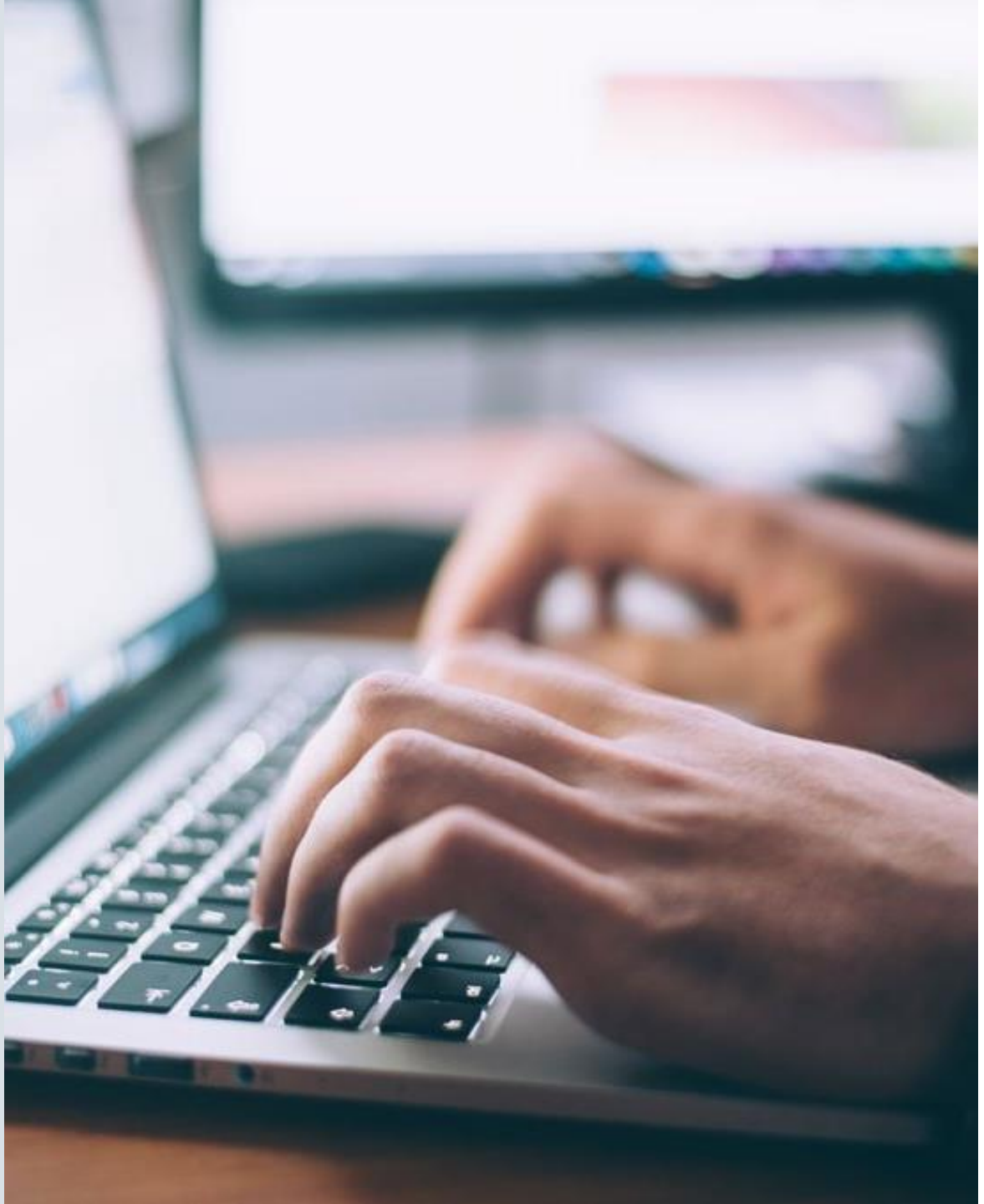
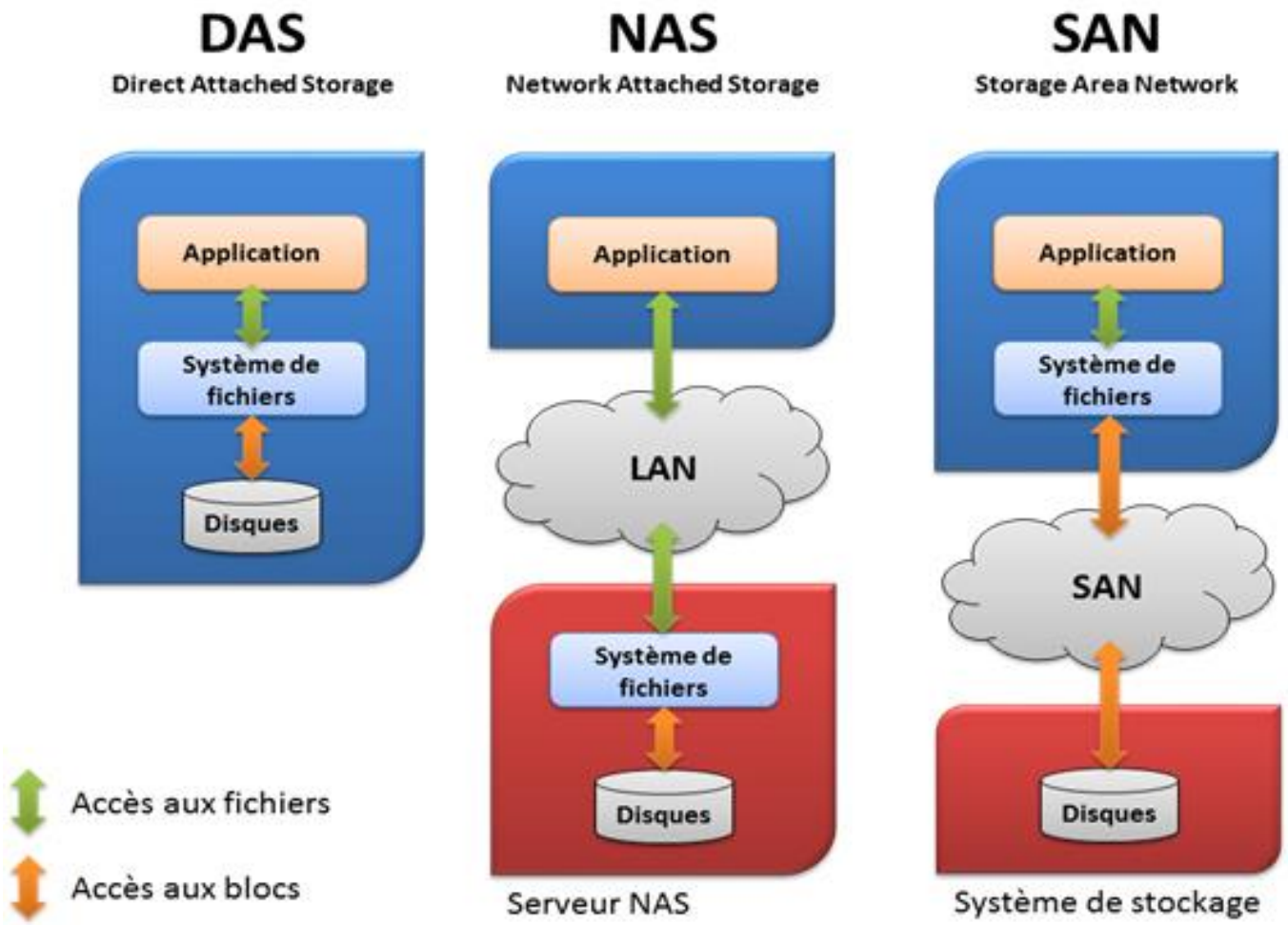
Stockage



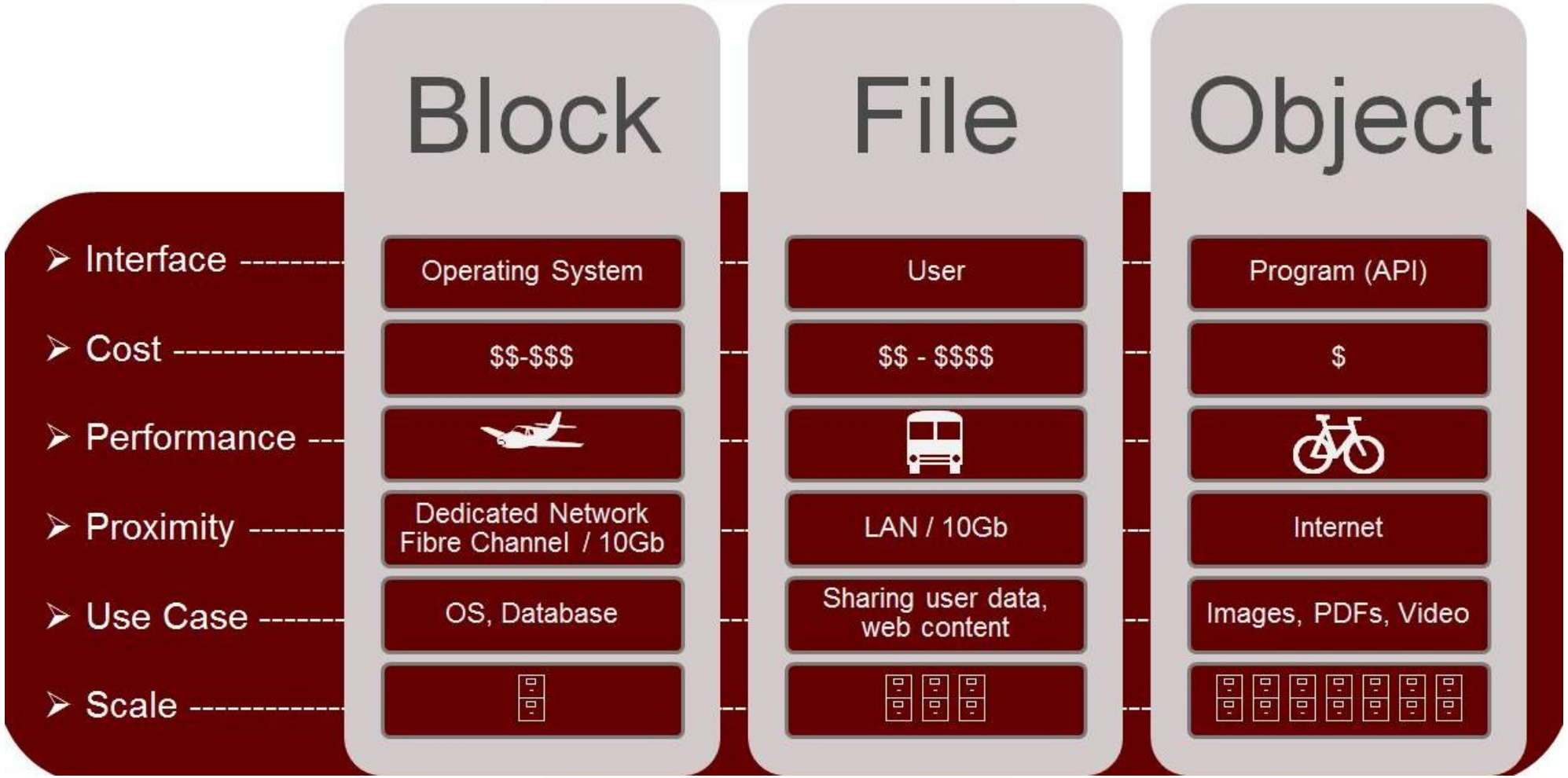
Storage

- What storage is ?
  - Architecture
  - Storage types
  - Protocols
- Fundamentals
  - Hardware
  - Logical
  - Resiliency
  - Storage Efficiency

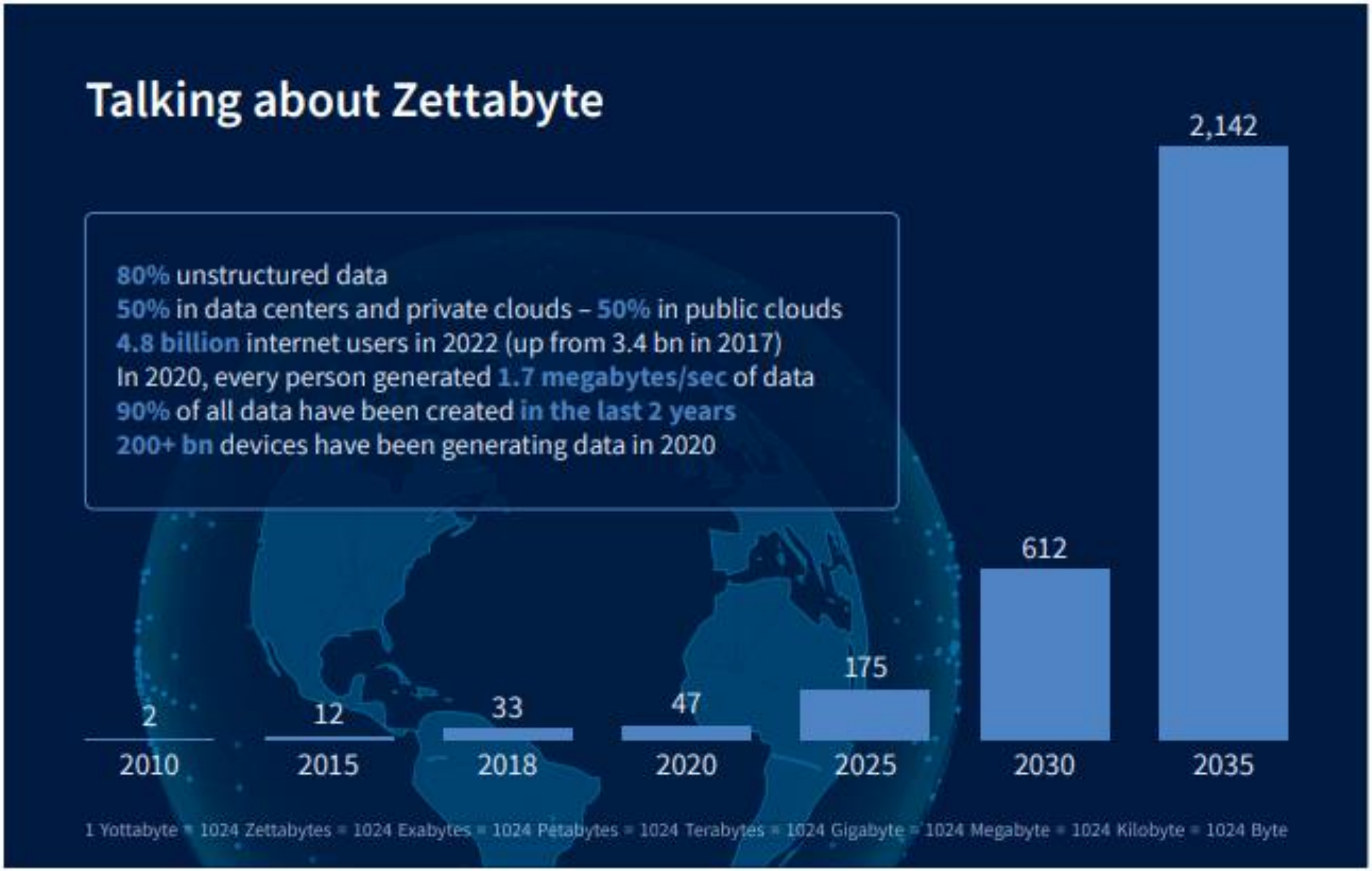
Storage


DAS
Direct Attached Storage
NAS
Network Attached Storage
SAN
Storage Area Network
Application
Système de fichiers
Disques
Application
LAN
Système de fichiers
Disques
Serveur NAS
Application
Système de fichiers
SAN
Disques
Système de stockage
Accès aux fichiers
Accès aux blocs

Storage

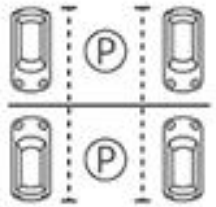

Block
File
Object
Interface
Cost
Performance
Proximity
Use Case
Scale
Operating System
$$-$$$
Dedicated Network
Fibre Channel / 10Gb
OS, Database
User
$$ - $$$$
LAN / 10Gb
Sharing user data,
web content
Program (API)
$
Internet
Images, PDFs, Video

Talking about Zettabyte



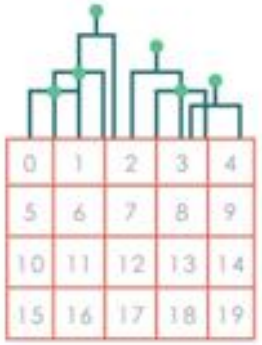
Storage

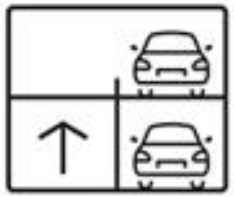
Block



Block storage
'Parking lot' metaphor—data stored in rigidly defined blocks—access by specific 'space' location

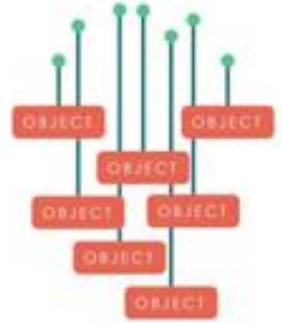
File





File storage
'Parking garage' metaphor—data arranged in hierarchical levels—retrace path to access

Object

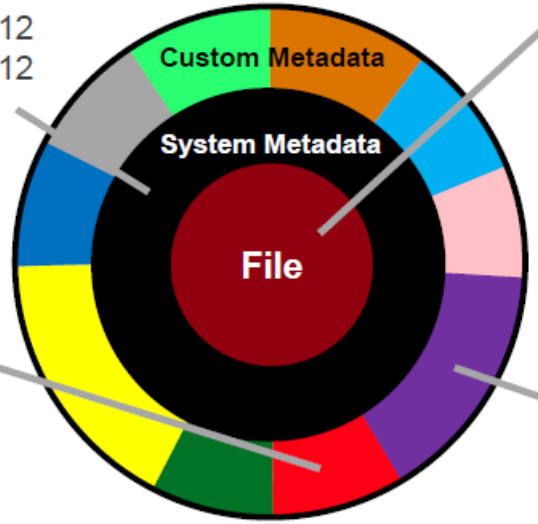


Object storage
'Valet parking' metaphor—no need to worry about storage details—easy to store and access data

Storage

- Enable apps and users to store their unique metadata separately from one another

System Metadata
- Filename: NZ219983.JPG
- Created: January 4, 2012
- Last modified: January 4, 2012



File + Metadata = Object

File Class = Image

Custom Metadata Annotation 1
- Subject: Tibia fracture
- Place Taken: ABC Hospital
- Department: Emergency Room
- Patient ID: 547968840

Custom Metadata Annotation 2
- Subject: Physical Therapy Consult
- Place Accessed: XYZ Therapy
- Insurance: PDQ #13342
- Patient ID: 547968840

Storage

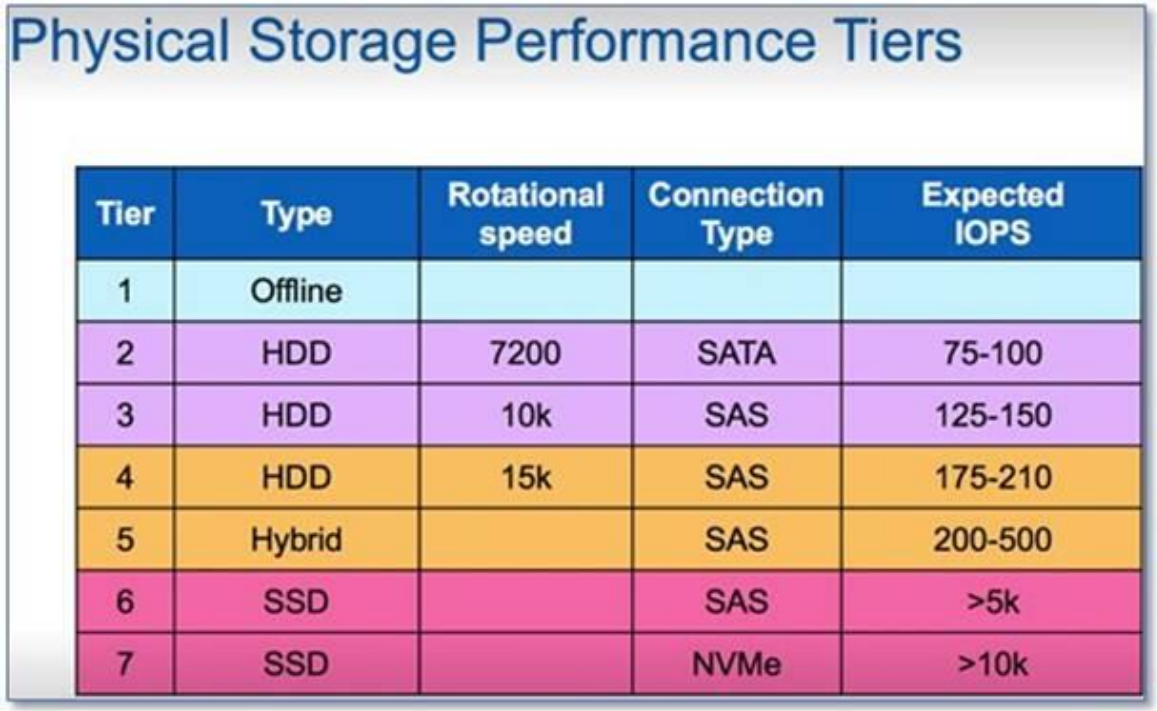
Data Archives	Media Repository	Web Data Repository
Long access latency tolerance Long retention periods Erasure coding	Large object sizes (+250MB) Distributed repositories High data rates for redistribution Time to first byte latency < 50ms	Small object (~KB) performance Searchable, scalable metadata High object counts

Storage

Architecture	Storage	Protocol
DAS	Block storage	SCSI
SAN	Block storage	FCP / iSCSI
NAS	File storage	NFS => Linux SMB => Windows
NAS	Object storage	S3 => Amazon Web Service (AWS) Blob => Azure

Storage

Media	Interface	Form factor	Capacity (e.g. 2022)	Price
HDD	SATA	3.5'' / 2.5''	30 TB	$
HDD	SAS	3.5'' / 2.5''	4 TB	$$
SSD	SAS	2.5'' / mSATA	8 TB	$$$$
SSD	NVMe	M.2	2 TB	$$$$$

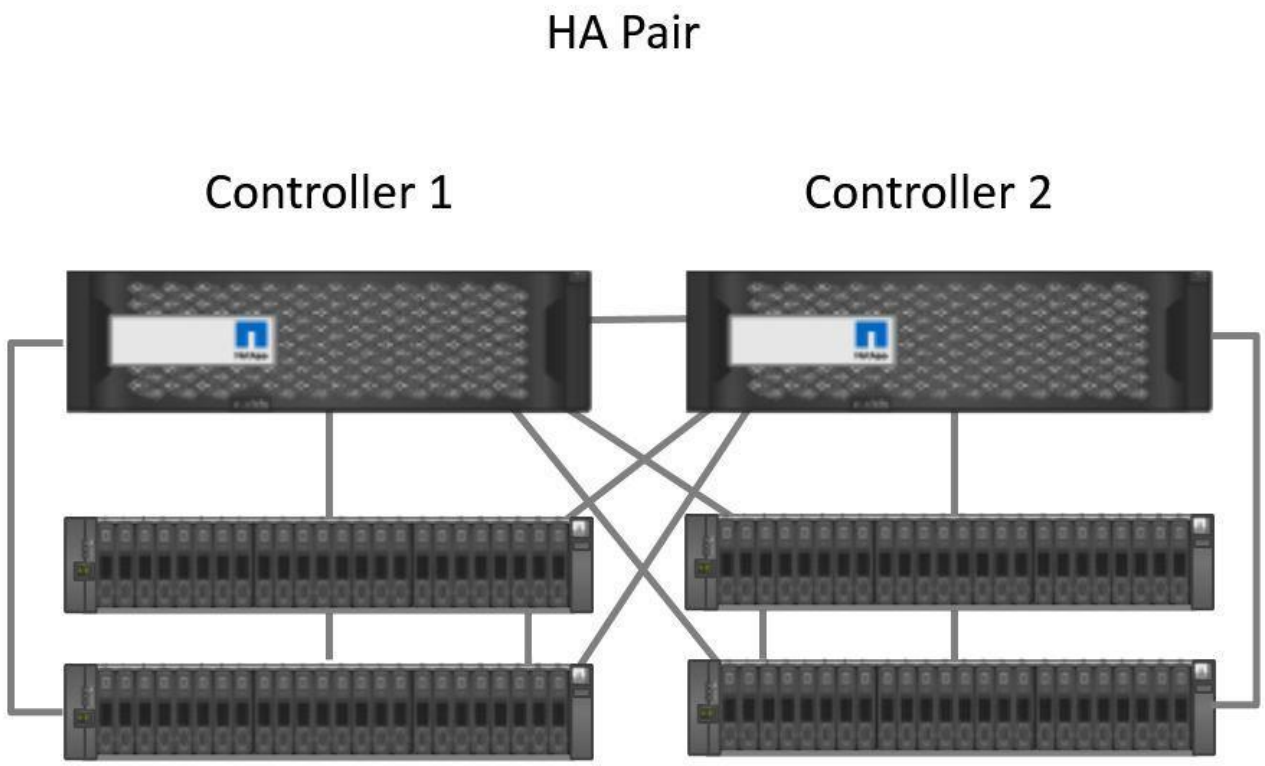


Knowledge check

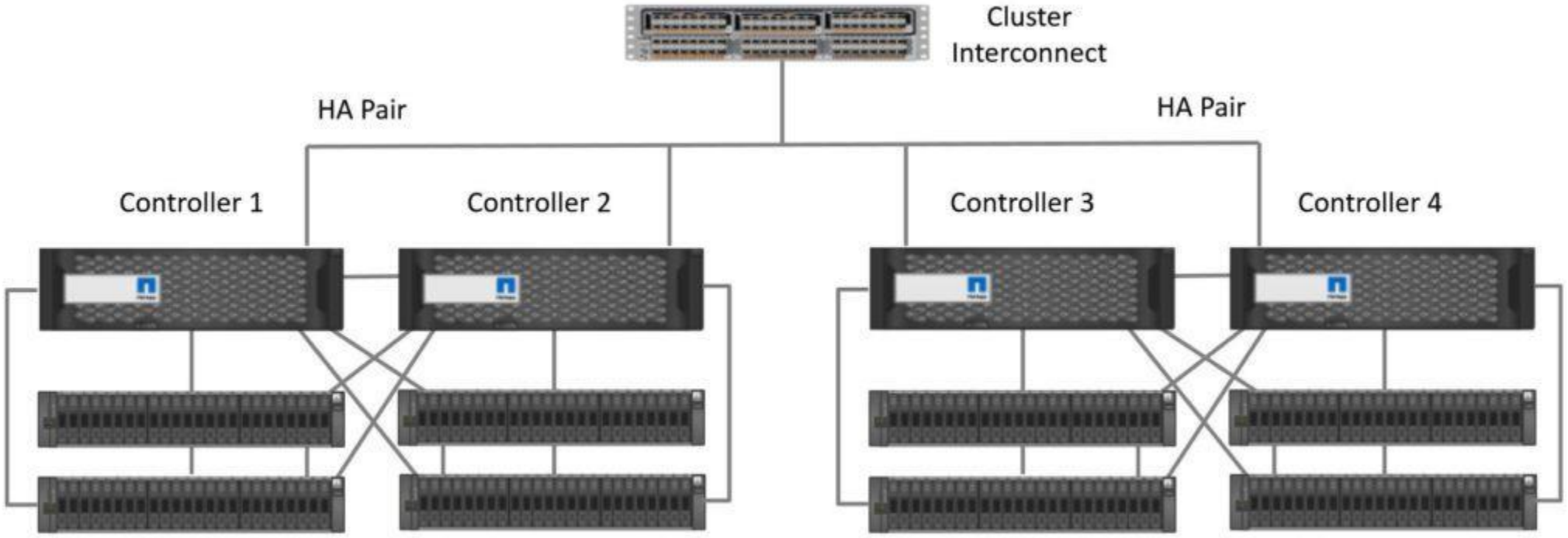
- Raid 0/1/3/5

Storage

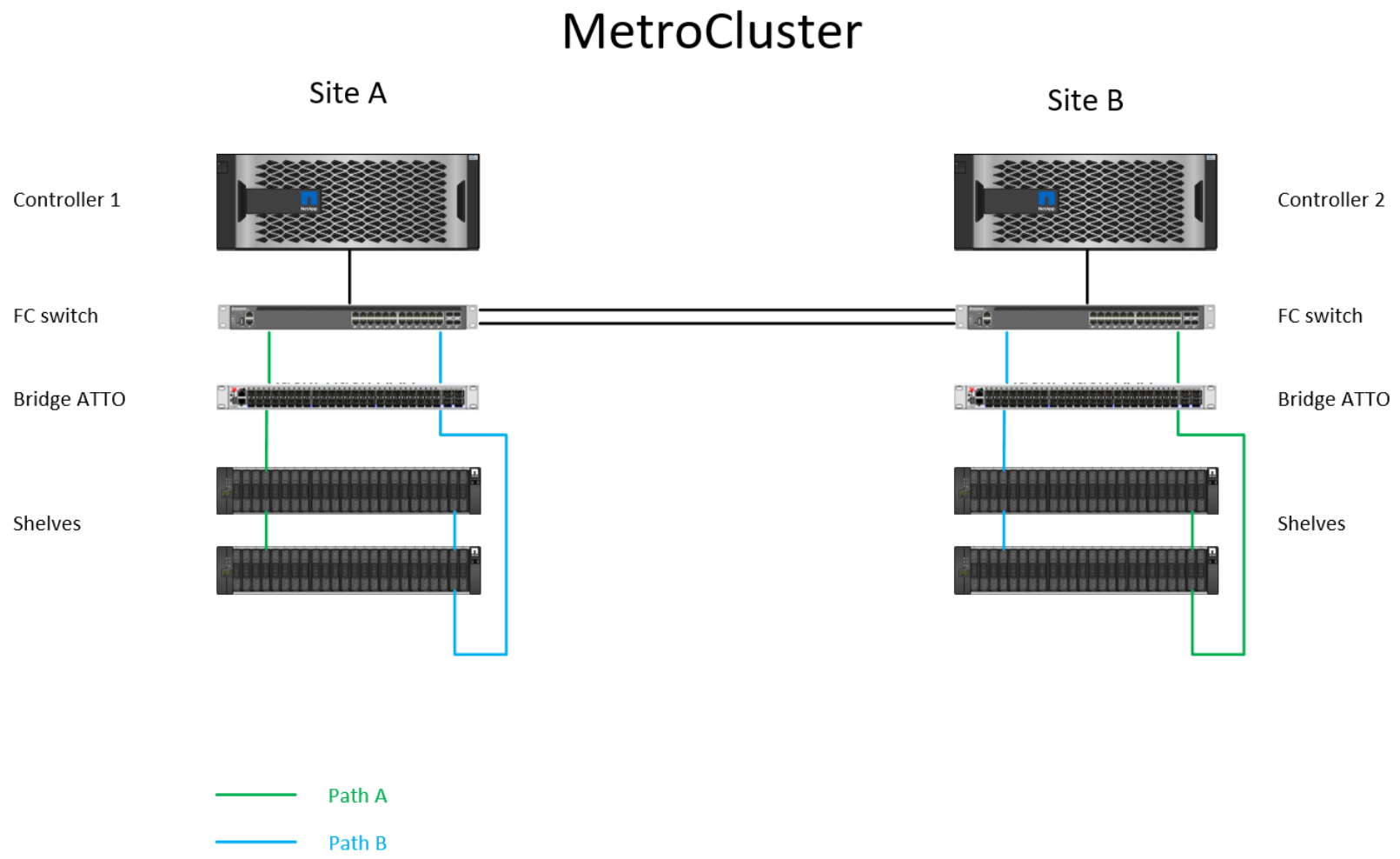
Storage enclosure



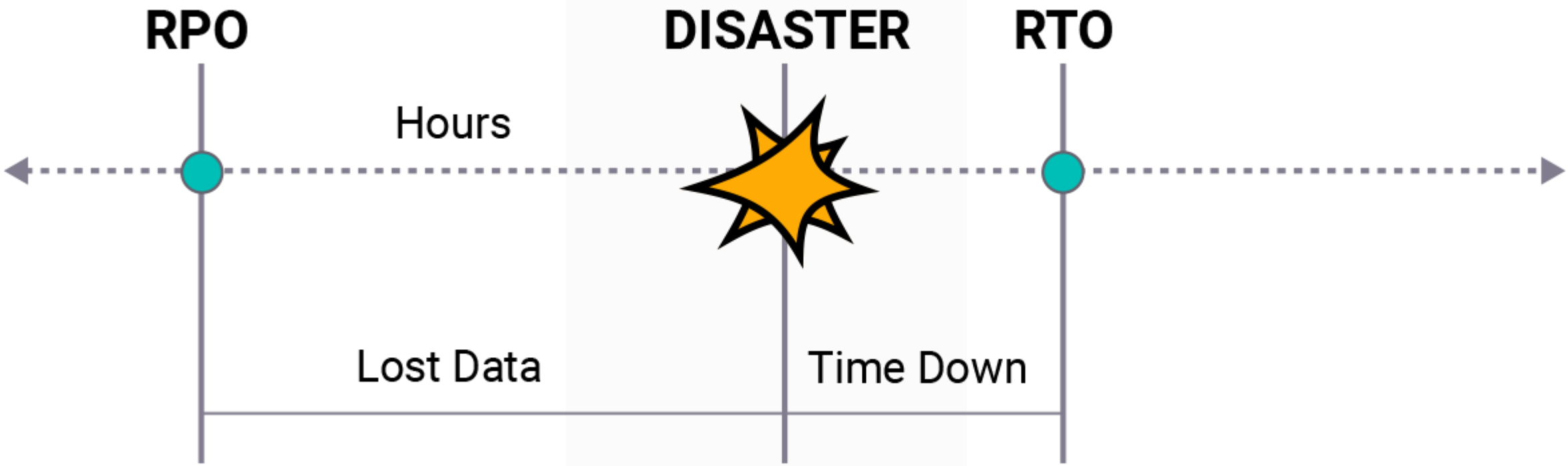
Storage enclosure



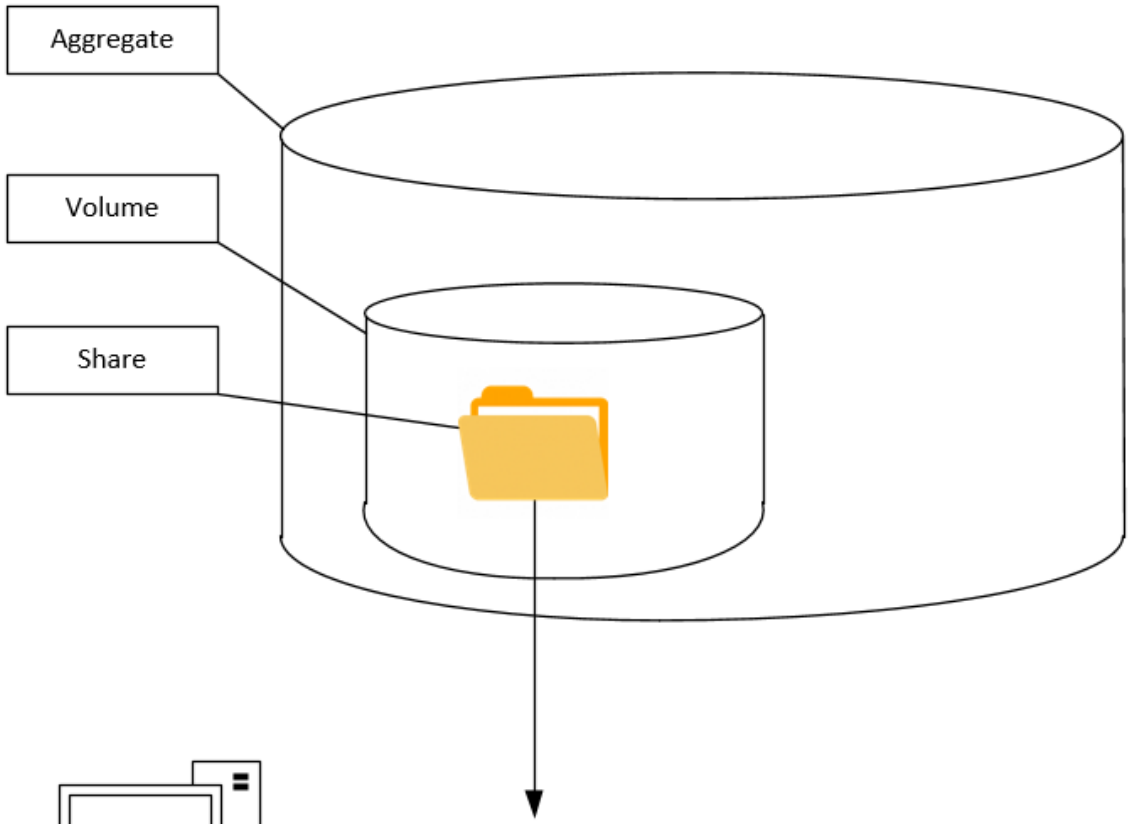
Storage enclosure

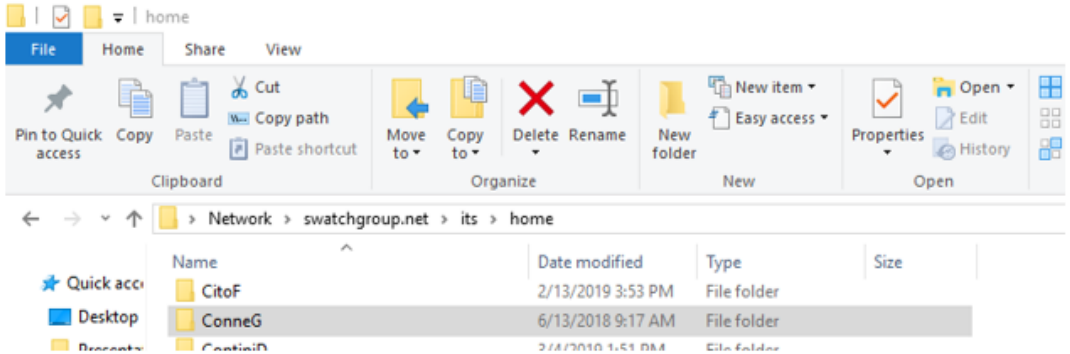


Storage

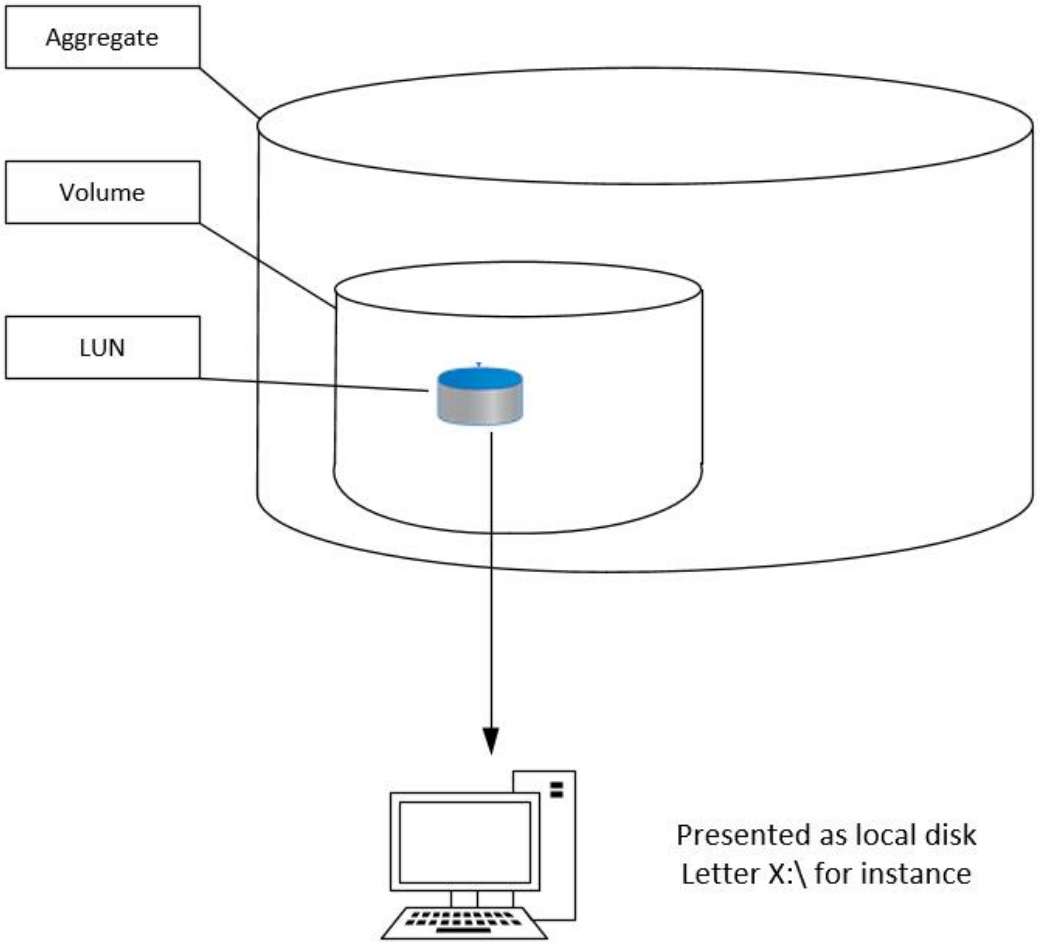


Storage

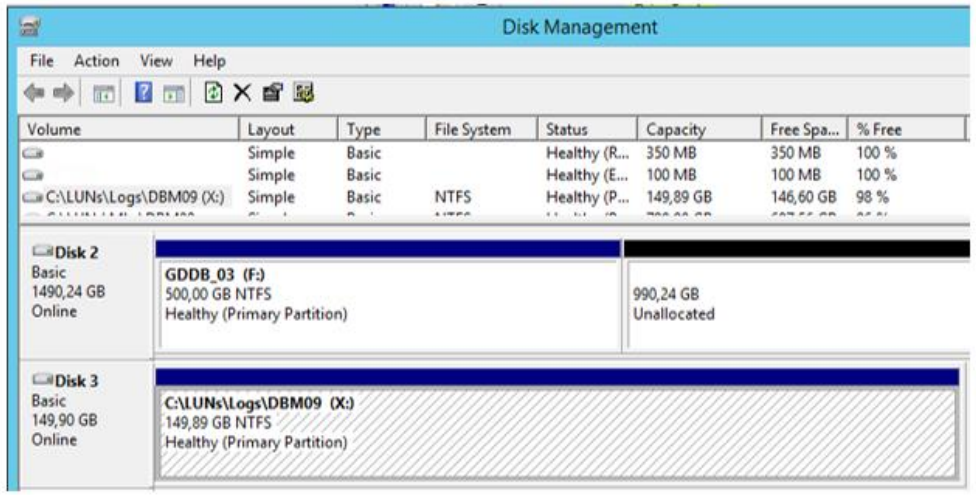

Aggregate
Volume
Share
URL : \\swatchgroup.net\its\home

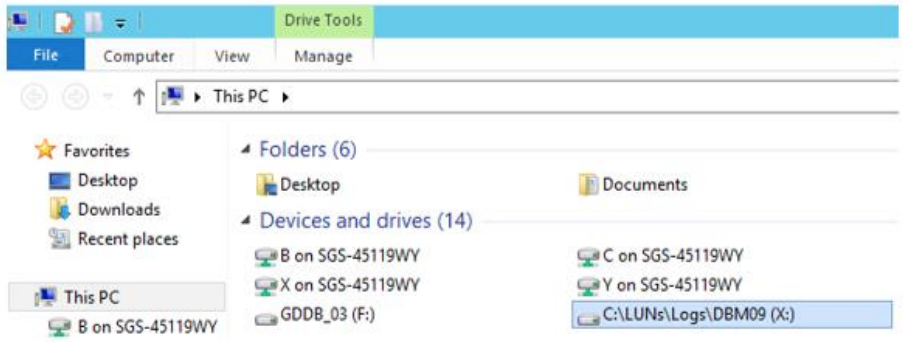

home
File
Home
Share
View
Pin to Quick access
Copy
Paste
Cut
Copy path
Paste shortcut
Clipboard
Move to
Copy to
Delete
Rename
Organize
New folder
New item
Easy access
New
Properties
Open
Edit
History
Open
Network
swatchgroup.net
its
home
Name
Date modified
Type
Size
Quick acc
Desktop
CitoF
2/13/2019 3:53 PM
File folder
ConneG
6/13/2018 9:17 AM
File folder

Storage



Presented as local disk
Letter X:\ for instance





Lab

- Create RAID 1 via Storage Space Windows
- Create share SMB with default values

Same exercise via Powershell :

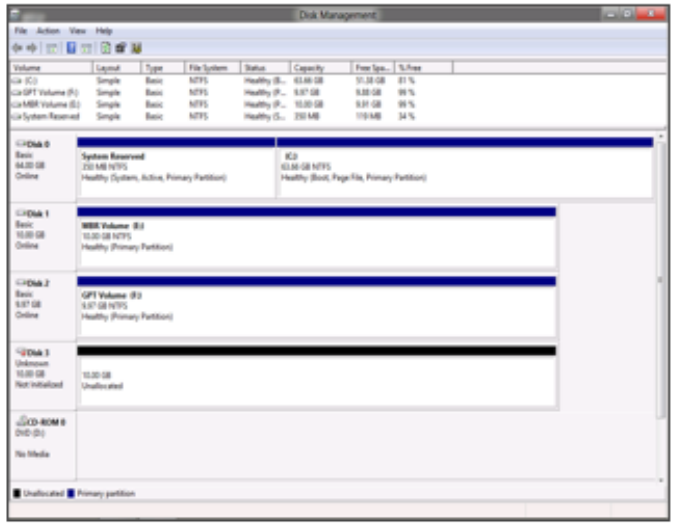
- Create RAID 1 with 2 disks
- Create SMB share
- Set share permissions Full Control for gs_all
- Set NTFS ACLs Full control for gs_admins
- Set NTFS ACLs read only for gs_standard
- Remove all others NTFS ACLs

Knowledge check

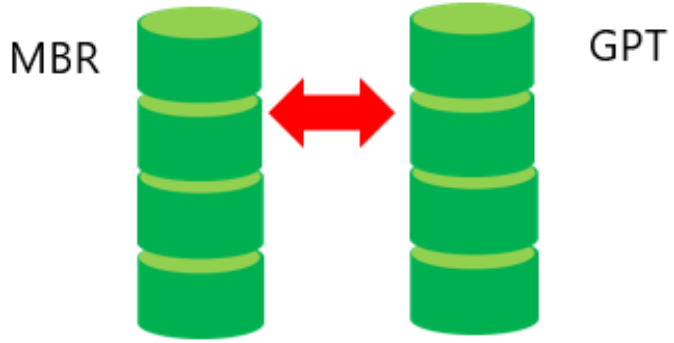
- Team 1 : Block storage
- Team 2 : File storage
- Team 3 : Object storage

Disk Management tools

- Disk Management snap-in:
  - GUI
  - Manage disks and volumes, both basic and dynamic,locally or on remote computers
  - Simple partition creation
- DiskPart:
  - Scriptable command-line tool
  - Create scripts to automate disk-related tasks
  - Always runs locally
- Windows PowerShell:
  - Has native disk management commands
  - Can be used to script disk-related tasks

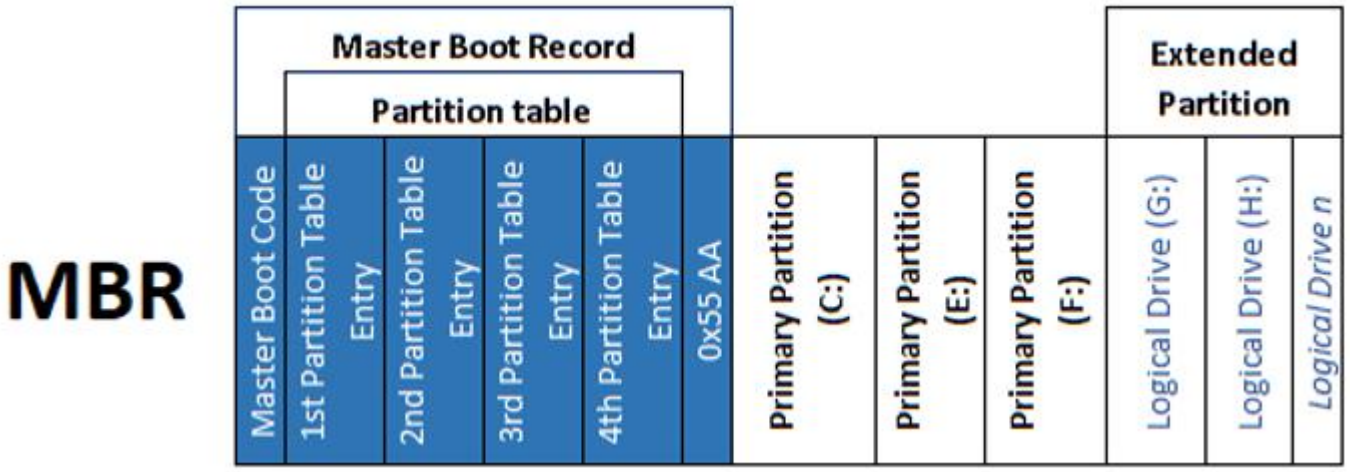


Use DiskPart or Windows PowerShell to convert partition styles



MBR

MBR (Master Boot Record) is the name of the first sector of the hard disk drive (512 bytes)
It contains the partition table (4 primary parititions maximum) and is responsible to launch the bootloader to start the operating system if it exists on the disk.



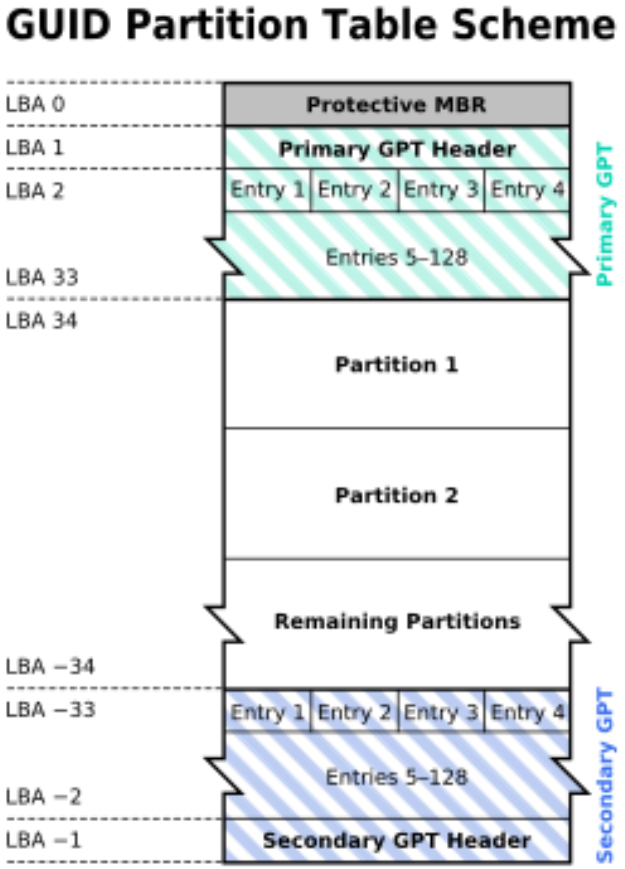
GPT

GUID Partition Table (GPT) is the new standard for the layout of partition tables, replacing MBR. Like MBR, GPTs use logical block addressing (LBA) in place of the historical cylinder-head-sector (CHS) addressing.

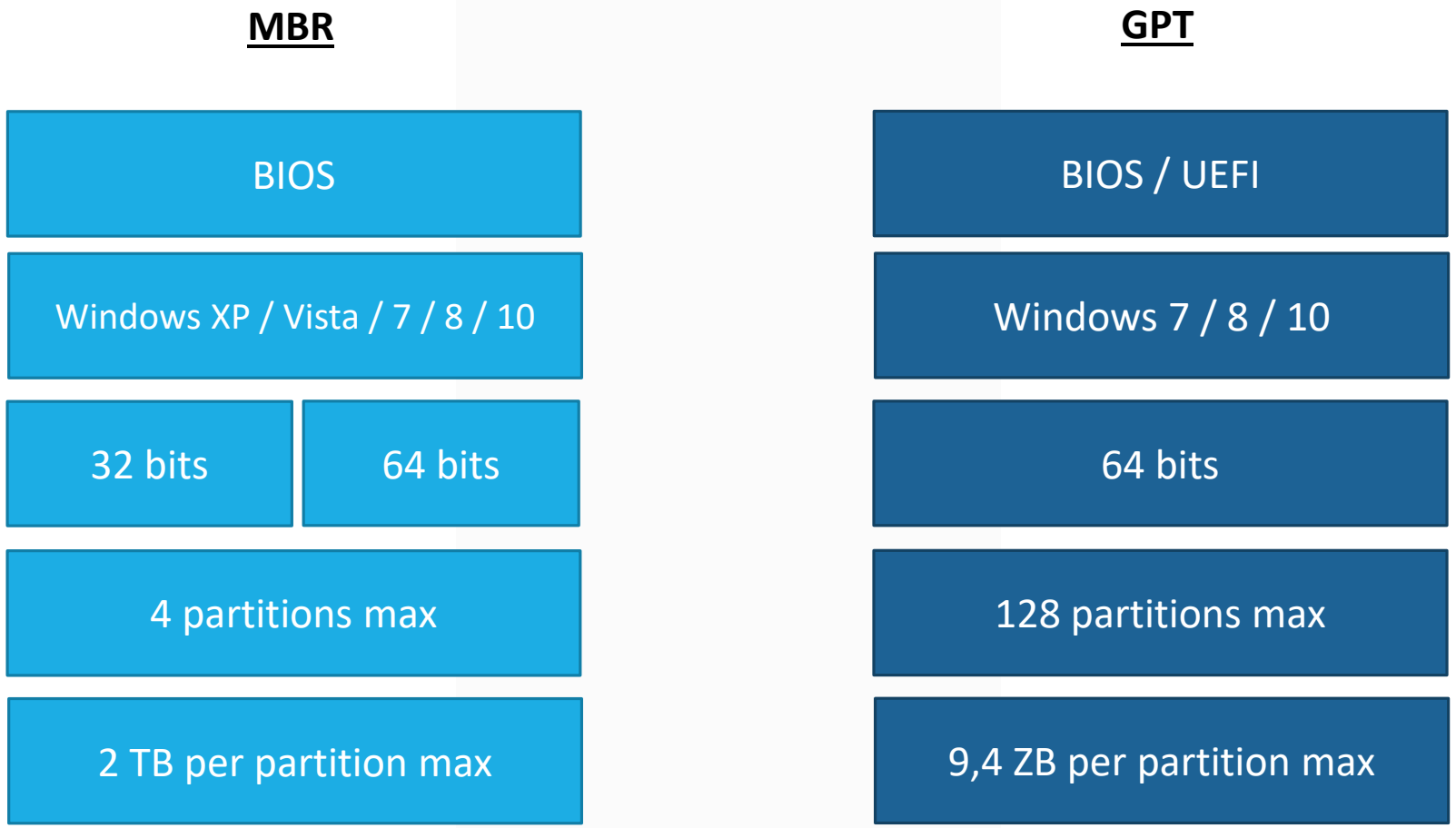
The protective MBR is stored at LBA 0, and the GPT header is in LBA 1. The GPT header has a pointer to the partition table (Partition Entry Array), which is typically at LBA 2. Each entry on the partition table has a size of 128 bytes, meaning each disk can support 128 partitions.

GPT uses 64 bits for logical block addresses, allowing a maximum disk size of 264 sectors. For disks with 512-byte sectors, the maximum size is 8 ZiB (264 × 512-bytes) or 9.44 ZB (9.44×10^{21} bytes).

Partition header is redundant to provide better resiliency, a second partition table is stored at the end of the disk.

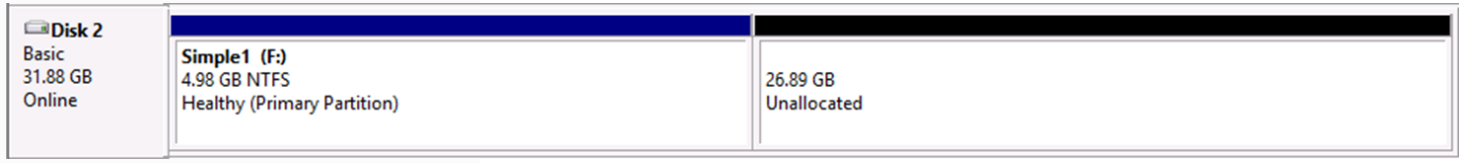


MBR and GPT

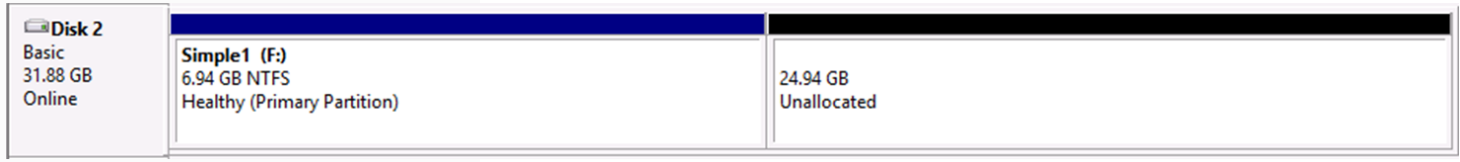

MBR
BIOS
Windows XP / Vista / 7 / 8 / 10
32 bits
64 bits
4 partitions max
2 TB per partition max
GPT
BIOS / UEFI
Windows 7 / 8 / 10
64 bits
128 partitions max
9,4 ZB per partition max

Simple volumes

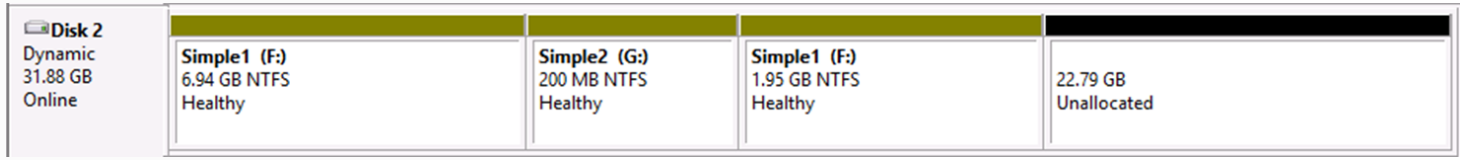
- Simple volume that encompasses available free space from a single, basic, or dynamic hard disk drive



- Can be extended if contiguous space is free on the same disk



- If extending into noncontiguous space, the disk will be converted to dynamic if it is a basic disk



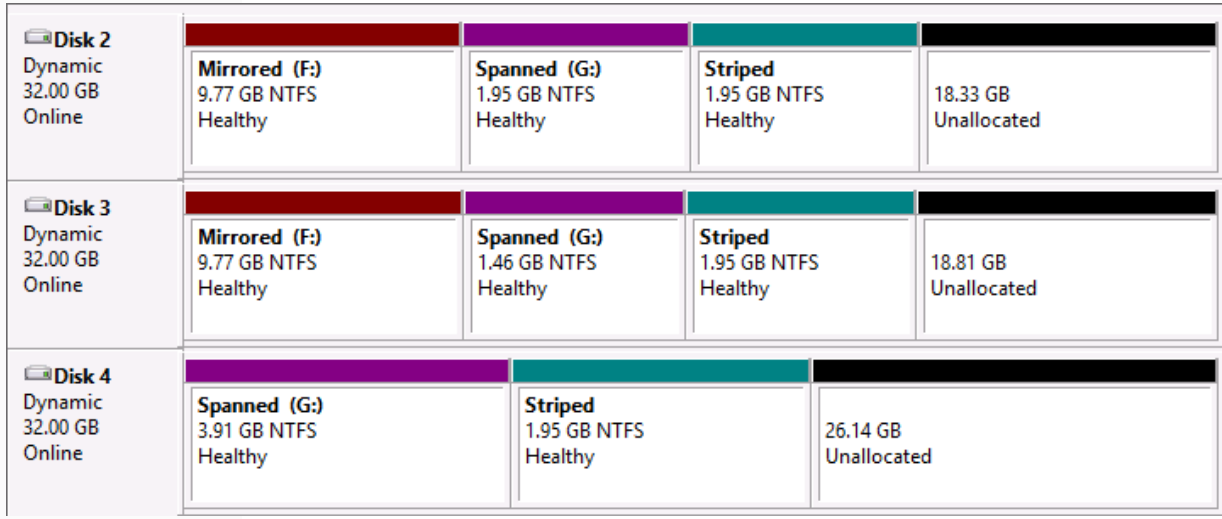
Dynamic disks

- Consists of multidisk volumes:
  - Spanned
  - Striped
  - Mirrored
- Can contain up to 1024 volumes
- Can convert from basic disk without data loss
- Requires all volumes to be deleted when converting to basic disk
- Can be managed by using DiskPart or Disk Management:
  - There are no Windows PowerShell cmdlets for managing dynamic disks

Mirrored, spanned, and striped volumes

Join areas of unallocated space on disks into a single logical disk

- MIRRORED:
  - Disk space is allocated once and used simultaneously
- SPANNED:
  - Disk space is added and used sequentially
- STRIPED:
  - Disk space is allocated once and used equally across every physical disk in the striped set

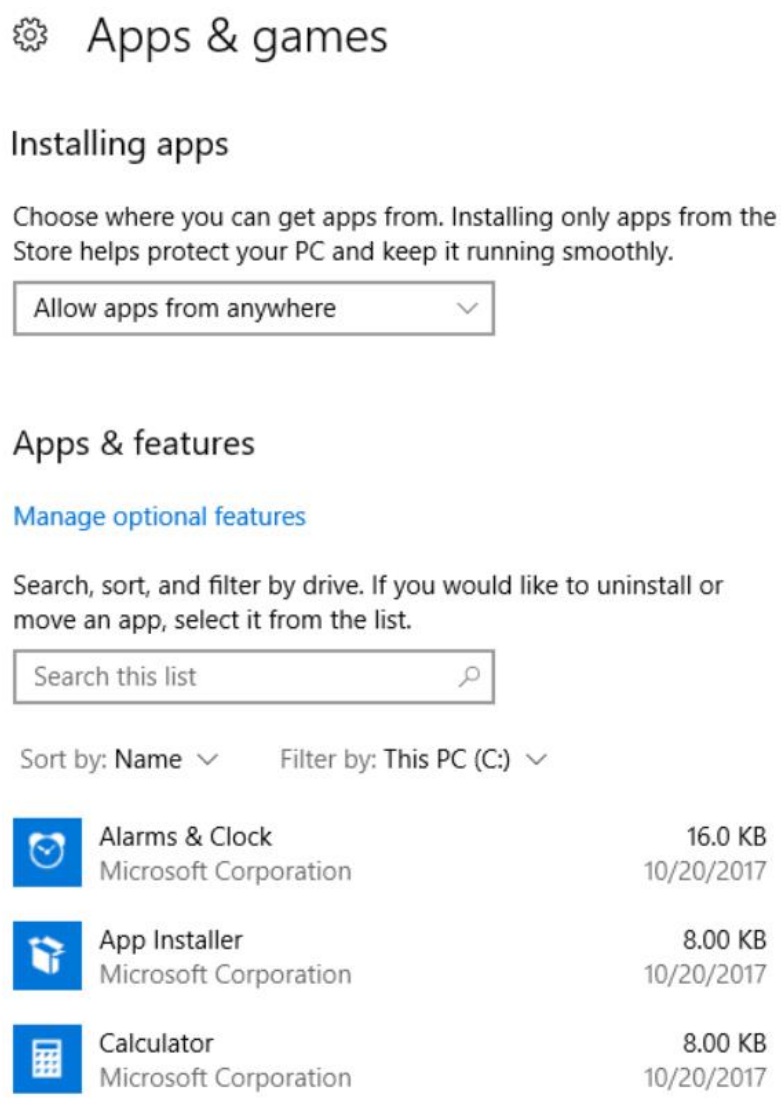


Managing existing volumes

- Resize a volume to create additional, unallocated space to use for data or apps on a new volume.
- Before shrinking:
  - Defragment the disk
  - Ensure that the volume you want to shrink does not contain any page files

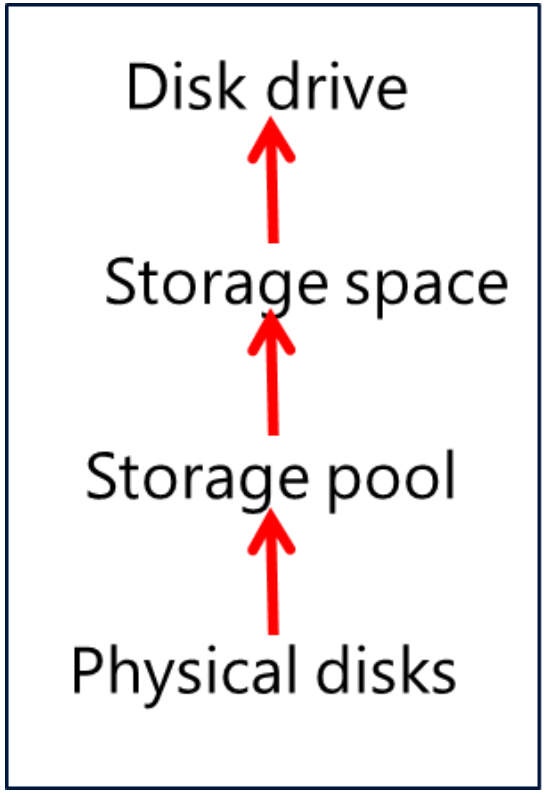
Monitoring storage usage

- Presents an overview of storage usage by:
  - Drive (internal, external, and OneDrive)
  - 13 categories including System, Apps, Music, and Pictures
- Enables you to choose the drive to which you want to save new files, such as:
  - Apps
  - Music
  - Documents
  - Videos
  - Pictures
- Storage Sense can automatically free up space



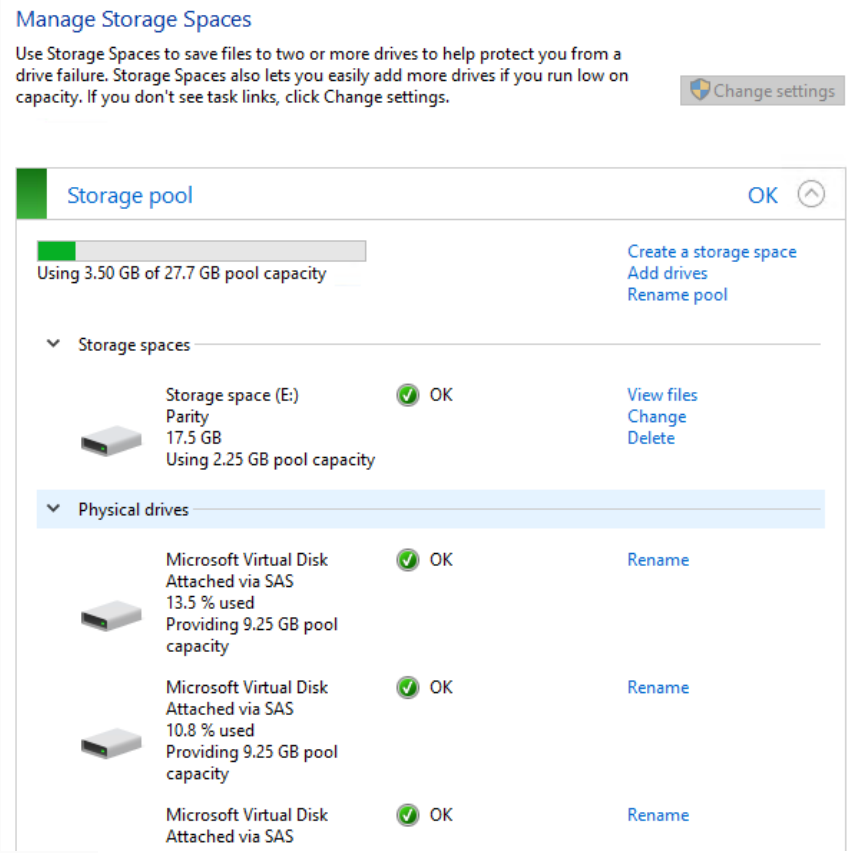
Storage Spaces Overview

- Use Storage Spaces to add physical disks of any type and size to a storage pool, and then create highly available virtual disks from the storage pool
- To create a storage space, you need the following:
  - One or more physical disks
  - Storage pool that includes the disks
  - Storage space that is created with disks from the storage pool
  - Disk drives that are based on storage spaces



Features of Storage Spaces

Feature	Options
Storage layout	• Simple • Two-way or three-way mirror • Parity
Provisioning schemes	• Thin vs. fixed provisioning



The FAT file system

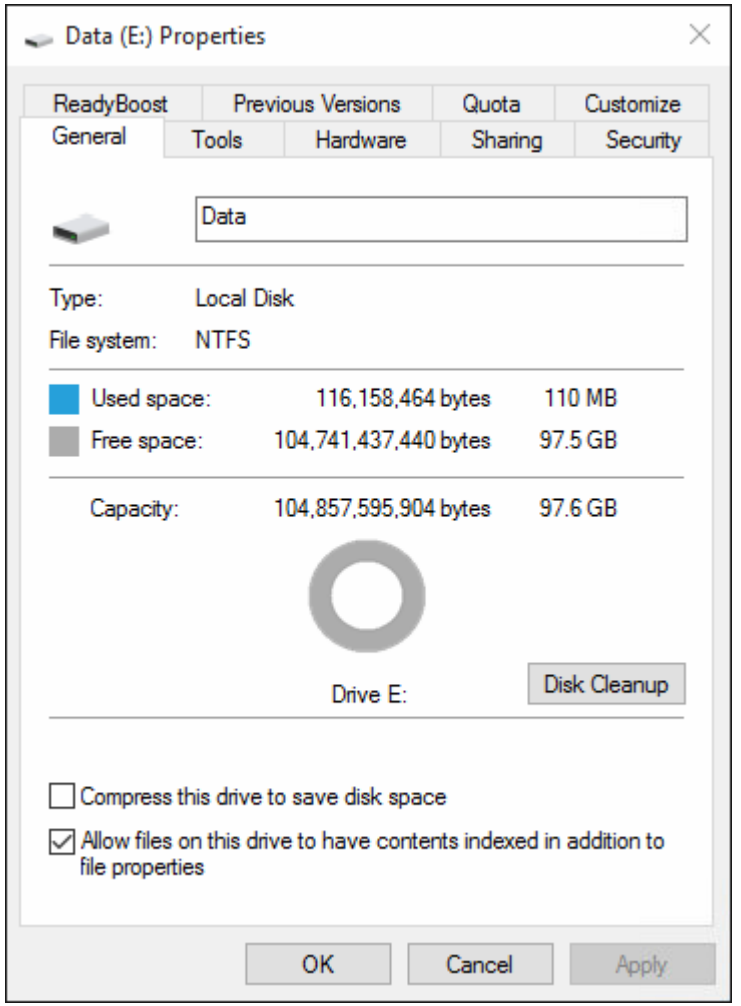
- Supported by most operating systems
- For small volumes with simple folder structure
- Often used for removable media
- Windows supports FAT, FAT32, and exFAT:
  - Maximum volume size, cluster size, and number of files
- No support for security and other NTFS features

The NTFS file system

Default file system in Windows

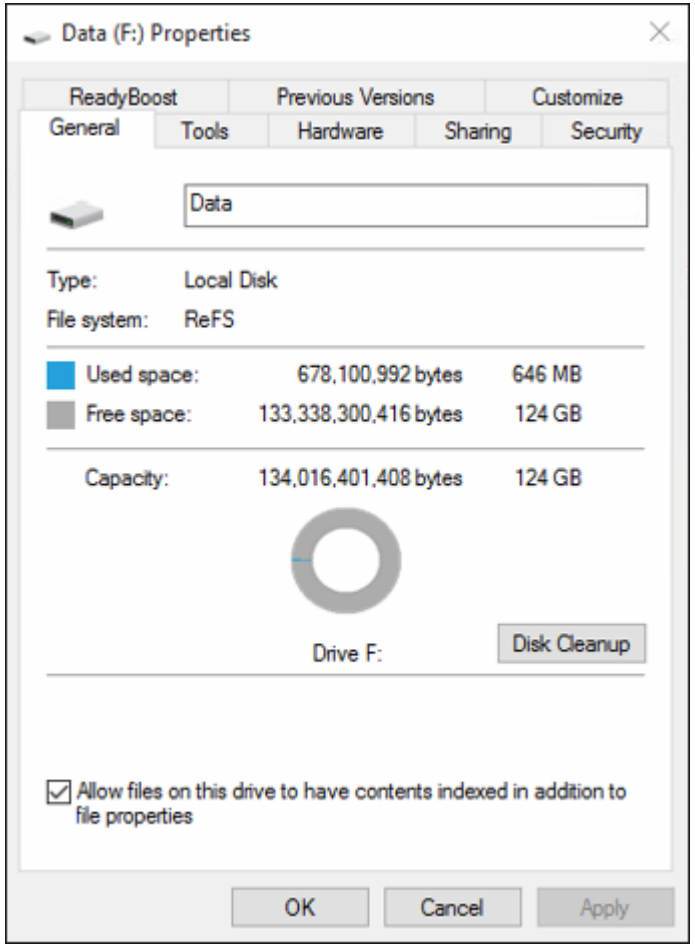
Supports many features not available with FAT:

- Security and auditing
- Large volumes
- Quotas
- Compression
- Encryption
- Reliability
- Other advanced features



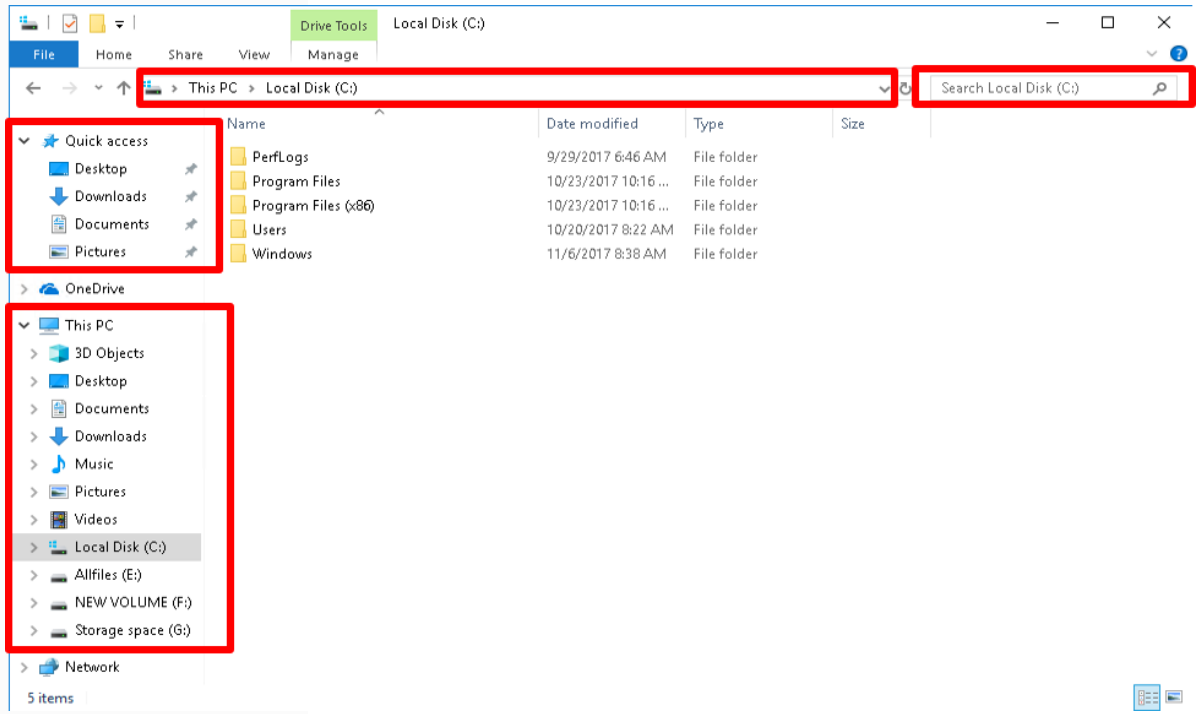
The ReFS file system

- Provides the highest level of resiliency and scalability
- Can be used only on mirrored storage spaces:
  - Automatically detects and corrects errors
  - Two-way or three-way mirror
- Supports security and auditing
- Does not support:
  - Compression
  - Quotas
  - Encryption
  - Volume shrinking



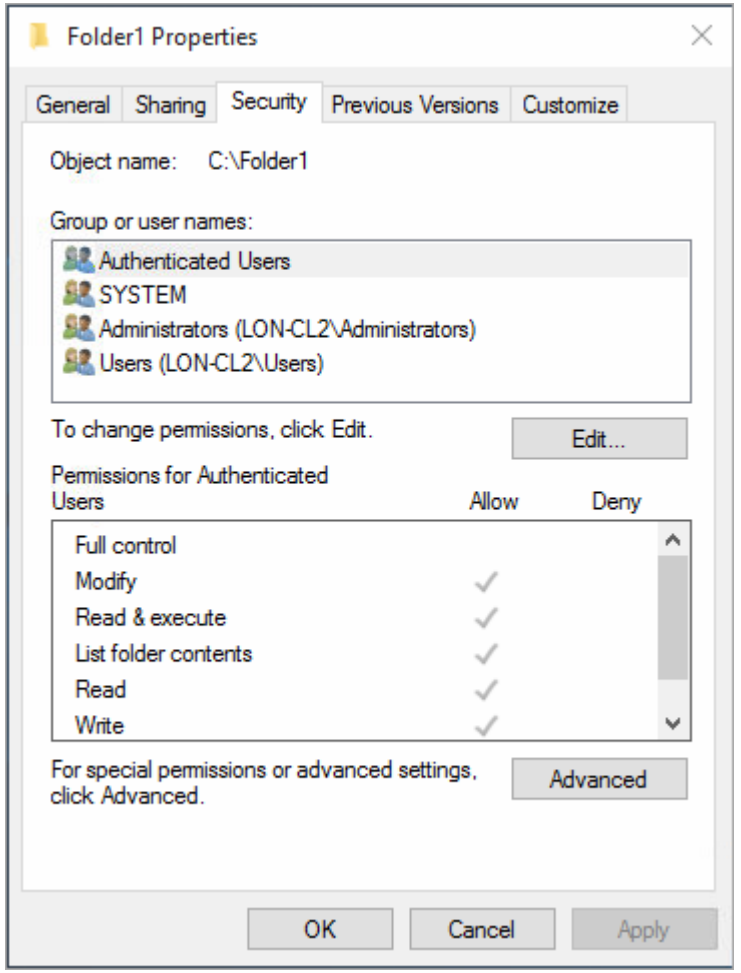
Tools Used for Managing Files and Folders

- Command prompt:
  - **cd** or **chdir** to change the parent directory
  - **del**, **md**, **move**, and other commands to manage files and folders
  - **icacls** to displays and modifies permissions
- Windows PowerShell:
  - **Set-Location**, **Remove-Item**, and other cmdlets
  - Same aliases as command prompt commands
  - **Set-ACL** to manage file permissions

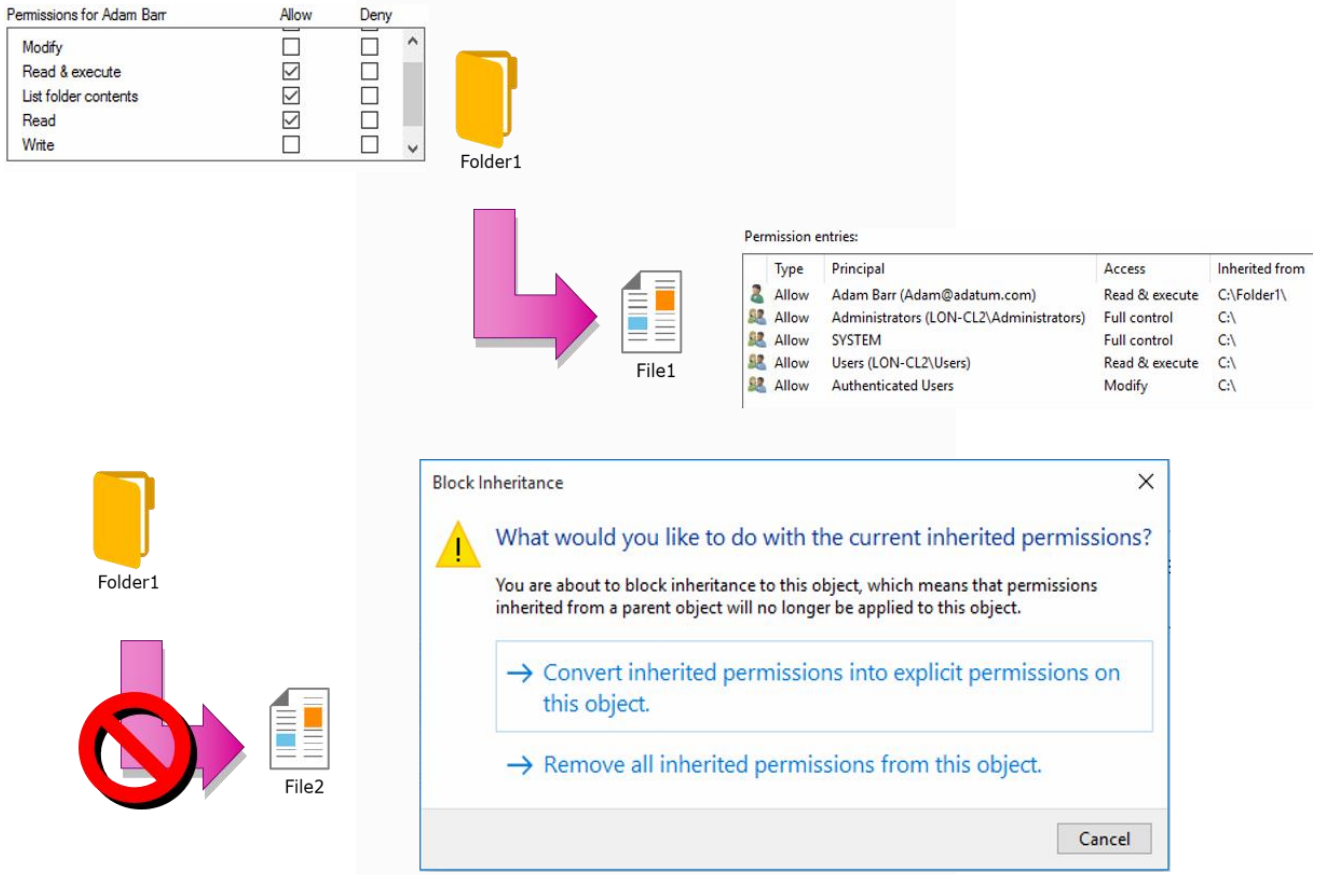


File and Folder Permissions

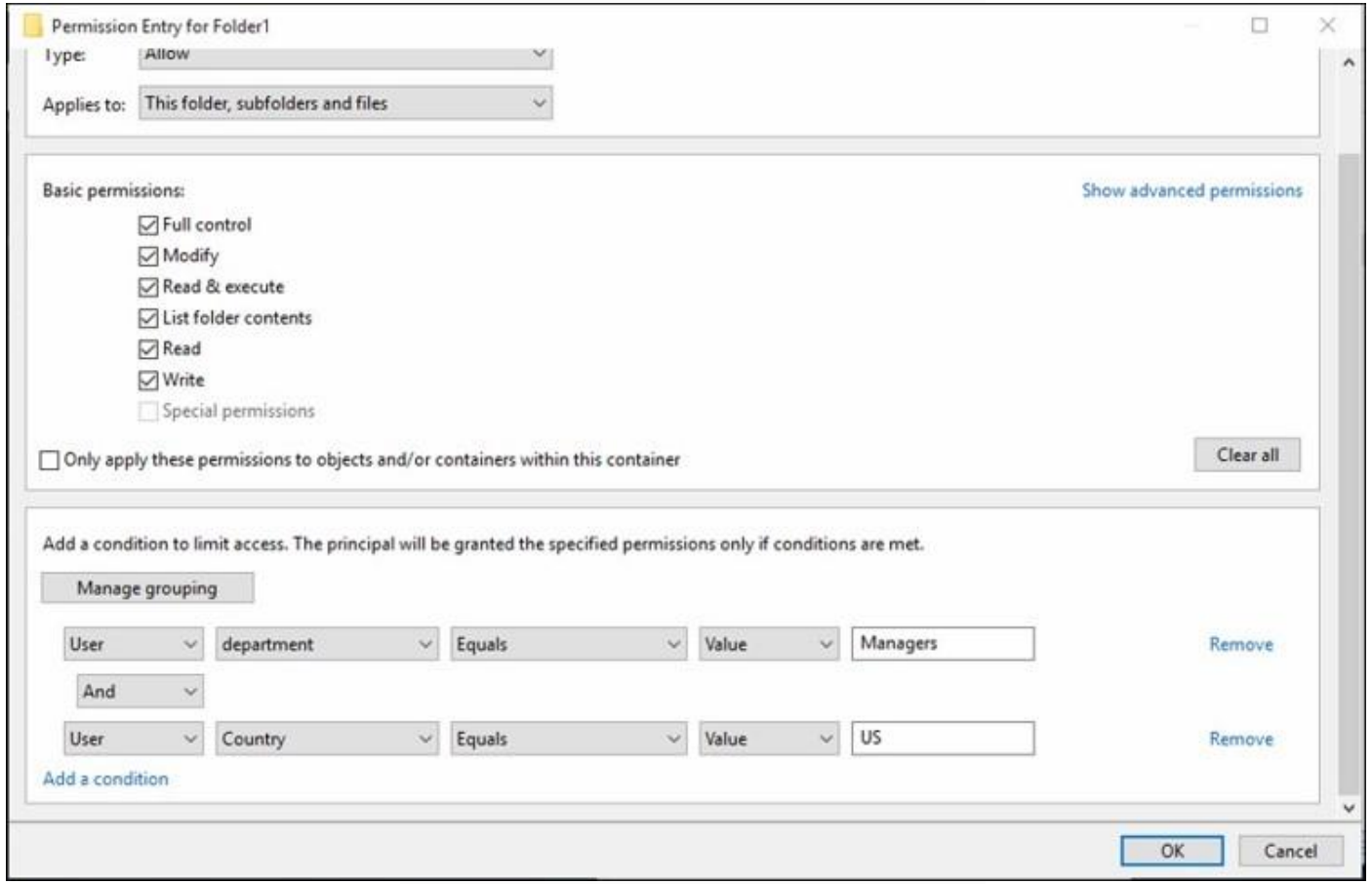
- Control access on NTFS and ReFS file system
- Can be added for groups, users, and computers:
  - Cumulative for group members
- Can be assigned to:
  - Files
  - Folders
  - Volumes (root folder)
- Permissions can be:
  - Allow
  - Deny (takes precedence)
- Basic and advanced



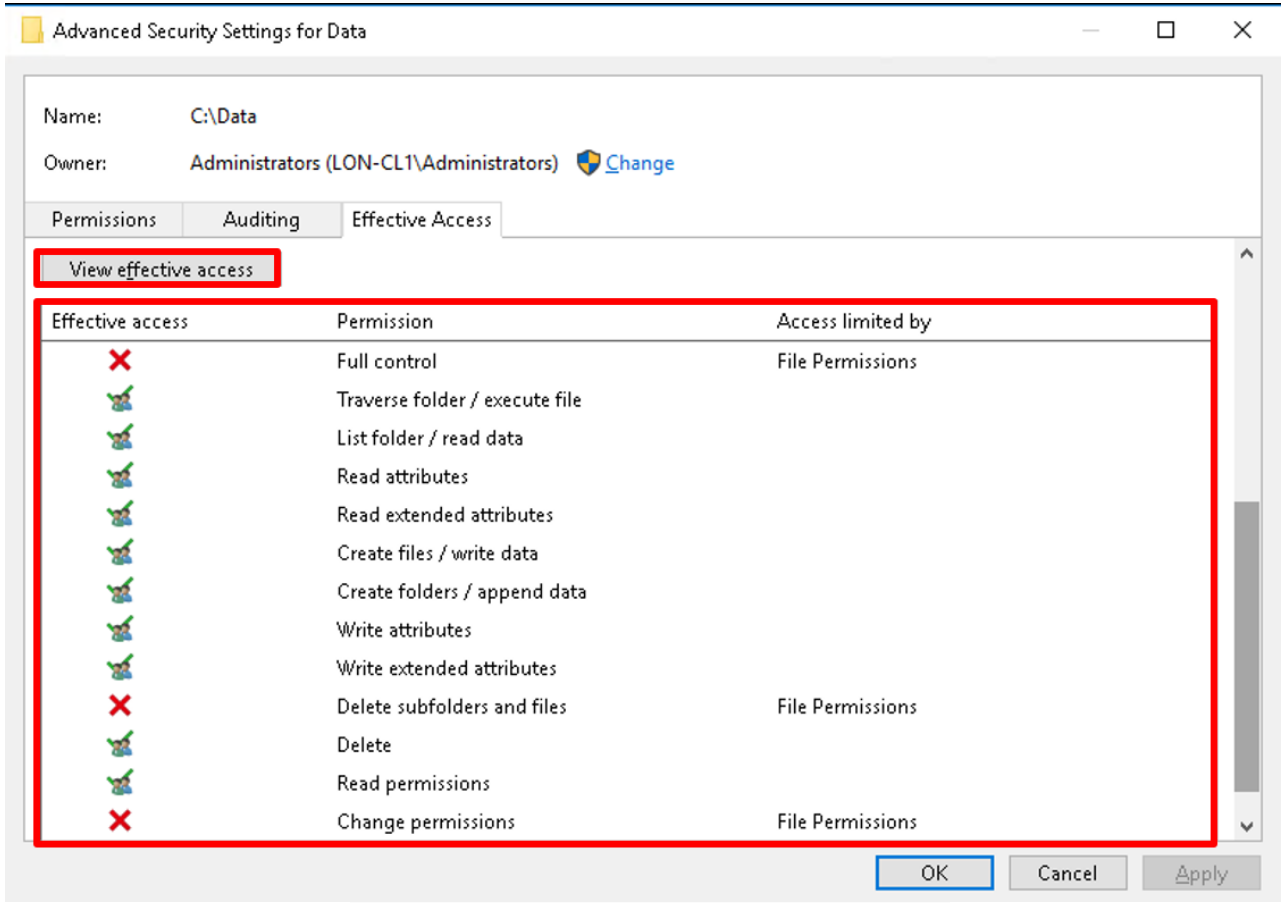
Overview of Permission Inheritance



Implementing Conditions to Limit File and Folder Access

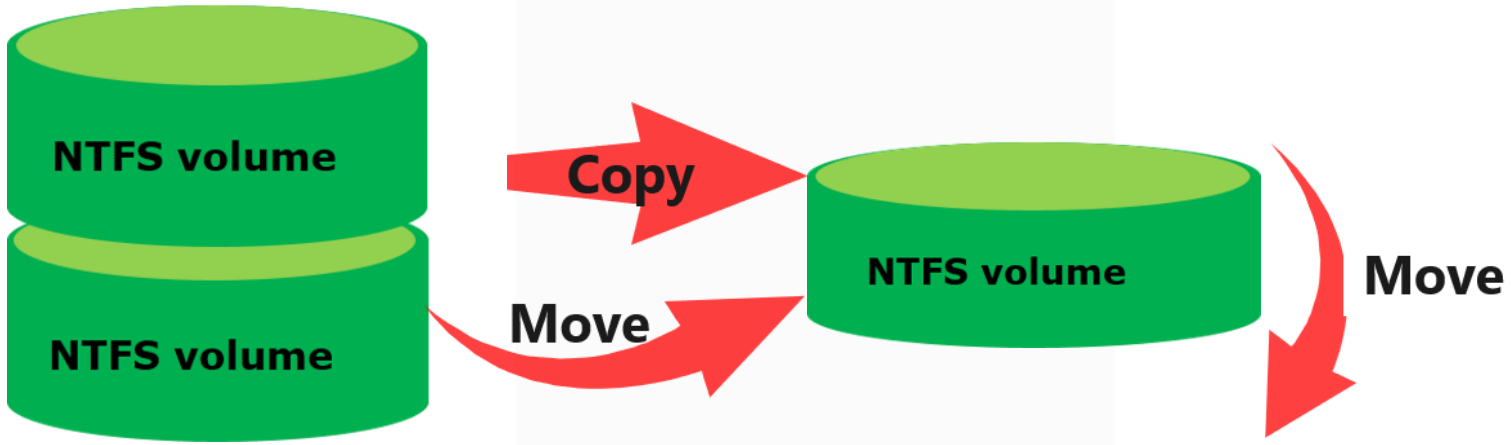


Effective Access Feature



Copying and moving files

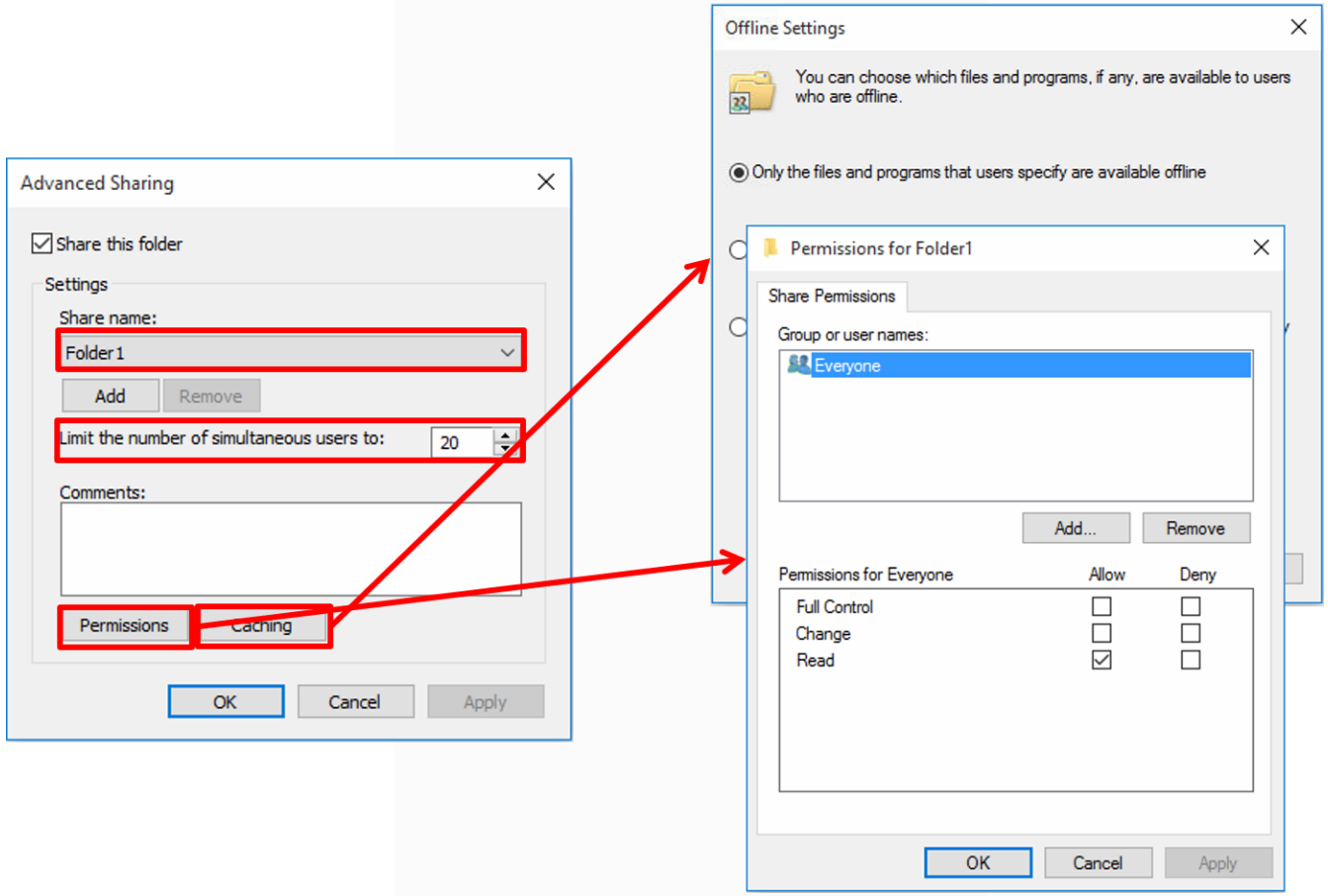
- When you copy files and folders, they always inherit the permissions of the destination folder
- When you move files and folders within the same volume, they keep their explicit permissions
- When you move files and folders to a different volume, they inherit the permissions of the destination folder



What are Shared Folders?

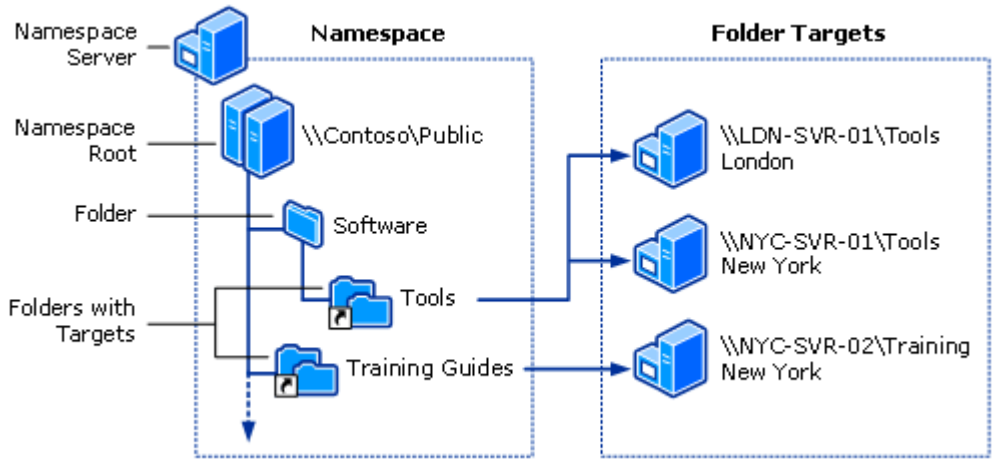
- Shared Folders are accessible over a network
- You can share only volumes and folders
- Share permissions control access over a network:
  - They do not apply if users access the content locally
- You must have Administrative permissions to create a share
- There are many ways to view shared folders:
  - File Explorer
  - The Shared Folders snap-in
  - **Net view***computername* ***/all***
  - The **Get-SmbShare** cmdlet
- You can access a shared folder by using UNC

Shared Folder Properties



Distributed File System

DFS groups shared folders located on different servers into one or more logically structured namespaces. This makes it possible to give users a virtual view of shared folders, where a single path leads to files located on multiple servers, as shown in the following figure:

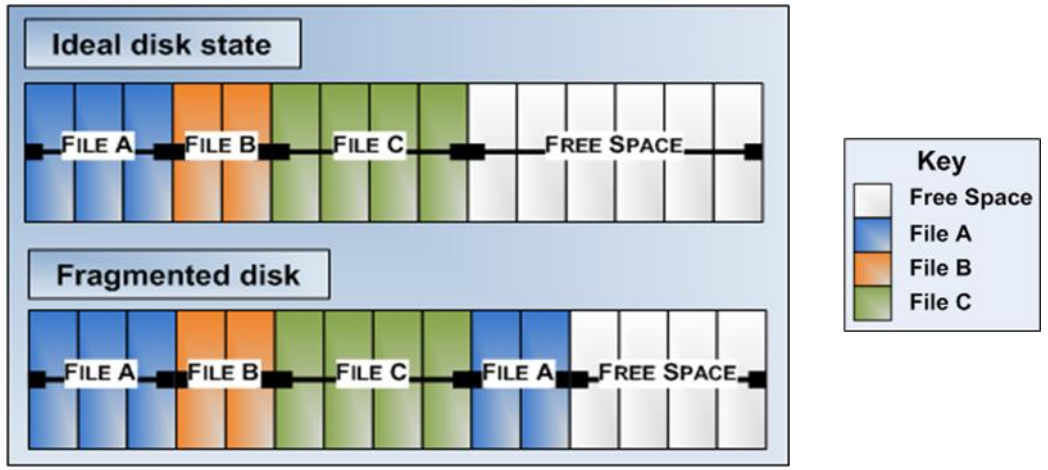


Labs

- Exercise 1 : Compare Share permissions **VS** NTFS rights
- Exercise 2 : Use of robocopy
- Exercise 3 : DFS
  - Install DFS replication role on 2 servers
  - Create 1 Folder with 2x targets (different locations)
  - Enable DFS Replication on the DFS Folder
  - Monitor replication (via powershell)
- Exercise 4 : Mount NFS share to linux client

Disk optimization

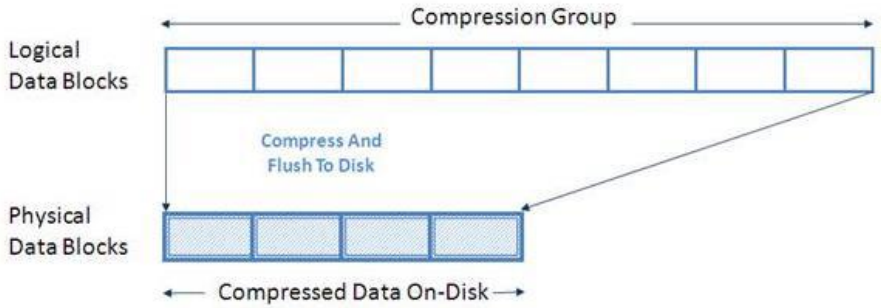
- Defragmentation not needed on SSDs.
  - Windows Auto-Detects Disk Type
  - Optimize will run TRIM on SSDs
- Disk fragmentation on HDDs can:
  - Consist of both fragmented files and fragmented free space
  - Lead to poor performance of a disk subsystem
- Default settings are usually sufficient.



Storage compression

Compression

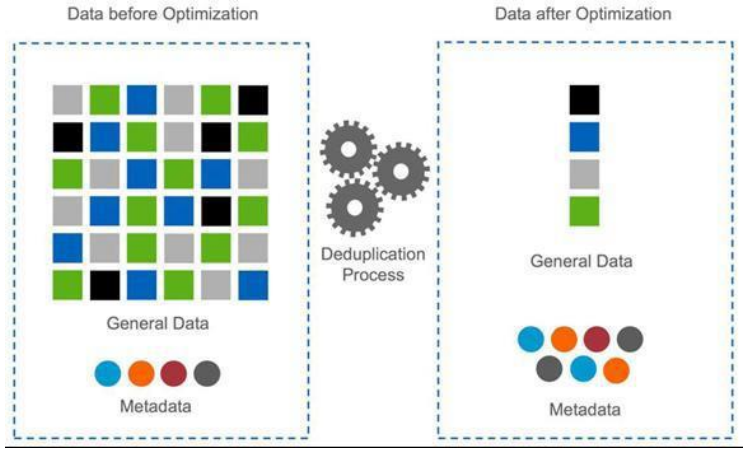
Reduce data storage cost by transparently compressing the data on disk using standard compression algorithms.



Storage deduplication

Deduplication

Data deduplication is a process that eliminates excessive copies of data and significantly decreases storage capacity requirements.

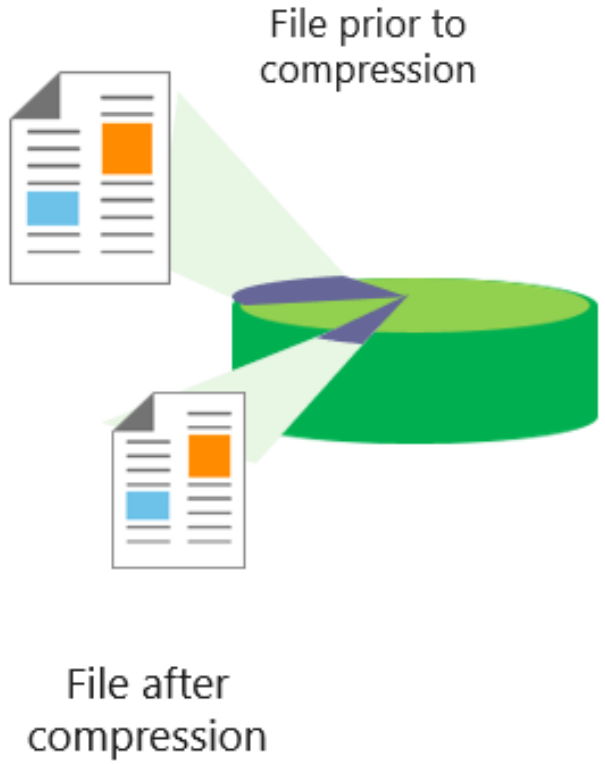


Scenario	Content	Typical space savings
User documents	Office documents, photos, music, videos, etc.	30-50%
Deployment shares	Software binaries, cab files, symbols, etc.	70-80%
Virtualization libraries	ISOs, virtual hard disk files, etc.	80-95%
General file share	All the above	50-60%

File and folder compression

The NTFS file system uses NTFS file compression to compress files, folders, and volumes:

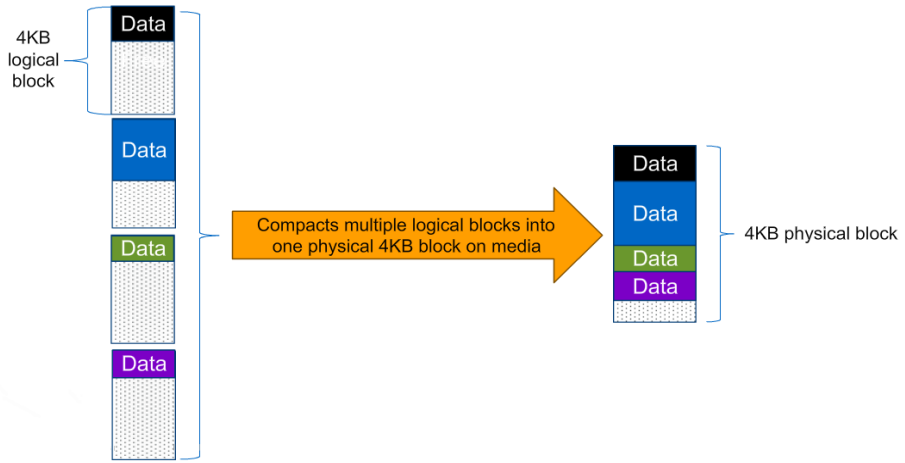
- Uses compression to save disk space
- Does not use compression for system files and folders
- Compression is configured as an NTFS attribute
- NTFS calculates disk space based on uncompressed file size
- Applications that open a compressed file only see the uncompressed data



Storage compaction

Compaction

Space saving technology called Inline Adaptive Data Compaction that places multiple logical data blocks in a single 4KB block on storage, thereby multiplying compression savings.



Storage allocation space

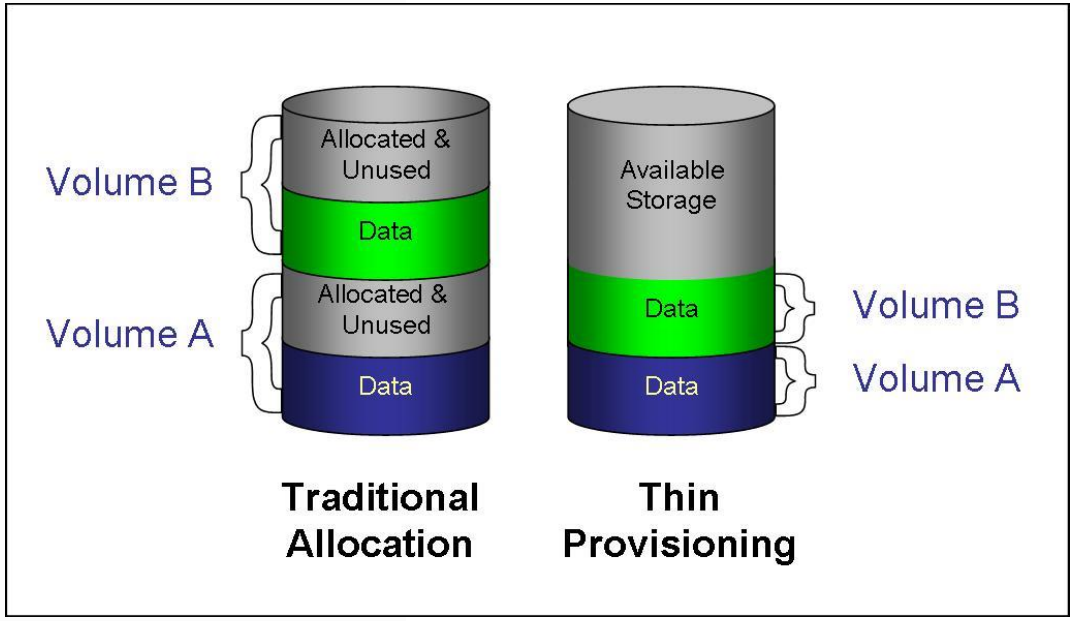
Thin provisioning

Space saving technology which storage is not reserved in advance.
Instead, storage is allocated dynamically, as it is needed.
Free space is released back to the storage system when data in the volume or LUN is deleted.

Pros & Cons:

+ Easier storage growth
+ Add disks when the need arises

- Monitor carefully



Storage snapshots

Snapshot

Snapshot copy is a read-only, point-in-time image of a volume. The image consumes minimal storage space and incurs negligible performance overhead because it records only changes to files since the last Snapshot copy was made.

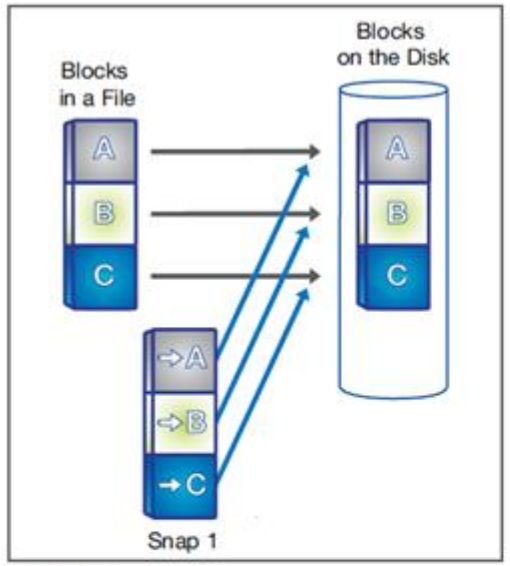


Figure 1a

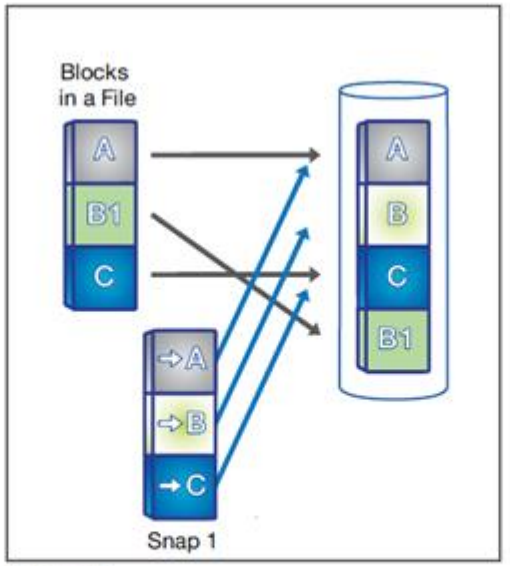


Figure 1b

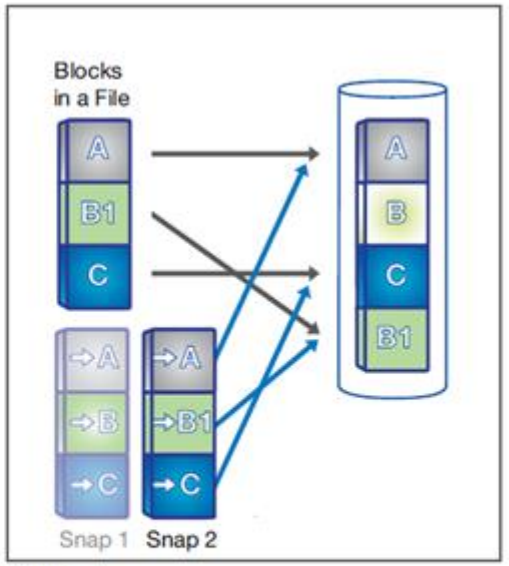


Figure 1c

A snapshot is taken in 1a. In 1b, changed data is written to a new block and the pointer is updated, but the snapshot pointer still points to the old block, giving you a live view of the data and an historical view. Another snapshot is taken in 1c and you now have access to 3 generations of your data without taking up the disk space that 3 unique copies would require; live, snapshot 2 and snapshot 1 in order of age.

Storage tiering

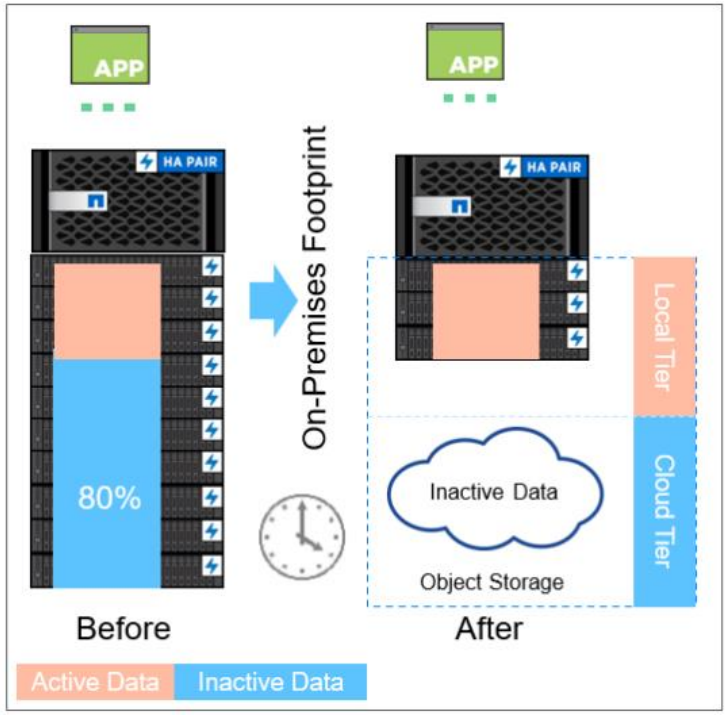
Tiering / Auto-tiering

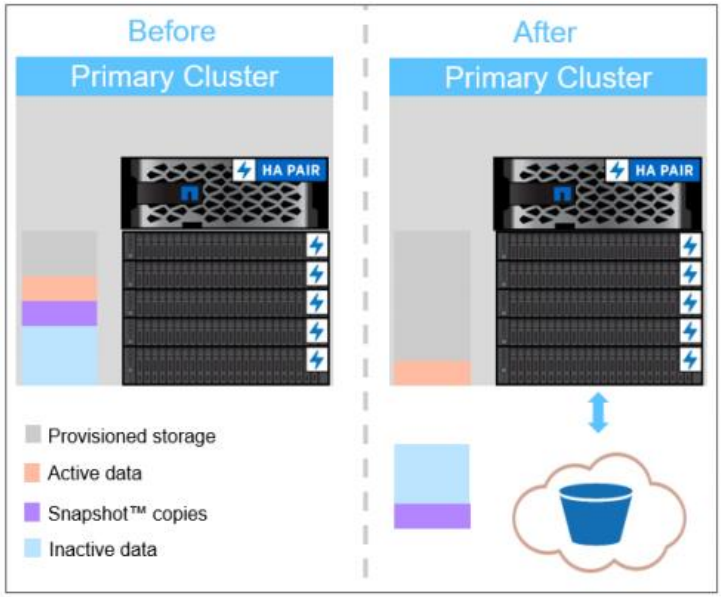
Identify and classify data based on their access rate.

Usually classified in two categories :

- Hot data are active data => Need to be stored in the high-performance storage
- Cold data are not access for some time => Should be stored in low-cost storage.

Depending on the technology, tiering and auto-tiering can be done at file level or block level. Different policies can be applied.



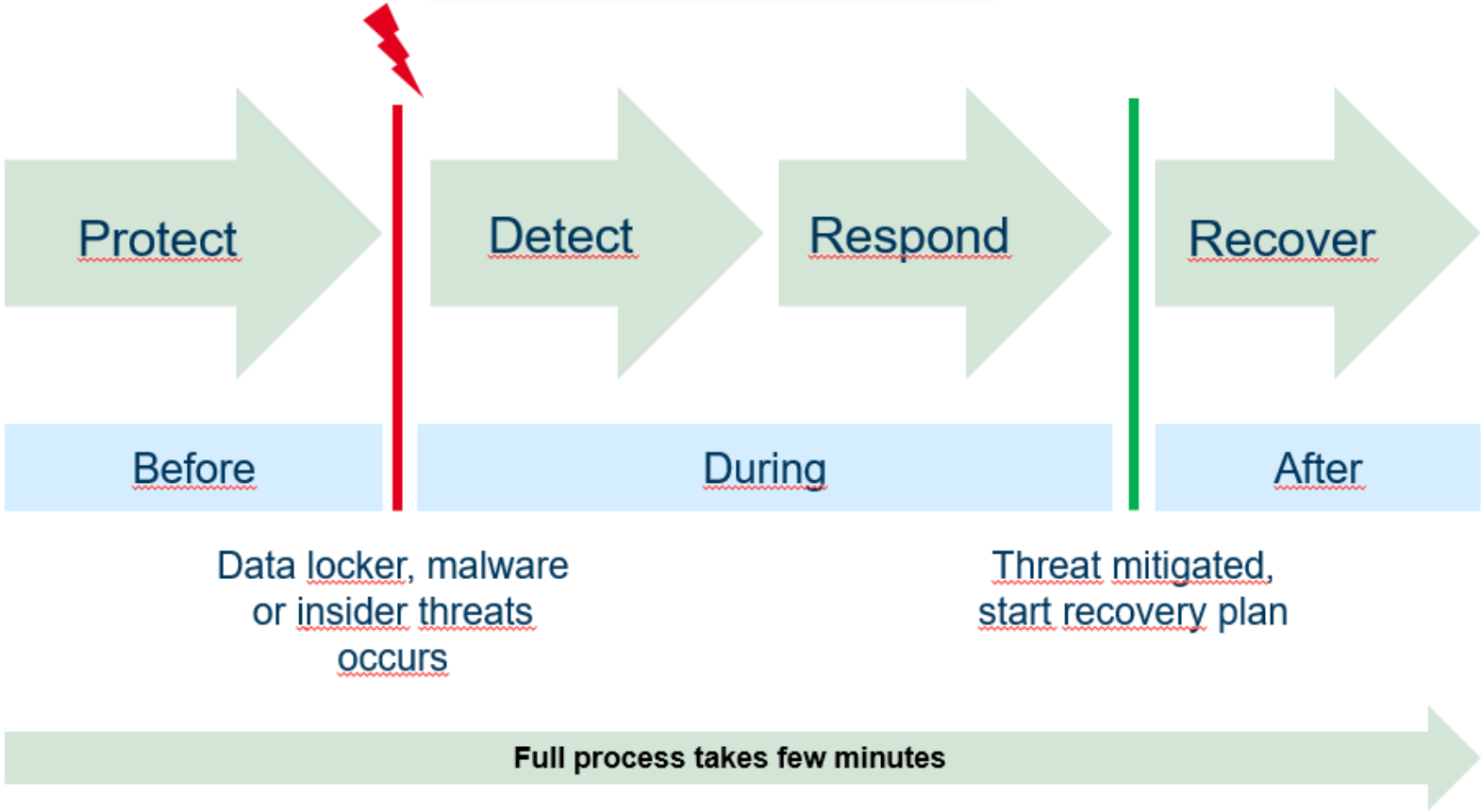


File storage threats

- Corruption
- Manual / Accidental deletion
- Data steal
- Virus / Malware
- Cyber-Attack

- Firewall
- WORM storage (specific use case)
- Encryption
  - At rest => protect against hardware stolen
  - In transit => protect against man in the middle
- Set strict ACL / Share permissions
- Security awareness
- Use MFA where possible
- Antivirus
- Antiransomware
- Backup
- Auditing
- Don’t use vulnerable technologies SMB v1 / Windows file servers (Previous version can be removed by attackers)

File storage threats



Lab

Block Storage

- Start “iSCSI initiator” on Clt1
- Collect iQN from Clt1
- Install iSCSI Target server & iSCSI Target storage Provider roles on SrvFS1
- Create iSCSI disk on SrvFS1 based on the Storage Space (raid1) created in Lab 1
- Present the iSCSI disk to Clt1 iQN
- Discover iSCSI target on Clt1 and connect SrvFS1
- Mount the disk in Clt1 via “iSCSI initiator”
- Initiate the disk + mount on letter E:\
- Write some data + dismount + offline the disk
- Start “iSCSI initiator” on SrvDC1
- Collect iQN from SrvDC1
- Change the iSCSI disk targets in SrvFS1 to present the disk to SrvDC1
- Discover iSCSI target on SrvDC1 and connect SrvFS1 with multipath
- Mount the disk in SrvDC1 via “iSCSI initiator”
- Where is it mounted ? And Why ?
- Check if data written from Clt1 are there ?
- What is MPIO / ALUA ?

Lab

Object Storage

Exercise 1

- Install S3 browser on your BYOD
- Configure access with S3 Keys
- Create your own bucket + enable versioning
- Upload a word document
- Add custom tags + check properties to verify if tag is applied
- Delete the document in the bucket
- Check the version history

Exercise 2

- Install AWS Tools for Windows
- Create bucket and upload data via PowerShell
- Create a static website