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CITCOT

ZERGAW CLOUD

IT Infrastructure Administration

Day 9: Storage and SAN

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Aug 5, 2025

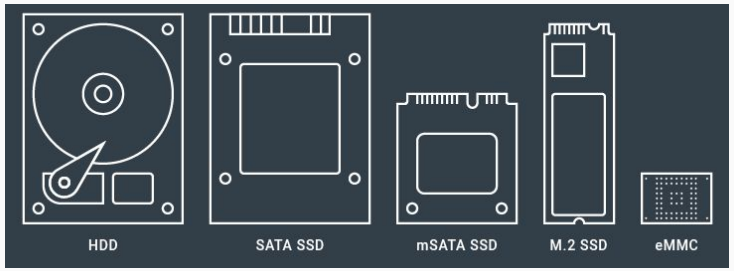
Storage and NAS

Day 9
Training Outline

storage device
storage layers
storage redundancy
storage management techniques
storage tiers
storage network technologies
types of storage
configuring a simple NFS server on linux
configuring a simple NFS client on linux
configuring NFS server using cockpit
truenas
why truenas
zfs data architecture
zfs/truenas concepts
truenas installation
knowledge check

Storage Device

A Storage device is nothing but a non-volatile recording media on which information can be persistently stored.

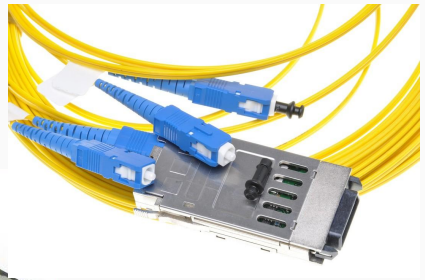


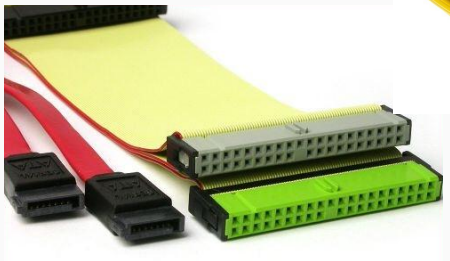
Physical storage's, based on the nature of the storage media can be broadly classified as:

- Magnetic spinning drives(HDD)
- Optical storage drives(DVD, CD, blu-ray)
- Flash-based drives(SSD, USB)

Storage devices uses various types of interface technology to communicate with the server over the network. from those interfaces some of the commons are

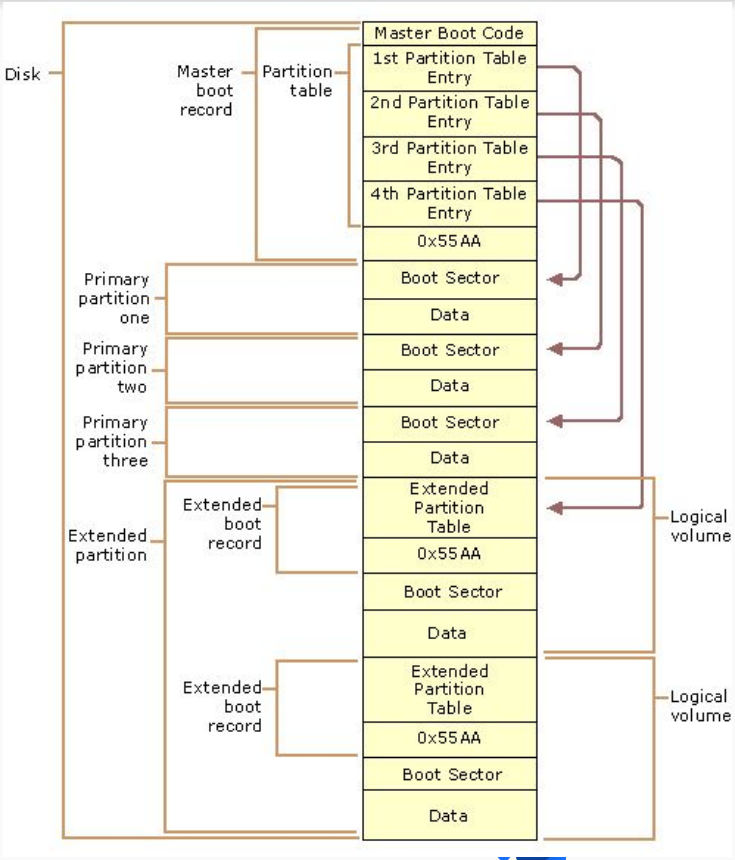
- SCSI(small computer system interface)
- ATA(advanced technology attachment)
- SATA(serial advanced technology attachment)
- FC(fiber channel)





Storage Layers

- Storage devices can be divided with the help of operating system file system into one or more logical disk called partition.
- A partition editor program can be used to create, delete or modify these partitions such as gparted.
- To store data on a partition we need a file system which is a structured representation of a set of data that is being written to a disk partition.
- From the well know file system types some of them are,
  - EXT(extended file system)
  - NTFS(new technology file system)
  - FAT(file allocation table)
  - ZFS(zettabyte file system)

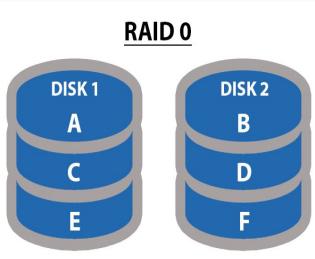


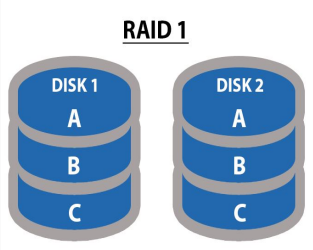
Storage Redundancy

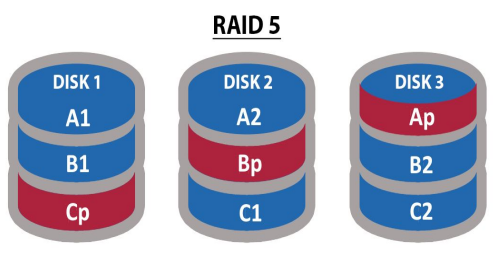
- Redundant array of independent disks combine physical disks to achieve redundancy without having to sacrifice performance.
- Large storage volumes can be created by grouping the individual disks.
- When a storage logical unit spans multiple hard drive, it increases performance, speed and volume size.

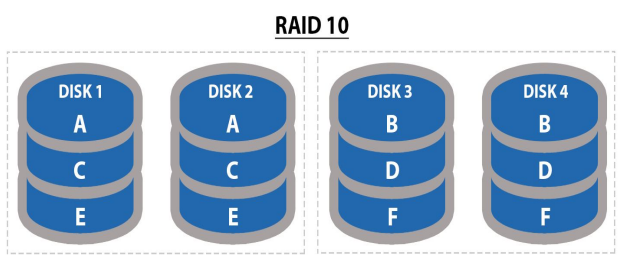
Their are different types of raid levels, from these

- **RAID0**: stripes data evenly across two or more disks
- **RAID1**: mirrors data on two or more disks
- **RAID3**: byte level striping with dedicated parity
- **RAID5**: block level striping with distributed parity
- **RAID10**: mirroring without parity, and block level striping



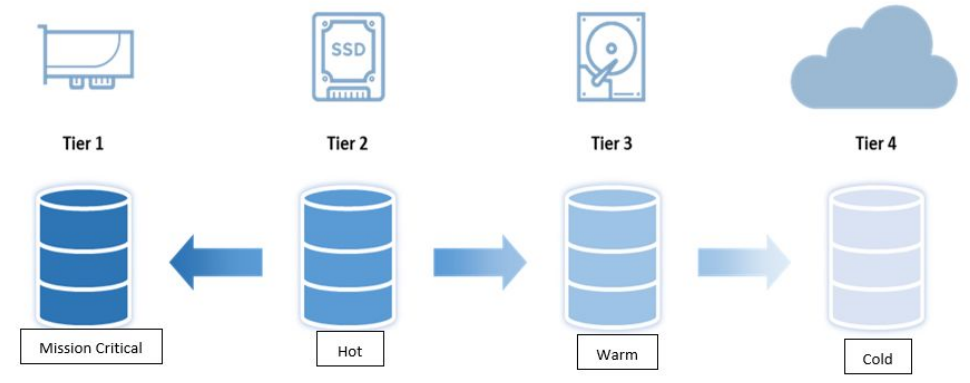






Storage Management Techniques

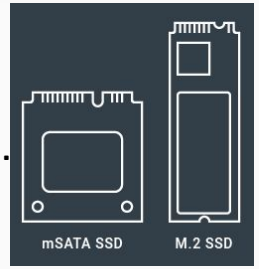
- Different application need different read and write speed for better performance.
- Some data may need to be accessed very frequently, where are other data can be stored and accessed by an application.
- There can be many different tiers created in a storage design in the cloud. More than three tiers can be implemented based on the complexity and the requirements of the storage system.
- Generally the higher the tier, the more critical the data is considered.



Storage Tiers

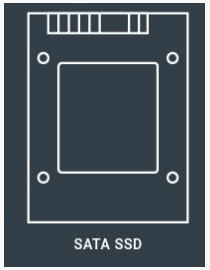
Tier 1 Storage

- Used for most critical or frequently accessed data and is generally stored on the fastest, most redundant, or highest quality media available.
- Configured with one or more disks to fail with no data being lost and access is still available.
- They have the greatest manageability and monitoring capabilities and are designed to be the most reliable.
- It is able to give higher IOPS
- Application: Financial Application, E commerce



Tier 2 Storage

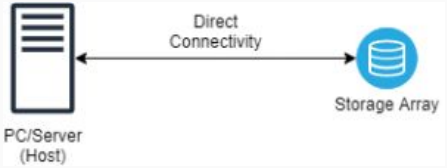
- Generally used for data that does not have fast read or write performance requirements or that is accessed infrequently.
- Can use less expensive storage device and can even be accessed over a remote storage network.
- Configured to provide balanced IOPs and throughput
- Application:Business processing, Data Analytic s



Tier 3 Storage

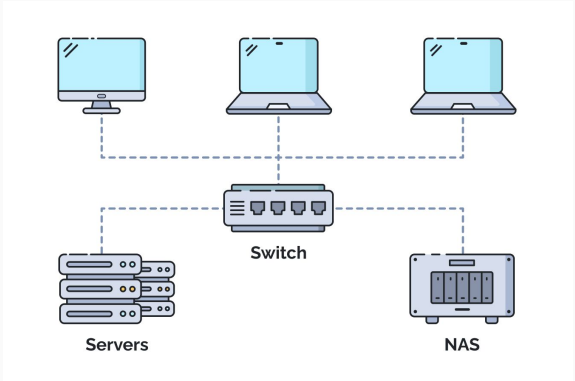
- This storage tier is used for data that is often at rest and rarely accessed or backups of tier 1 and tier 2 data.
- Application: Data Backup, Archival

Storage Network Technologies



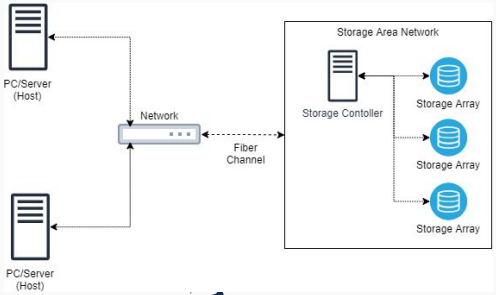
Direct Attached Storage(DAS)

- A device having its own storage directly connected.
- The connection used is commonly ATA, SATA or SCSI interface connecting the device directly to the motherboard.
- Uses block level access technique to access the data on the storage device



Network Attached Storage(NAS)

- Is a file-level access of the data across a network.
- Files are sent over the network using a protocol such as TCP/IP
- It is a common solution for sharing files between servers of users



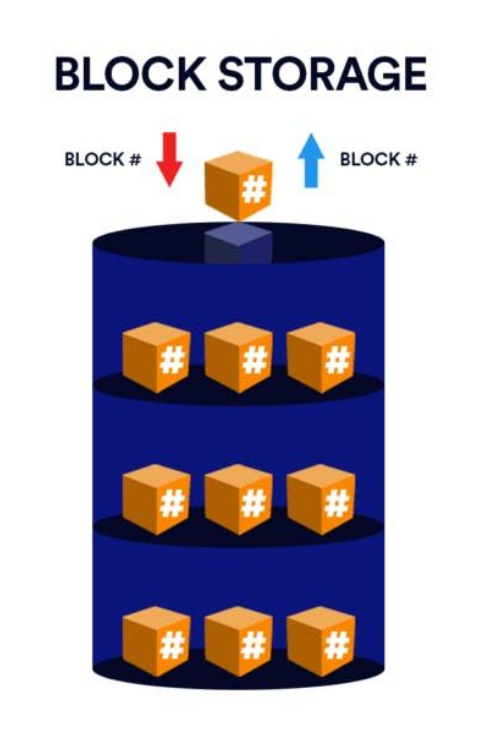
Storage Area Network(SAN)

- A very high speed, highly redundant and completely dedicated to storage traffic
- It needs to be configured in a high available and redundant way
- It uses block-level access mechanism to access the data on the storage device
- The connection used is commonly fiber channel and iSCSI

Types of storage

Block Storage

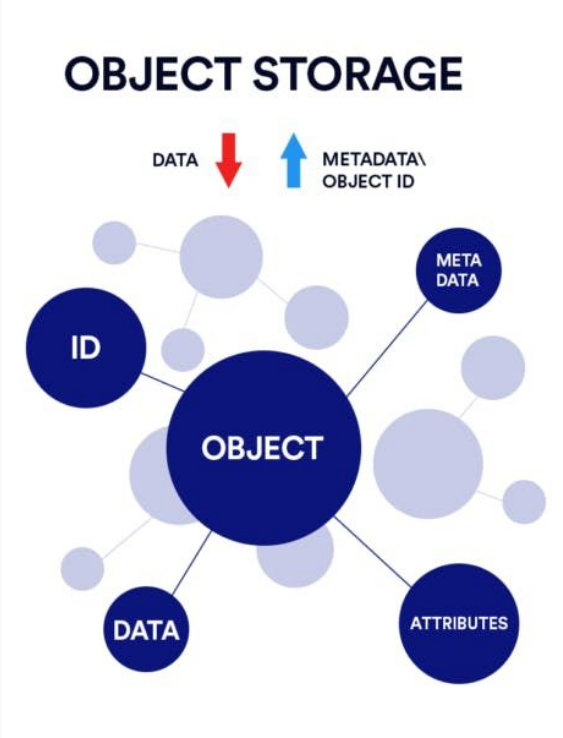
- Block storage chops data into blocks and stores them as separate pieces.
- It is often configured to decouple the data from the user's environment and spread it across multiple environments that can better server the data.
- Then when data is requested by the underlying software reassembles the blocks of data from these environments and present them back to the user.
- It is usually deployed in storage-area network environment.
- Different cloud providers have different names for their block storage services. i.e
  - AWS: Elastic Block Storage
  - GCP: Persistent Disk
  - Azure: Managed Disk



Types of storage

Object Storage

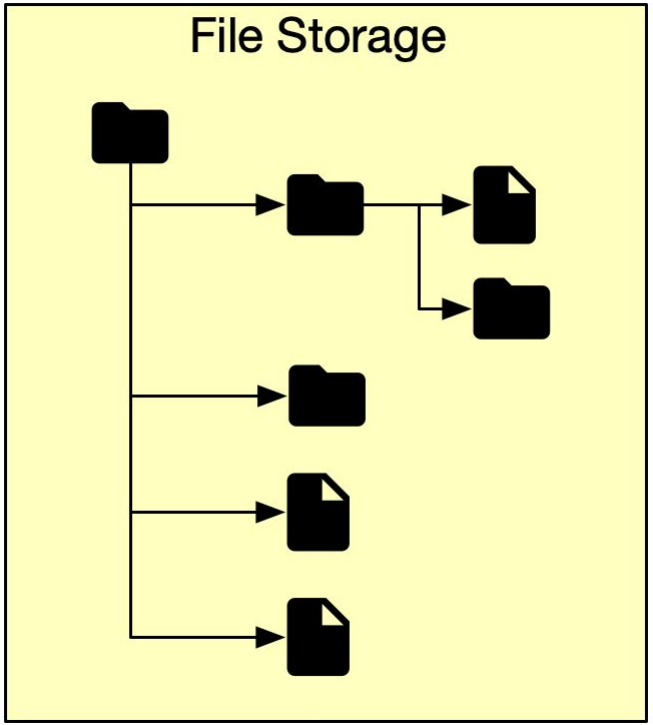
- A flat structure in which files are broken into pieces and spread out among hardware, the data is broken into discrete units called objects and kept in a single repository, instead of being kept as files in folders or as blocks on servers.
- Objects stored on object storage systems have an extremely detailed meta-data like age, securities and access contingencies.
- Object storage requires a simple HTTP API which is used by most clients in all languages
- Different cloud providers have different names for their object storage services. i.e
  - AWS: S3
  - GCP: Cloud Storage
  - Azure: Blob Storage



Types of storage

File Storage

- In file storage document is arranged in some type of logical hierarchy
- Data is stored as a single piece of information inside a folder
- It is the oldest and most widely used data storage system for direct and network-attached Storage..
- Different cloud providers have different names for thei file storage services. i.e
  - AWS: Elastic File Storage
  - GCP: Cloud File store
  - Azure: Azure Files



Types of storage

Summary

	Block	Object	File
Storage Cost	High	Low	Medium
Scalability	Low	High	Medium
Performance	High	Medium	Low
Mountable	Yes	No	Yes
Bootable	Yes	No	No
Use case	Database, HPC, OS Storage, Boot Volume	Images, Audio, Video, DR, Archiving	Sharing files across many compute instance

Configuring a Simple NFS Server on Linux

1. Install NFS server packages

sudo apt update

sudo apt install nfs-kernel-server

2. Create a shared directory

sudo mkdir -p /srv/nfs/shared

sudo chown nobody:nogroup /srv/nfs/shared

sudo chmod 755 /srv/nfs/shared

3. Configure the exports file

sudo nano /etc/exports

Add a line like:

/srv/nfs/shared 192.168.1.0/24(rw,sync,no_subtree_check)

Configuring a Simple NFS Server on Linux

Explanation:

192.168.1.0/24: Subnet allowed to access.

rw: Read-write access.

sync: Writes changes immediately.

no_subtree_check: Speeds up export, used when sharing subdirectories.

4. Export the shared directories

sudo exportfs -ra

To see what is exported:

sudo exportfs -v

5. Enable and start NFS services

sudo systemctl enable nfs-server

sudo systemctl start nfs-server

Configuring a Simple NFS Client on Linux

1. Install NFS client packages

sudo apt install nfs-common

2. Create a mount point

sudo mkdir -p /mnt/nfs/shared

3. Mount the NFS share temporarily

sudo mount 192.168.1.100:/srv/nfs/shared /mnt/nfs/shared

4. Make the mount permanent

sudo nano /etc/fstab

Add this line:

192.168.1.100:/srv/nfs/shared /mnt/nfs/shared nfs defaults 0 0

Then test:

sudo mount -a

Configuring an NFS Server using cockpit

1. Install cockpit

apt update

apt install cockpit

2. Install cockpit file share

curl -LO

https://github.com/45Drives/cockpit-file-sharing/releases/download/v3.3.7/cockpit-file-sharing_3.3.7-1focal_all.deb

sudo apt install ./cockpit-file-sharing_3.3.7-1focal_all.deb

3. Install cockpit navigator

wget

https://github.com/45Drives/cockpit-navigator/releases/download/v0.5.10/cockpit-navigator_0.5.10-1focal_all.deb

apt install ./cockpit-navigator_0.5.10-1focal_all.deb

4. Allow ssh login

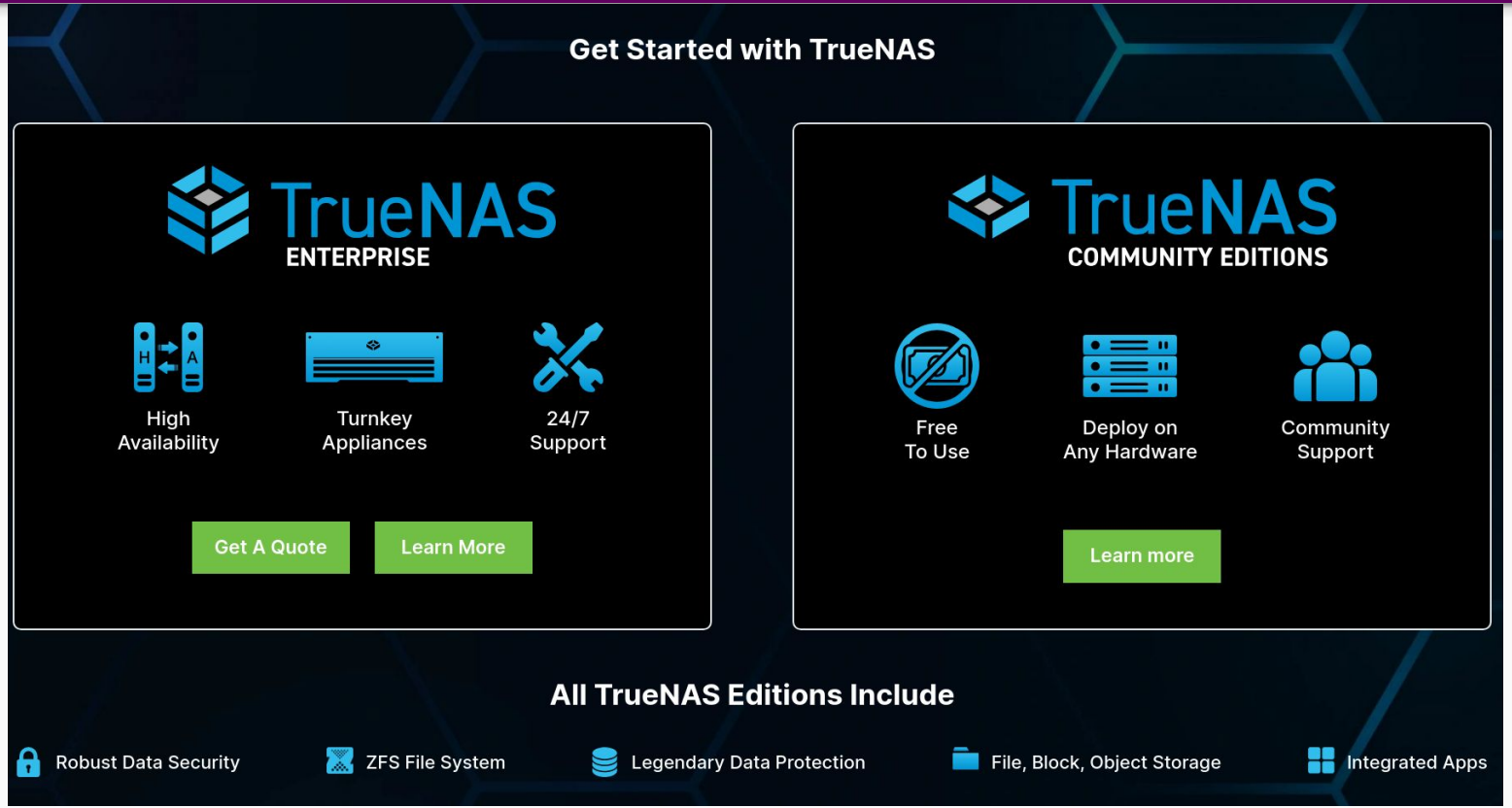
sudo sed -i '/root/s/^/#/' /etc/cockpit/disallowed-users

sudo systemctl restart cockpit

Configuring an NFS Server with ZFS

```
 sudo apt update
sudo apt install zfsutils-linux nfs-kernel-server -y
sudo wipefs -a /dev/sdX
sudo zpool create -f mypool raidz /dev/sdb /dev/sdc /dev/sdd
zpool list
ls /mypool
sudo zfs set atime=off mypool        # Disable access time updates
sudo zfs set compression=lz4 mypool   # Enable compression
sudo zfs create mypool/mydataset
zfs list
sudo zfs set quota=10G mypool/mydataset
sudo zfs set compression=lz4 mypool/mydataset
sudo zfs set sharenfs=on mypool/mydataset
sudo zfs set sharenfs="rw=@192.168.1.0/24,no_root_squash,sync" mypool/mydataset
showmount -e
zfs get sharenfs mypool/mydataset
sudo chown -R nobody:nogroup /mypool/mydataset
sudo chmod -R 755 /mypool/mydataset
```

TrueNAS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All TrueNAS Editions Include
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ZFS File System
Legendary Data Protection
File, Block, Object Storage
Integrated Apps

Why TrueNAS

While ZFS can seem complex, the TrueNAS UI helps to simplify that to ensure that your experience with the platform is straightforward and seamless

Copy-on-Write

ZFS keeps your data safe. Utilising Copy-on-Write technology, ZFS does not change the location of data until a write is completed and verified. This ensures that your data isn't lost during a interrupted task such as a power outage.

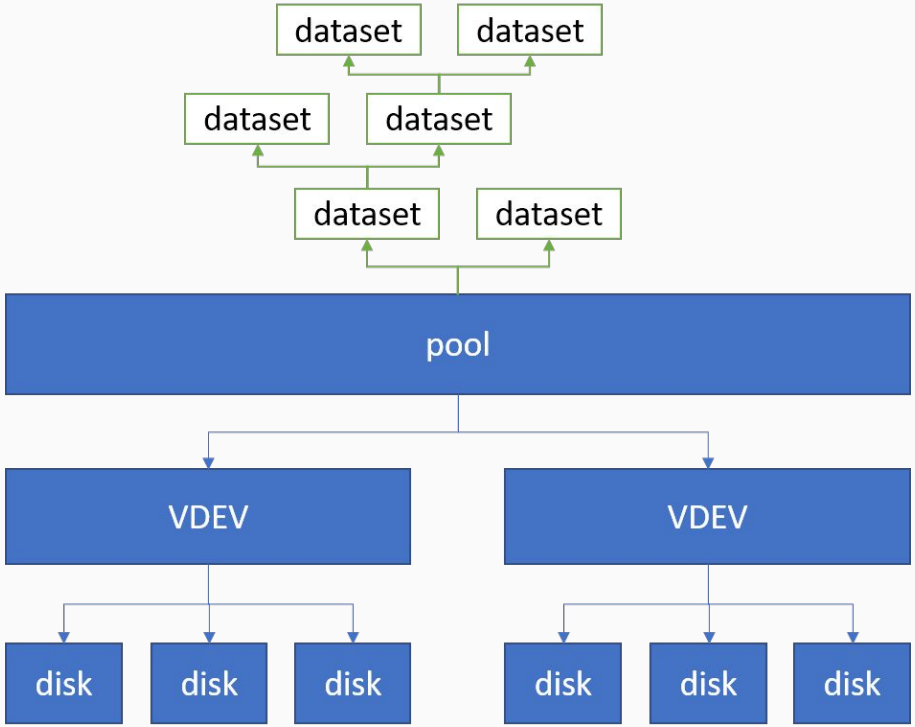
RAID

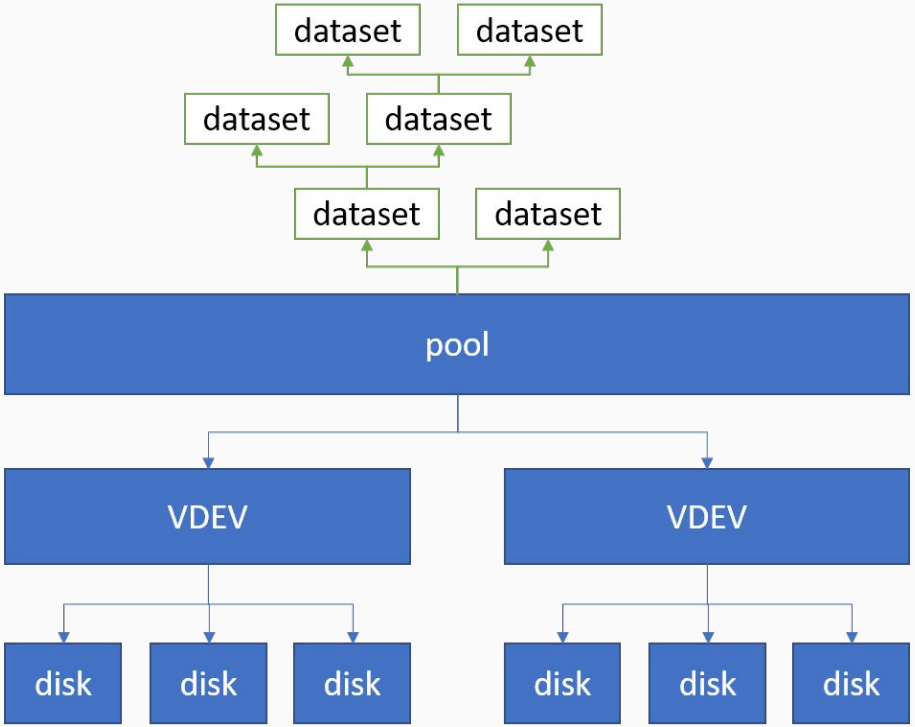
Striped VDEV's, Mirrored VDEV's and Striped Mirrored VDEV's are essentially the same as RAID0, RAID1 and RAID10 accordingly with one difference; automatic check summing prevents silent data corruption that is otherwise usually undetectable by most hardware RAID cards.

Scalable

ZFS can handle enormous data pools of up to 1.84 x 10^19 times more data than other 64bit systems such as BTRFS as it uses a 128-bit file system.

ZFS Data Architecture

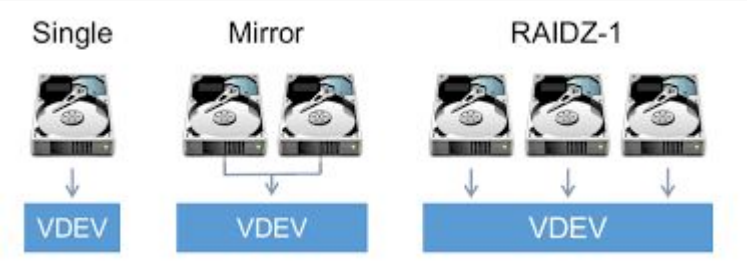




TrueNAS/ZFS Concepts

VDev

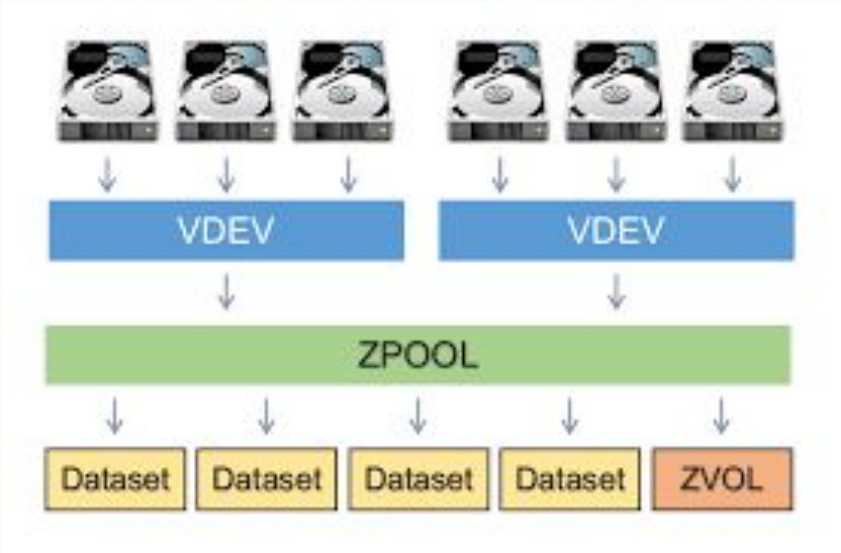
- A VDev is one or more hard disks that are allocated together and are intended to work together to store data.
- VDevs are allocated in RAID formats such as Mirrors(RAID1 equivalent), RAID-Z1(RAID5 equivalent) and RAID-Z2(RAID-6 equivalent).
- VDevs with single disks are known as “striped” disks. They have no redundancy.
- VDevs can provide redundancy from individual hard disk failure inside the same VDev.
- VDevs cannot operate outside of a zpool.
- You cannot add more hard drives to a VDev once it is created.*
- When a VDev can no longer provide 100% of its data using checksums or mirrors, the VDev will fail.
- If any VDev in a zpool is failed, you will lose the entire zpool with no chance of partial recovery. (Read this again so it sinks in)



TrueNAS/ZFS Concepts

zpool

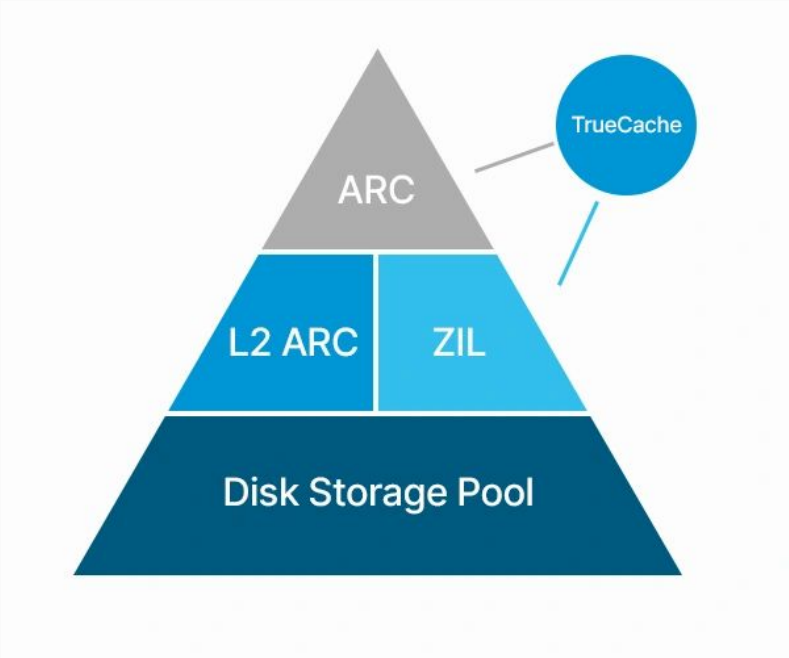
- A zpool is one or more VDevs allocated together.
- You can add more VDevs to a zpool after it is created.
- If any VDev in a zpool fails, then all data in the zpool is unavailable.



TrueNAS/ZFS Concepts

ZIL

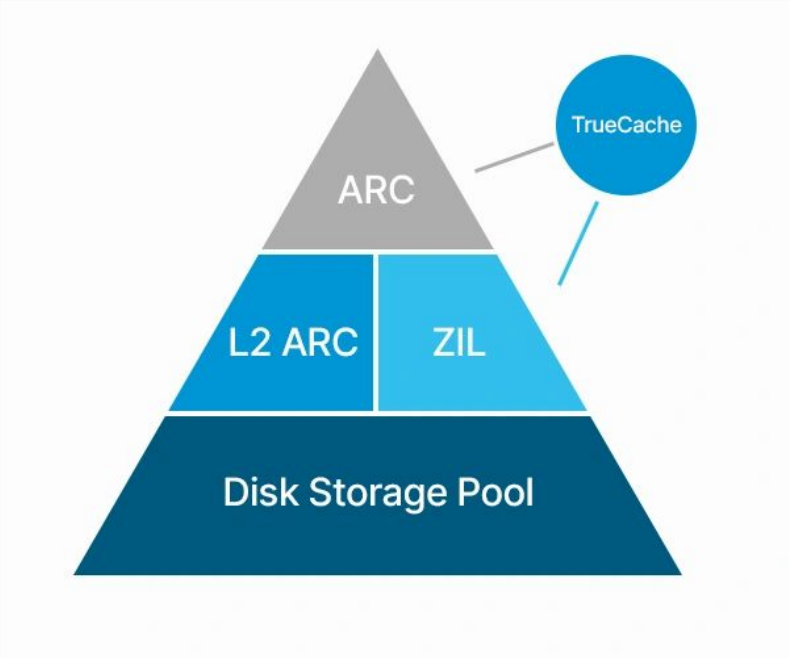
- ZIL stands for ZFS intent log.
- The ZIL stores data that will need to be written to a zpool later and acts as a “non-volatile write cache” for the zpool.
- ZIL drive performance will need to be very fast for writes (read speeds do NOT matter). Typically an SSD is used for this application. An Enterprise class SSD or SSD based on SLC memory is recommended.
- Whatever SSD you plan to use should have it’s own battery backup to ensure disk writes are completed even if power is lost suddenly. This often means that consumer SSDs are NOT suitable for slogs.
- TrueNAS does use RAM as a short term write cache for non-sync writes, so a ZIL is not always required for high performance.



TrueNAS/ZFS Concepts

L2ARC

- L2ARC stands for Level 2 Adaptive Replacement Cache.
- The L2ARC is a read cache for the zpool. Note that it is not a read-ahead cache. L2ARC is used for random reads of static data(i.e. databases) and provides no benefit for streaming workloads. It is also only useful when the same data is constantly read over and over.
- L1ARC, or often referred to as simply “ARC” typically uses a significant portion of available RAM on the FreeNAS server(usually around 85%). This is most commonly your read cache.
- The L2ARC stores frequently read data that exceeds the amount of RAM assigned to the ARC.
- SSDs are the primary device used for these functions.



TrueNAS/ZFS Example 1

This zpool provides redundancy against any 2 simultaneous hard disk failures. Any 2 hard disks can fail with no loss of data.

TrueNAS/ZFS Example 2

This zpool provides redundancy against a maximum of 4 simultaneous hard disk failures(2 in each VDev), but not 3 in any one VDev.

TrueNAS/ZFS Example 3

This zpool provides no redundancy. A failure of any hard disk will result in complete data loss of the zpool.

A failure of any disk will make its VDev unavailable which will cause a loss of the entire zpool.

This is a good example where a failure of a VDev results in a loss of the entire pool.

TrueNAS/ZFS Example 4

This zpool provides partial redundancy. The zpool can withstand up to 2 hard disk failures in VDev 1, but a failure of any hard disk on VDev 2,3,4,5,6 or 7 will result in a loss of all data.

This is NOT a recommended configuration because of the single points of failure.

TrueNAS

Installation and Configuration

Knowledge Check

What does RAID 1 provide?

A. Striping without redundancy

B. Mirroring for redundancy

C. Parity-based error correction

D. Data deduplication

Which of the following is a storage management technique?

A. Port forwarding

B. LVM (Logical Volume Management)

C. NAT

D. Routing

What is the purpose of storage tiering?

A. Improve CPU performance

B. Separate internal and external traffic

C. Optimize storage cost and performance

D. Encrypt all stored data

Knowledge Check

Which technology is commonly used in a Storage Area Network (SAN)?

A. SMB

B. iSCSI

C. NFS

D. HTTP

What type of storage is best suited for shared access over a network using file-level protocols?

A. DAS

B. SAN

C. NAS

D. Flash

Which file in Linux is primarily used to define NFS exports?

A. /etc/fstab

B. /etc/exports

C. /etc/nfs.conf

D. /var/nfs/exports

Knowledge Check

When configuring a basic NFS client on Linux, what command is commonly used to mount the NFS share?

A. nfsd

B. nfsstat

C. mount

D. df

TrueNAS is primarily used for which of the following?

A. Container orchestration

B. Web hosting

C. Centralized storage and backup

D. DNS management

What is a key feature that makes TrueNAS stand out?

A. Supports only FAT32 filesystems

B. Built-in ZFS support for data integrity

C. Proprietary software licensing

D. Requires enterprise-grade hardware

Knowledge Check

In ZFS architecture, what is a vdev?

A. A Linux system service

B. A virtual disk used in ZFS pools

C. A compression algorithm

D. A snapshot of a file system

Which concept is unique to ZFS and TrueNAS compared to traditional filesystems?

A. File permissions

B. Journaling

C. Copy-on-write

D. Logical volumes

What does a ZFS dataset represent?

A. A pool of RAID devices

B. A logical filesystem or volume

C. A group of VMs

D. An array of CPUs

Thank You

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