

Discrepancies in Disk Space on your TitaniumZ

Using an example TitaniumZ with 8 drives, where every drive is a 2 Terabyte(TB) drive, we will explore some of the confusion that comes up when comparing your Titanium's available disk space across several systems.

Differences in Hard Drive Space

The first issue that should be mentioned is how disk space is reported for hard drives. When purchasing a hard drive from a manufacturer, something to keep in mind is that the marketed amount of space advertised is measured in decimal notation base 10. This means that to the distributor, 1 MegaByte(MB) is equal to 1,000,000 Bytes(B). Computers, when reporting disk space do not use this decimal system however, and report the amount of disk space with the binary numbering system (base 2). What this means is that 1 MB in this system is not equal to 1,000,000 B, but instead is actually 1,048,576 B. This means that a manufacturer's reported Bytes per MegaByte are off by 48,576. Remember that there are 1000MB in a GigaByte. As you can see, this method of reporting quickly adds up.

Another misrepresentation in the way disk space is reported by a manufacturer is they do not discuss a partition of the hard drive that is made on every hard drive for overhead computation, meta-data, and also a small pool of blocks where the hard drive can perform actions and hold blocks that may have been corrupted or damaged. This area is required for Hard drives to function properly, and is an unavoidable loss.

Lets take a look at the TitaniumZ for an example. By navigating to the WebUI's System->Information (default page after login), if we look at the "Disk Group Status" we can see how this affects us already. Recall that this TitaniumZ has 8 drives and each drive is reported as 2 TB:

Disk group status	
Controller: 0 EID:Slot: 252:0 DID: 10	Size: 1.818 TB State: Onln
Controller: 0 EID:Slot: 252:1 DID: 11	Size: 1.818 TB State: Onln
Controller: 0 EID:Slot: 252:2 DID: 9	Size: 1.818 TB State: Onln
Controller: 0 EID:Slot: 252:3 DID: 8	Size: 1.818 TB State: Onln
Controller: 0 EID:Slot: 252:4 DID: 15	Size: 1.818 TB State: Onln
Controller: 0 EID:Slot: 252:5 DID: 14	Size: 1.818 TB State: Onln
Controller: 0 EID:Slot: 252:6 DID: 12	Size: 1.818 TB State: Onln
Controller: 0 EID:Slot: 252:7 DID: 13	Size: 1.818 TB State: Onln

It is visible that the 2 TB hard drives are reporting a bit smaller numbers than advertised. This is an example of the discrepancies described above. If we add all of these together, we can see that though the total disk space available should be 16 TB, what we actually end up with is 14.544TB. this means that we actually have 1.46TB less than what we thought we would have. This is the effects of using the decimal system instead of the binary system. The amount of difference between advertised and actual disk space increases as the total size of disk space does.

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Differences in TitaniumZ Reporting

After examining how much disk space we have versus what was advertised, another factor that leads to disk space loss is how Small Tree uses the disks. Looking at that same Summary page from before, we notice another bit of information that is important to look at, the "Disk Space Usage."



Looking at the highlighted region, it becomes obvious that there even less disk space than we calculated earlier. The reason for this is that Small Tree uses a Raid 5 which has striping and parity. Without going into too much detail, what this means is that 1 hard drive's worth of space is divided between all the drives in the TitaniumZ, and stores enough information to restore any 1 of the 8 drives should they fail. This is done to ensure that even if a drive fails, Small Tree can protect and restore the data on that drive to a factory fresh drive. With that said, if we remember the number we computed earlier we see that we have *total storage - size of one drive = remaining space*, or 14.544 TB - 1.818 TB = 12.726 TB. We can see that this number is very close to the number reported.

Differences In Reporting on A Mounted Mac

Now we will look at this from the client side. When we mount the TitaniumZ we have the option of right clicking on the share point and selecting "Get Info" on a mac or "properties on a windows computer. Using an example with a share that has data on it, lets analyze what the WebGUI displays under "Disks->ZFS->Pools->Management" and the "Get Info" information from the mac.

Small Tree WebGUI interface showing disk space usage for a pool named **tank0**. The interface includes a sidebar with navigation options (System, Network, Disks, Services, Access, Status, Diagnostics, Advanced, Help) and a main content area with tabs for Pools, Datasets, Volumes, Snapshots, and Configuration. The Pools tab is active, showing a table of virtual devices.

Name	Size	Used	Free	Capacity	Dedup	Health	AltRoot
tank0	12.6T	2.76T	9.67T	21%	1.00x	ONLINE	-

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Looking at the example reveals that there is a capacity of 13.26 reported on the mac side, while there is a capacity of 12.6 reported on the TitaniumZ side. Looking at what is used, we see a 2.63T versus 2.76T used. Free space is 10.63 on a mac, and 9.67T on a TitaniumZ.

Why does this happen? A look at ZFS disk space reporting.

The reason you see a difference on your TitaniumZ is because of the fact that it is a ZFS disk space accounting report. ZFS is based on the idea of pooled storage, and because of this the available disk space can be known to change even when the file system is inactive. Other file systems in the pool (like datasets) can consume or release disk space. If any writes or frees are pending and have not yet been committed, these changes will not be counted by the ZFS disk space reporting. This is another reason for one to see possible changes with the reporting. Snapshots are also not counted by common terminal commands like `df` either. All of these lead to a disk space report that is *mostly* correct.

What this means then is that the disk space pool will fluctuate slightly at times and this is no cause for alarm. For the best idea of how much actual space you have however, the general rule of thumb is to trust the WebGUI's report.

Another option to see a greater breakdown of what is taking up space on the TitaniumZ would be to ssh into the machine and run the following command:

```
titaniumz:~# df -h
```

More Information

For more information, see this article on ZFS disk space Reporting:

http://docs.oracle.com/cd/E23824_01/html/821-1448/gbchp.html