

IT2654: Systems Administration & Security

**TOPIC 5:
MANAGING DISKS AND
DATA STORAGE**

Objectives

- Managing Disks and Volumes
- Implementing Fault Tolerant Disks - RAID
- Maintaining Disk Storage Volumes

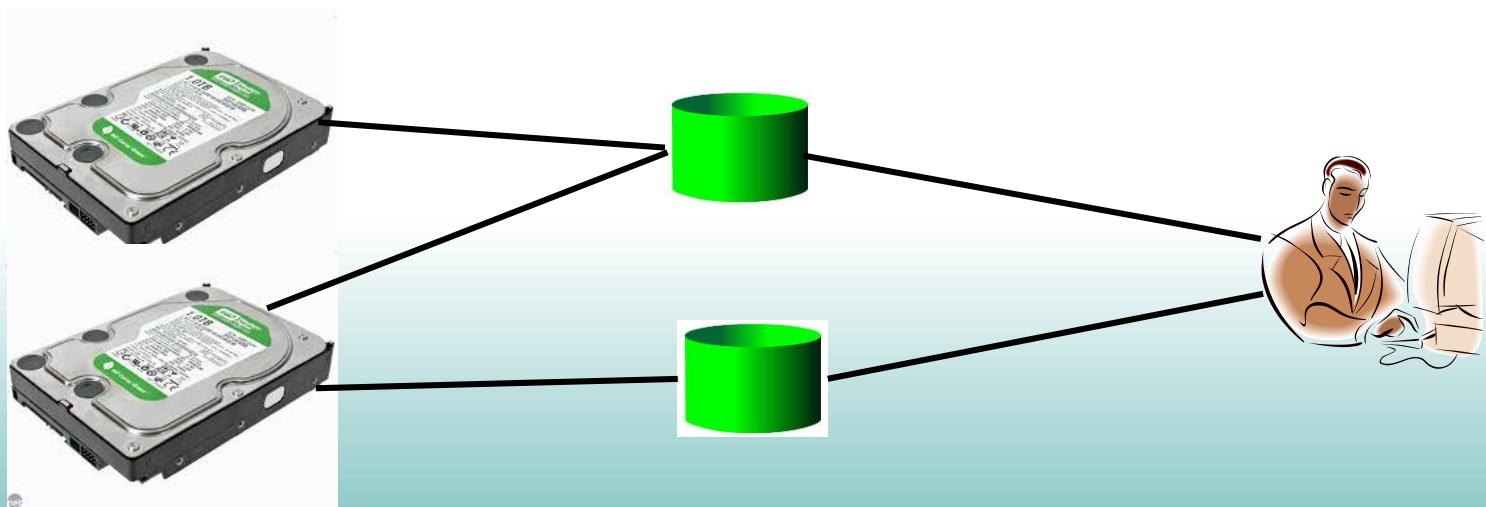
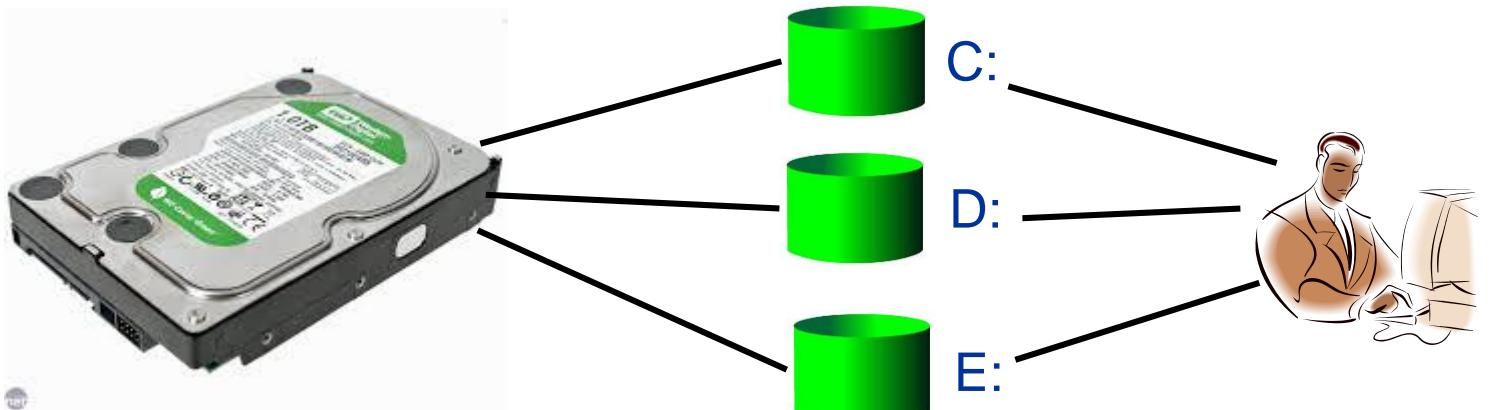


Physical Disk

- A disk (or hard disk)
 - A physical disk drive installed in your computer
 - Disk 0, Disk 1, Disk 2, etc.
 - Configuration options:
 - Partition Style – MBR or GPT
 - Disk Type – Basic or Dynamic



Logical Disk or Volume



Mounted Volumes

- Mounting a drive is an alternative to assigning it a drive letter
- A mounted drive is represented as a folder with a normal path
- To mount a drive:
 - Must be on an NTFS volume
 - Must be an empty folder
- Reasons:
 - 26 drive letter limit
 - Path access is convenient
 - Backups

Selecting a Partition Table Format

MBR (Master Boot Record)

- Standard Partition table format since early 1980s
- Supports a maximum of 4 primary partitions per drive
- Can partition a disk up to 2 TB

GPT (GUID Partition Table)

- GPT is the successor of MBR partition table format
- Supports a maximum of 128 partitions per drive
- Can partition a disk up to 18 EB

- ✓ Use MBR for disks smaller than 2 TB
- ✓ Use GPT for disks larger than 2 TB

Basic Disk Examples

- Maximum of 4 primary partitions or 3 primary and 1 extended partition on a disk
 - Four Primary Partitions

Disk 1	(D:)	(G:)	(H:)	(I:)	
Basic 7.87 GB Online	4.88 GB NTFS Healthy (Active)	996 MB FAT32 Healthy	502 MB FAT32 Healthy	1.46 GB FAT32 Healthy	63 MB Unallocat

- Three Primary Partitions, One Extended Partition with Three Logical Drives

Disk 1	(D:)	(G:)	(H:)	(I:)	(J:)	(K:)
Basic 7.87 GB Online	4.88 GB NTFS Healthy (Active)	996 MB FAT32 Healthy	502 MB FAT32 Healthy	502 MB FAT32 Healthy	502 MB FAT32 Healthy	557 MB FAT32 Healthy

█ Primary partition █ Extended partition █ Free space █ Logical drive

Dynamic Disk

- Volumes are created within the disk. (partition not used here)
- Max of 128 volumes per disk
- Supports spanning, striping, and RAID implementations
- A dynamic disk does not have a partition table. Information about the layout of disk volumes is stored in a database on the last 1 MB of the disk

Disk 2	New Volume (K)	New Volume (L)	New Volume (M)	New Volume (N)	New Volume (O)	15.1
Dynamic 2.00 GB Online	1000 MB NTFS Healthy	1000 MB ReFS Healthy	1000 MB NTFS Healthy	1000 MB NTFS Healthy	1000 MB NTFS Healthy	Un



Reasons for Dynamic Disks Implementation

- Can extend NTFS volumes
- Can configure RAID volumes for fault tolerance and performance
- Can reactivate missing or offline disks
- Can change disk settings without restarting computer

Converting a Basic Disk to a Dynamic Disk

- Make a backup before converting.
- Partitions and logical drives are converted to simple volumes.
- Existing Windows NT volume sets and stripe sets are converted to spanned volumes and striped volumes, respectively.
- You cannot convert back to basic without erasing all the data

Simple Volume and Spanned Volume

- A simple volume:
 - Dedicated, formatted portion of space on a dynamic disk
 - NTFS volumes can be extended (not system or boot volume)
 - A spanned volume:
 - Space in 2 to 32 dynamic disks
 - Treated as a single volume
 - Allows you to maximize use of scattered space across several disks
 - only NTFS volumes can be extended

Extending Volumes

- If you have additional unallocated space on a dynamic disk—either the same disk or another disk—you can extend an existing volume to increase its size
 - Must use dynamic disk
 - Must have NTFS Format
- Volume can be extended unless
 - Functioning as boot or system volume
- Possible tools
 - Disk Management
 - DISKPART command-line utility

Fault Tolerant Disk Strategies

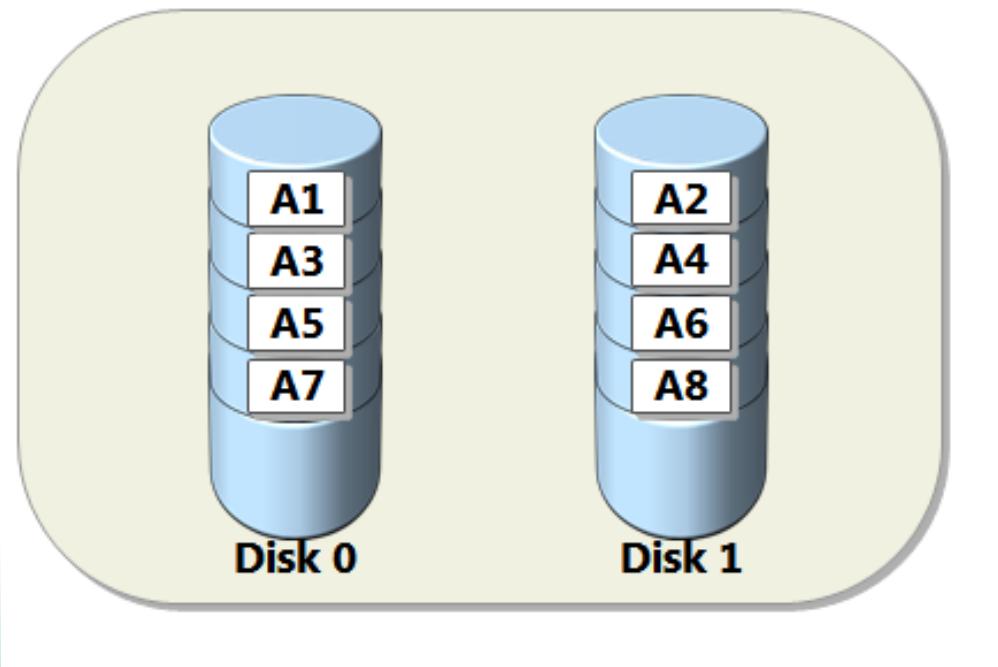
- Fault tolerance
 - The ability to recover gracefully from hardware or software failure
- Hard disks do fail eventually.
- In fault-tolerance disk configurations, 2 or more disks are used, and space is allocated to store data that will enable the system to recover in the event of 1 or more disk failure.
- **4 types of fault-tolerance disks:**
 - 1) Mirrored (RAID-1)
 - 2) Striped with parity (RAID-5)
 - 3) RAID 6
 - 4) RAID 1+0

RAID (Redundant Array of Independent Disk)

- Set of standards for:
 1. Lengthening disk life
 2. Preventing data loss
 3. Enabling uninterrupted access to data (fault tolerant)
- Windows Server supports 5 RAID levels (only 4 are fault tolerant):
 - 0 - striping
 - **1 - mirroring**
 - **5 - striping with parity**
 - **6 - striping with double parity**
 - **10 (1+0) - combining mirroring and striping**

RAID 0

Striped set without parity or mirroring

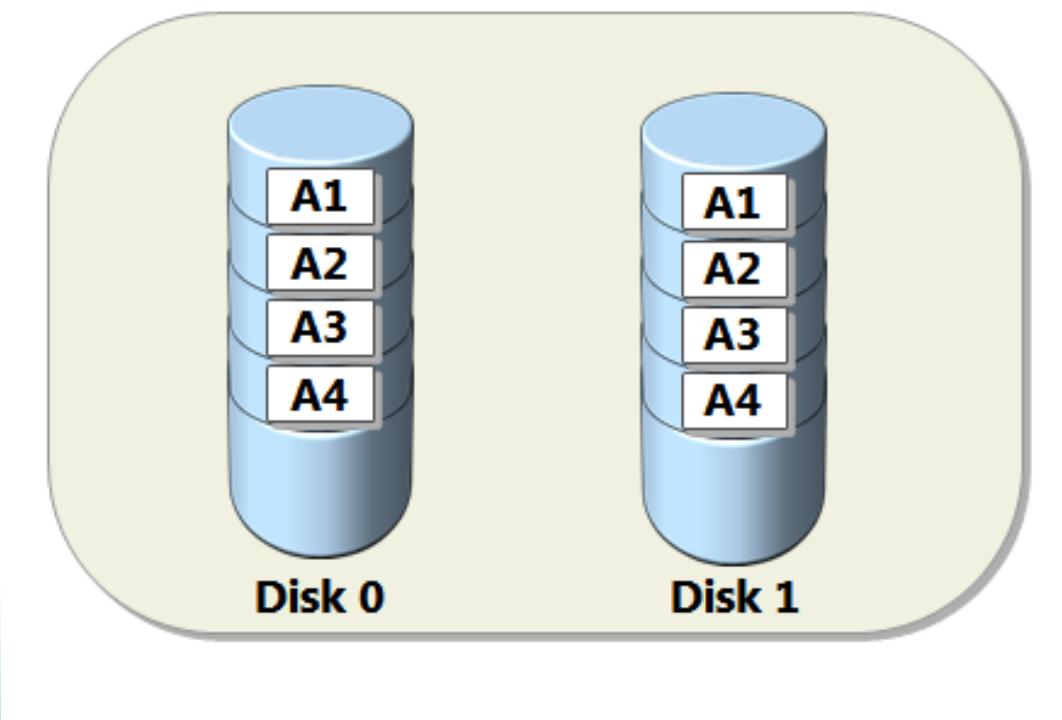


Striped Volume (RAID 0)

- Referred to as RAID level 0
- Implemented for performance enhancement, particularly for storage of large files
- Reduce wear on multiple disk drives by equally spreading the load.
- **Not fault tolerant**
- Requires from 2 to 32 disks

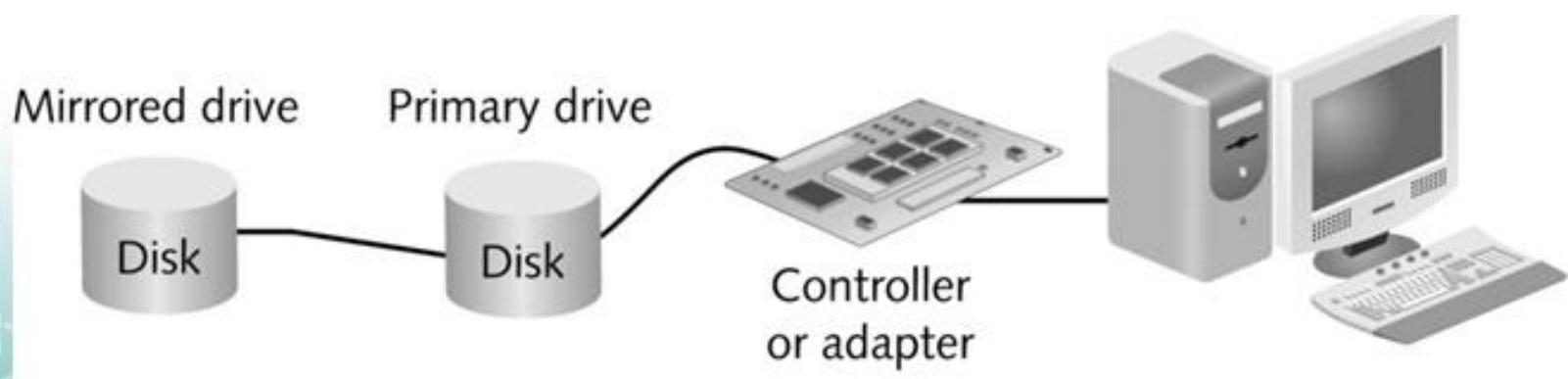
RAID 1

Mirrored drives



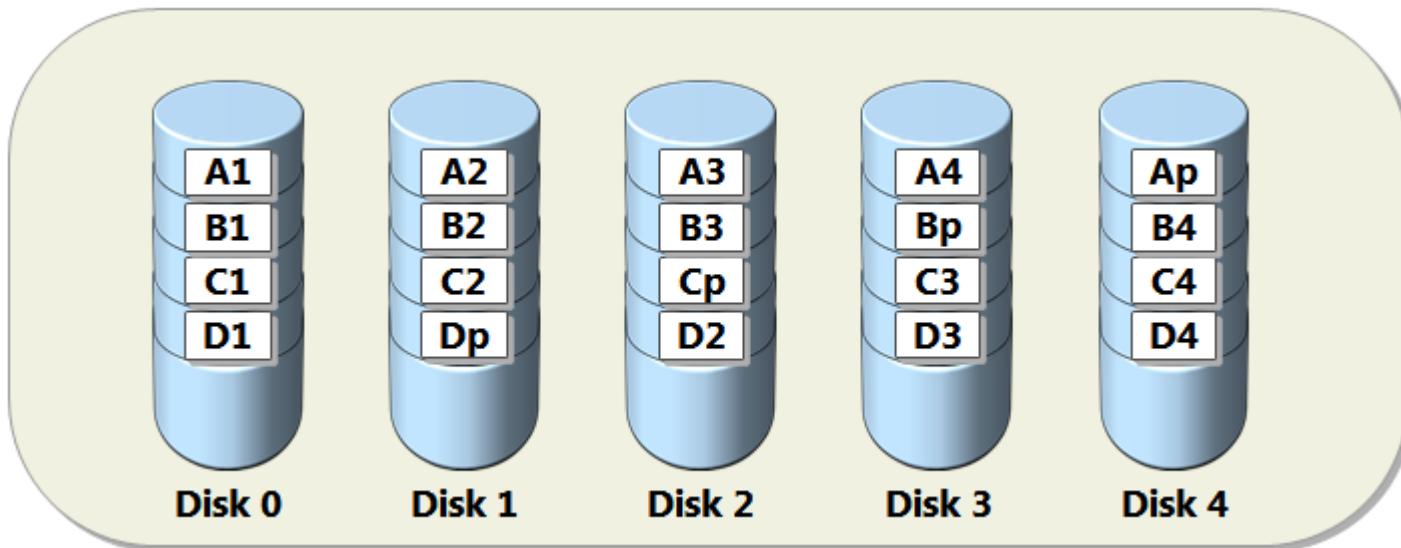
Mirrored Volume (RAID 1)

- Creates a copy of data on a backup disk
 - Requires 2 disks
 - Highly effective fault tolerance since a complete copy of data is available
 - Disk read performance is equal to non-mirrored
 - Disk write time is doubled



RAID 5

Block level striped set with parity distributed across all disks



RAID-5 Volume

- Requires a minimum of 3 disks
- Provides good fault tolerance
- Parity information distributed across all drives
- Performance slower than with a striped volume (parity information must be computed and stored)
- Read access is equal to striped volume
- Storage requirement for parity information is $1/n$ with n the number of disks

RAID-5 Volume (continued)

Parity at the bit level

In a data block if the sums of 1's & 0's...

Equals an even number

==> Block has a value of 0

Equals an odd number

==> Block has a value of 1

1st bit	0	→	1	→	1	→	0	←
2nd bit	1	0	0	0	1			
3rd bit	0	0	0	0	0			
4th bit	1	1	1	1	1			

Sum of the values makes up the value in the parity block

Rebuilding

If any drive fails, you can solve for the missing value.

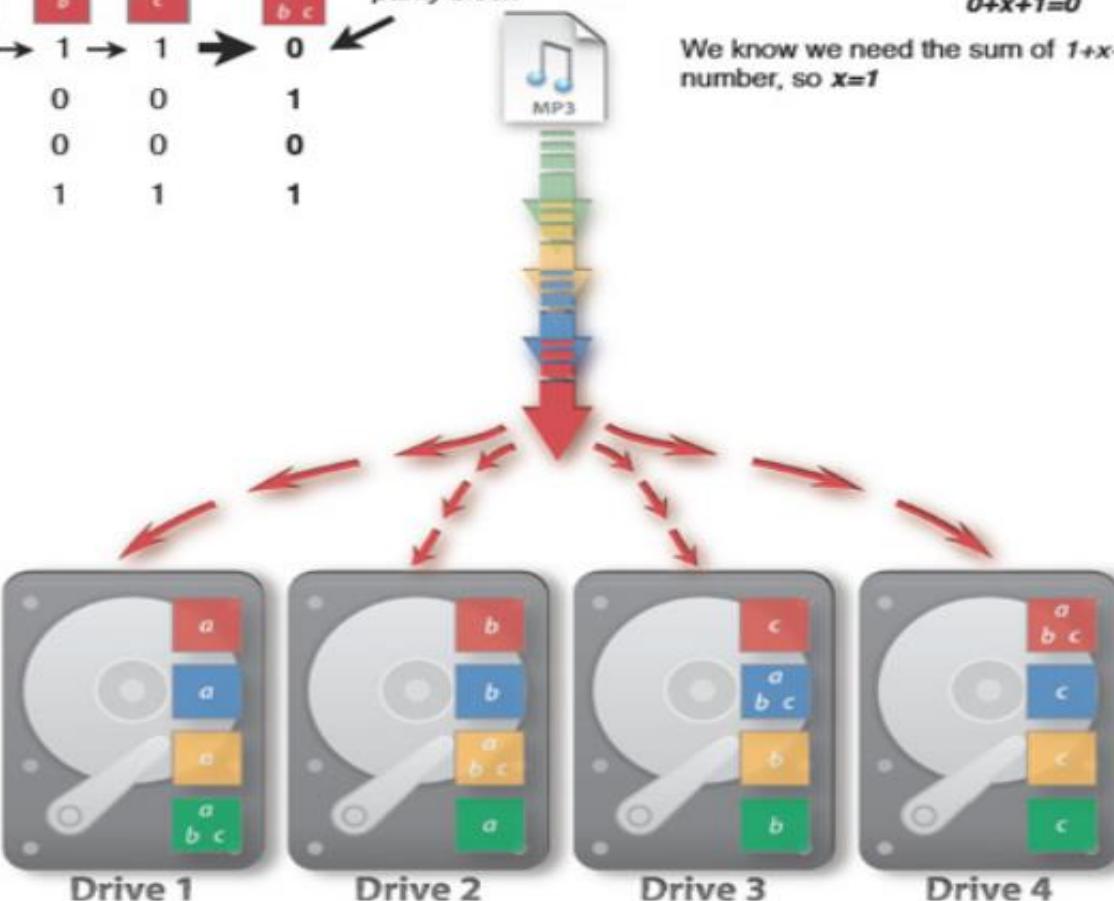
Before the failure, we know:

$$0+1+1=0$$

If drive 2 fails, we have:

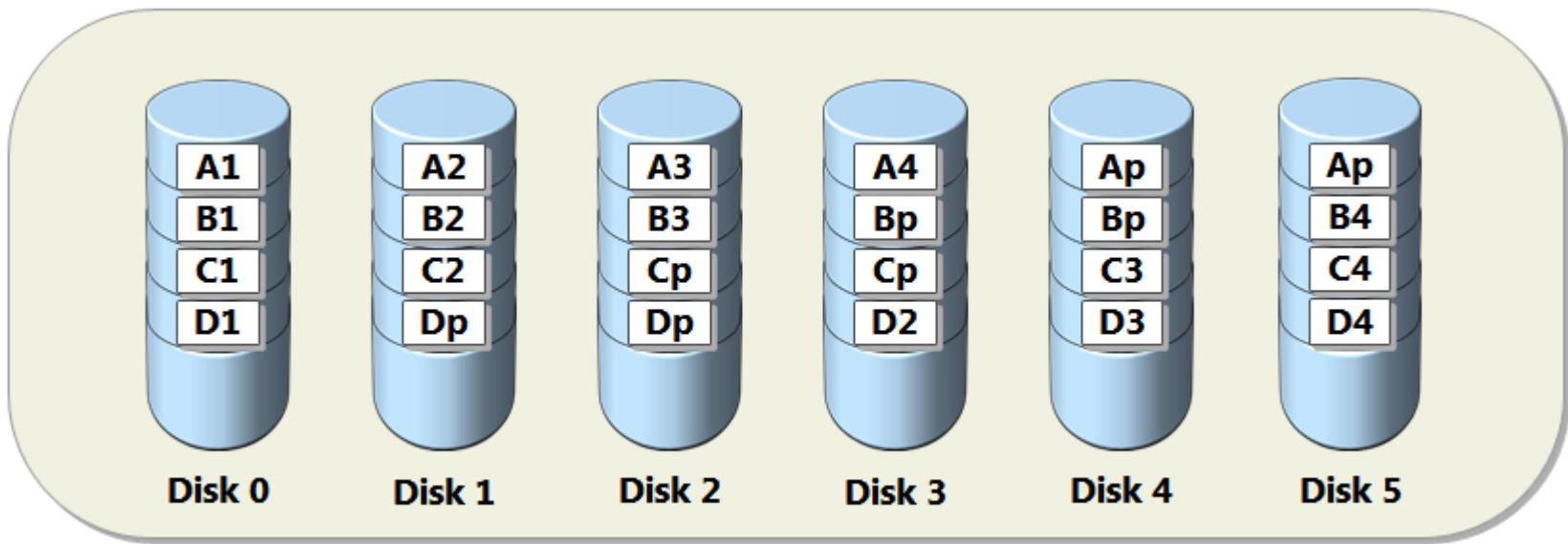
$$0+x+1=0$$

We know we need the sum of $1+x+0$ to equal an even number, so $x=1$



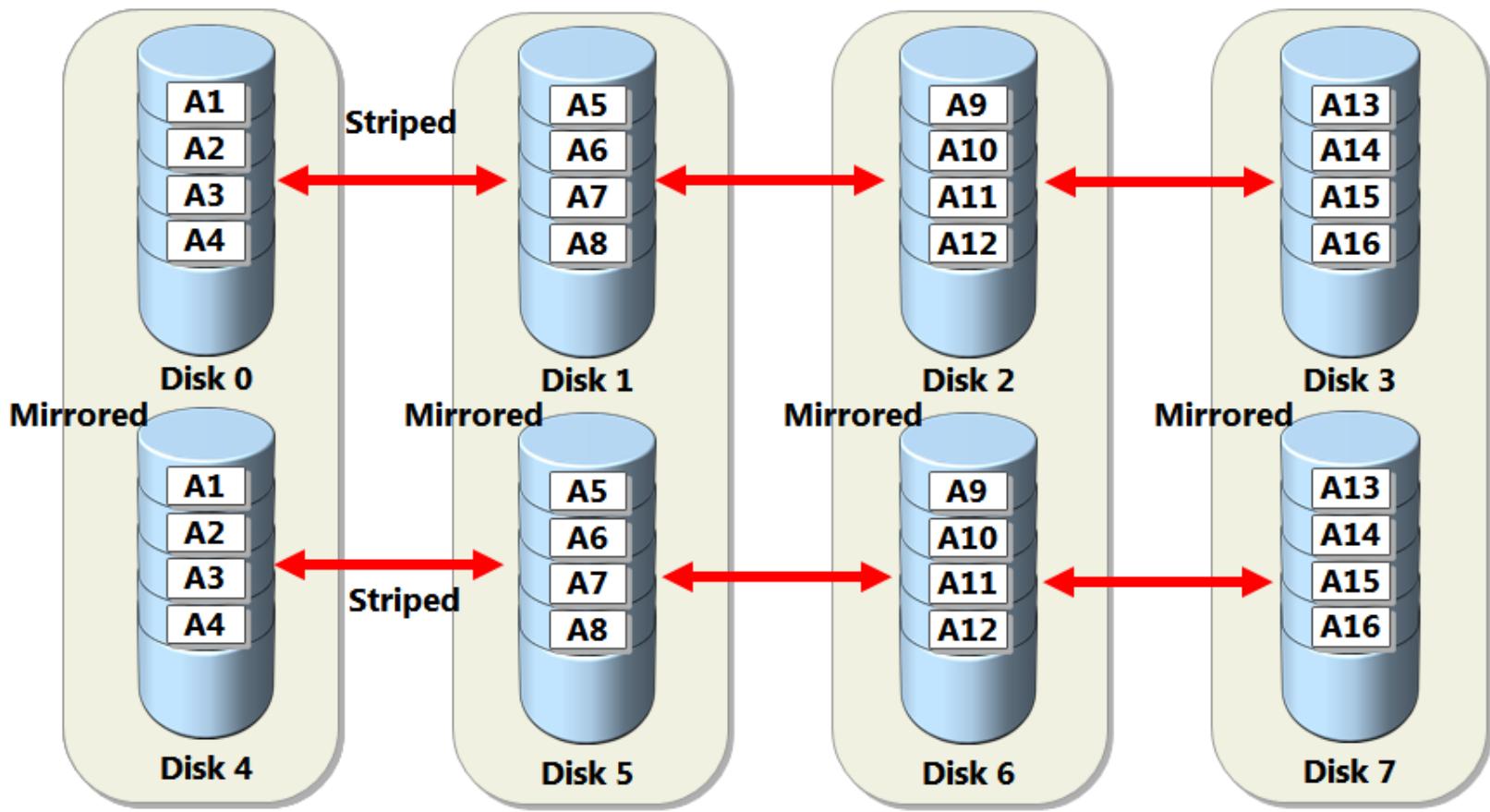
RAID 6

Block level striped set with parity distributed across all disks



- ❖ Requires minimum 4 disks
- ❖ Maximum can fail 2 disks

RAID 1 + 0



- ❖ Requires minimum 5 disks, max fail 2 disks
- ❖ 7 disks can fail max 3 disks

Software RAID and Hardware RAID

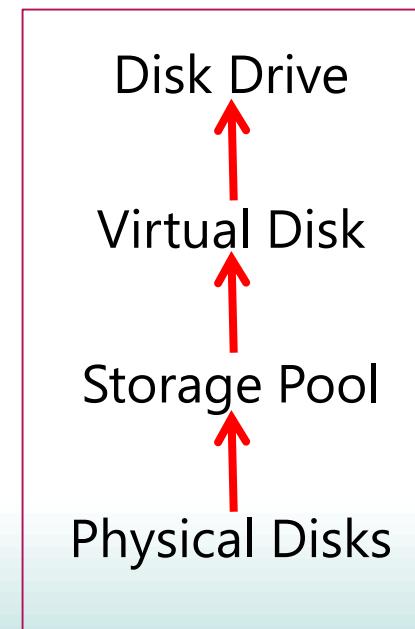
- Software RAID uses existing hardware and implements particular software strategies
- Hardware RAID requires specialized hardware (more expensive) but lessens the burden on the OS
- Often implemented on the adapter for disk drives
- Often includes a battery backup
- Advantages include: faster read and write, mixed RAID levels, failed disk hot-swap, better setup options

Windows Storage Space Feature

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 virtual disk, you need the following:

- One or more physical disks
- Storage pool that includes the disks
- Virtual drives that are created with disks from the storage pool
- Disk drives that are based on virtual drives



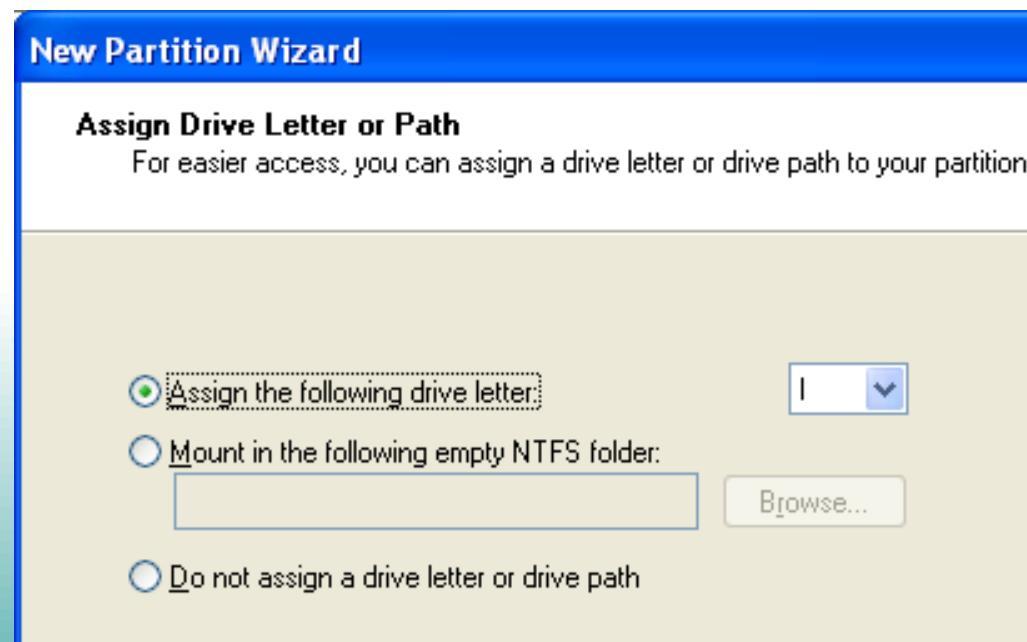
Virtual drives are not virtual hard disks (VHDs); they should be considered a drive in Disk Manager

Disk Management

- Performed using the Disk Management snap-in, which is part of the Computer Management Console
- Central facility for
 - View information – Check the size, file system, status, and other properties of disks and volumes
 - Create & delete partitions and volumes
 - Convert basic disks to dynamic disks
 - Assign drive letters to hard disk volumes, removable disk drives, and CD-ROM drives
 - **discmgmt.msc**

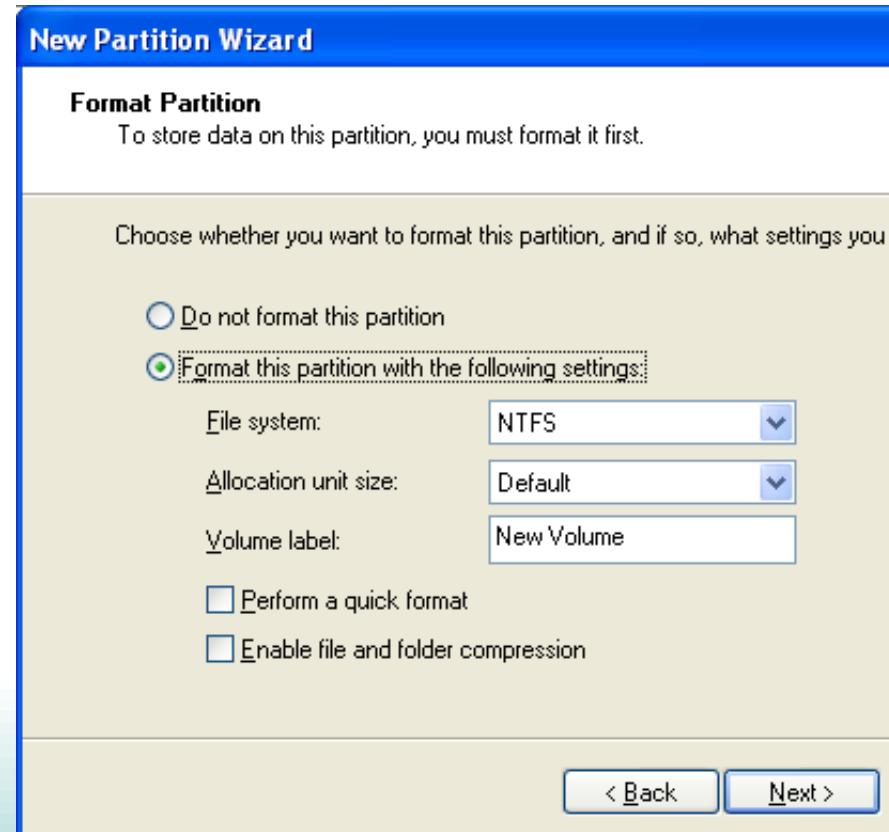
Creating Partitions on a Basic Disk

- In Disk Management, right-click an unallocated space, select New Simple Volume
- On the Assign Drive Letter Or Path page, these three options appear:
 - Assign The Following Drive Letter
 - Mount In The Following Empty NTFS Folder
 - Do Not Assign A Drive Letter Or Drive Path



The Format Partition page

- File System: NTFS or FAT32 or ReFS
- Allocation Unit Size
- Volume Label
- Quick format
- Compression



Performing Disk Management Tasks from the Command Prompt

- **Chkdsk**
 - Scan a disk for errors and, optionally, attempt to correct those errors
- **Convert**
 - FAT/FAT32 → NTFS
- **Fsutil**
 - Managing FAT, FAT32 or NTFS volumes
- **Mountvol**
 - Manages mounted volumes
- **DISKPART**
 - Powerful disk management tool

Check Disk

- Allows you to scan a disk for bad sectors and file system errors
- Disk can't be in use during scan
- Two start options:
 - Automatically fix file system errors
 - Scan for and attempt recovery of bad sectors
- CHKDSK command-line utility has similar functionality
- Does not work for ReFS format

CONVERT

- CONVERT is a command-line utility
- Converts existing FAT and FAT32 partitions or volumes to NTFS
- Leaves existing data intact

Example:

Convert D: /fs:ntfs

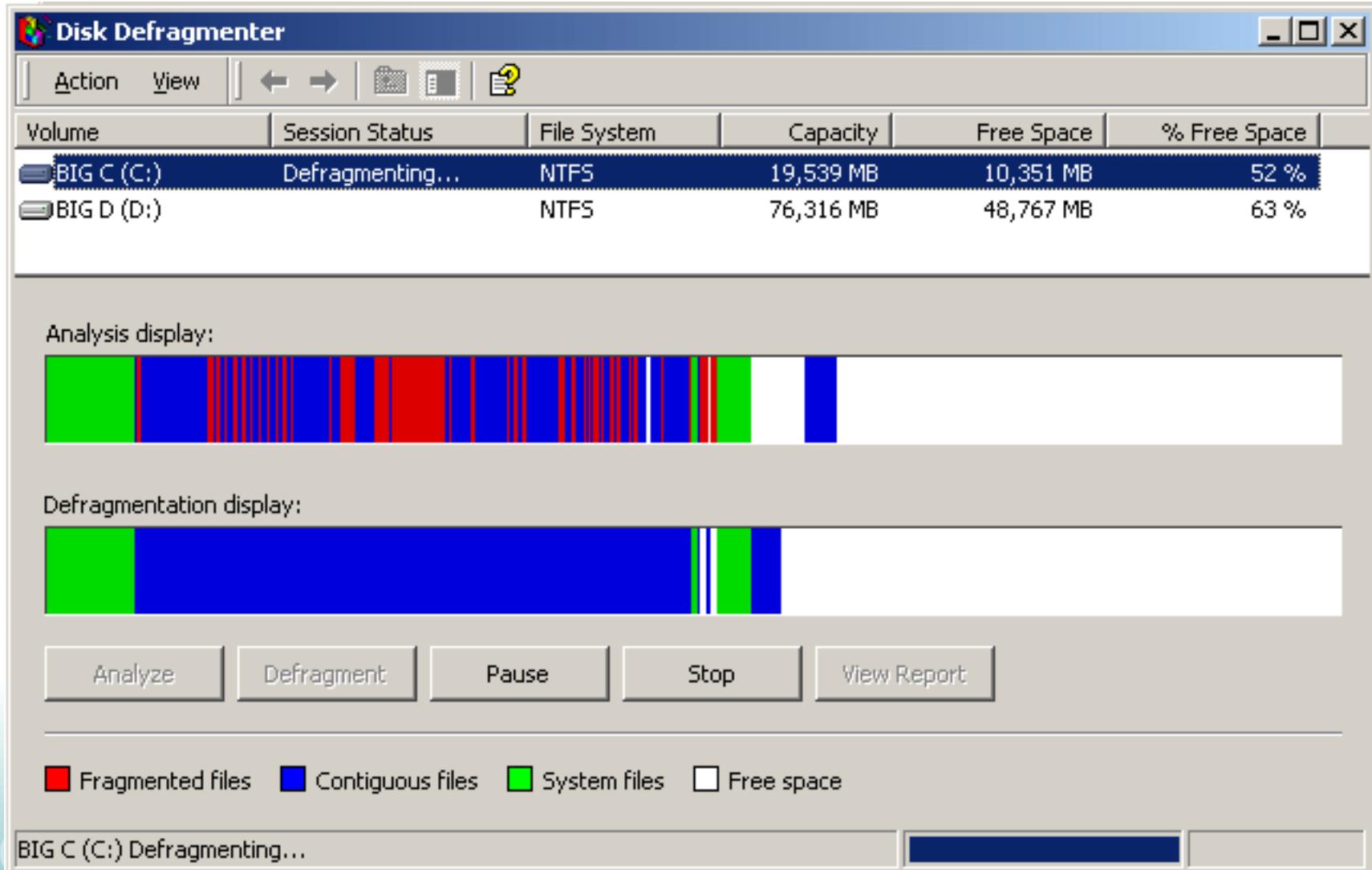
Disk Cleanup

- Allows an administrator to determine where disk space is being used and could potentially be freed
 - Files that can be removed include:
 - Temporary internet files
 - Downloaded program files
 - Files in recycle bin
 - Windows temporary files
 - No longer used Windows components and programs
 - Can also compress files
 - Command-line version is CLEANMGR (need to install “Desktop Experience” via Server Manager first).

Disk Defragmenter

- Free disk space eventually become fragmented as files are created and removed
- Results in slower access and higher disk wear
- Defragmentation attempts to place files in contiguous areas
- Defragmentation should be done periodically

Disk Defragmenter



FSUTIL

- Used with FAT, FAT32, and NTFS file systems
 - Includes many advanced features, requires experienced user
 - Information available includes:
 - Listings of drives, volume information, NTFS-specific data
 - Tasks include:
 - Managing disk quotas, displaying free space
 - Get complete information in Help and Support Center

DISKPART

- Command-line utility for managing disks, volumes, partitions
- Uses include:
 - Configuring active partition, assigning drive letters, implementing fault tolerance schemes, etc.
- Can manage disks from within scripts
- Get the complete syntax and options with DISKPART /?

FORMAT

- Used to implement a file system on an existing partition
- Also used on MS-DOS and Windows 9X
- Has a variety of advanced settings
 - Setting allocation unit (cluster) size
- Command-line version can be run from scripts
- Get the complete syntax and options with **FORMAT /?**



MOUNTVOL

- Used to create, delete, or list volume mount points from command line
- VolumeName parameter is difficult to use
 - Complicates adding new mount point
 - Doesn't affect removing mount points
- Get complete syntax and options with MOUNTVOL /?

Summary

- Windows Server supports:
 - Partition Style – MBR or GPT
 - Disk Type – Basic disk or Dynamic disk
- Volume - Extension, Spanning
- RAID
 - RAID 0 - not fault tolerant
 - RAID 1, 5, 6, 1+0 – fault tolerant
- Disk Management
 - Tools – chkdsk, convert, disk cleanup, disk defragmenter, fsutil, diskpart, format, mountvol