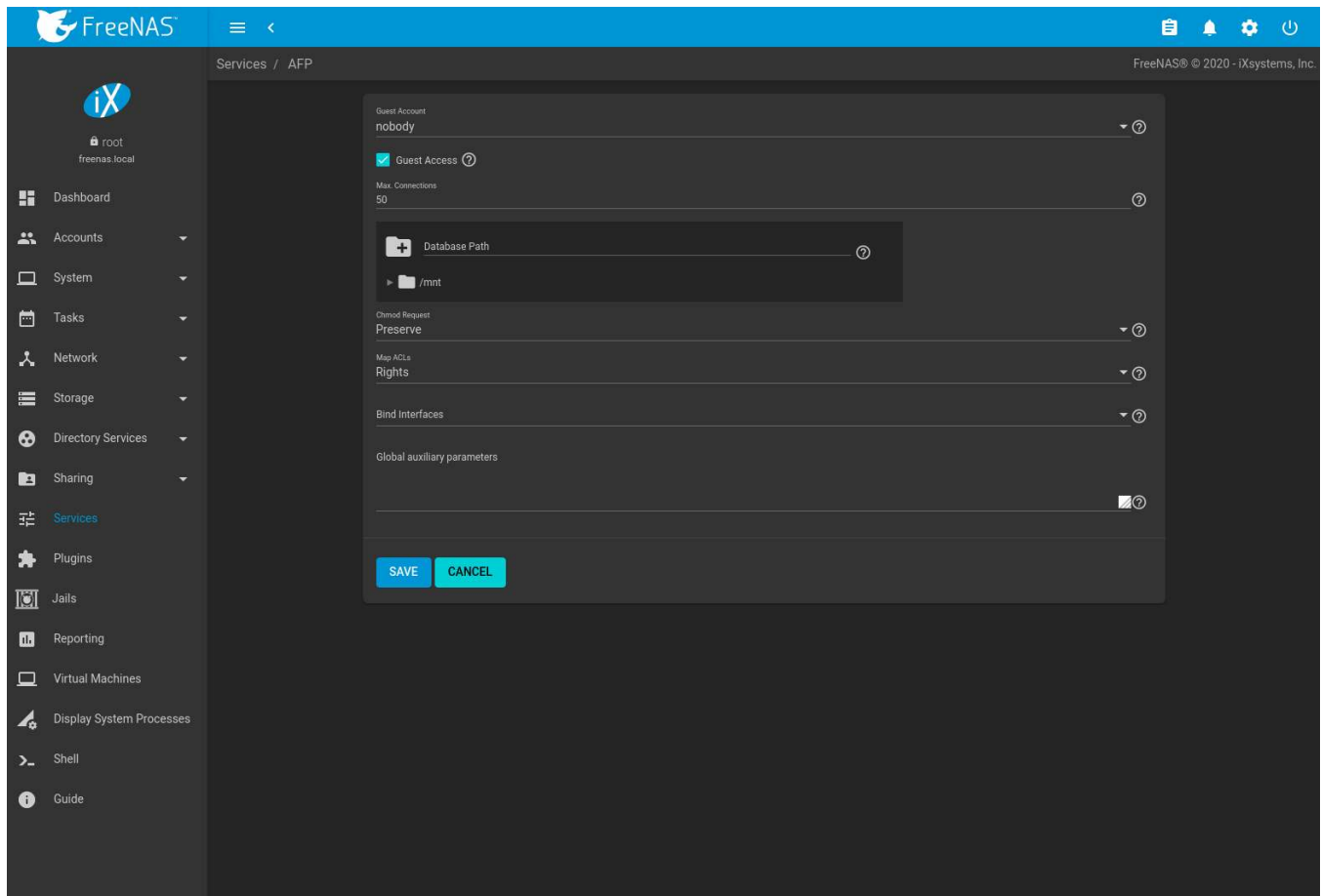


Fig. 13.2: Global AFP Configuration

Table 13.1: Global AFP Configuration Options

Setting	Value	Description
Guest Account	drop-down menu	Select an account to use for guest access. The account must have permissions to the pool or dataset being shared.
Guest Access	checkbox	If enabled, clients are not prompted to authenticate before accessing AFP shares.
Max. Connections	integer	Maximum number of simultaneous connections permitted via AFP. The default limit is 50.
Database Path	browse button	Sets the database information to be stored in the path. Default is the root of the pool. The path must be writable even if the pool is read only.
Chmod Request	drop-down menu	Set how ACLs are handled. Choices are: <i>Ignore</i> , <i>Preserve</i> , or <i>Simple</i> .
Map ACLs	drop-down menu	Choose mapping of effective permissions for authenticated users: <i>Rights</i> (default, Unix-style permissions), <i>Mode</i> (ACLs), or <i>None</i> .
Bind Interfaces	selection	Specify the IP addresses to listen for FTP connections. Select the desired IP addresses in the list to add them to the <i>Bind Interfaces</i> list.
Global auxiliary parameters	string	Additional afp.conf(5) parameters not covered elsewhere in this screen.

13.2.1 Troubleshooting AFP

Check for error messages in `/var/log/afp.log`.

Determine which users are connected to an AFP share by typing `afpusers`.

If *Something wrong with the volume's CNID DB* is shown, run this command from *Shell* (page 335), replacing the path to the problematic AFP share:

```
dbd -rf /path/to/share
```

This command can take some time, depending upon the size of the pool or dataset being shared. The CNID database is wiped and rebuilt from the CNIDs stored in the AppleDouble files.

13.3 Dynamic DNS

Dynamic DNS (DDNS) is useful if the FreeNAS® system is connected to an ISP that periodically changes the IP address of the system. With dynamic DNS, the system can automatically associate its current IP address with a domain name, allowing access to the FreeNAS® system even if the IP address changes. DDNS requires registration with a DDNS service such as [DynDNS](https://dyn.com/dns/) (<https://dyn.com/dns/>).

Figure 13.3 shows the DDNS configuration screen and Table 13.2 summarizes the configuration options. The values for these fields are provided by the DDNS provider. After configuring DDNS, remember to start the DDNS service in *Services* → *Dynamic DNS*.

The screenshot displays the FreeNAS web interface for configuring Dynamic DNS. The sidebar on the left contains various system management links. The main panel, titled 'Services / DynamicDNS', features a configuration form with the following fields:

- Provider:** A dropdown menu with a help icon.
- CheckIP Server:** A text input field with a help icon.
- CheckIP Path:** A text input field with a help icon.
- SSL:** A checkbox with a help icon.
- Domain name:** A text input field with a help icon.
- Username *:** A text input field containing 'admin' with a help icon.
- Password:** A password input field with a toggle icon and a help icon.
- Confirm Password:** A password input field.
- Update Period:** A text input field containing '300' with a help icon.

At the bottom of the form are two buttons: 'SAVE' (blue) and 'CANCEL' (red).

Fig. 13.3: Configuring DDNS

Table 13.2: DDNS Configuration Options

Setting	Value	Description
Provider	drop-down menu	Several providers are supported. If a specific provider is not listed, select <i>Custom Provider</i> and enter the information in the <i>Custom Server</i> and <i>Custom Path</i> fields.
CheckIP Server SSL	checkbox	Use HTTPS for the connection to the <i>CheckIP Server</i> .
CheckIP Server	string	Name and port of the server that reports the external IP address. For example, entering <code>checkip.dyndns.org:80</code> uses Dyn IP detection (https://help.dyn.com/remote-access-api/checkip-tool/) to discover the remote socket IP address.
CheckIP Path	string	Path to the <i>CheckIP Server</i> . For example, <i>no-ip.com</i> uses a <i>CheckIP Server</i> of <code>dynamic.zoneedit.com</code> and <i>CheckIP Path</i> of <code>/checkip.html</code> .
SSL	checkbox	Use HTTPS for the connection to the server that updates the DNS record.
Custom Server	string	DDNS server name. For example, <code>members.dyndns.org</code> denotes a server similar to <code>dyndns.org</code> .
Custom Path	string	DDNS server path. Path syntax varies by provider and must be obtained from that provider. For example, <code>/update?hostname=</code> is a simple path for the <code>update.twodns.de</code> <i>Custom Server</i> . The hostname is automatically appended by default. More examples are in the In-A-Dyn documentation (https://github.com/troglobit/inadyn#custom-ddns-providers).
Domain name	string	Fully qualified domain name of the host with the dynamic IP address. Separate multiple domains with a space, comma (,), or semicolon (;). Example: <code>myname.dyndns.org; myothername.dyndns.org</code>
Username	string	Username for logging in to the provider and updating the record.
Password	string	Password for logging in to the provider and updating the record.
Update period	integer	How often the IP is checked in seconds.

When using the `he.net` *Provider*, enter the domain name for *Username* and enter the DDNS key generated for that domain's A entry at the he.net (<https://he.net>) website for *Password*.

13.4 FTP

FreeNAS® uses the [proftpd](http://www.proftpd.org/) (<http://www.proftpd.org/>) FTP server to provide FTP services. Once the FTP service is configured and started, clients can browse and download data using a web browser or FTP client software. The advantage of FTP is that easy-to-use cross-platform utilities are available to manage uploads to and downloads from the FreeNAS® system. The disadvantage of FTP is that it is considered to be an insecure protocol, meaning that it should not be used to transfer sensitive files. If concerned about sensitive data, see [Encrypting FTP](#) (page 261).

This section provides an overview of the FTP configuration options. It then provides examples for configuring anonymous FTP, specified user access within a chroot environment, encrypting FTP connections, and troubleshooting tips.

[Figure 13.4](#) shows the configuration screen for *Services → FTP → Configure*. Some settings are only available in *ADVANCED MODE*. To see these settings, either click the *ADVANCED MODE* button or configure the system to always display these settings by setting the *Show advanced fields by default* option in *System → Advanced*.

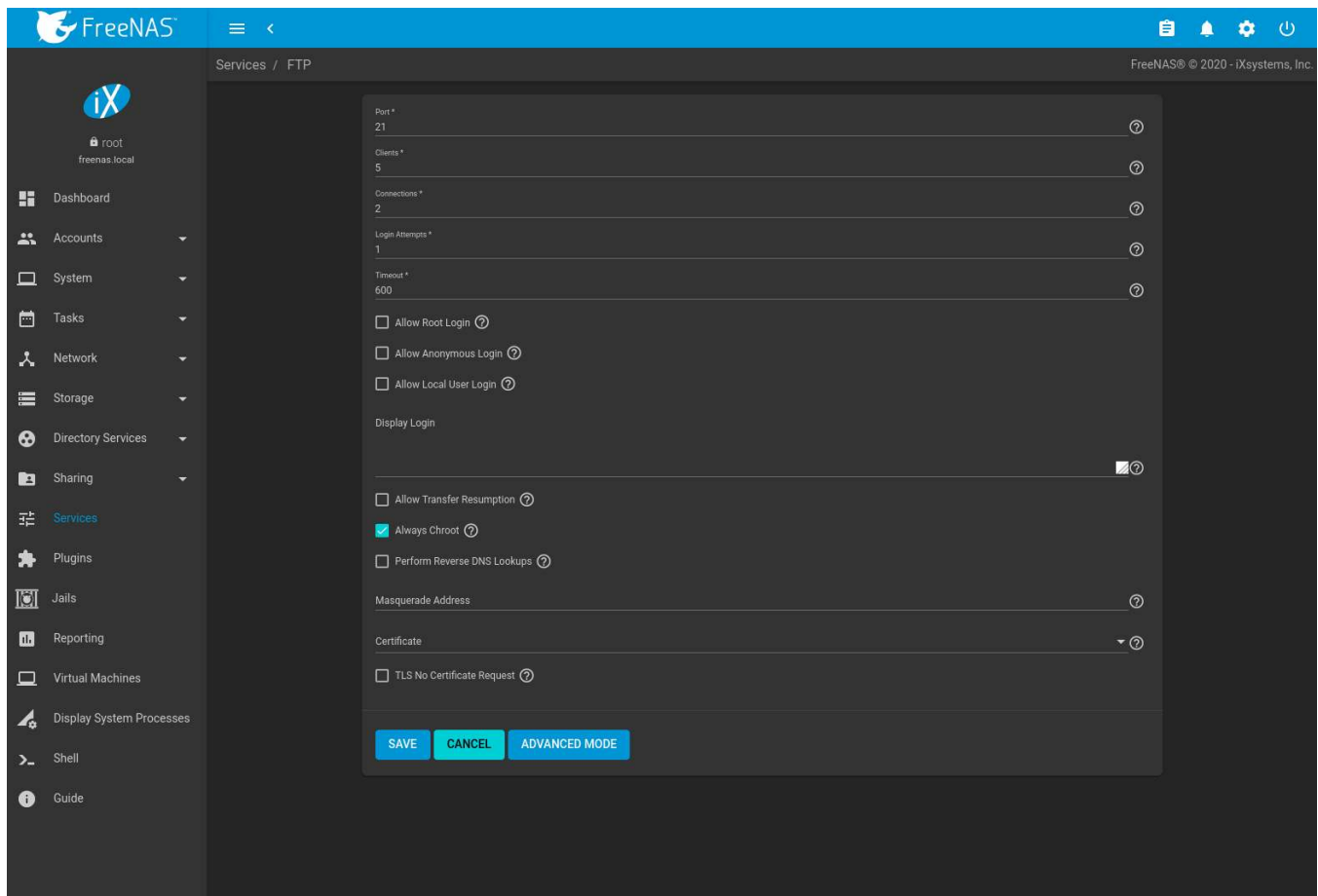


Fig. 13.4: Configuring FTP

Table 13.3 summarizes the available options when configuring the FTP server.

Table 13.3: FTP Configuration Options

Setting	Value	Advanced Mode	Description
Port	integer		Set the port the FTP service listens on.
Clients	integer		Maximum number of simultaneous clients.
Connections	integer		Set the maximum number of connections per IP address. 0 means unlimited.
Login Attempts	integer		Enter the maximum number of attempts before the client is disconnected. Increase this if users are prone to typos.
Timeout	integer		Maximum client idle time in seconds before client is disconnected.
Allow Root Login	checkbox		Setting this option is discouraged as it increases security risk.
Allow Anonymous Login	checkbox		Allow anonymous FTP logins with access to the directory specified in the <i>Path</i> .
Path	browse button		Set the root directory for anonymous FTP connections.
Allow Local User Login	checkbox		Allow any local user to log in. By default, only members of the <code>ftp</code> group are allowed to log in.
Display Login	string		Specify the message displayed to local login users after authentication. Not displayed to anonymous login users.

Continued on next page

Table 13.3 – continued from previous page

Setting	Value	Advanced Mode	Description
Allow Transfer Re- sumption	checkbox		Set to allow FTP clients to resume interrupted transfers.
Always Chroot	checkbox		When set a local user is only allowed access to their home directory when they are a member of the <i>wheel</i> group.
Perform Reverse DNS Lookups	checkbox		Set to perform reverse DNS lookups on client IPs. Can cause long delays if reverse DNS is not configured.
Masquerade ad- dress	string		Public IP address or hostname. Set if FTP clients cannot connect through a NAT device.
Certificate	drop-down menu		Select the SSL certificate to be used for TLS FTP connec- tions. Go to <i>System</i> → <i>Certificates</i> to create a certificate.
TLS No Certificate Request	checkbox		Set if the client cannot connect, and it is suspected the client is not properly handling server certificate requests.
File Permission	checkboxes	✓	Sets default permissions for newly created files.
Directory Permis- sion	checkboxes	✓	Sets default permissions for newly created directories.
Enable FXP (https://en.wikipedia.org/wiki/File_eXchange_Protocol)	checkbox	✓	Set to enable the File eXchange Protocol. This is discour- aged as it makes the server vulnerable to FTP bounce at- tacks.
Require IDENT Au- thentication	checkbox	✓	Setting this option results in timeouts if <i>identd</i> is not run- ning on the client.
Minimum Passive Port	integer	✓	Used by clients in PASV mode, default of 0 means any port above 1023.
Maximum Passive Port	integer	✓	Used by clients in PASV mode, default of 0 means any port above 1023.
Local User Upload Bandwidth	integer	✓	Defined in KiB/s, default of 0 means unlimited.
Local User Down- load Bandwidth	integer	✓	Defined in KiB/s, default of 0 means unlimited.
Anonymous User Upload Bandwidth	integer	✓	Defined in KiB/s, default of 0 means unlimited.
Anonymous User Download Band- width	integer	✓	Defined in KiB/s, default of 0 means unlimited.
Enable TLS	checkbox	✓	Set to enable encrypted connections. Requires a certificate to be created or imported using Certificates (page 113).
TLS Policy	drop-down menu	✓	The selected policy defines whether the con- trol channel, data channel, both channels, or neither channel of an FTP session must occur over SSL/TLS. The policies are described here (http://www.proftpd.org/docs/directives/linked/config_ref_TLSRequired.h)
TLS Allow Client Renegotiations	checkbox	✓	Setting this option is not recommended as it breaks several security measures. For this and the rest of the TLS fields, refer to mod_tls (http://www.proftpd.org/docs/contrib/mod_tls.html) for more details.
TLS Allow Dot Login	checkbox	✓	If set, the user home directory is checked for a <i>.tlslogin</i> file which contains one or more PEM-encoded certificates. If not found, the user is prompted for password authenti- cation.
TLS Allow Per User	checkbox	✓	If set, the user password may be sent unencrypted.
TLS Common Name Required	checkbox	✓	When set, the common name in the certificate must match the FQDN of the host.

Continued on next page

Table 13.3 – continued from previous page

Setting	Value	Advanced Mode	Description
TLS Enable Diagnostics	checkbox	✓	If set when troubleshooting a connection, logs more verbosely.
TLS Export Certificate Data	checkbox	✓	If set, exports the certificate environment variables.
TLS No Certificate Request	checkbox	✓	Set if the client cannot connect and it is suspected the client is poorly handling the server certificate request.
TLS No Empty Fragments	checkbox	✓	Setting this option is not recommended as it bypasses a security mechanism.
TLS No Session Reuse Required	checkbox	✓	Setting this option reduces the security of the connection. Only use if the client does not understand reused SSL sessions.
TLS Export Standard Vars	checkbox	✓	If enabled, sets several environment variables.
TLS DNS Name Required	checkbox	✓	If set, the client DNS name must resolve to its IP address and the cert must contain the same DNS name.
TLS IP Address Required	checkbox	✓	If set, the client certificate must contain the IP address that matches the IP address of the client.
Auxiliary Parameters	string	✓	Used to add proftpd(8) (https://www.freebsd.org/cgi/man.cgi?query=proftpd) parameters not covered elsewhere in this screen.

This example demonstrates the auxiliary parameters that prevent all users from performing the FTP DELETE command:

```
<Limit DELE>
DenyAll
</Limit>
```

13.4.1 Anonymous FTP

Anonymous FTP may be appropriate for a small network where the FreeNAS® system is not accessible from the Internet and everyone in the internal network needs easy access to the stored data. Anonymous FTP does not require a user account for every user. In addition, passwords are not required so it is not necessary to manage changed passwords on the FreeNAS® system.

To configure anonymous FTP:

1. Give the built-in ftp user account permissions to the pool or dataset to be shared in *Storage* → *Pools* → *Edit Permissions*:
 - *User*: select the built-in *ftp* user from the drop-down menu
 - *Group*: select the built-in *ftp* group from the drop-down menu
 - *Mode*: review that the permissions are appropriate for the share

Note: For FTP, the type of client does not matter when it comes to the type of ACL. This means that Unix ACLs are used even if Windows clients are accessing FreeNAS® via FTP.

2. Configure anonymous FTP in *Services* → *FTP* → *Configure* by setting these attributes:
 - *Allow Anonymous Login*: set this option
 - *Path*: browse to the pool/dataset/directory to be shared
3. Start the FTP service in *Services*. Click the sliding button on the *FTP* row. The FTP service takes a second or so to start. The sliding button moves to the right when the service is running.

4. Test the connection from a client using a utility such as [Filezilla](https://filezilla-project.org/) (<https://filezilla-project.org/>).

In the example shown in [Figure 13.5](#), The user has entered this information into the Filezilla client:

- IP address of the FreeNAS® server: *192.168.1.113*
- *Username: anonymous*
- *Password:* the email address of the user

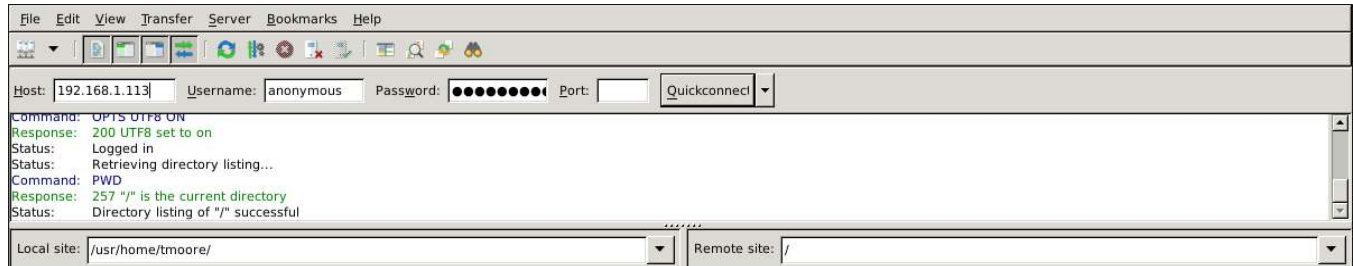


Fig. 13.5: Connecting Using Filezilla

The messages within the client indicate the FTP connection is successful. The user can now navigate the contents of the root folder on the remote site. This is the pool or dataset specified in the FTP service configuration. The user can also transfer files between the local site (their system) and the remote site (the FreeNAS® system).

13.4.2 FTP in chroot

If users are required to authenticate before accessing the data on the FreeNAS® system, either create a user account for each user or import existing user accounts using [Active Directory](#) (page 198) or [LDAP](#) (page 203). Create a ZFS dataset for *each* user, then chroot each user so they are limited to the contents of their own home directory. Datasets provide the added benefit of configuring a quota so that the size of a user home directory is limited to the size of the quota.

To configure this scenario:

1. Create a ZFS dataset for each user in *Storage* → *Pools*. Click the **⋮** (Options) button, then *Add Dataset*. Set an appropriate quota for each dataset. Repeat this process to create a dataset for every user that needs access to the FTP service.
2. When [Active Directory](#) (page 198) or [LDAP](#) (page 203) are not being used, create a user account for each user by navigating to *Accounts* → *Users*, and clicking *ADD*. For each user, browse to the dataset created for that user in the *Home Directory* field. Repeat this process to create a user account for every user that needs access to the FTP service, making sure to assign each user their own dataset.
3. Set the permissions for each dataset by navigating to *Storage* → *Pools*, and clicking the **⋮** (Options) on the desired dataset. Click the *Edit Permissions* button, then assign a user account as *User* of that dataset. Set the desired permissions for that user. Repeat for each dataset.

Note: For FTP, the type of client does not matter when it comes to the type of ACL. This means Unix ACLs are always used, even if Windows clients will be accessing FreeNAS® via FTP.

4. Configure FTP in *Services* → *FTP* → *Configure* with these attributes:
 - *Path:* browse to the parent pool containing the datasets.
 - Make sure the options for *Allow Root Login* and *Allow Anonymous Login* are **unselected**.
 - Select the *Allow Local User Login* option to enable it.
 - Select the *Always Chroot* option to enable it.

5. Start the FTP service in *Services* → *FTP*. Click the sliding button on the *FTP* row. The FTP service takes a second or so to start. The sliding button moves to the right to show the service is running.
6. Test the connection from a client using a utility such as Filezilla.

To test this configuration in Filezilla, use the *IP address* of the FreeNAS® system, the *Username* of a user that is associated with a dataset, and the *Password* for that user. The messages will indicate the authorization and the FTP connection are successful. The user can now navigate the contents of the root folder on the remote site. This time it is not the entire pool but the dataset created for that user. The user can transfer files between the local site (their system) and the remote site (their dataset on the FreeNAS® system).

13.4.3 Encrypting FTP

To configure any FTP scenario to use encrypted connections:

1. Import or create a certificate authority using the instructions in [CAs](#) (page 110). Then, import or create the certificate to use for encrypted connections using the instructions in [Certificates](#) (page 113).
2. In *Services* → *FTP* → *Configure*, click *ADVANCED*, choose the certificate in *Certificate*, and set the *Enable TLS* option.
3. Specify secure FTP when accessing the FreeNAS® system. For example, in Filezilla enter *ftps://IP_address* (for an implicit connection) or *ftpes://IP_address* (for an explicit connection) as the Host when connecting. The first time a user connects, they will be presented with the certificate of the FreeNAS® system. Click *SAVE* to accept the certificate and negotiate an encrypted connection.
4. To force encrypted connections, select *On* for the *TLS Policy*.

13.4.4 Troubleshooting FTP

The FTP service will not start if it cannot resolve the system hostname to an IP address with DNS. To see if the FTP service is running, open [Shell](#) (page 335) and issue the command:

```
sockstat -4p 21
```

If there is nothing listening on port 21, the FTP service is not running. To see the error message that occurs when FreeNAS® tries to start the FTP service, go to *System* → *Advanced*, enable *Show console messages*, and click *SAVE*. Go to *Services* and switch the FTP service off, then back on. Watch the console messages at the bottom of the browser for errors.

If the error refers to DNS, either create an entry in the local DNS server with the FreeNAS® system hostname and IP address, or add an entry for the IP address of the FreeNAS® system in the *Network* → *Global Configuration Host name database* field.

13.5 iSCSI

Refer to [Block \(iSCSI\)](#) (page 215) for instructions on configuring iSCSI. Start the iSCSI service in *Services* by clicking the sliding button in the *iSCSI* row.

Note: A warning message is shown the iSCSI service stops when initiators are connected. Open the [Shell](#) (page 335) and type `ctladm islist` to determine the names of the connected initiators.

13.6 LLDP

The Link Layer Discovery Protocol (LLDP) is used by network devices to advertise their identity, capabilities, and neighbors on an Ethernet network. FreeNAS® uses the `ladvd` (<https://github.com/sspan/ladvd>) LLDP implemen-

tation. If the network contains managed switches, configuring and starting the LLDP service will tell the FreeNAS® system to advertise itself on the network.

Figure 13.6 shows the LLDP configuration screen and Table 13.4 summarizes the configuration options for the LLDP service.

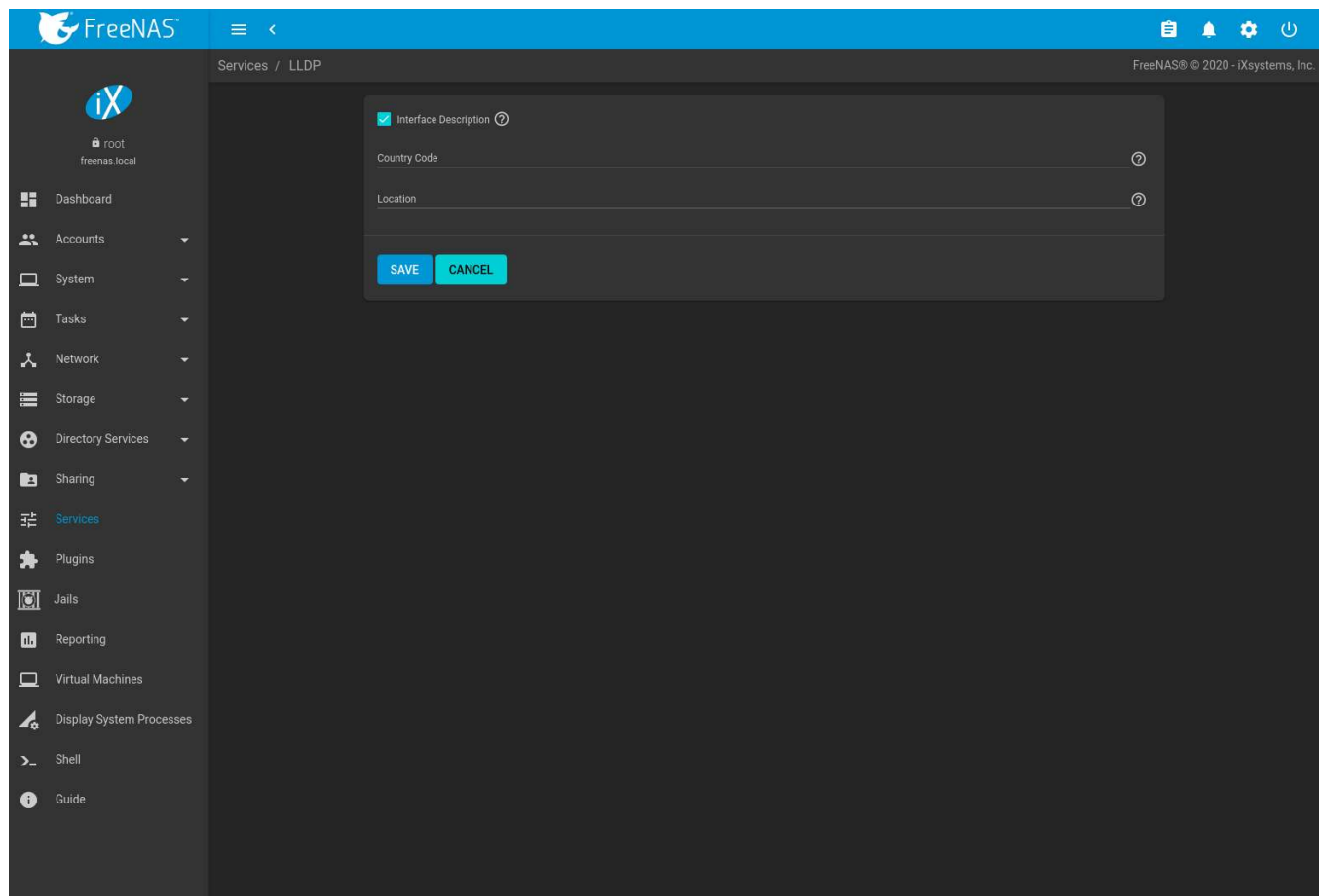


Fig. 13.6: Configuring LLDP

Table 13.4: LLDP Configuration Options

Setting	Value	Description
Interface De- scription	checkbox	Set to enable receive mode and to save and received peer information in interface descriptions.
Country Code	string	Required for LLDP location support. Enter a two-letter ISO 3166 country code.
Location	string	Optional. Specify the physical location of the host.

13.7 NFS

The settings that are configured when creating NFS shares in are specific to each configured NFS share. An NFS share is created by going to *Sharing* → *Unix (NFS) Shares* and clicking *ADD*. Global settings which apply to all NFS shares are configured in *Services* → *NFS* → *Configure*.

Figure 13.7 shows the configuration screen and Table 13.5 summarizes the configuration options for the NFS service.

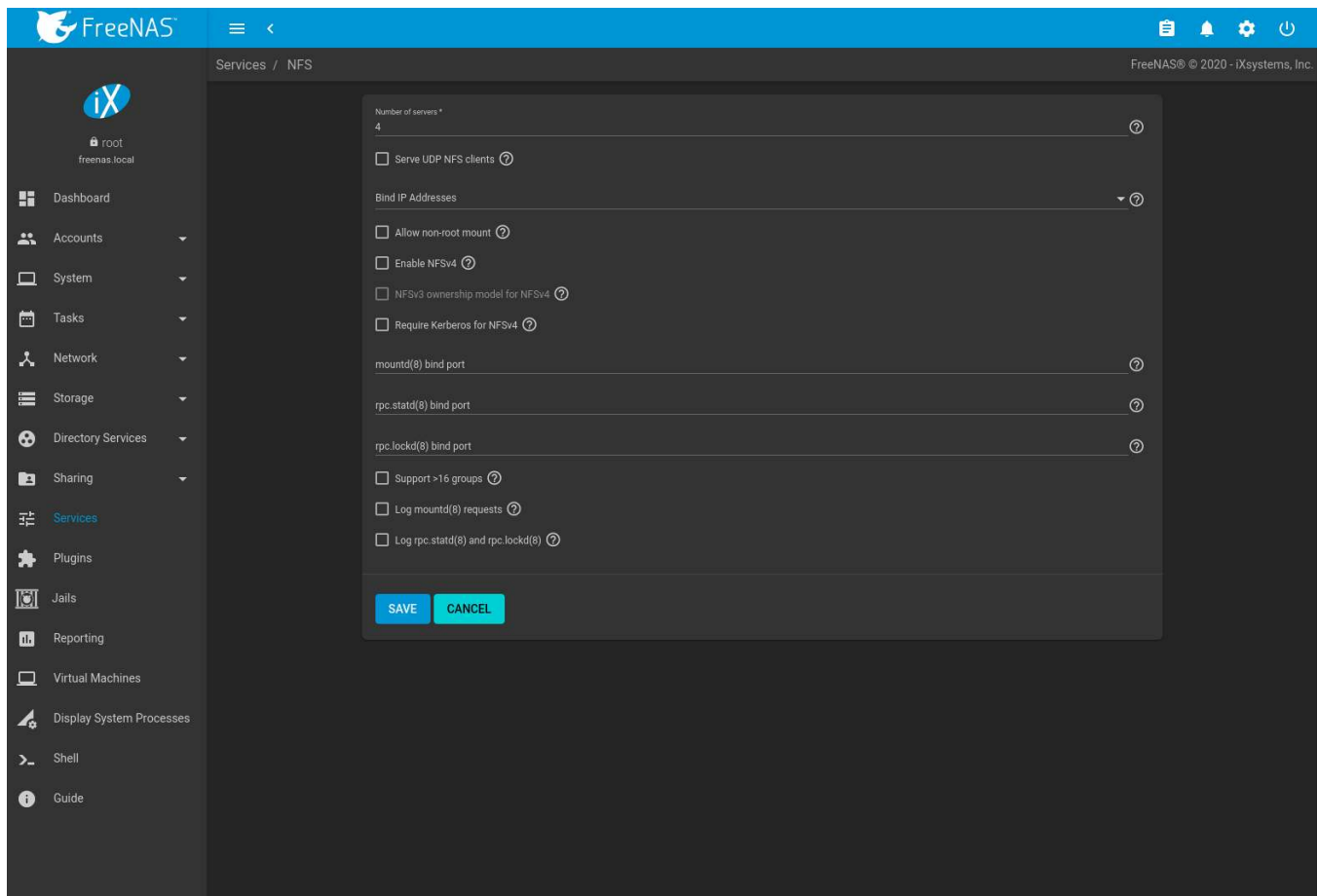


Fig. 13.7: Configuring NFS

Table 13.5: NFS Configuration Options

Setting	Value	Description
Number of servers	integer	Specify how many servers to create. Increase if NFS client responses are slow. To limit CPU context switching, keep this number less than or equal to the number of CPUs reported by <code>sysctl -n kern.smp.cpus</code> .
Serve UDP NFS clients	checkbox	Set if NFS clients need to use UDP.
Bind IP Addresses	drop-down	Select IP addresses to listen on for NFS requests. When all options are unset, NFS listens on all available addresses.
Allow non-root mount	checkbox	Set only if required by the NFS client.
Enable NFSv4	checkbox	Set to switch from NFSv3 to NFSv4. The default is NFSv3.
NFSv3 ownership model for NFSv4	checkbox	Grayed out unless <i>Enable NFSv4</i> is selected and, in turn, grays out <i>Support >16 groups</i> which is incompatible. Set this option if NFSv4 ACL support is needed without requiring the client and the server to sync users and groups.
Require Kerberos for NFSv4	checkbox	Set to force NFS shares to fail if the Kerberos ticket is unavailable.

Continued on next page

Table 13.5 – continued from previous page

Setting	Value	Description
mountd(8) bind port	integer	Optional. Specify the port that mountd(8) (https://www.freebsd.org/cgi/man.cgi?query=mountd) binds to.
rpc.statd(8) bind port	integer	Optional. Specify the port that rpc.statd(8) (https://www.freebsd.org/cgi/man.cgi?query=rpc.statd) binds to.
rpc.lockd(8) bind port	integer	Optional. Specify the port that rpc.lockd(8) (https://www.freebsd.org/cgi/man.cgi?query=rpc.lockd) binds to.
Support >16 groups	checkbox	Set this option if any users are members of more than 16 groups (useful in AD environments). Note this assumes group membership is configured correctly on the NFS server.
Log mountd(8) requests	checkbox	Enable logging of mountd(8) (https://www.freebsd.org/cgi/man.cgi?query=mountd) requests by syslog.
Log rpc.statd(8) and rpc.lockd(8)	checkbox	Enable logging of rpc.statd(8) (https://www.freebsd.org/cgi/man.cgi?query=rpc.statd) and rpc.lockd(8) (https://www.freebsd.org/cgi/man.cgi?query=rpc.lockd) requests by syslog.

Note: NFSv4 sets all ownership to *nobody:nobody* if user and group do not match on client and server.

13.8 Rsync

Services → *Rsync* is used to configure an rsync server when using rsync module mode. Refer to [Rsync Module Mode](#) (page 129) for a configuration example.

This section describes the configurable options for the `rsyncd` service and rsync modules.

13.8.1 Configure Rsyncd

To configure the `rsyncd` server, go to *Services* and click  *EDIT* for the *Rsync* service.

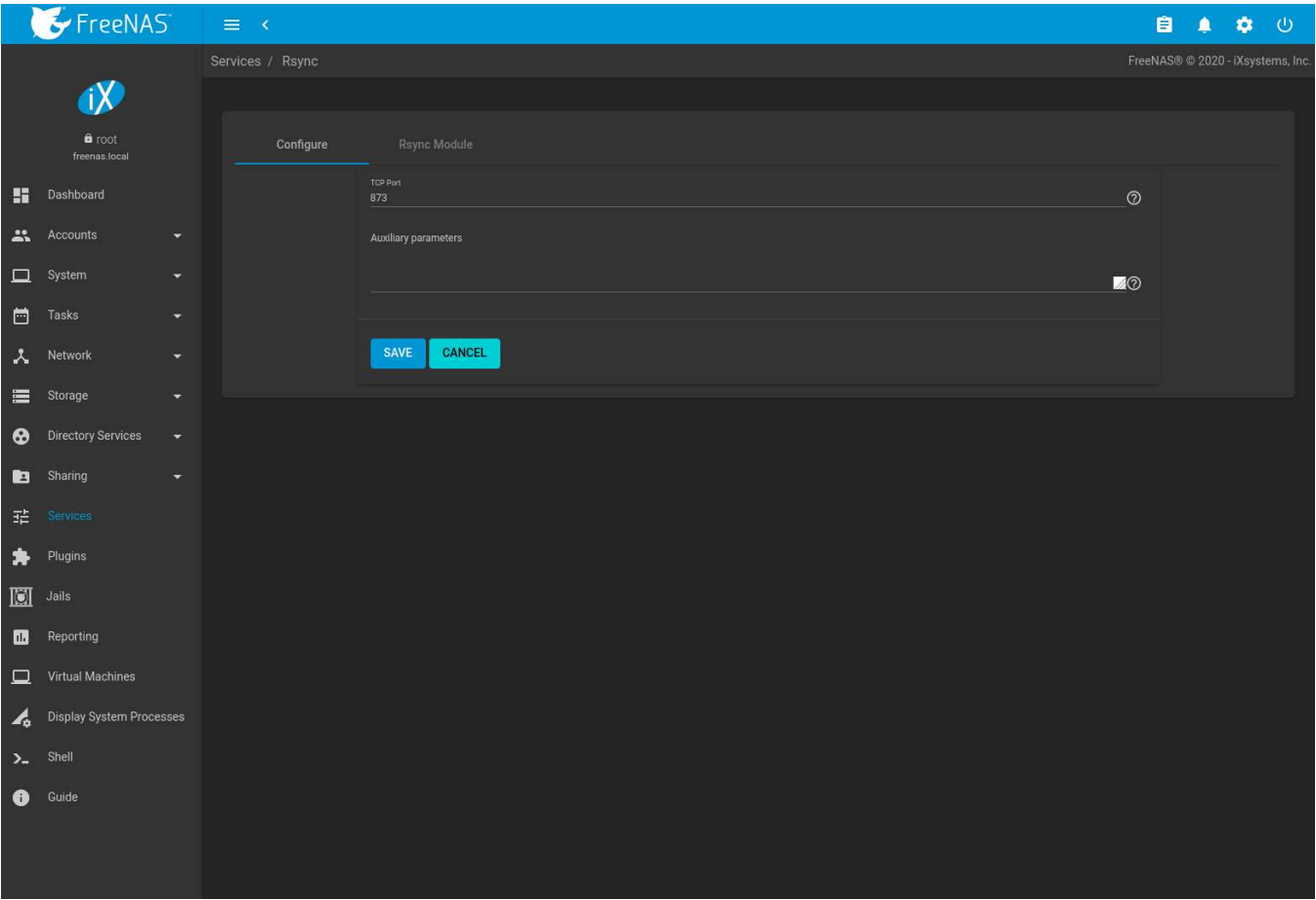


Fig. 13.8: Rsyncd Configuration

Table 13.6 summarizes the configuration options for the rsync daemon:

Table 13.6: Rsyncd Configuration Options

Setting	Value	Description
TCP Port	integer	<code>rsyncd</code> listens on this port. The default is 873.
Auxiliary pa- rameters	string	Enter any additional parameters from <code>rsyncd.conf(5)</code> (https://www.freebsd.org/cgi/man.cgi?query=rsyncd.conf).

13.8.2 Rsync Modules

To add a new Rsync module, go to *Services*, click *EDIT* for the *Rsync* service, select the *Rsync Module* tab, and click *ADD*.

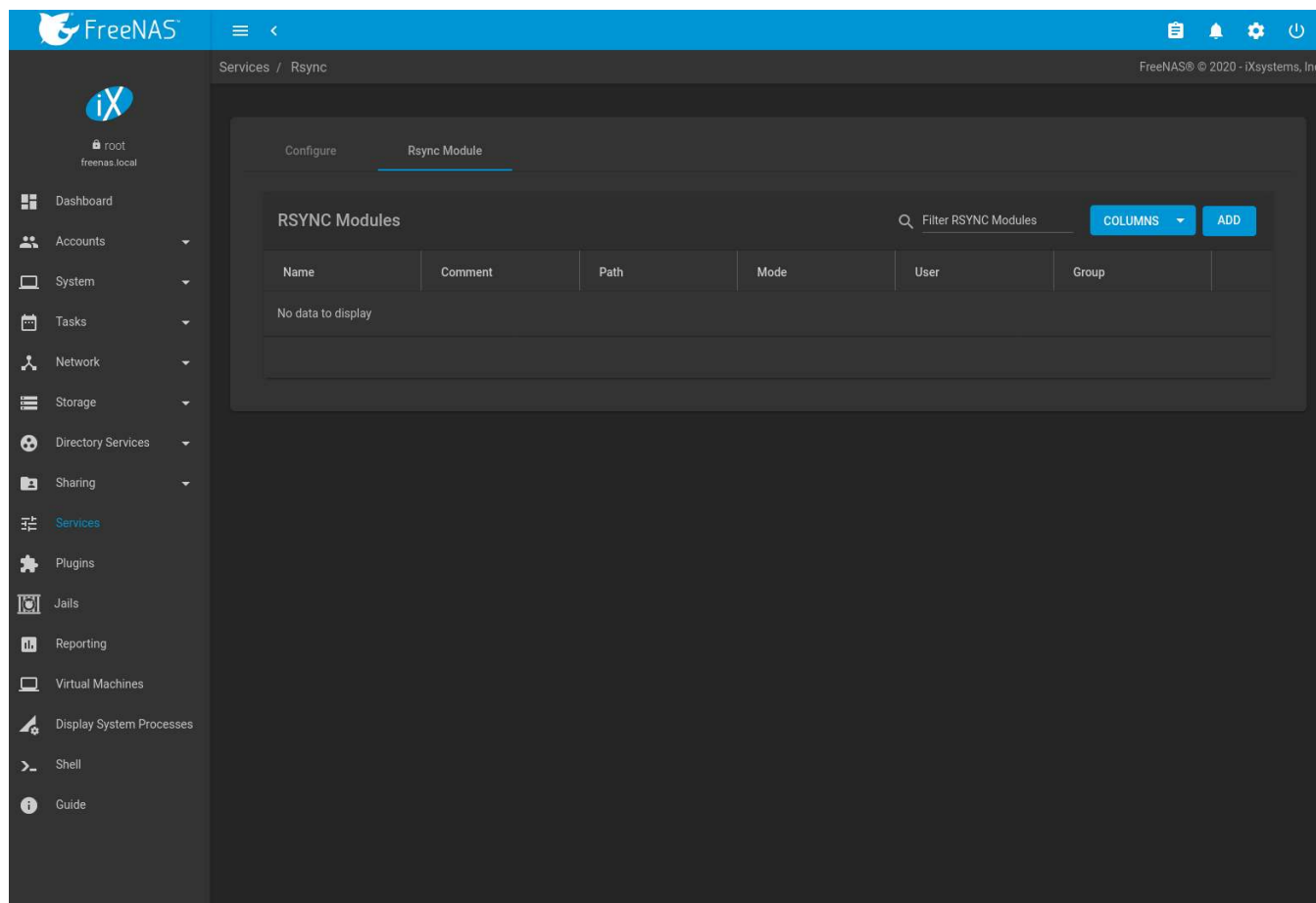


Fig. 13.9: Adding an Rsync Module

Table 13.7 summarizes the configuration options available when creating a rsync module.

Table 13.7: Rsync Module Configuration Options

Setting	Value	Description
Name	string	Module name that matches the name requested by the rsync client.
Comment	string	Describe this module.
Path	file browser	Browse to the pool or dataset to store received data.
Access Mode	drop-down menu	Choose permissions for this rsync module.
Maximum connections	integer	Maximum connections to this module. 0 is unlimited.
User	drop-down menu	User to run as during file transfers to and from this module.
Group	drop-down menu	Group to run as during file transfers to and from this module.
Hosts Allow	string	From rsyncd.conf(5) (https://www.freebsd.org/cgi/man.cgi?query=rsyncd.conf). A list of patterns to match with the hostname and IP address of a connecting client. The connection is rejected if no patterns match. Separate patterns with whitespace or a comma.
Hosts Deny	string	From rsyncd.conf(5) (https://www.freebsd.org/cgi/man.cgi?query=rsyncd.conf). A list of patterns to match with the hostname and IP address of a connecting client. The connection is rejected when the patterns match. Separate patterns with whitespace or a comma.
Auxiliary parameters	string	Enter any additional parameters from rsyncd.conf(5) (https://www.freebsd.org/cgi/man.cgi?query=rsyncd.conf).

13.9 S3

S3 is a distributed or clustered filesystem protocol compatible with Amazon S3 cloud storage. The FreeNAS® S3 service uses [Minio](https://minio.io/) (<https://minio.io/>) to provide S3 storage hosted on the FreeNAS® system itself. Minio also provides features beyond the limits of the basic Amazon S3 specifications.

Figure 13.10 shows the S3 service configuration screen and Table 13.8 summarizes the configuration options. After configuring the S3 service, start it in *Services*.

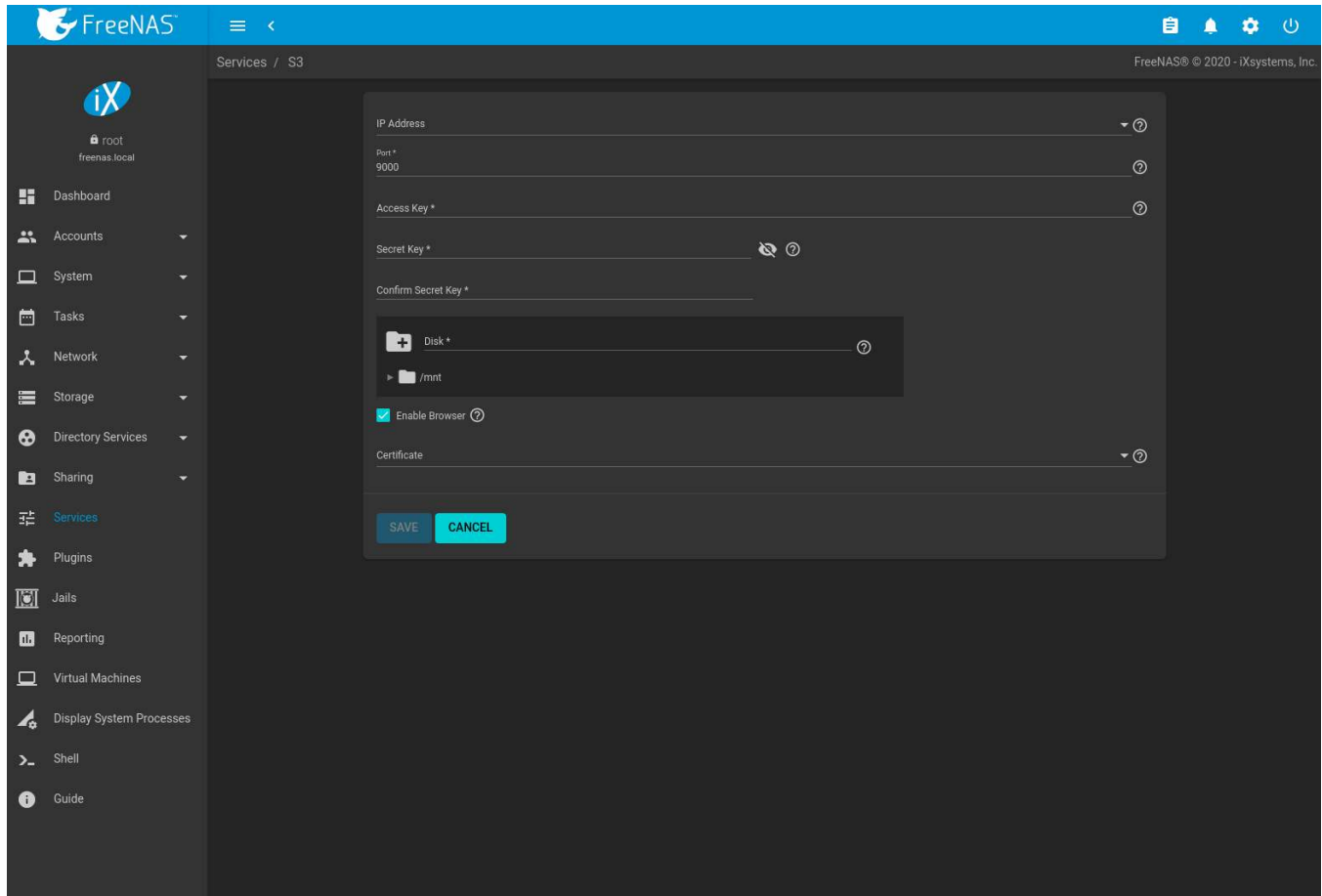


Fig. 13.10: Configuring S3

Table 13.8: S3 Configuration Options

Setting	Value	Description
IP Address	drop-down menu	Enter the IP address to run the S3 service. <i>0.0.0.0</i> sets the server to listen on all addresses.
Port	string	Enter the TCP port on which to provide the S3 service. Default is <i>9000</i> .
Access Key	string	Enter the S3 user name. This username must contain only alphanumeric characters and be between 5 and 20 characters long.
Secret Key	string	Enter the password to be used by connecting S3 systems. The key must contain only alphanumeric characters and be at least 8 but no more than 40 characters long.
Confirm Secret Key	string	Re-enter the S3 password to confirm.

Continued on next page

Table 13.8 – continued from previous page

Setting	Value	Description
Disk	browse	Directory where the S3 filesystem will be mounted. Ownership of this directory and all subdirectories is set to <i>minio:minio</i> . Create a separate dataset (page 177) for Minio to avoid issues with conflicting directory permissions or ownership.
Enable Browser	checkbox	Set to enable the web user interface for the S3 service.
Certificate	drop-down menu	Add the SSL certificate (page 113) to be used for secure S3 connections.

13.10 S.M.A.R.T.


S.M.A.R.T., or [Self-Monitoring, Analysis, and Reporting Technology](https://en.wikipedia.org/wiki/S.M.A.R.T.) (<https://en.wikipedia.org/wiki/S.M.A.R.T.>), is an industry standard for disk monitoring and testing. Drives can be monitored for status and problems, and several types of self-tests can be run to check the drive health.

Tests run internally on the drive. Most tests can run at the same time as normal disk usage. However, a running test can greatly reduce drive performance, so they should be scheduled at times when the system is not busy or in normal use. It is very important to avoid scheduling disk-intensive tests at the same time. For example, do not schedule S.M.A.R.T. tests to run at the same time, or preferably, even on the same days as [Scrub Tasks](#) (page 144).

Of particular interest in a NAS environment are the *Short* and *Long* S.M.A.R.T. tests. Details vary between drive manufacturers, but a *Short* test generally does some basic tests of a drive that takes a few minutes. The *Long* test scans the entire disk surface, and can take several hours on larger drives.

FreeNAS® uses the [smartd\(8\)](https://www.smartmontools.org/browser/trunk/smartmontools/smartd.8.in) (<https://www.smartmontools.org/browser/trunk/smartmontools/smartd.8.in>) service to monitor S.M.A.R.T. information, including disk temperature. A complete configuration consists of:

1. Scheduling when S.M.A.R.T. tests are run. S.M.A.R.T. tests are created by navigating to *Tasks* → *S.M.A.R.T. Tests*, and clicking *ADD*.
2. Enabling or disabling S.M.A.R.T. for each disk member of a pool in *Storage* → *Pools*. This setting is enabled by default for disks that support S.M.A.R.T.
3. Checking the configuration of the S.M.A.R.T. service as described in this section.
4. Starting the S.M.A.R.T. service in *Services*.

[Figure 13.11](#) shows the configuration screen that appears after going to *Services* → *S.M.A.R.T* and clicking  (Configure).

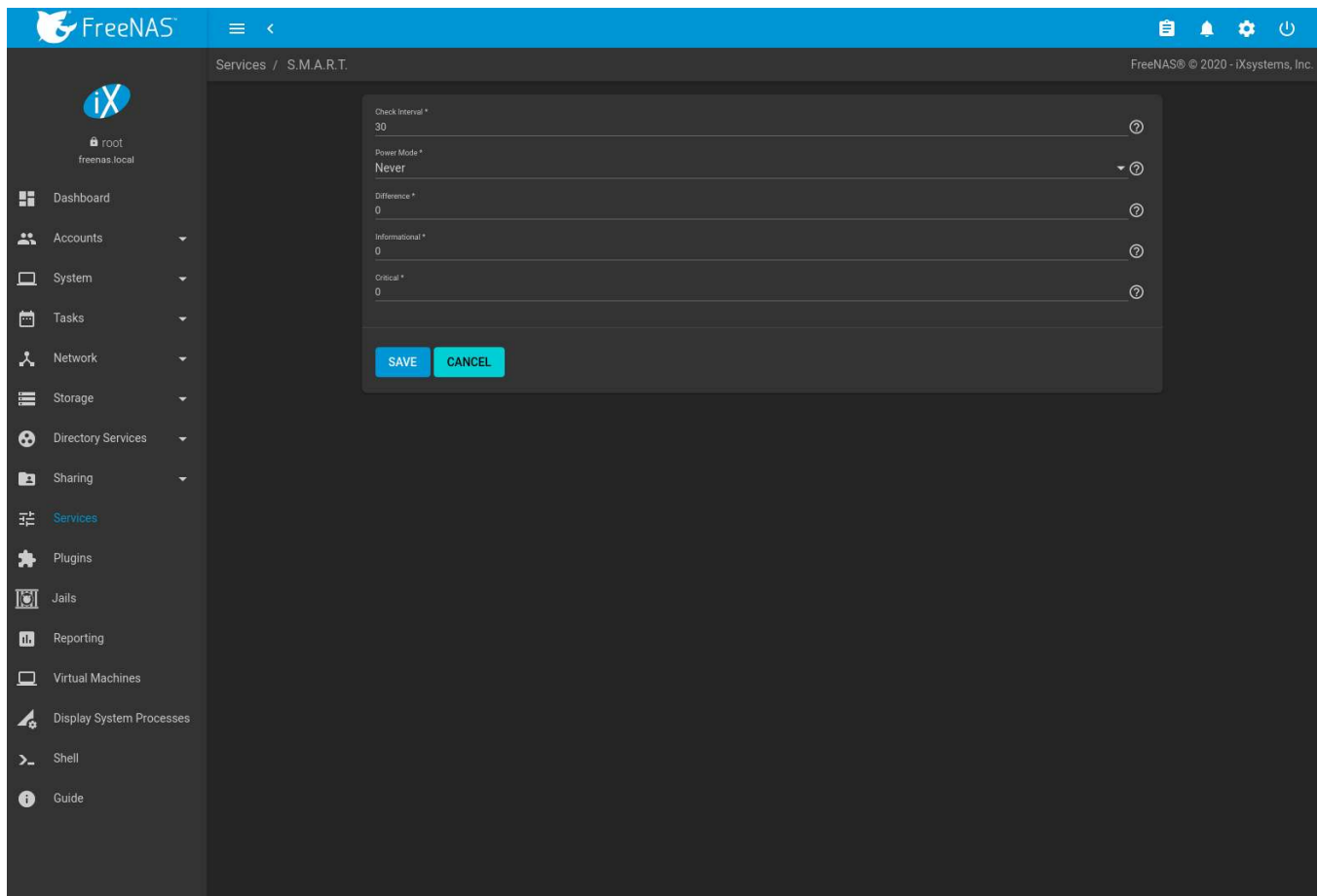


Fig. 13.11: S.M.A.R.T Configuration Options

Note: `smartd` wakes up at the configured *Check Interval*. It checks the times configured in *Tasks* → *S.M.A.R.T. Tests* to see if a test must begin. Since the smallest time increment for a test is an hour, it does not make sense to set a *Check Interval* value higher than 60 minutes. For example, if the *Check Interval* is set to 120 minutes and the smart test to every hour, the test will only be run every two hours because `smartd` only activates every two hours.

Table 13.9 summarizes the options in the S.M.A.R.T configuration screen.

Table 13.9: S.M.A.R.T Configuration Options

Setting	Value	Description
Check Interval	integer	Define in minutes how often <code>smartd</code> activates to check if any tests are configured to run.
Power Mode	drop-down menu	Tests are only performed when <i>Never</i> is selected. Choices are: <i>Never</i> , <i>Sleep</i> , <i>Standby</i> , or <i>Idle</i> .
Difference	integer in degrees Celsius	Enter number of degrees in Celsius. S.M.A.R.T reports if the temperature of a drive has changed by N degrees Celsius since the last report. Default of 0 disables this option.
Informational	integer in degrees Celsius	Enter a threshold temperature in Celsius. S.M.A.R.T will message with a log level of LOG_INFO if the temperature is higher than the threshold. Default of 0 disables this option.
Critical	integer in degrees Celsius	Enter a threshold temperature in Celsius. S.M.A.R.T will message with a log level of LOG_CRIT and send an email if the temperature is higher than the threshold. Default of 0 disables this option.

13.11 SMB

Note: After starting the SMB service, it can take several minutes for the [master browser election](https://www.samba.org/samba/docs/old/Samba3-HOWTO/NetworkBrowsing.html#id2581357) (<https://www.samba.org/samba/docs/old/Samba3-HOWTO/NetworkBrowsing.html#id2581357>) to occur and for the FreeNAS® system to become available in Windows Explorer.

Figure 13.12 shows the global configuration options which apply to all SMB shares. This configuration screen displays the configurable options from [smb4.conf](https://www.freebsd.org/cgi/man.cgi?query=smb4.conf) (<https://www.freebsd.org/cgi/man.cgi?query=smb4.conf>).

These options are described in Table 13.10.

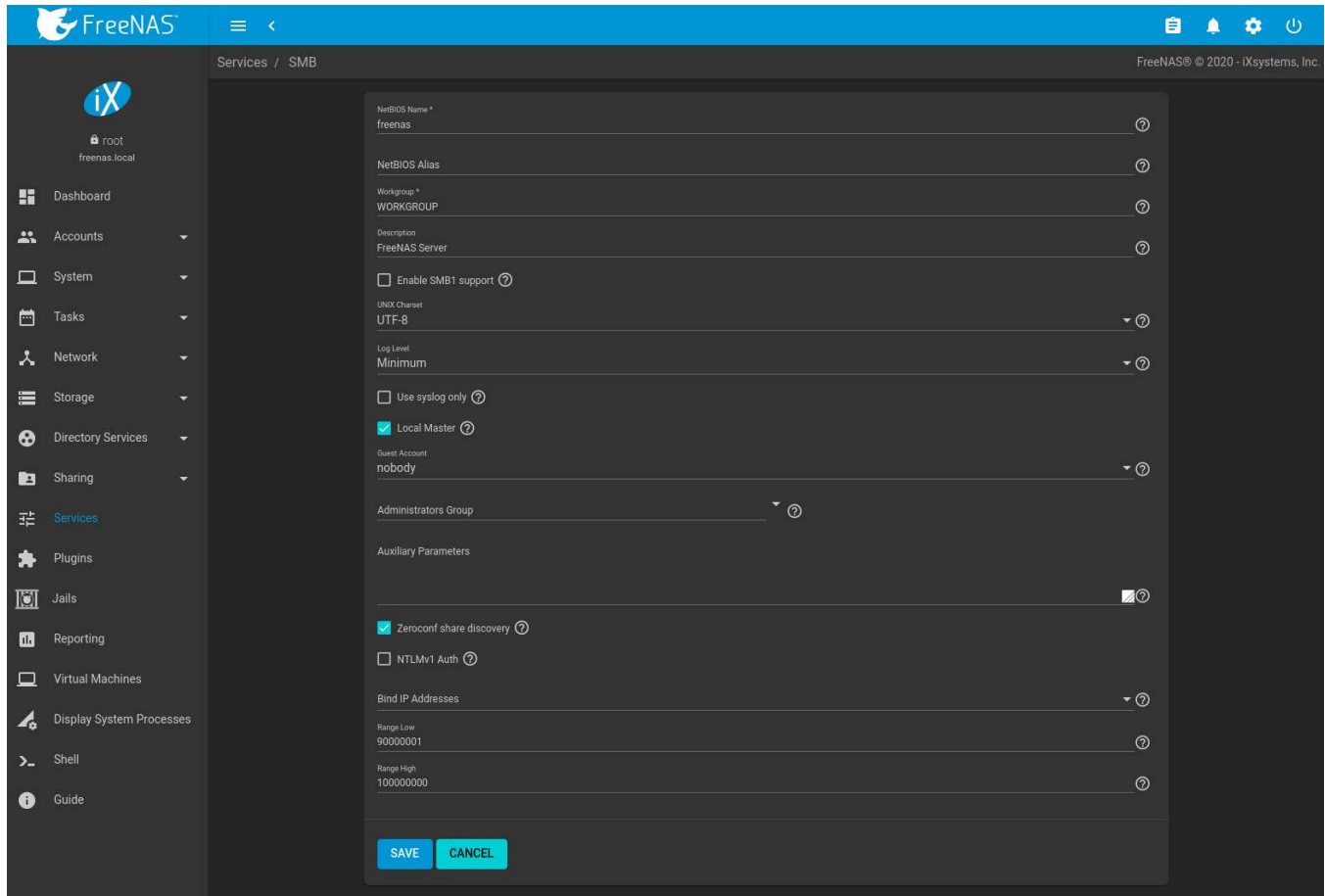


Fig. 13.12: Global SMB Configuration

Table 13.10: Global SMB Configuration Options

Setting	Value	Description
NetBIOS Name	string	Automatically populated with the original hostname of the system. Limited to 15 characters. It must be different from the <i>Workgroup</i> name.
NetBIOS Alias	string	Enter any aliases, separated by spaces. Each alias cannot be longer than 15 characters.
Workgroup	string	Must match the Windows workgroup name. This setting is ignored if the Active Directory (page 198) or LDAP (page 203) service is running.
Description	string	Enter a server description. Optional.

Continued on next page

Table 13.10 – continued from previous page

Setting	Value	Description
Enable SMB1 support	checkbox	Allow legacy SMB clients to connect to the server. Warning: SMB1 is not secure and has been deprecated by Microsoft. See Do Not Use SMB1 (https://www.ixsystems.com/blog/library/do-not-use-smb1/).
UNIX Charset	drop-down menu	Default is <i>UTF-8</i> which supports all characters in all languages.
Log Level	drop-down menu	Choices are <i>Minimum</i> , <i>Normal</i> , or <i>Debug</i> .
Use syslog only	checkbox	Set to log authentication failures in <code>/var/log/messages</code> instead of the default of <code>/var/log/samba4/log.smbd</code> .
Local Master	checkbox	Set to determine if the system participates in a browser election. Disable when network contains an AD or LDAP server or Vista or Windows 7 machines are present.
Guest Account	drop-down menu	Select the account to be used for guest access. Default is <i>nobody</i> . Account must have permission to access the shared pool or dataset. If Guest Account user is deleted, resets to <i>nobody</i> .
Administrators Group	drop-down menu	Members of this group are local admins and automatically have privileges to take ownership of any file in an SMB share, reset permissions, and administer the SMB server through the Computer Management MMC snap-in.
Auxiliary Parameters	string	Add any <code>smb.conf</code> options not covered elsewhere in this screen. See the Samba Guide (https://www.oreilly.com/openbook/samba/book/appb_02.html) for additional settings.
Zeroconf share discovery	checkbox	Enable if Mac clients will be connecting to the SMB share.
NTLMv1 Auth	checkbox	Set to allow NTLMv1 authentication. Required by Windows XP clients and sometimes by clients in later versions of Windows.
Bind IP Addresses	checkboxes	Static IP addresses which SMB listens on for connections. Leaving all unselected defaults to listening on all active interfaces.
Range Low	integer	Range Low and Range High set the range of UID/GID numbers which this IDMap backend translates. If an external credential like a Windows SID maps to a UID or GID number outside this range, the external credential is ignored.
Range High	integer	

Changes to SMB settings take effect immediately. Changes to share settings only take effect after the client and server negotiate a new session.

Note: Do not set the *directory name cache size* as an *Auxiliary Parameter*. Due to differences in how Linux and BSD handle file descriptors, directory name caching is disabled on BSD systems to improve performance.

Note: *SMB* (page 270) cannot be disabled while *Active Directory* (page 198) is enabled.

13.11.1 Troubleshooting SMB

Do not connect to SMB shares as `root`, and do not add the root user in the SMB user database. There are security implications in attempting to do so, and Samba 4 and later take measures to prevent such actions. This can produce `auth_check_ntlm_password` and `FAILED` with error `NT_STATUS_WRONG_PASSWORD` errors.

Samba is single threaded, so CPU speed makes a big difference in SMB performance. A typical 2.5Ghz Intel quad core or greater should be capable of handling speeds in excess of Gb LAN while low power CPUs such as Intel Atoms and AMD C-30sE-350E-450 will not be able to achieve more than about 30-40MB/sec typically. Remember that other loads such as ZFS will also require CPU resources and may cause Samba performance to be less than optimal.

Samba's *write cache* parameter has been reported to improve write performance in some configurations and can be added to the *Auxiliary parameters* field. Use an integer value which is a multiple of `_SC_PAGESIZE` (typically 4096) to avoid memory fragmentation. This will increase Samba's memory requirements and should not be used on systems with limited RAM.

Windows automatically caches file sharing information. If changes are made to an SMB share or to the permissions of a pool or dataset being shared by SMB and the share becomes inaccessible, log out and back in to the Windows system. Alternately, users can type `net use /delete` from the command line to clear their SMB sessions.

Windows also automatically caches login information. To require users to log in every time they access the system, reduce the cache settings on the client computers.

Where possible, avoid using a mix of case in filenames as this can cause confusion for Windows users. [Representing and resolving filenames with Samba](https://www.oreilly.com/openbook/samba/book/ch05_04.html) (https://www.oreilly.com/openbook/samba/book/ch05_04.html) explains in more detail.

If a particular user cannot connect to a SMB share, ensure their password does not contain the `?` character. If it does, have the user change the password and try again.

If the SMB service will not start, run this command from *Shell* (page 335) to see if there is an error in the configuration:

```
testparm /usr/local/etc/smb4.conf
```

If clients have problems connecting to the SMB share, go to *Services* → *SMB* → *Configure* and verify that *Server maximum protocol* is set to *SMB2*.

Using a dataset for SMB sharing is recommended. When creating the dataset, make sure that the *Share type* is set to *SMB*.

Do not use `chmod` to attempt to fix the permissions on a SMB share as it destroys the Windows ACLs. The correct way to manage permissions on a SMB share is to manage the share security from a Windows system as either the owner of the share or a member of the group that owns the share. To do so, right-click on the share, click *Properties* and navigate to the *Security* tab. If the ACLs are already destroyed by using `chmod`, `winacl` can be used to fix them. Type `winacl` from *Shell* (page 335) for usage instructions.

The [Common Errors](https://www.samba.org/samba/docs/old/Samba3-HOWTO/domain-member.html#id2573692) (<https://www.samba.org/samba/docs/old/Samba3-HOWTO/domain-member.html#id2573692>) section of the Samba documentation contains additional troubleshooting tips.

The Samba [Performance Tuning](https://wiki.samba.org/index.php/Performance_Tuning) (https://wiki.samba.org/index.php/Performance_Tuning) page describes options to improve performance.

Directory listing speed in folders with a large number of files is sometimes a problem. A few specific changes can help improve the performance. However, changing these settings can affect other usage. In general, the defaults are adequate. **Do not change these settings unless there is a specific need.**

- *Log Level* can also have a performance penalty. When not needed, it can be disabled or reduced in the [global SMB service options](#) (page 270).
- Make Samba datasets case insensitive by setting *Case Sensitivity* to *Insensitive* when creating them. This ZFS property is only available when creating a dataset. It cannot be changed on an existing dataset. To convert such datasets, back up the data, create a new case-insensitive dataset, create an SMB share on it, set the share level auxiliary parameter *case sensitive = true*, then copy the data from the old one onto it. After the data has been checked and verified on the new share, the old one can be deleted.
- If present, remove options for extended attributes and DOS attributes in the [Auxiliary Parameters](#) (page 240) for the share.
- Disable as many *VFS Objects* as possible in the [share settings](#) (page 240). Many have performance overhead.

13.12 SNMP

SNMP (Simple Network Management Protocol) is used to monitor network-attached devices for conditions that warrant administrative attention. FreeNAS® uses [Net-SNMP](http://net-snmp.sourceforge.net/) (<http://net-snmp.sourceforge.net/>) to provide SNMP. When starting the SNMP service, this port will be enabled on the FreeNAS® system:

- UDP 161 (listens here for SNMP requests)

Available MIBs are located in `/usr/local/share/snmp/mibs`.

Figure 13.13 shows the *Services* → *SNMP* → *Configure* screen. Table 13.11 summarizes the configuration options.

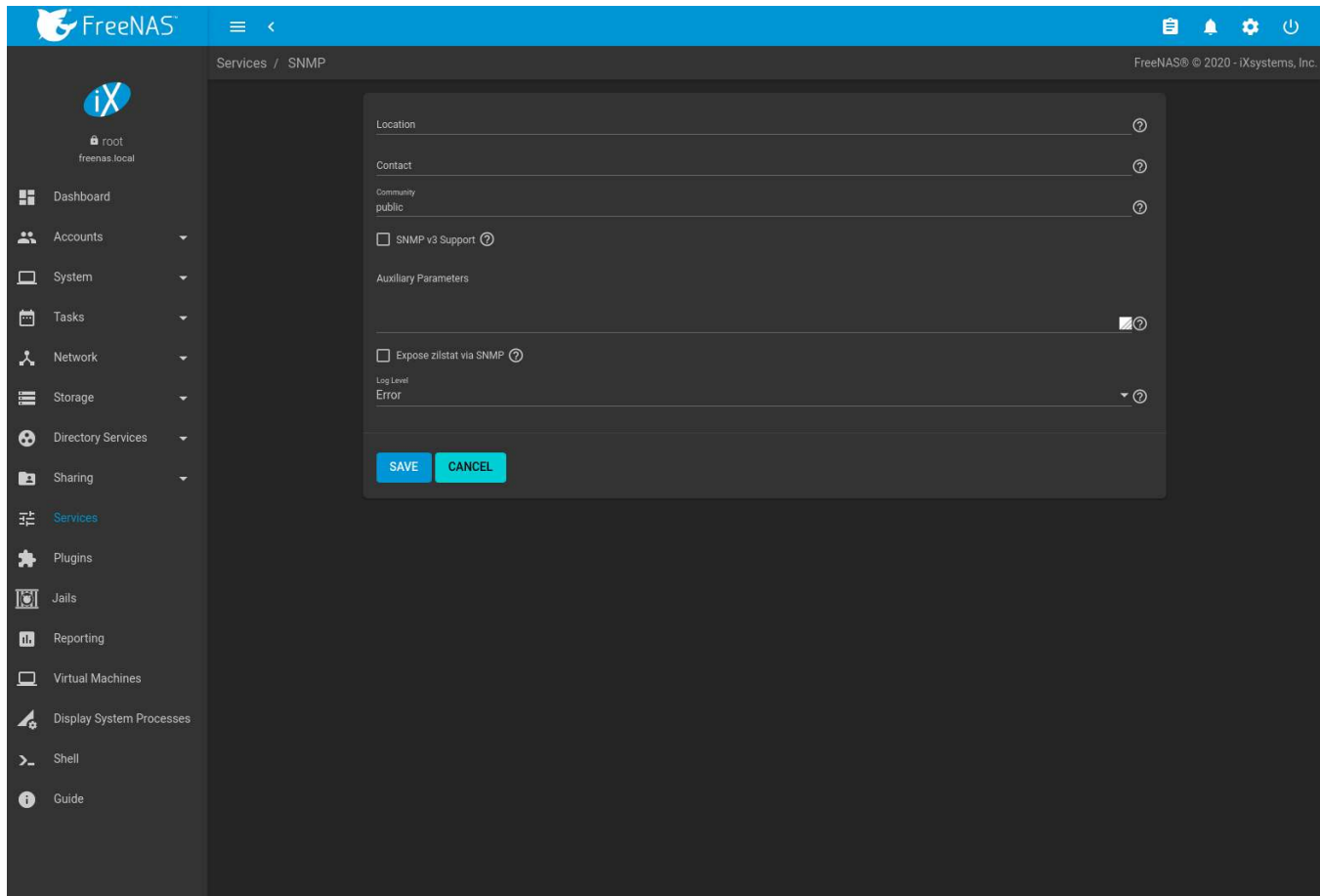


Fig. 13.13: Configuring SNMP

Table 13.11: SNMP Configuration Options

Setting	Value	Description
Location	string	Enter the location of the system.
Contact	string	Enter an email address to receive messages from the SNMP service.
Community	string	Change from <i>public</i> to increase system security. Can only contain alphanumeric characters, underscores, dashes, periods, and spaces. This can be left empty for SNMPv3 networks.
SNMP v3 Support	checkbox	Set to enable support for SNMP version 3 (https://tools.ietf.org/html/rfc3410). See snmpd.conf(5) (http://net-snmp.sourceforge.net/docs/man/snmpd.conf.html) for more information about configuring this and the <i>Authentication Type</i> , <i>Password</i> , <i>Privacy Protocol</i> , and <i>Privacy Passphrase</i> fields.

Continued on next page

Table 13.11 – continued from previous page

Setting	Value	Description
Username	string	Only applies if <i>SNMP v3 Support</i> is set. Enter a username to register with this service.
Authentication Type	drop-down menu	Only applies if <i>SNMP v3 Support</i> is enabled. Choices are <i>MD5</i> or <i>SHA</i> .
Password	string	Only applies if <i>SNMP v3 Support</i> is enabled. Enter and confirm a password of at least eight characters.
Privacy Protocol	drop-down menu	Only applies if <i>SNMP v3 Support</i> is enabled. Choices are <i>AES</i> or <i>DES</i> .
Privacy Passphrase	string	Enter a separate privacy passphrase. <i>Password</i> is used when this is left empty.
Auxiliary Parameters	string	Enter additional snmpd.conf(5) (https://www.freebsd.org/cgi/man.cgi?query=snmpd.conf) options. Add one option for each line.
Expose zilstat via SNMP	checkbox	Enabling this option may have pool performance implications.
Log Level	drop-down menu	Choose how many log entries to create. Choices range from the least log entries (Emergency) to the most (Debug).

Zenoss (<https://www.zenoss.com/>) provides a seamless monitoring service through SNMP for FreeNAS® called **TrueNAS ZenPack** (<https://www.zenoss.com/product/zenpacks/truenas>).

13.13 SSH

Secure Shell (SSH) is used to transfer files securely over an encrypted network. When a FreeNAS® system is used as an SSH server, the users in the network must use [SSH client software](https://en.wikipedia.org/wiki/Comparison_of_SSH_clients) (https://en.wikipedia.org/wiki/Comparison_of_SSH_clients) to transfer files with SSH.

This section shows the FreeNAS® SSH configuration options, demonstrates an example configuration that restricts users to their home directory, and provides some troubleshooting tips.

[Figure 13.14](#) shows the *Services* → *SSH* → *Configure* screen.

Note: After configuring SSH, remember to start it in *Services* by clicking the sliding button in the *SSH* row. The sliding button moves to the right when the service is running.

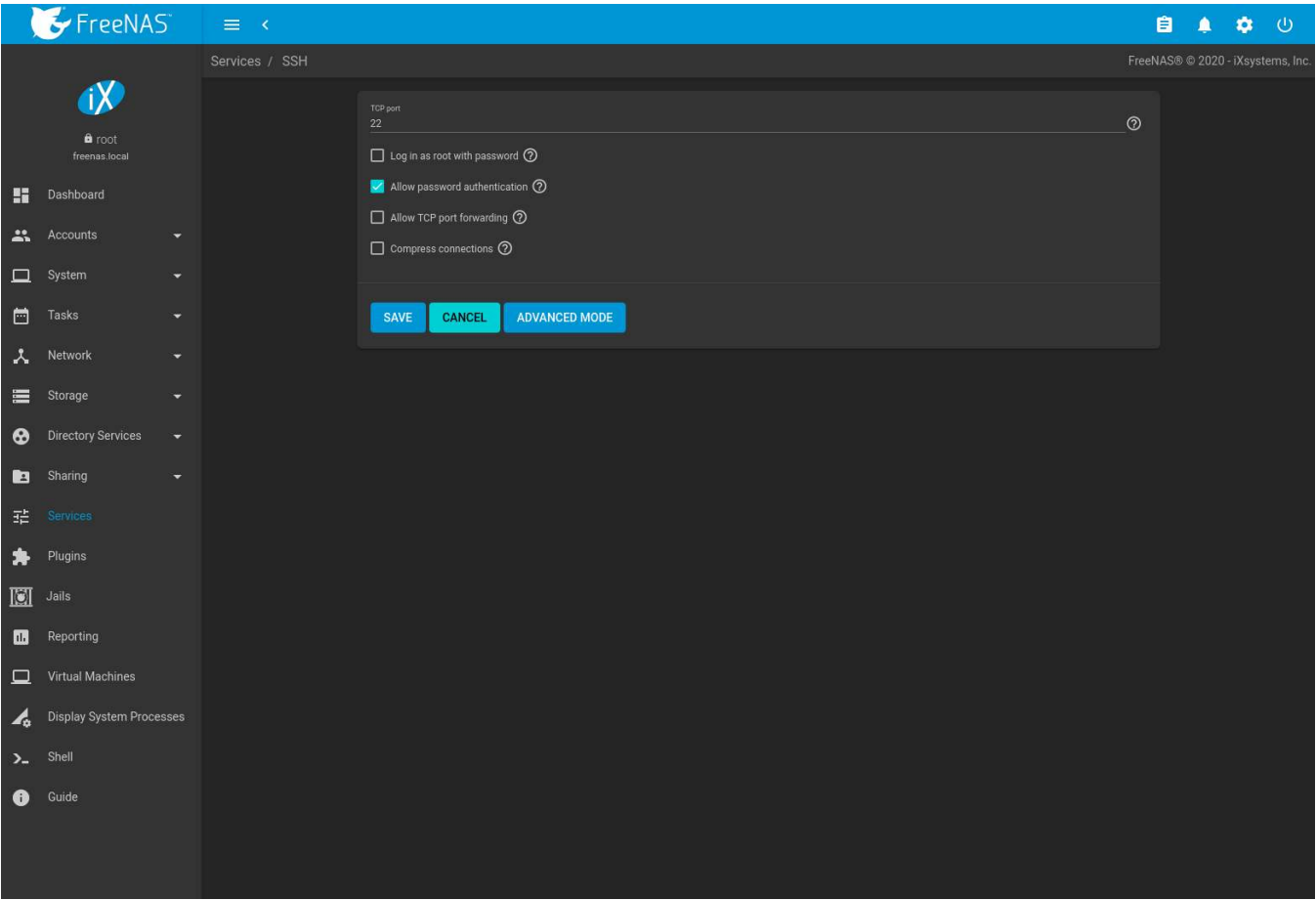


Fig. 13.14: SSH Configuration

Table 13.12 summarizes the configuration options. Some settings are only available in *Advanced Mode*. To see these settings, either click the *ADVANCED MODE* button, or configure the system to always display these settings by enabling the *Show advanced fields by default* option in *System* → *Advanced*.

Table 13.12: SSH Configuration Options

Setting	Value	Advanced Mode	Description
Bind interfaces	selection	✓	By default, SSH listens on all interfaces unless specific interfaces are selected in this drop-down menu.
TCP port	integer		Port to open for SSH connection requests. 22 by default.
Log in as root with password	checkbox		As a security precaution, root logins are discouraged and disabled by default. If enabled, password must be set for the <i>root</i> user in <i>Users</i> .
Allow password authentication	checkbox		Unset to require key-based authentication for all users. This requires additional setup (http://the.earth.li/~sgtatham/putty/0.55/html/doc/Chapter8.html) on both the SSH client and server.
Allow kerberos authentication	checkbox	✓	Ensure Kerberos Realms (page 207) and Kerberos Keytabs (page 208) are configured and FreeNAS® can communicate with the Kerberos Domain Controller (KDC) before enabling this option.

Continued on next page

Table 13.12 – continued from previous page

Setting	Value	Advanced Mode	Description
Allow TCP port forwarding	checkbox		Set to allow users to bypass firewall restrictions using the SSH port forwarding feature (https://www.symantec.com/connect/articles/ssh-port-forwarding).
Compress connections	checkbox		Set to attempt to reduce latency over slow networks.
SFTP log level	drop-down menu	✓	Select the syslog(3) (https://www.freebsd.org/cgi/man.cgi?query=syslog) level of the SFTP server.
SFTP log facility	drop-down menu	✓	Select the syslog(3) (https://www.freebsd.org/cgi/man.cgi?query=syslog) facility of the SFTP server.
Extra options	string	✓	Add any additional sshd_config(5) (https://www.freebsd.org/cgi/man.cgi?query=sshd_config) options not covered in this screen, one per line. These options are case-sensitive and misspellings can prevent the SSH service from starting.

Here are some recommendations for the *Extra options*:

- Add `NoneEnabled no` to disable the insecure `none` cipher.
- Increase the `ClientAliveInterval` if SSH connections tend to drop.
- `ClientMaxStartup` defaults to `10`. Increase this value when more concurrent SSH connections are required.

13.13.1 SCP Only

When SSH is configured, authenticated users with a user account can use `ssh` to log into the FreeNAS® system over the network. User accounts are created by navigating to *Accounts* → *Users*, and clicking *ADD*. The user home directory is the pool or dataset specified in the *Home Directory* field of the FreeNAS® account for that user. While the SSH login defaults to the user home directory, users are able to navigate outside their home directory, which can pose a security risk.

It is possible to allow users to use `scp` and `sftp` to transfer files between their local computer and their home directory on the FreeNAS® system, while restricting them from logging into the system using `ssh`. To configure this scenario, go to *Accounts* → *Users*, click *:* (Options) for the user, and then *Edit*. Change the *Shell* to `scponly`. Repeat for each user that needs restricted SSH access.

Test the configuration from another system by running the `sftp`, `ssh`, and `scp` commands as the user. `sftp` and `scp` will work but `ssh` will fail.

Note: Some utilities like WinSCP and Filezilla can bypass the `scponly` shell. This section assumes users are accessing the system using the command line versions of `scp` and `sftp`.

13.13.2 Troubleshooting SSH

Keywords listed in [sshd_config\(5\)](https://www.freebsd.org/cgi/man.cgi?query=sshd_config) (https://www.freebsd.org/cgi/man.cgi?query=sshd_config) are case sensitive. This is important to remember when adding any *Extra options*. The configuration will not function as intended if the upper and lowercase letters of the keyword are not an exact match.

If clients are receiving “reverse DNS” or timeout errors, add an entry for the IP address of the FreeNAS® system in the *Host name database* field of *Network* → *Global Configuration*.

When configuring SSH, always test the configuration as an SSH user account to ensure the user is limited by the configuration and they have permission to transfer files within the intended directories. If the user account is experiencing problems, the SSH error messages are specific in describing the problem. Type this command within *Shell* (page 335) to read these messages as they occur:

```
tail -f /var/log/messages
```

Additional messages regarding authentication errors are found in `/var/log/auth.log`.

13.14 TFTP

Trivial File Transfer Protocol (TFTP) is a light-weight version of FTP typically used to transfer configuration or boot files between machines, such as routers, in a local environment. TFTP provides an extremely limited set of commands and provides no authentication.

If the FreeNAS® system will be used to store images and configuration files for network devices, configure and start the TFTP service. Starting the TFTP service opens UDP port 69.

Figure 13.15 shows the TFTP configuration screen and Table 13.13 summarizes the available options.

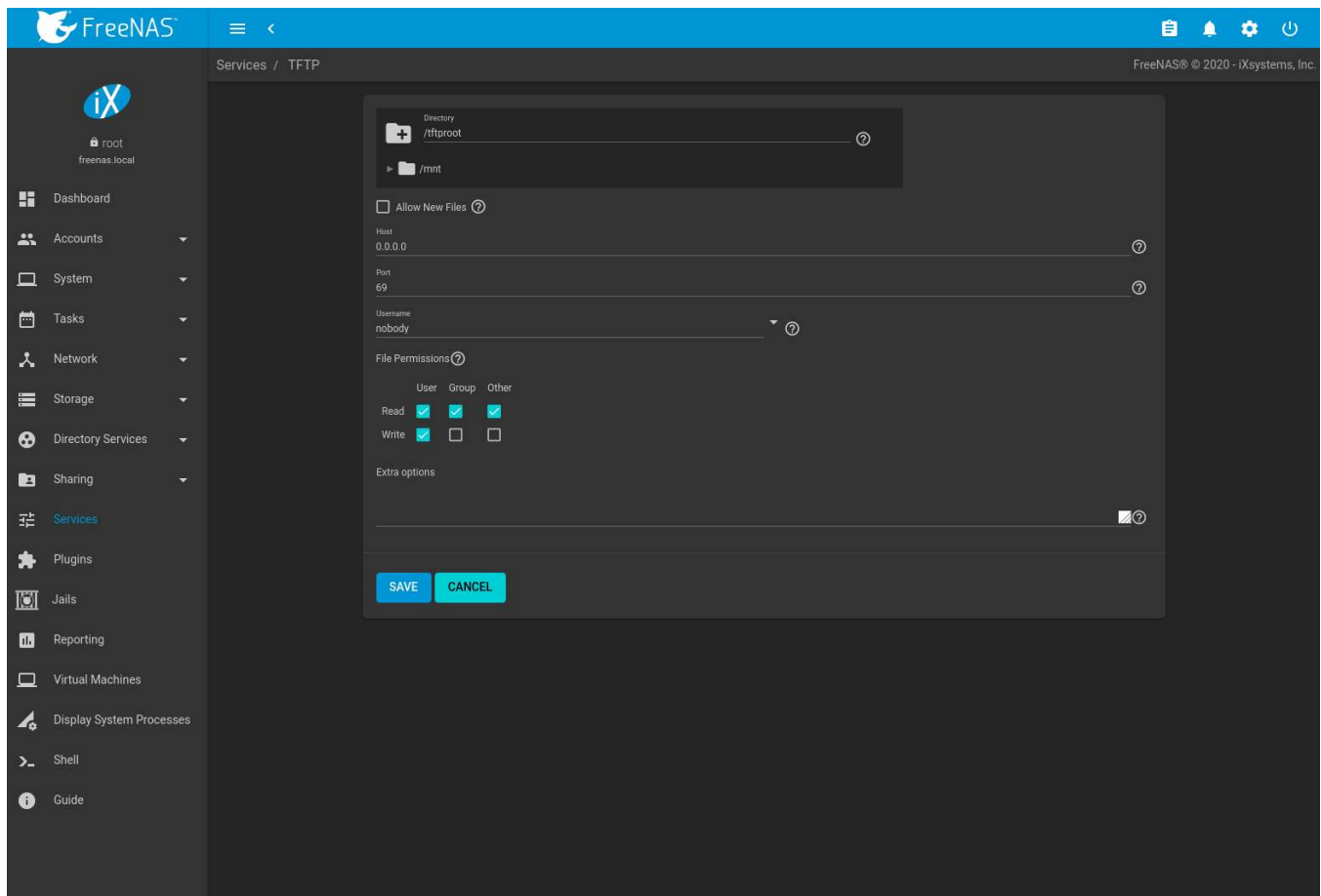


Fig. 13.15: TFTP Configuration

Table 13.13: TFTP Configuration Options

Setting	Value	Description
Directory	Browse button	Browse to an existing directory to be used for storage. Some devices require a specific directory name, refer to the device documentation for details.
Allow New Files	checkbox	Set when network devices need to send files to the system. For example, to back up their configuration.
Host	IP address	The default host to use for TFTP transfers. Enter an IP address. Example: <i>192.0.2.1</i> .
Port	integer	The UDP port number that listens for TFTP requests. Example: <i>8050</i> .
Username	drop-down menu	Select the account to use for TFTP requests. This account must have permission to the <i>Directory</i> .
File Permissions	checkboxes	Set permissions for newly created files. The default is everyone can read and only the owner can write. Some devices require less strict permissions.
Extra options	string	Add more options from tftpd(8) (https://www.freebsd.org/cgi/man.cgi?query=tftpd) Add one option on each line.

13.15 UPS

FreeNAS® uses [NUT](https://networkupstools.org/) (https://networkupstools.org/) (Network UPS Tools) to provide UPS support. If the FreeNAS® system is connected to a UPS device, configure the UPS service in *Services* → *UPS* → *Configure*.

Figure 13.16 shows the UPS configuration screen:

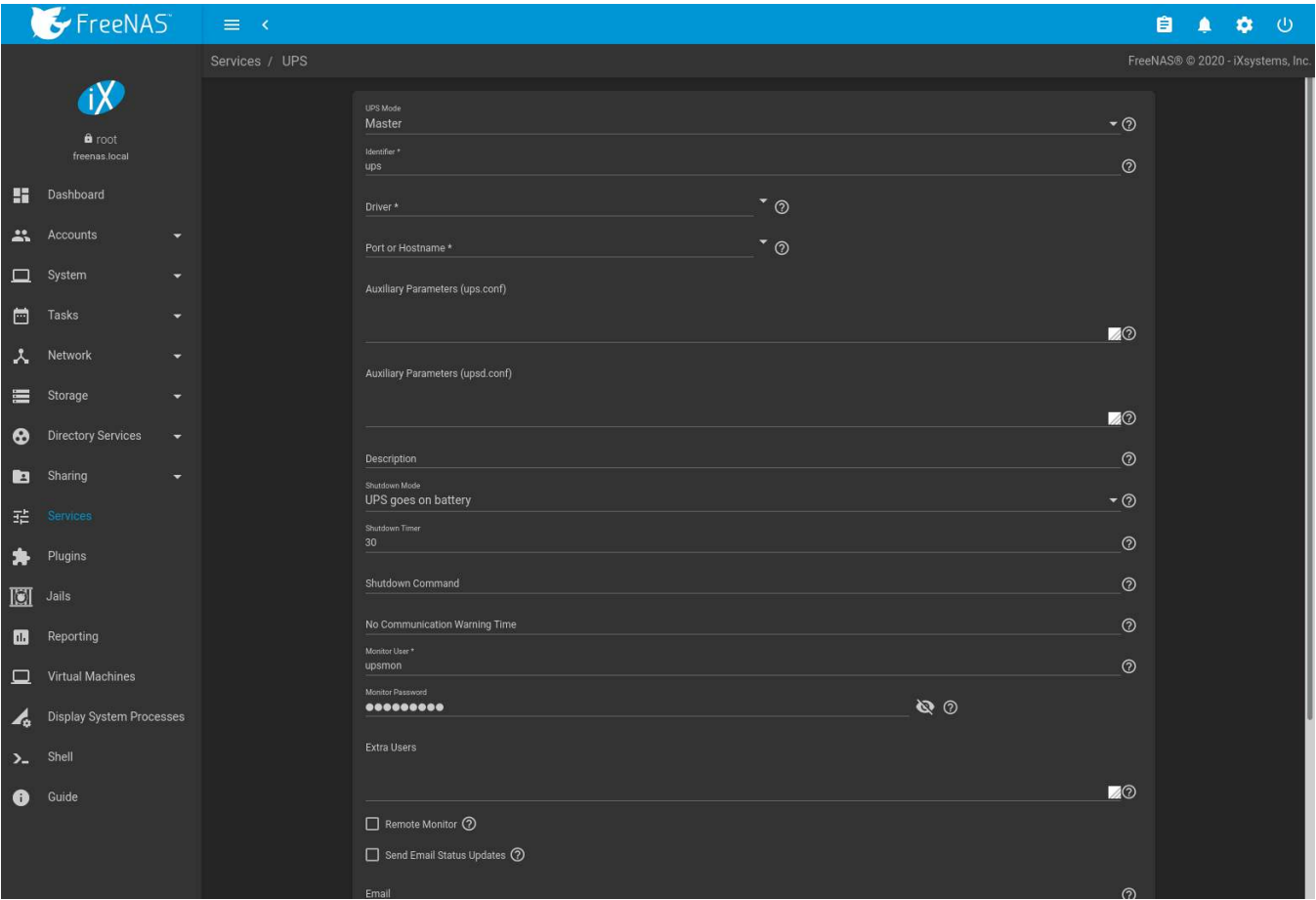


Fig. 13.16: UPS Configuration Screen

Table 13.14 summarizes the options in the UPS Configuration screen.

Table 13.14: UPS Configuration Options

Setting	Value	Description
UPS Mode	drop-down menu	Select <i>Master</i> if the UPS is plugged directly into the system serial port. The UPS will remain the last item to shut down. Select <i>Slave</i> to have the system shut down before <i>Master</i> .
Identifier	string	Required. Describe the UPS device. Can contain alphanumeric, period, comma, hyphen, and underscore characters.
Driver / Remote Host	combo-box	Required. For a list of supported devices, see the Network UPS Tools compatibility list (https://networkupstools.org/stable-hcl.html). The field suggests drivers based on the text entered. To search for a specific driver, begin typing the name of the driver. The search is case sensitive. The <i>Driver</i> field changes to <i>Remote Host</i> when <i>UPS Mode</i> is set to <i>Slave</i> . Enter the IP address of the system configured as the <i>UPS Master</i> system. See this post (https://forums.freenas.org/index.php?resources/configuring-ups-support-for-single-or-multiple-freenas-servers.30/) for more details about configuring multiple systems with a single UPS.

Continued on next page

Table 13.14 – continued from previous page

Setting	Value	Description
Port or Hostname	drop-down menu	Serial or USB port connected to the UPS. To automatically detect and manage the USB port settings, open the drop-down menu and select <i>auto</i> . If the specific USB port must be chosen, see this note (page 280) about identifying the USB port used by the UPS. When an SNMP driver is selected, enter the IP address or hostname of the SNMP UPS device. <i>Port or Hostname</i> becomes <i>Remote Port</i> when the <i>UPS Mode</i> is set to <i>Slave</i> . Enter the open network port number of the UPS <i>Master</i> system. The default port is 3493.
Auxiliary Parameters (ups.conf)	string	Enter any additional options from ups.conf(5) (https://www.freebsd.org/cgi/man.cgi?query=ups.conf).
Auxiliary Parameters (upsd.conf)	string	Enter any additional options from upsd.conf(5) (https://www.freebsd.org/cgi/man.cgi?query=upsd.conf).
Description	string	Optional. Describe the UPS service.
Shutdown Mode	drop-down menu	Choose when the UPS initiates shutdown. Choices are <i>UPS goes on battery</i> and <i>UPS reaches low battery</i> .
Shutdown Timer	integer	Select a value in seconds for the UPS to wait before initiating shutdown. Shutdown will not occur if the power is restored while the timer is counting down. This value only applies when <i>Shutdown Mode</i> is set to <i>UPS goes on battery</i> .
Shutdown Command	string	Enter the command to run to shut down the computer when battery power is low or shutdown timer runs out.
No Communication Warning Time	string	Enter a value in seconds to wait before alerting that the service cannot reach any UPS. Warnings continue until the situation is fixed.
Monitor User	string	Required. Enter a user to associate with this service. The recommended default user is <i>upsmon</i> .
Monitor Password	string	Required. Default is the known value <i>fixmepass</i> . Change this to enhance system security. Cannot contain a space or #.
Extra Users	string	Enter accounts that have administrative access. See upsd.users(5) (https://www.freebsd.org/cgi/man.cgi?query=upsd.users) for examples.
Remote Monitor	checkbox	Set for the default configuration to listen on all interfaces using the known values of user: <i>upsmon</i> and password: <i>fixmepass</i> .
Send Email Status Updates	checkbox	Set to enables the FreeNAS® system to send email updates to the configured <i>Email</i> field.
Email	email address	Enter any email addresses to receive status updates. Separate multiple addresses with a semicolon (;).
Email Subject	string	Enter a subject line for email status updates.
Power Off UPS	checkbox	Set for the UPS to power off after shutting down the FreeNAS® system.
Host Sync	integer	Enter a time in seconds for UPSMON(8) (https://www.freebsd.org/cgi/man.cgi?query=upsmon) to wait in master mode for the slaves to disconnect during a shutdown.

Note: For USB devices, the easiest way to determine the correct device name is to enable the *Show console messages* option in *System* → *Advanced*. Plug in the USB device and look for a */dev/ugen* or */dev/uhid* device name in the console messages.

Some UPS models might be unresponsive with the default polling frequency. This can show in FreeNAS® logs as a recurring error like: `libusb_get_interrupt: Unknown error`.

If this error occurs, decrease the polling frequency by adding an entry to *Auxiliary Parameters (ups.conf)*:

`pollinterval = 10`. The default polling frequency is two seconds.

`upsc(8)` (<https://www.freebsd.org/cgi/man.cgi?query=upsc>) can be used to get status variables from the UPS daemon such as the current charge and input voltage. It can be run from *Shell* (page 335) using this syntax:

```
upsc ups@localhost
```

The `upsc(8)` (<https://www.freebsd.org/cgi/man.cgi?query=upsc>) man page gives some other usage examples.

`upscmd(8)` (<https://www.freebsd.org/cgi/man.cgi?query=upscmd>) can be used to send commands directly to the UPS, assuming the hardware supports the command being sent. Only users with administrative rights can use this command. These users are created in the *Extra users* field.

13.15.1 Multiple Computers with One UPS

A UPS with adequate capacity can power multiple computers. One computer is connected to the UPS data port with a serial or USB cable. This *master* makes UPS status available on the network for other computers. These *slave* computers are powered by the UPS, but receive UPS status data from the master computer. See the *NUT User Manual* (<https://networkupstools.org/docs/user-manual.chunked/index.html>) and *NUT User Manual Pages* (https://networkupstools.org/docs/man/index.html#User_man).

13.16 WebDAV

The WebDAV service can be configured to provide a file browser over a web connection. Before starting this service, at least one WebDAV share must be created by navigating to *Sharing* → *WebDAV Shares*, and clicking *ADD*. Refer to *WebDAV Shares* (page 237) for instructions on how to create a share and connect to it after the service is configured and started.

The settings in the WebDAV service apply to all WebDAV shares. *Figure 13.17* shows the WebDAV configuration screen. *Table 13.15* summarizes the available options.

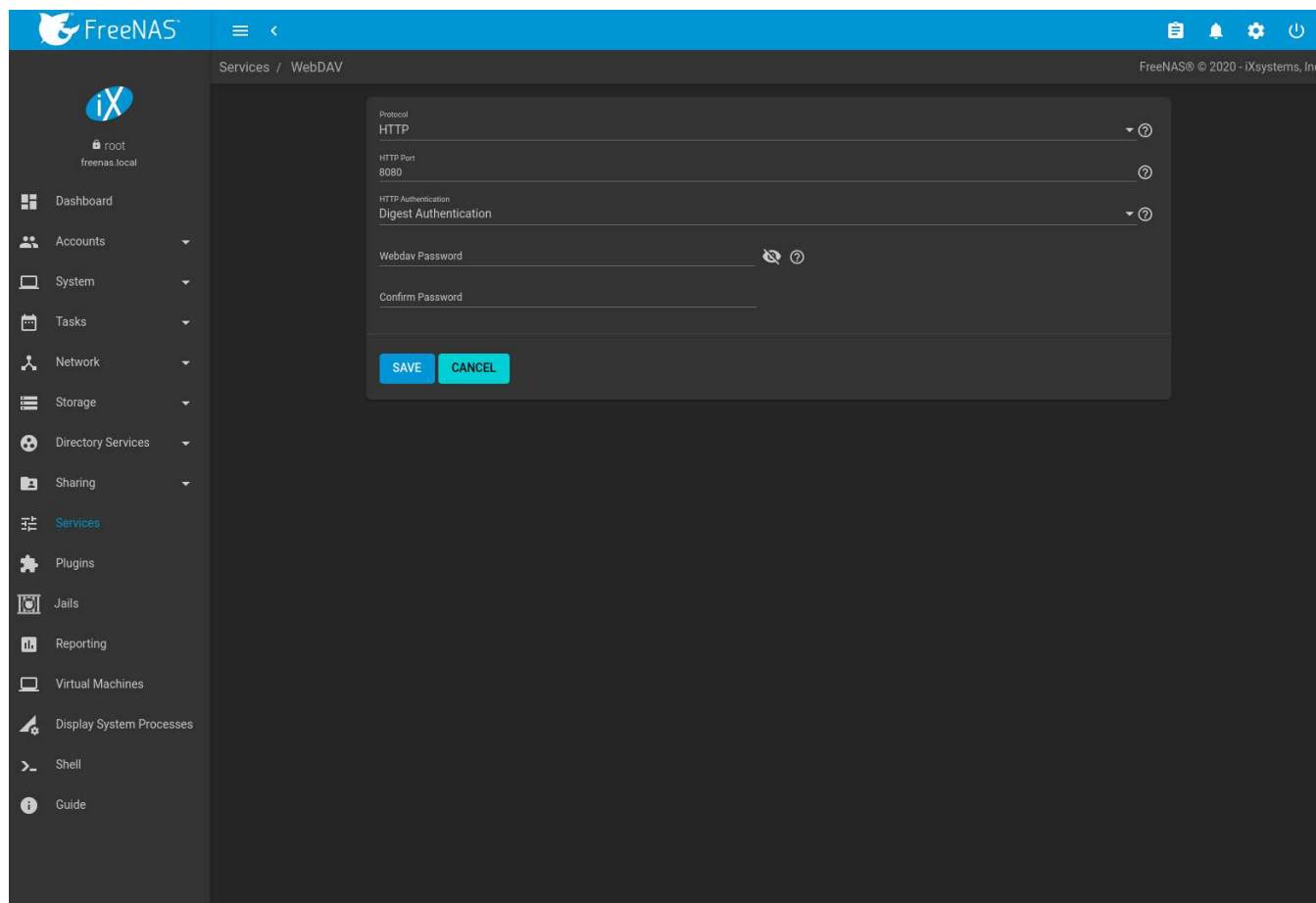


Fig. 13.17: WebDAV Configuration Screen

Table 13.15: WebDAV Configuration Options

Setting	Value	Description
Protocol	drop-down menu	<i>HTTP</i> keeps the connection unencrypted. <i>HTTPS</i> encrypts the connection. <i>HTTP+HTTPS</i> allows both types of connections.
HTTP Port	string	Specify a port for unencrypted connections. The default port <i>8080</i> is recommended. Do not use a port number already being used by another service.
HTTPS Port	string	Specify a port for encrypted connections. The default port <i>8081</i> is recommended. Do not use a port number already being used by another service.
Webdav SSL Certificate	drop-down menu	Select the SSL certificate to be used for encrypted connections. To create a certificate, use <i>System</i> → <i>Certificates</i> .
HTTP Authentication	drop-down menu	Choices are <i>No Authentication</i> , <i>Basic Authentication</i> (unencrypted) or <i>Digest Authentication</i> (encrypted).
Webdav Password	string	Default is <i>davtest</i> . Change this password as it is a known value.

PLUGINS

FreeNAS® provides the ability to extend the built-in NAS services by providing two methods for installing additional software.

Plugins (page 283) allow the user to browse, install, and configure pre-packaged software from the web interface. This method is easy to use, but provides a limited amount of available software. Each plugin is automatically installed into its own limited [FreeBSD jail](https://en.wikipedia.org/wiki/Freebsd_jail) (https://en.wikipedia.org/wiki/Freebsd_jail) that cannot install additional software.

Jails (page 294) provide more control over software installation, but requires working from the command line and a good understanding of networking basics and software installation on FreeBSD-based systems.

Look through the *Plugins* (page 283) and *Jails* (page 294) sections to become familiar with the features and limitations of each. Choose the method that best meets the needs of the application.

Note: *Jail Storage* (page 294) must be configured before plugins are available on FreeNAS®. This means having a suitable *pool* (page 164) created to store plugins.

14.1 Installing Plugins

A plugin is a self-contained application installer designed to integrate into the FreeNAS® web interface. A plugin offers several advantages:

- the FreeNAS® web interface provides a browser for viewing the list of available plugins
- the FreeNAS® web interface provides buttons for installing, starting, managing, and uninstalling plugins
- if the plugin has configuration options, a management screen is added to the FreeNAS® web interface for these options to be configured

View available plugins by clicking *Plugins*.

[Figure 14.1](#) shows some of the available plugins.

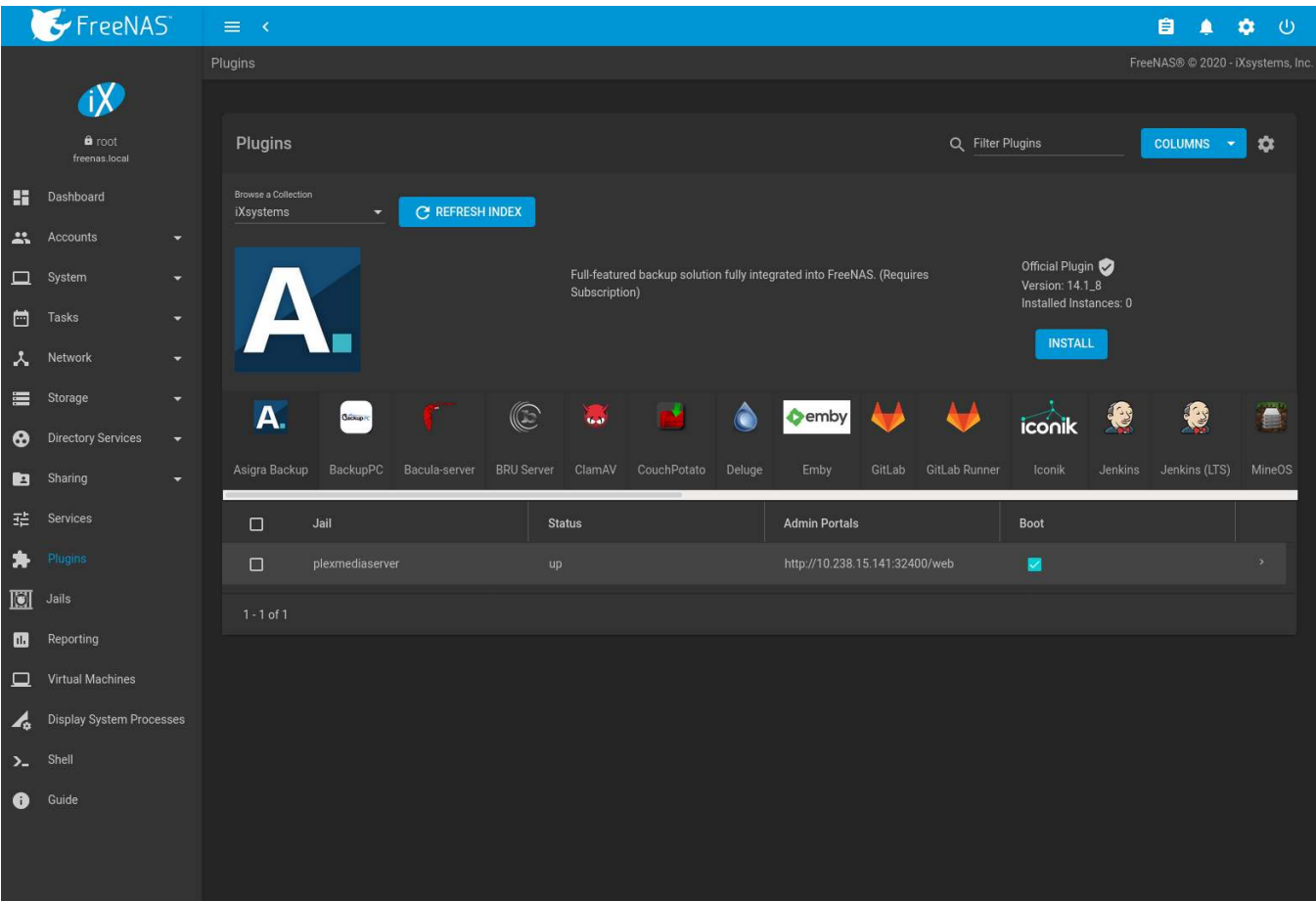


Fig. 14.1: Viewing the List of Available Plugins

Note: If the list of available plugins is not displayed, open [Shell](#) (page 335) and verify that the FreeNAS® system can ping an address on the Internet. If it cannot, add a default gateway address and DNS server address in *Network* → *Global Configuration*.

Click *Browse a Collection* to toggle the plugins list between *ixsystems plugins* (<https://www.freenas.org/plugins/>), which receive updates every few weeks, and *Community plugins* (<https://github.com/ix-plugin-hub/iocage-plugin-index>).

Click *REFRESH INDEX* to refresh the current list of plugins.

Click a plugin icon to see the description, whether it is an Official or Community plugin, the version available, and the number of installed instances.

To install the selected plugin, click *INSTALL*.

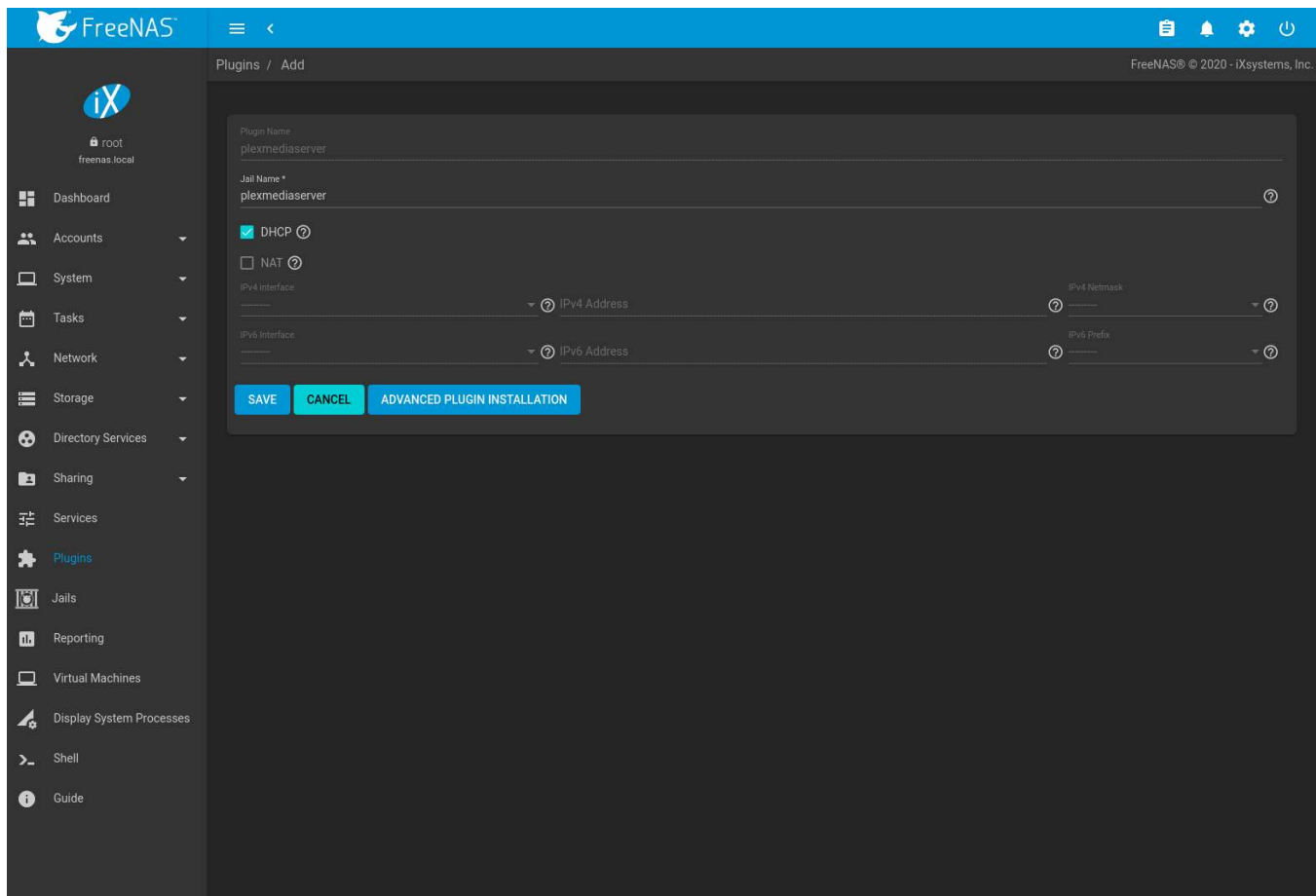


Fig. 14.2: Installing the Plex Plugin

Note: A warning will display when an unofficial plugin is selected for installation.

Enter a *Jail Name*. A unique name is required, since multiple installations of the same plugin are supported. Names can contain letters, numbers, periods (.), dashes (-), and underscores (_).

Most plugins default to *NAT*. This setting is recommended as it does not require manual configuration or multiple available IP addresses and prevents addressing conflicts on the network.

Some plugins default to *DHCP* as their management utility conflicts with *NAT*. Keep these plugins set to *DHCP* unless manually configuring an IP address is preferred.

If both *NAT* and *DHCP* are unset, an IPv4 or IPv6 address can be manually entered.

Click **ADVANCED PLUGIN INSTALLATION** to show all options for the plugin jail. The options are described in [Advanced Jail Creation](#) (page 297).

To start the installation, click **SAVE**.

Depending on the size of the application, the installation can take several minutes to download and install. A confirmation message is shown when the installation completes, along with any post-installation notes.

Installed plugins appear on the *Plugins* page as shown in [Figure 14.3](#).

Note: Plugins are also added to *Jails* as a *pluginv2* jail. This type of jail is editable like a standard jail, but the *UUID* cannot be altered. See [Managing Jails](#) (page 305) for more details about modifying jails.

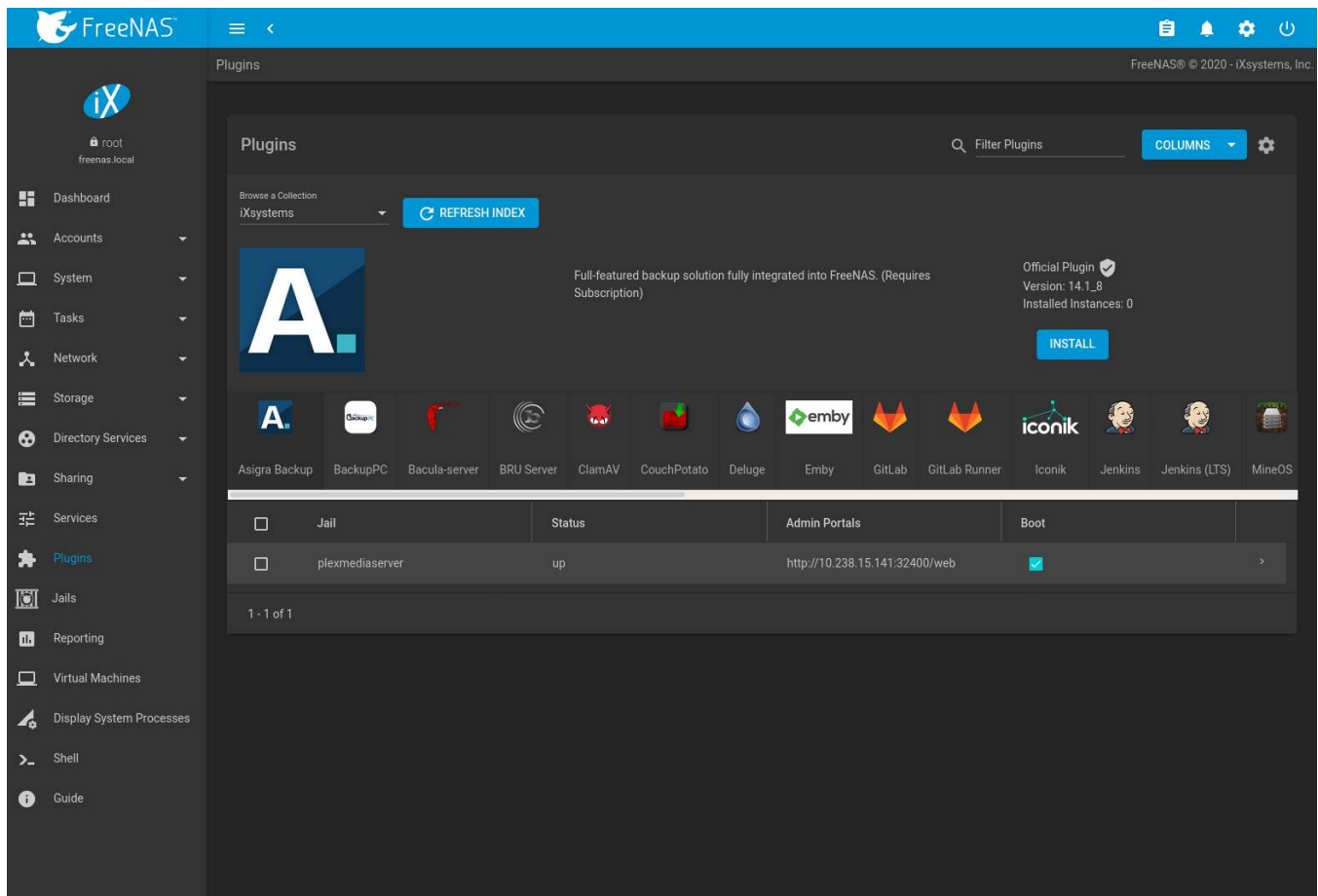


Fig. 14.3: Viewing Installed Plugins

Plugins are immediately started after installation. By default, all plugins are started when the system boots. Un-setting *Boot* means the plugin will not start when the system boots and must be started manually.

In addition to the *Jail* name, the *Columns* menu can be used to display more information about installed Plugins.

More information such as *RELEASE* and *VERSION* is shown by clicking **>** (Expand). Options to *RESTART*, *STOP*, *UPDATE*, *MANAGE*, and *UNINSTALL* the plugin are also displayed. If an installed plugin has notes, the notes can be viewed by clicking *POST INSTALL NOTES*.

Plugins with additional documentation also have a *DOCUMENTATION* button which opens the README in the plugin repository.

The plugin must be started before the installed application is available. Click **>** (Expand) and *START*. The plugin *Status* changes to *up* when it starts successfully.

Stop and immediately start an *up* plugin by clicking **>** (Expand) and *RESTART*.

Click **>** (Expand) and *MANAGE* to open a management or configuration screen for the application. Plugins with a management interface show the IP address and port to that page in the *Admin Portal* column.

Note: Not all plugins have a functional management option. See [Managing Jails](#) (page 305) for more instructions about interacting with a plugin jail with the shell.

Some plugins have options that need to be set before their service will successfully start. Check the website of the application to see what documentation is available. If there are any difficulties using a plugin, refer to the official documentation for that application.

If the application requires access to the data stored on the FreeNAS® system, click the entry for the associated jail in the *Jails* page and add storage as described in [Additional Storage](#) (page 310).

Click **:** (Options) and *Shell* for the plugin jail in the *Jails* page. This will give access to the shell of the jail containing the application to complete or test the configuration.

If a plugin jail fails to start, open the plugin jail shell from the *Jail* page and type `tail -f /var/log/messages` to see if any errors were logged.

14.2 Updating Plugins

When a newer version of a plugin or release becomes available in the official repository, click **>** (Expand) and *UPDATE*. Updating a plugin updates the operating system and version of the plugin.

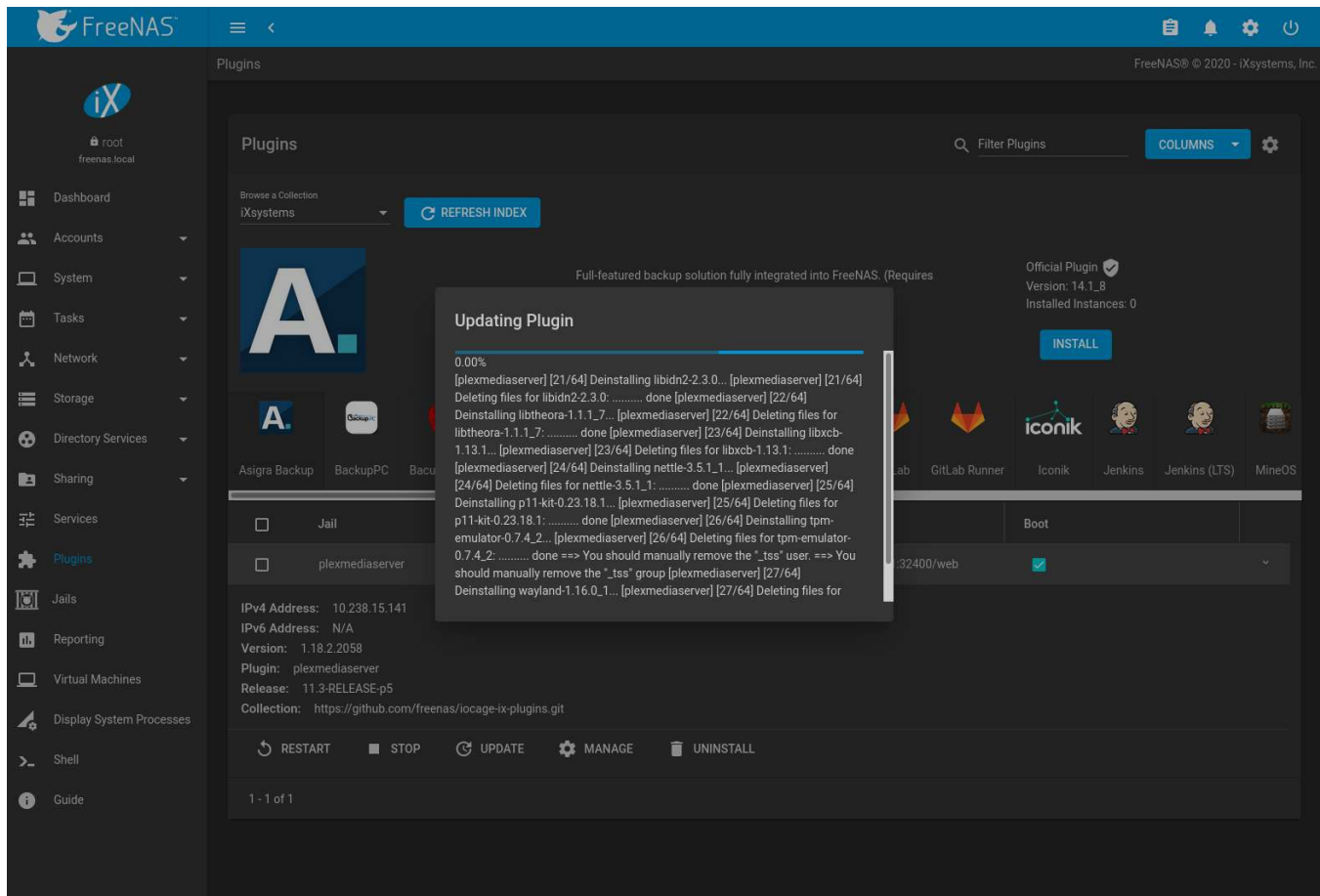


Fig. 14.4: Updating a Plugin

To update or upgrade the plugin jail operating system, see [Jail Updates and Upgrades](#) (page 308).

14.3 Uninstalling Plugins

Installing a plugin creates an associated jail. Uninstalling a plugin deletes the jail because it is no longer required. This means all **datasets or snapshots that are associated with the plugin are also deleted**. Make sure to back up any important data from the plugin **before** uninstalling it.

Figure 14.5 shows an example of uninstalling a plugin by expanding the plugin's entry and clicking *UNINSTALL*. A two-step dialog opens to confirm the action. **This is the only warning.** Enter the plugin name, set the *Confirm* checkbox, and click *DELETE* to remove the plugin and the associated jail, dataset, and snapshots.

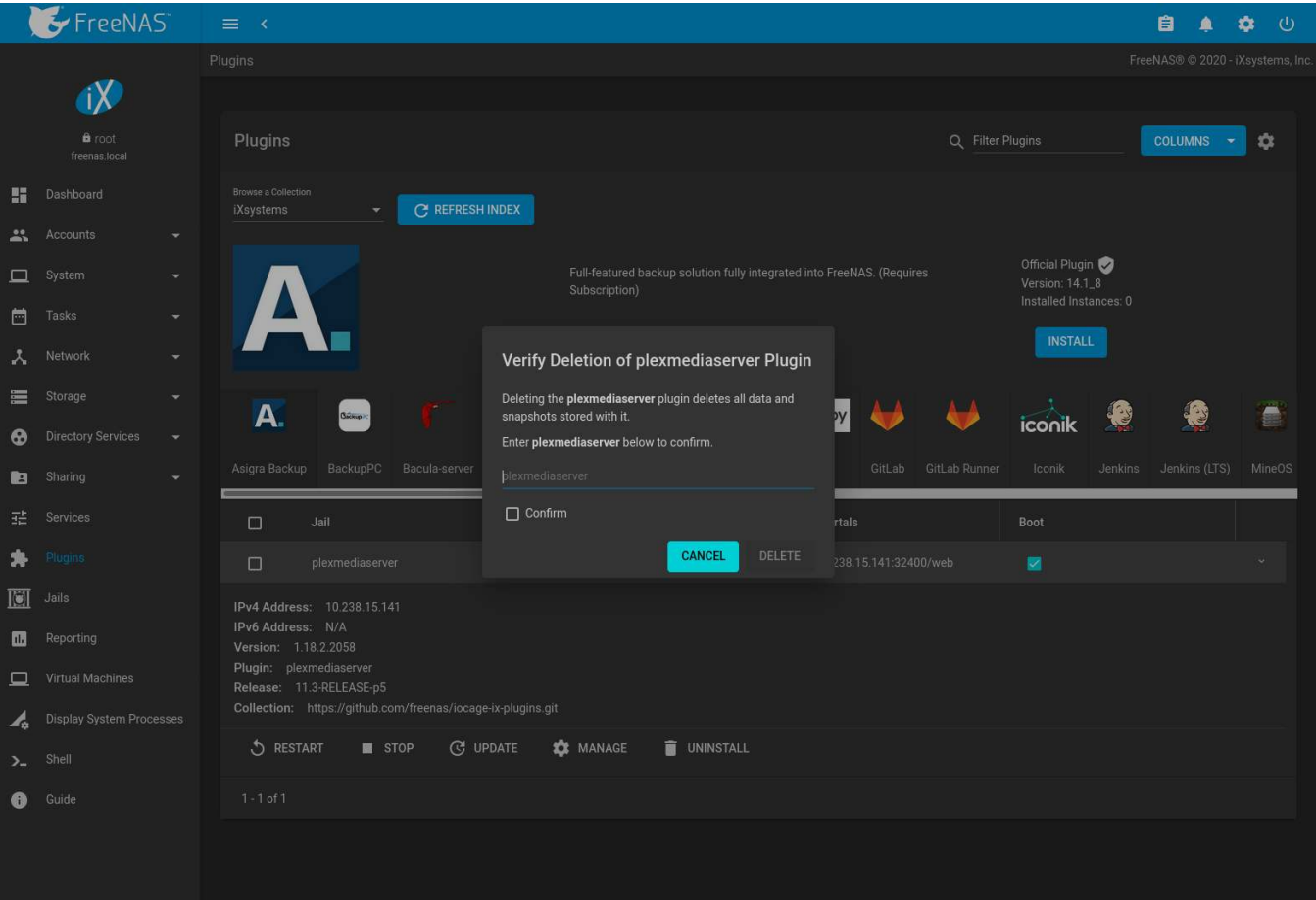


Fig. 14.5: Uninstalling a Plugin and its Associated Jail and Dataset

14.4 Create a Plugin

If an application is not available as a plugin, it is possible to create a new plugin for FreeNAS® in a few steps. This requires an existing [GitHub](https://github.com) (<https://github.com>) account.

Create a new artifact repository on [GitHub](https://github.com) (<https://github.com>).

Refer to [table 14.1](#) for the files to add to the artifact repository.

Table 14.1: FreeNAS® Plugin Artifact Files

Directory/File	Description
post_install.sh	This script is run <i>inside</i> the jail after it is created and any packages installed. Enable services in <code>/etc/rc.conf</code> that need to start with the jail and apply any configuration customizations with this script.
ui.json	JSON file that accepts the key or value options. For example: adminportal: "http://%%IP%%/" designates the web-interface of the plugin.

Continued on next page

Table 14.1 – continued from previous page

Directory/File	Description
overlay/	Directory of files overlaid on the jail after install. For example, <code>usr/local/bin/myfile</code> is placed in the <code>/usr/local/bin/myfile</code> location of the jail. Can be used to supply custom files and configuration data, scripts, and any other type of customized files to the plugin jail.
settings.json	<p>JSON file that manages the settings interface of the plugin. Required fields include:</p> <ul style="list-style-type: none"> • <code>"servicerestart" : "service foo restart"</code> Command to run when restarting the plugin service after changing settings. • <code>"serviceget" : "/usr/local/bin/myget"</code> Command used to get values for plugin configuration. Provided by the plugin creator. The command accepts two arguments for key or value pair. • <code>"options" :</code> This subsection contains arrays of elements, starting with the "key" name and required arguments for that particular type of setting. See <i>options subsection example</i> (page 289) below.

This example `settings.json` file is used for the *Quasselcore* plugin. It is also available online in the *iocage-plugin-quassel* artifact repository (<https://github.com/freenas/iocage-plugin-quassel/blob/master/settings.json>).

```
{
  "servicerestart": "service quasselcore restart",
  "serviceget": "/usr/local/bin/quasselget",
  "serviceset": "/usr/local/bin/quasselset",
  "options": {
    "adduser": {
      "type": "add",
      "name": "Add User",
      "description": "Add new quasselcore user",
      "requiredargs": {
        "username": {
          "type": "string",
          "description": "Quassel Client Username"
        },
        "password": {
          "type": "password",
          "description": "Quassel Client Password"
        },
        "fullname": {
          "type": "string",
          "description": "Quassel Client Full Name"
        }
      },
      "optionalargs": {
        "adminuser": {
          "type": "bool",
          "description": "Can this user administrate quasselcore?"
        }
      }
    },
    "port": {
      "type": "int",
      "name": "Quassel Core Port",
      "description": "Port for incoming quassel connections",
      "range": "1024-32000",
      "default": "4242",
      "requirerestart": true
    }
  }
}
```

```

    },
    "sslmode": {
        "type": "bool",
        "name": "SSL Only",
        "description": "Only accept SSL connections",
        "default": true,
        "requirerestart": true
    },
    "ssloption": {
        "type": "combo",
        "name": "SSL Options",
        "description": "SSL Connection Options",
        "requirerestart": true,
        "default": "tlsallow",
        "options": {
            "tlsrequire": "Require TLS",
            "tlsallow": "Allow TLS",
            "tlsdisable": "Disable TLS"
        }
    },
    "deluser": {
        "type": "delete",
        "name": "Delete User",
        "description": "Remove a quasselcore user"
    }
}

```

Create and submit a new JSON file for the plugin:

Clone the [iocage-plugin-index](https://github.com/ix-plugin-hub/iocage-plugin-index) (<https://github.com/ix-plugin-hub/iocage-plugin-index>) GitHub repository.

Tip: Full tutorials and documentation for GitHub and `git` commands are available on [GitHub Guides](https://guides.github.com/) (<https://guides.github.com/>).

On the local copy of `iocage-plugin-index`, create a new JSON file for the FreeNAS® plugin. The JSON file describes the plugin, the packages it requires for operation, and other installation details. This file is named `pluginname.json`. For example, the [Madsonic](https://github.com/ix-plugin-hub/iocage-plugin-index/blob/master/madsonic.json) (<https://github.com/ix-plugin-hub/iocage-plugin-index/blob/master/madsonic.json>) plugin is named `madsonic.json`.

The fields of the file are described in [table 14.2](#).

Table 14.2: Plugin JSON File Contents

Data Field	Description
"name":	Name of the plugin.
"plugin_schema":	Optional. Enter 2 if simplified post-install information has been supplied in <code>post_install.sh</code> . After specifying 2, echo the information to be presented to the user in <code>/root/PLUGIN_INFO</code> inside the <code>post_install.sh</code> file. See the rsync.json (page 291) and rsync post_install.sh (page 291) examples.
"release":	FreeBSD RELEASE to use for the plugin jail.
"artifact":	URL of the plugin artifact repository.
"pkgs":	The FreeBSD packages required by the plugin.
"packagesite":	Content Delivery Network (CDN) used by the plugin jail. Default for the TrueOS CDN is http://pkg.cdn.trueos.org/iocage .

Continued on next page

Table 14.2 – continued from previous page

Data Field	Description
"fingerprints":	"function": Default is sha256. "fingerprint": The pkg fingerprint for the artifact repository. Default is 226efd3a126fb86e71d60a37353d17f57af816d1c7ecad0623c21f0bf73eb0c7
"official":	Define whether this is an official iXsystems-supported plugin. Enter true or false.

Listing 14.1: rslsync.json

```
1 {
2   "name": "rslsync",
3   "plugin_schema": "2",
4   "release": "11.2-RELEASE",
5   "artifact": "https://github.com/freenas/iocage-plugin-btsync.git",
6   "pkgs": [
7     "net-p2p/rslsync"
8   ],
9   "packagesite": "http://pkg.cdn.trueos.org/iocage/unstable",
10  "fingerprints": {
11    "iocage-plugins": [
12      {
13        "function": "sha256",
14        "fingerprint": "226efd3a126fb86e71d60a37353d17f57af816d1c7ecad0623c21f0bf73eb0c7"
15      }
16    ]
17  },
18  "official": true
19 }
```

Listing 14.2: post_install.sh

```
1 #!/bin/sh -x
2
3 # Enable the service
4 sysrc -f /etc/rc.conf rslsync_enable="YES"
5 # Start the service
6 service rslsync start 2>/dev/null
7
8 echo "rslsync now installed" > /root/PLUGIN_INFO
9 echo "foo" >> /root/PLUGIN_INFO
```

Here is quasselcore.json reproduced as an example:

```
{
  "name": "Quasselcore",
  "release": "11.1-RELEASE",
  "artifact": "https://github.com/freenas/iocage-plugin-quassel.git",
  "pkgs": [
    "irc/quassel-core"
  ],
  "packagesite": "http://pkg.cdn.trueos.org/iocage",
  "fingerprints": {
    "iocage-plugins": [
      {
        "function": "sha256",
        "fingerprint": "226efd3a126fb86e71d60a37353d17f57af816d1c7ecad0623c21f0bf73eb0c7"
      }
    ]
  }
}
```

```

    }
  ]
},
"official": true
}

```

The correct directory and package name of the plugin application must be used for the "pkgs" : value. Find the package name and directory by searching [FreshPorts](https://www.freshports.org/) (<https://www.freshports.org/>) and checking the "To install the port:" line. For example, the *Quasselcore* plugin uses the directory and package name `/irc/quassel-core`.

Now edit `iocage-plugin-index/INDEX`. Add an entry for the new plugin that includes these fields:

- "MANIFEST" : Add the name of the newly created `plugin.json` file here.
- "name" : Use the same name used within the `.json` file.
- "icon" : Most plugins will have a specific icon. Search the web and save the icon to the `iocage-plugin-index/icons/` directory as a `.png`. The naming convention is `pluginname.png`. For example, the *Madsonic* plugin has the icon file `madsonic.png`.
- "description" : Describe the plugin in a single sentence.
- "official" : Specify if the plugin is supported by iXsystems. Enter `false`.

See the [INDEX](https://github.com/ix-plugin-hub/iocage-plugin-index/blob/master/INDEX) (<https://github.com/ix-plugin-hub/iocage-plugin-index/blob/master/INDEX>) for examples of `INDEX` entries.

Submit the plugin

Open a pull request for the [iocage-plugin-index repo](https://github.com/ix-plugin-hub/iocage-plugin-index) (<https://github.com/ix-plugin-hub/iocage-plugin-index>). Make sure the pull request contains:

- the new `plugin.json` file.
- the plugin icon `.png` added to the `iocage-plugin-index/icons/` directory.
- an update to the `INDEX` file with an entry for the new plugin.
- a link to the artifact repository populated with all required plugin files.

14.4.1 Test a Plugin

Warning: Installing experimental plugins is not recommended for general use of FreeNAS®. This feature is meant to help plugin creators test their work before it becomes generally available on FreeNAS®.

Plugin pull requests are merged into the `master` branch of the [iocage-plugin-index](https://github.com/ix-plugin-hub/iocage-plugin-index) (<https://github.com/ix-plugin-hub/iocage-plugin-index>) repository. These plugins are not available in the web interface until they are tested and added to a `RELEASE` branch of the repository. It is possible to test an in-development plugin by using this `iocage` command: `iocage fetch -P --name PLUGIN IPADDRESS_PROPS --branch 'master'`

This will install the plugin, configure it with any chosen properties, and specifically use the `master` branch of the repository to download the plugin.

Here is an example of downloading and configuring an experimental plugin with the FreeNAS® *Shell*:

```

[root@freenas ~]# iocage fetch -P --name mineos ip4_addr="em0|10.231.1.37/24" --branch 'master'
Plugin: mineos
  Official Plugin: False
  Using RELEASE: 11.2-RELEASE
  Using Branch: master
  Post-install Artifact: https://github.com/jsegaert/iocage-plugin-mineos.git
  These pkgs will be installed:
...

```



```
...
Running post_install.sh
Command output:
...

...
Admin Portal:
http://10.231.1.37:8443
[root@freenas ~]#
```

This plugin appears in the *Jails* and *Plugins* screens as `mineos` and can be tested with the FreeNAS® system.

14.5 Asigra Plugin

The Asigra plugin connects FreeNAS® to a third party service and is subject to licensing. Please read the [Asigra Software License Agreement](https://www.asigra.com/legal/software-license-agreement) (<https://www.asigra.com/legal/software-license-agreement>) before using this plugin.

To begin using Asigra services after installing the plugin, open the plugin options and click *Register*. A new browser tab opens to [register a user with Asigra](https://licenseportal.asigra.com/licenseportal/user-registration.do) (<https://licenseportal.asigra.com/licenseportal/user-registration.do>).

The FreeNAS® system must have a public static IP address for Asigra services to function.

Refer to the Asigra documentation for details about using the Asigra platform:

- [DS-Operator Management Guide](https://s3.amazonaws.com/asigra-documentation/Help/v14.1/DS-System%20Help/index.html) (<https://s3.amazonaws.com/asigra-documentation/Help/v14.1/DS-System%20Help/index.html>): Using the `DS-Operator` interface to manage the plugin `DS-System` service. Click *Management* in the plugin options to open the `DS-Operator` interface.
- [DS-Client Installation Guide](https://s3.amazonaws.com/asigra-documentation/Guides/Cloud%20Backup/v14.1/Client_Software_Installation_Guide.pdf) (https://s3.amazonaws.com/asigra-documentation/Guides/Cloud%20Backup/v14.1/Client_Software_Installation_Guide.pdf): How to install the `DS-Client` system. `DS-Client` aggregates backup content from endpoints and transmits it to the `DS-System` service.
- [DS-Client Management Guide](https://s3.amazonaws.com/asigra-documentation/Help/v14.1/DS-Client%20Help/index.html) (<https://s3.amazonaws.com/asigra-documentation/Help/v14.1/DS-Client%20Help/index.html>): Managing the `DS-Client` system after it has been successfully installed at one or more locations.

JAILS

Jails are a lightweight, operating-system-level virtualization. One or multiple services can run in a jail, isolating those services from the host FreeNAS[®] system. FreeNAS[®] uses [iocage](https://github.com/iocage/iocage) (<https://github.com/iocage/iocage>) for jail and [plugin](#) (page 283) management. The main differences between a user-created jail and a plugin are that plugins are preconfigured and usually provide only a single service.

By default, jails run the [FreeBSD](https://www.freebsd.org/) (<https://www.freebsd.org/>) operating system. These jails are independent instances of FreeBSD. The jail uses the host hardware and runs on the host kernel, avoiding most of the overhead usually associated with virtualization. The jail installs FreeBSD software management utilities so FreeBSD packages or ports can be installed from the jail command line. This allows for FreeBSD ports to be compiled and FreeBSD packages to be installed from the command line of the jail.

It is important to understand that users, groups, installed software, and configurations within a jail are isolated from both the FreeNAS[®] host operating system and any other jails running on that system.

The ability to create multiple jails offers flexibility regarding software management. For example, an administrator can choose to provide application separation by installing different applications in each jail, to create one jail for all installed applications, or to mix and match how software is installed into each jail.

15.1 Jail Storage

A [pool](#) (page 164) must be created before using jails or [Plugins](#) (page 283). Make sure the pool has enough storage for all the intended jails and plugins. The *Jails* screen displays a message and button to *CREATE POOL* if no pools exist on the FreeNAS[®] system.

If pools exist, but none have been chosen for use with jails or plugins, a dialog appears to choose a pool. Select a pool and click *CHOOSE*.

To select a different pool for jail and plugin storage, click  (Settings). A dialog shows the active pool. A different pool can be selected from the drop-down.

Jails and downloaded FreeBSD release files are stored in a dataset named `iocage/`.

Notes about the `iocage/` dataset:

- At least 10 GiB of free space is recommended.
- Cannot be located on a [Share](#) (page 210).
- [iocage](http://iocage.readthedocs.io/en/latest/index.html) (<http://iocage.readthedocs.io/en/latest/index.html>) automatically uses the first pool that is not a root pool for the FreeNAS[®] system.
- A `defaults.json` file contains default settings used when a new jail is created. The file is created automatically if not already present. If the file is present but corrupted, `iocage` shows a warning and uses default settings from memory.
- Each new jail installs into a new child dataset of `iocage/`. For example, with the `iocage/jails` dataset in `pool1`, a new jail called *jail1* installs into a new dataset named `pool1/iocage/jails/jail1`.

- FreeBSD releases are fetched as a child dataset into the `/iocage/download` dataset. This dataset is then extracted into the `/iocage/releases` dataset to be used in jail creation. The dataset in `/iocage/download` can then be removed without affecting the availability of fetched releases or an existing jail.
- `iocage/` datasets on activated pools are independent of each other and do **not** share any data.

Note: `iocage` jail configs are stored in `/mnt/poolname/iocage/jails/jailname`. When `iocage` is updated, the `config.json` configuration file is backed up as `/mnt/poolname/iocage/jails/jailname/config_backup.json`. The backup file can be renamed to `config.json` to restore previous jail settings.

15.2 Creating Jails

FreeNAS® has two options to create a jail. The *Jail Wizard* makes it easy to quickly create a jail. *ADVANCED JAIL CREATION* is an alternate method, where every possible jail option is configurable. There are numerous options spread across four different primary sections. This form is recommended for advanced users with very specific requirements for a jail.

15.2.1 Jail Wizard

New jails can be created quickly by going to *Jails* → *ADD*. This opens the wizard screen shown in Figure 15.1.

The screenshot shows the FreeNAS web interface. On the left is a sidebar with a navigation menu. The main area is titled 'Jails / Add / Wizard'. It features a progress bar with three steps: '1 Name Jail and Choose FreeBSD Release', '2 Configure Networking', and '3 Confirm Options'. Step 1 is currently active. Below the progress bar, there are three input fields: 'Name *' with the value 'samplejail1', 'Jail Type' with a dropdown menu showing 'Default (Clone Jail)', and 'Release *' with a dropdown menu showing '11.3-RELEASE'. At the bottom of this section are three buttons: 'CANCEL', 'NEXT', and 'ADVANCED JAIL CREATION'.

Fig. 15.1: Jail Creation Wizard

The wizard provides the simplest process to create and configure a new jail.


Enter a *Jail Name*. Names can contain letters, numbers, periods (.), dashes (-), and underscores (_).

Choose a *Jail Type*: *Default (Clone Jail)* or *Basejail*. Clone jails are clones of the specified FreeBSD RELEASE. They are linked to that RELEASE, even if they are upgraded. Basejails mount the specified RELEASE directories as nullfs mounts over the jail directories. Basejails are not linked to the original RELEASE when upgraded.

Jails can run FreeBSD versions up to the same version as the host FreeNAS® system. Newer releases are not shown.

Tip: Versions of FreeBSD are downloaded the first time they are used in a jail. Additional jails created with the same version of FreeBSD are created faster because the download has already been completed.

Click *NEXT* to see a simplified list of networking options. Jails support several different networking solutions:

- *VNET* can be set to add a virtual network interface to the jail. This interface can be used to set NAT, DHCP, or static jail network configurations. Since *VNET* provides the jail with an independent networking stack, it can broadcast an IP address, which is required by some applications.
- The jail can use [Network Address Translation \(NAT\)](https://en.wikipedia.org/wiki/Network_address_translation) (https://en.wikipedia.org/wiki/Network_address_translation), which uses the FreeNAS® IP address and sets a unique port for the jail to use. *VNET* is required when *NAT* is selected.
- Configure the jail to receive its IP address from a DHCP server by setting *DHCP Autoconfigure IPv4*.
- Networking can be manually configured by entering values for the *IPv4 Address* or *IPv6 Address* fields. Any combination of these fields can be configured. Multiple interfaces are supported in the *IPv4 Address* and *IPv6 Address* fields by entering a comma-separated list. Leaving the *IPv4 Default Router* and *IPv6 Default Router* fields empty automatically configures these values.
- Leaving all checkboxes unset and fields empty initializes the jail without any networking abilities. Networking can be added to the jail after creation by going to *Jails* → > (Expand) →  *EDIT* → *Basic Properties*.

Setting a proxy in the FreeNAS® [network settings](#) (page 153) also configures new jails to use the proxy settings, except when performing DNS lookups. Make sure a firewall is properly configured to maximize system security.

When pairing the jail with a physical interface, edit the [network interface](#) (page 155) and set *Disable Hardware Offloading*. This prevents a network interface reset when the jail starts.

FreeNAS® 11.3-U1 User Guide, Release 11.3

Jails / Add / Wizard

FreeNAS® © 2020 - iXsystems, Inc.

1 Name Jail and Choose FreeBSD Release **2** Configure Networking **3** Confirm Options

☐ DHCP Autoconfigure IPv4 ⓘ

☐ NAT ⓘ

☐ VNET ⓘ

IPv4 Interface IPv4 Address IPv4 Netmask

IPv4 Default Router

☐ Autoconfigure IPv6 ⓘ

IPv6 Interface IPv6 Address IPv6 Prefix

IPv6 Default Router

CANCEL **BACK** **NEXT**

Fig. 15.2: Configure Jail Networking

Click *NEXT* to view a summary screen of the chosen jail options. Click *SUBMIT* to create the new jail. After a few moments, the new jail is added to the primary jails list.

15.2.2 Advanced Jail Creation

The advanced jail creation form is opened by clicking *Jails* → *ADD* then *Advanced Jail Creation*. The screen in [Figure 15.3](#) is shown.

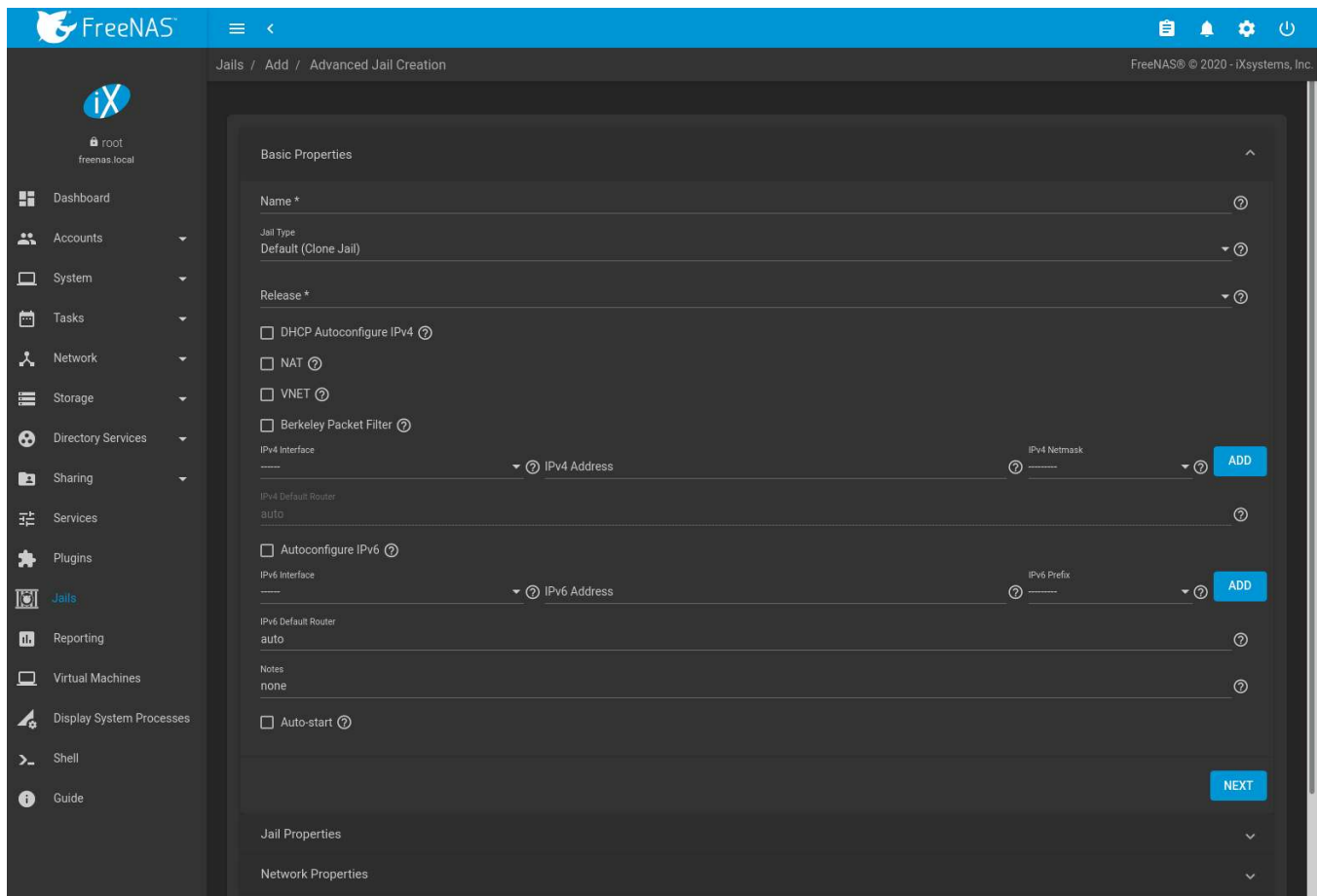


Fig. 15.3: Creating a Jail

A usable jail can be quickly created by setting only the required values, the *jail Name* and *Release*. Additional settings are in the *Jail Properties*, *Network Properties*, and *Custom Properties* sections. Table 15.1 shows the available options of the *Basic Properties* of a new jail.

Table 15.1: Basic Properties

Setting	Value	Description
Name	string	Required. Can contain letters, numbers, periods (.), dashes (-), and underscores (_).
Release	drop-down menu	Required. Jails can run FreeBSD versions up to the same version as the host FreeNAS® system. Newer releases are not shown.
DHCP Autoconfigure IPv4	checkbox	Automatically configure IPv4 networking with an independent VNET stack. <i>VNET</i> and <i>Berkeley Packet Filter</i> must also be checked. If not set, ensure the defined address in <i>IPv4 Address</i> does not conflict with an existing address.
NAT	checkbox	Network Address Translation (NAT). When set, the jail is given an internal IP address and connections are forwarded from the host to the jail. When NAT is set, <i>Berkeley Packet Filter</i> cannot be set. Adds the <i>NAT Port Forwarding</i> options to the jail <i>Network Properties</i> (page 302).
VNET	checkbox	Use VNET to emulate network devices for this jail and a create a fully virtualized per-jail network stack. See VNET(9) (https://www.freebsd.org/cgi/man.cgi?query=vnet) for more details.

Continued on next page

Table 15.1 – continued from previous page

Setting	Value	Description
Berkeley Packet Filter	checkbox	Use the Berkeley Packet Filter to data link layers in a protocol independent fashion. Unset by default to avoid security vulnerabilities. See BPF(4) (https://www.freebsd.org/cgi/man.cgi?query=bpf) for more details. Cannot be set when <i>NAT</i> is set.
IPv4 Interface	drop-down menu	Choose a network interface to use for this IPv4 connection. See <i>note</i> (page ??) to add more.
IPv4 Address	string	This and the other IPv4 settings are grayed out if <i>DHCP autoconfigure IPv4</i> is set. Configures the interface to use for network or internet access for the jail. Enter an IPv4 address for this IP jail. Example: <i>192.168.0.10</i> . See <i>note</i> (page ??) to add more.
IPv4 Netmask	drop-down menu	Choose a subnet mask for this IPv4 Address.
IPv4 Default Router	string	Type <i>none</i> or a valid IP address. Setting this property to anything other than <i>none</i> configures a default route inside a VNET jail.
Auto Configure IPv6	checkbox	Set to use SLAAC (Stateless Address Auto Configuration) to auto-configure IPv6 in the jail.
IPv6 Interface	drop-down menu	Choose a network interface to use for this IPv6 connection. See <i>note</i> (page ??) to add more.
IPv6 Address	string	Configures network or internet access for the jail. Type the IPv6 address for VNET and shared IP jails. Example: <i>2001:0db8:85a3:0000:0000:8a2e:0370:7334</i> . See <i>note</i> (page ??) to add more.
IPv6 Prefix	drop-down menu	Choose a prefix for this IPv6 Address.
IPv6 Default Router	string	Type <i>none</i> or a valid IP address. Setting this property to anything other than <i>none</i> configures a default route inside a VNET jail.
Notes	string	Enter any notes or comments about the jail.
Auto-start	checkbox	Start the jail at system startup.

Note: For static configurations not using DHCP or NAT, multiple IPv4 and IPv6 addresses and interfaces can be added to the jail by clicking *ADD*.

Similar to the *Jail Wizard* (page 295), configuring the basic properties, then clicking *SAVE* is often all that is needed to quickly create a new jail. To continue configuring more settings, click *NEXT* to proceed to the *Jail Properties* section of the form. [Table 15.2](#) describes each of these options.

Table 15.2: Jail Properties

Setting	Value	Description
devfs_ruleset	integer	Number of the devfs(8) (https://www.freebsd.org/cgi/man.cgi?query=devfs) ruleset to enforce when mounting <i>devfs</i> in the jail. The default value of <i>0</i> means no ruleset is enforced. Mounting <i>devfs</i> inside a jail is only possible when the <i>allow_mount</i> and <i>allow_mount_devfs</i> permissions are enabled and <i>enforce_statfs</i> is set to a value lower than <i>2</i> .
exec.start	string	Commands to run in the jail environment when a jail is created. Example: <i>sh /etc/rc</i> . See jail(8) (https://www.freebsd.org/cgi/man.cgi?query=jail) for more details.
exec.stop	string	Commands to run in the jail environment before a jail is removed and after any <i>exec_prestop</i> commands are complete. Example: <i>sh /etc/rc.shutdown</i> .

Continued on next page

Table 15.2 – continued from previous page

Setting	Value	Description
exec_prestart	string	Commands to run in the system environment before a jail is started.
exec_poststart	string	Commands to run in the system environment after a jail is started and after any <i>exec_start</i> commands are finished.
exec_prestop	string	Commands to run in the system environment before a jail is stopped.
exec_poststop	string	Commands to run in the system environment after a jail is started and after any <i>exec_start</i> commands are finished.
exec.clean	checkbox	Run commands in a clean environment. The current environment is discarded except for \$HOME, \$SHELL, \$TERM and \$USER. \$HOME and \$SHELL are set to the target login. \$USER is set to the target login. \$TERM is imported from the current environment. The environment variables from the login class capability database for the target login are also set.
exec_timeout	integer	The maximum amount of time in seconds to wait for a command to complete. If a command is still running after the allotted time, the jail is terminated.
stop_timeout	integer	The maximum amount of time in seconds to wait for the jail processes to exit after sending a SIGTERM signal. This happens after any <i>exec_stop</i> commands are complete. After the specified time, the jail is removed, killing any remaining processes. If set to 0, no SIGTERM is sent and the jail is immediately removed.
exec_jail_user	string	Enter either <code>root</code> or a valid <i>username</i> . Inside the jail, commands run as this user.
exec_system_jail_user	string	Set to <i>True</i> to look for the <i>exec.jail_user</i> in the system <code>passwd(5)</code> (https://www.freebsd.org/cgi/man.cgi?query=passwd) file <i>instead</i> of the jail <code>passwd</code> .
exec_system_user	string	Run commands in the jail as this user. By default, commands are run as the current user.
mount_devfs	checkbox	Mount a <code>devfs(5)</code> (https://www.freebsd.org/cgi/man.cgi?query=devfs) filesystem on the chrooted <code>/dev</code> directory and apply the ruleset in the <i>devfs_ruleset</i> parameter to restrict the devices visible inside the jail.
mount_fdescfs	checkbox	Mount an <code>fdescfs(5)</code> (https://www.freebsd.org/cgi/man.cgi?query=fdescfs) filesystem in the jail <code>/dev/fd</code> directory.
enforce_statfs	drop-down	Determine which information processes in a jail are able to obtain about mount points. The behavior of multiple syscalls is affected: <code>statfs(2)</code> (https://www.freebsd.org/cgi/man.cgi?query=statfs), <code>fsstatfs(2)</code> (https://www.freebsd.org/cgi/man.cgi?query=statfs), <code>getfsstat(2)</code> (https://www.freebsd.org/cgi/man.cgi?query=getfsstat), <code>fhstatfs(2)</code> (https://www.freebsd.org/cgi/man.cgi?query=fhstatfs), and other similar compatibility syscalls. All mount points are available without any restrictions if this is set to 0. Only mount points below the jail chroot directory are available if this is set to 1. Set to 2, the default option only mount points where the jail chroot directory is located are available.
children_max	integer	Number of child jails allowed to be created by the jail or other jails under this jail. A limit of 0 restricts the jail from creating child jails. <i>Hierarchical Jails</i> in the <code>jail(8)</code> (https://www.freebsd.org/cgi/man.cgi?query=jail) man page explains the finer details.

Continued on next page

Table 15.2 – continued from previous page

Setting	Value	Description
login_flags	string	Flags to pass to login(1) (https://www.freebsd.org/cgi/man.cgi?query=login) when logging in to the jail using the console function.
securelevel	integer	Value of the jail securelevel (https://www.freebsd.org/doc/faq/security.html) sysctl. A jail never has a lower securelevel than the host system. Setting this parameter allows a higher securelevel. If the host system securelevel is changed, jail securelevel will be at least as secure. Securelevel options are: 3, 2 (default), 1, 0, and -1.
sysvmsg	drop-down	Allow or deny access to SYSV IPC message primitives. Set to <i>Inherit</i> : All IPC objects on the system are visible to the jail. Set to <i>New</i> : Only objects the jail created using the private key namespace are visible. The system and parent jails have access to the jail objects but not private keys. Set to <i>Disable</i> : The jail cannot perform any sysvmsg related system calls.
sysvsem	drop-down	Allow or deny access to SYSV IPC semaphore primitives. Set to <i>Inherit</i> : All IPC objects on the system are visible to the jail. Set to <i>New</i> : Only objects the jail creates using the private key namespace are visible. The system and parent jails have access to the jail objects but not private keys. Set to <i>Disable</i> : The jail cannot perform any sysvsem related system calls.
sysvshm	drop-down	Allow or deny access to SYSV IPC shared memory primitives. Set to <i>Inherit</i> : All IPC objects on the system are visible to the jail. Set to <i>New</i> : Only objects the jail creates using the private key namespace are visible. The system and parent jails have access to the jail objects but not private keys. Set to <i>Disable</i> : The jail cannot perform any sysvshm related system calls.
allow_set_hostname	checkbox	Allow the jail hostname to be changed with hostname(1) (https://www.freebsd.org/cgi/man.cgi?query=hostname) or sethostname(3) (https://www.freebsd.org/cgi/man.cgi?query=sethostname).
allow_sysvipc	checkbox	Choose whether a process in the jail has access to System V IPC primitives. Equivalent to setting <i>sysvmsg</i> , <i>sysvsem</i> , and <i>sysvshm</i> to <i>Inherit</i> . <i>Deprecated in FreeBSD 11.0 and later! Use sysvmsg, sysvsem, and sysvshm instead.</i>
allow_raw_sockets	checkbox	Allow the jail to use raw sockets (https://en.wikipedia.org/wiki/Network_socket#Raw_socket). When set, the jail has access to lower-level network layers. This allows utilities like ping(8) (https://www.freebsd.org/cgi/man.cgi?query=ping) and traceroute(8) (https://www.freebsd.org/cgi/man.cgi?query=traceroute) to work in the jail, but has security implications and should only be used on jails running trusted software.
allow_chflags	checkbox	Treat jail users as privileged and allow the manipulation of system file flags. <i>securelevel</i> constraints are still enforced.
allow_mlock	checkbox	Allow jail to run services that use mlock(2) (https://www.freebsd.org/cgi/man.cgi?query=mlock) to lock physical pages in memory.
allow_mount	checkbox	Allow privileged users inside the jail to mount and unmount filesystem types marked as jail-friendly.

Continued on next page

Table 15.2 – continued from previous page

Setting	Value	Description
allow_mount_devfs	checkbox	Allow privileged users inside the jail to mount and unmount the devfs(5) device filesystem (https://www.freebsd.org/cgi/man.cgi?query=devfs). This permission is only effective when <i>allow_mount</i> is set and <i>enforce_statfs</i> is set to a value lower than 2.
allow_mount_fusefs	checkbox	Allow privileged users inside the jail to mount and unmount fusefs. The jail must have FreeBSD 12.0 or newer installed. This permission is only effective when <i>allow_mount</i> is set and <i>enforce_statfs</i> is set to a value lower than 2.
allow_mount_nullfs	checkbox	Allow privileged users inside the jail to mount and unmount the nullfs(5) file system (https://www.freebsd.org/cgi/man.cgi?query=nullfs). This permission is only effective when <i>allow_mount</i> is set and <i>enforce_statfs</i> is set to a value lower than 2.
allow_mount_procfs	checkbox	Allow privileged users inside the jail to mount and unmount the procfs(5) file system (https://www.freebsd.org/cgi/man.cgi?query=procfs). This permission is only effective when <i>allow_mount</i> is set and <i>enforce_statfs</i> is set to a value lower than 2.
allow_mount_tmpfs	checkbox	Allow privileged users inside the jail to mount and unmount the tmpfs(5) file system (https://www.freebsd.org/cgi/man.cgi?query=tmpfs). This permission is only effective when <i>allow_mount</i> is set and <i>enforce_statfs</i> is set to a value lower than 2.
allow_mount_zfs	checkbox	Allow privileged users inside the jail to mount and unmount the ZFS file system. This permission is only effective when <i>allow_mount</i> is set and <i>enforce_statfs</i> is set to a value lower than 2. The ZFS(8) (https://www.freebsd.org/cgi/man.cgi?query=zfs) man page has information on how to configure the ZFS filesystem to operate from within a jail.
allow_vmm	checkbox	Grants the jail access to the Bhyve Virtual Machine Monitor (VMM). The jail must have FreeBSD 12.0 or newer installed with the vmm(4) (https://www.freebsd.org/cgi/man.cgi?query=vmm) kernel module loaded.
allow_quotas	checkbox	Allow the jail root to administer quotas on the jail filesystems. This includes filesystems the jail shares with other jails or with non-jailed parts of the system.
allow_socket_af	checkbox	Allow access to other protocol stacks beyond IPv4, IPv6, local (UNIX), and route. Warning: jail functionality does not exist for all protocol stacks.
vnet_interfaces	string	Space-delimited list of network interfaces to attach to a VNET-enabled jail after it is created. Interfaces are automatically released when the jail is removed.

Click *NEXT* to view all jail *Network Properties*. These are shown in [Table 15.3](#):

Table 15.3: Network Properties

Setting	Value	Description
interfaces	string	Enter up to four interface configurations in the format <i>interface:bridge</i> , separated by a comma (,). The left value is the virtual VNET interface name and the right value is the bridge name where the virtual interface is attached.

Continued on next page

Table 15.3 – continued from previous page

Setting	Value	Description
host_domainname	string	Enter an NIS Domain name (https://www.freebsd.org/doc/handbook/network-nis.html) for the jail.
host_hostname	string	Enter a hostname for the jail. By default, the system uses the jail NAME/UUID.
exec_fib	integer	Enter a number to define the routing table (FIB) to set when running commands inside the jail.
ip4.saddrsel	checkbox	Disables IPv4 source address selection for the jail in favor of the primary IPv4 address of the jail. Only available when the jail is not configured to use VNET.
ip4	drop-down	Control the availability of IPv4 addresses. Set to <i>Inherit</i> : allow unrestricted access to all system addresses. Set to <i>New</i> : restrict addresses with <i>ip4_addr</i> . Set to <i>Disable</i> : stop the jail from using IPv4 entirely.
ip6.saddrsel	string	Disable IPv6 source address selection for the jail in favor of the primary IPv6 address of the jail. Only available when the jail is not configured to use VNET.
ip6	drop-down	Control the availability of IPv6 addresses. Set to <i>Inherit</i> : allow unrestricted access to all system addresses. Set to <i>New</i> : restrict addresses with <i>ip6_addr</i> . Set to <i>Disable</i> : stop the jail from using IPv6 entirely.
resolver	string	Add lines to <code>resolv.conf</code> in file. Example: <i>nameserver IP;search domain.local</i> . Fields must be delimited with a semicolon (;), this is translated as new lines in <code>resolv.conf</code> . Enter <i>none</i> to inherit <code>resolv.conf</code> from the host.
mac_prefix	string	Optional. Enter a valid MAC address vendor prefix. Example: <i>E4F4C6</i>
vnet_default_interface	drop-down	Set the default VNET interface. Only takes effect when <i>VNET</i> is set. Choose a specific interface, or set to <i>auto</i> to use the interface that has the default route. Choose <i>none</i> to not set a default VNET interface.
vnet0_mac	string	Leave this blank to generate random MAC addresses for the host and jail. To assign fixed MAC addresses, enter the host MAC address and the jail MAC address separated by a space.
vnet1_mac	string	Leave this blank to generate random MAC addresses for the host and jail. To assign fixed MAC addresses, enter the host MAC address and the jail MAC address separated by a space.
vnet2_mac	string	Leave this blank to generate random MAC addresses for the host and jail. To assign fixed MAC addresses, enter the host MAC address and the jail MAC address separated by a space.
vnet3_mac	string	Leave this blank to generate random MAC addresses for the host and jail. To assign fixed MAC addresses, enter the host MAC address and the jail MAC address separated by a space.
NAT Interface	checkbox	System network interface that remaps jail network addresses into a different IP address space. To override using the default system network interface, enter the name of a network interface to use for NAT. Only appears when <i>NAT Port Forwarding</i> is set.
NAT Port Forwarding	checkbox	Configure the ports that allow remote access to the jail. To override the default port settings for a plugin, set this checkbox and configure a <i>Protocol</i> , <i>Jail Port Number</i> , and <i>Host Port Number</i> . Only appears if <i>NAT</i> is set.

Continued on next page

Table 15.3 – continued from previous page

Setting	Value	Description
Protocol	string	The type of connection the port uses. Choose TCP (https://www.freebsd.org/cgi/man.cgi?query=tcp) for a reliable two-way transmission of data or UDP (https://www.freebsd.org/cgi/man.cgi?query=udp) for an unreliable and unordered one-way data transmission. Only appears if <i>NAT Port Forwarding</i> is set.
Jail Port Number	integer	Port to assign to this jail. Avoid using a port that is already in use by another jail or system service. For a list of commonly-used ports, see this Internet Assigned Numbers Authority (IANA) registry (https://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml). Only appears if <i>NAT Port Forwarding</i> is set.
Host Port Number	integer	The port on the host system that forwards data to the jail. Avoid using a port that is already in use by another system service. For a list of commonly-used ports, see this Internet Assigned Numbers Authority (IANA) registry . (https://www.iana.org/assignments/service-names-port-numbers/service-names-port-numbers.xhtml) Only appears if <i>NAT Port Forwarding</i> is set.

The final set of jail properties are contained in the *Custom Properties* section. [Table 15.4](#) describes these options.

Table 15.4: Custom Properties

Setting	Value	Description
owner	string	The owner of the jail. Can be any string.
priority	integer	The numeric start priority for the jail at boot time. Smaller values mean a higher priority. At system shutdown, the priority is <i>reversed</i> . Example: 99
hostid	string	A new a jail hostid, if necessary. Example hostid: <i>1a2bc345-678d-90e1-23fa-4b56c78901de</i> .
hostid_strict_check	checkbox	Check the jail <i>hostid</i> property. Prevents the jail from starting if the <i>hostid</i> does not match the host.
comment	string	Comments about the jail.
depends	string	Specify any jails the jail depends on. Child jails must already exist before the parent jail can be created.
mount_procfs	checkbox	Allow mounting of a procfs(5) (https://www.freebsd.org/cgi/man.cgi?query=procfs) filesystems in the jail <i>/dev/proc</i> directory.
mount_linprocfs	checkbox	Allow mounting of a linprocfs(5) (https://www.freebsd.org/cgi/man.cgi?query=linprocfs) filesystem in the jail.
template	checkbox	Convert the jail into a template. Template jails can be used to quickly create jails with the same configuration.
host_time	checkbox	Synchronize the time between jail and host.
jail_zfs	checkbox	Enable automatic ZFS jailing inside the jail. The assigned ZFS dataset is fully controlled by the jail. Note: <i>allow_mount</i> , <i>enforce_statfs</i> , and <i>allow_mount_zfs</i> must all be set for ZFS management inside the jail to work correctly.
jail_zfs_dataset	string	Define the dataset to be jailed and fully handed over to a jail. Enter a ZFS filesystem name without a pool name. <i>jail_zfs</i> must be set for this option to work.
jail_zfs_mountpoint	string	The mountpoint for the <i>jail_zfs_dataset</i> . Example: <i>/data/example-dataset-name</i>

Continued on next page

Table 15.4 – continued from previous page

Setting	Value	Description
allow_tun	checkbox	Expose host tun(4) (https://www.freebsd.org/cgi/man.cgi?query=tun) devices in the jail. Allow the jail to create tun devices.
Autoconfigure IPv6 with rtsold	checkbox	Use rtsold(8) (https://www.freebsd.org/cgi/man.cgi?query=rtsold) as part of IPv6 autoconfiguration. Send ICMPv6 Router Solicitation messages to interfaces to discover new routers.
ip_hostname	checkbox	Use DNS records during jail IP configuration to search the resolver and apply the first open IPv4 and IPv6 addresses. See jail(8) (https://www.freebsd.org/cgi/man.cgi?query=jail).
assign_localhost	checkbox	Add network interface <i>lo0</i> to the jail and assign it the first available localhost address, starting with <i>127.0.0.2</i> . <i>VNET</i> cannot be set. Jails using <i>VNET</i> configure a localhost as part of their virtualized network stack.

Click *SAVE* when the desired jail properties have been set. New jails are added to the primary list in the *Jails* menu.

15.2.2.1 Creating Template Jails

Template jails are basejails that can be used as a template to efficiently create jails with the same configuration. These steps create a template jail:

1. Go to *Jails* → *ADD* → *ADVANCED JAIL CREATION*.
2. Select *Basejail* as the *Jail Type*. Configure the jail with desired options.
3. Set *template* in the *Custom Properties* tab.
4. Click *Save*.
5. Click *ADD*.
6. Enter a name for the template jail. Leave *Jail Type* as *Default (Clone Jail)*. Set *Release* to *basejailname(template)*, where *basejailname* is the name of the base jail created earlier.
7. Complete the jail creation wizard.

15.3 Managing Jails

Clicking *Jails* shows a list of installed jails. An example is shown in [Figure 15.4](#).

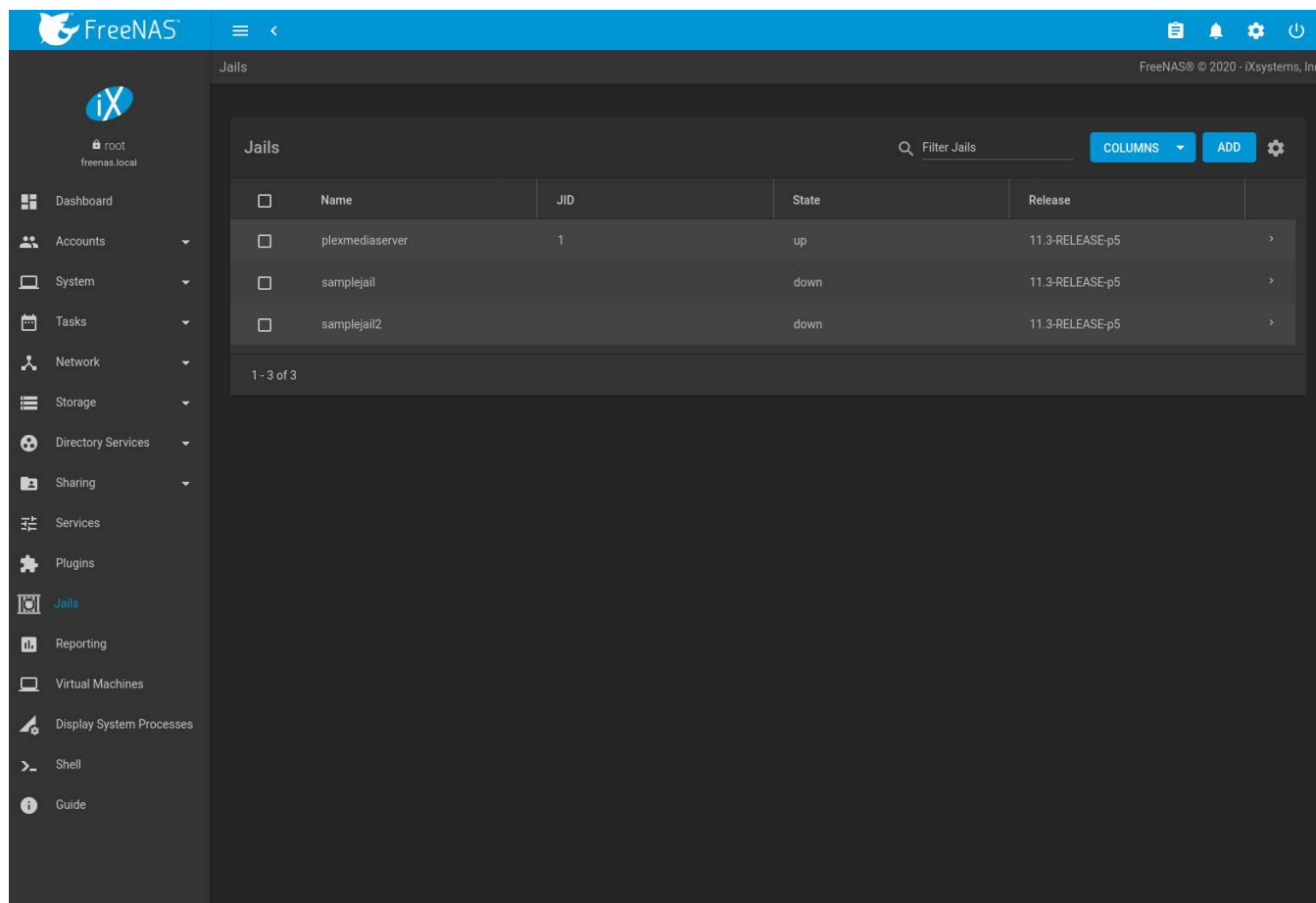


Fig. 15.4: Jail Overview Section

Operations can be applied to multiple jails by selecting those jails with the checkboxes on the left. After selecting one or more jails, icons appear which can be used to ► (Start), ■ (Stop), ⌘ (Update), or 🗑 (Delete) those jails.

More information such as *IPV4*, *IPV6*, *TYPE* of jail, and whether it is a *TEMPLATE* jail or *BASEJAIL* can be shown by clicking > (Expand). Additional options for that jail are also displayed. These are described in [Table 15.5](#).

[Figure 15.5](#) shows the menu that appears.

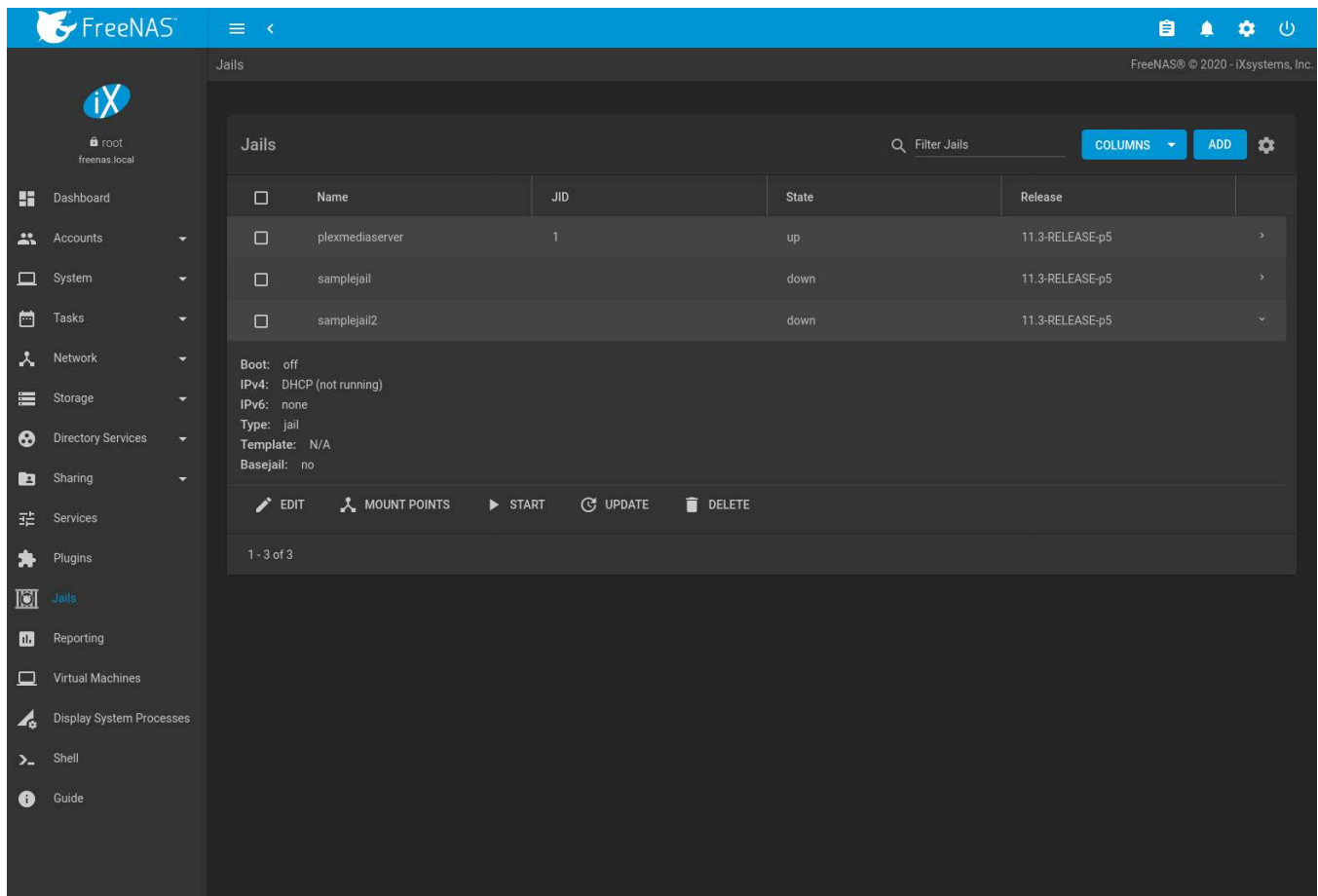


Fig. 15.5: Jail Options Menu

Warning: Modify the IP address information for a jail by clicking > (Expand) → *EDIT* instead of issuing the networking commands directly from the command line of the jail. This ensures the changes are saved and will survive a jail or FreeNAS® reboot.

Table 15.5: Jail Option Menu Entry Descriptions

Option	Description
EDIT	Used to modify the settings described in Advanced Jail Creation (page 297). A jail cannot be edited while it is running. The settings can be viewed, but are read only.
MOUNT POINTS	Select an existing mount point to <i>EDIT</i> or click <i>ACTIONS</i> → <i>Add Mount Point</i> to create a mount point for the jail. A mount point gives a jail access to storage located elsewhere on the system. A jail must be stopped before adding, editing, or deleting a mount point. See Additional Storage (page 310) for more details.
RESTART	Stop and immediately start an <i>up</i> jail.
START	Start a jail that has a current <i>STATE</i> of <i>down</i> .
STOP	Stop a jail that has a current <i>STATE</i> of <i>up</i> .
UPDATE	Runs <code>freebsd-update</code> (https://www.freebsd.org/cgi/man.cgi?query=freebsd-update) to update the jail to the latest patch level of the installed FreeBSD release.
SHELL	Access a <i>root</i> command prompt to interact with a jail directly from the command line. Type <code>exit</code> to leave the command prompt.

Continued on next page

Table 15.5 – continued from previous page

Option	Description
DELETE	Caution: deleting the jail also deletes all of the jail contents and all associated <i>snapshots</i> (page 186). Back up the jail data, configuration, and programs first. There is no way to recover the contents of a jail after deletion!

Note: Menu entries change depending on the jail state. For example, a stopped jail does not have a *STOP* or *SHELL* option.

Jail status messages and command output are stored in `/var/log/iocage.log`.

15.3.1 Jail Updates and Upgrades

Click **>** (Expand) → *Update* to update a jail to the most current patch level of the installed FreeBSD release. This does **not** change the release.

A jail *upgrade* replaces the jail FreeBSD operating system with a new release of FreeBSD. Upgrade a jail by stopping it, opening the *Shell* (page 335) and entering `iocage upgrade name`, where *name* is the plugin jail name.

Tip: It is possible to *manually remove* (page 179) unused releases from the `/iocage/releases/` dataset after upgrading a jail. The release **must** not be in use by any jail on the system!

15.3.2 Accessing a Jail Using SSH

The ssh daemon `sshd(8)` (<https://www.freebsd.org/cgi/man.cgi?query=sshd>) must be enabled in a jail to allow SSH access to that jail from another system.

The jail *STATE* must be *up* before the *SHELL* option is available. If the jail is not up, start it by clicking *Jails* → **>** (Expand) → *START* for the desired jail. Click **>** (Expand) → *SHELL* to open a shell in the jail. A jail root shell is shown in this example:

```
Last login: Fri Apr 6 07:57:04 on pts/12
FreeBSD 11.1-STABLE (FreeNAS.amd64) #0 0ale9f753(freenas/11-stable): Fri Apr 6 04:46:31 UTC 2018

Welcome to FreeBSD!

Release Notes, Errata: https://www.FreeBSD.org/releases/
Security Advisories:  https://www.FreeBSD.org/security/
FreeBSD Handbook:     https://www.FreeBSD.org/handbook/
FreeBSD FAQ:          https://www.FreeBSD.org/faq/
Questions List: https://lists.FreeBSD.org/mailman/listinfo/freebsd-questions/
FreeBSD Forums:       https://forums.FreeBSD.org/

Documents installed with the system are in the /usr/local/share/doc/freebsd/
directory, or can be installed later with: pkg install en-freebsd-doc
For other languages, replace "en" with a language code like de or fr.

Show the version of FreeBSD installed: freebsd-version ; uname -a
Please include that output and any error messages when posting questions.
Introduction to manual pages: man man
FreeBSD directory layout:     man hier

Edit /etc/motd to change this login announcement.
root@jailexamp:~ #
```


Tip: A root shell can also be opened for a jail using the FreeNAS® UI *Shell*. Open the *Shell*, then type `iocage console jailname`.

Enable sshd:

```
sysrc sshd_enable="YES"
sshd_enable: NO -> YES
```

Tip: Using `sysrc` to enable sshd verifies that sshd is enabled.

Start the SSH daemon: `service sshd start`

The first time the service runs, the jail RSA key pair is generated and the key fingerprint is displayed.

Add a user account with `adduser`. Follow the prompts, `Enter` will accept the default value offered. Users that require *root* access must also be a member of the *wheel* group. Enter *wheel* when prompted to *invite user into other groups?* []:

```
root@jailexamp:~ # adduser
Username: jailuser
Full name: Jail User
Uid (Leave empty for default):
Login group [jailuser]:
Login group is jailuser. Invite jailuser into other groups? []: wheel
Login class [default]:
Shell (sh csh tcsh git-shell zsh rzsh nologin) [sh]: csh
Home directory [/home/jailuser]:
Home directory permissions (Leave empty for default):
Use password-based authentication? [yes]:
Use an empty password? (yes/no) [no]:
Use a random password? (yes/no) [no]:
Enter password:
Enter password again:
Lock out the account after creation? [no]:
Username   : jailuser
Password   : *****
Full Name  : Jail User
Uid        : 1002
Class      :
Groups     : jailuser wheel
Home       : /home/jailuser
Home Mode  :
Shell      : /bin/csh
Locked     : no
OK? (yes/no): yes
adduser: INFO: Successfully added (jailuser) to the user database.
Add another user? (yes/no): no
Goodbye!
root@jailexamp:~
```

After creating the user, set the jail *root* password to allow users to use `su` to gain superuser privileges. To set the jail *root* password, use `passwd`. Nothing is echoed back when using `passwd`

```
root@jailexamp:~ # passwd
Changing local password for root
New Password:
Retype New Password:
root@jailexamp:~ #
```

Finally, test that the user can successfully `ssh` into the jail from another system and gain superuser privileges. In the example, a user named *jailuser* uses `ssh` to access the jail at 192.168.2.3. The host RSA key fingerprint must be verified the first time a user logs in.

```
ssh jailuser@192.168.2.3
The authenticity of host '192.168.2.3 (192.168.2.3)' can't be established.
RSA key fingerprint is 6f:93:e5:36:4f:54:ed:4b:9c:c8:c2:71:89:c1:58:f0.
Are you sure you want to continue connecting (yes/no)? yes
Warning: Permanently added '192.168.2.3' (RSA) to the list of known hosts.
Password:
```

Note: Every jail has its own user accounts and service configuration. These steps must be repeated for each jail that requires SSH access.

15.3.3 Additional Storage

Jails can be given access to an area of storage outside of the jail that is configured on the FreeNAS® system. It is possible to give a FreeBSD jail access to an area of storage on the FreeNAS® system. This is useful for applications or plugins that store large amounts of data or if an application in a jail needs access to data stored on the FreeNAS® system. For example, Transmission is a plugin that stores data using BitTorrent. The FreeNAS® external storage is added using the `mount_nullfs(8)` (https://www.freebsd.org/cgi/man.cgi?query=mount_nullfs) mechanism, which links data that resides outside of the jail as a storage area within a jail.

› (Expand) → *MOUNT POINTS* shows any added storage and allows adding more storage.

Note: A jail must have a *STATE* of *down* before adding a new mount point. Click › (Expand) and *STOP* for a jail to change the jail *STATE* to *down*.

Storage can be added by clicking *Jails* → › (Expand) → *MOUNT POINTS* for the desired jail. The *MOUNT POINT* section is a list of all of the currently defined mount points.

Go to *MOUNT POINTS* → *ACTIONS* → *Add Mount Point* to add storage to a jail. This opens the screen shown in [Figure 15.6](#).

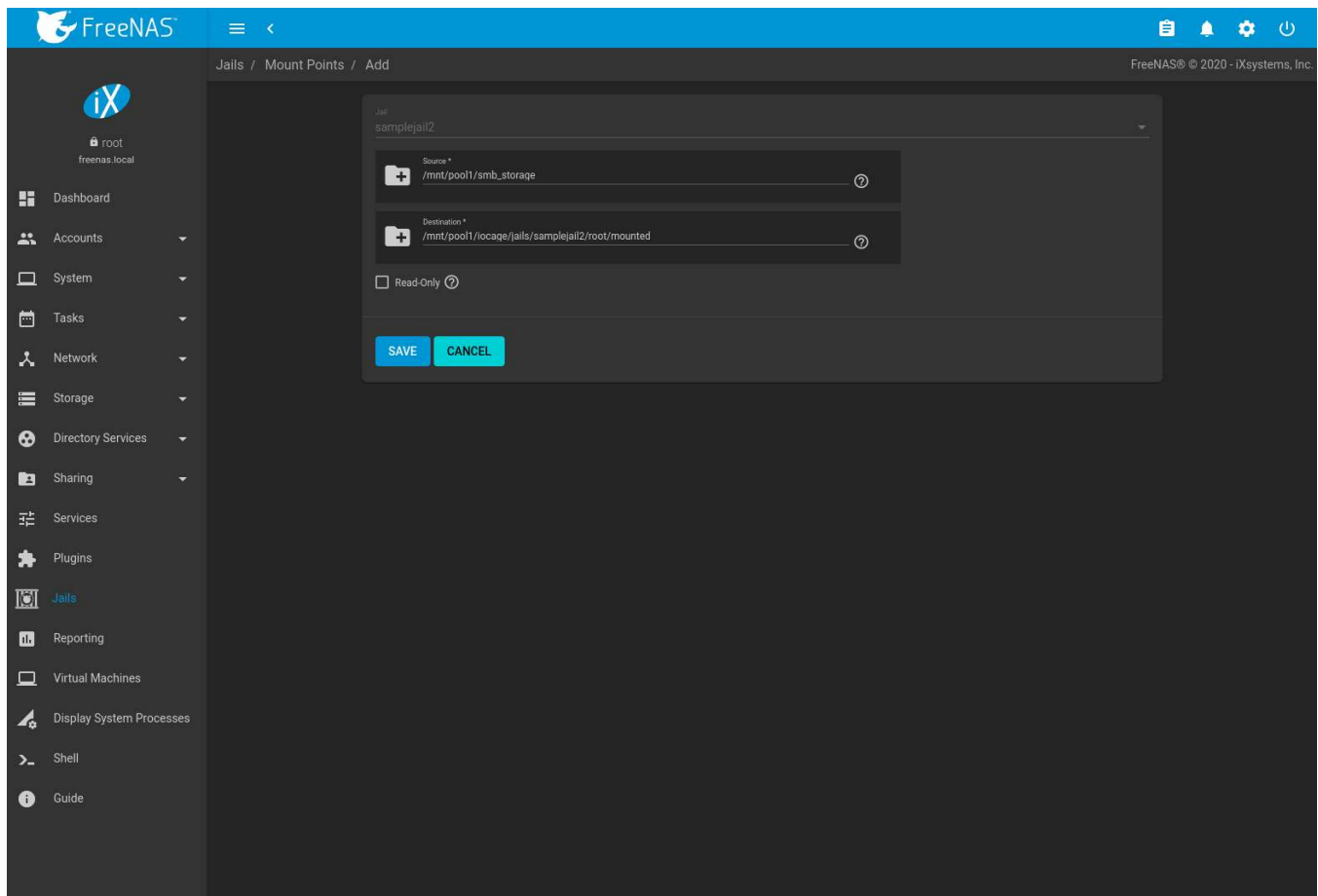


Fig. 15.6: Adding Storage to a Jail

Browse to the *Source* and *Destination*, where:

- *Source*: is the directory or dataset on the FreeNAS® system which will be accessed by the jail. FreeNAS® creates the directory if it does not exist. This directory must reside outside of the pool or dataset being used by the jail. This is why it is recommended to create a separate dataset to store jails, so the dataset holding the jails is always separate from any datasets used for storage on the FreeNAS® system.
- *Destination*: Browse to an existing and **empty** directory within the jail to link to the *Source* storage area. It is also possible to add / and a name to the end of the path and FreeNAS® automatically creates a new directory. New directories created must be **within** the jail directory structure. Example: `/mnt/iocage/jails/samplejail/root/new-destination-directory`.

Storage is typically added because the user and group account associated with an application installed inside of a jail needs to access data stored on the FreeNAS® system. Before selecting the *Source*, it is important to first ensure that the permissions of the selected directory or dataset grant permission to the user/group account inside of the jail. This is not the default, as the users and groups created inside of a jail are totally separate from the users and groups of the FreeNAS® system.

The workflow for adding storage usually goes like this:

1. Determine the name of the user and group account used by the application. For example, the installation of the transmission application automatically creates a user account named *transmission* and a group account also named *transmission*. When in doubt, check the files `/etc/passwd` (to find the user account) and `/etc/group` (to find the group account) inside the jail. Typically, the user and group names are similar to the application name. Also, the UID and GID are usually the same as the port number used by the service.

A *media* user and group (GID 8675309) are part of the base system. Having applications run as this group or user makes it possible to share storage between multiple applications in a single jail, between multiple jails,

or even between the host and jails.

2. On the FreeNAS® system, create a user account and group account that match the user and group names used by the application in the jail.
3. Decide whether the jail will be given access to existing data or a new storage area will be allocated.
4. If the jail accesses existing data, edit the permissions of the pool or dataset so the user and group accounts have the desired read and write access. If multiple applications or jails are to have access to the same data, create a new group and add each needed user account to that group.
5. If an area of storage is being set aside for that jail or individual application, create a dataset. Edit the permissions of that dataset so the user and group account has the desired read and write access.
6. Use the jail > (Expand) → *MOUNT POINTS* → *ACTIONS* → *Add Mount Point* to select the *Source* of the data and the *Destination* where it will be mounted in the jail.

To prevent writes to the storage, click *Read-Only*.

After storage has been added or created, it appears in the *MOUNT POINTS* for that jail. In the example shown in [Figure 15.7](#), a dataset named `pool1/smb-backups` has been chosen as the *Source* as it contains the files stored on the FreeNAS® system. The user entered `/mnt/iocage/jails/jail1/root/mounted` as the directory to be mounted in the *Destination* field. To users inside the jail, this data appears in the `/root/mounted` directory.

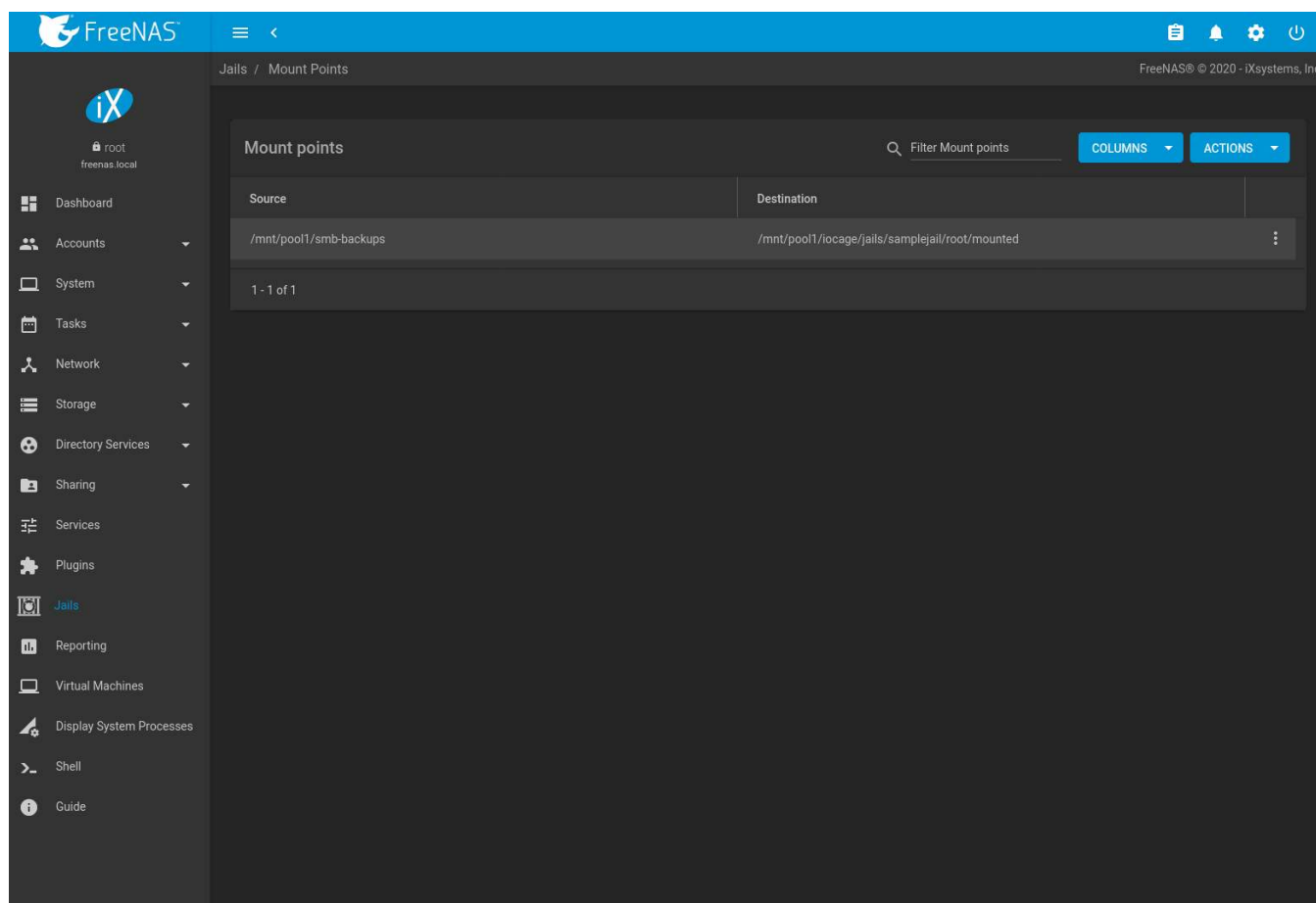


Fig. 15.7: Example Storage

Storage is automatically mounted as it is created.

Note: Mounting a dataset does not automatically mount any child datasets inside it. Each dataset is a separate

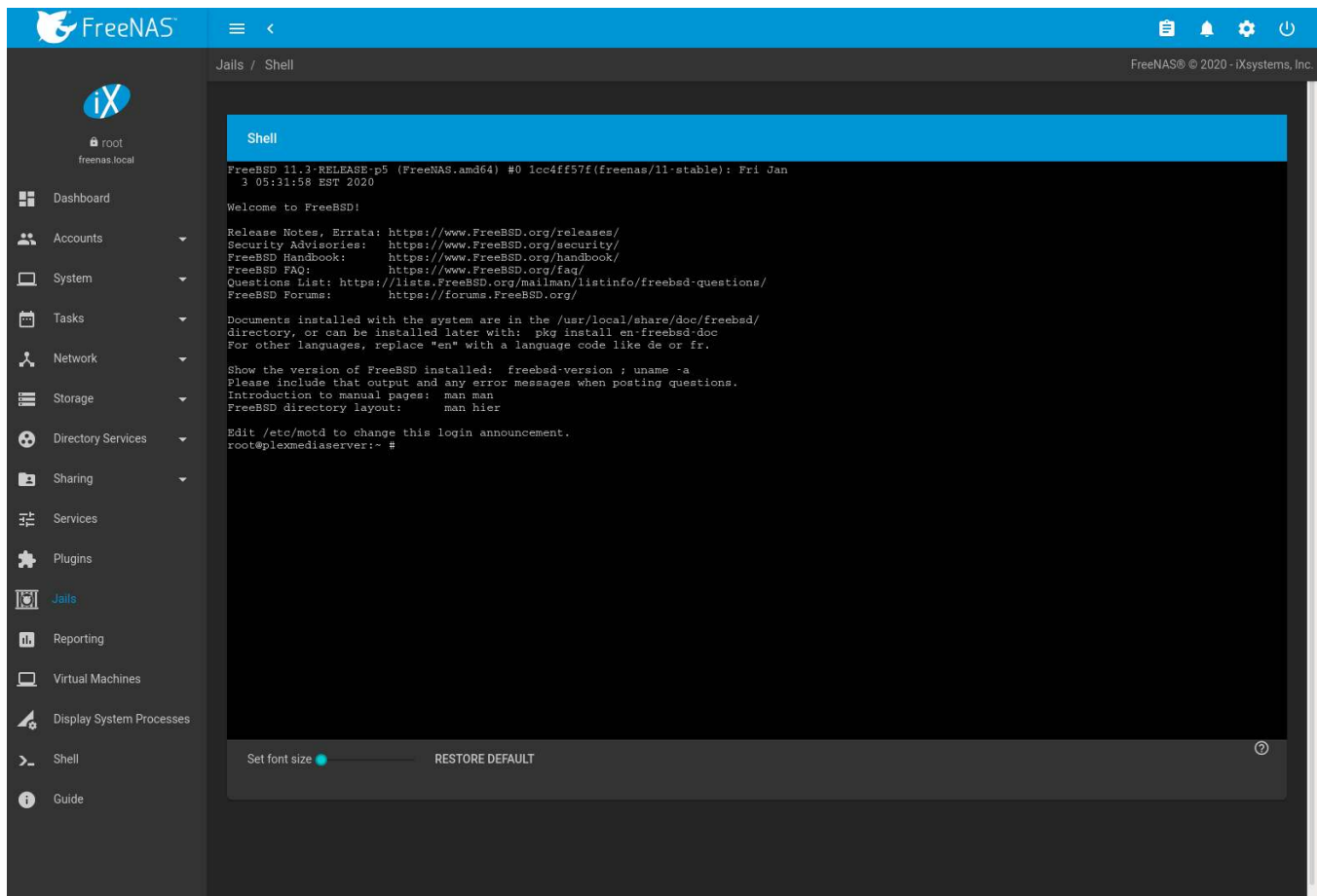
filesystem, so child datasets must each have separate mount points.

Click **:** (Options) → *Delete* to delete the storage.

Warning: Remember that added storage is just a pointer to the selected storage directory on the FreeNAS® system. It does **not** copy that data to the jail. **Files that are deleted from the Destination directory in the jail are really deleted from the Source directory on the FreeNAS® system.** However, removing the jail storage entry only removes the pointer. This leaves the data intact but not accessible from the jail.

15.4 Jail Software

A jail is created with no software aside from the core packages installed as part of the selected version of FreeBSD. To install more software, start the jail and click > SHELL.



15.4.1 Installing FreeBSD Packages

The quickest and easiest way to install software inside the jail is to install a FreeBSD package. FreeBSD packages are precompiled and contain all the binaries and a list of dependencies required for the software to run on a FreeBSD system.

A huge amount of software has been ported to FreeBSD. Most of that software is available as packages. One way to find FreeBSD software is to use the search bar at [FreshPorts.org](https://www.freshports.org/) (<https://www.freshports.org/>).

After finding the name of the desired package, use the `pkg install` command to install it. For example, to install the audiotag package, use the command `pkg install audiotag`

When prompted, press `y` to complete the installation. Messages will show the download and installation status.

A successful installation can be confirmed by querying the package database:

```
pkg info -f audiotag
audiotag-0.19_1
Name:          audiotag
Version:       0.19_1
Installed on:  Fri Nov 21 10:10:34 PST 2014
Origin:        audio/audiotag
Architecture:  freebsd:9:x86:64
Prefix:        /usr/local
Categories:    multimedia audio
Licenses:      GPLv2
Maintainer:    ports@FreeBSD.org
WWW:           http://github.com/Daenyth/audiotag
Comment:       Command-line tool for mass tagging/renaming of audio files
Options:
  DOCS:        on
  FLAC:        on
  ID3:         on
  MP4:         on
  VORBIS:      on
Annotations:
  repo_type:   binary
  repository:  FreeBSD
Flat size:     62.8KiB
Description:   Audiotag is a command-line tool for mass tagging/renaming of audio files
                it supports the vorbis comment, id3 tags, and MP4 tags.
WWW:           http://github.com/Daenyth/audiotag
```

To show what was installed by the package:

```
pkg info -l audiotag
audiotag-0.19_1:
/usr/local/bin/audiotag
/usr/local/share/doc/audiotag/COPYING
/usr/local/share/doc/audiotag/ChangeLog
/usr/local/share/doc/audiotag/README
/usr/local/share/licenses/audiotag-0.19_1/GPLv2
/usr/local/share/licenses/audiotag-0.19_1/LICENSE
/usr/local/share/licenses/audiotag-0.19_1/catalog.mk
```

In FreeBSD, third-party software is always stored in `/usr/local` to differentiate it from the software that came with the operating system. Binaries are almost always located in a subdirectory called `bin` or `sbin` and configuration files in a subdirectory called `etc`.

15.4.2 Compiling FreeBSD Ports

Compiling a port is another option. Compiling ports offer these advantages:

- Not every port has an available package. This is usually due to licensing restrictions or known, unaddressed security vulnerabilities.
- Sometimes the package is out-of-date and a feature is needed that only became available in the newer version.
- Some ports provide compile options that are not available in the pre-compiled package. These options are used to add or remove features or options.

Compiling a port has these disadvantages:

- It takes time. Depending upon the size of the application, the amount of dependencies, the speed of the CPU, the amount of RAM available, and the current load on the FreeNAS® system, the time needed can range from a few minutes to a few hours or even to a few days.

Note: If the port does not provide any compile options, it saves time and preserves the FreeNAS® system resources to use the `pkg install` command instead.

The [FreshPorts.org](https://www.freshports.org/) (<https://www.freshports.org/>) listing shows whether a port has any configurable compile options. [Figure 15.8](#) shows the *Configuration Options* for *audiotag*, a utility for renaming multiple audio files.



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audiotag Command-line tool for mass tagging/renaming of audio files 0.19_1 audio Z=1 🔍 🔗 🔖 <p>There is no maintainer for this port. Any concerns regarding this port should be directed to the FreeBSD Ports mailing list via ports@FreeBSD.org 🔗</p> <p>Port Added: 2008-04-15 13:43:37 Last Updated: 2016-12-02 09:21:59 SVN Revision: 427548 Also Listed In: multimedia License: GPLv2+</p> <p>Audiotag is a command-line tool for mass tagging/renaming of audio files it supports the vorbis comment, id3 tags, and MP4 tags.</p> <p>WWW: https://github.com/Daenyth/audiotag</p> <p>SVNWeb : Homepage : PortsMon Pseudo-pkg-plist information, but much better, from make generate-plist ▼ Expand this list (4 items)</p> <p>Dependency line: <code>audiotag>0:audio/audiotag</code></p> <p>To install the port: <code>cd /usr/ports/audio/audiotag/ && make install clean</code> To add the package: <code>pkg install audiotag</code></p> <p>PKGNAME: audiotag</p> <p>There is no flavor information for this port.</p> <p>distinfo:</p> <pre>SHA256 (audiotag-0.19.tar.bz2) = 7b6a2de751058a95755f0842b83f2b1d8b94e5cd7634cbe71d67257208bf4646 SIZE (audiotag-0.19.tar.bz2) = 15816</pre> <p>NOTE: FreshPorts displays only information on required and default dependencies. Optional dependencies are not covered.</p> <p>Runtime dependencies:</p> <ol style="list-style-type: none"> 1. flac : audio/flac 2. id3tag : audio/id3lib 3. AtomicParsley : multimedia/atomicparsley 4. vorbiscomment : audio/vorbis-tools 5. perl5 >= 5.24 < 5.25 : lang/perl5.24 <p>There are no ports dependent upon this port</p> <p>Configuration Options</p> <p>====> The following configuration options are available for audiotag-0.19.1: DOCS=on: Build and/or install documentation FLAC=on: FLAC lossless audio codec support ID3=on: ID3 tags support MP4=on: MP4 media format support VORBIS=on: Ogg Vorbis audio codec support ====> Use 'make config' to modify these settings</p> <p>USES:</p> <p>tar:bzip2 shebangfix perl5</p> <p>Master Sites:</p> <ol style="list-style-type: none"> 1. https://cloud.github.com/downloads/Daenyth/audiotag/ 	<p>User Login Create account</p> <p>Servers and bandwidth provided by New York Internet, SuperNews, and RootBSD</p> <p>This site</p> <p>What is FreshPorts? About the authors Issues FAQ How big is it? The latest upgrade! Privacy Forums Blog Contact</p> <p>Search</p> <p>Enter Keywords:</p> <input type="text"/> <p><input type="button" value="go"/></p> <p>more...</p> <p>Latest Vulnerabilities</p> <table border="1"> <thead> <tr> <th>Package</th> <th>Date</th> </tr> </thead> <tbody> <tr> <td>powerdns</td> <td>Mar 19</td> </tr> <tr> <td>rubygem-actionview4</td> <td>Mar 18</td> </tr> <tr> <td>rubygem-actionview5</td> <td>Mar 18</td> </tr> <tr> <td>rubygem-actionview50</td> <td>Mar 18</td> </tr> <tr> <td>putty</td> <td>Mar 17</td> </tr> <tr> <td>putty-gtk2</td> <td>Mar 17</td> </tr> <tr> <td>putty-nogtk</td> <td>Mar 17</td> </tr> <tr> <td>py-notebook</td> <td>Mar 16</td> </tr> <tr> <td>ruby-gems</td> <td>Mar 15</td> </tr> <tr> <td>ntp</td> <td>Mar 07</td> </tr> <tr> <td>openssl*</td> <td>Mar 07</td> </tr> <tr> <td>openssl111</td> <td>Mar 07</td> </tr> <tr> <td>rsh</td> <td>Mar 06</td> </tr> <tr> <td>rt42</td> <td>Mar 06</td> </tr> <tr> <td>rt44</td> <td>Mar 06</td> </tr> </tbody> </table> <p>13 vulnerabilities affecting 42 ports have been reported in the past 14 days</p> <p>* - modified, not new</p> <p>All vulnerabilities</p> <p>Last updated: 2019-03-19 14:51:44</p> <p>Ports</p> <p>Home Categories Deleted ports Sanity Test Failures Newsfeeds</p> <p>Statistics</p> <p>Graphs NEW Graphs (javascript) Traffic</p> <p>Calculated hourly:</p> <table border="1"> <thead> <tr> <th>Category</th> <th>Count</th> </tr> </thead> <tbody> <tr> <td>Port count</td> <td>36286</td> </tr> <tr> <td>Broken</td> <td>116</td> </tr> <tr> <td>Deprecated</td> <td>119</td> </tr> <tr> <td>Ignore</td> <td>337</td> </tr> <tr> <td>Forbidden</td> <td>5</td> </tr> <tr> <td>Restricted</td> <td>161</td> </tr> <tr> <td>No CDROM</td> <td>74</td> </tr> <tr> <td>Vulnerable</td> <td>37</td> </tr> <tr> <td>Expired</td> <td>6</td> </tr> <tr> <td>Set to expire</td> <td>93</td> </tr> <tr> <td>Interactive</td> <td>0</td> </tr> <tr> <td>new 24 hours</td> <td>4</td> </tr> <tr> <td>new 48 hours</td> <td>12</td> </tr> <tr> <td>new 7 days</td> <td>35</td> </tr> <tr> <td>new fortnight</td> <td>65</td> </tr> <tr> <td>new month</td> <td>138</td> </tr> </tbody> </table>	Package	Date	powerdns	Mar 19	rubygem-actionview4	Mar 18	rubygem-actionview5	Mar 18	rubygem-actionview50	Mar 18	putty	Mar 17	putty-gtk2	Mar 17	putty-nogtk	Mar 17	py-notebook	Mar 16	ruby-gems	Mar 15	ntp	Mar 07	openssl*	Mar 07	openssl111	Mar 07	rsh	Mar 06	rt42	Mar 06	rt44	Mar 06	Category	Count	Port count	36286	Broken	116	Deprecated	119	Ignore	337	Forbidden	5	Restricted	161	No CDROM	74	Vulnerable	37	Expired	6	Set to expire	93	Interactive	0	new 24 hours	4	new 48 hours	12	new 7 days	35	new fortnight	65	new month	138
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Number of commits found: 22

Commit History - (may be incomplete: see SVNWeb link above for full details)

Date	By	Description
02 Dec 2016 09:21:59 0.19_1	mat 🔍	http://github.com redirects to https://github.com, spare everyone a redirect. Sponsored by: Absolight
25 May 2016 15:43:34 0.19_1	mat 🔍	Remove useless WRKSRC definitions. While there, correct DEV_WARNINGS when they occur. Sponsored by: Absolight
01 Apr 2016 13:29:17 0.19_1	mat 🔍	Remove \${PORTSDIR}/ from dependencies, Mk and categories a, b, and c. With hat: portmgr Sponsored by: Absolight
12 Jan 2016 16:20:32 0.19_1	amdmi3 🔍	Convert LICENSE= "GPLxx # or later" to "GPLxx+" Approved by: portmgr blanket
18 Nov 2015 10:14:05 0.19_1	amdmi3 🔍	- Clarify LICENSE - Add LICENSE_FILE - Add NO_ARCH - Switch to options helpers
01 Jun 2014 13:03:14 0.19_1	ohauer 🔍	- USE_BZIP2(XZ) -> USES= tar:(bzip2 xz)
24 Nov 2013 18:38:39 0.19_1	bapt 🔍	Remove cruft
24 Nov 2013 18:36:37 0.19_1	bapt 🔍	Support staging Use options helpers
20 Sep 2013 14:36:37 0.19_1	bapt 🔍	Add NO_STAGE all over the place in preparation for the staging support (cat: audio)
03 Aug 2013 13:44:01 0.19_1	mat 🔍	- Convert to new perl framework - Remove MAKE_JOBS_SAFE=yes, it's the default.
06 May 2013 22:26:27 0.19_1	bapt 🔍	Use shebangfix
23 Mar 2013 19:36:24 0.19_1	bapt 🔍	Fix USE_GITHUB in combinaison with MASTER_SITE= GHC which breaks WRKSRC Drop maintainership
31 Dec 2012 11:31:44 0.19_1	bapt 🔍	- Trim headers - Switch to USE_GITHUB - Remove useless LICENSE_FILE license being plain GPLv2 - Various cleanup
29 May 2012 14:01:15 0.19_1	bapt 🔍	Convert to new options framework While here activate flac by default share descriptions of mp4, id3, flac and vorbis

Packages are built with default options. Ports let the user select options.

The Ports Collection must be installed in the jail before ports can be compiled. Inside the jail, use the `portsnap` utility. This command downloads the ports collection and extracts it to the `/usr/ports/` directory of the jail:

```
portsnap fetch extract
```

Note: To install additional software at a later date, make sure the ports collection is updated with `portsnap fetch update`.

To compile a port, `cd` into a subdirectory of `/usr/ports/`. The entry for the port at FreshPorts provides the location to `cd` into and the `make` command to run. This example compiles and installs the audiotag port:

```
cd /usr/ports/audio/audiotag
make install clean
```

The first time this command is run, the configure screen shown in Figure 15.9 is displayed:

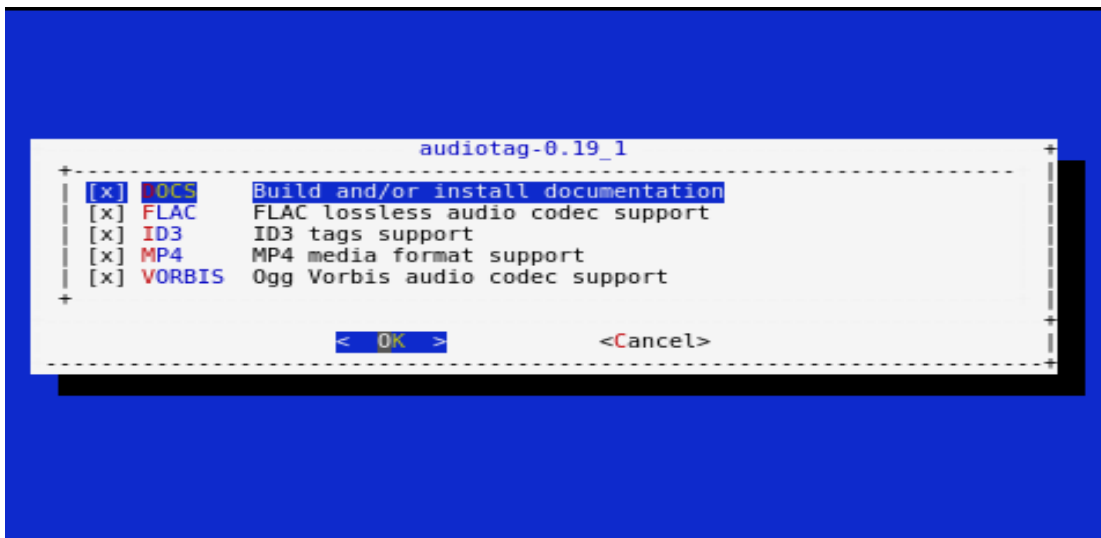


Fig. 15.9: Configuration Options for Audiotag Port

This port has several configurable options: *DOCS*, *FLAC*, *ID3*, *MP4*, and *VORBIS*. Selected options are shown with a *. Use the arrow keys to select an option and press `spacebar` to toggle the value. Press `Enter` when satisfied with the options. The port begins to compile and install.

Note: After options have been set, the configuration screen is normally not shown again. Use `make config` to display the screen and change options before rebuilding the port with `make clean install clean`.

Many ports depend on other ports. Those other ports also have configuration screens that are shown before compiling begins. It is a good idea to watch the compile until it finishes and the command prompt returns.

Installed ports are registered in the same package database that manages packages. The `pkg info` can be used to determine which ports were installed.

15.4.3 Starting Installed Software

After packages or ports are installed, they must be configured and started. Configuration files are usually in `/usr/local/etc` or a subdirectory of it. Many FreeBSD packages contain a sample configuration file as a reference.

Take some time to read the software documentation to learn which configuration options are available and which configuration files require editing.

Most FreeBSD packages that contain a startable service include a startup script which is automatically installed to `/usr/local/etc/rc.d/`. After the configuration is complete, test starting the service by running the script with the `onestart` option. For example, with `openvpn` installed in the jail, these commands are run to verify that the service started:

```
/usr/local/etc/rc.d/openvpn onestart
Starting openvpn.

/usr/local/etc/rc.d/openvpn onestatus
openvpn is running as pid 45560.

sockstat -4
USER  COMMAND          PID      FD      PROTO  LOCAL ADDRESS  FOREIGN ADDRESS
root  openvpn            48386    4       udp4    *:54789        *:*
```

If it produces an error:

```
/usr/local/etc/rc.d/openvpn onestart
Starting openvpn.
/usr/local/etc/rc.d/openvpn: WARNING: failed to start openvpn
```

Run `tail /var/log/messages` to see any error messages if an issue is found. Most startup failures are related to a misconfiguration in a configuration file.

After verifying that the service starts and is working as intended, add a line to `/etc/rc.conf` to start the service automatically when the jail is started. The line to start a service always ends in `_enable="YES"` and typically starts with the name of the software. For example, this is the entry for the `openvpn` service:

```
openvpn_enable="YES"
```

When in doubt, the startup script shows the line to put in `/etc/rc.conf`. This is the description in `/usr/local/etc/rc.d/openvpn`:

```
# This script supports running multiple instances of openvpn.
# To run additional instances link this script to something like
# % ln -s openvpn openvpn_foo

# and define additional openvpn_foo_* variables in one of
# /etc/rc.conf, /etc/rc.conf.local or /etc/rc.conf.d/openvpn_foo

#
# Below NAME should be substituted with the name of this script. By default
# it is openvpn, so read as openvpn_enable. If you linked the script to
# openvpn_foo, then read as openvpn_foo_enable etc.
#
# The following variables are supported (defaults are shown).
# You can place them in any of
# /etc/rc.conf, /etc/rc.conf.local or /etc/rc.conf.d/NAME
#
# NAME_enable="NO"
# set to YES to enable openvpn
```

The startup script also indicates if any additional parameters are available:

```
# NAME_if=
# driver(s) to load, set to "tun", "tap" or "tun tap"
#
# it is OK to specify the if_ prefix.
#
```

```
# # optional:
# NAME_flags=
# additional command line arguments
# NAME_configfile="/usr/local/etc/openvpn/NAME.conf"
# --config file
# NAME_dir="/usr/local/etc/openvpn"
# --cd directory
```

REPORTING

Reporting displays several graphs, as seen in [Figure 16.1](#). Choose a category from the drop-down menu to view those graphs. There are also options to change the graph view and number of graphs on each page.

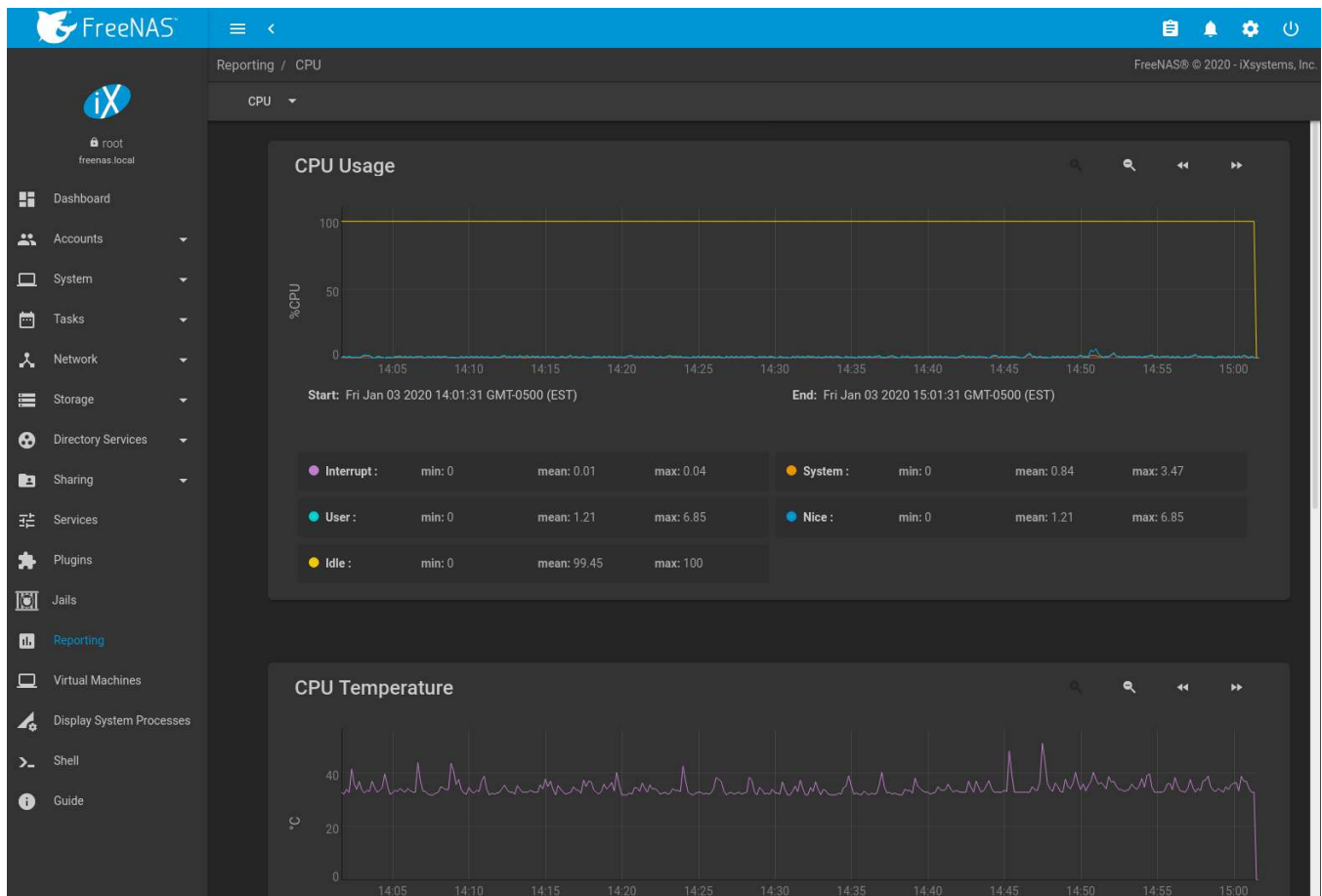


Fig. 16.1: Reporting Graphs

FreeNAS® uses [collectd](https://collectd.org/) (<https://collectd.org/>) to provide reporting statistics. For a clearer picture, hover over a point in the graph to show exact numbers for that point in time. Use the magnifier buttons next to each graph to increase or decrease the displayed time increment from 10 minutes, hourly, daily, weekly, or monthly. The << and >> buttons scroll through the output.

Note: Reporting graphs do not appear if there is no related data.

Graphs are grouped by category on the Reporting page:

- *CPU*
 - *CPU* (<https://collectd.org/wiki/index.php/Plugin:CPU>) shows the amount of time spent by the CPU in various states such as executing user code, executing system code, and being idle. Graphs of short-, mid-, and long-term load are shown, along with CPU temperature graphs.
- *Disk*
 - *Disk* (<https://collectd.org/wiki/index.php/Plugin:Disk>) shows read and write statistics on I/O, percent busy, latency, operations per second, pending I/O requests, and disk temperature. Choose the *DEVICES* and *METRICS* to view the selected metrics for the chosen devices.

Note: Temperature monitoring for the disk is disabled if *HDD Standby* is enabled in *Disks* (page 191).

- *Memory*
 - *Memory* (<https://collectd.org/wiki/index.php/Plugin:Memory>) displays memory usage.
 - *Swap* (<https://collectd.org/wiki/index.php/Plugin:Swap>) displays the amount of free and used swap space.
- *Network*
 - *Interface* (<https://collectd.org/wiki/index.php/Plugin:Interface>) shows received and transmitted traffic in megabytes per second for each configured interface.
- *NFS*
 - *NFS* (<https://collectd.org/wiki/index.php/Plugin:NFS>) shows information about the number of procedure calls for each procedure and whether the system is a server or client.
- *Partition*
 - *Disk space* (<https://collectd.org/wiki/index.php/Plugin:DF>) displays free, used, and reserved space for each pool and dataset. However, the disk space used by an individual zvol is not displayed as it is a block device.
- *System*
 - *Processes* (<https://collectd.org/wiki/index.php/Plugin:Processes>) displays the number of processes. It is grouped by state.
- *Target*
 - Target shows bandwidth statistics for iSCSI ports.
- *UPS*
 - *UPS* (<https://collectd.org/wiki/index.php/Plugin:NUT>) displays statistics about an uninterruptible power supply (UPS) using *Network UPS tools* (<https://networkupstools.org/>). Statistics include voltages, currents, power, frequencies, load, and temperatures.
- *ZFS*
 - *ZFS* (https://collectd.org/wiki/index.php/Plugin:ZFS_ARC) shows compressed physical ARC size, hit ratio, demand data, demand metadata, and prefetch data.

Reporting data is saved to permit viewing and monitoring usage trends over time. This data is preserved across system upgrades and restarts.

Data files are saved in `/var/db/collectd/rrd/`.

Warning: Reporting data is frequently written and should not be stored on the boot pool or operating system device.

VIRTUAL MACHINES

A Virtual Machine (VM) is an environment on a host computer that can be used as if it were a separate physical computer. VMs can be used to run multiple operating systems simultaneously on a single computer. Operating systems running inside a VM see emulated virtual hardware rather than the actual hardware of the host computer. This provides more isolation than *Jails* (page 294), although there is additional overhead. A portion of system RAM is assigned to each VM, and each VM uses a *zvol* (page 181) for storage. While a VM is running, these resources are not available to the host computer or other VMs.

FreeNAS® VMs use the *bhyve*(8) (<https://www.freebsd.org/cgi/man.cgi?query=bhyve>) virtual machine software. This type of virtualization requires an Intel processor with Extended Page Tables (EPT) or an AMD processor with Rapid Virtualization Indexing (RVI) or Nested Page Tables (NPT). VMs cannot be created unless the host system supports these features.

To verify that an Intel processor has the required features, use *Shell* (page 335) to run `grep VT-x /var/run/dmesg.boot`. If the *EPT* and *UG* features are shown, this processor can be used with *bhyve*.

To verify that an AMD processor has the required features, use *Shell* (page 335) to run `grep POPCNT /var/run/dmesg.boot`. If the output shows the POPCNT feature, this processor can be used with *bhyve*.

Note: AMD K10 “Kuma” processors include POPCNT but do not support NRIPS, which is required for use with *bhyve*. Production of these processors ceased in 2012 or 2013.

By default, new VMs have the *bhyve*(8) (<https://www.freebsd.org/cgi/man.cgi?query=bhyve>) `-H` option set. This causes the virtual CPU thread to yield when a HLT instruction is detected and prevents idle VMs from consuming all of the host CPU.

Virtual Machines shows a list of installed virtual machines and available memory. The available memory changes depending on what the system is doing, including which virtual machines are running.

A log file for each VM is written to `/var/log/vm/vmname`.

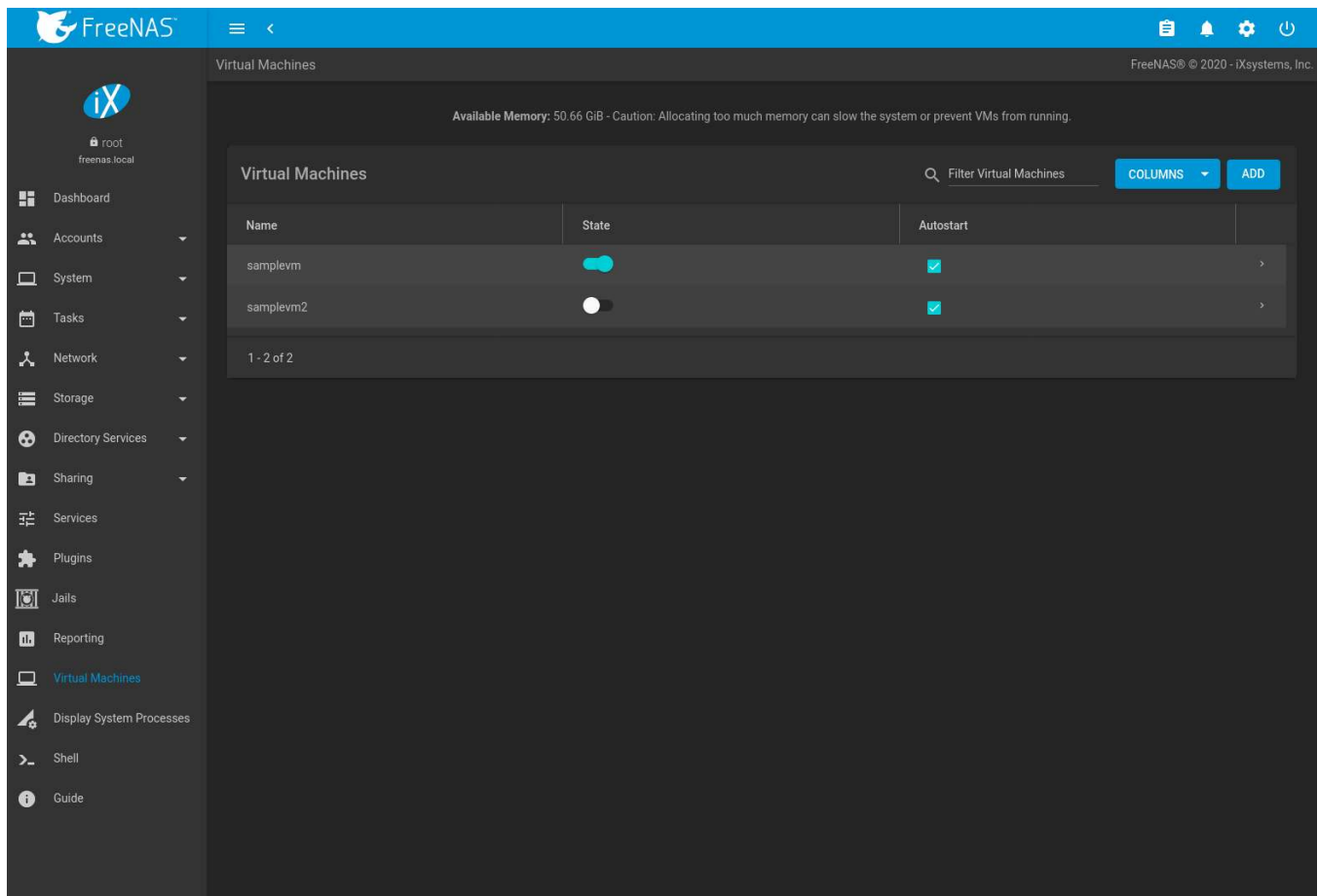


Fig. 17.1: Virtual Machines

Name, *State*, and *Autostart* are displayed on the *Virtual Machines* page. Click > (Expand) to view additional options for controlling and modifying VMs:

- *Start* boots a VM. VMs can also be started by clicking the slide toggle on the desired VM.
If there is insufficient memory to start the VM, a dialog will prompt to *Overcommit Memory*. Memory overcommitment allows the VM to launch even though there is insufficient free memory. Proceeding with the overcommitment option should be used with caution.
To start a VM when the host system boots, set *Autostart*. If *Autostart* is set and the VM is in an encrypted, locked pool, the VM starts when the pool is unlocked.
- *Edit* changes VM settings.
- *Delete* removes the VM. *Zvols* (page 181) used in *disk devices* (page 330) and image files used in *raw file* (page 331) devices are *not* removed when a VM is deleted. These resources can be removed manually in *Storage* → *Pools* after it is determined that the data in them has been backed up or is no longer needed.
- *Devices* is used to add, remove, or edit devices attached to a virtual machine.
- *Clone* copies the VM. A new name for the clone can be specified. If a custom name is not entered, the name assigned is `vmname_cloneN`, where *vmname* is the original VM name and *N* is the clone number. Each clones is given a new VNC port.

These additional options in > (Expand) are available when a VM is running:

- *Power off* immediately halts the VM. This is equivalent to unplugging the power cord from a computer.
- *Stop* shuts down the VM.
- *Restart* shuts down and immediately starts the VM.

- VMs with *Enable VNC* set show a *VNC* button. VNC connections permit remote graphical access to the VM.
- *SERIAL* opens a connection to a virtual serial port on the VM. `/dev/nmdm1B` is assigned to the first VM, `/dev/nmdm2B` is assigned to the second VM, and so on. These virtual serial ports allow connections to the VM console from the *Shell* (page 335).

Tip: The `nmdm` (<https://www.freebsd.org/cgi/man.cgi?query=nmdm>) device is dynamically created. The actual `nmdm XY` name varies on each VM.

To connect to the first VM, type `cu -l /dev/nmdm1B -s 9600` in the *Shell* (page 335). See `cu(1)` (<https://www.freebsd.org/cgi/man.cgi?query=cu>) for more information.

17.1 Creating VMs

Click **ADD** to open the wizard in Figure 17.2:

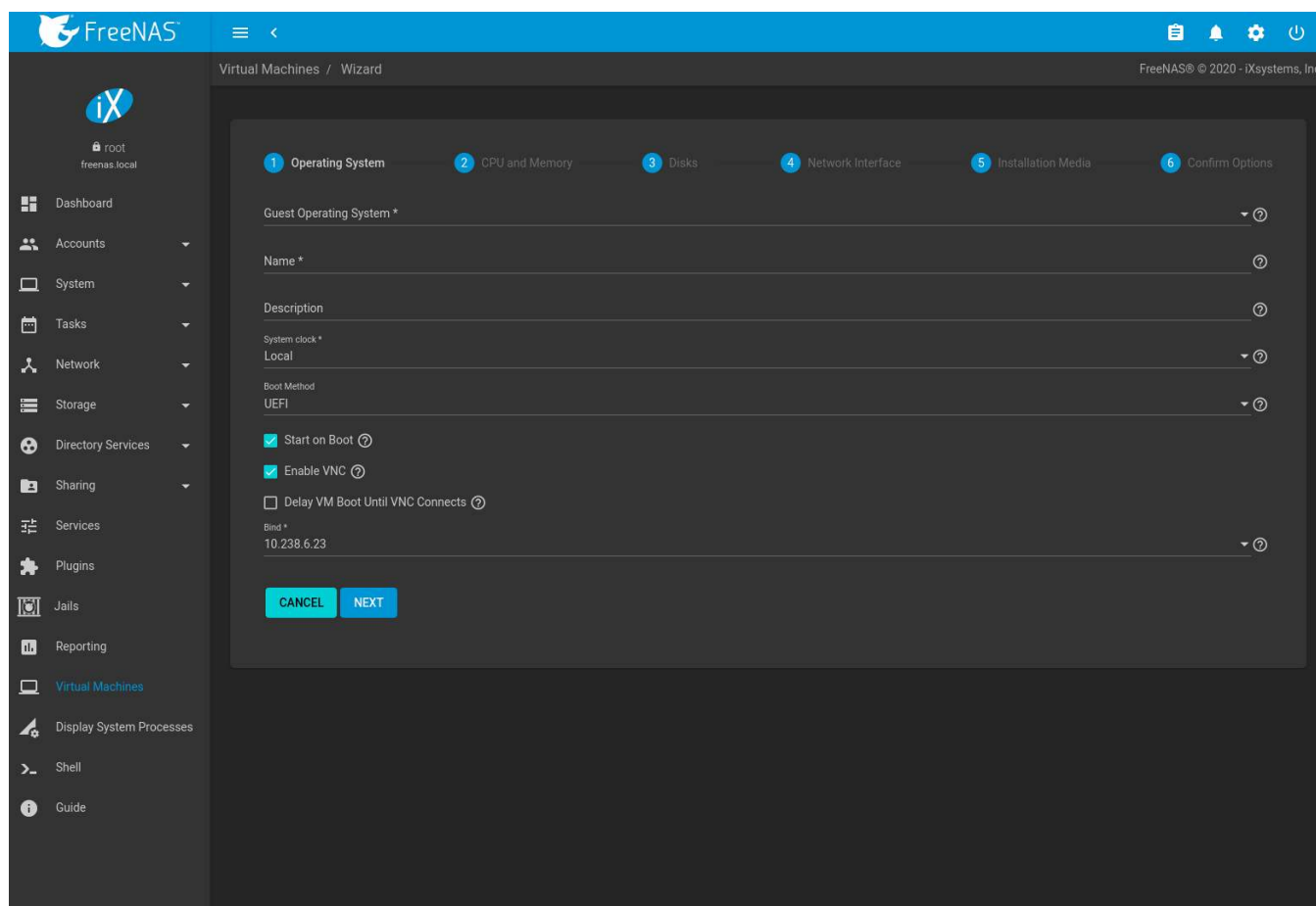


Fig. 17.2: Add VM


The configuration options for a Virtual Machine (VM) type are described in Table 17.1.

Table 17.1: VM Wizard Options



Screen #	Setting	Value	Description
1	Guest Operating System	drop-down menu	Choose the VM operating system type. Choices are: <i>Windows</i> , <i>Linux</i> , or <i>FreeBSD</i> . See this guide (https://github.com/FreeBSD-UPB/freebsd/wiki/How-to-launch-different-guest-OS) for detailed instructions about using a different guest OS.
1	Name	string	Name of the VM. Alphanumeric characters and <code>_</code> are allowed. The name must be unique.
1	Description	string	Description (optional).
1	System Clock	drop-down menu	Virtual Machine system time. Options are <i>Local</i> and <i>UTC</i> . <i>Local</i> is default.
1	Boot Method	drop-down menu	Choices are <i>UEFI</i> , <i>UEFI-CSM</i> , and <i>Grub</i> . Select <i>UEFI</i> for newer operating systems, or <i>UEFI-CSM</i> (Compatibility Support Mode) for older operating systems that only understand <i>BIOS booting</i> . <i>VNC connections are only available with *UEFI</i> .
1	Start on Boot	checkbox	Set to start the VM when the system boots.
1	Enable VNC	checkbox	Add a VNC remote connection. Requires <i>UEFI</i> booting.
1	Delay VM Boot Until VNC Connects	checkbox	Wait to start VM until VNC client connects. Only appears when <i>Enable VNC</i> is set.
1	Bind	drop-down menu	VNC network interface IP address. The primary interface IP address is the default. A different interface IP address can be chosen.
2	Virtual CPUs	integer	Number of virtual CPUs to allocate to the VM. The maximum is 16 unless limited by the host CPU. The VM operating system might also have operational or licensing restrictions on the number of CPUs.
2	Memory Size	integer	Set the amount of RAM for the VM. Allocating too much memory can slow the system or prevent VMs from running. This is a humanized field (page 21).
3	Disk image	checkbox option with custom fields	Select <i>Create new disk image</i> to create a new zvol on an existing dataset. This is used as a virtual hard drive for the VM. Select <i>Use existing disk image</i> and choose an existing zvol from the <i>Select Existing zvol</i> drop-down.
3	Select Disk Type	drop-down menu	Select the disk type. Choices are <i>AHCI</i> and <i>VirtIO</i> . Refer to Disk Devices (page 330) for more information about these disk types.
3	Size (Examples: 500 KiB, 500M, 2TB)		Allocate the amount of storage for the zvol. This is a humanized field (page 21). Numbers without unit letters are interpreted as megabytes. For example, <code>500</code> sets the zvol size to 500 megabytes.
3	Zvol Location		When <i>Create new disk image</i> is chosen, select a pool or dataset for the new zvol.
3	Select existing zvol	drop-down menu	When <i>Use existing disk image</i> is chosen, select an existing zvol for the VM.
4	Adapter Type	drop-down menu	<i>Intel e82545 (e1000)</i> emulates the same Intel Ethernet card. This provides compatibility with most operating systems. <i>VirtIO</i> provides better performance when the operating system installed in the VM supports VirtIO paravirtualized network drivers.
4	MAC Address	string	Enter the desired MAC address to override the auto-generated randomized MAC address.
4	Attach NIC	drop-down menu	Select the physical interface to associate with the VM.

Continued on next page

Table 17.1 – continued from previous page

Screen #	Setting	Value	Description
5	Optional: Choose installation media image	browse button	Click  (Browse) to select an installer ISO or image file on the FreeNAS® system.
5	Upload ISO	checkbox and	Set to upload an installer ISO or image file to the FreeNAS® system.

The final screen of the Wizard displays the chosen options for the new Virtual Machine (VM) type. Click *SUBMIT* to create the VM or *BACK* to change any settings.

After the VM has been installed, remove the install media device. Go to *Virtual Machines* →  (Options) → *Devices*. Remove the *CDROM* device by clicking  (Options) → *Delete*. This prevents the virtual machine from trying to boot with the installation media after it has already been installed.

This example creates a FreeBSD VM:

1. *Guest Operating System* is set to *FreeBSD*. *Name* is set to *samplevm*. Other options are left at defaults.
2. *Virtual CPUs* is set to 2 and *Memory Size (MiB)* is set to 2048.
3. *Create new disk image* is selected. The zvol size is set to 20 GiB and stored on the pool named *pool1*.
4. Network settings are left at default values.
5. A FreeBSD ISO installation image has been selected and uploaded to the FreeNAS® system. The *Choose installation media image* field is populated when the upload completes.
6. After verifying the *VM Summary* is correct, *SUBMIT* is clicked.

Figure 17.3 shows the confirmation step and basic settings for the new virtual machine:

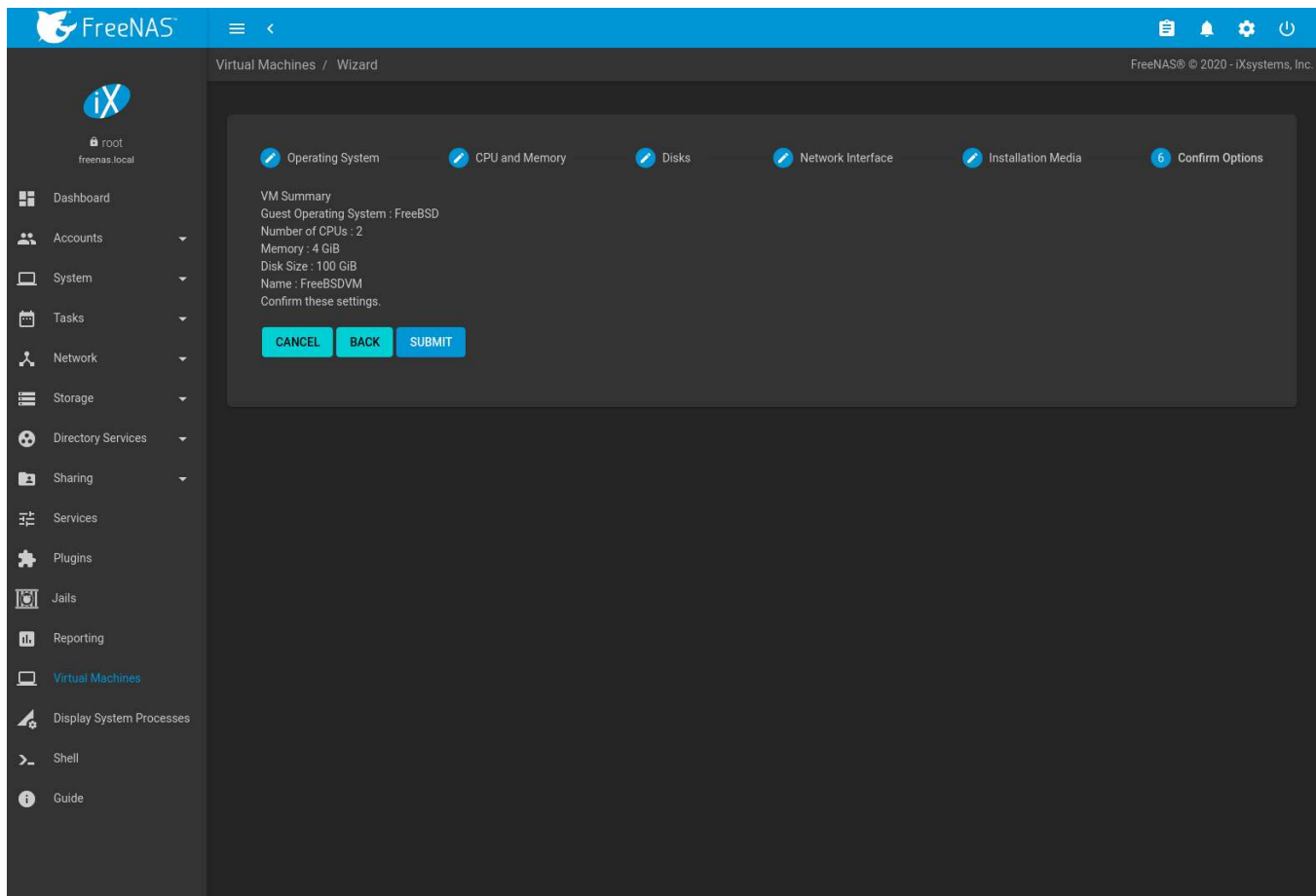


Fig. 17.3: Creating a Sample Virtual Machine

17.2 Installing Docker

Docker (<https://www.docker.com/>) can be used on FreeNAS® by installing it on a Linux virtual machine.

Choose a Linux distro and install it on FreeNAS® by following the steps in [Creating VMs](#) (page 324). Using **Ubuntu** (<https://ubuntu.com/>) is recommended.

After the Linux operating system has been installed, start the VM. Connect to it by clicking > (Expand) → VNC. Follow the [Docker documentation](https://docs.docker.com/) (<https://docs.docker.com/>) for Docker installation and usage.

17.3 Adding Devices to a VM

Go to *Virtual Machines*, ⋮ (Options) → *Devices*, and click **ADD** to add a new VM device.

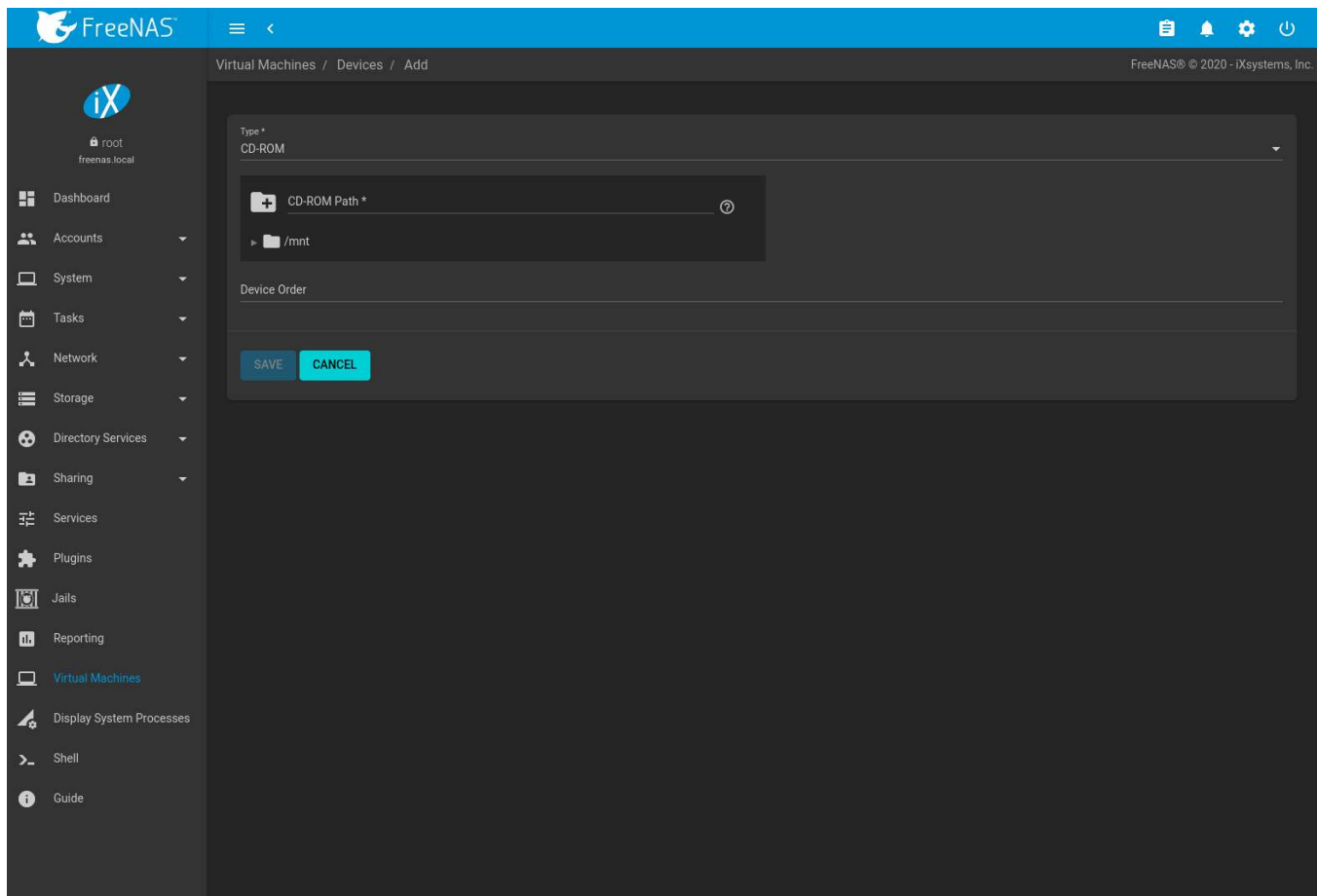


Fig. 17.4: VM Devices

Select the new device from the *Type* field. These devices are available:

- *CD-ROM* (page 328)
- *NIC (Network Interface Card)* (page 329)
- *Disk Device* (page 330)
- *Raw File* (page 331)
- *VNC Interface* (page 332) (only available on virtual machines with *Boot Loader Type* set to *UEFI*)

Virtual Machines → ⓘ (Options) → *Devices* is also used to edit or delete existing devices. Click ⓘ (Options) for a device to display *Edit*, *Delete*, *Change Device Order*, and *Details* options:

- *Edit* modifies a device.
- *Delete* removes the device from the VM.
- *Change Device Order* sets the priority number for booting this device. Smaller numbers are higher in boot priority.
- *Details* shows additional information about the specific device. This includes the physical interface and MAC address in a *NIC* device, the path to the zvol in a *DISK* device, and the path to an *.iso* or other file for a *CDROM* device.

17.3.1 CD-ROM Devices

Adding a CD-ROM device makes it possible to boot the VM from a CD-ROM image, typically an installation CD. The image must be present on an accessible portion of the FreeNAS® storage. In this example, a FreeBSD installation

image is shown:

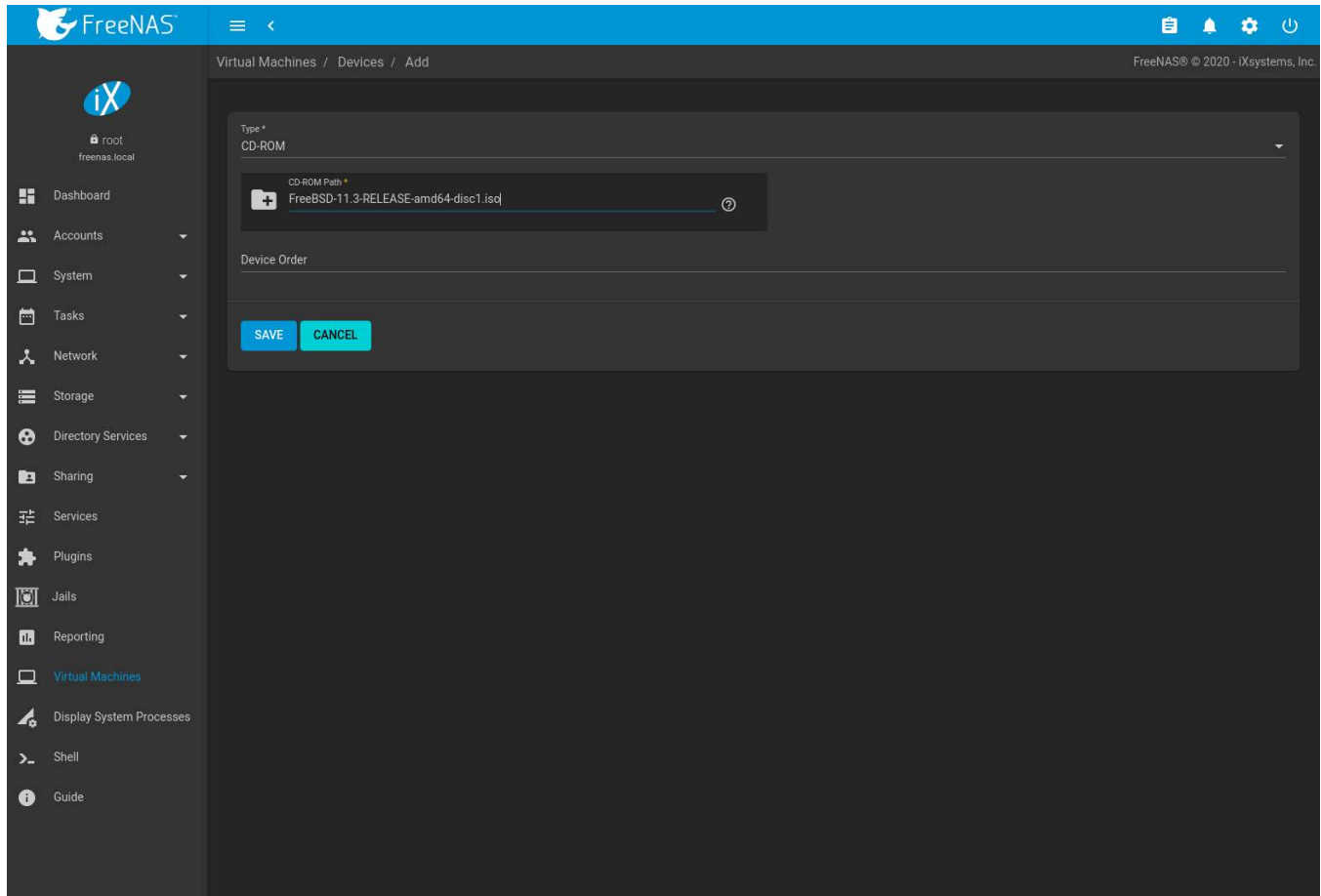


Fig. 17.5: CD-ROM Device

Note: VMs from other virtual machine systems can be recreated for use in FreeNAS®. Back up the original VM, then create a new FreeNAS® VM with virtual hardware as close as possible to the original VM. Binary-copy the disk image data into the *zvol* (page 181) created for the FreeNAS® VM with a tool that operates at the level of disk blocks, like *dd(1)* (<https://www.freebsd.org/cgi/man.cgi?query=dd>). For some VM systems, it is best to back up data, install the operating system from scratch in a new FreeNAS® VM, and restore the data into the new VM.

17.3.2 NIC (Network Interfaces)

Figure 17.6 shows the fields that appear after going to *Virtual Machines* → ⋮ (Options) → *Devices*, clicking *ADD*, and selecting *NIC* as the *Type*.

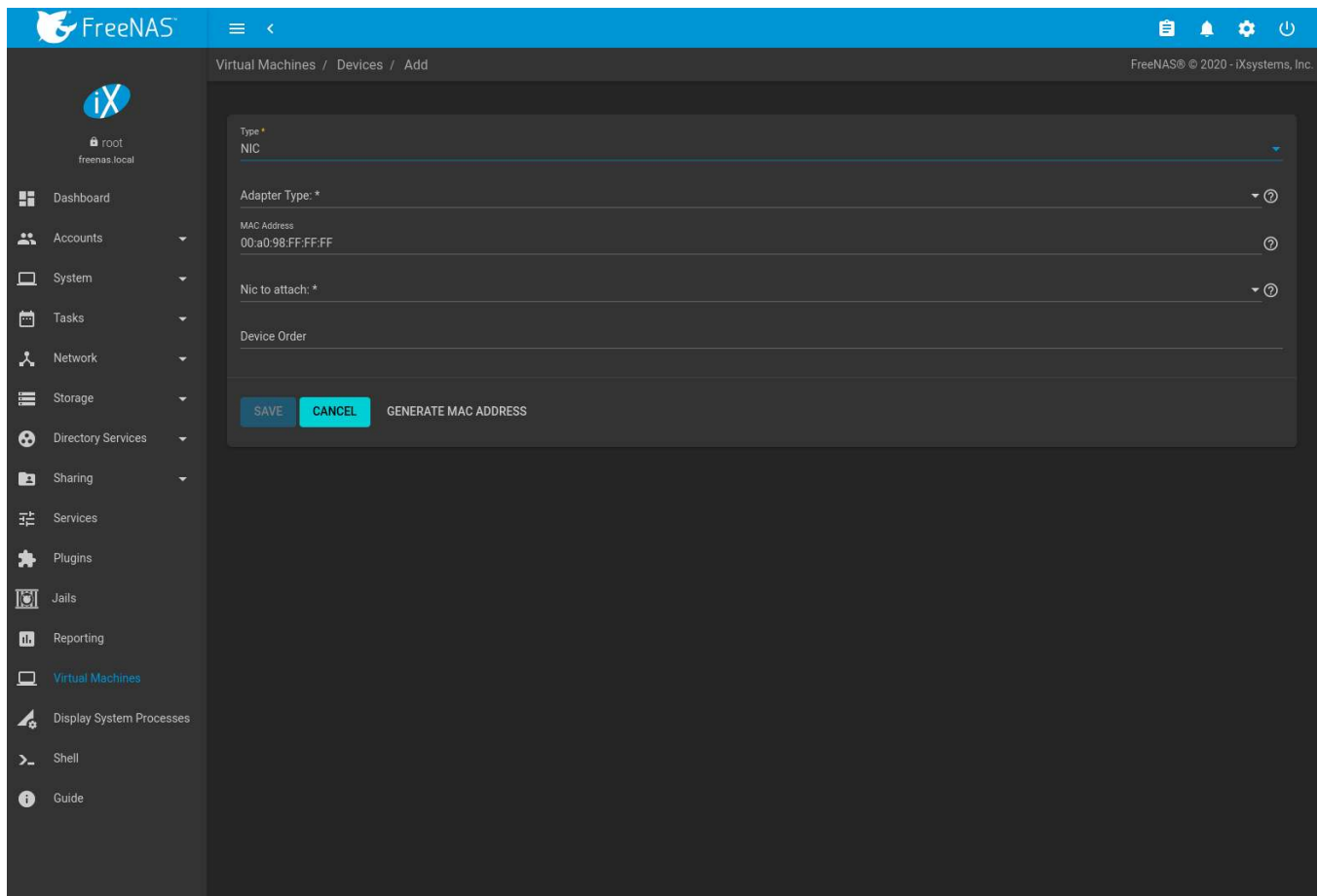


Fig. 17.6: Network Interface Device

The *Adapter Type* can emulate an Intel e82545 (e1000) Ethernet card for compatibility with most operating systems. *VirtIO* can provide better performance when the operating system installed in the VM supports VirtIO paravirtualized network drivers.

By default, the VM receives an auto-generated random MAC address. To override the default with a custom value, enter the desired address in *MAC Address*. Click *GENERATE MAC ADDRESS* to automatically populate *MAC Address* with a new randomized MAC address.

If the system has multiple physical network interface cards, use the *NIC to attach* drop-down menu to specify which physical interface to associate with the VM. To prevent a network interface reset when the VM starts, edit the [network interface](#) (page 155) and set *Disable Hardware Offloading*.

Set a *Device Order* number to determine the boot order of this device. A lower number means a higher boot priority.

Tip: To check which interface is attached to a VM, start the VM and go to the [Shell](#) (page 335). Type `ifconfig` and find the `tap` (<https://en.wikipedia.org/wiki/TUN/TAP>) interface that shows the name of the VM in the description.

17.3.3 Disk Devices

Zvols (page 181) are typically used as virtual hard drives. After [creating a zvol](#) (page 181), associate it with the VM by clicking *Virtual Machines* → ⋮ (Options) → *Devices*, clicking *ADD*, and selecting *Disk* as the *Type*.

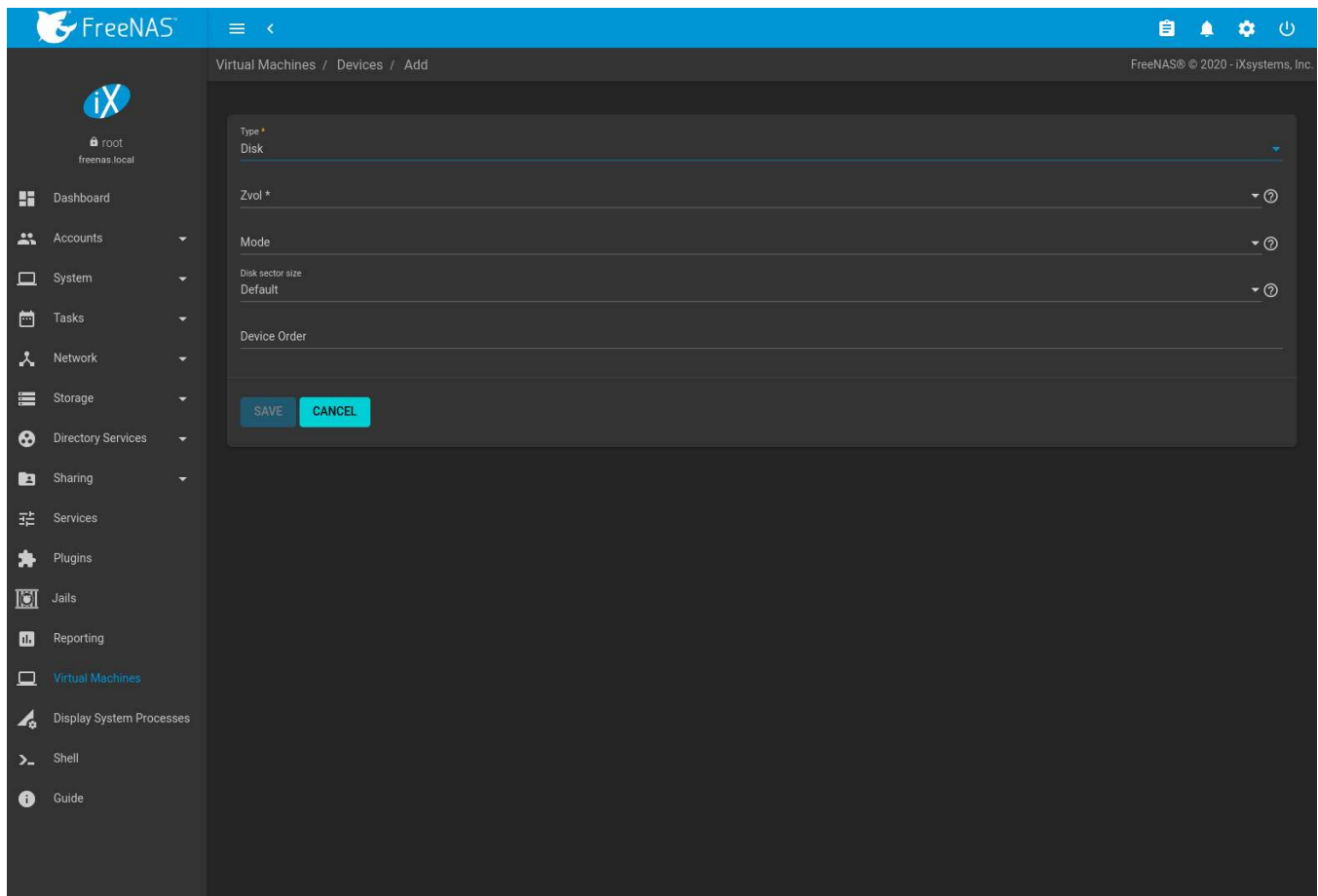


Fig. 17.7: Disk Device

Open the drop-down menu to select a created *Zvol*, then set the disk *Mode*:

- *AHCI* emulates an AHCI hard disk for best software compatibility. This is recommended for Windows VMs.
- *VirtIO* uses paravirtualized drivers and can provide better performance, but requires the operating system installed in the VM to support VirtIO disk devices.

If a specific sector size is required, enter the number of bytes in *Disk sector size*. The default of 0 uses an autotune script to determine the best sector size for the zvol.

Set a *Device Order* number to determine the boot order of this device. A lower number means a higher boot priority.

17.3.4 Raw Files

Raw Files are similar to *Zvol* (page 181) disk devices, but the disk image comes from a file. These are typically used with existing read-only binary images of drives, like an installer disk image file meant to be copied onto a USB stick.

After obtaining and copying the image file to the FreeNAS® system, click *Virtual Machines* → ⋮ (Options) → *Devices*, click *ADD*, then set the *Type* to *Raw File*.

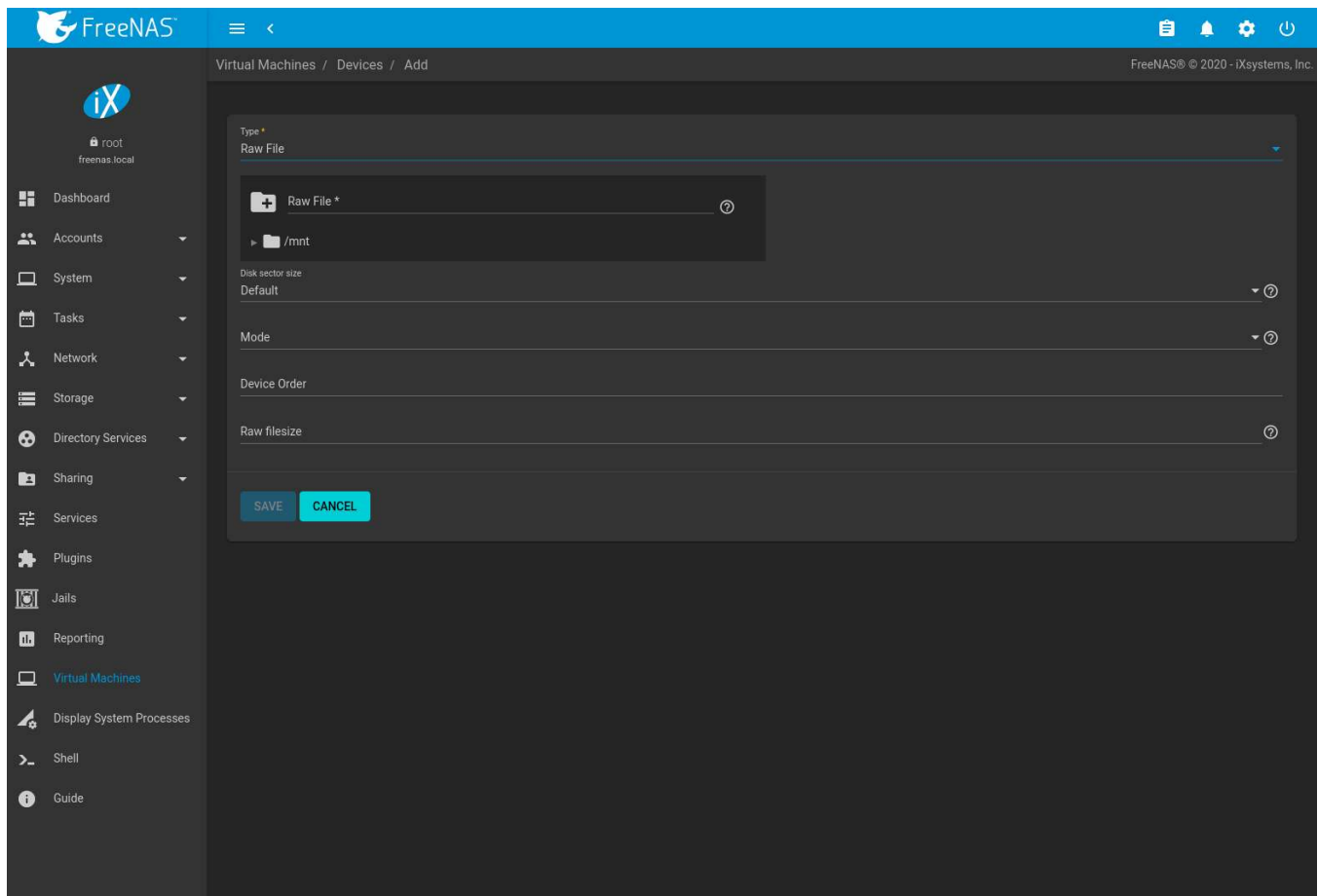



Fig. 17.8: Raw File Disk Device

Click  (Browse) to select the image file. If a specific sector size is required, choose it from *Disk sector size*. The *Default* value automatically selects a preferred sector size for the file.

Setting disk *Mode* to *AHCI* emulates an AHCI hard disk for best software compatibility. *VirtIO* uses paravirtualized drivers and can provide better performance, but requires the operating system installed in the VM to support *VirtIO* disk devices.

Set a *Device Order* number to determine the boot order of this device. A lower number means a higher boot priority.



Set the size of the file in GiB.

17.3.5 VNC Interface

VMs set to *UEFI* booting are also given a VNC (Virtual Network Computing) remote connection. A standard [VNC](https://en.wikipedia.org/wiki/Virtual_Network_Computing) (https://en.wikipedia.org/wiki/Virtual_Network_Computing) client can connect to the VM to provide screen output and keyboard and mouse input.

Each VM can have a single VNC device. An existing VNC interface can be changed by clicking  (Options) and *Edit*.

Note: Using a non-US keyboard with VNC is not yet supported. As a workaround, select the US keymap on the system running the VNC client, then configure the operating system running in the VM to use a keymap that matches the physical keyboard. This will enable passthrough of all keys regardless of the keyboard layout.

Figure 17.9 shows the fields that appear after going to *Virtual Machines* →  (Options) → *Devices*, and clicking  (Options) → *Edit* for VNC.

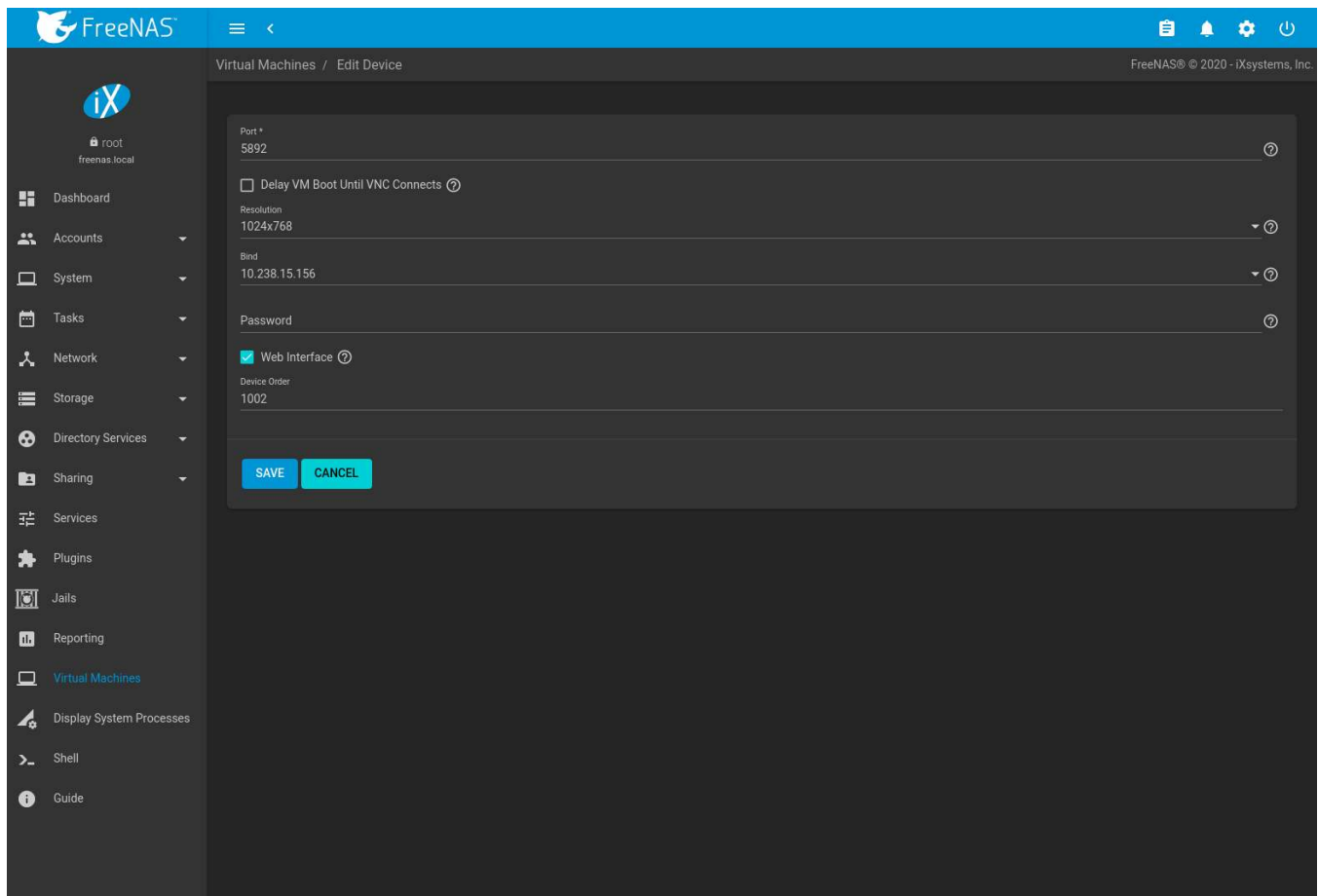


Fig. 17.9: VNC Device

Setting *Port* to 0 automatically assigns a port when the VM is started. If a fixed, preferred port number is needed, enter it here.

Set *Delay VM Boot until VNC Connects* to wait to start the VM until a VNC client connects.

Resolution sets the default screen resolution used for the VNC session.

Use *Bind* to select the IP address for VNC connections.

To automatically pass the VNC password, enter it into the *Password* field. Note that the password is limited to 8 characters.

To use the VNC web interface, set *Web Interface*.

Tip: If a RealVNC 5.X Client shows the error `RFB protocol error: invalid message type`, disable the *Adapt to network speed* option and move the slider to *Best quality*. On later versions of RealVNC, select *File* → *Preferences*, click *Expert*, *ProtocolVersion*, then select 4.1 from the drop-down menu.

Set a *Device Order* number to determine the boot order of this device. A lower number means a higher boot priority.

DISPLAY SYSTEM PROCESSES

Clicking *Display System Processes* opens a screen showing the output of `top(1)` (<https://www.freebsd.org/cgi/man.cgi?query=top>). An example is shown in Figure 18.1.

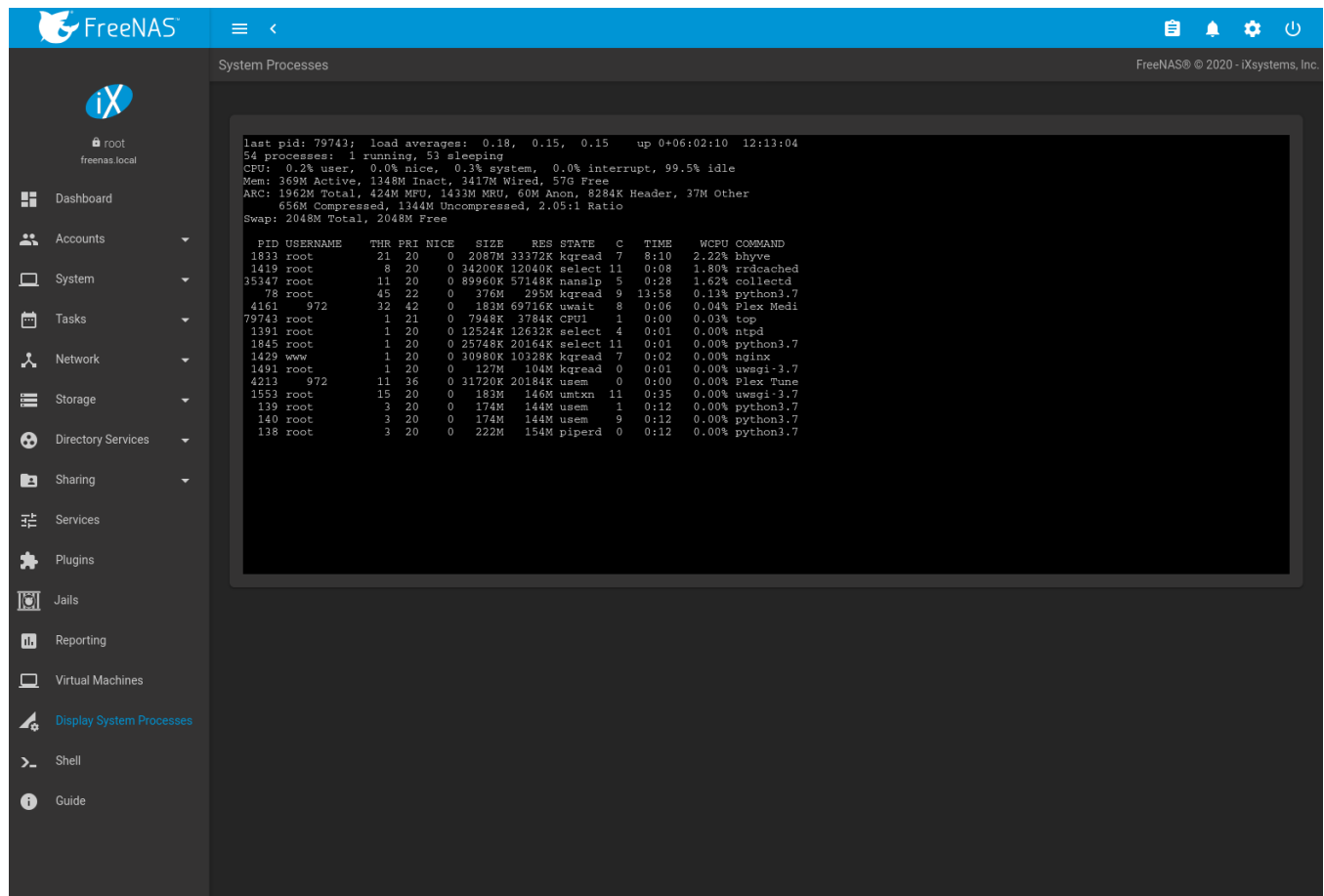


Fig. 18.1: System Processes Running on FreeNAS®

The display automatically refreshes itself. The display is read-only.

SHELL

The FreeNAS® web interface provides a web shell, making it convenient to run command line tools from the web browser as the *root* user.

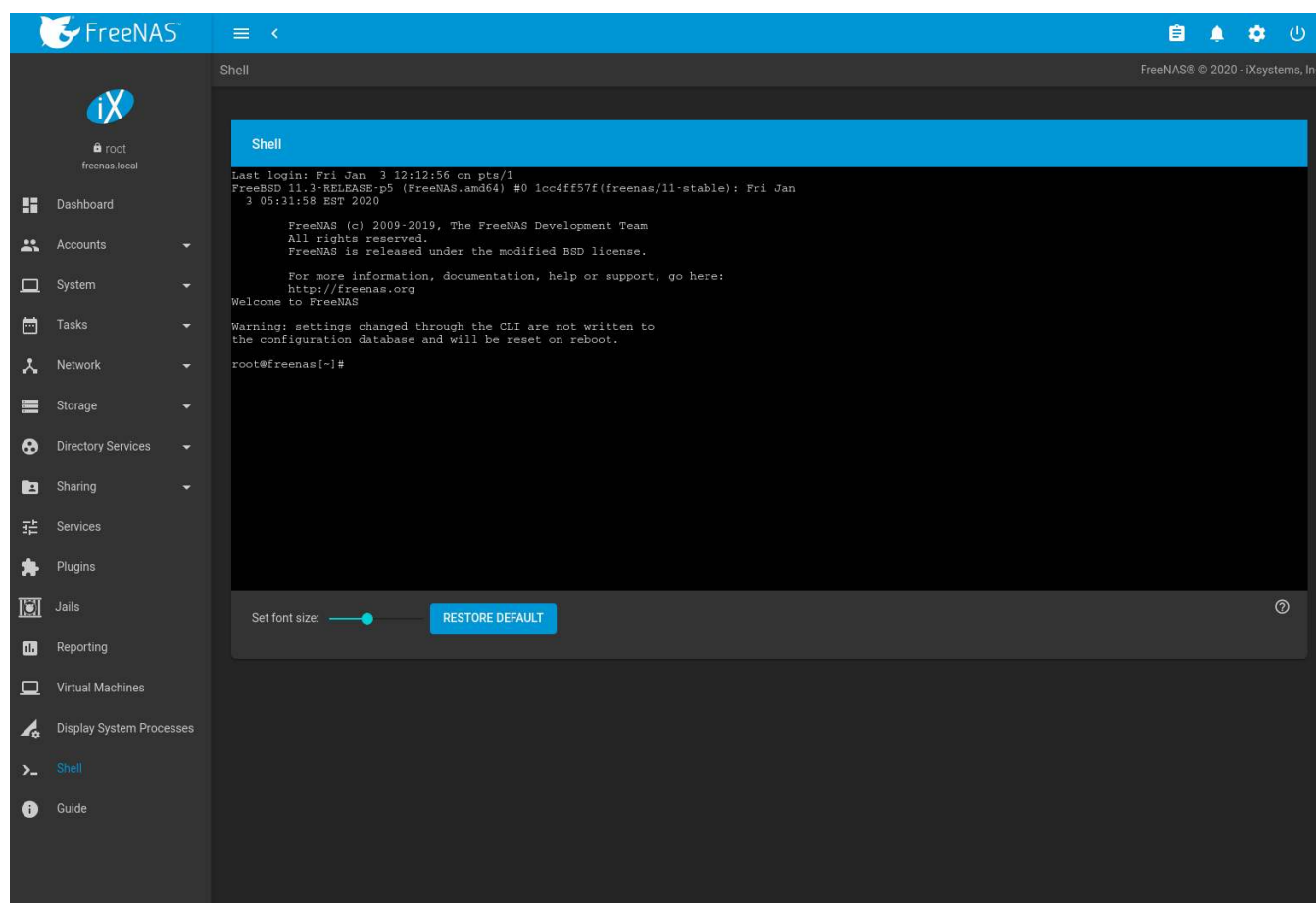


Fig. 19.1: Web Shell

The prompt shows that the current user is *root*, the hostname is *freenas*, and the current working directory is *~*, the home directory of the logged-in user.

Note: The default shell for a new install of FreeNAS® is *zsh* (<https://www.freebsd.org/cgi/man.cgi?query=zsh>). FreeNAS® systems which have been upgraded from an earlier version will continue to use *csh* as the default shell. The default shell can be changed in *Accounts* → *Users*. Click **:** (Options) and *Edit* for the *root* user. Choose the desired shell from the *Shell* drop-down and click *SAVE*.

The *Set font size* slider adjusts the size of text displayed in the Shell. Click *RESTORE DEFAULT* to reset the shell font and size.

A history of previous commands is available. Use the up and down arrow keys to scroll through previously entered commands. Edit the command if desired, then press `Enter` to re-enter the command.

`Home`, `End`, and `Delete` keys are supported. Tab completion is also available. Type a few letters and press `Tab` to complete a command name or filename in the current directory. Right-clicking in the terminal window displays a reminder about using `Command+c` and `Command+v` or `Ctrl+Insert` and `Shift+Insert` for copy and paste operations in the FreeNAS® shell.

Type `exit` to leave the session.

Clicking other web interface menus closes the shell session and stops commands running in the shell. [tmux](#) (page 364) provides the ability to detach shell sessions and then reattach to them later. Commands continue to run in a detached session.

Note: Not all shell features render correctly in Chrome. Firefox is the recommended browser when using the shell.

Most FreeBSD [command line utilities](#) (page 350) are available in the *Shell*, including additional troubleshooting applications for FreeNAS®.


LOG OUT, RESTART, OR SHUT DOWN

The  (Power) button is used to log out of the web interface or restart or shut down the FreeNAS[®] system.

20.1 Log Out

To log out, click  (Power), then *Log Out*. After logging out, the login screen is displayed.

20.2 Restart

To restart the system, click  (Power), then *Restart*. A confirmation screen asks for verification of the restart. [Figure 20.1](#). Click *Confirm* to confirm the action, then click *RESTART* to restart the system.

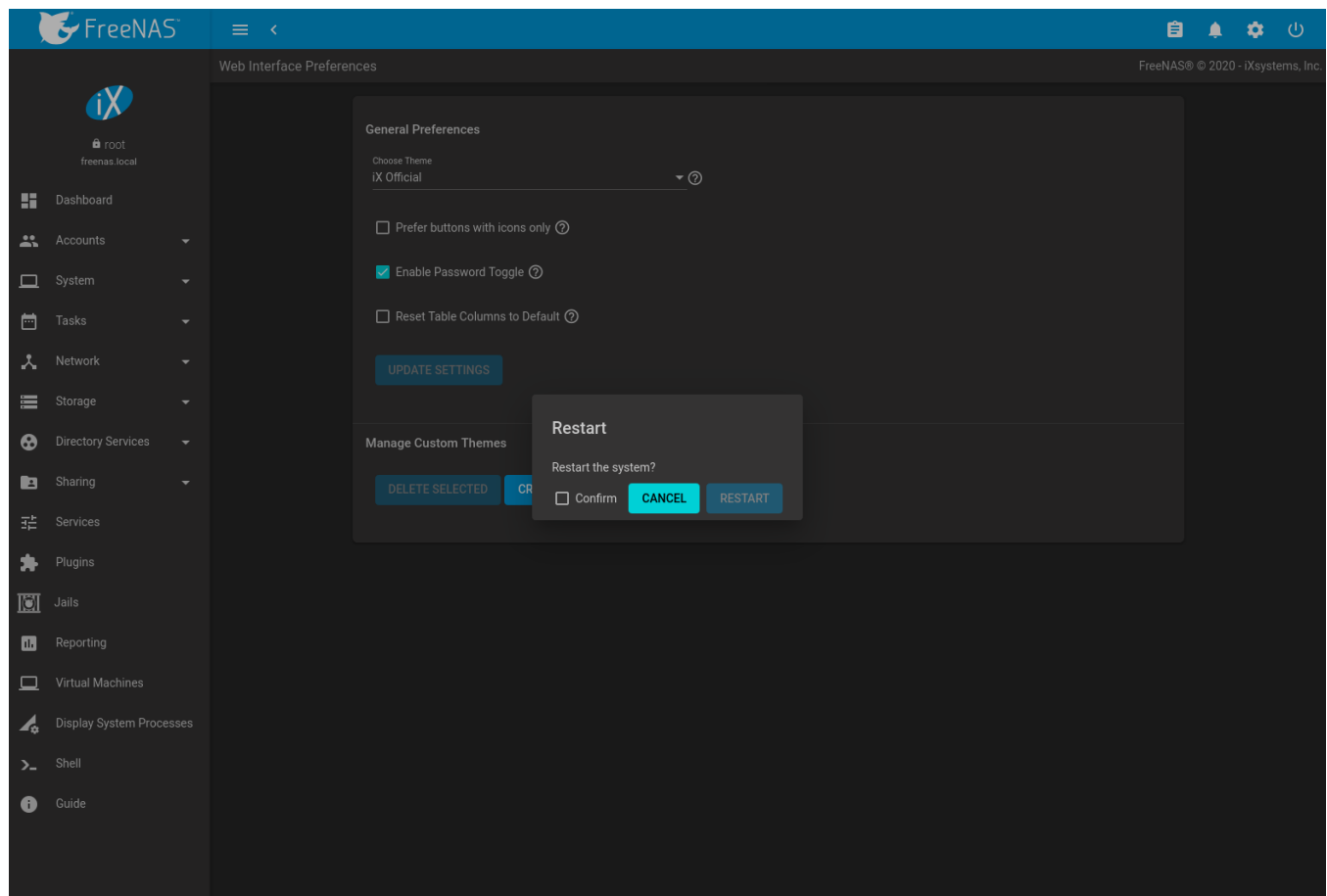



Fig. 20.1: Restart Warning Message

An additional warning message appears when a restart is attempted when a scrub or resilver is in progress. When that warning appears, the recommended steps are to *CANCEL* the restart request and to periodically run `zpool status` from *Shell* (page 335) until it shows that the scrub or verify has completed. Then the restart request can be entered again.

To complete the restart request, click the *Confirm* checkbox and then the *RESTART* button. Restarting the system disconnects all clients, including the web administration interface. Wait a few minutes for the system to boot, then use the back button in the browser to return to the IP address of the FreeNAS® system. The login screen appears after a successful reboot. If the login screen does not appear, using a monitor and keyboard to physically access the FreeNAS® system is required to determine the issue preventing the system from resuming normal operation.

20.3 Shut Down

Click  (Power) and *Shut Down* to shut down the system. The warning message shown in Figure 20.2 is displayed.

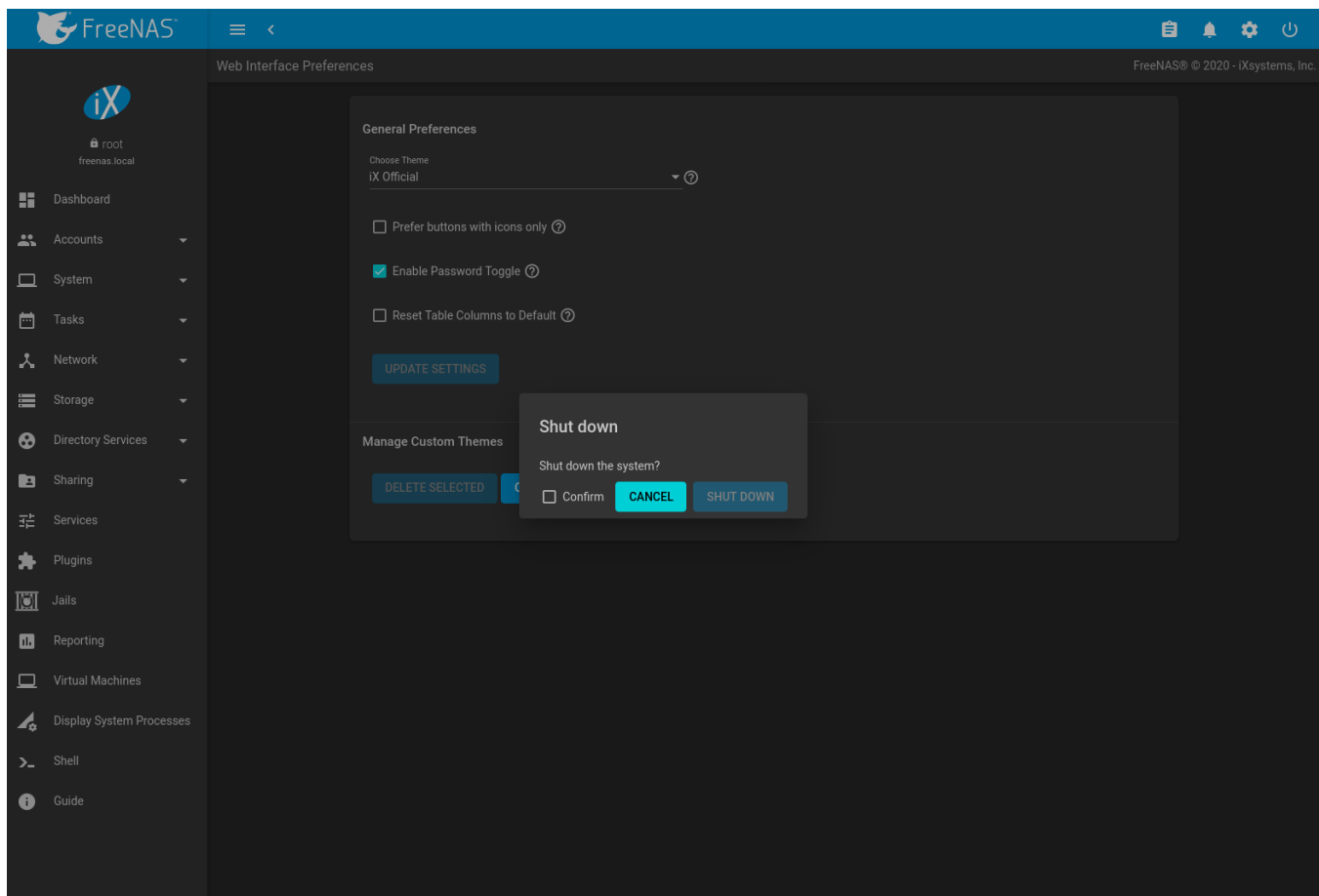


Fig. 20.2: Shut Down Warning Message

Click *Confirm* and then *SHUT DOWN* to shut down the system. Shutting down the system disconnects all clients, including the web interface. Physical access to the FreeNAS® system is required to turn it back on.

ALERT

The FreeNAS® alert system provides a visual warning of any conditions that require administrative attention. The *Alert* icon in the upper right corner has a notification badge that displays the total number of unread alerts. In the example alert shown in [Figure 21.1](#), the system is warning that a pool is degraded.

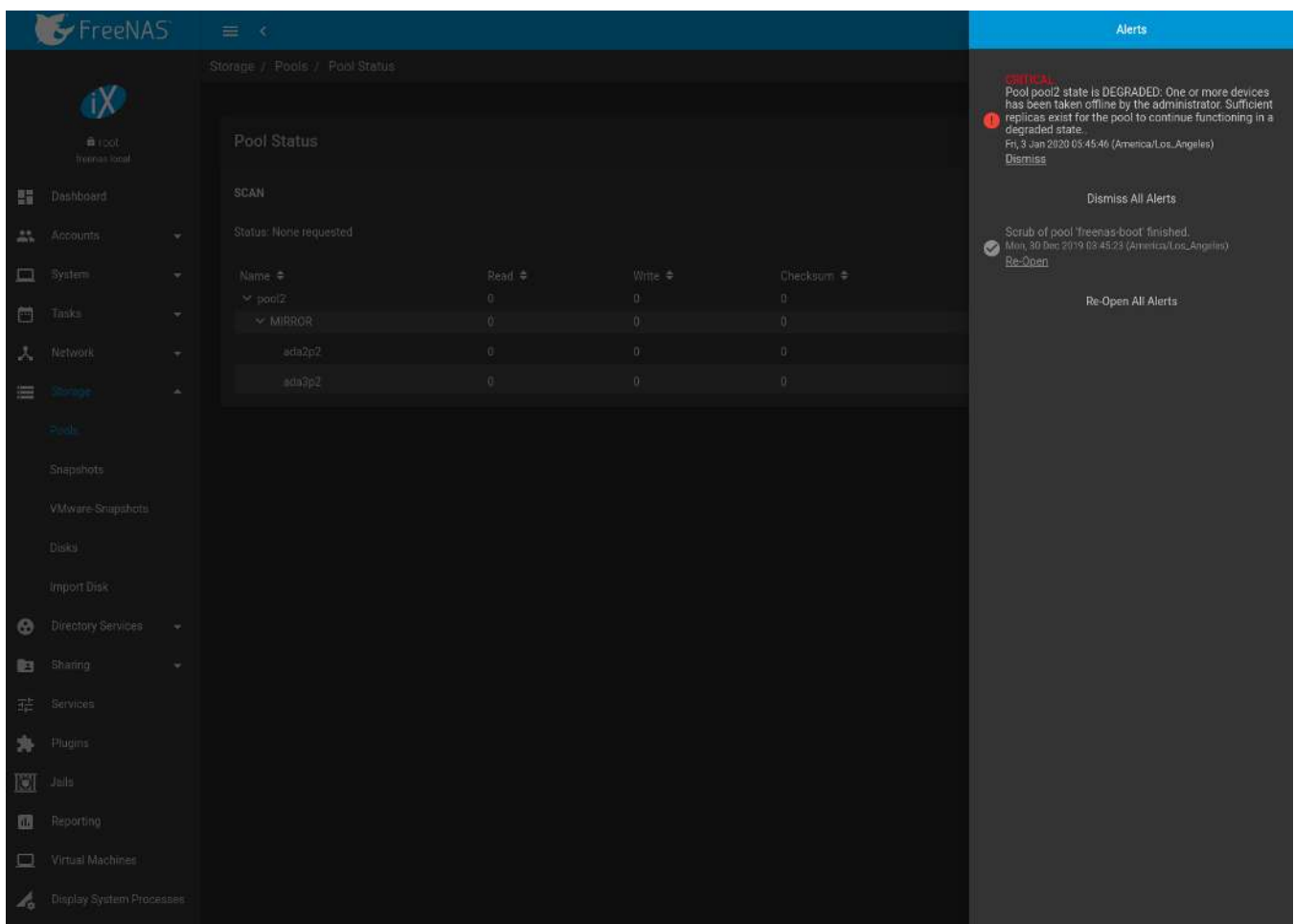






Fig. 21.1: Example Alert Message

[Table 21.1](#) shows the icons that indicate notification, warning, critical, and one-shot critical alerts. Critical messages are also emailed to the root account. One-shot critical alerts must be dismissed by the user.

Table 21.1: FreeNAS® Alert Icons

Alert Level	Icon
Notification	
Warning	
Critical	
One-shot Critical	

Close an alert message by clicking *Dismiss*. There is also an option to *Dismiss All Alerts*. Dismissing all alerts removes the notification badge from the alerts icon. Dismissed alerts can be re-opened by clicking *Re-Open*.

Behind the scenes, an alert daemon checks for various alert conditions, such as pool and disk status, and writes the current conditions to the system RAM. These messages are flushed to the SQLite database periodically and then published to the user interface.

Current alerts are viewed from the Shell option of the Console Setup Menu (Figure 3.1) or the Web Shell (Figure 19.1) by running `midclt call alert.list`.

Notifications for specific alerts are adjusted in the *Alert Settings* (page 93) menu. An alert message can be set to publish *IMMEDIATELY*, *HOURLY*, *DAILY*, or *NEVER*.

Some of the conditions that trigger an alert include:


- used space on a pool, dataset, or zvol goes over 80%; the alert goes red at 95%
- new *ZFS Feature Flags* (page 369) are available for the pool; this alert can be adjusted in *Alert Settings* (page 93) if a pool upgrade is not desired at present
- a new update is available
- hardware events detected by an attached *IPMI* (page 160) controller
- an error with the *Active Directory* (page 198) connection
- ZFS pool status changes from *HEALTHY*
- a S.M.A.R.T. error occurs
- the system is unable to bind to the *WebGUI IPv4 Address* set in *System* → *General*
- the system can not find an IP address configured on an iSCSI portal
- the NTP server cannot be contacted
- *syslog-ng*(8) (<https://www.freebsd.org/cgi/man.cgi?query=syslog-ng>) is not running
- a periodic snapshot or replication task fails
- a VMware login or a *VMware-Snapshots* (page 190) task fails
- a *Cloud Sync task* (page 146) fails
- deleting a VMware snapshot fails
- a Certificate Authority or certificate is invalid or malformed
- an update failed, or the system needs to reboot to complete a successful update
- a re-key operation fails on an encrypted pool
- an Active Directory domain goes offline; by default the winbindd connection manager will try to reconnect every 30 seconds and will clear the alert when the domain comes back online
- LDAP failed to bind to the domain
- any member interfaces of a lagg interface are not active
- a device is slowing pool I/O
- *Rsync task* (page 126) status
- the status of an Avago MegaRAID SAS controller has changed; *mfiutil*(8) (<https://www.freebsd.org/cgi/man.cgi?query=mfiutil>) is included for managing these devices

- a scrub has been paused for more than eight hours
- a connected Uninterruptible Power Supply (UPS) switches to battery power, switches to line power, communication with the UPS is lost or established, the battery is low, or the battery needs to be replaced

TASK MANAGER

The task manager shows a list of tasks performed by the FreeNAS® system starting with the most recent. Click a task name to display its start time, progress, finish time, and whether the task succeeded. If a task failed, the error status is shown.

Tasks with log file output have a *View Logs* button to show the log files.

The task manager can be opened by clicking  (Task Manager). Close the task manager by clicking *CLOSE*, clicking anywhere outside the task manager dialog, or by pressing `Esc`.

SUPPORT RESOURCES

FreeNAS® has a large installation base and an active user community. This means that many usage questions have already been answered and the details are available on the Internet. If an issue occurs while using FreeNAS®, it can be helpful to spend a few minutes searching the Internet for the word *FreeNAS* with some keywords that describe the error message or function that is being implemented.

The section discusses resources available to FreeNAS® users:

- *User Guide* (page 343)
- *Website and Social Media* (page 343)
- *Forums* (page 343)
- *IRC* (page 344)
- *Videos* (page 344)
- *Professional Support* (page 345)

23.1 User Guide

The FreeNAS® User Guide with complete configuration instructions is available either by clicking *Guide* in the FreeNAS® user interface or going to <https://www.ixsystems.com/documentation/freenas/>

23.2 Website and Social Media

The [FreeNAS® website](http://www.freenas.org/) (<http://www.freenas.org/>) contains links to all of the available documentation, support, and social media resources. Major announcements are also posted to the main page.

Users are welcome to network on the FreeNAS® social media sites:

- [LinkedIn](https://www.linkedin.com/groups/3903140/profile) (<https://www.linkedin.com/groups/3903140/profile>)
- [Facebook FreeNAS Community](https://www.facebook.com/freenascommunity) (<https://www.facebook.com/freenascommunity>)
- [Facebook FreeNAS Consortium \(please request to be added\)](https://www.facebook.com/groups/1707686686200221) (<https://www.facebook.com/groups/1707686686200221>)
- [Twitter](https://mobile.twitter.com/freenas) (<https://mobile.twitter.com/freenas>)

23.3 Forums

The [FreeNAS Forums](https://forums.freenas.org/index.php) (<https://forums.freenas.org/index.php>) are an active online resource where people can ask questions, receive help, and share findings with other FreeNAS® users. New users are encouraged to post a brief message about themselves and how they use FreeNAS® in the [Introductions](https://forums.freenas.org/index.php?forums/introductions.25/) (<https://forums.freenas.org/index.php?forums/introductions.25/>) forum.

The [Resources](https://forums.freenas.org/index.php?resources/) (https://forums.freenas.org/index.php?resources/) section contains categorized, user-contributed guides on many aspects of building and using FreeNAS® systems.

Language-specific categories are available under **International**.

- [Chinese](https://forums.freenas.org/index.php?forums/chinese-%E4%B8%AD%E6%96%87.60/) (https://forums.freenas.org/index.php?forums/chinese-%E4%B8%AD%E6%96%87.60/)
- [Dutch - Nederlands](https://forums.freenas.org/index.php?forums/dutch-nederlands.35/) (https://forums.freenas.org/index.php?forums/dutch-nederlands.35/)
- [French - Francais](https://forums.freenas.org/index.php?forums/french-francais.29/) (https://forums.freenas.org/index.php?forums/french-francais.29/)
- [German - Deutsch](https://forums.freenas.org/index.php?forums/german-deutsch.31/) (https://forums.freenas.org/index.php?forums/german-deutsch.31/)
- [Italian - Italiano](https://forums.freenas.org/index.php?forums/italian-italiano.30/) (https://forums.freenas.org/index.php?forums/italian-italiano.30/)
- [Portuguese - Português](https://forums.freenas.org/index.php?forums/portuguese-portugu%C3%AAs.44/) (https://forums.freenas.org/index.php?forums/portuguese-portugu%C3%AAs.44/)
- [Romanian - Română](https://forums.freenas.org/index.php?forums/romanian-rom%C3%A2n%C4%83.53/) (https://forums.freenas.org/index.php?forums/romanian-rom%C3%A2n%C4%83.53/)
- [Russian - Русский](https://forums.freenas.org/index.php?forums/russian-%D0%A0%D1%83%D1%81%D0%BA%D0%B8%D0%B9.38/) (https://forums.freenas.org/index.php?forums/russian-%D0%A0%D1%83%D1%81%D0%BA%D0%B8%D0%B9.38/)
- [Spanish - Español](https://forums.freenas.org/index.php?forums/spanish-espa%C3%B1ol.33/) (https://forums.freenas.org/index.php?forums/spanish-espa%C3%B1ol.33/)
- [Swedish - Svenske](https://forums.freenas.org/index.php?forums/swedish-svenske.51/) (https://forums.freenas.org/index.php?forums/swedish-svenske.51/)
- [Turkish - Türkçe](https://forums.freenas.org/index.php?forums/turkish-t%C3%BCrk%C3%A7e.36/) (https://forums.freenas.org/index.php?forums/turkish-t%C3%BCrk%C3%A7e.36/)

To join the forums, create an account with the *Sign Up Now!* link.

Before asking a question on the forums, check the [Resources](https://forums.freenas.org/index.php?resources/) (https://forums.freenas.org/index.php?resources/) to see if the information is already there. See the [Forum Rules](https://forums.freenas.org/index.php?threads/updated-forum-rules-4-11-17.45124/) (https://forums.freenas.org/index.php?threads/updated-forum-rules-4-11-17.45124/) for guidelines on posting your hardware information and how to ask a questions that will get a response.

23.4 IRC

To ask a question in real time, use the *#freenas* channel on IRC [Freenode](http://freenode.net/) (http://freenode.net/). Depending on the time of day and the time zone, FreeNAS® developers or other users may be available to provide assistance. If no one answers right away, remain on the channel, as other users tend to read the channel history to answer questions as time permits.

Typically, an IRC [client](https://en.wikipedia.org/wiki/Comparison_of_Internet_Relay_Chat_clients) (https://en.wikipedia.org/wiki/Comparison_of_Internet_Relay_Chat_clients) is used to access the *#freenas* IRC channel. Alternately, use [webchat](http://webchat.freenode.net/?channels=freenas) (http://webchat.freenode.net/?channels=freenas) from a web browser.

To get the most out of the IRC channel, keep these points in mind:

- Do not ask “Can anyone help me?”. Just ask the question.
- Do not ask a question and leave. Users who know the answer cannot help you if you disappear.
- If no one answers, the question may be difficult to answer or it has been asked before. Research other resources while waiting for the question to be answered.
- Do not post error messages in the channel. Instead, use a pasting service such as [pastebin](https://pastebin.com/) (https://pastebin.com/) and paste the resulting URL into the IRC discussion.

23.5 Videos

A series of instructional videos are available for FreeNAS®:

- [Install Murmur \(Mumble server\) on FreeNAS/FreeBSD](https://www.youtube.com/watch?v=aAeZRNfarJc) (https://www.youtube.com/watch?v=aAeZRNfarJc)
- [FreeNAS® 9.10 - Certificate Authority & SSL Certificates](https://www.youtube.com/watch?v=OT1Le5VQlc0) (https://www.youtube.com/watch?v=OT1Le5VQlc0)
- [How to Update FreeNAS® 9.10](https://www.youtube.com/watch?v=2nvb90AhgL8) (https://www.youtube.com/watch?v=2nvb90AhgL8)

- FreeNAS® 9.10 LAGG & VLAN Overview (https://www.youtube.com/watch?v=wqSH_uQSArQ)
- FreeNAS 9.10 and Samba (SMB) Permissions (<https://www.youtube.com/watch?v=RxggaE935PM>)
- FreeNAS® 11 - What's New (https://www.youtube.com/watch?v=-uj_7eG88zk)
- FreeNAS® 11 - How to Install (<https://www.youtube.com/watch?v=R3f-Sr6y-c4>)

23.6 Professional Support

In addition to free community resources, support might be available in your area through third-party consultants. Submit a support inquiry using the form at <https://www.ixsystems.com/freenas-commercial-support/>.

CONTRIBUTING TO FREENAS®

FreeNAS® is an open source community, relying on the input and expertise of users to grow and improve. When users take time to assist the community, their contributions benefit everyone.

This section describes how to participate and contribute to FreeNAS®. It is by no means an exhaustive list. If you have an idea that will benefit the community, bring it up on one of the resources mentioned in [Support Resources](#) (page 343).

This section demonstrates how to:

- [Help with Translation](#) (page 346)

24.1 Translation

FreeNAS® is developed and documented in English. Having complete translations of the user interface into other languages helps make FreeNAS® much more useful to communities around the world.

FreeNAS® uses .po files stored in the [webui GitHub repository](https://github.com/freenas/webui/tree/master/src/assets/i18n) (https://github.com/freenas/webui/tree/master/src/assets/i18n) to manage the translation of text shown in the FreeNAS® graphical administrative interface. GitHub provides an easy to use web-based editor, making it possible for individuals to assist with translation or comment on existing translations.

To view translation files, open the `/src/assets/i18n` directory of the FreeNAS® [webui repository](https://github.com/freenas/webui/tree/master/src/assets/i18n) (https://github.com/freenas/webui/tree/master/src/assets/i18n), as shown in [Figure 24.1](#).

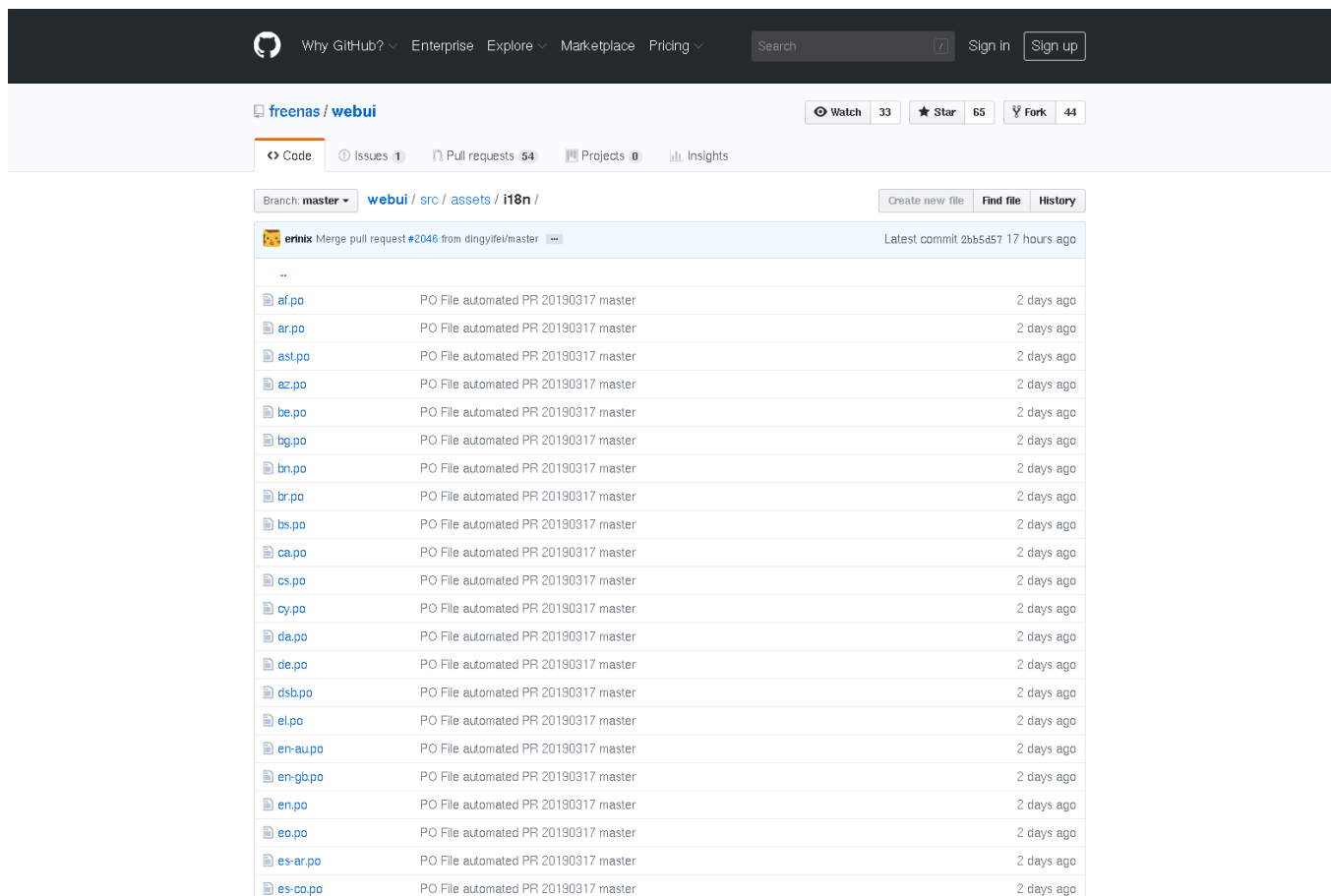


Fig. 24.1: FreeNAS® Translation Files

To assist with translating FreeNAS®, first create an account with [GitHub](https://github.com/) (<https://github.com/>) and *Fork* the [freenas/webui](https://github.com/freenas/webui) (<https://github.com/freenas/webui>) repository.

There are two methods for committing translations:

1. Use the GitHub website to edit the `.po` files.

OR

2. Make a local copy of the forked repository and use a text editor for translations.

24.1.1 Translate with GitHub

Open a browser and go to your GitHub profile. Select the *Repositories* tab and open your fork of the `freenas/webui` repository. Click `src` → `assets` → `i18n` to open the translations directory. Click on the desired language `.po` file to begin translating.

Tip: Here is a list of [common language abbreviations](https://www.abbreviations.com/acronyms/LANGUAGES2L) (<https://www.abbreviations.com/acronyms/LANGUAGES2L>)

Click the *Pencil* icon in the upper right area to open the online file editor. [Figure 24.2](#) shows the page that appears:

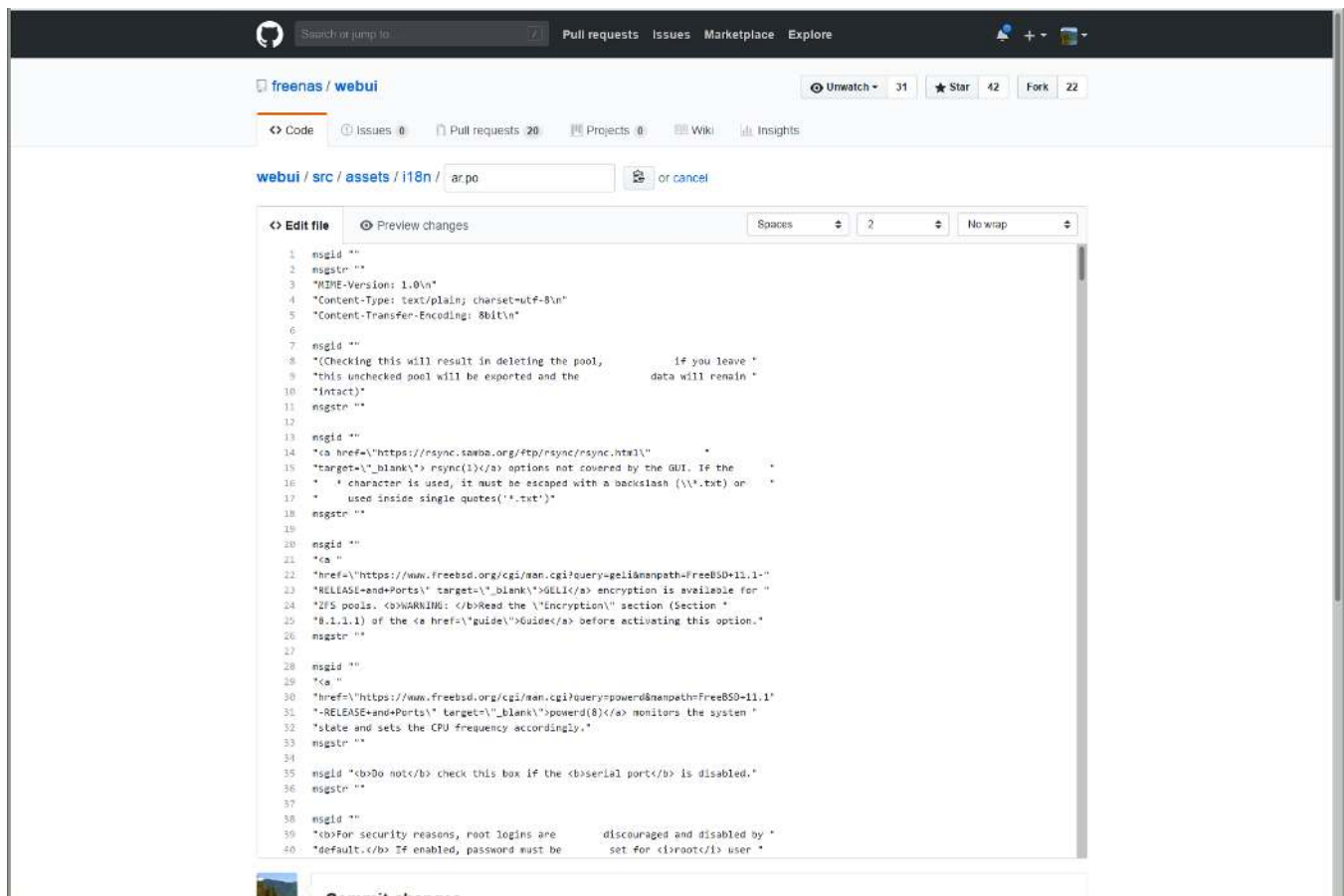


Fig. 24.2: GitHub Online Editor

There are numerous `msgid ""` and `msgstr ""` entries in the file. Read the `msgid` text and enter the translation between the `msgstr` quotes.

Scroll to the bottom of the page when finished entering translations. Enter a descriptive title and summary of changes for the edits and click *Commit changes*.

24.1.2 Download and Translate Offline

Install Git (<https://git-scm.com/book/en/v2/Getting-Started-Installing-Git>). There are numerous examples in these instructions of using git, but full documentation for git is [available online](https://git-scm.com/doc) (<https://git-scm.com/doc>).

These instructions show using the Command Line Interface (CLI) with git, but many graphical utilities are available.

Create a suitable directory to store the local copy of the forked repository. Download the repository with git clone:

```
% git clone https://github.com/ghuser/webui.git
```

The download can take several minutes, depending on connection speed.

Use `cd` to go to the `i18n` directory:

```
% cd src/assets/i18n/
```

Use a `po` editor to add translations to the desired language file. Any capable editor will work, but [poedit](https://poedit.net/) (<https://poedit.net/>) and [gtranslator](https://wiki.gnome.org/Apps/Gtranslator) (<https://wiki.gnome.org/Apps/Gtranslator>) are two common options.

Commit any file changes with `git commit`:


```
% git commit ar.po
```

Enter a descriptive message about the changes and save the commit.

When finished making commits to the branch, use `git push` to send your changes to the online fork repository.

24.1.3 Translation Pull Requests

When ready to merge translations in the original `freenas/webui` repository, open a web browser and go to your forked repository on GitHub. Select the *Code* tab and click *New pull request*. Set the *base repository* drop-down to `freenas/webui` and the *head repository* to your fork. Click *Create pull request*, write a title and summary of your proposed changes, and click *Create pull request* again to submit your translations to the `freenas/webui` repository.

The FreeNAS® project automatically tests pull requests for compatibility. If there any issues with a pull request, either the automated system will update the request or a FreeNAS® team member will leave a message in the comment section of the request.

All assistance with translations helps to benefit the FreeNAS® community. Thank you!

COMMAND LINE UTILITIES

Several command line utilities which are provided with FreeNAS® are demonstrated in this section.

The following utilities can be used for benchmarking and performance testing:

- *lperf* (page 350): used for measuring maximum TCP and UDP bandwidth performance
- *Netperf* (page 353): a tool for measuring network performance
- *IOzone* (page 354): filesystem benchmark utility used to perform a broad filesystem analysis
- *arcstat* (page 356): used to gather ZFS ARC statistics

The following utilities are specific to RAID controllers:

- *tw_cli* (page 361): used to monitor and maintain 3ware RAID controllers
- *MegaCli* (page 363): used to configure and manage Broadcom MegaRAID SAS family of RAID controllers

This section also describes these utilities:

- *freenas-debug* (page 363): the backend used to dump FreeNAS® debugging information
- *tmux* (page 364): a terminal multiplexer similar to GNU screen
- *Dmidecode* (page 365): reports information about system hardware as described in the system's BIOS

25.1 Iperf

Iperf is a utility for measuring maximum TCP and UDP bandwidth performance. It can be used to chart network throughput over time. For example, it is used to test the speed of different types of shares to determine which type performs best on the network.

FreeNAS® includes the iperf server. To perform network testing, install an iperf client on a desktop system that has network access to the FreeNAS® system. This section demonstrates how to use the *xjperf user interface client* (<https://code.google.com/archive/p/xjperf/downloads>) as it works on Windows, macOS, Linux, and BSD systems.

Since this client is Java-based, the appropriate JRE (<http://www.oracle.com/technetwork/java/javase/downloads/index.html>) must be installed on the client computer.

Linux and BSD users will need to install the iperf package using the package management system for their operating system.

To start xjperf on Windows: unzip the downloaded file, start Command Prompt in Run as administrator mode, `cd` to the unzipped folder, and run `jperf.bat`.

To start xjperf on macOS, Linux, or BSD, unzip the downloaded file, `cd` to the unzipped directory, type `chmod u+x jperf.sh`, and run `./jperf.sh`.

Start the iperf server on FreeNAS® when the client is ready.

Note: Beginning with FreeNAS® version 11.1, both [iperf2](https://sourceforge.net/projects/iperf2/) (https://sourceforge.net/projects/iperf2/) and [iperf3](http://software.es.net/iperf/) (http://software.es.net/iperf/) are pre-installed. To use iperf2, use `iperf`. To use iperf3, instead type `iperf3`. The examples below are for iperf2.

To see the available server options, open Shell and type:

```
iperf --help | more
```

or:

```
iperf3 --help | more
```

For example, to perform a TCP test and start the server in daemon mode (to get the prompt back), type:

```
iperf -sD
-----
Server listening on TCP port 5001
TCP window size: 64.0 KByte (default)
-----
Running Iperf Server as a daemon
The Iperf daemon process ID: 4842
```

Note: The daemon process stops when [Shell](#) (page 335) closes. Set up the environment with shares configured and started **before** starting the Iperf process.

From the desktop, open the client. Enter the IP of address of the FreeNAS® system, specify the running time for the test under *Application layer options* → *Transmit* (the default test time is 10 seconds), and click the *Run Iperf!* button. [Figure 25.1](#) shows an example of the client running on a Windows system while an SFTP transfer is occurring on the network.

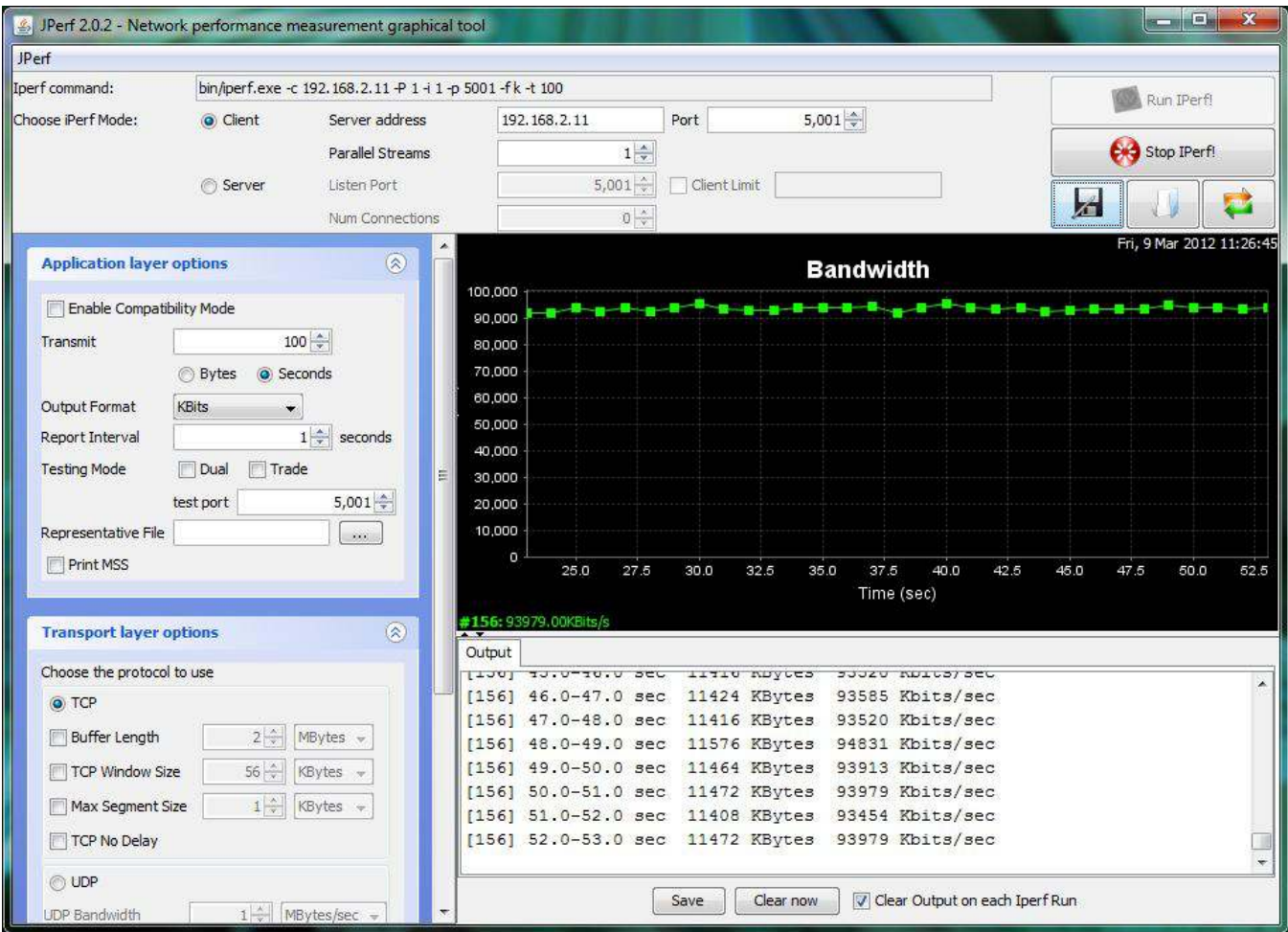


Fig. 25.1: Viewing Bandwidth Statistics Using xjperf

Check the type of traffic before testing UDP or TCP. The iperf server is used to get additional details for services using TCP `iperf -sD` or UDP `iperf -sDu`. The startup message indicates when the server is listening for TCP or UDP. The `sockstat -4 | more` command gives an overview of the services running on the FreeNAS® system. This helps to determine if the traffic to test is UDP or TCP.

```
sockstat -4 | more
USER      COMMAND  PID    FD  PROTO  LOCAL ADDRESS  FOREIGN ADDRESS
root      iperf    4870   6   udp4    *:5001         *:
root      iperf    4842   6   tcp4    *:5001         *:
www       nginx    4827   3   tcp4    127.0.0.1:15956 127.0.0.1:9042
www       nginx    4827   5   tcp4    192.168.2.11:80 192.168.2.26:56964
www       nginx    4827   7   tcp4    *:80           *:
root      sshd     3852   5   tcp4    *:22           *:
root      python   2503   5   udp4    *:             *:
root      mountd   2363   7   udp4    *:812          *:
root      mountd   2363   8   tcp4    *:812          *:
root      rpcbind  2359   9   udp4    *:111          *:
root      rpcbind  2359   10  udp4    *:886          *:
root      rpcbind  2359   11  tcp4    *:111          *:
root      nginx    2044   7   tcp4    *:80           *:
root      python   2029   3   udp4    *:             *:
root      python   2029   4   tcp4    127.0.0.1:9042  *:
root      python   2029   7   tcp4    127.0.0.1:9042 127.0.0.1:15956
root      ntpd     1548   20  udp4    *:123          *:
root      ntpd     1548   22  udp4    192.168.2.11:123*:*
```

root	ntpd	1548	25	udp4	127.0.0.1:123	*:*
root	syslogd	1089	6	udp4	127.0.0.1:514	*:*

When testing is finished, either type `killall iperf` or close Shell to terminate the iperf server process.

25.2 Netperf

Netperf is a benchmarking utility that can be used to measure the performance of unidirectional throughput and end-to-end latency.

Before using the `netperf` command, start its server process with this command:

```
netserver
Starting netserver with host 'IN(6)ADDR_ANY' port '12865' and family AF_UNSPEC
```

The following command displays the available options for performing tests with the `netperf` command. The [Netperf Manual](https://hewlettpackard.github.io/netperf/) (<https://hewlettpackard.github.io/netperf/>) describes each option in more detail and explains how to perform many types of tests. It is the best reference for understanding how each test works and how to interpret the results. When testing is finished, type `killall netserver` to stop the server process.

```
netperf -h |more
Usage: netperf [global options] -- [test options]
Global options:
  -a send,recv      Set the local send,recv buffer alignment
  -A send,recv      Set the remote send,recv buffer alignment
  -B brandstr        Specify a string to be emitted with brief output
  -c [cpu_rate]      Report local CPU usage
  -C [cpu_rate]      Report remote CPU usage
  -d                Increase debugging output
  -D [secs,units] *  Display interim results at least every secs seconds
                    using units as the initial guess for units per second
  -f G|M|K|g|m|k     Set the output units
  -F fill_file        Pre-fill buffers with data from fill_file
  -h                Display this text
  -H name|ip,fam *   Specify the target machine and/or local ip and family
  -i max,min          Specify the max and min number of iterations (15,1)
  -I lvl[,intvl]     Specify confidence level (95 or 99) (99)
                    and confidence interval in percentage (10)
  -j                Keep additional timing statistics
  -l testlen          Specify test duration (>0 secs) (<0 bytes|trans)
  -L name|ip,fam *   Specify the local ip|name and address family
  -o send,recv        Set the local send,recv buffer offsets
  -O send,recv        Set the remote send,recv buffer offset
  -n numcpu           Set the number of processors for CPU util
  -N                Establish no control connection, do 'send' side only
  -p port,lport*      Specify netserver port number and/or local port
  -P 0|1             Don't/Do display test headers
  -r                Allow confidence to be hit on result only
  -s seconds          Wait seconds between test setup and test start
  -S                Set SO_KEEPALIVE on the data connection
  -t testname         Specify test to perform
  -T lcpu,rcpu        Request netperf/netserver be bound to local/remote cpu
  -v verbosity        Specify the verbosity level
  -W send,recv        Set the number of send,recv buffers
  -v level            Set the verbosity level (default 1, min 0)
  -V                Display the netperf version and exit
```

For those options taking two parms, at least one must be specified. Specifying one value without a comma will set both parms to that value, specifying a value with a leading comma will set just the second parm, and specifying a

value with a trailing comma will set the first. To set each parm to unique values, specify both and separate them with a comma.

For these options taking two parms, specifying one value with no comma will only set the first parms and will leave the second at the default value. To set the second value it must be preceded with a comma or be a comma-separated pair. This is to retain previous netperf behavior.

25.3 IOzone

IOzone is a disk and filesystem benchmarking tool. It can be used to test file I/O performance for the following operations: read, write, re-read, re-write, read backwards, read strided, fread, fwrite, random read, pread, mmap, aio_read, and aio_write.

FreeNAS® ships with IOzone so it can be run from Shell. When using IOzone on FreeNAS®, `cd` to a directory in a pool that you have permission to write to, otherwise an error about being unable to write the temporary file will occur.

Before using IOzone, read through the [IOzone documentation PDF](http://www.iozone.org/docs/IOzone_msword_98.pdf) (http://www.iozone.org/docs/IOzone_msword_98.pdf) as it describes the tests, the many command line switches, and how to interpret the results.

These resources provide good starting points on which tests to run, when to run them, and how to interpret the results:

- [How To Measure Linux Filesystem I/O Performance With iozone](https://www.cyberciti.biz/tips/linux-filesystem-benchmarking-with-iozone.html) (<https://www.cyberciti.biz/tips/linux-filesystem-benchmarking-with-iozone.html>)
- [Analyzing NFS Client Performance with IOzone](http://www.iozone.org/docs/NFSClientPerf_revised.pdf) (http://www.iozone.org/docs/NFSClientPerf_revised.pdf)
- [10 iozone Examples for Disk I/O Performance Measurement on Linux](https://www.thegeekstuff.com/2011/05/iozone-examples/) (<https://www.thegeekstuff.com/2011/05/iozone-examples/>)

Type the following command to receive a summary of the available switches. IOzone is comprehensive so it may take some time to learn how to use the tests effectively.

Starting with version 9.2.1, FreeNAS® enables compression on newly created ZFS pools by default. Since IOzone creates test data that is compressible, this can skew test results. To configure IOzone to generate incompressible test data, include the options `--w 1 --y 1 --C 1`.

Alternatively, consider temporarily disabling compression on the ZFS pool or dataset when running IOzone benchmarks.

Note: If a visual representation of the collected data is preferred, scripts are available to render IOzone's output in [Gnuplot](http://www.gnuplot.info/) (<http://www.gnuplot.info/>).

```
iozone -h | more
iozone: help mode
Usage: iozone[-s filesize_Kb] [-r record_size_Kb] [-f [path]filename] [-h]
      [-i test] [-E] [-p] [-a] [-A] [-z] [-Z] [-m] [-M] [-t children]
      [-l min_number_procs] [-u max_number_procs] [-v] [-R] [-x] [-o]
      [-d microseconds] [-F path1 path2...] [-V pattern] [-j stride]
      [-T] [-C] [-B] [-D] [-G] [-I] [-H depth] [-k depth] [-U mount_point]
      [-S cache_size] [-O] [-L cacheline_size] [-K] [-g maxfilesize_Kb]
      [-n minfilesize_Kb] [-N] [-Q] [-P start_cpu] [-e] [-c] [-b Excel.xls]
      [-J milliseconds] [-X write_telemetry_filename] [-w] [-W]
      [-Y read_telemetry_filename] [-y minrecsize_Kb] [-q maxrecsize_Kb]
      [--u] [--m cluster_filename] [--d] [--x multiplier] [--p # ]
      [--r] [--t] [--X] [--Z] [--w percent dedupable] [--y percent_interior_dedup]
      [--C percent_dedup_within]
      -a Auto mode
      -A Auto2 mode
```

```

-b Filename Create Excel worksheet file
-B Use mmap() files
-c Include close in the timing calculations
-C Show bytes transferred by each child in throughput testing
-d # Microsecond delay out of barrier
-D Use msync(MS_ASYNC) on mmap files
-e Include flush (fsync,fflush) in the timing calculations
-E Run extension tests
-f filename to use
-F filenames for each process/thread in throughput test
-g # Set maximum file size (in Kbytes) for auto mode (or #m or #g)
-G Use msync(MS_SYNC) on mmap files
-h help
-H # Use POSIX async I/O with # async operations
-i # Test to run (0=write/rewrite, 1=read/re-read, 2=random-read/write
    3=Read-backwards, 4=Re-write-record, 5=stride-read, 6=fwrite/re-fwrite
    7=fread/Re-fread, 8=random_mix, 9=pwrite/Re-pwrite, 10=pread/Re-pread
    11=pwritev/Re-pwritev, 12=preadv/Re-preadv)
-I Use VxFS VX_DIRECT, O_DIRECT, or O_DIRECTIO for all file operations
-j # Set stride of file accesses to (# * record size)
-J # milliseconds of compute cycle before each I/O operation
-k # Use POSIX async I/O (no bcopy) with # async operations
-K Create jitter in the access pattern for readers
-l # Lower limit on number of processes to run
-L # Set processor cache line size to value (in bytes)
-m Use multiple buffers
-M Report uname -a output
-n # Set minimum file size (in Kbytes) for auto mode (or #m or #g)
-N Report results in microseconds per operation
-o Writes are synch (O_SYNC)
-O Give results in ops/sec.
-p Purge on
-P # Bind processes/threads to processors, starting with this cpu
-q # Set maximum record size (in Kbytes) for auto mode (or #m or #g)
-Q Create offset/latency files
-r # record size in Kb
    or -r #k .. size in Kb
    or -r #m .. size in Mb
    or -r #g .. size in Gb
-R Generate Excel report
-s # file size in Kb
    or -s #k .. size in Kb
    or -s #m .. size in Mb
    or -s #g .. size in Gb
-S # Set processor cache size to value (in Kbytes)
-t # Number of threads or processes to use in throughput test
-T Use POSIX pthreads for throughput tests
-u # Upper limit on number of processes to run
-U Mount point to remount between tests
-v version information
-V # Verify data pattern write/read
-w Do not unlink temporary file
-W Lock file when reading or writing
-x Turn off stone-walling
-X filename Write telemetry file. Contains lines with (offset reclen compute_time) in_
→ascii
-y # Set minimum record size (in Kbytes) for auto mode (or #m or #g)
-Y filename Read telemetry file. Contains lines with (offset reclen compute_time) in_
→ascii
-z Used in conjunction with -a to test all possible record sizes
-Z Enable mixing of mmap I/O and file I/O

```

```

-E Use existing non-Iozone file for read-only testing
-K Sony special. Manual control of test 8.
-m Cluster_filename Enable Cluster testing
-d File I/O diagnostic mode. (To troubleshoot a broken file I/O subsystem)
-u Enable CPU utilization output (Experimental)
-x # Multiplier to use for incrementing file and record sizes
-p # Percentage of mix to be reads
-r Enable O_RSYNC|O_SYNC for all testing.
-t Enable network performance test. Requires -m
-n No retests selected.
-k Use constant aggregate data set size.
-q Delay in seconds between tests.
-l Enable record locking mode.
-L Enable record locking mode, with shared file.
-B Sequential mixed workload.
-A # Enable madvise. 0 = normal, 1=random, 2=sequential 3=dontneed, 4=willneed
-N Do not truncate existing files on sequential writes.
-S # Dedup-able data is limited to sharing within each numerically identified file set
-V Enable shared file. No locking.
-X Enable short circuit mode for filesystem testing ONLY
  ALL Results are NOT valid in this mode.
-Z Enable old data set compatibility mode. WARNING.. Published
  hacks may invalidate these results and generate bogus, high values for results.
-w ## Percent of dedup-able data in buffers.
-y ## Percent of dedup-able within & across files in buffers.
-C ## Percent of dedup-able within & not across files in buffers.
-H Hostname Hostname of the PIT server.
-P Service Service of the PIT server.
-z Enable latency histogram logging.

```

25.4 arcstat

Arcstat is a script that prints out ZFS ARC (https://en.wikipedia.org/wiki/Adaptive_replacement_cache) statistics. Originally it was a perl script created by Sun. That perl script was ported to FreeBSD and then ported as a Python script for use on FreeNAS®.

Watching ARC hits/misses and percentages shows how well the ZFS pool is fetching from the ARC rather than using disk I/O. Ideally, there will be as many things fetching from cache as possible. Keep the load in mind while reviewing the stats. For random reads, expect a miss and having to go to disk to fetch the data. For cached reads, expect it to pull out of the cache and have a hit.

Like all cache systems, the ARC takes time to fill with data. This means that it will have a lot of misses until the pool has been in use for a while. If there continues to be lots of misses and high disk I/O on cached reads, there is cause to investigate further and tune the system.

The [FreeBSD ZFS Tuning Guide](https://wiki.freebsd.org/ZFSTuningGuide) (<https://wiki.freebsd.org/ZFSTuningGuide>) provides some suggestions for commonly tuned `sysctl` values. It should be noted that performance tuning is more of an art than a science and that any changes made will probably require several iterations of tune and test. Be aware that what needs to be tuned will vary depending upon the type of workload and that what works for one one network may not benefit another.

In particular, the value of pre-fetching depends upon the amount of memory and the type of workload, as seen in [Understanding ZFS: Prefetch](http://cuddletech.com/?page_id=834&id=1040) (http://cuddletech.com/?page_id=834&id=1040)

FreeNAS® provides two command line scripts which can be manually run from *Shell* (page 335):

- `arc_summary.py`: provides a summary of the statistics
- `arcstat.py`: used to watch the statistics in real time

The advantage of these scripts is that they provide real time information, whereas the current web interface reporting mechanism is designed to only provide graphs charted over time.

This [forum post](https://forums.freenas.org/index.php?threads/benchmarking-zfs.7928/) (https://forums.freenas.org/index.php?threads/benchmarking-zfs.7928/) demonstrates some examples of using these scripts with hints on how to interpret the results.

To view the help for arcstat.py:

```
arcstat.py -h
[-havxp] [-f fields] [-o file] [-s string] [interval [count]]

-h : Print this help message
-a : Print all possible stats
-v : List all possible field headers and definitions
-x : Print extended stats
-f : Specify specific fields to print (see -v)
-o : Redirect output to the specified file
-s : Override default field separator with custom character or string
-p : Disable auto-scaling of numerical fields

Examples:
arcstat -o /tmp/a.log 2 10
arcstat -s "," -o /tmp/a.log 2 10
arcstat -v
arcstat -f time,hit%,dh%,ph%,mh% 1
```

To view ARC statistics in real time, specify an interval and a count. This command will display every 1 second for a count of five.

```
arcstat.py 1 5
  time  read  miss  miss%  dmis  dm%  pmis  pm%  mmis  mm%  arcz  c
06:19:03    7    0    0    0    0    0    0    0    0    153M 6.6G
06:19:04   257    0    0    0    0    0    0    0    0    153M 6.6G
06:19:05   193    0    0    0    0    0    0    0    0    153M 6.6G
06:19:06   193    0    0    0    0    0    0    0    0    153M 6.6G
06:19:07   255    0    0    0    0    0    0    0    0    153M 6.6G
```

Table 25.1 briefly describes the columns in the output.

Table 25.1: arcstat Column Descriptions

Column	Description
read	total ARC accesses/second
miss	ARC misses/second
miss%	ARC miss percentage
dmis	demand data misses/second
dm%	demand data miss percentage
pmis	prefetch misses per second
pm%	prefetch miss percentage
mmis	metadata misses/second
mm%	metadata miss percentage
arcz	arc size
c	arc target size

To receive a summary of statistics, use:

```
arcsummary.py
System Memory:
  2.36%  93.40  MiB Active,    8.95%  353.43  MiB Inact
  8.38%  330.89  MiB Wired,    0.15%   5.90  MiB Cache
 80.16%   3.09  GiB Free,    0.00%   0      Bytes Gap
Real Installed:                      4.00  GiB
Real Available:                      99.31%  3.97  GiB
Real Managed:                        97.10%  3.86  GiB
```

```

    Logical Total:                4.00    GiB
    Logical Used:                  13.93%  570.77 MiB
    Logical Free:                  86.07%   3.44    GiB
Kernel Memory:                   87.62    MiB
    Data:                         69.91%  61.25    MiB
    Text:                         30.09%  26.37    MiB
Kernel Memory Map:               3.86     GiB
    Size:                         5.11%  201.70 MiB
    Free:                        94.89%   3.66     GiB
ARC Summary: (HEALTHY)
    Storage pool Version:         5000
    Filesystem Version:           5
    Memory Throttle Count:        0
ARC Misc:
    Deleted:                      8
    Mutex Misses:                 0
    Evict Skips:                  0
ARC Size:                        5.83%   170.45 MiB
    Target Size: (Adaptive)       100.00%  2.86     GiB
    Min Size (Hard Limit):        12.50%  365.69 MiB
    Max Size (High Water):        8:1     2.86     GiB
ARC Size Breakdown:
    Recently Used Cache Size:     50.00%   1.43     GiB
    Frequently Used Cache Size:   50.00%   1.43     GiB
ARC Hash Breakdown:
    Elements Max:                 5.90k
    Elements Current:             100.00%  5.90k
    Collisions:                   72
    Chain Max:                    1
    Chains:                       23
ARC Total accesses:                                     954.06k
    Cache Hit Ratio:              99.18%  946.25k
    Cache Miss Ratio:             0.82%   7.81k
    Actual Hit Ratio:             98.84%  943.00k
    Data Demand Efficiency:       99.20%  458.77k
    CACHE HITS BY CACHE LIST:
        Anonymously Used:         0.34%   3.25k
        Most Recently Used:       3.73%  35.33k
        Most Frequently Used:     95.92%  907.67k
        Most Recently Used Ghost: 0.00%   0
        Most Frequently Used Ghost: 0.00%   0
    CACHE HITS BY DATA TYPE:
        Demand Data:              48.10%  455.10k
        Prefetch Data:            0.00%   0
        Demand Metadata:          51.56%  487.90k
        Prefetch Metadata:        0.34%   3.25k
    CACHE MISSES BY DATA TYPE:
        Demand Data:              46.93%   3.66k
        Prefetch Data:            0.00%   0
        Demand Metadata:          49.76%   3.88k
        Prefetch Metadata:        3.30%   258
ZFS Tunable (sysctl):
    kern.maxusers                 590
    vm.kmem_size                  4141375488
    vm.kmem_size_scale            1
    vm.kmem_size_min              0
    vm.kmem_size_max              1319413950874
    vfs.zfs.vol.unmap_enabled     1
    vfs.zfs.vol.mode              2
    vfs.zfs.sync_pass_rewrite     2
    vfs.zfs.sync_pass_dont_compress 5

```

vfs.zfs.sync_pass_deferred_free	2
vfs.zfs.zio.exclude_metadata	0
vfs.zfs.zio.use_uma	1
vfs.zfs.cache_flush_disable	0
vfs.zfs.zil_replay_disable	0
vfs.zfs.version.zpl	5
vfs.zfs.version.spa	5000
vfs.zfs.version.acl	1
vfs.zfs.version.ioctl	5
vfs.zfs.debug	0
vfs.zfs.super_owner	0
vfs.zfs.min_auto_ashift	9
vfs.zfs.max_auto_ashift	13
vfs.zfs.vdev.write_gap_limit	4096
vfs.zfs.vdev.read_gap_limit	32768
vfs.zfs.vdev.aggregation_limit	131072
vfs.zfs.vdev.trim_max_active	64
vfs.zfs.vdev.trim_min_active	1
vfs.zfs.vdev.scrub_max_active	2
vfs.zfs.vdev.scrub_min_active	1
vfs.zfs.vdev.async_write_max_active	10
vfs.zfs.vdev.async_write_min_active	1
vfs.zfs.vdev.async_read_max_active	3
vfs.zfs.vdev.async_read_min_active	1
vfs.zfs.vdev.sync_write_max_active	10
vfs.zfs.vdev.sync_write_min_active	10
vfs.zfs.vdev.sync_read_max_active	10
vfs.zfs.vdev.sync_read_min_active	10
vfs.zfs.vdev.max_active	1000
vfs.zfs.vdev.async_write_active_max_dirty_percent	60
vfs.zfs.vdev.async_write_active_min_dirty_percent	30
vfs.zfs.vdev.mirror.non_rotating_seek_inc	1
vfs.zfs.vdev.mirror.non_rotating_inc	0
vfs.zfs.vdev.mirror.rotating_seek_offset	1048576
vfs.zfs.vdev.mirror.rotating_seek_inc	5
vfs.zfs.vdev.mirror.rotating_inc	0
vfs.zfs.vdev.trim_on_init	1
vfs.zfs.vdev.larger_ashift_minimal	0
vfs.zfs.vdev.bio_delete_disable	0
vfs.zfs.vdev.bio_flush_disable	0
vfs.zfs.vdev.cache.bshift	16
vfs.zfs.vdev.cache.size	0
vfs.zfs.vdev.cache.max	16384
vfs.zfs.vdev.metaslabs_per_vdev	200
vfs.zfs.vdev.trim_max_pending	10000
vfs.zfs.txg.timeout	5
vfs.zfs.trim.enabled	1
vfs.zfs.trim.max_interval	1
vfs.zfs.trim.timeout	30
vfs.zfs.trim.txg_delay	32
vfs.zfs.space_map_blksize	4096
vfs.zfs.spa_slop_shift	5
vfs.zfs.spa_ashift_inflation	24
vfs.zfs.deadman_enabled	1
vfs.zfs.deadman_checktime_ms	5000
vfs.zfs.deadman_synctime_ms	1000000
vfs.zfs.recover	0
vfs.zfs.spa_load_verify_data	1
vfs.zfs.spa_load_verify_metadata	1
vfs.zfs.spa_load_verify_maxinflight	10000
vfs.zfs.check_hostid	1

vfs.zfs.mg_fragmentation_threshold	85
vfs.zfs.mg_noalloc_threshold	0
vfs.zfs.condense_pct	200
vfs.zfs.metaslab.bias_enabled	1
vfs.zfs.metaslab.lba_weighting_enabled	1
vfs.zfs.metaslab.fragmentation_factor_enabled	1
vfs.zfs.metaslab.preload_enabled	1
vfs.zfs.metaslab.preload_limit	3
vfs.zfs.metaslab.unload_delay	8
vfs.zfs.metaslab.load_pct	50
vfs.zfs.metaslab.min_alloc_size	33554432
vfs.zfs.metaslab.df_free_pct	4
vfs.zfs.metaslab.df_alloc_threshold	131072
vfs.zfs.metaslab.debug_unload	0
vfs.zfs.metaslab.debug_load	0
vfs.zfs.metaslab.fragmentation_threshold	70
vfs.zfs.metaslab.gang_bang	16777217
vfs.zfs.free_bpobj_enabled	1
vfs.zfs.free_max_blocks	18446744073709551615
vfs.zfs.no_scrub_prefetch	0
vfs.zfs.no_scrub_io	0
vfs.zfs.resilver_min_time_ms	3000
vfs.zfs.free_min_time_ms	1000
vfs.zfs.scan_min_time_ms	1000
vfs.zfs.scan_idle	50
vfs.zfs.scrub_delay	4
vfs.zfs.resilver_delay	2
vfs.zfs.top_maxinflight	32
vfs.zfs.delay_scale	500000
vfs.zfs.delay_min_dirty_percent	60
vfs.zfs.dirty_data_sync	67108864
vfs.zfs.dirty_data_max_percent	10
vfs.zfs.dirty_data_max_max	4294967296
vfs.zfs.dirty_data_max	426512793
vfs.zfs.max_recordsz	1048576
vfs.zfs.zfetch.array_rd_sz	1048576
vfs.zfs.zfetch.max_distance	8388608
vfs.zfs.zfetch.min_sec_reap	2
vfs.zfs.zfetch.max_streams	8
vfs.zfs.prefetch_disable	1
vfs.zfs.mdcomp_disable	0
vfs.zfs.nopwrite_enabled	1
vfs.zfs.dedup.prefetch	1
vfs.zfs.l2c_only_size	0
vfs.zfs.mfu_ghost_data_lsize	0
vfs.zfs.mfu_ghost_metadata_lsize	0
vfs.zfs.mfu_ghost_size	0
vfs.zfs.mfu_data_lsize	26300416
vfs.zfs.mfu_metadata_lsize	1780736
vfs.zfs.mfu_size	29428736
vfs.zfs.mru_ghost_data_lsize	0
vfs.zfs.mru_ghost_metadata_lsize	0
vfs.zfs.mru_ghost_size	0
vfs.zfs.mru_data_lsize	122090496
vfs.zfs.mru_metadata_lsize	2235904
vfs.zfs.mru_size	139389440
vfs.zfs.anon_data_lsize	0
vfs.zfs.anon_metadata_lsize	0
vfs.zfs.anon_size	163840
vfs.zfs.l2arc_norw	1
vfs.zfs.l2arc_feed_again	1

vfs.zfs.l2arc_noprefetch	1
vfs.zfs.l2arc_feed_min_ms	200
vfs.zfs.l2arc_feed_secs	1
vfs.zfs.l2arc_headroom	2
vfs.zfs.l2arc_write_boost	8388608
vfs.zfs.l2arc_write_max	8388608
vfs.zfs.arc_meta_limit	766908416
vfs.zfs.arc_free_target	7062
vfs.zfs.arc_shrink_shift	7
vfs.zfs.arc_average_blocksize	8192
vfs.zfs.arc_min	383454208
vfs.zfs.arc_max	3067633664

When reading the tunable values, 0 means no, 1 typically means yes, and any other number represents a value. To receive a brief description of a “sysctl” value, use `sysctl -d`. For example:

```
sysctl -d vfs.zfs.zio.use_uma
vfs.zfs.zio.use_uma: Use uma(9) for ZIO allocations
```

The ZFS tunables require a fair understanding of how ZFS works, meaning that reading man pages and searching for the meaning of unfamiliar acronyms is required. **Do not change a tunable’s value without researching it first.** If the tunable takes a numeric value (rather than 0 for no or 1 for yes), do not make one up. Instead, research examples of beneficial values that match the workload.

If any of the ZFS tunables are changed, continue to monitor the system to determine the effect of the change. It is recommended that the changes are tested first at the command line using `sysctl`. For example, to disable prefetch (i.e. change disable to 1 or yes):

```
sysctl vfs.zfs.prefetch_disable=1
vfs.zfs.prefetch_disable: 0 -> 1
```

The output will indicate the old value followed by the new value. If the change is not beneficial, change it back to the original value. If the change turns out to be beneficial, it can be made permanent by creating a *sysctl* using the instructions in [Tunables](#) (page 102).

25.5 tw_cli

FreeNAS® includes the `tw_cli` command line utility for providing controller, logical unit, and drive management for AMCC/3ware ATA RAID Controllers. The supported models are listed in the man pages for the [twe\(4\)](#) (<https://www.freebsd.org/cgi/man.cgi?query=twe>) and [twa\(4\)](#) (<https://www.freebsd.org/cgi/man.cgi?query=twa>) drivers.

Before using this command, read its [man page](#) (https://www.cyberciti.biz/files/tw_cli.8.html) as it describes the terminology and provides some usage examples.

When `tw_cli` in Shell is entered, the prompt will change, indicating that interactive mode is enabled where all sorts of maintenance commands on the controller and its arrays can be run.

Alternately, one command can be specified to run. For example, to view the disks in the array:

```
tw_cli /c0 show
```

Unit	UnitType	Status	%RCmpl	%V/I/M	Stripe	Size (GB)	Cache	AVrfy
u0	RAID-6	OK	-	-	256K	5587.88	RiW	ON
u1	SPARE	OK	-	-	-	931.505	-	OFF
u2	RAID-10	OK	-	-	256K	1862.62	RiW	ON

VPort	Status	Unit	Size	Type	Phy	Encl-Slot	Model
p8	OK	u0	931.51 GB	SAS	-	/c0/e0/slt0	SEAGATE ST31000640SS

p9	OK	u0	931.51	GB	SAS	-	/c0/e0/slt1	SEAGATE	ST31000640SS
p10	OK	u0	931.51	GB	SAS	-	/c0/e0/slt2	SEAGATE	ST31000640SS
p11	OK	u0	931.51	GB	SAS	-	/c0/e0/slt3	SEAGATE	ST31000640SS
p12	OK	u0	931.51	GB	SAS	-	/c0/e0/slt4	SEAGATE	ST31000640SS
p13	OK	u0	931.51	GB	SAS	-	/c0/e0/slt5	SEAGATE	ST31000640SS
p14	OK	u0	931.51	GB	SAS	-	/c0/e0/slt6	SEAGATE	ST31000640SS
p15	OK	u0	931.51	GB	SAS	-	/c0/e0/slt7	SEAGATE	ST31000640SS
p16	OK	u1	931.51	GB	SAS	-	/c0/e0/slt8	SEAGATE	ST31000640SS
p17	OK	u2	931.51	GB	SATA	-	/c0/e0/slt9	ST31000340NS	
p18	OK	u2	931.51	GB	SATA	-	/c0/e0/slt10	ST31000340NS	
p19	OK	u2	931.51	GB	SATA	-	/c0/e0/slt11	ST31000340NS	
p20	OK	u2	931.51	GB	SATA	-	/c0/e0/slt15	ST31000340NS	

Name	OnlineState	BBUReady	Status	Volt	Temp	Hours	LastCapTest
bbu	On	Yes	OK	OK	OK	212	03-Jan-2012

Or, to review the event log:

tw_cli /c0 show events			
Ctl	Date	Severity	AEN Message
c0	[Thu Feb 23 2012 14:01:15]	INFO	Battery charging started
c0	[Thu Feb 23 2012 14:03:02]	INFO	Battery charging completed
c0	[Sat Feb 25 2012 00:02:18]	INFO	Verify started: unit=0
c0	[Sat Feb 25 2012 00:02:18]	INFO	Verify started: unit=2,subunit=0
c0	[Sat Feb 25 2012 00:02:18]	INFO	Verify started: unit=2,subunit=1
c0	[Sat Feb 25 2012 03:49:35]	INFO	Verify completed: unit=2,subunit=0
c0	[Sat Feb 25 2012 03:51:39]	INFO	Verify completed: unit=2,subunit=1
c0	[Sat Feb 25 2012 21:55:59]	INFO	Verify completed: unit=0
c0	[Thu Mar 01 2012 13:51:09]	INFO	Battery health check started
c0	[Thu Mar 01 2012 13:51:09]	INFO	Battery health check completed
c0	[Thu Mar 01 2012 13:51:09]	INFO	Battery charging started
c0	[Thu Mar 01 2012 13:53:03]	INFO	Battery charging completed
c0	[Sat Mar 03 2012 00:01:24]	INFO	Verify started: unit=0
c0	[Sat Mar 03 2012 00:01:24]	INFO	Verify started: unit=2,subunit=0
c0	[Sat Mar 03 2012 00:01:24]	INFO	Verify started: unit=2,subunit=1
c0	[Sat Mar 03 2012 04:04:27]	INFO	Verify completed: unit=2,subunit=0
c0	[Sat Mar 03 2012 04:06:25]	INFO	Verify completed: unit=2,subunit=1
c0	[Sat Mar 03 2012 16:22:05]	INFO	Verify completed: unit=0
c0	[Thu Mar 08 2012 13:41:39]	INFO	Battery charging started
c0	[Thu Mar 08 2012 13:43:42]	INFO	Battery charging completed
c0	[Sat Mar 10 2012 00:01:30]	INFO	Verify started: unit=0
c0	[Sat Mar 10 2012 00:01:30]	INFO	Verify started: unit=2,subunit=0
c0	[Sat Mar 10 2012 00:01:30]	INFO	Verify started: unit=2,subunit=1
c0	[Sat Mar 10 2012 05:06:38]	INFO	Verify completed: unit=2,subunit=0
c0	[Sat Mar 10 2012 05:08:57]	INFO	Verify completed: unit=2,subunit=1
c0	[Sat Mar 10 2012 15:58:15]	INFO	Verify completed: unit=0

If the disks added to the array do not appear in the web interface, try running this command:

```
tw_cli /c0 rescan
```

Use the drives to create units and export them to the operating system. When finished, run `camcontrol rescan all` to make them available in the FreeNAS® web interface.

This [forum post](https://forums.freenas.org/index.php?threads/3ware-drive-monitoring.13835/) (<https://forums.freenas.org/index.php?threads/3ware-drive-monitoring.13835/>) contains a handy wrapper script that will give error notifications.

25.6 MegaCli

MegaCli is the command line interface for the Broadcom :MegaRAID SAS family of RAID controllers. FreeNAS® also includes the `mfiutil(8)` (<https://www.freebsd.org/cgi/man.cgi?query=mfiutil>) utility which can be used to configure and manage connected storage devices.

The MegaCli command is quite complex with several dozen options. The commands demonstrated in the [Emergency Cheat Sheet](#) (<http://tools.rapidsoft.de/perc/perc-cheat-sheet.html>) can get you started.

25.7 freenas-debug

The FreeNAS® web interface provides an option to save debugging information to a text file using *System* → *Advanced* → *Save Debug*. This debugging information is created by the `freenas-debug` command line utility and a copy of the information is saved to `/var/tmp/fndebug`.

This command can be run manually from *Shell* (page 335) to gather specific debugging information. To see a usage explanation listing all options, run the command without any options:

```
freenas-debug
Usage: /usr/local/bin/freenas-debug <options>
Where options are:

-A  Dump all debug information
-B  Dump System Configuration Database
-C  Dump SMB Configuration
-I  Dump IPMI Configuration
-M  Dump SATA DOMs Information
-N  Dump NFS Configuration
-S  Dump SMART Information
-T  Loader Configuration Information
-Z  Remove old debug information
-a  Dump Active Directory Configuration
-c  Dump (AD|LDAP) Cache
-e  Email debug log to this comma-delimited list of email addresses
-f  Dump AFP Configuration
-g  Dump GEOM Configuration
-h  Dump Hardware Configuration
-i  Dump iSCSI Configuration
-j  Dump Jail Information
-l  Dump LDAP Configuration
-n  Dump Network Configuration
-s  Dump SSL Configuration
-t  Dump System Information
-v  Dump Boot System File Verification Status and Inconsistencies
-y  Dump Sysctl Configuration
-z  Dump ZFS Configuration
```

Individual tests can be run alone. For example, when troubleshooting an Active Directory configuration, use:

```
freenas-debug -a
```

To collect the output of every module, use `-A`:

```
freenas-debug -A
```

For collecting debug information about a single pool, use `zdb` with `-U /data/zfs/zpool.cache` followed by the name of the pool:

```
zdb -U /data/zfs/zpool.cache pool1
```

See the [zdb\(8\) manual page](https://www.freebsd.org/cgi/man.cgi?query=zdb) (<https://www.freebsd.org/cgi/man.cgi?query=zdb>) for more information.

25.8 tmux

`tmux` is a terminal multiplexer which enables a number of :terminals to be created, accessed, and controlled from a single :screen. `tmux` is an alternative to GNU `screen`. Similar to `screen`, `tmux` can be detached from a screen and continue running in the background, then later reattached. Unlike [Shell](#) (page 335), `tmux` provides access to a command prompt while still giving access to the graphical administration screens.

To start a session, simply type `tmux`. As seen in [Figure 25.2](#), a new session with a single window opens with a status line at the bottom of the screen. This line shows information on the current session and is used to enter inter-active commands.

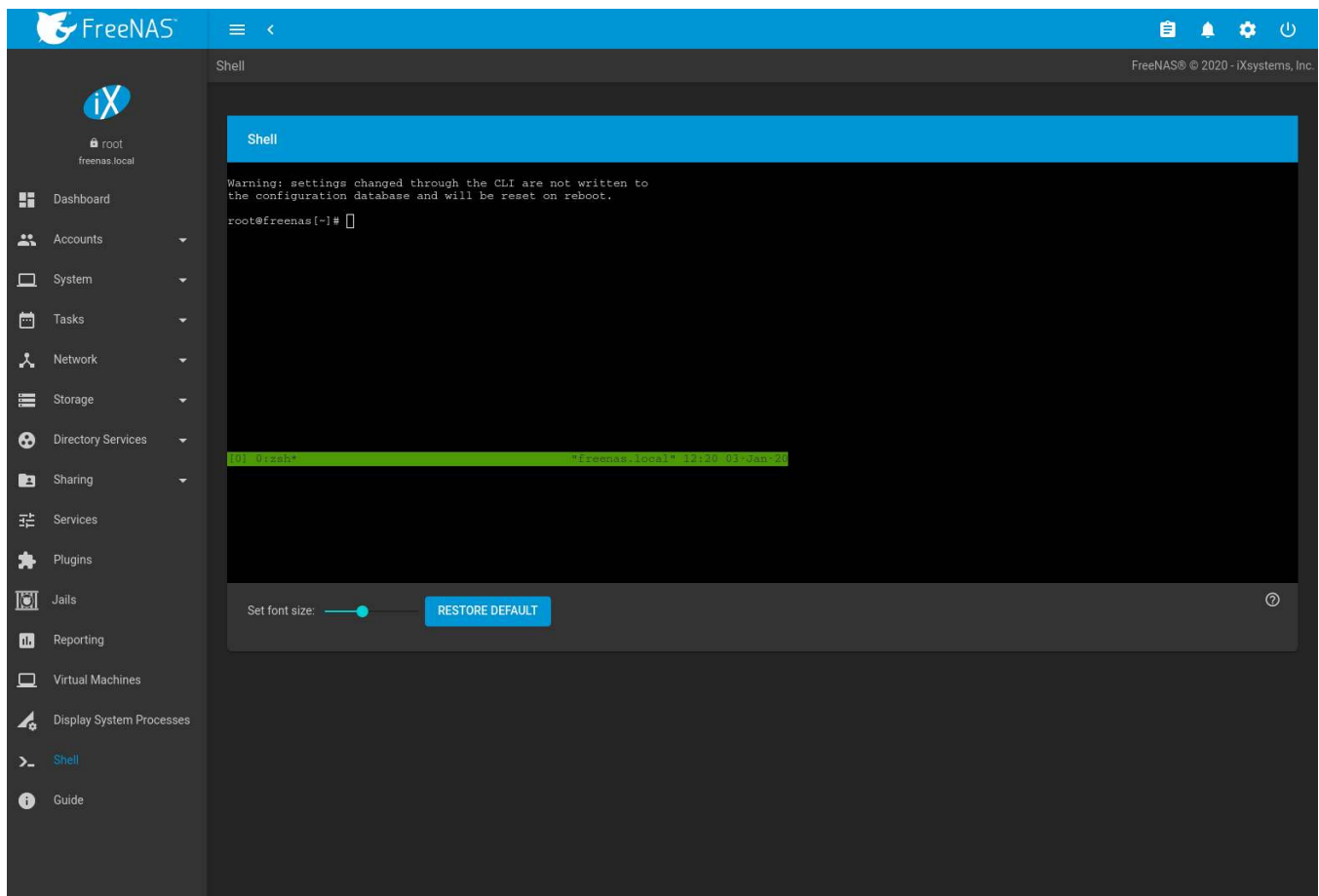


Fig. 25.2: tmux Session

To create a second window, press `Ctrl+b` then `”`. To close a window, type `exit` within the window.

[tmux\(1\)](http://man.openbsd.org/cgi-bin/man.cgi/OpenBSD-current/man1/tmux.1?query=tmux) (<http://man.openbsd.org/cgi-bin/man.cgi/OpenBSD-current/man1/tmux.1?query=tmux>) lists all of the key bindings and commands for interacting with `tmux` windows and sessions.

If [Shell](#) (page 335) is closed while `tmux` is running, it will detach its session. The next time Shell is open, run `tmux attach` to return to the previous session. To leave the `tmux` session entirely, type `exit`. If multiple windows are running, it is required to `exit` out of each first.

These resources provide more information about using `tmux`:

- [A tmux Crash Course](https://robots.thoughtbot.com/a-tmux-crash-course) (<https://robots.thoughtbot.com/a-tmux-crash-course>)
- [TMUX - The Terminal Multiplexer](http://blog.hawkhost.com/2010/06/28/tmux-the-terminal-multiplexer/) (<http://blog.hawkhost.com/2010/06/28/tmux-the-terminal-multiplexer/>)

25.9 Dmidecode

Dmidecode reports hardware information as reported by the system BIOS. Dmidecode does not scan the hardware, it only reports what the BIOS told it to. A sample output can be seen [here](http://www.nongnu.org/dmidecode/sample/dmidecode.txt) (<http://www.nongnu.org/dmidecode/sample/dmidecode.txt>).

To view the BIOS report, type the command with no arguments:

```
dmidecode | more
```

[dmidecode\(8\)](https://linux.die.net/man/8/dmidecode) (<https://linux.die.net/man/8/dmidecode>) describes the supported strings and types.

25.10 Midnight Commander

Midnight Commander is a program used to manage files from the shell. Open the application by running `mc`. The arrow keys are used to navigate and select files. Function keys are used to perform operations such as renaming, editing, and copying files. These resources provide more information about using Midnight Commander:


- [Midnight Commander wikipedia page](https://en.wikipedia.org/wiki/Midnight_Commander) (https://en.wikipedia.org/wiki/Midnight_Commander)
- [Midnight Commander website](https://midnight-commander.org/) (<https://midnight-commander.org/>)
- [mc\(1\)](https://www.freebsd.org/cgi/man.cgi?query=mc) (<https://www.freebsd.org/cgi/man.cgi?query=mc>)
- [Basic Tutorial](http://linuxcommand.org/lc3_adv_mc.php) (http://linuxcommand.org/lc3_adv_mc.php)

ZFS PRIMER

ZFS is an advanced, modern filesystem that was specifically designed to provide features not available in traditional UNIX filesystems. It was originally developed at Sun with the intent to open source the filesystem so that it could be ported to other operating systems. After the Oracle acquisition of Sun, some of the original ZFS engineers founded [OpenZFS](http://open-zfs.org/wiki/Main_Page) (http://open-zfs.org/wiki/Main_Page) to provide continued, collaborative development of the open source version.

Here is an overview of the features provided by ZFS:

ZFS is a transactional, Copy-On-Write (COW) (https://en.wikipedia.org/wiki/ZFS#Copy-on-write_transactional_model) filesystem. For each write request, a copy is made of the associated disk blocks and all changes are made to the copy rather than to the original blocks. When the write is complete, all block pointers are changed to point to the new copy. This means that ZFS always writes to free space, most writes are sequential, and old versions of files are not unlinked until a complete new version has been written successfully. ZFS has direct access to disks and bundles multiple read and write requests into transactions. Most filesystems cannot do this, as they only have access to disk blocks. A transaction either completes or fails, meaning there will never be a [write-hole](https://blogs.oracle.com/bonwick/raid-z) (<https://blogs.oracle.com/bonwick/raid-z>) and a filesystem checker utility is not necessary. Because of the transactional design, as additional storage capacity is added, it becomes immediately available for writes. To rebalance the data, one can copy it to re-write the existing data across all available disks. As a 128-bit filesystem, the maximum filesystem or file size is 16 exabytes.

ZFS was designed to be a self-healing filesystem. As ZFS writes data, it creates a checksum for each disk block it writes. As ZFS reads data, it validates the checksum for each disk block it reads. Media errors or “bit rot” can cause data to change, and the checksum no longer matches. When ZFS identifies a disk block checksum error on a pool that is mirrored or uses RAIDZ, it replaces the corrupted data with the correct data. Since some disk blocks are rarely read, regular scrubs should be scheduled so that ZFS can read all of the data blocks to validate their checksums and correct any corrupted blocks. While multiple disks are required in order to provide redundancy and data correction, ZFS will still provide data corruption detection to a system with one disk. FreeNAS® automatically schedules a monthly scrub for each ZFS pool and the results of the scrub are displayed by selecting the [Pools](#) (page 164), clicking  (Settings), then the *Status* button. Checking scrub results can provide an early indication of potential disk problems.

Unlike traditional UNIX filesystems, **it is not necessary to define partition sizes when filesystems are created.** Instead, a group of disks, known as a *vdev*, are built into a ZFS *pool*. Filesystems are created from the pool as needed. As more capacity is needed, identical vdevs can be striped into the pool. In FreeNAS®, [Pools](#) (page 164) is used to create or extend pools. After a pool is created, it can be divided into dynamically-sized datasets or fixed-size zvols as needed. Datasets can be used to optimize storage for the type of data being stored as permissions and properties such as quotas and compression can be set on a per-dataset level. A zvol is essentially a raw, virtual block device which can be used for applications that need raw-device semantics such as iSCSI device extents.

ZFS supports real-time data compression. Compression happens when a block is written to disk, but only if the written data will benefit from compression. When a compressed block is accessed, it is automatically decompressed. Since compression happens at the block level, not the file level, it is transparent to any applications accessing the compressed data. ZFS pools created on FreeNAS® version 9.2.1 or later use the recommended LZ4 compression algorithm.

ZFS provides low-cost, instantaneous snapshots of the specified pool, dataset, or zvol. Due to COW, snapshots initially take no additional space. The size of a snapshot increases over time as changes to the files in the snapshot are written to disk. Snapshots can be used to provide a copy of data at the point in time the snapshot was

created. When a file is deleted, its disk blocks are added to the free list; however, the blocks for that file in any existing snapshots are not added to the free list until all referencing snapshots are removed. This makes snapshots a clever way to keep a history of files, useful for recovering an older copy of a file or a deleted file. For this reason, many administrators take snapshots often, store them for a period of time, and store them on another system. Such a strategy allows the administrator to roll the system back to a specific time. If there is a catastrophic loss, an off-site snapshot can restore the system up to the last snapshot interval, within 15 minutes of the data loss, for example. Snapshots are stored locally but can also be replicated to a remote ZFS pool. During replication, ZFS does not do a byte-for-byte copy but instead converts a snapshot into a stream of data. This design means that the ZFS pool on the receiving end does not need to be identical and can use a different RAIDZ level, pool size, or compression settings.

ZFS boot environments provide a method for recovering from a failed upgrade. In FreeNAS®, a snapshot of the dataset the operating system resides on is automatically taken before an upgrade or a system update. This saved boot environment is automatically added to the GRUB boot loader. Should the upgrade or configuration change fail, simply reboot and select the previous boot environment from the boot menu. Users can also create their own boot environments in *System* → *Boot* as needed, for example before making configuration changes. This way, the system can be rebooted into a snapshot of the system that did not include the new configuration changes.

ZFS provides a write cache in RAM as well as a ZFS Intent Log (ZIL). The ZIL is a storage area that temporarily holds **synchronous* writes until they are written to the ZFS pool* (<https://pthree.org/2013/04/19/zfs-administration-appendix-a-visualizing-the-zfs-intent-log/>). Adding a fast (low-latency), power-protected SSD as a SLOG (*Separate Log*) device permits much higher performance. This is a necessity for NFS over ESXi, and highly recommended for database servers or other applications that depend on synchronous writes. More detail on SLOG benefits and usage is available in these blog and forum posts:

- [The ZFS ZIL and SLOG Demystified](http://www.freenas.org/blog/zfs-zil-and-slog-demystified/) (<http://www.freenas.org/blog/zfs-zil-and-slog-demystified/>)
- [Some insights into SLOG/ZIL with ZFS on FreeNAS®](https://forums.freenas.org/index.php?threads/some-insights-into-slog-zil-with-zfs-on-freenas.13633/) (<https://forums.freenas.org/index.php?threads/some-insights-into-slog-zil-with-zfs-on-freenas.13633/>)
- [ZFS Intent Log](http://nex7.blogspot.com/2013/04/zfs-intent-log.html) (<http://nex7.blogspot.com/2013/04/zfs-intent-log.html>)

Synchronous writes are relatively rare with SMB, AFP, and iSCSI, and adding a SLOG to improve performance of these protocols only makes sense in special cases. The `zilstat` utility can be run from *Shell* (page 335) to determine if the system will benefit from a SLOG. See [this website](http://www.richardelling.com/Home/scripts-and-programs-1/zilstat) (<http://www.richardelling.com/Home/scripts-and-programs-1/zilstat>) for usage information.

ZFS currently uses 16 GiB of space for SLOG. Larger SSDs can be installed, but the extra space will not be used. SLOG devices cannot be shared between pools. Each pool requires a separate SLOG device. Bandwidth and throughput limitations require that a SLOG device must only be used for this single purpose. Do not attempt to add other caching functions on the same SSD, or performance will suffer.

In mission-critical systems, a mirrored SLOG device is highly recommended. Mirrored SLOG devices are *required* for ZFS pools at ZFS version 19 or earlier. The ZFS pool version is checked from the *Shell* (page 335) with `zpool get version poolname`. A version value of - means the ZFS pool is version 5000 (also known as *Feature Flags*) or later.

ZFS provides a read cache in RAM, known as the ARC, which reduces read latency. FreeNAS® adds ARC stats to `top(1)` (<https://www.freebsd.org/cgi/man.cgi?query=top>) and includes the `arc_summary.py` and `arcstat.py` tools for monitoring the efficiency of the ARC. If an SSD is dedicated as a cache device, it is known as an L2ARC (<http://www.brendangregg.com/blog/2008-07-22/zfs-l2arc.html>). Additional read data is cached here, which can increase random read performance. L2ARC does *not* reduce the need for sufficient RAM. In fact, L2ARC needs RAM to function. If there is not enough RAM for an adequately-sized ARC, adding an L2ARC will not increase performance. Performance actually decreases in most cases, potentially causing system instability. RAM is always faster than disks, so always add as much RAM as possible before considering whether the system can benefit from an L2ARC device.

When applications perform large amounts of *random* reads on a dataset small enough to fit into L2ARC, read performance can be increased by adding a dedicated cache device. SSD cache devices only help if the active data is larger than system RAM but small enough that a significant percentage fits on the SSD. As a general rule, L2ARC should not be added to a system with less than 32 GiB of RAM, and the size of an L2ARC should not exceed ten times the amount of RAM. In some cases, it may be more efficient to have two separate pools: one on SSDs for

active data, and another on hard drives for rarely used content. After adding an L2ARC device, monitor its effectiveness using tools such as `arcstat`. To increase the size of an existing L2ARC, stripe another cache device with it. The web interface will always stripe L2ARC, not mirror it, as the contents of L2ARC are recreated at boot. Failure of an individual SSD from an L2ARC pool will not affect the integrity of the pool, but may have an impact on read performance, depending on the workload and the ratio of dataset size to cache size. Note that dedicated L2ARC devices cannot be shared between ZFS pools.

ZFS was designed to provide redundancy while addressing some of the inherent limitations of hardware RAID such as the write-hole and corrupt data written over time before the hardware controller provides an alert. ZFS provides three levels of redundancy, known as *RAIDZ*, where the number after the *RAIDZ* indicates how many disks per vdev can be lost without losing data. ZFS also supports mirrors, with no restrictions on the number of disks in the mirror. ZFS was designed for commodity disks so no RAID controller is needed. While ZFS can also be used with a RAID controller, it is recommended that the controller be put into JBOD mode so that ZFS has full control of the disks.

When determining the type of ZFS redundancy to use, consider whether the goal is to maximize disk space or performance:

- RAIDZ1 maximizes disk space and generally performs well when data is written and read in large chunks (128K or more).
- RAIDZ2 offers better data availability and significantly better mean time to data loss (MTTDL) than RAIDZ1.
- A mirror consumes more disk space but generally performs better with small random reads. For better performance, a mirror is strongly favored over any RAIDZ, particularly for large, uncacheable, random read loads.
- Using more than 12 disks per vdev is not recommended. The recommended number of disks per vdev is between 3 and 9. With more disks, use multiple vdevs.
- Some older ZFS documentation recommends that a certain number of disks is needed for each type of RAIDZ in order to achieve optimal performance. On systems using LZ4 compression, which is the default for FreeNAS® 9.2.1 and higher, this is no longer true. See [ZFS RAIDZ stripe width, or: How I Learned to Stop Worrying and Love RAIDZ](https://www.delphix.com/blog/delphix-engineering/zfs-raidz-stripe-width-or-how-i-learned-stop-worrying-and-love-raidz) (<https://www.delphix.com/blog/delphix-engineering/zfs-raidz-stripe-width-or-how-i-learned-stop-worrying-and-love-raidz>) for details.

These resources can also help determine the RAID configuration best suited to the specific storage requirements:

- [Getting the Most out of ZFS Pools](https://forums.freenas.org/index.php?threads/getting-the-most-out-of-zfs-pools.16/) (<https://forums.freenas.org/index.php?threads/getting-the-most-out-of-zfs-pools.16/>)
- [A Closer Look at ZFS, Vdevs and Performance](https://constantin.glez.de/2010/06/04/a-closer-look-zfs-vdevs-and-performance/) (<https://constantin.glez.de/2010/06/04/a-closer-look-zfs-vdevs-and-performance/>)

Warning: RAID AND DISK REDUNDANCY ARE NOT A SUBSTITUTE FOR A RELIABLE BACKUP STRATEGY. BAD THINGS HAPPEN AND A GOOD BACKUP STRATEGY IS STILL REQUIRED TO PROTECT VALUABLE DATA. See [Periodic Snapshot Tasks](#) (page 133) and [Replication Tasks](#) (page 142) to use replicated ZFS snapshots as part of a backup strategy.

ZFS manages devices. When an individual drive in a mirror or RAIDZ fails and is replaced by the user, ZFS adds the replacement device to the vdev and copies redundant data to it in a process called *resilvering*. Hardware RAID controllers usually have no way of knowing which blocks were in use and must copy every block to the new device. ZFS only copies blocks that are in use, reducing the time it takes to rebuild the vdev. Resilvering is also interruptible. After an interruption, resilvering resumes where it left off rather than starting from the beginning.

While ZFS provides many benefits, there are some caveats:

- At 90% capacity, ZFS switches from performance- to space-based optimization, which has massive performance implications. For maximum write performance and to prevent problems with drive replacement, add more capacity before a pool reaches 80%.
- When considering the number of disks to use per vdev, consider the size of the disks and the amount of time required for resilvering, which is the process of rebuilding the vdev. The larger the size of the vdev, the

longer the resilvering time. When replacing a disk in a RAIDZ, it is possible that another disk will fail before the resilvering process completes. If the number of failed disks exceeds the number allowed per vdev for the type of RAIDZ, the data in the pool will be lost. For this reason, RAIDZ1 is not recommended for drives over 1 TiB in size.

- Using drives of equal sizes is recommended when creating a vdev. While ZFS can create a vdev using disks of differing sizes, its capacity will be limited by the size of the smallest disk.

For those new to ZFS, the [Wikipedia entry on ZFS](https://en.wikipedia.org/wiki/Zfs) (<https://en.wikipedia.org/wiki/Zfs>) provides an excellent starting point to learn more about its features. These resources are also useful for reference:

- [FreeBSD ZFS Tuning Guide](https://wiki.freebsd.org/ZFSTuningGuide) (<https://wiki.freebsd.org/ZFSTuningGuide>)
- [ZFS Administration Guide](https://docs.oracle.com/cd/E19253-01/819-5461/index.html) (<https://docs.oracle.com/cd/E19253-01/819-5461/index.html>)
- [Becoming a ZFS Ninja Part 1 \(video\)](https://www.youtube.com/watch?v=tPsV_8k-aVU) (https://www.youtube.com/watch?v=tPsV_8k-aVU) and [Becoming a ZFS Ninja Part 2 \(video\)](https://www.youtube.com/watch?v=wy6cJRVHiYU) (<https://www.youtube.com/watch?v=wy6cJRVHiYU>)
- [The Z File System \(ZFS\)](https://www.freebsd.org/doc/en_US.ISO8859-1/books/handbook/zfs.html) (https://www.freebsd.org/doc/en_US.ISO8859-1/books/handbook/zfs.html)
- [ZFS: The Last Word in File Systems - Part 1 \(video\)](https://www.youtube.com/watch?v=aTXKxpL_0OI&list=PL5AD0E439599) (https://www.youtube.com/watch?v=aTXKxpL_0OI&list=PL5AD0E439599)
- [The Zettabyte Filesystem](https://www.youtube.com/watch?v=ptY6-K78McY) (<https://www.youtube.com/watch?v=ptY6-K78McY>)

26.1 ZFS Feature Flags

To differentiate itself from Oracle ZFS version numbers, OpenZFS uses feature flags. Feature flags are used to tag features with unique names to provide portability between OpenZFS implementations running on different platforms, as long as all of the feature flags enabled on the ZFS pool are supported by both platforms. FreeNAS® uses OpenZFS and each new version of FreeNAS® keeps up-to-date with the latest feature flags and OpenZFS bug fixes.

See [zpool-features\(7\)](https://www.freebsd.org/cgi/man.cgi?query=zpool-features) (<https://www.freebsd.org/cgi/man.cgi?query=zpool-features>) for a complete listing of all OpenZFS feature flags available on FreeBSD.

OPENSTACK CINDER DRIVER

An open source, community-supported FreeNAS® driver for OpenStack is available at <https://github.com/ixsystems/cinder>.

VMWARE RECOMMENDATIONS

This section offers FreeNAS® configuration recommendations and troubleshooting tips when using FreeNAS® with a [VMware](https://www.vmware.com/) (<https://www.vmware.com/>) hypervisor.

28.1 FreeNAS® as a VMware Guest

This section has recommendations for configuring FreeNAS® when it is installed as a Virtual Machine (VM) in VMware.

To create a new FreeNAS® Virtual Machine in VMware, see the [VMware ESXi](#) (page 52) section of this guide.

Configure and use the [vmx\(4\)](https://www.freebsd.org/cgi/man.cgi?query=vmx) (<https://www.freebsd.org/cgi/man.cgi?query=vmx>) drivers for the FreeNAS® system.

Network connection errors for plugins or jails inside the FreeNAS® VM can be caused by a misconfigured [virtual switch](https://pubs.vmware.com/vsphere-51/index.jsp?topic=%2Fcom.vmware.wssdk.pg.doc%2FPG_Networking.11.4.html) (https://pubs.vmware.com/vsphere-51/index.jsp?topic=%2Fcom.vmware.wssdk.pg.doc%2FPG_Networking.11.4.html) or [VMware port group](https://pubs.vmware.com/vsphere-4-esx-vcenter/index.jsp?topic=/com.vmware.vsphere.server_configclassic.doc_40/esx_server_configure_networking.html) (https://pubs.vmware.com/vsphere-4-esx-vcenter/index.jsp?topic=/com.vmware.vsphere.server_configclassic.doc_40/esx_server_configure_networking.html). Make sure MAC spoofing and promiscuous mode are enabled on the switch first, and then the port group the VM is using.

28.2 Hosting VMware Storage with FreeNAS®

This section has recommendations for configuring FreeNAS® when the system is being used as a VMware datastore.

Make sure guest VMs have the latest version of `vmware-tools` installed. VMware provides instructions to [install VMware Tools](https://www.vmware.com/support/ws5/doc/new_guest_tools_ws.html) (https://www.vmware.com/support/ws5/doc/new_guest_tools_ws.html) on different guest operating systems.

Increase the VM disk timeouts to better survive long disk operations. Set the timeout to a minimum of *300 seconds*. See the guest operating system documentation for setting disk timeouts. VMware provides instructions for setting disk timeouts on some specific guest operating systems:

- Windows guest operating system: <https://docs.vmware.com/en/VMware-vSphere/6.7/com.vmware.vsphere.storage.doc/GUID-EA1E1AAD-7130-457F-8894-70A63BD0623A.html>
- Linux guests running kernel version 2.6: <https://kb.vmware.com/s/article/1009465>

When FreeNAS® is used as a VMware datastore, [coordinated ZFS and VMware snapshots](#) (page 190) can be used.

28.3 VAAI for iSCSI

VMware's vStorage APIs for Array Integration, or *VAAI*, allows storage tasks such as large data moves to be offloaded from the virtualization hardware to the storage array. These operations are performed locally on the NAS without transferring bulk data over the network.

VAAI for iSCSI supports these operations:

- *Atomic Test and Set (ATS)* allows multiple initiators to synchronize LUN access in a fine-grained manner rather than locking the whole LUN and preventing other hosts from accessing the same LUN simultaneously.
- *Clone Blocks (XCOPY)* copies disk blocks on the NAS. Copies occur locally rather than over the network. This operation is similar to [Microsoft ODX](https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/hh831628(v=ws.11)) ([https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/hh831628\(v=ws.11\)](https://docs.microsoft.com/en-us/previous-versions/windows/it-pro/windows-server-2012-R2-and-2012/hh831628(v=ws.11))).
- *LUN Reporting* allows a hypervisor to query the NAS to determine whether a LUN is using thin provisioning.
- *Stun* pauses virtual machines when a pool runs out of space. The space issue can then be fixed and the virtual machines can continue rather than reporting write errors.
- *Threshold Warning* the system reports a warning when a configurable capacity is reached. In FreeNAS®, this threshold is configured at the pool level when using zvols (see [Table 12.2](#)) or at the extent level (see [Table 12.7](#)) for both file and device based extents. Typically, the warning is set at the pool level, unless file extents are used, in which case it must be set at the extent level.
- *Unmap* informs FreeNAS® that the space occupied by deleted files should be freed. Without unmap, the NAS is unaware of freed space created when the initiator deletes files. For this feature to work, the initiator must support the unmap command.
- *Zero Blocks* or *Write Same* zeros out disk regions. When allocating virtual machines with thick provisioning, the zero write is done locally, rather than over the network. This makes virtual machine creation and any other zeroing of disk regions much quicker.

USING THE API

A [REST](https://en.wikipedia.org/wiki/Representational_state_transfer) (https://en.wikipedia.org/wiki/Representational_state_transfer) API is provided to be used as an alternate mechanism for remotely controlling a FreeNAS[®] system.

REST provides an easy-to-read, HTTP implementation of functions, known as resources, which are available beneath a specified base URL. Each resource is manipulated using the HTTP methods defined in [RFC 2616](https://tools.ietf.org/html/rfc2616.html) (<https://tools.ietf.org/html/rfc2616.html>), such as GET, PUT, POST, or DELETE.

As shown in [Figure 29.1](#), an online version of the API is available at api.freenas.org (<http://api.freenas.org>).

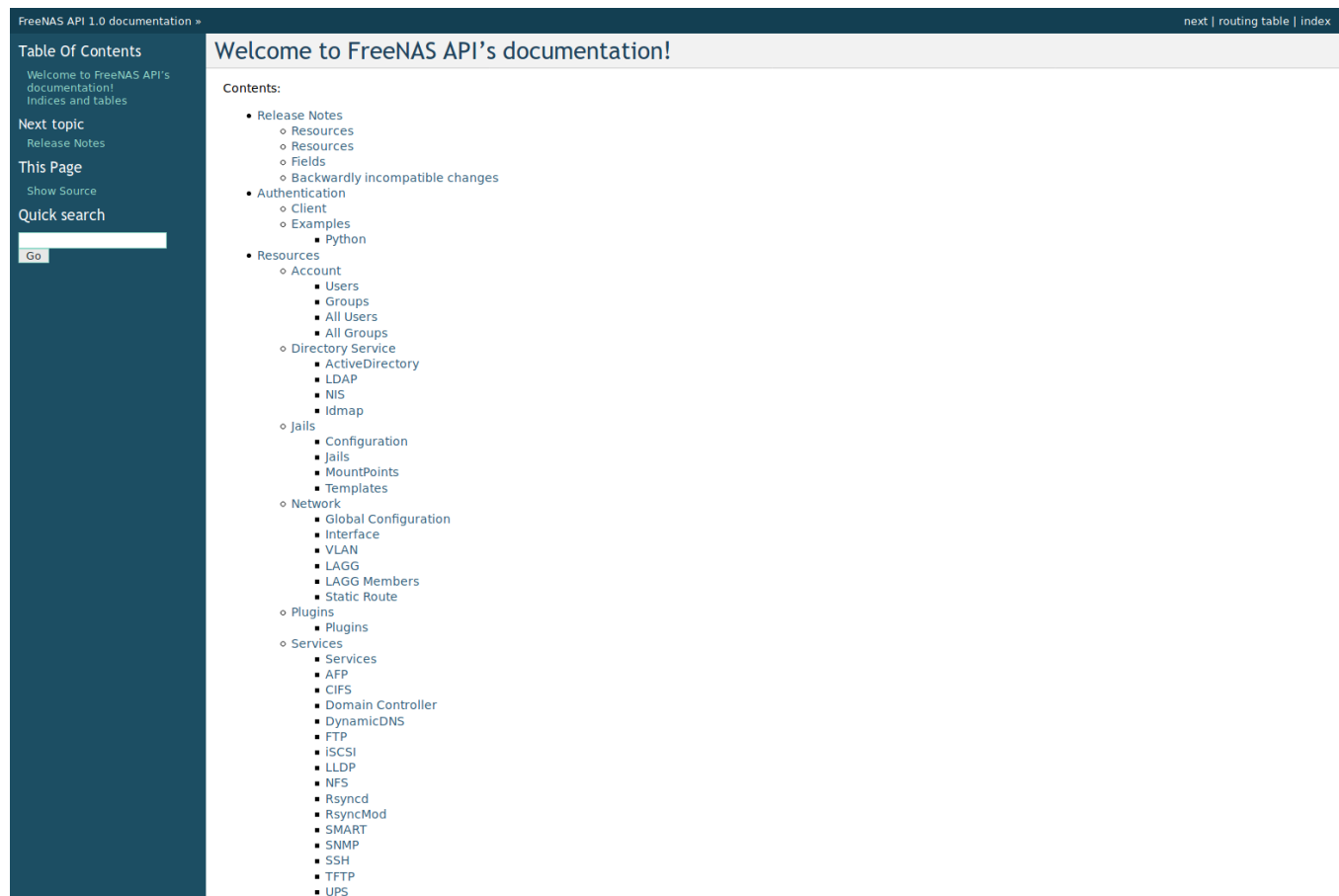


Fig. 29.1: API Documentation

The rest of this section shows code examples to illustrate the use of the API.

Note: A new API was released with FreeNAS[®] 11.1. The previous API is still present and in use because it is feature-complete. Documentation for the new API is available on the FreeNAS[®] system at the `/api/docs/` URL. For

example, if the FreeNAS® system is at IP address 192.168.1.119, enter `http://192.168.1.119/api/docs/` in a browser to see the API documentation. Work is under way to make the new API feature-complete. The new APIv2 uses [WebSockets](https://developer.mozilla.org/en-US/docs/Web/API/WebSockets_API) (https://developer.mozilla.org/en-US/docs/Web/API/WebSockets_API). This advanced technology makes it possible to open interactive communication sessions between web browsers and servers, allowing event-driven responses without the need to poll the server for a reply. When APIv2 is feature-complete, the FreeNAS® documentation will include relevant examples that make use of the new API.

29.1 A Simple API Example

The [API directory of the FreeNAS® GitHub repository](https://github.com/freenas/freenas/tree/master/examples/api) (<https://github.com/freenas/freenas/tree/master/examples/api>) contains some API usage examples. This section provides a walk-through of the `newuser.py` script, shown below, as it provides a simple example that creates a user.

A FreeNAS® system running at least version 9.2.0 is required when creating a customized script based on this example. To test the scripts directly on the FreeNAS® system, create a user account and select an existing pool or dataset for the user *Home Directory*. After creating the user, start the SSH service in *Services* → *SSH*. That user will now be able to `ssh` to the IP address of the FreeNAS® system to create and run scripts. Alternately, scripts can be tested on any system with the required software installed as shown in the previous section.

To customize this script, copy the contents of this example into a filename that ends in `.py`. The text that is highlighted in red below can be modified in the new version to match the needs of the user being created. Do not change the text in black. After saving changes, run the script by typing `python scriptname.py`. The new user account will appear in *Accounts* → *Users* in the FreeNAS® web interface.

Here is the example script with an explanation of the line numbers below it.

```

1  import json
2  import requests
3  r = requests.post(
4      'https://freenas.mydomain/api/v1.0/account/users/',
5      auth=('root', 'freenas'),
6      headers={'Content-Type': 'application/json'},
7      verify=False,
8      data=json.dumps({
9          'bsdusr_uid': '1100',
10         'bsdusr_username': 'myuser',
11         'bsdusr_mode': '755',
12         'bsdusr_creategroup': 'True',
13         'bsdusr_password': '12345',
14         'bsdusr_shell': '/usr/local/bin/bash',
15         'bsdusr_full_name': 'Full Name',
16         'bsdusr_email': 'name@provider.com',
17     })
18 )
19 print r.text

```

Where:

Lines 1-2: import the Python modules used to make HTTP requests and handle data in JSON format.

Line 4: replace *freenas.mydomain* with the *Hostname* value in *Network* → *Global Configuration*. Note that the script will fail if the machine running it is unable to resolve that hostname. Go to *System* → *General* and set the *Protocol* to *HTTP*.

Line 5: replace *freenas* with the password used to access the FreeNAS® system.

Line 7: to force validation of the SSL certificate while using HTTPS, change *False* to *True*.

Lines 8-16: set the values for the user being created. The [Users resource](http://api.freenas.org/resources/account.html#users) (<http://api.freenas.org/resources/account.html#users>) describes this in more detail. Allowed parameters are listed in the JSON Parameters section of that resource. Since this resource creates a FreeBSD user, the values

entered must be valid for a FreeBSD user account. Table 29.1 summarizes acceptable values. This resource uses JSON, so the boolean values are *True* or *False*.

Table 29.1: JSON Parameters for Users Create Resource

JSON Parameter	Type	Description
<code>bsdusr_username</code>	string	Maximum 32 characters, though a maximum of 8 is recommended for interoperability. Can include numerals but cannot include a space.
<code>bsdusr_full_name</code>	string	May contain spaces and uppercase characters.
<code>bsdusr_password</code>	string	Can include a mix of upper and lowercase letters, characters, and numbers.
<code>bsdusr_uid</code>	integer	By convention, user accounts have an ID greater than 1000 with a maximum allowable value of 65,535.
<code>bsdusr_group</code>	integer	If <code>bsdusr_creategroup</code> is set to <i>False</i> , specify the numeric ID of the group to create.
<code>bsdusr_creategroup</code>	boolean	Set <i>True</i> to automatically create a primary group with the same numeric ID as <code>bsdusr_uid</code> .
<code>bsdusr_mode</code>	string	Sets default numeric UNIX permissions of a user home directory.
<code>bsdusr_shell</code>	string	Specify the full path to a UNIX shell that is installed on the system.
<code>bsdusr_password_disabled</code>	boolean	Set to <i>True</i> to disable user login.
<code>bsdusr_locked</code>	boolean	Set to <i>True</i> to disable user login.
<code>bsdusr_sudo</code>	boolean	Set to <i>True</i> to enable <code>sudo</code> for the user.
<code>bsdusr_sshpubkey</code>	string	Contents of SSH authorized keys file.

Note: When using boolean values, JSON returns raw lowercase values but Python uses uppercase values. So use *True* or *False* in Python scripts even though the example JSON responses in the API documentation are displayed as *true* or *false*.

29.2 A More Complex Example

This section provides a walk-through of a more complex example found in the `startup.py` script. Use the search bar within the API documentation to quickly locate the JSON parameters used here. This example defines a class and several methods to create a ZFS pool, create a ZFS dataset, share the dataset over CIFS, and enable the CIFS service. Responses from some methods are used as parameters in other methods. In addition to the import lines seen in the previous example, two Python modules are imported to provide parsing functions for command line arguments:

```
import argparse
import sys
```

It then creates a *Startup* class which is started with the hostname, username, and password provided by the user through the command line:

```
1 class Startup(object):
2     def __init__(self, hostname, user, secret):
3         self._hostname = hostname
4         self._user = user
5         self._secret = secret
6         self._ep = 'http://%s/api/v1.0' % hostname
7     def request(self, resource, method='GET', data=None):
8         if data is None:
9             data = ''
10        r = requests.request(
11            method,
12            '%s/%s/' % (self._ep, resource),
```

```

13         data=json.dumps(data),
14         headers={'Content-Type': "application/json"},
15         auth=(self._user, self._secret),
16     )
17     if r.ok:
18         try:
19             return r.json()
20         except:
21             return r.text
22     raise ValueError(r)

```

A *get_disks* method is defined to get all the disks in the system as a *disk_name* response. The *create_pool* method uses this information to create a ZFS pool named *tank* which is created as a stripe. The *volume_name* and *layout* JSON parameters are described in the *Storage Volume* resource of the API documentation.:

```

1 def _get_disks(self):
2     disks = self.request('storage/disk')
3     return [disk['disk_name'] for disk in disks]
4
5 def create_pool(self):
6     disks = self._get_disks()
7     self.request('storage/volume', method='POST', data={
8         'volume_name': 'tank',
9         'layout': [
10             {'vdevtype': 'stripe', 'disks': disks},
11         ],
12     })

```

The *create_dataset* method is defined which creates a dataset named *MyShare*:

```

1 def create_dataset(self):
2     self.request('storage/volume/tank/datasets', method='POST', data={
3         'name': 'MyShare',
4     })

```

The *create_cifs_share* method is used to share */mnt/tank/MyShare* with guest-only access enabled. The *cifs_name*, *cifs_path*, *cifs_guestonly* JSON parameters, as well as the other allowable parameters, are described in the *Sharing CIFS* resource of the API documentation.:

```

1 def create_cifs_share(self):
2     self.request('sharing/cifs', method='POST', data={
3         'cifs_name': 'My Test Share',
4         'cifs_path': '/mnt/tank/MyShare',
5         'cifs_guestonly': True
6     })

```

Finally, the *service_start* method enables the CIFS service. The *srv_enable* JSON parameter is described in the *Services* resource.

```

1 def service_start(self, name):
2     self.request('services/services/%s' % name, method='PUT', data={
3         'srv_enable': True,
4     })
5

```