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FILE SYSTEM AND BACKUP

CST 8202

The Windows File System

A file system is a way of organizing and storing files on a computer or other digital device. It provides a hierarchical structure for storing and retrieving files, using directories, folders, and file names.

- **NTFS (New Technology File System):** Default file system for Windows, offering security, compression, and large storage support.
- **FAT (File Allocation Table):** Older file system, still used for compatibility with older systems and devices.
- **exFAT (Extended FAT):** Modernized FAT file system, designed for flash storage and large files.
- **UDF (Universal Disk Format):** File system used for optical media, such as DVDs and CDs.
- **CDFS (Compact Disc File System):** File system used for CDs.
- **Live File System:** File system used for burning data to CDs and DVDs.
- **ReFS (Resilient File System):** Modern file system designed for storage spaces and large-scale storage.
- **EFS (Encrypting File System):** File-level encryption feature integrated with NTFS.

New Technology File System (NTFS) - 1993

- Originally developed for Windows NT
  - Still being widely used today
  - Support for disk quotas
  - File System Permissions
  - Compression
  - Encryption
  - Supports up to a Maximum file and volume size of 256 TB

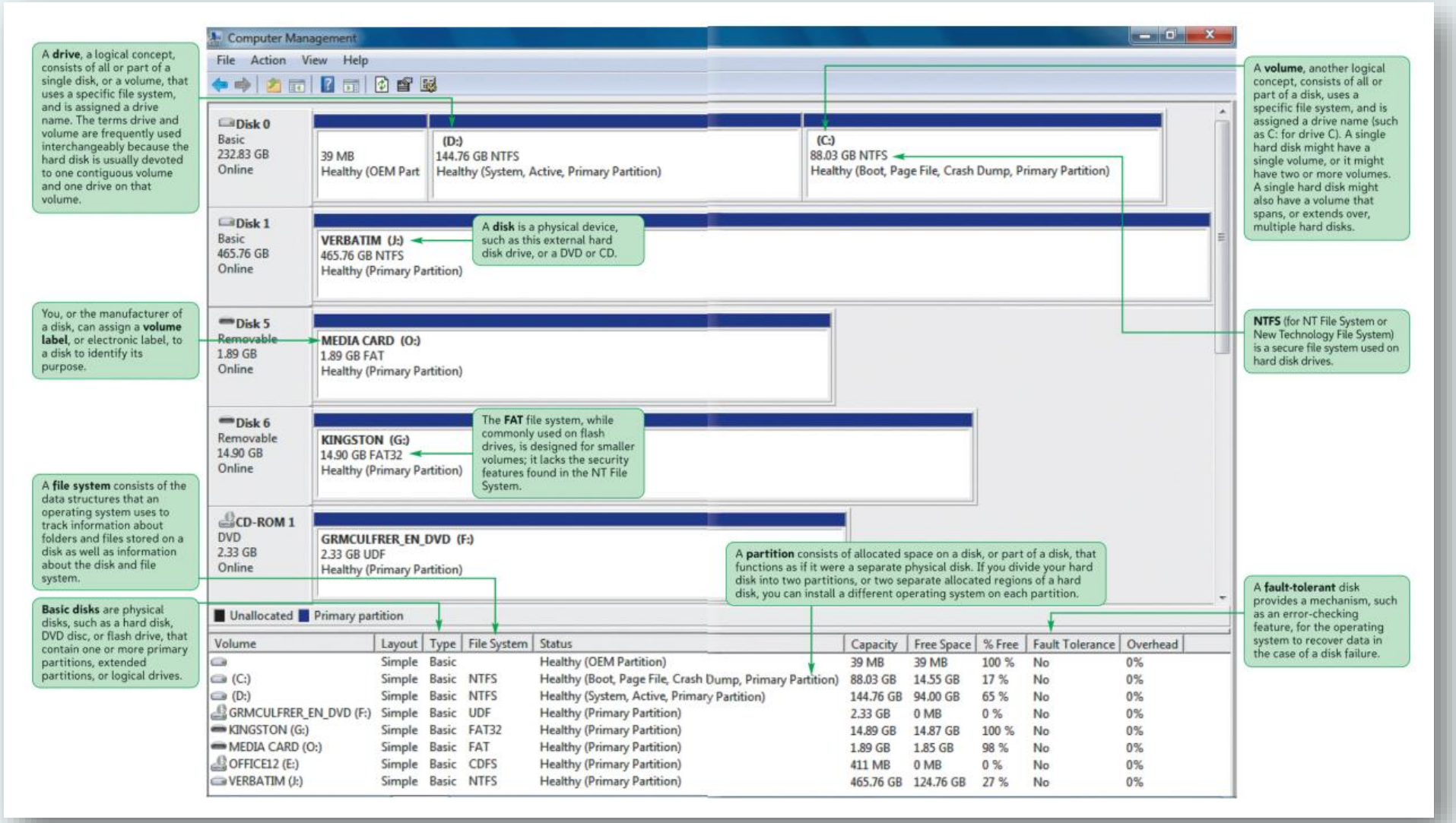
NTFS overview | Microsoft Learn

Resilient File System (ReFS)

- Microsoft's newest file system
  - designed to maximize data availability
  - scale efficiently to large data sets across diverse workloads
  - provide data integrity by means of resiliency to corruption
  - seeks to address an expanding set of storage scenarios and establish a foundation for future innovations.
  - Maximum volume and file size is 35 PB

[Resilient File System (ReFS) overview | Microsoft Learn]

Disk Management



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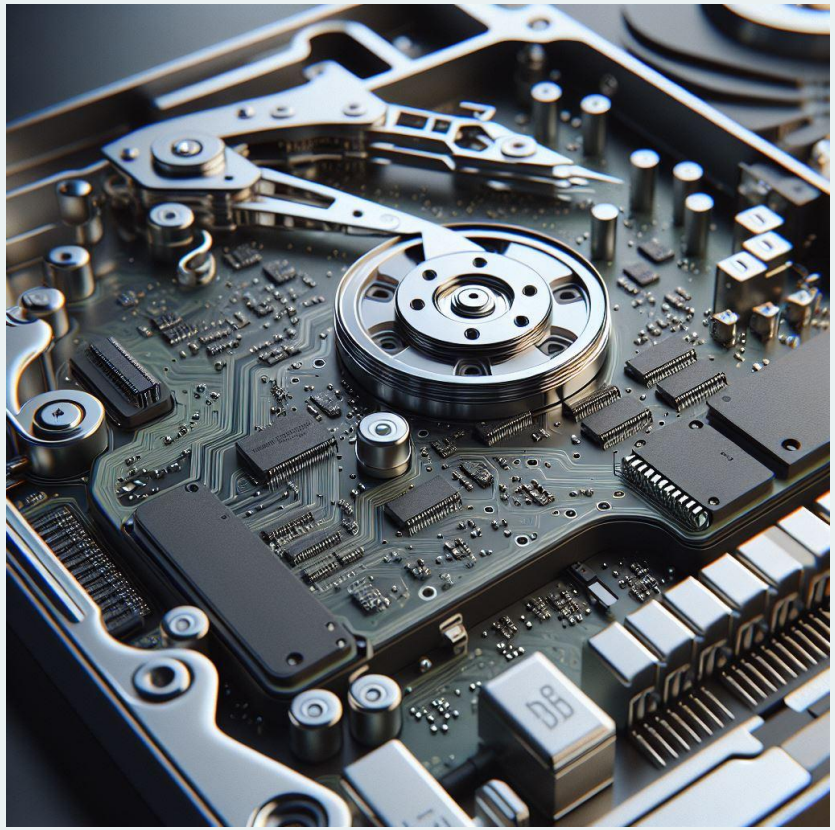
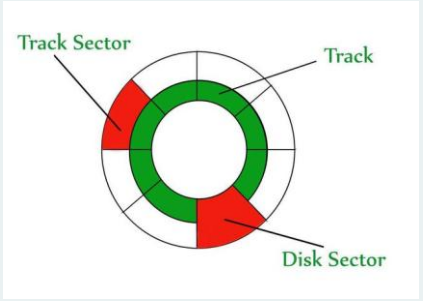
Parts of a Hard Disk





- Physical Components:
  - Platters: Rotating disks coated with magnetic material to store data.
  - Heads: Small magnetic devices that read and write data to the platters.
  - Actuator: Mechanism that positions the heads over the platters.
  - Spindle Motor: Motor that spins the platters.
  - Circuit Board: Controls the HDD's operations, including data transfer and motor control.
- Logical Components:
  - Tracks: Concentric circles on the platters where data is stored.
  - Sectors: Smallest units of storage on a track, typically 512 bytes or 4KB.
  - Cylinders: Group of tracks with the same radius on multiple platters.

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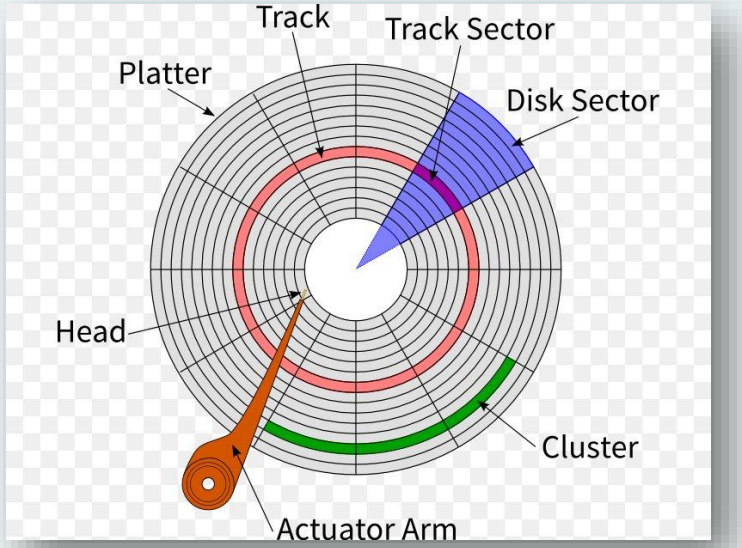
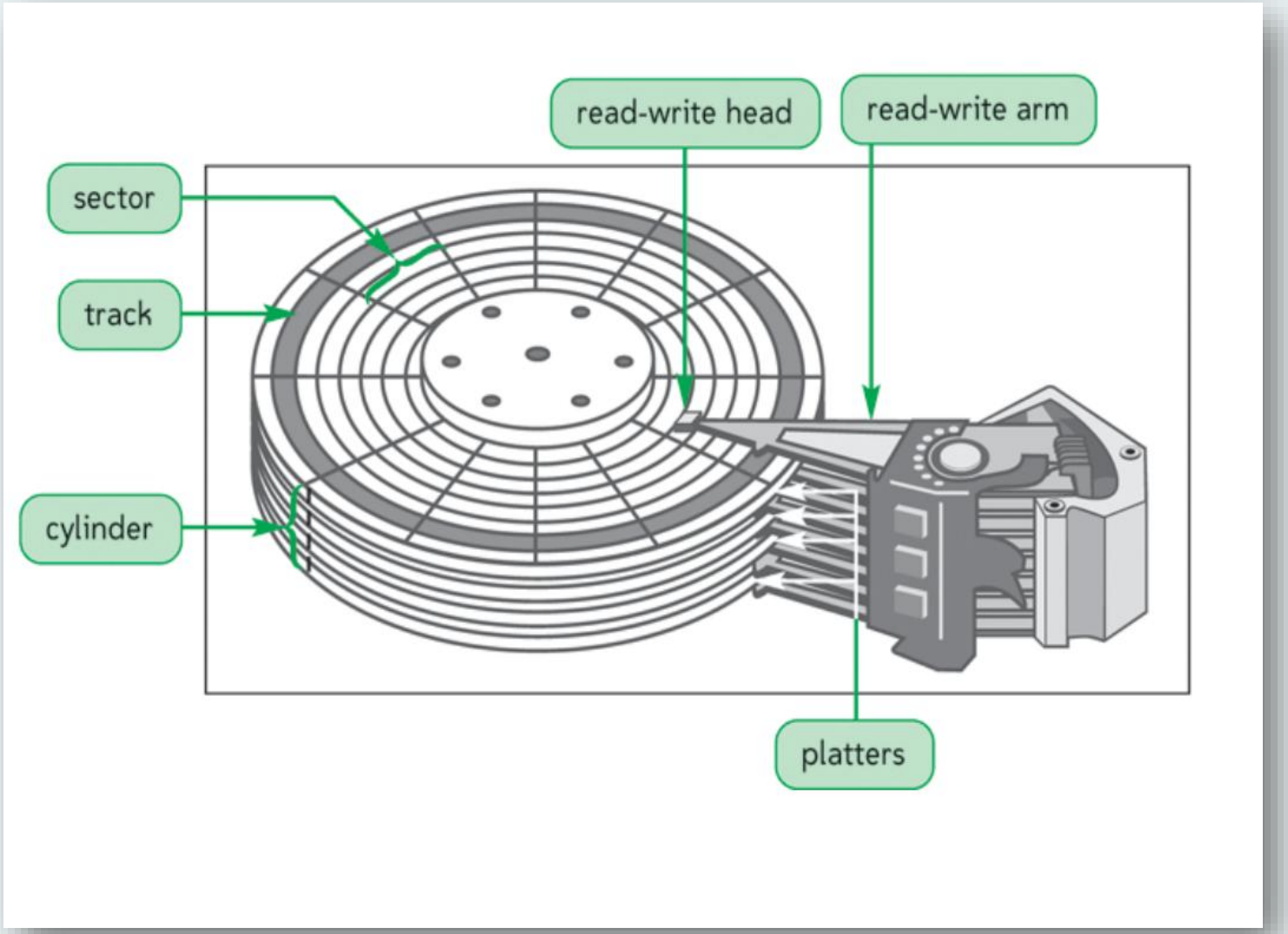
Logical Parts of a Hard Disk





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Formatting a Hard Disk

- **Low-level formatting** – creating tracks and sectors on a disk
  - **Physical formatting**: Divides the disk into tracks and sectors.
  - **Creates sector markers**: Identifies the start and end of each sector.
  - **Typically done at the factory**: Usually performed by the manufacturer.
- **High-level formatting** – creating a file system on the disk
  - **Logical formatting**: Creates a file system on the disk.
  - **Sets up file system structures**: Includes creating a boot sector, file allocation table (FAT), and root directory.
  - **Prepares the disk for use**: Allows the operating system to store and retrieve files.

Understanding the Role of the Master Boot Record

- Plays an important role in the booting process
  - Contains information about the **partitions**
    - **Hard Disk Partition Table**
- Contains **Master Boot Code**
  - **Boot sector** or **boot record**
- **Limitations:**
  - **Legacy**: MBR is an older technology, and modern systems often use GUID Partition Table (GPT) instead.
  - **Limitations**: MBR has limitations, such as supporting only four primary partitions and a maximum disk size of 2TB.
- The MBR plays a vital role in the boot process, but its limitations have led to the adoption of newer technologies like **GPT**.

Examining the Native File System of Windows 10 and 11 (NTFS)

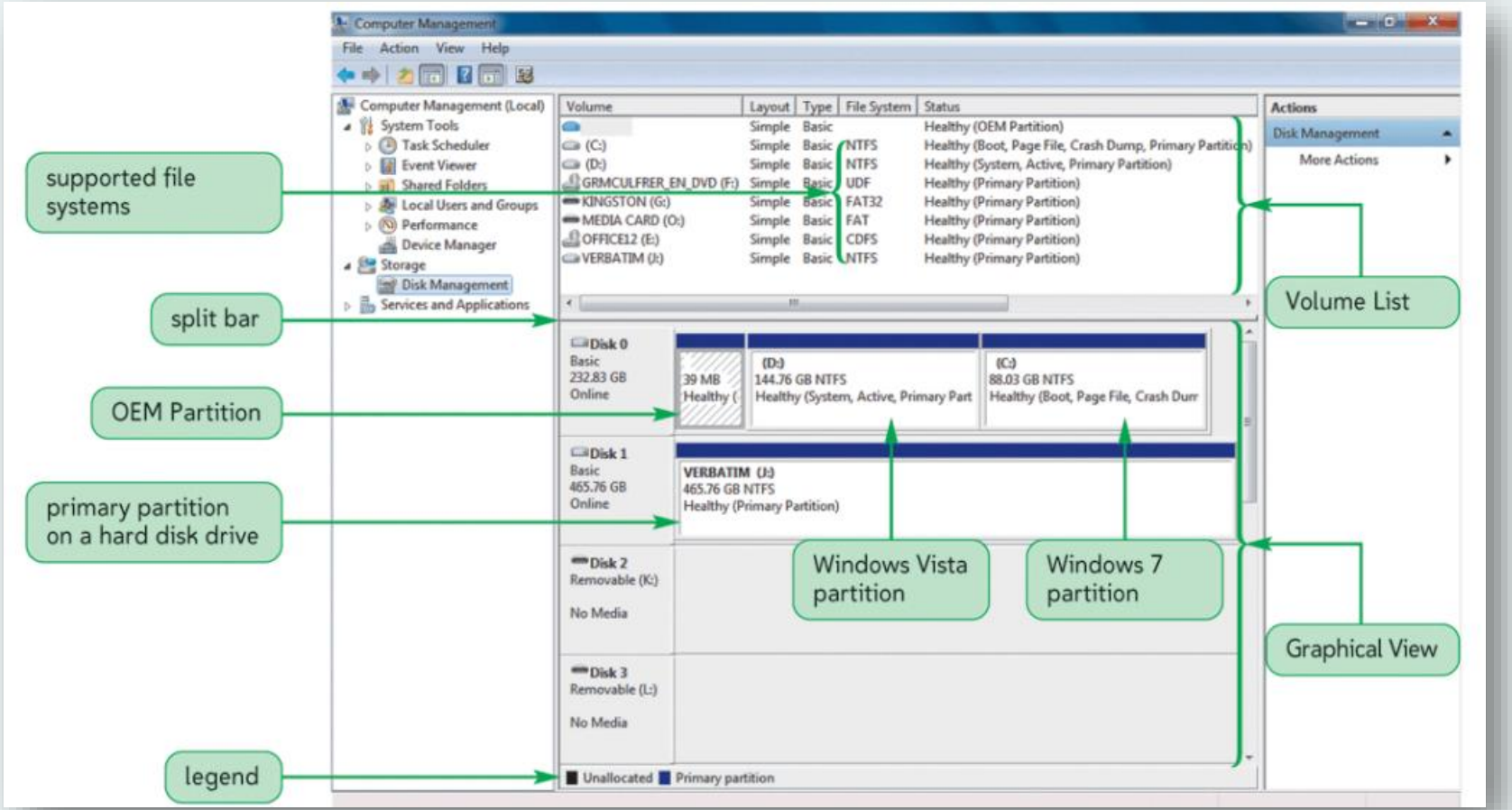
- NTFS Components and Features:
- 1. **Master File Table (MFT):** A database that stores metadata about files and directories.
- 2. **Master File Table Mirror (MFTMirr):** A mirror of the MFT, used for redundancy and recoverability.
- 3. **Metadata**: NTFS stores metadata about files, such as creation date, modification date, and file attributes.
- 4. **Media descriptor**: Identifies the type of storage media.
- 5. **Transaction log file**: Used for journaling, which improves file system reliability and recoverability.
- 6. **Self-healing:** NTFS has self-healing capabilities, which allow it to detect and repair file system corruption.

Windows 11 also supports other file systems, such as ReFS.

Using the Disk Management Tool

- Microsoft Management Console (MMC) provides access to administrative tools

- Disk Management Tool
  - Create Partitions and Volumes
  - Formatting and managing Volume



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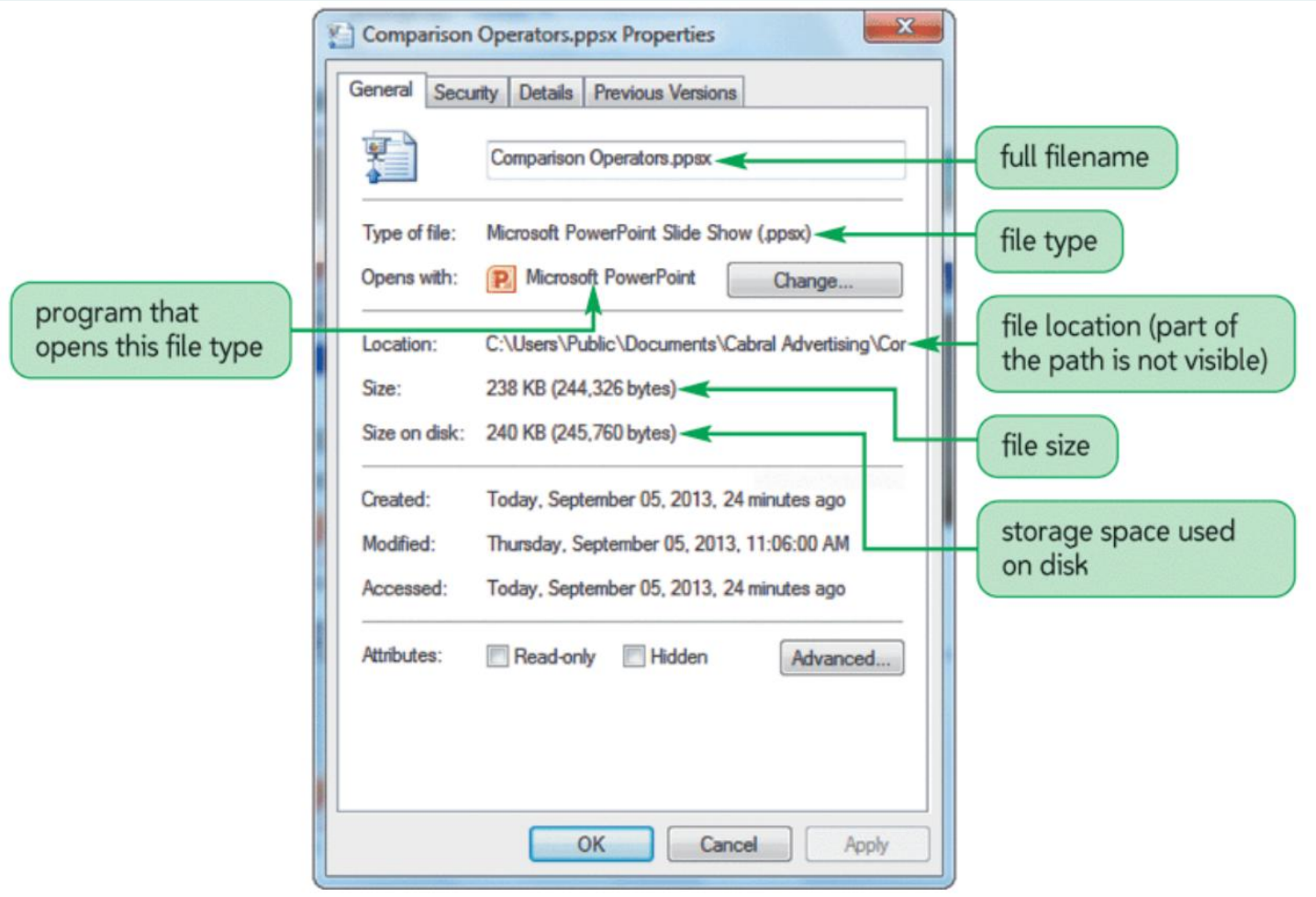
Viewing Properties of a File

- Right-click the file, and then click Properties (Alt+Enter)
- Note the file system "slack"



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WINDOWS DESKTOP SUPPORT

BACKUP & DISASTER RECOVERY

Objectives

- Back up and restore files
- Set up a system recovery drive
- Create a system restore point
- Fault Recovery vs Fault Tolerance

Disaster Recovery

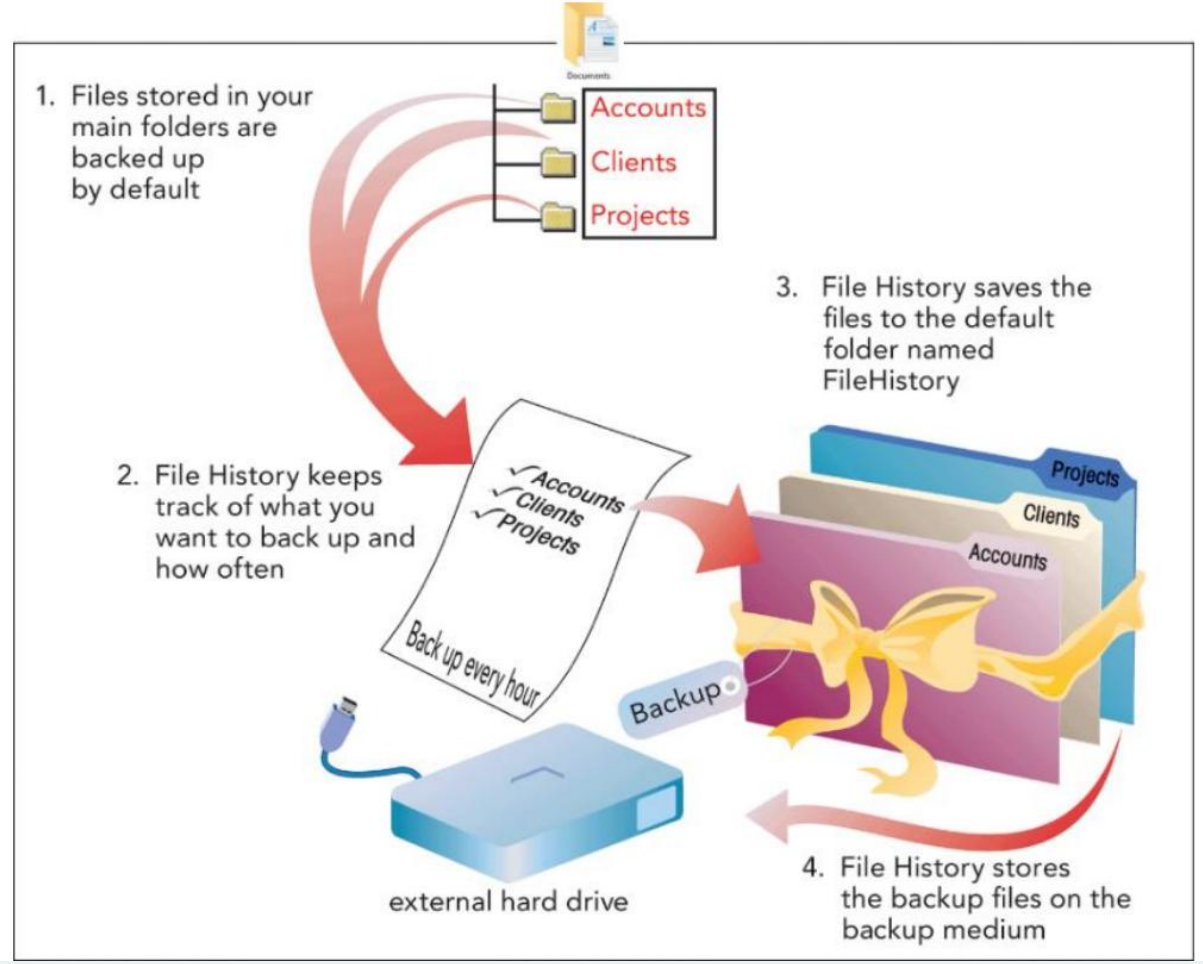
- Involves a set of policies and procedures to enable the **recovery** or continuation of vital technology infrastructure and systems following a natural or human-induced **disaster**.
- Two broad categories
  - **Natural disasters** such as floods, hurricanes, tornadoes or earthquakes
  - **Man-made disasters**, such as hazardous material spills, infrastructure failure, bio-terrorism, and disastrous IT bugs or failed change implementations

Disaster Recovery

- Disaster recovery focuses on the IT or technology systems supporting critical business functions
- Business continuity involves keeping all essential aspects of a business functioning despite significant disruptive events
- Disaster recovery is considered a subset of business continuity

Backing Up and Restoring Files

- A backup program copies files and folders from a hard disk to a specified location and then automatically compresses them



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The Importance of Backing Up Files

- Common causes of data loss include:
  - User errors
  - Malicious software, malicious Web sites, and hackers
  - Power failures, power surges, or power brownouts
  - Unresolved file system problems
  - Hardware malfunctions or failure
  - Software problems
  - Theft or vandalism of a computer
  - Natural disasters including fires, floods, and earthquakes

The Importance of Backing Up Files

- There are different approaches to back up important files:
  - Copy files from a hard disk to some type of removable storage
  - Copy files from a hard disk to an external hard disk drive or network folder
  - Use a backup utility
  - Use shadow copies
- Organize your files and folders logically

Developing an Effective Backup Strategy

- It is important to develop and implement an effective backup strategy
  - Backup cycle
  - Full backup (normal backup): makes a copy of all files
  - Incremental backup: backs up files that have been added/changed since the last backup
  - Differential backup: backs up files that have been added/changed since the last FULL backup

Incremental or Differential?

- Incremental backups take less time to acquire the data.
- Incremental backups take longer to restore.
- Incremental backups require all the incremental backups since the last full backup and the last full backup to fully restore your data

Incremental or Differential?

- Incremental backups take less time to acquire the data.
- Incremental backups take longer to restore.
- Incremental backups require all the incremental backups since the last full backup and the last full backup to fully restore your data

- Differential backups take more time to acquire the data.
- Differential backups take less time to restore.
- Differential backups require only the last differential backup and the full backup to fully restore your data

Understanding the Importance of the Archive Attribute

- The Archive attribute (or Archive bit) is used to tell the backup utility what to include in the backup

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Understanding the Importance of the Archive Attribute

How full, differential and incremental backups handle archive attribute		
Type of Backup	Archive Attribute	
	Before Backup	After Backup
Full Backup		
Already backed up files	Off	Off
New files	On	Off
Modified files	On	Off
Differential Backup	On	On
Incremental Backup	On	Off

Developing an Effective Backup Strategy

Using a backup strategy that combines full and differential backups

Backup Cycle	New or Modified Files	Type of Backup	Files Backed Up
Beginning of backup cycle		Full backup #1	All folders and files in: • Projects folder • Portfolio folder
End of week 1	Portfolio 1.docx Portfolio 2.docx	Differential backup #1	Portfolio 1.docx Portfolio 2.docx
End of week 2	Portfolio 3.docx Portfolio 4.docx	Differential backup #2	Portfolio 1.docx Portfolio 2.docx Portfolio 3.docx Portfolio 4.docx
End of week 3	Portfolio 2.docx Portfolio 5.docx Portfolio Cover Letter.docx	Differential backup #3	Portfolio 1.docx Portfolio 2.docx Portfolio 3.docx Portfolio 4.docx Portfolio 5.docx Portfolio Cover Letter.docx
Start of a new backup cycle	Portfolio 1.docx	Full backup #2	All folders and files in: • Projects folder • Portfolio folder

Developing an Effective Incremental Strategy

Using a backup strategy that combines full and incremental backups

Backup Cycle	New or Modified Files	Type of Backup	Files Backed Up
Beginning of backup cycle		Full backup #1	All folders and files in: • Projects folder • Portfolio folder
End of week 1	Portfolio 1.docx Portfolio 2.docx	Incremental backup #1	Portfolio 1.docx Portfolio 2.docx
End of week 2	Portfolio 3.docx Portfolio 4.docx	Incremental backup #2	Portfolio 3.docx Portfolio 4.docx
End of week 3	Portfolio 2.docx Portfolio 5.docx Portfolio Cover Letter.docx	Incremental backup #3	Portfolio 2.docx Portfolio 5.docx Portfolio Cover Letter.docx
Start of a new backup cycle	Portfolio 1.docx	Full backup #2	All folders and files in: • Projects folder • Portfolio folder

Developing an Effective Backup Strategy

- 3-2-1 Backup Schema
  - 3 Copies of the Data
  - 2 Types of Media
  - 1 Remote Storage Location
- Copies of Data
  - Typically, 3 copies is recommended.
  - Backup versioning is also recommended
    - Grandfather, Father, Son (these names will likely change)

Developing an Effective Backup Strategy

- Types of Media
  - Magnetic (Hard Disk, Tape)
  - Solid State (SSD, SD Card/other portable flash, USB Thumb drive)
  - Optical (CD, DVD, Blu-Ray)
  - Others?

Developing an Effective Backup Strategy

- Types of Locations
- In Production : Infrastructure and data are hosted in a cloud environment, colocation facility, or a third-party data center.
    - Fastest to restore, great for File History or recovering accidental deletion
    - Vulnerable to attack
- On-Premise : Infrastructure and data are hosted and managed within an organization's own premises.
    - Moderate time to restore
    - Potentially more resilient to attack

Developing an Effective Backup Strategy

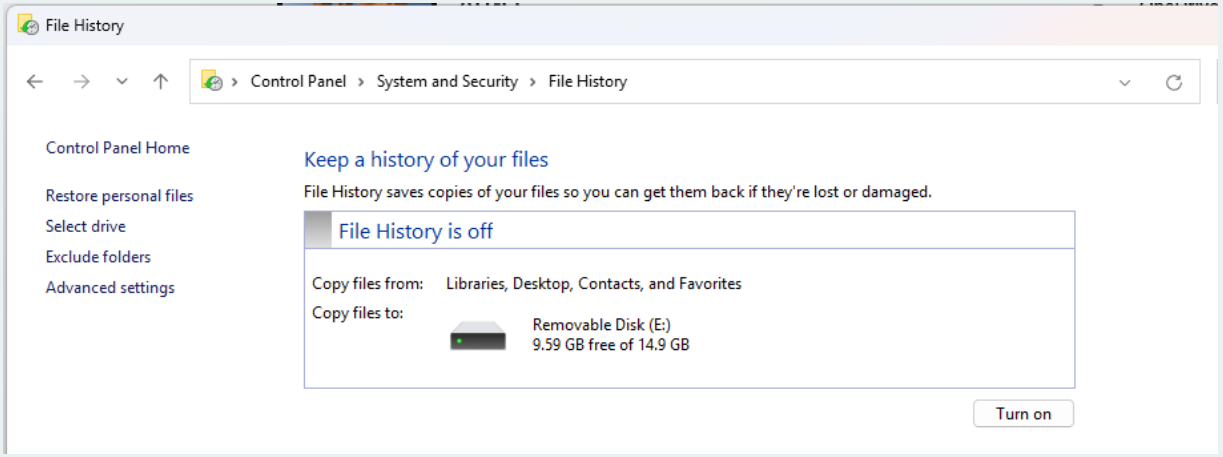
- Types of Locations
  - Remote
    - Cloud Storage
    - Companion Site (ie. Head Office, Satellite Office)
  - Slow to restore
  - Most resilient to attack
  - More costly

Developing an Effective Backup Strategy

- A proper Backup Strategy Consists of:
  - Scheduled Full Backups with Multiple Incremental or Differential Backups
  - Completed Automatically and reliably
  - Tested Regularly for consistency and viability

Setting Up File History to Back Up Files

- First enable File History if it isn't
  - Go to Control Panel > System and Security > File History
    - Click the Add a drive button, and then click a drive to use for backups



- If you want to use a network drive, follow the on-screen instructions to specify the drive
- Go to Settings > System > Storage > Advanced Storage Settingd

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Backing up Files

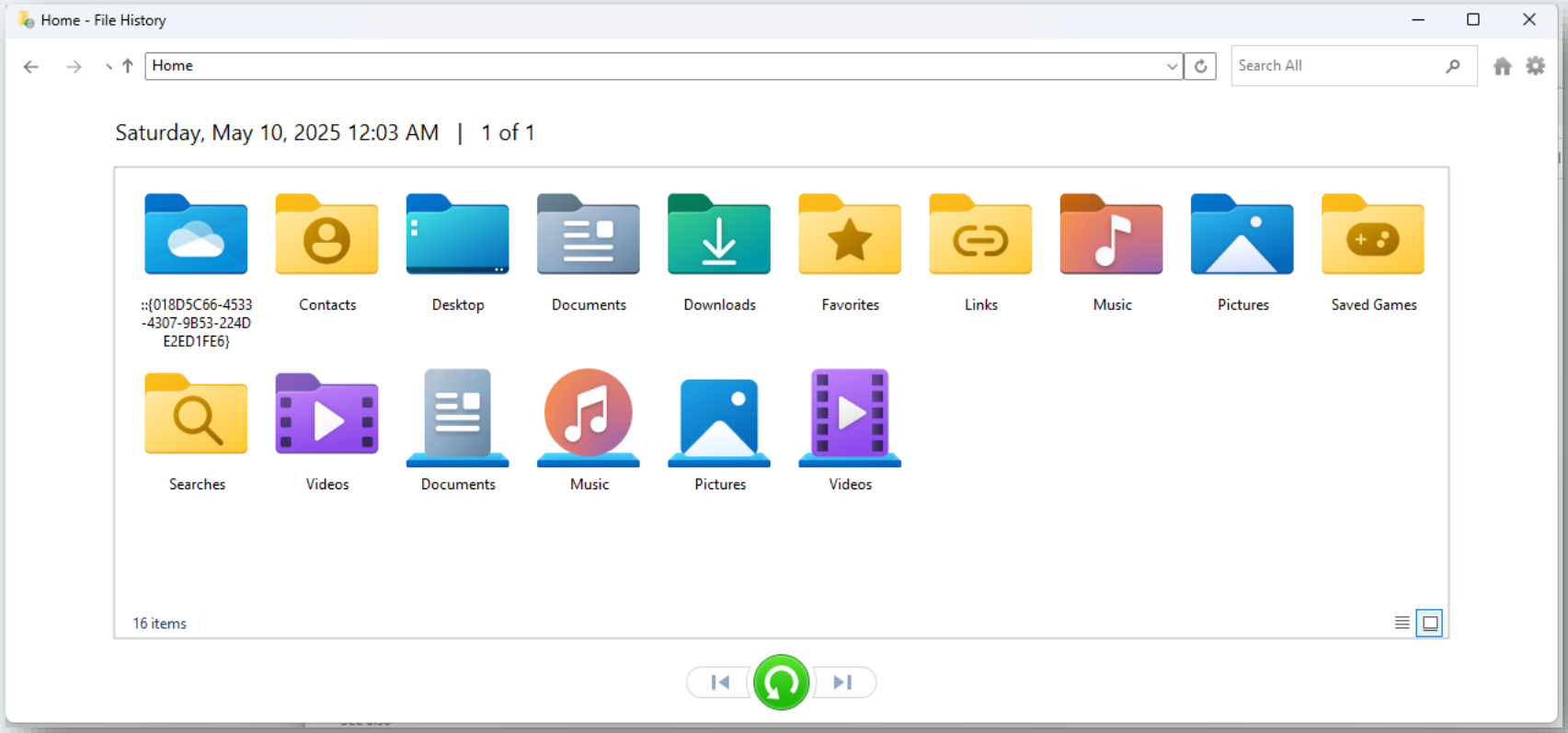
- Selecting the backup location
  - External hard drive
  - USB flash drive
  - Network folder

File History is New

- Most backup applications used brute force method of checking for changes in directories or files by scanning the entire volume
- This approach could significantly affect the system performance and requires an extended period of time to complete
- File History takes advantage of the NTFS change journal
    - The NTFS change journal records any changes made to any files stored on an NTFS volume. Instead of scanning the volume, which involves opening and reading directories, File History opens the NTFS change journal and quickly scans it for any changes. Based on this information it creates a list of files that have changed and need to be copied. The process is very quick and efficient.

File History

- By default, only backs up libraries & personal files (Desktop, Contacts, etc)
- Files and folders can be added or removed



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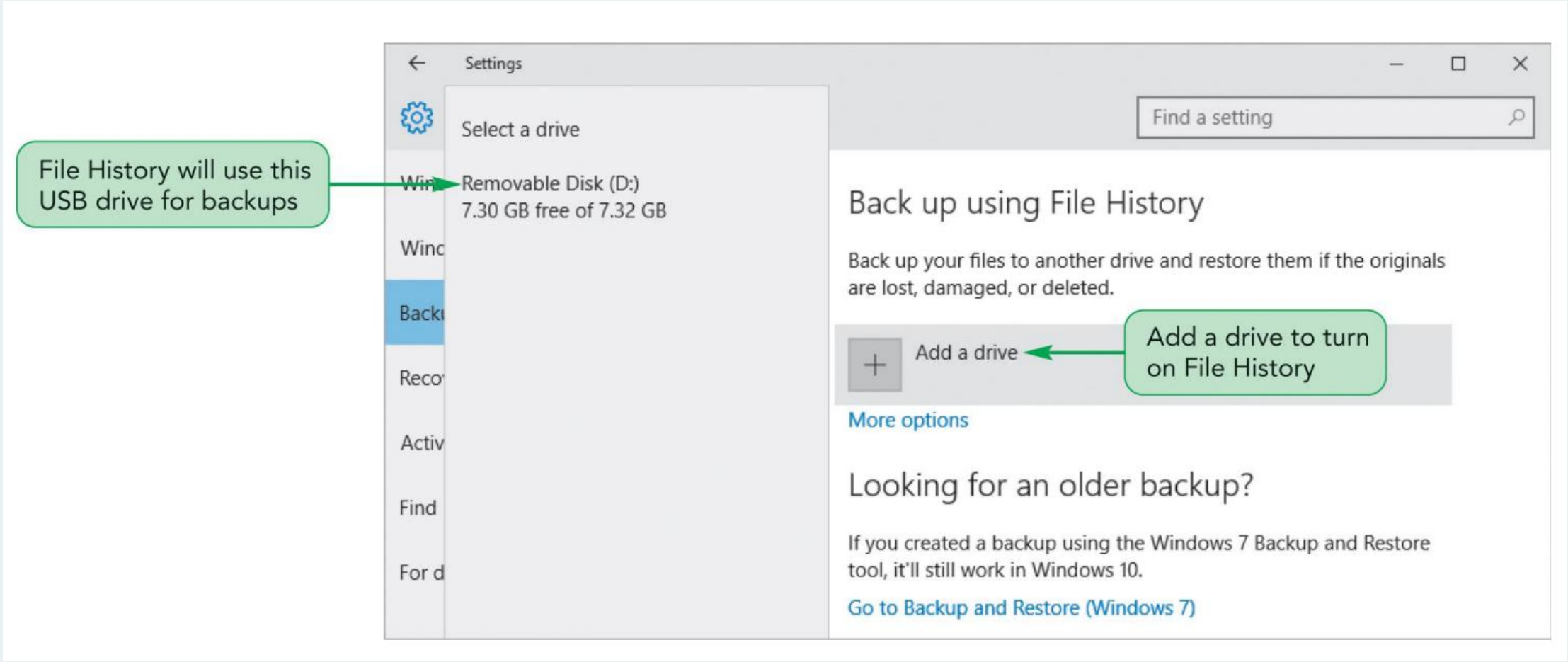
Backing Up Files



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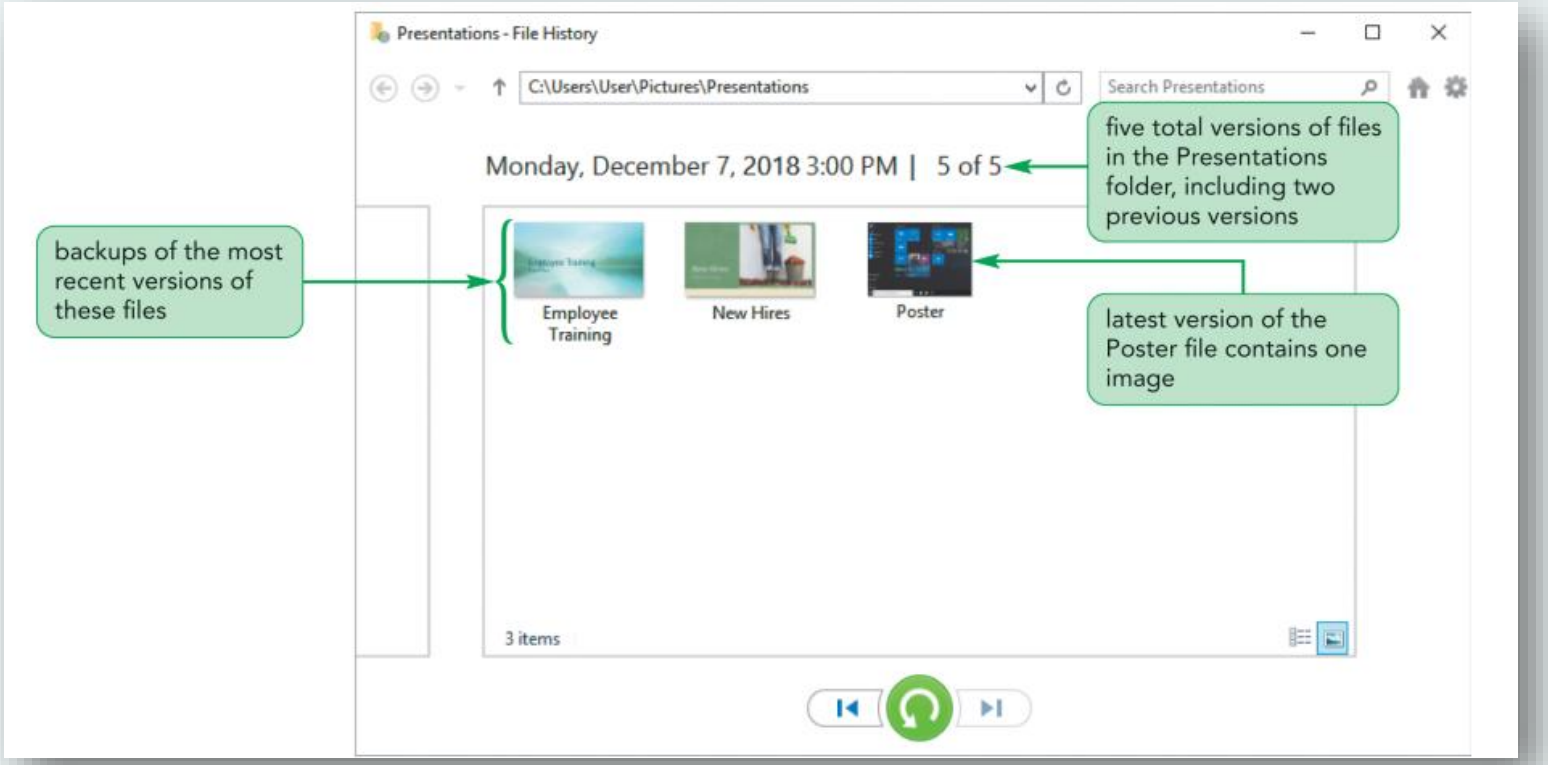
Backing Up Files

File History makes it much easier to restore the right version of a file because you use File Explorer and its familiar interface to find the file you want



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Managing System Restore

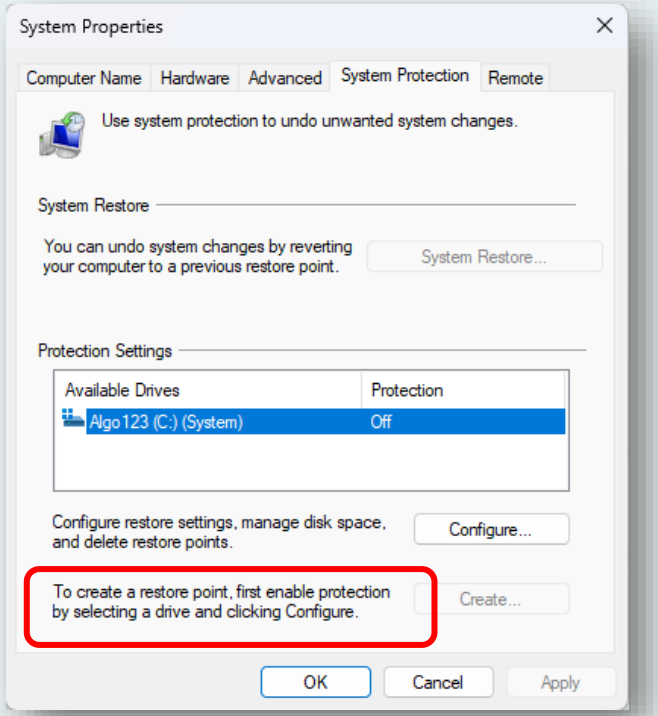
If you can start Windows but discover other system problems as you are working on the computer, you can save system files without affecting your personal files by using System Restore

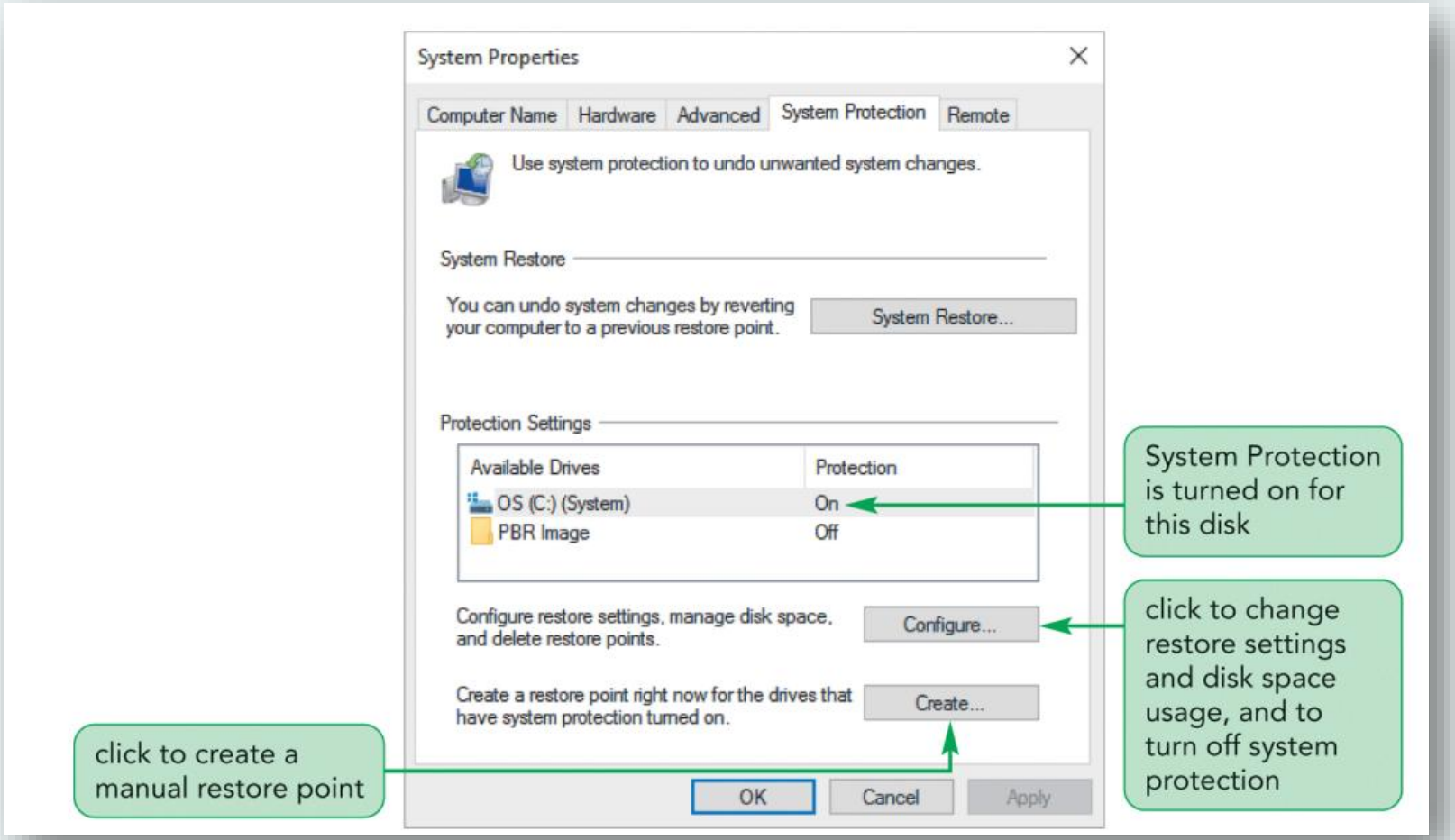
Managing System Restore

Recovery Options

Recovery Option	When to Use
System restore point	You recently installed an app, update, or other software, and now the system isn't working well.
Reset Windows	The system isn't working well, and you haven't installed any software recently.
Go back to an earlier build	The system hasn't been working well since a major update.
Recover Windows	The computer won't start and you've created a system recovery drive or a system repair disk.
Reinstall Windows from the original installation files	The computer won't start and you have not created a system recovery drive or a system repair disk.

Creating a System Restore Point





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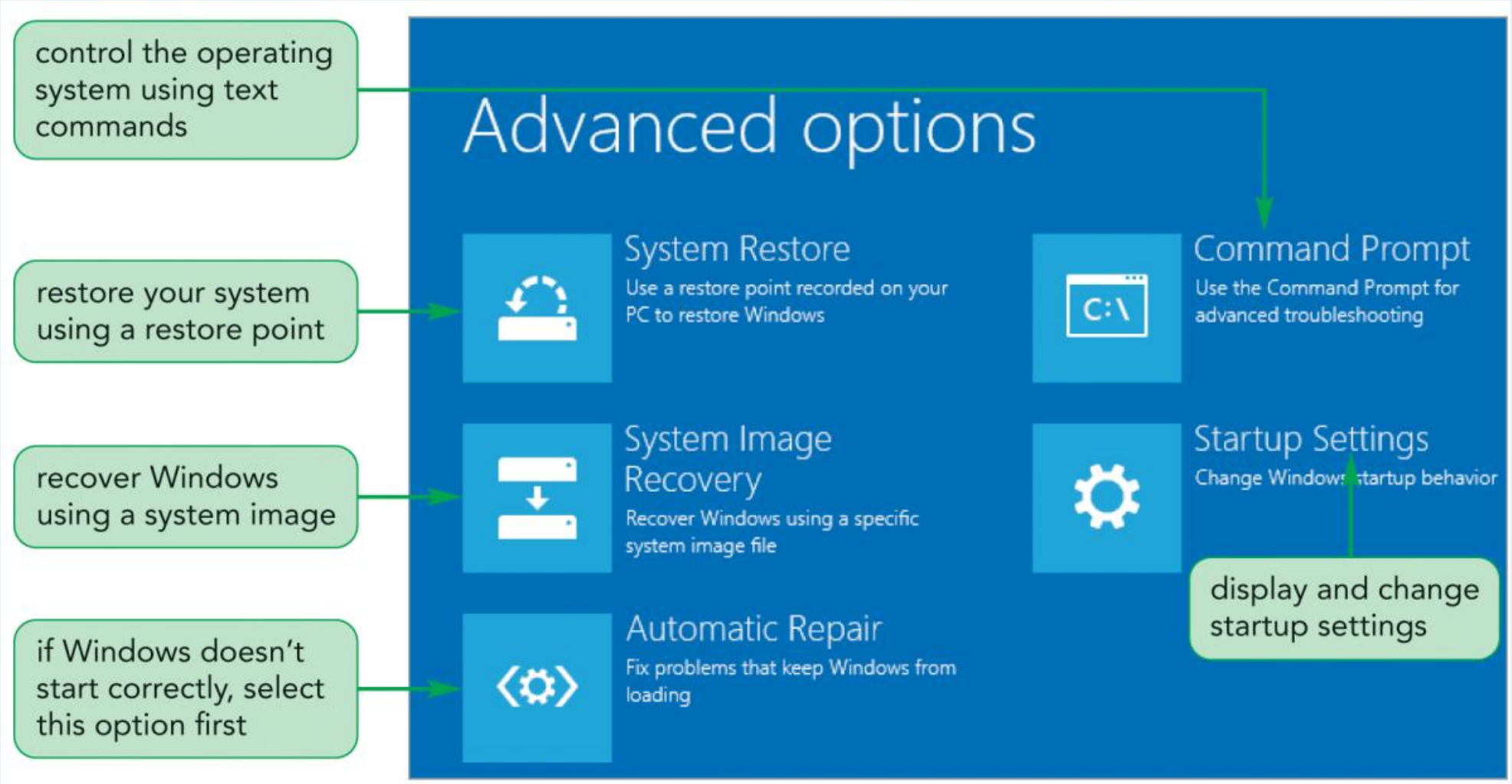
System Recovery

Restore points are created:

- At a scheduled time
- Installation of updates, software
- Uninstalling updates, software
- Manually

Resetting and Recovering a System



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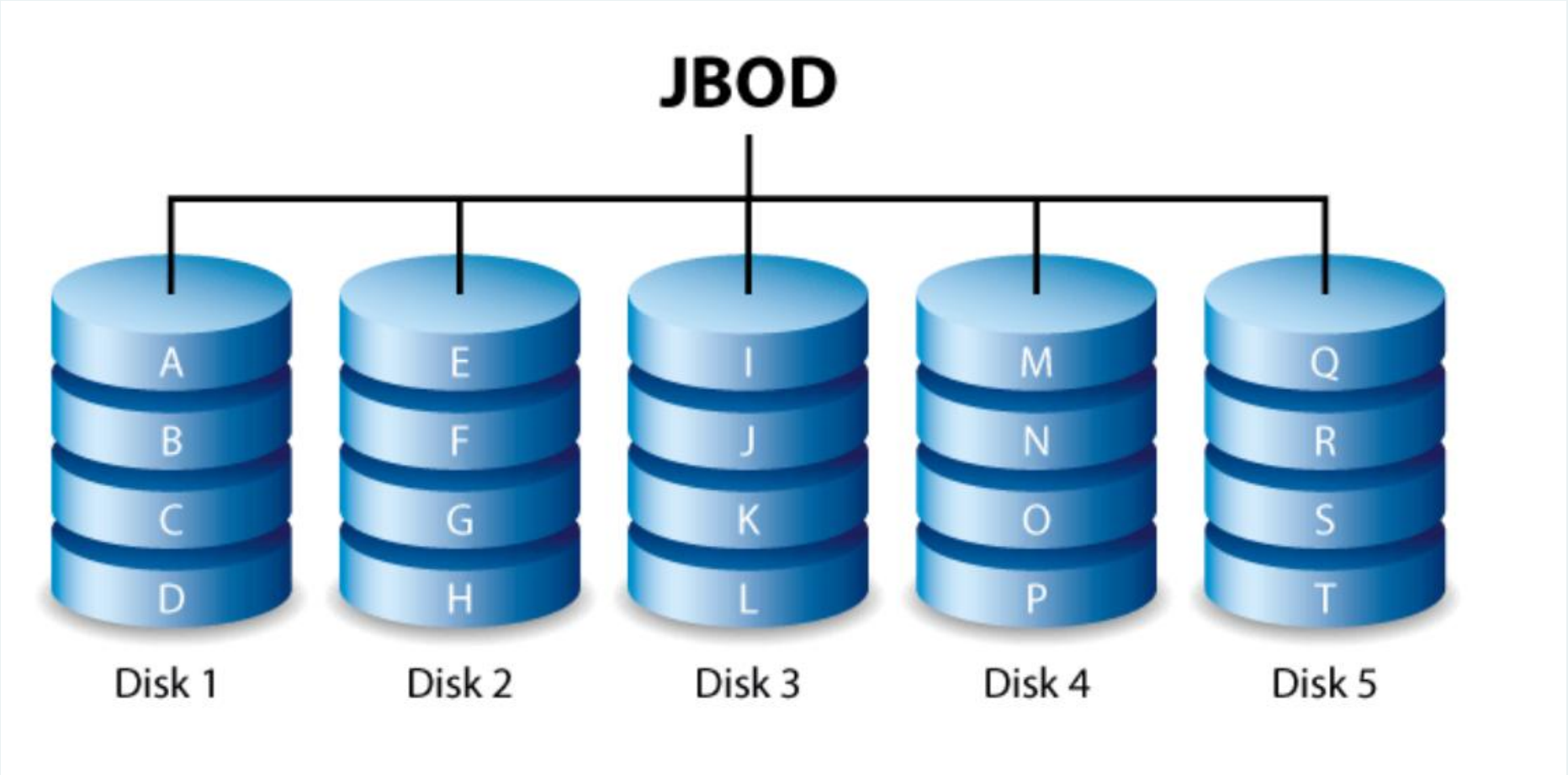
RAID

- Redundant Array of Inexpensive Disks
- Redundant Array of Independent Disks
  - What is it?
  - How does it work?

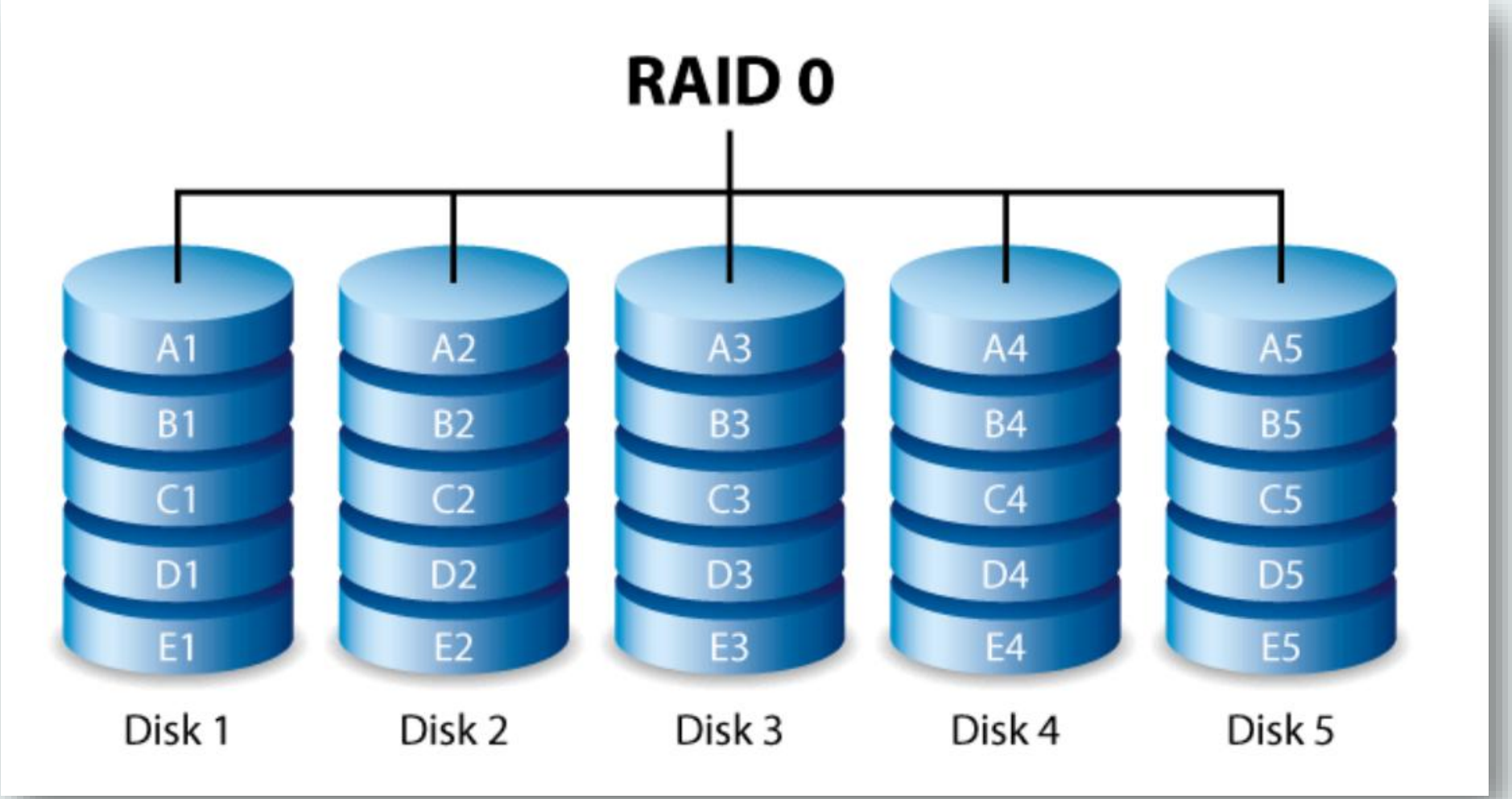
RAID

- Backup is a “Fault Recovery” strategy
  - Able to recover lost data in a reasonable amount of time
- RAID is a “Fault Tolerance” strategy
  - Able to maintain services in spite of system or environmental failures
  - High-availability and/or life-critical systems

JBOD



RAID 0 – Stripe Set



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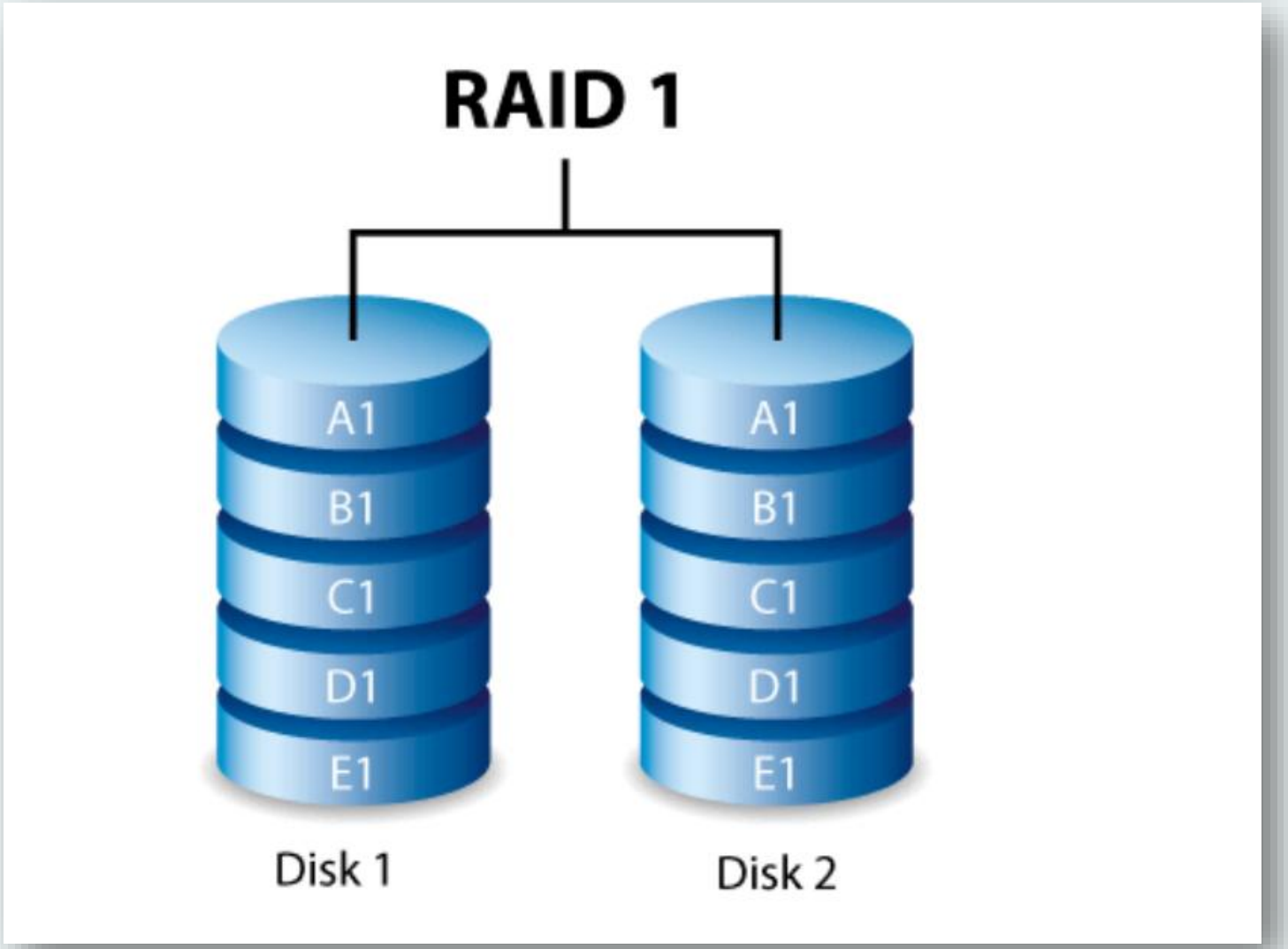
RAID 1 – Mirrored Disk



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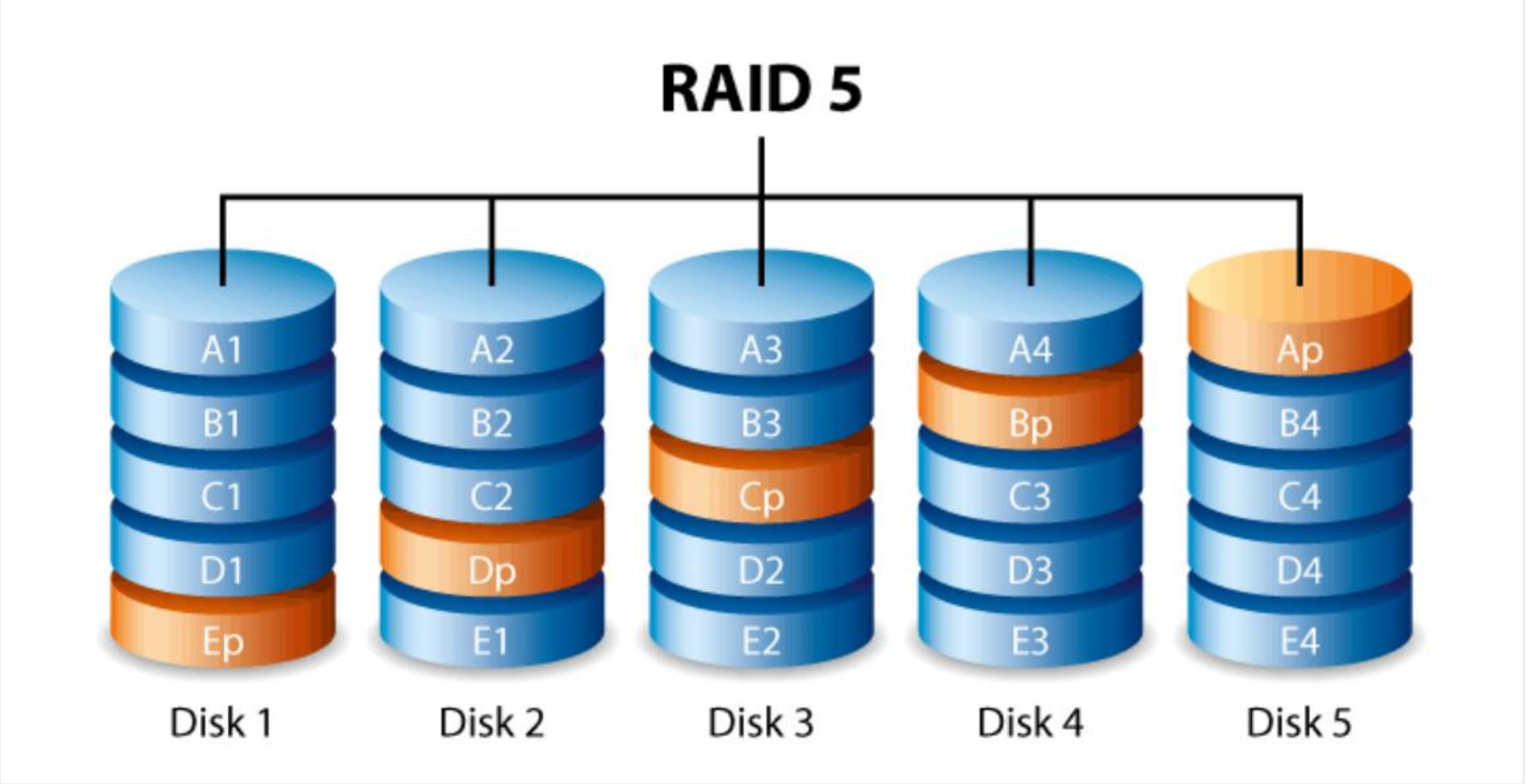
RAID 5 – Stripe Set w/Parity



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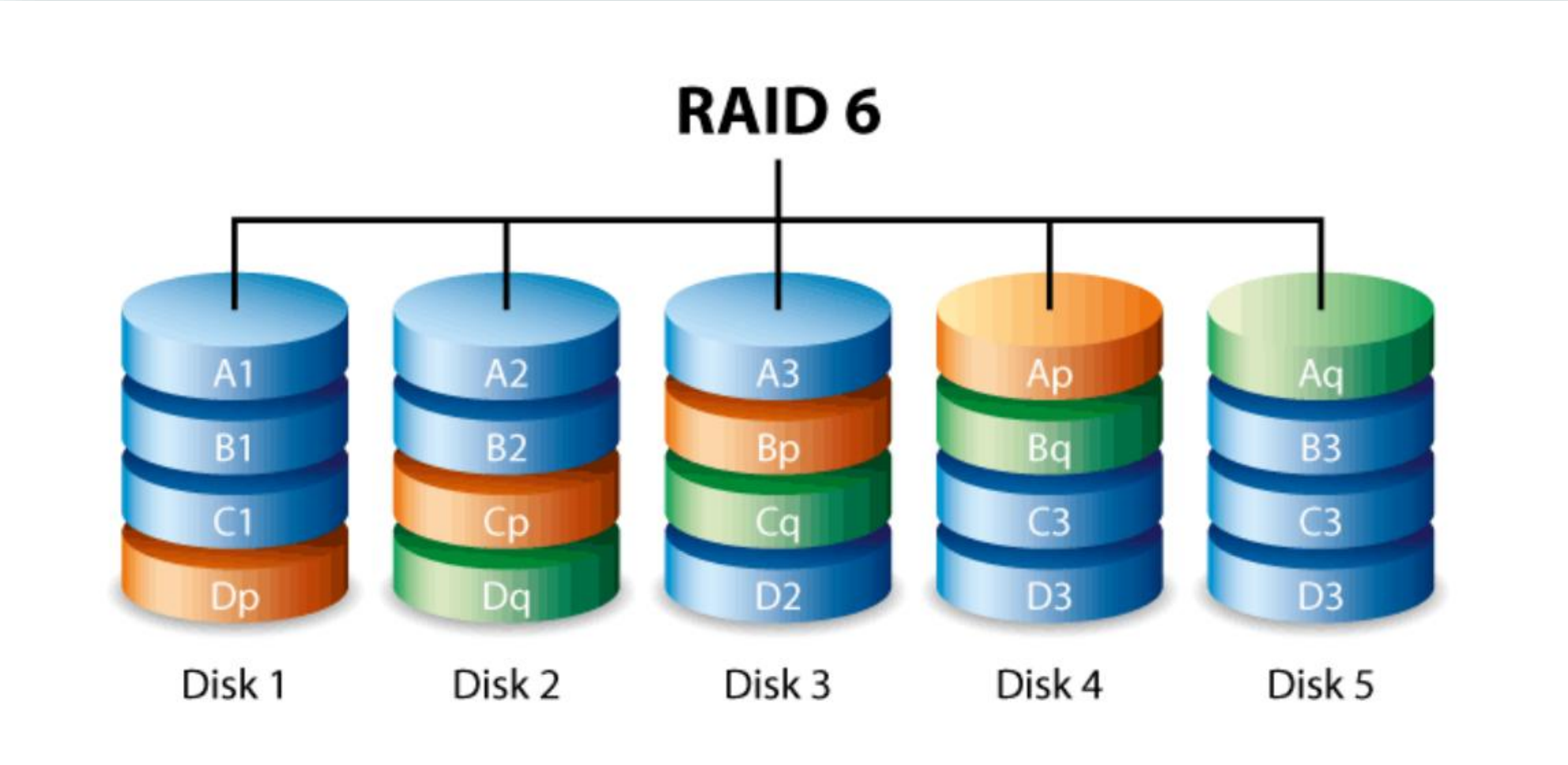
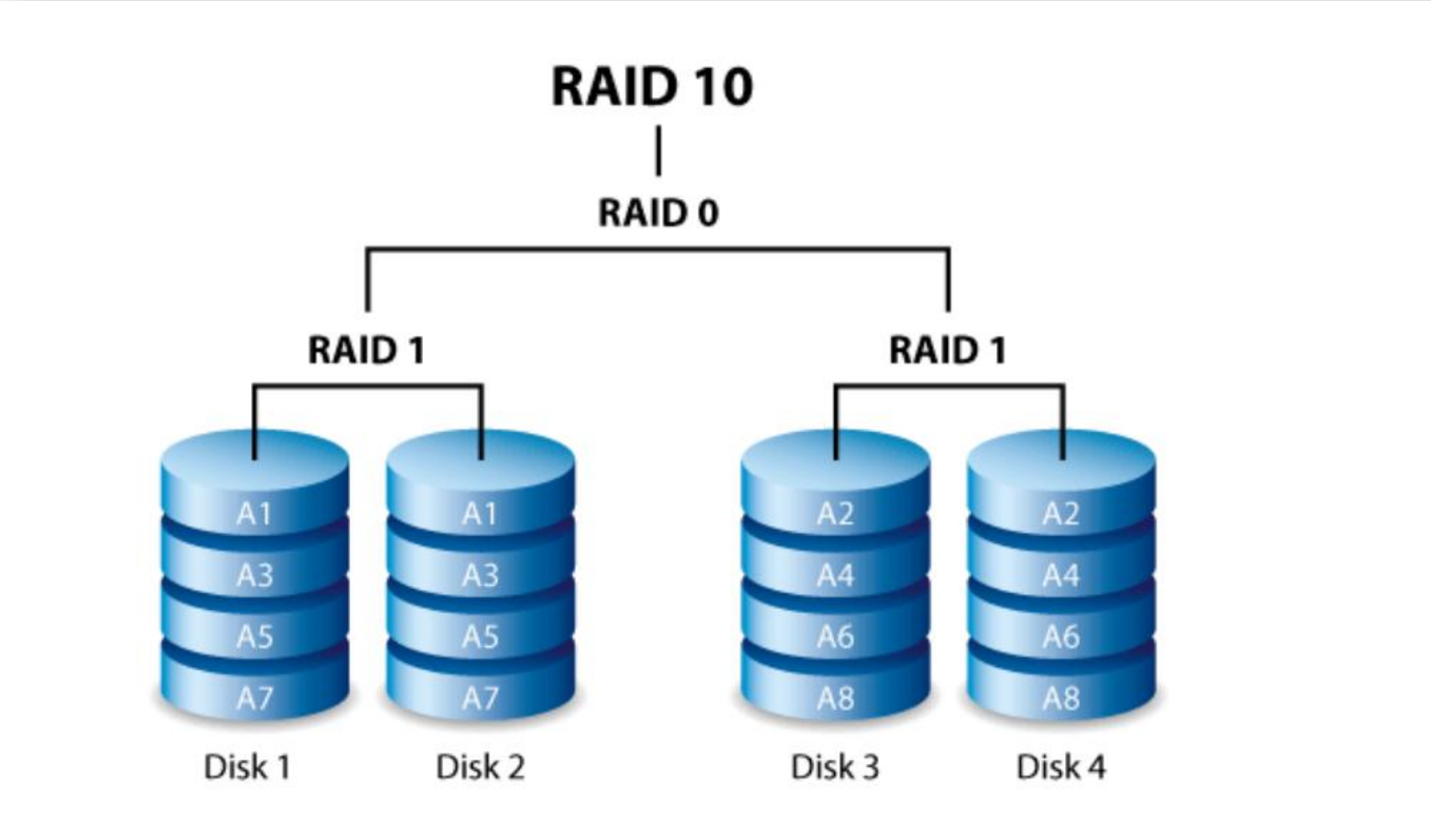
RAID 6 – Stripe Set w/2 Parity Blocks



RAID 1+0 – Combines RAID 1 & RAID 0



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Microsoft Storage Spaces

Storage Spaces is a powerful feature in Windows that provides flexibility and data protection for various storage needs.

- Create a "pool" using multiple drives
  - Windows treats this as a single storage device
- **Flexibility:** Could be used as:
  - **Simple space:** No redundancy, similar to JBOD.
  - Two-way (2 drives) or three-way (3 drives) **mirror**
  - Parity set (min 3 drives)

Thank you

Questions???