Cloud Storage 101

DATA STORAGE CONCEPTS AND CLOUD STORAGE OPTIONS

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TECHNOLOGY THAT POWERS MISSIONS

Licenses & Certifications

AWS Certified Solutions Architect - Associate

Amazon Web Services

Issued Dec 2018 · Expires Dec 2021

Credential ID RRW33LYK1E1Q1X38

See credential

Microsoft Certified Azure Administrator Associate

Microsoft

Issued Dec 2019 · Expires Dec 2021

Credential ID H292-3377

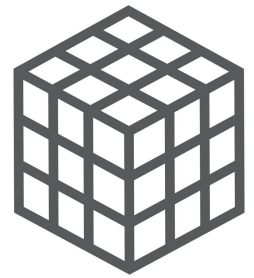
Professional Cloud Architect

Google Cloud Platform Certified

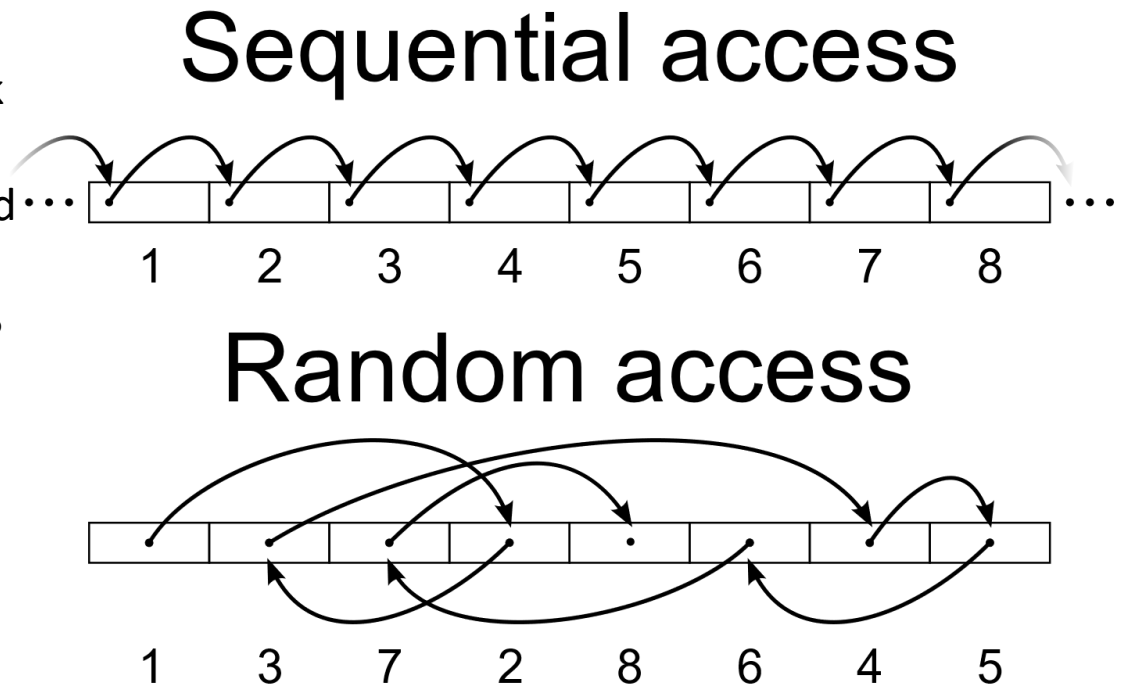
Issued Apr 2019 · Expires Apr 2021

Credential ID 12807815

Measuring Storage Performance
I/O Patterns, Block Sizes, Read/Write Ratios



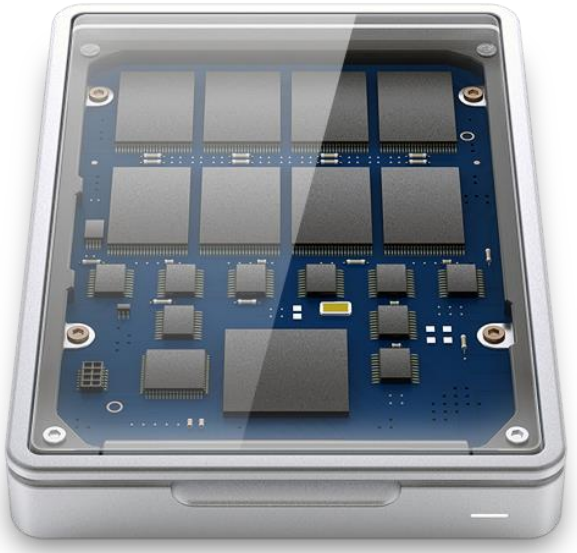
- Sequential I/O means to access the very next adjacent block in order on the media
- Random I/O means to access another block that is not adjacent to current block
- IOPS is Input/Output Operations Per Second
- An I/O operation is to request a read or write of a certain block size, i.e. 4KB, 256KB
- ~~Block size in storage performance is how large of a block is being requested for IOPS~~
- ~~Storage performance is measured by specifying a ratio of sequential to random access patterns, block size, and read/write ratio~~
- ~~i.e. 100% sequential, 0% random, 1KB block size, 100% read, 0% write~~



Storage Types

Magnetic

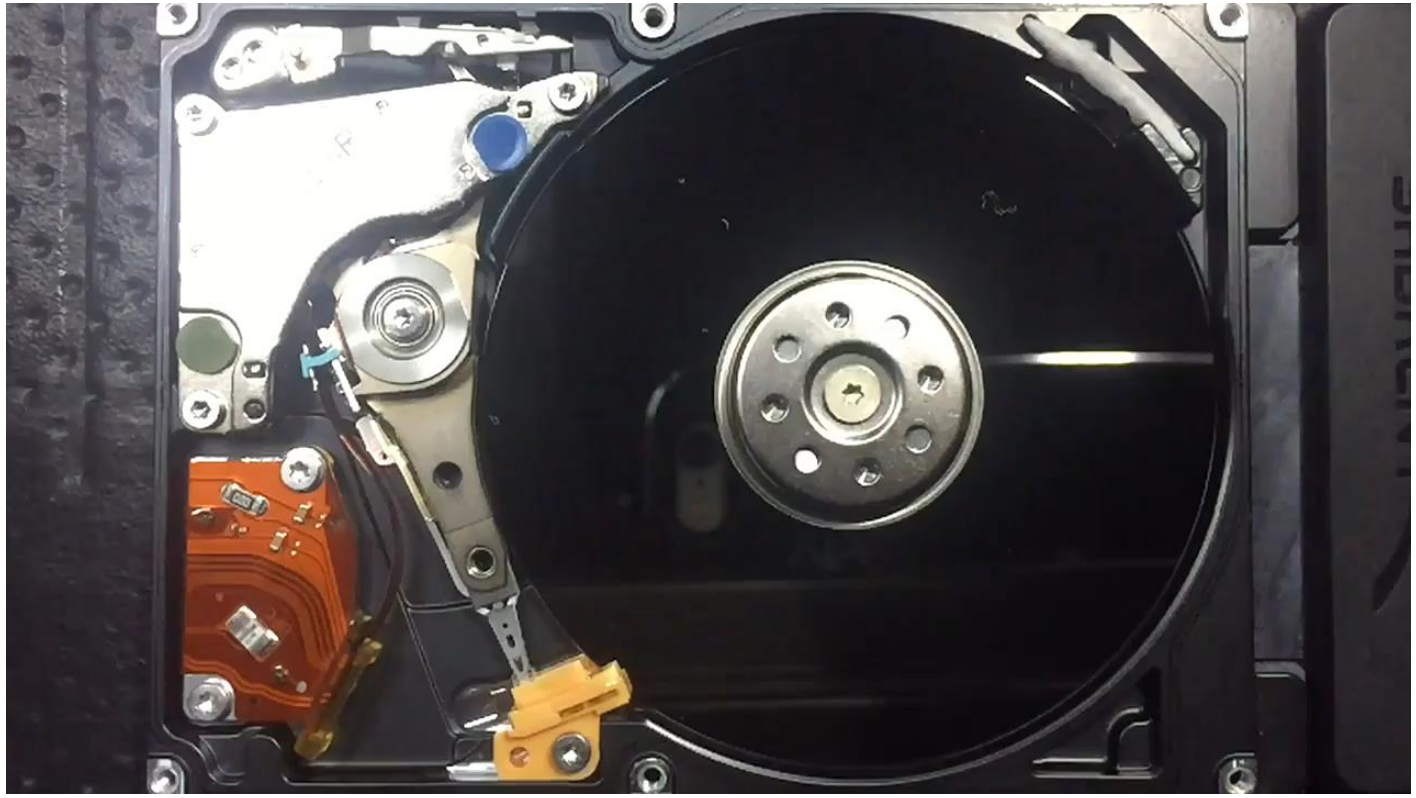
Solid State

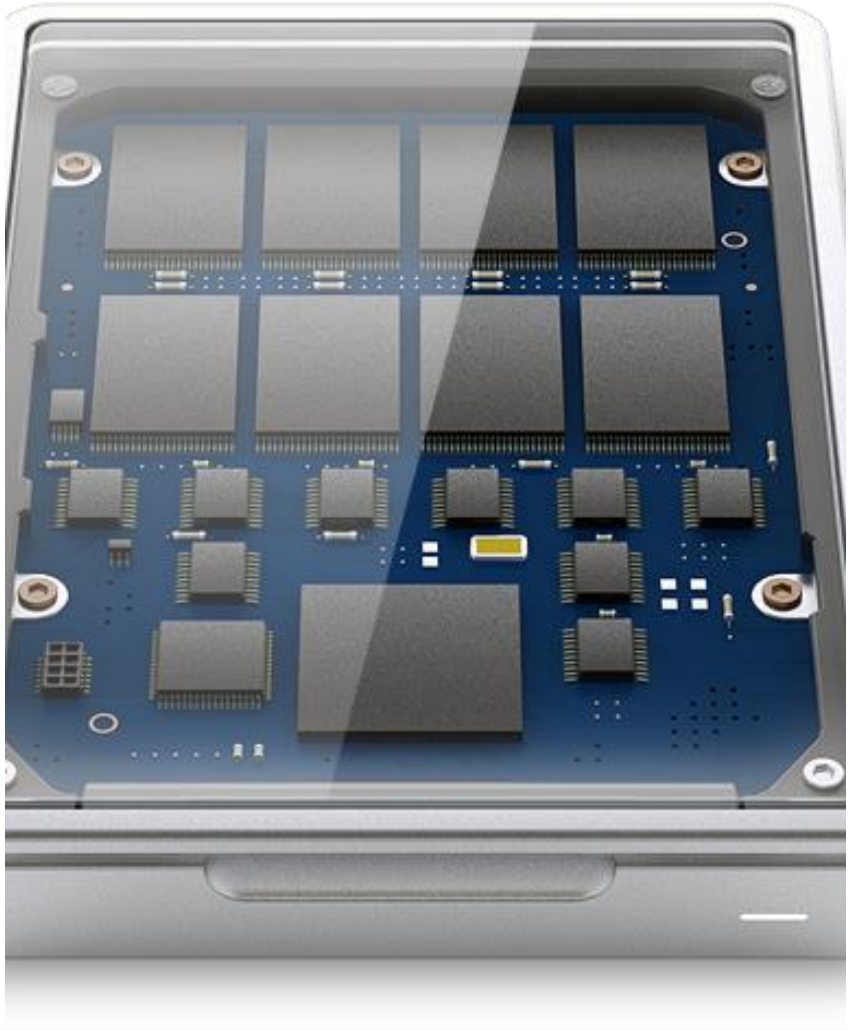


Magnetic Storage (HDD)

- High capacity (up to 16TB)
- Low price (2 cents per gigabyte)
- Orders of magnitude lower IOPS performance than SSD
- ~220MB/sec maximum throughput
- ~4ms average latency
- 600 maximum IOPS
- Good at sequential I/O, horrible at random I/O

Magnetic Storage Latency



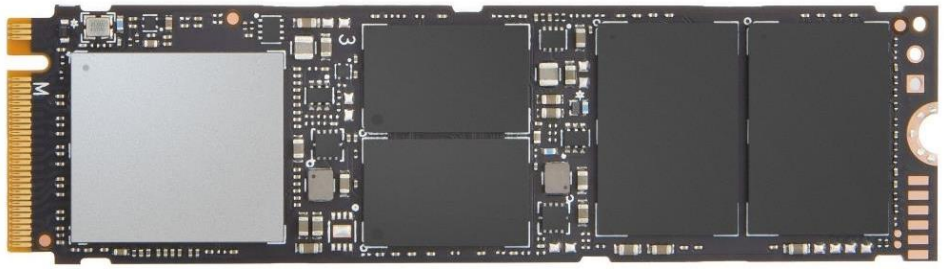


Solid State Storage (SSD)

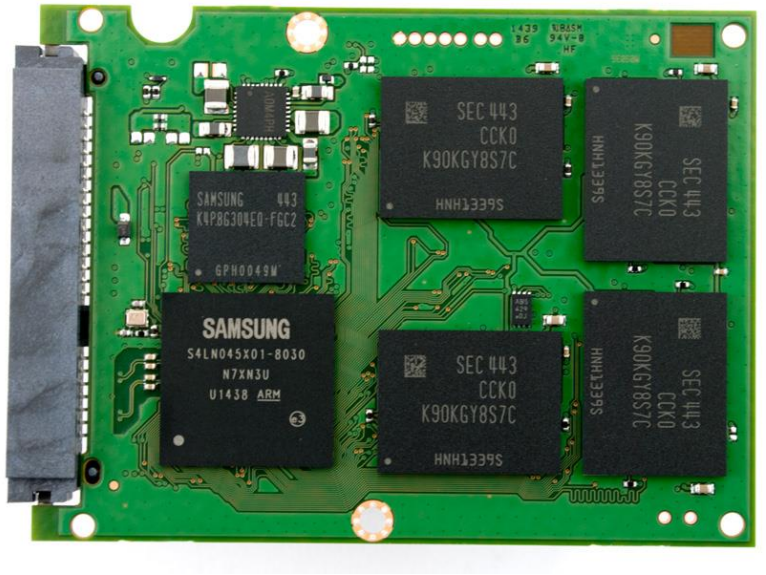
- Medium capacity (commonly up to 2TB)
- Higher price (11 cents per gigabyte)
- Orders of magnitude higher IOPS performance than HDD
- ~550MB/sec maximum throughput for SATA
- 4GB/sec max throughput for NVMe
- ~20µs average latency
- 500,000 maximum IOPS
- Good for sequential and random I/O

Solid State Storage Latency

M.2 NVMe SSD

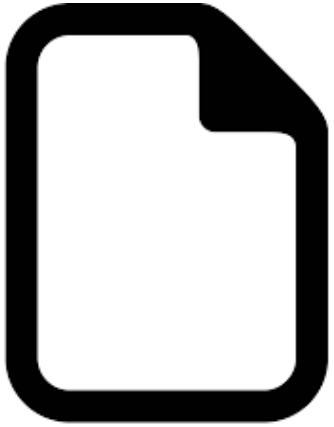


2.5 inch SATA SSD with case removed



Three ways to address storage

Block

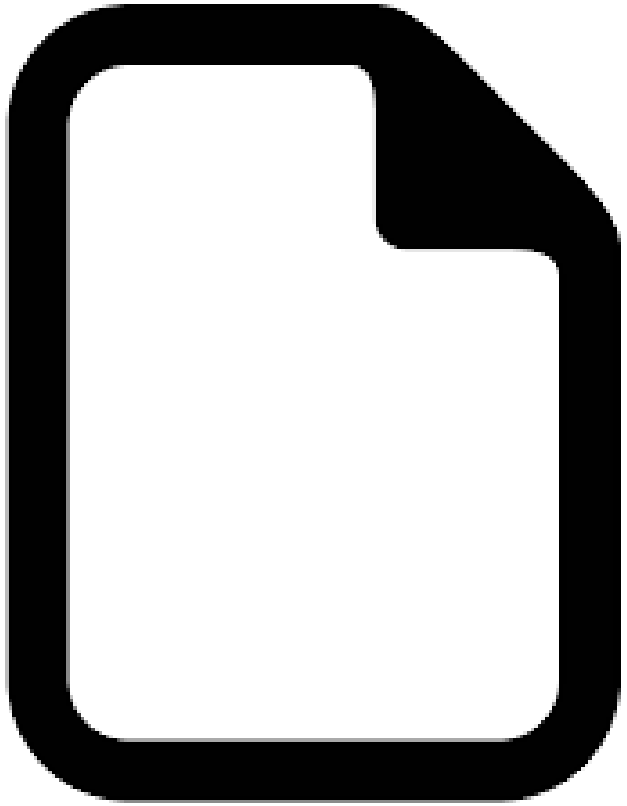


File

Object

Block Storage

- Accessed at the device level by drivers
- Connected to the system via SATA, SAS, USB, FC, iSCSI, etc.
- Virtual hard disk files can also be presented as block devices
- Presented to and controlled by operating system or hypervisor
  - Windows, Linux, VMware, Hyper-V, AWS EC2, Azure VM, etc.
- Formatted with file system such as NTFS, EXT4, VMFS, etc.
- File system's purpose converts "physical" geometry into files
- ALL storage is eventually block-based
- Examples include local drives, SD cards, USB sticks, VMware VMDK files, Hyper-V VHDX files, fiber channel and iSCSI LUNs, AWS EBS and Instance Store, Azure managed disks, Google Cloud Persistent Disks and Local SSDs



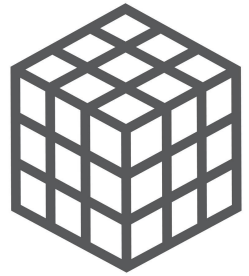
File Storage

- Hierarchical with folders
- Accessed over a network
- Only interacts with the storage system at the file level
- Block storage layer managed behind the scenes by another host
- Protocols include SMB and NFS
- Read, Write, **Modify**, Delete
- Examples – Windows SMB file shares, SAMBA open source file shares, Linux NFS targets, NetApp filers, AWS EFS, AWS FSx for Windows Server, Azure Files, Google Cloud Filestore

Object Storage

- Flat address space – no folders
- Hierarchy can be simulated by prefixes like “photos/” which aren’t truly folders
- Accessed over a network via API calls (GET, PUT, POST, COPY, DELETE, etc.)
- Protocol primarily HTTPS, REST web service interface
- Read, Write, Delete (no Modify!)
- Good for storing data that doesn’t frequently change i.e. logging, big data analytics, static web content, backups and archives
- Not good for high change rate data i.e. relational databases
- Examples – AWS S3, AWS S3 Glacier, Azure Blob, Google Cloud Storage

Block Storage Options



Used for Virtual Machine storage only – not for network or cloud native app storage

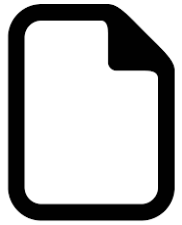
Examples: AWS EBS (Elastic Block Storage) – Azure managed disks – Google Cloud persistent disks

Volume type, size, and IOPS can be dynamically increased as needed up to volume maximums

SSD or HDD options – different performance, capacity, and costs

Ephemeral storage options mostly free – Good for temporary files like SQL Server tempdb, static web content that is synced during instance startup for auto scaling groups, page files, log files that aren’t needed keep long-term

File Storage Options



Used for network storage only – not for Virtual Machine or cloud native app storage

Examples: AWS EFS (Elastic File Storage) – AWS FSx for Windows File Server – AWS File Gateway – Azure Files – Google Cloud Filestore

SMB and NFS file shares and network drives as a service – no underlying OS to manage

Fully standards compatible, *unlimited* storage, accessible via cloud or on-premises resources

AWS EFS is an NFSv4 service and Google Cloud Filestore is an NFSv3 service

AWS FSx for Windows Files Server and Azure Files are SMB 3.1.1 services

Google Cloud has several partner solutions for file storage also available such as NetApp Cloud Volumes, Panzura, and Quobyte supporting NFSv3&4 and SMBv2&3 and Elastifile supporting NFSv3

Object Storage Options

Used primarily for cloud native apps – not for Virtual machine or network storage

Examples: AWS S3 – Azure Blob – Google Cloud Storage

Flat address space, *unlimited* storage, accessible via HTTPS REST web services interface

An instance in AWS S3 or Google Cloud Storage is called a **bucket**. An instance in Azure Blob storage is called a **container**. (binary large object)

Folders can be virtually represented by using prefixes like “photos/” or “photos/vacation/”

Accessible via web console, CLI, or programming API. Cannot be directly mounted as a file share.

Azure has the Storage Explorer application you can use to browse, upload/download, and otherwise administer all your storage types within their cloud.

Object Archive Storage Classes

Cost structure made for long-term archives - Very cheap to store, expensive to retrieve

AWS S3 Glacier, S3 Glacier Deep Archive, Azure cool and archive Blob storage tiers, Google Cloud Storage classes Nearline, Coldline, and Archive

The cheaper the storage class per-GB, the more expensive it is to retrieve it.

AWS S3 Glacier and Glacier Deep Archive is not immediately accessible. Hours to bring online.

Azure Blob warm and cool storage tiers immediately available. Archive is hours to bring online

Google Cloud Storage is always immediately available even in coldest tier.

AWS S3 Glacier Deep Archive & Azure Archive $0.00099 per GB, but Google Cloud Storage Archive $0.004 per GB