FreeNAS: A Worst Practices Guide

Sep 30, 2015 | FreeNAS | 7 comments

There are many best practices guides for managing storage solutions out there, but a lot of how you administer your storage depends on your specific use case and what you're trying to accomplish. While we have created a best practices for FreeNAS, we also decided to take a look at what you *don't* want to do; things that will leave you hurting either immediately or down the road.
In that spirit, we've put together a worst practices guide for FreeNAS based on years of experience with systems in the field. The easiest way to avoid these pitfalls is to simply purchase a TrueNAS system from the experts at iXsystems, who can help set up your systems for optimal performance and functionality. For those who prefer the DIY approach, here are some things to look out for when setting up and managing your own FreeNAS system.

Using Hardware RAID with ZFS

When setting up a RAID array, common knowledge says that hardware RAID is preferable to software RAID. This is something of a misconception as all RAID is software RAID. If you're using a hardware RAID controller, it has its own independent operating system that communicates with your disks and often has caches to improve read and write performance. This was a good idea in the distant past, and improved RAID performance substantially, but operating systems and the hardware they run on have come a long way since those days.

FreeNAS uses the ZFS file system and is designed to communicate directly with your disks using its own volume manager. ZFS includes a sophisticated yet efficient strategy for providing various levels of data redundancy, including the mirroring of disk and the "ZFS" equivalents of hardware RAID 5 and higher with the ability of

losing up to three disks in an array. If a given set of disks is provided to ZFS using a hardware RAID card, ZFS will not be able to efficiently balance its reads and writes between them or rebuild only the data used by any given disk. Hardware RAID cards typically rebuild disks in a linear manner from beginning to end without any regard for their actual contents.

The "one big disk" that hardware RAID cards provide limits some of ZFS's advantages, and the read and write caches found on many hardware RAID cards are how risk gets introduced. ZFS works carefully to guarantee that every write it receives from the operating systems is on disk and checksummed before reporting success. This strategy relies on each disk reporting that data has been successfully written, but if the data is written to a hardware cache on the RAID card, ZFS is constantly misinformed of write success. *This can work fine for some time but in the case of a power outage, catastrophic damage can be done to the ZFS "pool" if key metadata was lost in transit. Such failures have been known to carry five-figure price tags for data recovery services. Unlike hardware RAID, you will not suffer from data loss that can occur from interrupted writes or corrupt data returned from a hardware cache with ZFS.*

Finally, most hardware RAID cards will mask the S.M.A.R.T. disk health status information that each disk provides. Very simply, each disk is connected to the hardware RAID controller card and the disks become invisible to the standard S.M.A.R.T. monitoring utility "smartctl". Without access to this information, the user is left unaware of classic warning signs of impending disk failure, like reallocated sector count or unusually high temperature. Even the time it takes to run smartctl can be indicative of an impending problem.

While some hardware RAID cards may have a "pass-through" or "JBOD" mode that simply presents each disk to ZFS, the combination of the potential masking of S.M.A.R.T. information, high controller cost, and anecdotal evidence that any RAID mode is about 5% slower than non-RAID "target" mode results in zero reasons for using a hardware RAID card with ZFS.

Long story short, using hardware RAID on FreeNAS can lead to anything from corrupted writes to fatal errors that require you to invest in costly data recovery services.

Setting up Deduplication without Adequate Planning

Deduplication is a much-desired feature for storage solutions. On any given system, more than half your data may be duplicates of data elsewhere in your storage pool, causing a greater storage consumption. Deduplication reduces capacity requirements significantly and improves performance by tracking duplicate data with a 'deduplication table', eliminating the need to write and store duplicate information. ZFS stores this table on disk, which means that, if the host has to refer to the on-disk tables regularly, performance will be substantially reduced because of the slower speeds of standard spinning disks.

This means you need to plan to fit your entire deduplication table in memory to avoid major performance and, potentially, data loss. This generally isn't a problem when first setting up deduplication, but as the table grow over time, you may unexpectedly find its size exceeds memory. This splits the deduplication table between memory and hard disk, turning every write into multiple reads & writes, slowing your performance down to a crawl. In an enterprise environment, this can cause significant productivity decreases and angry staff workers. If this happens, the best solution is to add more system memory so that the pool will be able to import back to memory. Unfortunately, this can sometime take days to perform, and, if your hardware already

has maxed out its memory capabilities, would require migrating the disks to a whole new system to access the data.

The general rule of thumb here is to have 5 GB of memory for every 1TB of deduplicated data. That said, there may be instances where more is required, but you will need to plan to meet the maximum potential memory requirements to avoid problems down the road. To get a more precise estimate of the required memory for deduplication do the following: run the 'zdb -b (pool name)' command for the desired pool to get an idea of the number of blocks required, then multiply the 'bp count' by 320 bytes to get your required memory. If it's less than 5GB, still use the 5GB per terabyte of storage rule. If it's higher, go with that number per terabyte.

For must use cases, it is recommended to just utilize lz4 compression for data consumption savings, as there's no real processing cost. In fact, due to of the advances in CPU speeds, compression actually improves disk performance because writing uncompressed data to disk takes longer than compressed data. To be safe, always use compression instead of deduplication unless you know exactly what you are doing.

Striping Without Redundancy

ZFS offers all the typical forms of RAID redundancy and more, including ZFS striping (RAID 0), ZFS mirroring (RAID 1), RAID 10, and RAID-Z levels that allow for 1, 2 or 3 disk failures without affecting your storage pool. ZFS striping can speed up your performance by spreading out writes across multiple disks and combining all your disks into one large pool. *This can seem appealing to the new user because of its maximum speed and capacity, but if any of your disks has a failure, your entire pool will be lost.* While, with secondary storage or non-critical data, this may not prove to be a catastrophic loss, losing your storage pool is always a big deal and it's always recommended to configure your storage pool with some level of redundancy.

Using a SLOG for asynchronous write scenarios

The ZFS filesystem can tier cached data to help achieve sizable performance increases over spinning disks. Users can set up flash-based L2ARC read cache and SLOG (Separate ZFS Intent Log, sometimes called a ZIL) 'write cache' devices. *While an L2ARC read cache will speed up reads in most use cases, the SLOG only speeds up synchronous writes.*

The ZIL caches writes to guarantee their completion in the case of a power failure or system crash. *The ZIL normally exists as part of the ZFS pool, but with a SLOG, it resides on a separate, dedicated device. This speeds up performance by batching data together for synchronous writes for more efficiency.* These performance gains help with database operations, NFS operations such as virtualization where the operating system explicitly requests synchronous writes. If you aren't using something that is known to use synchronous writes like NFS or databases, chances are your SLOG will not help performance. A potential solution here is to set your pool to "sync=always". This ensures that every write goes to the write cache, improving write performance.

Too Many Snapshots.

Snapshots give users the ability to rollback to previous system states to retrieve lost files or go back to a configuration that worked properly, while only saving the file system's blocks that have changed since the last

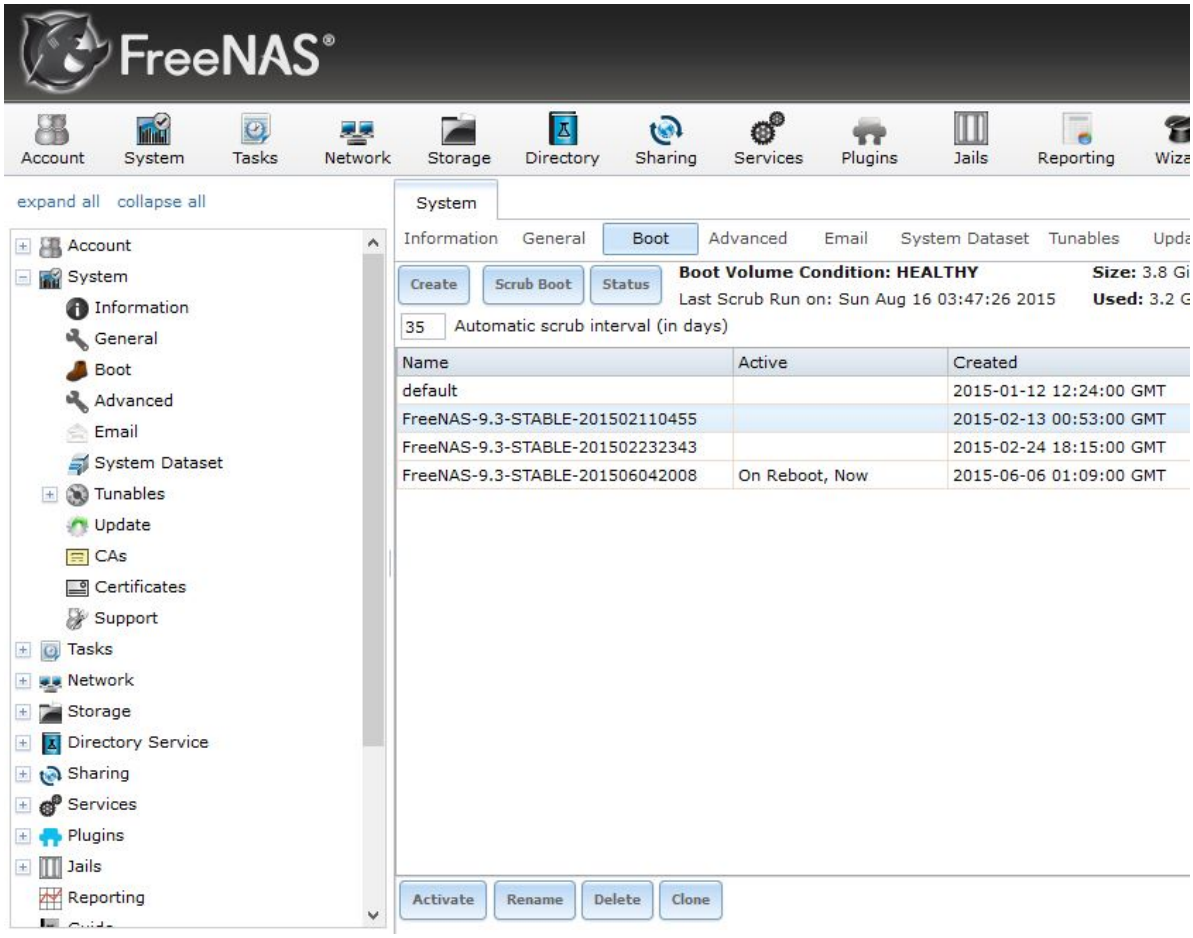
snapshot. This results in near instant snapshot tasks. Snapshot tasks can be set for regular intervals and stay stored as long as desired.

While ZFS generally boasts that you can save unlimited snapshots, there are some practical limits to this. Some users may decide to have periodic updates every few minutes for multiple datasets and make their lifetime indefinite. Taking one snapshot every five minutes will require over 100,000 snapshots each year, creating some substantial performance loss. If you have thousands of snapshots, this means you will have thousands of blocks accumulating. Depending on the capacity of the disk, this can cause slowdowns when you list snapshots, possibly across the entire ZFS pool.

Upgrading your FreeNAS version with a full boot device

FreeNAS makes upgrading to the latest version, switching between nightly and release versions and rolling back to earlier versions very easy by storing snapshots of the OS on your boot device. *However, if you fill your boot device beyond its capacity, updating your OS version may result in the upgrade process mysteriously failing.* Fortunately, FreeNAS will give you an alert when your boot device exceeds 80% capacity, so you should know when your boot drive is getting full and deleting version snapshots is easy to do.

Just go into your System>>Boot tab and select the image you would like to delete and click on the delete button on the bottom of the page.

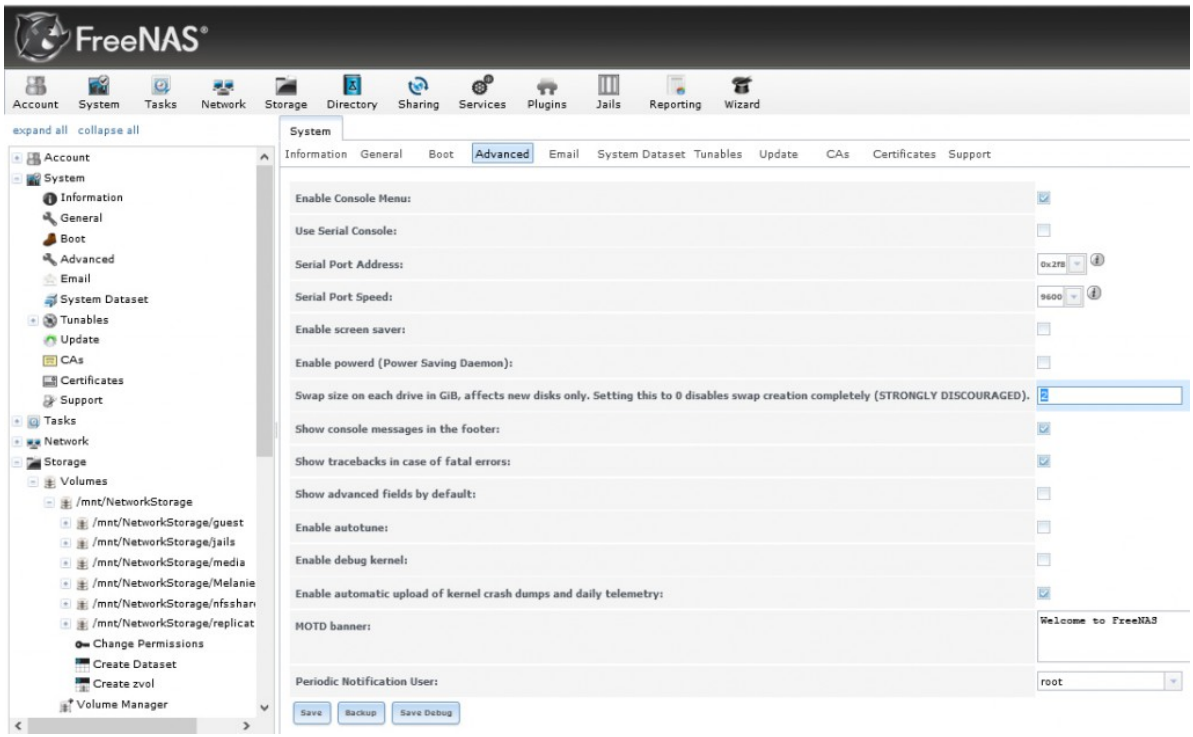


Rebuilding your ZFS array incorrectly

FreeNAS gives users the ability to set up ZFS arrays and resilver disks in the case of a drive failure. *If you remove the wrong disk and try to rebuild, you can end up losing your entire pool.* It is important to remember that the physical arrangement of the drives on your hardware may not correspond to your device numbers (ada0, ada1, ada2, etc). To counter this, we recommend writing down the serial numbers for each disk along with which slot they're in, as the GUI will give you associated serial numbers in the case of a drive failure.

In addition, if you try to rebuild a ZFS array with a disk that is too small, your rebuild will fail. This can happen if you use a smaller capacity drive, say a 2TB instead of a 3TB, but it can also happen between different drives of the same listed capacity. Different drive manufacturers may create each drive with a slightly different total capacity, making the effective capacity of your replacement drive slightly higher or lower than the disk you replaced. If the capacity is slightly higher, your rebuild will succeed, but if it is slightly lower, it will not.

If a failure occurs on drives with the same listed capacities, there is a workaround available from the FreeNAS web user interface. Just access your system>>advanced menu and temporarily change your Swap Size to 0 before rebuilding. Once your rebuild is complete, make sure to change it back though (usually the default of 2GiB). The extra 2GiB should accommodate any small difference in drive capacity but do try to use identical drives whenever possible.



Other Issues to Watch For

There are a couple of common issues with Active Directory that can cause problems. The first is if the system clock is out of sync. Make sure you're using a time server as AD/CIFS is very time sensitive. Second, having the domain name entered incorrectly can cause your Active Directory to have big problems. Ideally, your domain should have a reverse DNS entry, which you can determine easily enough:

https://www.google.com/search?q=dns+reverse+lookup&ie=utf-8&oe=utf-8#q=reverse+dns

Also, whenever possible, try not to mix sharing services on the same dataset. Differences in permissions between Unix (NFS) and Windows (CIFS) sharing formats can create some conflicts, so try and avoid this when you can. If you need users from multiple operating systems to have access to the same datasets, CIFS/SMB is your best choice. If you need to have multiple sharing protocols, you will want to separate your datasets between NFS & CIFS/SMB.

Finally, filling your storage pool over 80% of capacity will cause degraded performance. Try to plan your storage pool size to accommodate for this.

Conclusion

When deploying any server or storage system, setting up your system properly can help prevent headaches and even catastrophes down the road. As they say, an ounce of prevention is worth a pound of cure. While there are many aspects to setting up any given use case, this guide should avoid most of the major pitfalls people run into while setting up their FreeNAS storage. And if you're looking for even greater assurance, visit www.ixsystems.com/truenas, call us at 1-855-GREP-4-IX or email us at sales@ixsystems.com, for information on our qualified, professionally supported TrueNAS appliances. We look forward to hearing from you!

7 Comments

Marc CUCULIERE on October 2, 2015 at 8:06 am

Thanks to Ollivier Robert to forward this article, some practices I do seem to be awfull. Now I will manage to correct thoses stuffs 😉

Reply

BobJ on October 8, 2015 at 9:33 pm

Hardware Raid is not as evil as you say. Not sure what the motive is to push this. You failed to list the pros of Hardware raid in say a Dell Server.

1. I can blink failed drives light – cant do it on my nas zfs box
2. I can pull out a drive live then push it back in, nothing bad happens. Its all automated.
3. Battery backed up cache with auto sensing of low battery, will turn off cache if battery fails.
4. Speed – they are fast.
5. Auto email and also buzzer if a drive fails.
6. Probably many more things I can't think of.
7. Less reliable drives (SATA) vs SAS.
8. Probably many more things I can't think of.

Now does this make a freenas ZFS box a bad thing? No I have 4 ZFS NAS backup boxes i've built and they work well. I see a place for both types of systems.

Reply

Mark VonFange on October 22, 2015 at 1:36 pm

While hardware RAID isn't evil, it bybasses many of the features found in ZFS that can help you avoid costly drive-recovery services. We'd like to response to your listed benefits as well:

1. I can blink failed drives light – cant do it on my nas zfs box

TrueNAS offers cabinet management out of the box and while there is not an official way with FreeNAS, one can use various HBA blink features just as you would with a RAID HBA (they're related) and in a pinch do a 'dd' read from the drive.

2. I can pull out a drive live then push it back in, nothing bad happens. Its all automated.

Most non-home FreeNAS systems are hot-swappable. If you are talking about rebuilding, a ZFS system will only rebuild the actual data on disk, rather than the full disk in the case of a hardware RAID card. The hardware RAID card has no insights into what file system or data you have on the disk.

3. Battery backed up cache with auto sensing of low battery, will turn off cache if battery fails.

That is good if all RAID cards include the feature but we have seen such caches provide corrupt data that cannot be attributed to on-disk corruption. This probably rare, but we have seen it.

4. Speed – they are fast.

We have seen the same HBA perform around 5% slower with RAID firmware vs. HBA "target" firmware presumably because of the added RAID calculations. This may not apply to all cards but we have seen it in the field.

5. Auto email and also buzzer if a drive fails.

FreeNAS provides this via the GUI and e-mail. Various scripts exist to use a sound device but they are not incorporated into FreeNAS at this time. Any such buzzer would be card-specific.

6. Probably many more things I can't think of.

We'd love to hear any more information you can provide.

7. Less reliable drives (SATA) vs SAS.

Most HBAs are compatible with both. Do use SAS drives if your budget permits it.

8. Probably many more things I can't think of.

We'd love to hear any more information you can provide.

Reply

nicklowiczComputers on August 7, 2016 at 8:39 am

This guy knows little about raid! his opinion VS reality somewhat differ. GOOD comeback on his comment about hardware raid. thats a misconception. ever heard of bit-rot? i work in the field and have saw it and this is server with hardware raid! ZFS hopefully will prevent this

Reply

Dave R on October 9, 2015 at 4:18 am

Excellent read! Perhaps some of the tips should be part of a trouble shooting section of the FreeNAS manual

Reply

Egon on October 20, 2015 at 7:13 am

hello
i got a question, i set up a new Backup server, a poweredge R530.
it comes with Raid 5, but i´m using it with non Raid. I got problems with using it with Raid 5 on like it says in this article here.
but my question is, i´m using it as non Raid in its working so far great!
is it recomendable using it like that?

Reply

konzty on November 14, 2016 at 10:26 am

Hi!

this article is lovely – I love the "Worst Practise" approach to a topic like this. You've held the article straight forward with no bullshit and no marketing *bla*.

I've worked with ZFS (on Sun Solaris & now Oracle Solaris) professionally since around September 2007, hosting file servers for Unix and Windows clients as well as zvols used as raw devices for databases. I was like: "No help needed, I know my way around." when I finally bought a few pieces of hardware to suplement a few other pieces of hardware in order to build a home NAS for the wife and I – main intention: Backup of computers and bit rot immune data storage for fotos and other memories.

Well I've setup a system based on an Athlon X4 845 with a neat mini ITX board in a neat mini ITX case, with 3 disks of 2 TB – during OS trials I decided to give FreeNAS a go. I have to tell you: I love it. … @ work I do every adminstrative task of our systems on the shell. … but @ home? I don't want to work at home. *Enter your WebUI* – I can only say: "Well done."

So how did I stumble over your post?

Had created my volumes, with dedupe and compression, all the way. I started backing up my PC to my NAS and everything was fine, copied 2.2 Tib over night there, all cool. … today I wanted to backup my wifes laptop:
400-800 MBit/s of ethernet throughput for about 10 seconds, … then zero for about 30 seconds … then again: 400-800 MBit/s … Tried with my own laptop: same behaviour. Tried with different payload: same behaviour. … Thought about configuration: What about dedupe?! I didn't ask myself wether I had enough memory or not to acutally use dedupe and what would happen if I would run out of said memory?
Tried turning off dedupe: 400-800 MBit/s … all … the … time. Nice, found the cause. A quick google search later I got on to your site.

Thanks again for this nice article,

Have a nice evening,

K

Reply

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