Cloud Storage Models

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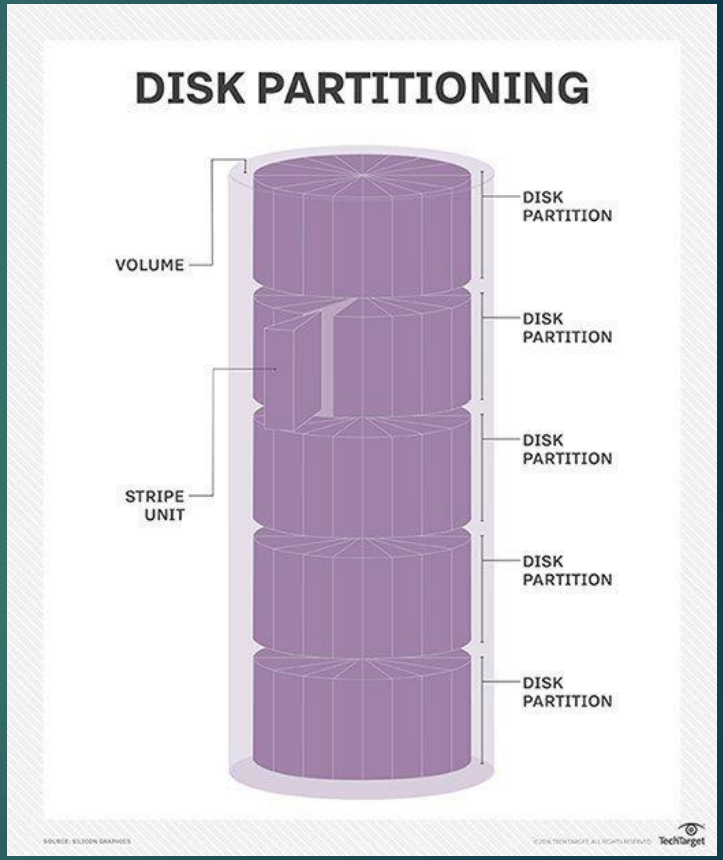
VM Block Storage Types: Ephemeral vs Persistent Disks

- When a VM is created, by default it has some ephemeral disks
  - Ephemeral disks are not permanent
  - They get automatically created when the VM is created
  - They get deleted when the VM is deleted.
  - Used for OS, paging, swap by default
- Limitations of ephemeral disks
  - Since they are on local disk of physical server
    - They cannot be detached from one VM and attached to another VM
    - Not permanent
- We will focus on persistent storage: used for DBs, etc.

Volume Manager

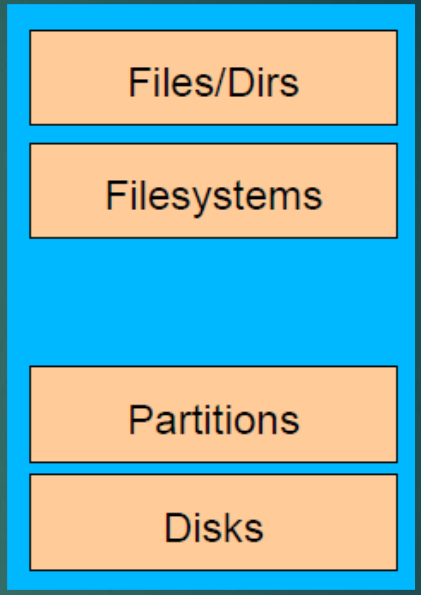
Storage devices: overview

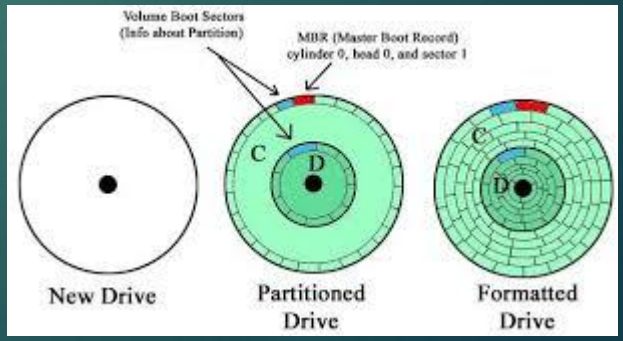
- Data generally stored on disk
- How is the disk organized?
  - Modeled as a continuous row of logical blocks
- What are partitions?
  - Blocks are broken in sections called partitions
  - Can be
    - Single partition covering entire disk
    - Several partitions on a disk
  - Why partition – if disk error, lose only part of the data
- Restriction
  - Continuity is a must
  - Once created, cannot change



What does the stack look like?

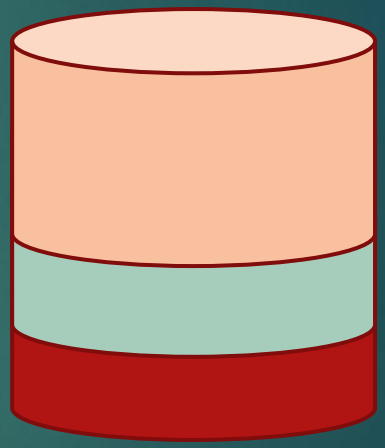
- Filesystems are created on Partitions
  - Requires a partition to be formatted.
  - Looks like the disk in the bottom right.
  - One filesystem == one partition
- Partitions are created using a utility like fdisk





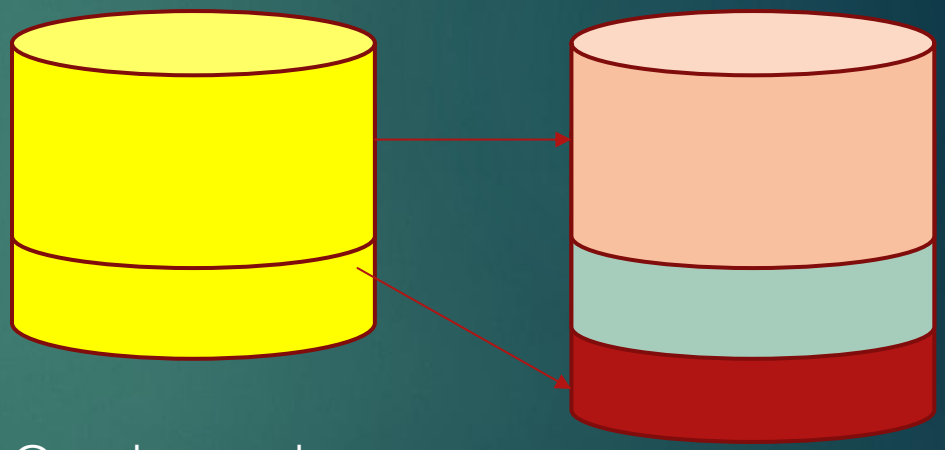
Class Exercise

- Filesystem on pink partition and pink is almost full
- Green partition is empty
- How can filesystem be extended to use green partition also?



Solution

- Introduce a concept of a volume
- Virtualizes the blocks across non-contiguous partitions
- Filesystem is created on the volume
  - Volume can grown/shrink magically.



Create a volume

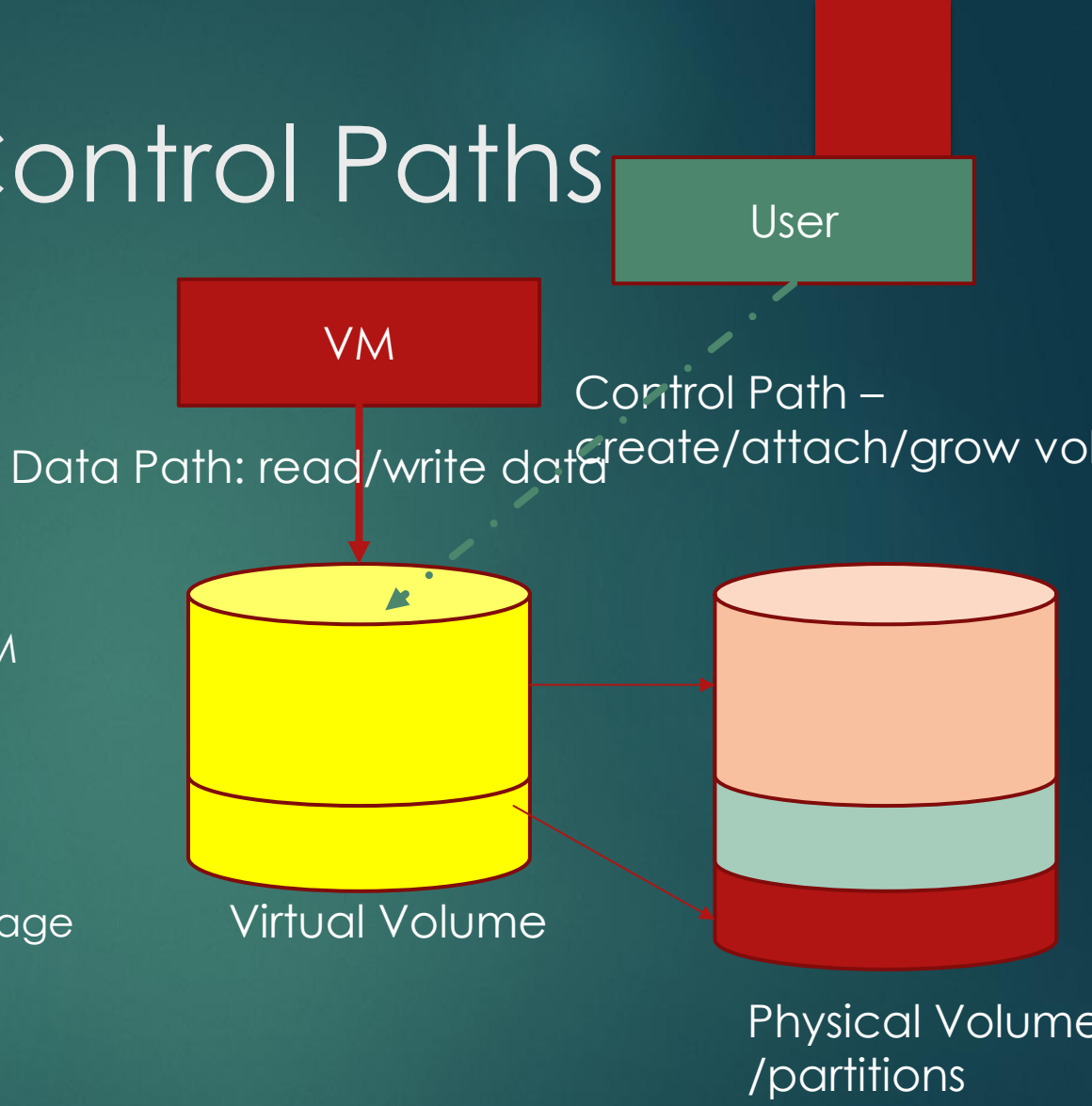
Map volume blocks to Partition blocks

Storage stack

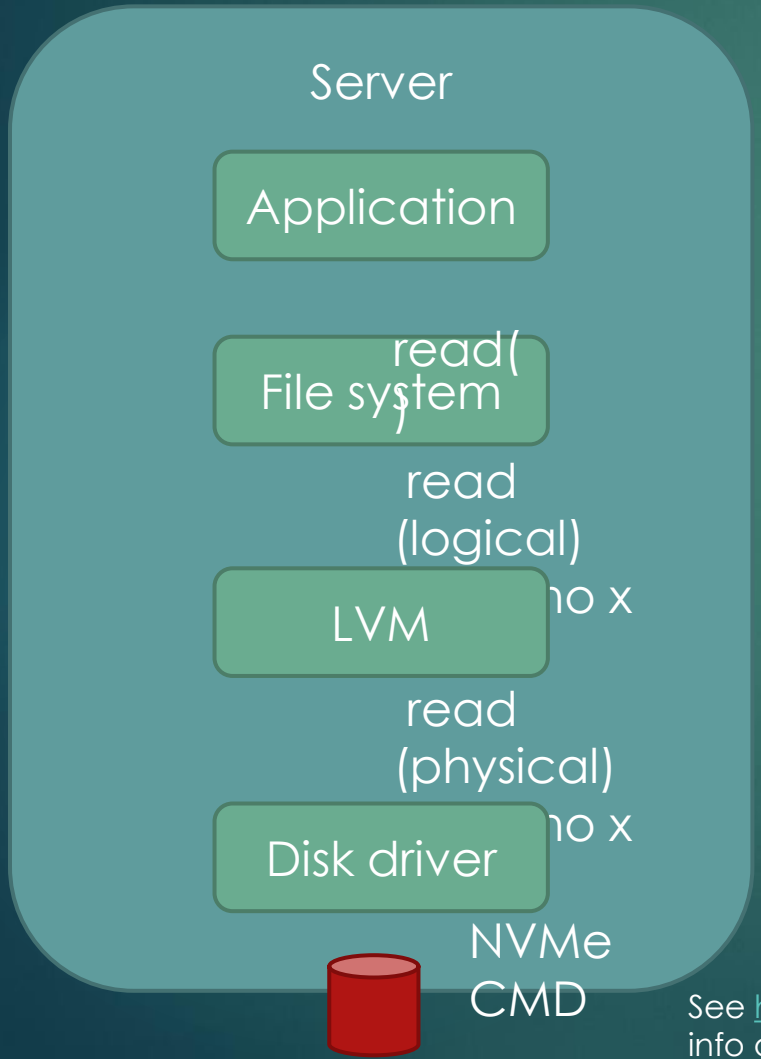
- Now our storage stack looks something like
- Linux
  - Logical Volume Manager (https://opensource.com/business/16/9/linux-users-guide-lvm)

Data and Control Paths

- Need two paths
- Data Path
  - On which the data flows from disk to VM
  - This is where the VM stores it's user data
- Control Path
  - Commands to manage the volume
  - Create volume
  - Attach to the VM



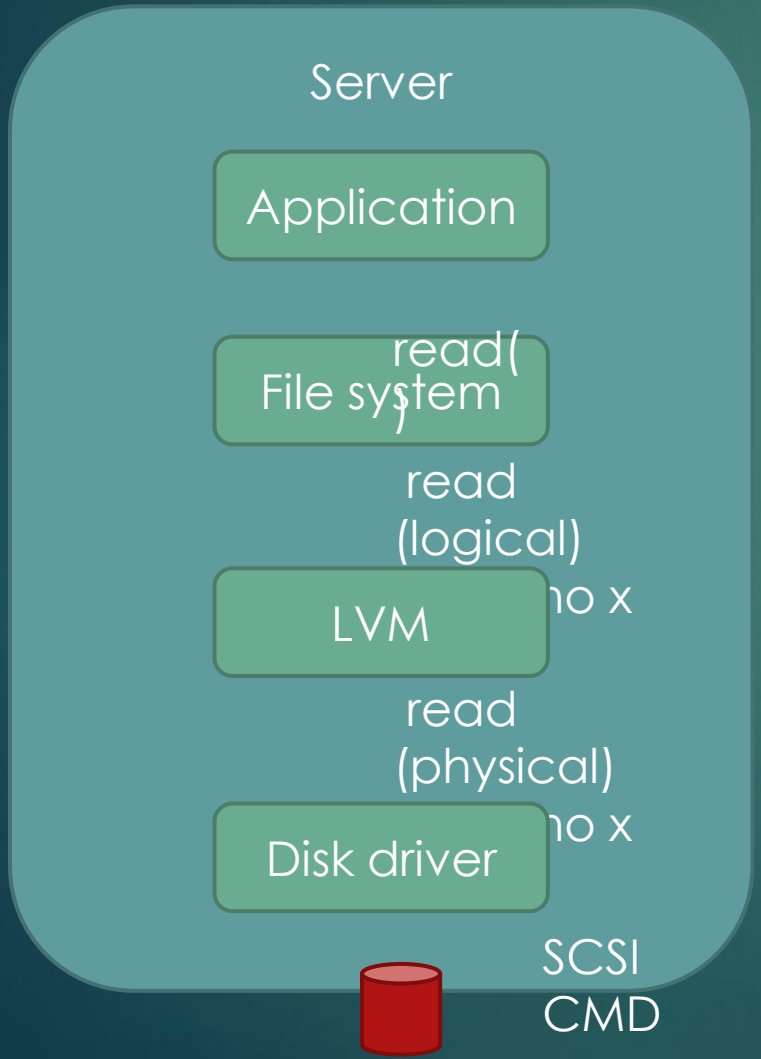
OS Storage Virtualisation



- LVM = Logical Volume Manager
  - Provides storage virtualisation in the OS
  - Create logical disks from the physical disks attached to the server
  - File system thinks it's running on a physical disk
  - LVM converts block number on logical disk to a block number on physical disk
- NVMe – Non Volatile Memory Express

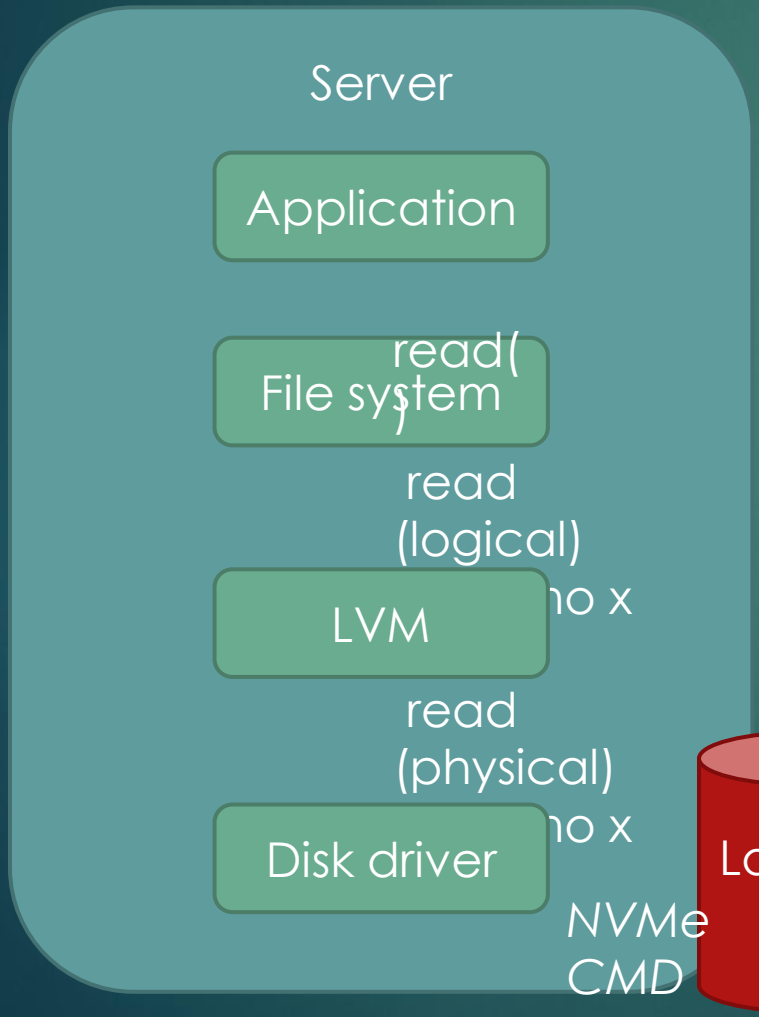
See http://www.tuxradar.com/content/lvm-made-easy for more info on LVM

Class Exercise(10 minutes)



- We know that the cloud (Cinder) provides *logical disks*
- How can we run an OS (like the one on the left) with cloud virtual disks?

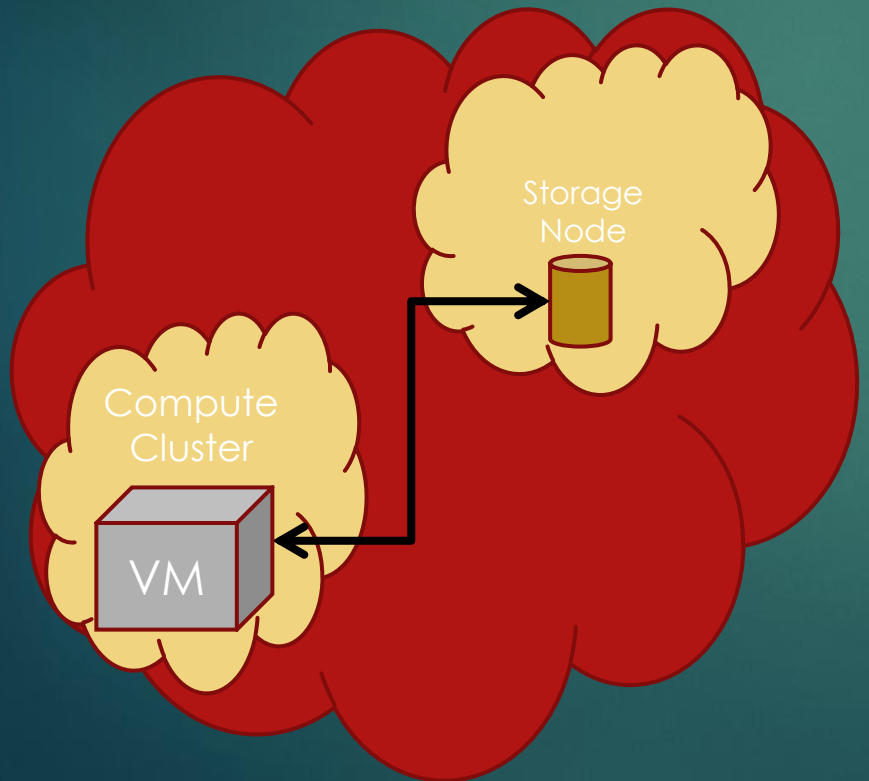
Answer to Exercise 1

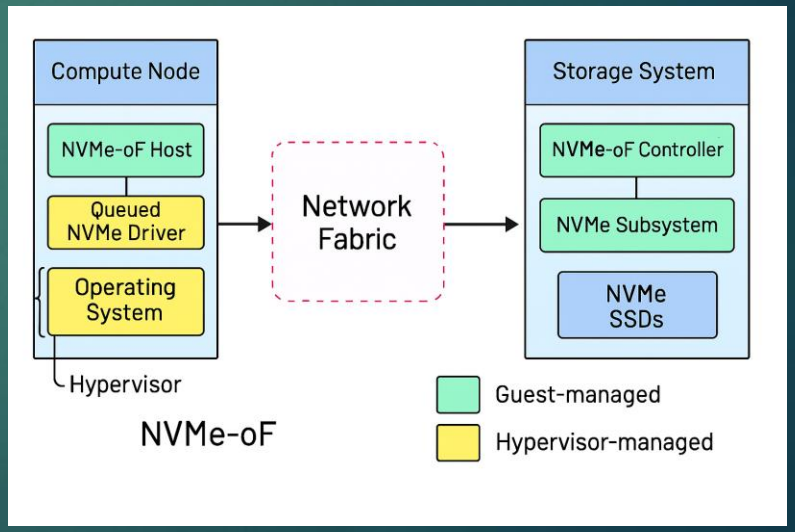


- Another virtualization layer
- We don't want to change the OS
  - Disk driver thinks it's connected to a physical disk
  - The SCSI command has to be sent to Cloud Storage Virt Layer
  - This has to be converted to a command to the physical disk
  - We now have two layers of virtualisation

Overview

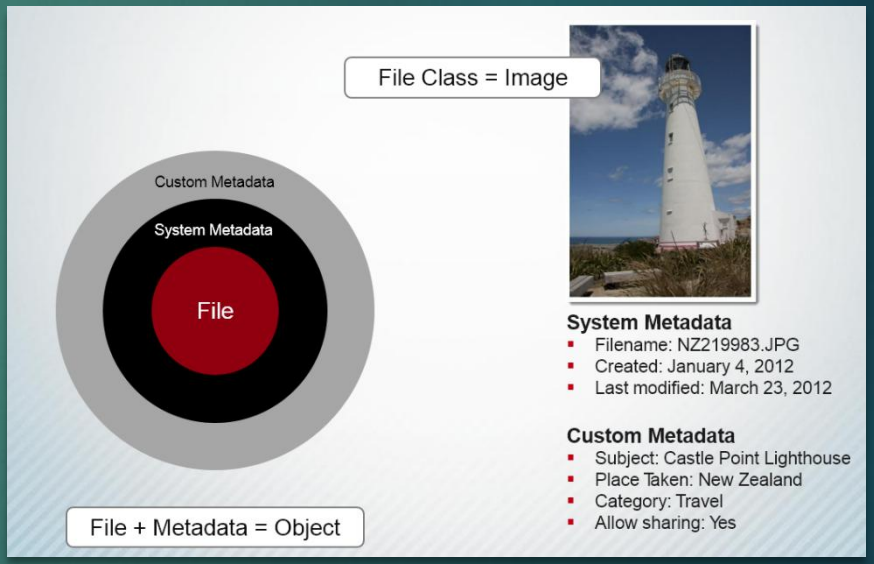
- How is the virtual disk connected to the VM?





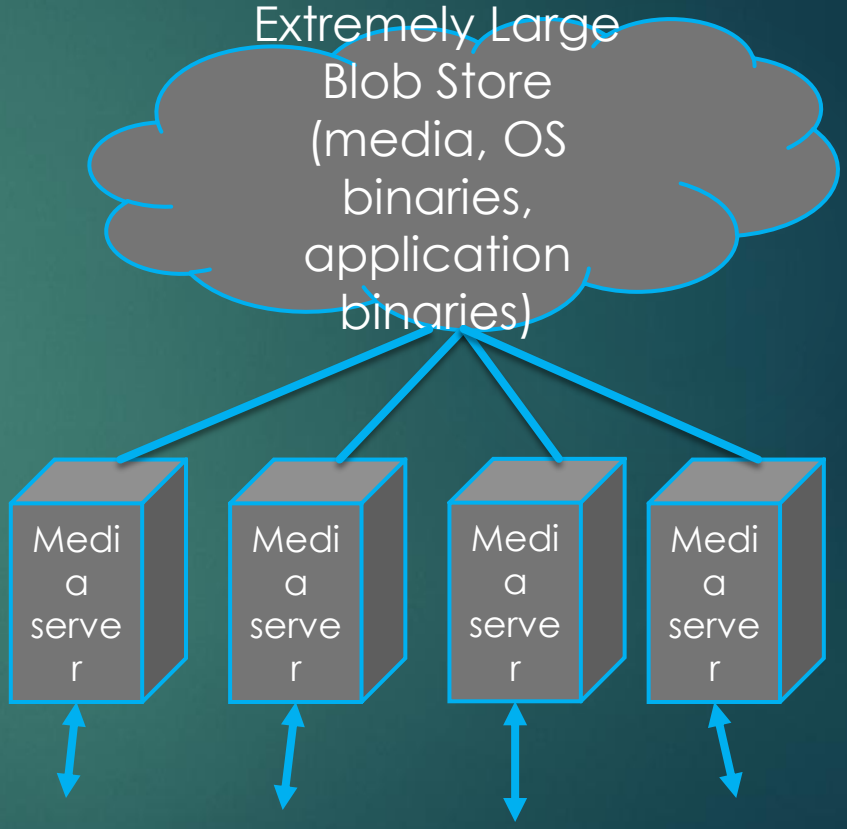
Object Storage

- What is an object?
  - An object is the basic storage unit in an object store.
  - Unlike files, objects have unique keys and exist in a flat namespace without directories.
  - Objects can be large and are immutable, with updates creating new versions.



Storage 2: Object Store (aka Blob Store)

- Similar to Dropbox or Google Drive
  - Stores files
  - Retrieved by application for usage
- Referenced by URL
- Typically <account>/<bucket>/<object name>
  - E.g., http://myaccount.blob.core.windows.net/container/object in Azure



Object Storage

What is an Object Store?

It's a flat storage architecture where data is stored in a single namespace without hierarchical folders.

Each piece of data is stored as an object, which includes:

Data (the actual content, e.g., an image, video, document).

Metadata (descriptive information about the object, e.g., size, content type, creation date, custom tags).

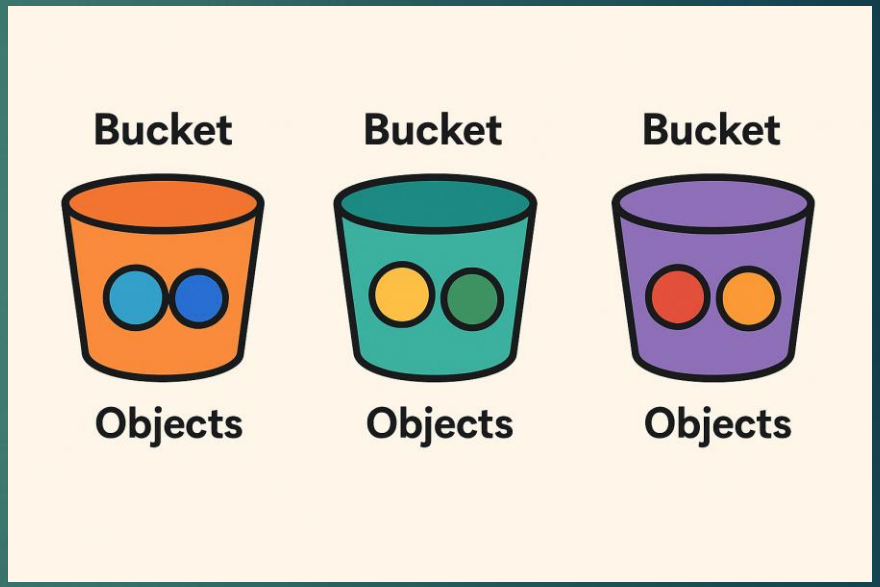
Unique Identifier (a globally unique ID or key used to retrieve the object).

Examples: Amazon S3, Azure Blob Storage, Google Cloud Storage, MinIO, Ceph.

Object Storage

Key Features of Object Storage

1. Handles billions of objects easily
2. Replicates data across multiple nodes or regions
3. Provides access via RESTful APIs (e.g., S3 API)
4. Suitable for backups, media storage, big data, analytics, archives
5. Objects are stored in buckets



Accessing an object

- https://<bucket-name>.s3.amazonaws.com/<object-key>

- Object name can have a '/' in it so it looks like a directory structure
- Bucket → similar to a folder and includes user id
- Object → what you want to store.

Object Storage Architecture