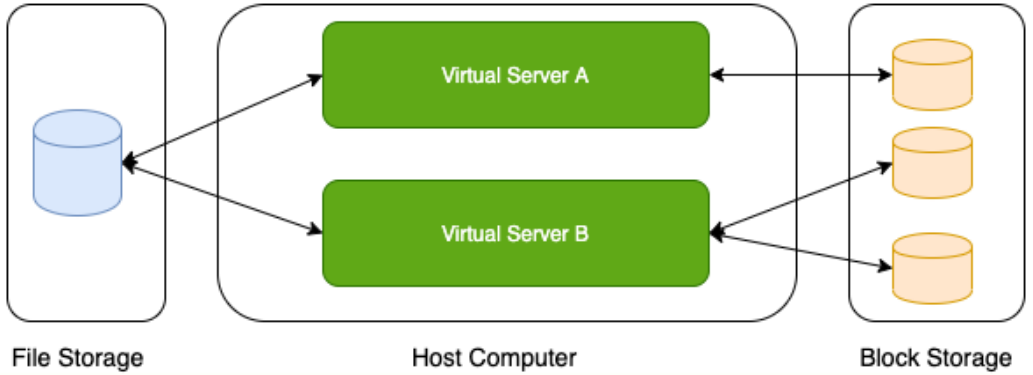
Storage

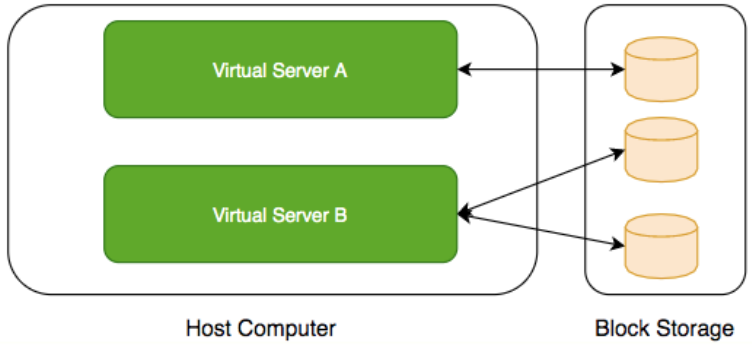
Storage Types - Block Storage and File Storage



- What is the type of storage of your hard disk?
  - **Block Storage**
- You've created a file share to share a set of files with your colleagues in a enterprise. What type of storage are you using?
  - **File Storage**

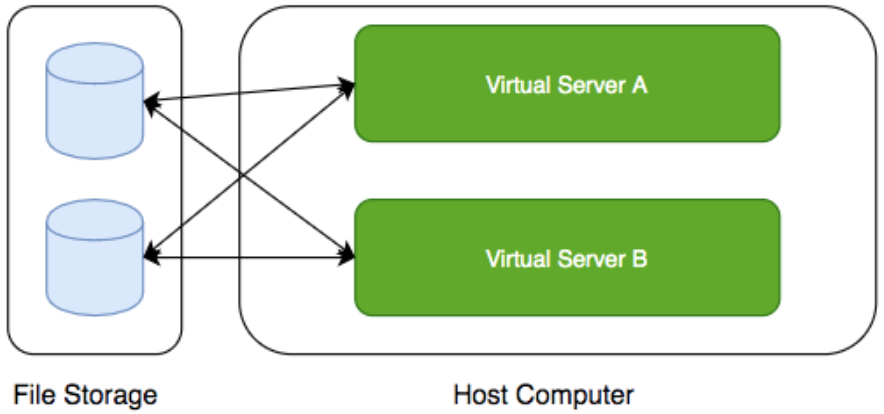
Block Storage

- Use case: Harddisks attached to your computers
- Typically, ONE Block Storage device can be connected to ONE virtual server
  - (EXCEPTIONS) You can attach read only block devices with multiple virtual servers and certain cloud providers are exploring multi-writer disks as well!
- HOWEVER, you can connect multiple different block storage devices to one virtual server
- Used as:
  - **Direct-attached storage (DAS)** - Similar to a hard disk
  - **Storage Area Network (SAN)** - High-speed network connecting a pool of storage devices
    - Used by Databases - Oracle and Microsoft SQL Server

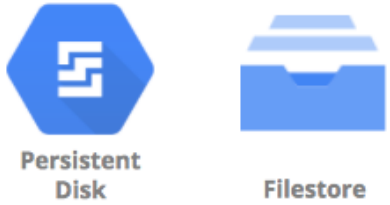


File Storage

- Media workflows need huge shared storage for supporting processes like video editing
- Enterprise users need a quick way to share files in a secure and organized way
- These file shares are shared by several virtual servers



GCP - Block Storage and File Storage



- **Block Storage**:
  - **Persistent Disks**: Network Block Storage
    - Zonal: Data replicated in one zone
    - Regional: Data replicated in multiple zone
  - **Local SSDs**: Local Block Storage
- **File Storage**:
  - **Filestore**: High performance file storage

GCP - Block Storage

In28 Minutes

- Two popular types of block storage can be attached to VM instances:
  - **Local SSDs**
  - **Persistent Disks**
- **Local SSDs** are physically attached to the host of the VM instance
  - Temporary data
  - Lifecycle tied to VM instance
- **Persistent Disks** are network storage
  - More durable
  - Lifecycle NOT tied to VM instance

Local SSDs

- **Physically attached** to the host of VM instance:
  - Provide very high (IOPS) and very low latency
  - (BUT) **Ephemeral storage** - Temporary data (Data persists only until instance is running)
    - **Enable live migration** for data to survive maintenance events
  - Data automatically encrypted
    - HOWEVER, you CANNOT configure encryption keys!
  - Lifecycle tied to VM instance
  - ONLY some machine types support Local SSDs
  - Supports SCSI and NVMe interfaces
- Remember:
  - Choose NVMe-enabled and multi-queue SCSI images for best performance
  - Larger Local SSDs (more storage), More vCPUs (attached to VM) => Even Better Performance

Local SSDs - Advantages and Disadvantages

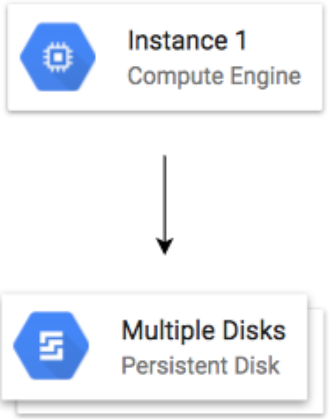
In28 Minutes

- **Advantages**
  - Very Fast I/O (~ 10-100X compared to PDs)
    - Higher throughput and lower latency
  - Ideal for use cases needing high IOPs while storing **temporary information**
    - Examples: Caches, temporary data, scratch files etc
- **Disadvantages**
  - **Ephemeral storage**
    - Lower durability, lower availability, lower flexibility compared to PDs
  - You **CANNOT detach and attach** it to another VM instance

Persistent Disks (PD)

In 28 Minutes

- **Network block storage** attached to your VM instance
- **Provisioned capacity**
- Very Flexible:
  - **Increase size when you need it** - when attached to VM instance
  - Performance scales with size
    - For higher performance, resize or add more PDs
- **Independent lifecycle** from VM instance
  - Attach/Detach from one VM instance to another
- Options: Regional and Zonal
  - Zonal PDs replicated in single zone. Regional PDs replicated in 2 zones in same Region.
  - Typically Regional PDs are 2X the cost of Zonal PDs
- **Use case** : Run your custom database



Persistent Disks vs Local SSDs

In28 Minutes

Feature	Persistent Disks	Local SSDs
Attachment to VM instance	As a network drive	Physically attached
Lifecycle	Separate from VM instance	Tied with VM instance
I/O Speed	Lower (network latency)	10-100X of PDs
Snapshots	Supported	Not Supported
Use case	Permanent storage	Ephemeral storage

Persistent Disks - Standard vs Balanced vs SSD

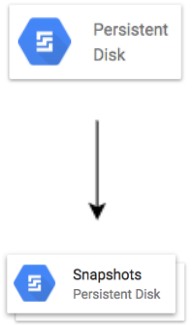
In28 Minutes

Feature	Standard	Balanced	SSD
Underlying Storage	Hard Disk Drive	Solid State Drive	Solid State Drive
Referred to as	pd-standard	pd-balanced	pd-ssd
Performance - Sequential IOPS (Big Data/Batch)	Good	Good	Very Good
Performance - Random IOPS (Transactional Apps)	Bad	Good	Very Good
Cost	Cheapest	In Between	Expensive
Use cases	Big Data (cost efficient)	Balance between cost and performance	High Performance

Persistent Disks - Snapshots

In28 Minutes

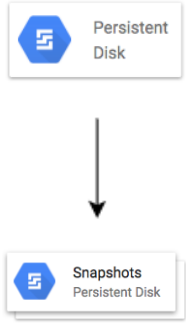
- Take **point-in-time snapshots** of your Persistent Disks
- You can also schedule snapshots (configure a schedule):
  - You can also auto-delete snapshots after X days
- Snapshots can be Multi-regional and Regional
- You can share snapshots across projects
- You can create new disks and instances from snapshots
- Snapshots are **incremental**:
  - Deleting a snapshot **only deletes data which is NOT needed** by other snapshots
- Keep similar data together on a Persistent Disk:
  - Separate your operating system, volatile data and permanent data
  - Attach multiple disks if needed
  - This helps to better organize your snapshots and images



Persistent Disks - Snapshots - Recommendations

In28 Minutes

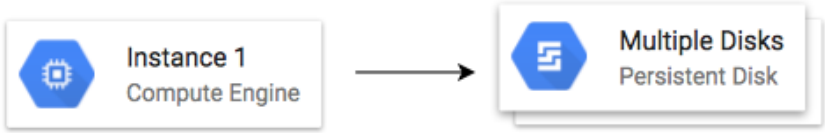
- **Avoid** taking snapshots more often than once an hour
- Disk volume is available for use **but Snapshots reduce performance**
  - (RECOMMENDED) Schedule snapshots during off-peak hours
- Creating snapshots from disk is faster than creating from images:
  - But creating disks from image is faster than creating from snapshots
  - (RECOMMENDED) If you are repeatedly creating disks from a snapshot:
    - Create an image from snapshot and use the image to create disks
- Snapshots are **incremental**:
  - BUT you don't lose data by deleting older snapshots
  - Deleting a snapshot **only deletes data which is NOT needed** by other snapshots
  - (RECOMMENDED) Do not hesitate to delete unnecessary snapshots



Mounting a Data Persistent Disk on a GCE VM

- Steps to attach a newly created Persistent Disk with an already running VM:
  - A: Attach Disk to running or stopped VM
    - `gcloud compute instances attach-disk INSTANCE_NAME --disk DISK_NAME`
  - B: Format the disk
    - 1: List disks attached to your VM
      - `sudo lsblk`
    - 2: Format to file format of your choice (example: ext4 file system)
      - `sudo mkfs.ext4 -m 0 -E lazy_itable_init=0,lazy_journal_init=0,discard /dev/sdb`
  - C: Mount the disk
    - 1: Create the directory to mount to
      - `sudo mkdir -p /mnt/disks/MY_DIR`
    - 2: Mount the disk
      - `sudo mount -o discard,defaults /dev/sdb /mnt/disks/MY_DIR`
    - 3: Provide permissions

Resizing Data Persistent Disks

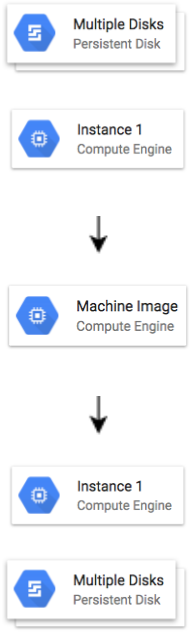


- Step I: Resize the Disk
  - `gcloud compute disks resize DISK_NAME --size DISK_SIZE`
- Step II: Take a snapshot (Just for backup in case things go wrong!)
- Step III: Resize the file system and partitions
  - `ext4: sudo resize2fs /dev/sdb`
  - `xfs: sudo xfs_growfs /dev/sdb`

Playing with Machine Images

In28 Minutes

- (Remember) **Machine Image** is different from Image
- **Multiple disks can be attached** with a VM:
  - One Boot Disk (Your OS runs from Boot Disk)
  - Multiple Data Disks
- An image is created from the boot Persistent Disk
- HOWEVER, a Machine Image is created from a VM instance:
  - Machine Image **contains everything you need** to create a VM instance:
    - Configuration
    - Metadata
    - Permissions
    - Data from one or more disks
- **Recommended for** disk backups, instance cloning and replication



Let's Compare

In28 Minutes

Scenarios	Machine image	Persistent disk snapshot	Custom image	Instance template
Single disk backup	Yes	Yes	Yes	No
Multiple disk backup	Yes	No	No	No
Differential backup	Yes	Yes	No	No
Instance cloning and replication	Yes	No	Yes	Yes
VM instance configuration	Yes	No	No	Yes

https://cloud.google.com/compute/docs/machine-images

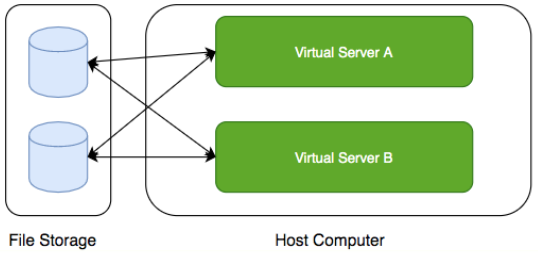
Storage - Scenarios - Persistent Disks

In28 Minutes

Scenario	Solution
You want to improve performance of Persistent Disks (PD)	Increase size of PD or Add more PDs. Increase vCPUs in your VM.
You want to increase durability of Persistent Disks (PD)	Go for Regional PDs (2X cost but replicated in 2 zones)
You want to take hourly backup of Persistent Disks (PD) for disaster recovery	Schedule hourly snapshots!
You want to delete old snapshots created by scheduled snapshots	Configure it as part of your snapshot scheduling!

Cloud Filestore

- **Shared cloud file storage**:
  - Supports NFSv3 protocol
  - Provisioned Capacity
- Suitable for **high performance** workloads:
  - Up to 320 TB with throughput of 16 GB/s and 480K IOPS
- Supports HDD (general purpose) and SSD (performance-critical workloads)
- **Use cases** : file share, media workflows and content management



Review - Global, Regional and Zonal Resources

In28 Minutes

- **Global**
  - Images
  - Snapshots
  - Instance templates (Unless you use zonal resources in your templates)
- **Regional**
  - Regional managed instance groups
  - Regional persistent disks
- **Zonal**
  - Zonal managed instance groups
  - Instances
  - Persistent disks
    - You can attach a disk only to instances in the same zone as the disk

Storage - Scenarios

Scenario	Solution
You want Very High IOPS but your data can be lost without a problem	Local SSDs
You want to create a high perfomance file sharing system in GCP which can be attached with multiple VMs	Filestore
You want to backup your VM configuration along with all its attached Persistent Disks	Create a Machine Image
You want to make it easy to launch VMs with hardened OS and customized software	Create a Custom Image