

# Chapter 9

## Implementing Mass Storage

# Episode 9.01

Episode **Understanding Partitioning**  
title:

Objective: N/A

# Episode 9.02

Episode **MBR Partitioning**  
title:

Objective: N/A

# Episode 9.03

Episode **GBT Partitioning**  
title:

Objective: N/A

# Episode 9.04

Episode **Understanding File Systems**  
title:

Objective: N/A

# Episode 9.05

Episode **Popular File Systems**  
title:

**Objective:** There are many file systems available for different systems, purposes, and type of storage. It's important to know the difference between files systems such as NTFS, ext3, FAT, and HFS+

## Lower 3rds

File System - Manages how data is stored and accessed on drives.

OBJ- File Allocation Table-32 bit (FAT32)

OBJ-New technology file system (NTFS)

OBJ-Extended FAT file system (ExFAT)

OBJ-Resilient File System (ReFS)

OBJ-Extended File System iteration 4 (ext4)

OBJ-eXtended File System (XFS)

OBJ-Apple File System (APFS)

## Lower 3rds

FAT32 - Widely compatible; 4GB max file size, 8TB max partition.

NTFS - Default for Windows; supports large files, permissions, encryption.

ExFAT - Cross-platform; better limits than FAT32—no journaling.



## Lower 3rds

ReFS - Resilient file system; auto error correction—used in Windows servers.

Ext4 - Linux default; supports 1EB volumes and 16TB files.

XFS - High-performance Linux file system for large-scale storage.

APFS - Apple's file system—used in macOS and iOS.

Chkdsk - Windows tool to check and fix file system errors.

# File System



Manages how data is  
stored and accessed  
on drives



A file system  
organizes data for the  
operating system

## File Allocation Table 32 (FAT32)

Oldest file system still in use

- Uses 32 bits for the address of each cluster
- Works on many devices (PCs, phones, consoles)
- Uses a table to track files and storage clusters
- Max file size = 4 GB; Max partition = 8 TB
- No built-in encryption or compression
- Highly compatible across systems

## New Technology File System (NTFS)

Primary file system used by Microsoft Windows

- Supports up to 16 exabyte volumes and 8 petabyte individual files
- Supports file-level compression and encryption
- Other OS can often read NTFS-formatted drives

## Extensible File Allocation Table (exFAT)

Halfway between FAT32 and NTFS

- Modern replacement for FAT32
- Works on Windows, macOS, Linux, consoles
- Supports large files and volumes like NTFS
- No built-in compression or encryption
- Ideal for SD cards and USB drives
- Great for cross-platform file sharing

## Resilient File System (ReFS)

Designed to resist data corruption

- Uses mirror and parity tiers (like RAID)
- Checks files automatically—no need for chkdsk
- Fixes corrupted data with regular scans
- Can't boot Windows from ReFS
- No built-in compression or encryption

## Check disk (chkdsk)

Windows tool to check  
and fix file system errors

```
C:\Windows\System32>chkdsk  
The type of the file system is NTFS.  
Volume label is C-Drive.
```

```
WARNING! /F parameter not specified.  
Running CHKDSK in read-only mode.
```



## Fourth extended File System (ext4)

Standard file system for most Linux distros

- Supports up to 1 EB storage and 16 TB files
- Uses extents (efficient block grouping)
- Backward compatible with ext3
- No built-in compression, encryption, or deduplication
- Can be read by Windows and macOS



## Extended File System (XFS)

Default for Red Hat Linux

- Handles very large files—up to 8 EB
- Best for enterprise servers and storage
- High performance for big data systems
- Not as common on general Linux desktops
- More scalable than ext4 for large workloads

## Apple File System (APFS)

File system for macOS and iOS

Optimized for flash and solid-state drives  
with support for encryption and on reliability

Standard file system for all Apple products



## Check disk (chkdsk)

Windows tool to check and fix file system errors

```
C:\Windows\System32>chkdsk  
The type of the file system is NTFS.  
Volume label is C-Drive.
```

```
WARNING! /F parameter not specified.  
Running CHKDSK in read-only mode.
```

# Episode 9.06

Episode **Formatting in Action**  
title:

Objective: N/A

# Episode 9.07

Episode **Dynamic Disks**  
title:

Objective: N/A

# Episode 9.08

Episode **New Installation – First Drive**  
title:

Objective: N/A

# Episode 9.09

Episode **RAID**  
title:

Objective: N/A

# Episode 9.10

Episode **Hardware RAID**  
title:

Objective: N/A



# Episode 9.11

Episode **Software RAID in Storage Spaces**  
title:

Objective: N/A

# Episode 9.12

Episode **Encrypting Mass Storage**  
title:

Objective: N/A

# Episode 9.13

Episode **Maintaining Storage Disk**  
title:

**Objective:** Mass storage devices need ongoing maintenance to ensure optimal operation. Windows systems have automated tools to optimize performance and to check drives for bad areas.

## Lower 3rds

Error Checking: Scans drives for file system issues or corruption

Disk Cleanup (cleanmgr.exe)

Disk Cleanup: Frees up space by removing temp files, cache, and trash

Run Disk Cleanup: Press Windows + R, type cleanmgr, select drive, choose items, and click OK

## Lower 3rds

Disk Defragment (dfrgui.exe)

# Episode 9.14

Episode **Mass Storage Troubleshooting**  
title:

**Objective:** Mass storage devices sometimes fail, resulting in the potential loss of critical data. A good tech knows the tools and procedures to diagnose and repair many mass storage problems.

# Lower 3rds

- OBJ - Light-emitting diode (LED) status indicators
- OBJ - Grinding noises
- OBJ - Clicking sounds
- OBJ - Bootable device not found
- OBJ - Data loss/corruption
- OBJ - RAID failure
- OBJ - Self-monitoring and Reporting Technology (S.M.A.R.T.) failure
- OBJ - Extended read/write times
- OBJ - Low performance input/output operations per second (IOPS)
- OBJ - Missing drives in OS
- OBJ - Array missing
- OBJ - Audible alarms

## Lower 3rds

Backup First - Always back up data before working on a drive

Common Drive Issues: Read/Write Failure, Slow Performance, Clicking/Grinding Noises, Boot Failure / OS Not Found, Drive Not Recognized, Data Loss or Corruption, and Missing Drives in OS

Self-Monitoring, Analysis, and Reporting Technology for drive health (SMART)

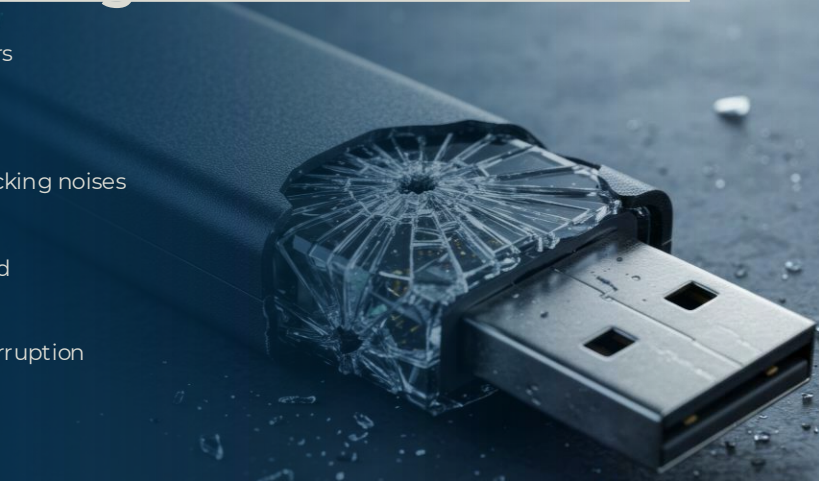
RAID Issues - Not Found, Disk Failure/Volume Deleted, Defective RAID Controller

LED Indicators - Can signal drive or connection problems



# Data Storage Device Problems

- LED status indicators
- Read/Write failure
- Performance issues
- Grinding or loud clicking noises
- Failure to boot
- Drive not recognized
- OS not found
- Data loss or data corruption
- Missing drives in OS



# Health of a Drive

S.M.A.R.T. detects a drive failure

Display a message that indicates preventive action

- Avoid data loss
- Replace the failing drive

Check documentation for the meaning of the codes

```
C:\Windows\System32>wmic /namespace:\\root\wmi path MSStorageDriver_FailurePredictStatus  
Active InstanceName PredictFailure Reason  
True SCSI\DiskDrive_MPHsProd_HDC_PC_S9530_5209\48318000e5408a20000_0 FALSE 0
```

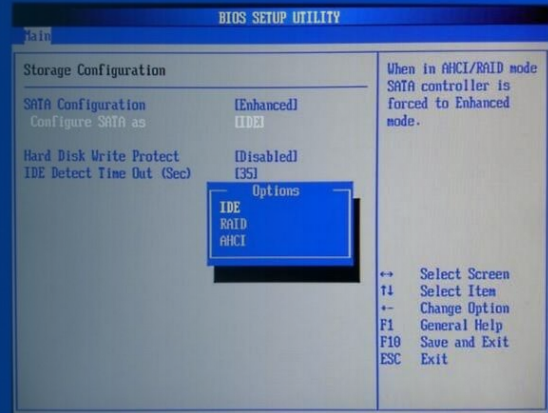
ⓘ Drives do not support all attribute codes (ID). Some codes are specific to particular drive types (magnetic platter, flash, SSD). Drives may use different codes for the same parameter.

⚠ If a drive is reported to have a critical status, it is recommended to back up and replace the drive immediately.

# RAID Not Found

RAID (redundant arrays of independent disks)

- Made up of hard disks
- Can have errors and failures
  - Caused by the RAID controller
  - Storage devices
- Can have errors and failures
  - "RAID not found"



## RAID problems

If RAID is enabled in BIOS, the problem could be:

- RAID disks have failed
- RAID volume deleted
- Defective RAID controller