

RAID



RAID: (redundant array of independent disks) A set of vendor-independent specifications for fault-tolerant configurations on multiple-disk systems.

- Can act as backups for each other to increase reliability.
- Can act together to create one very large drive.

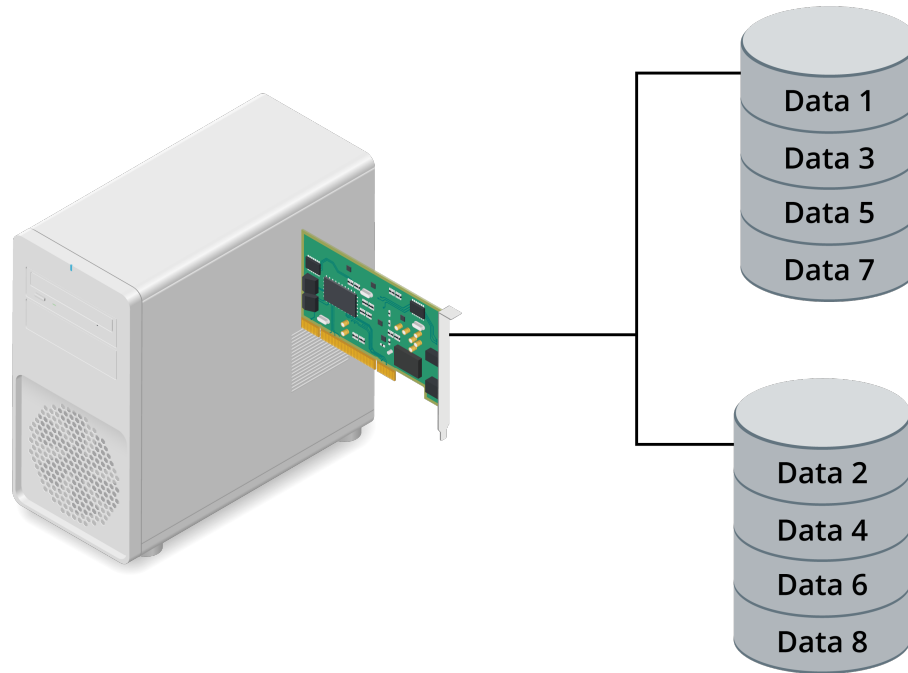
RAID Levels (Slide 1 of 9)



Disk striping: A disk array access pattern where data is written in stripes to two or more disks sequentially, improving performance. Also known as RAID 0.

- RAID 0 (Striping without Parity):
 - Logical volume size is combined total of smallest capacity physical disk.
 - Ideally all disks are identical capacity, type, and performance.
 - Adds no storage overhead.
 - A means of creating a large logical volume from multiple low capacity disks.
 - Provides no redundancy.
 - If any physical disk fails, the entire array fails.

RAID Levels (Slide 2 of 9)



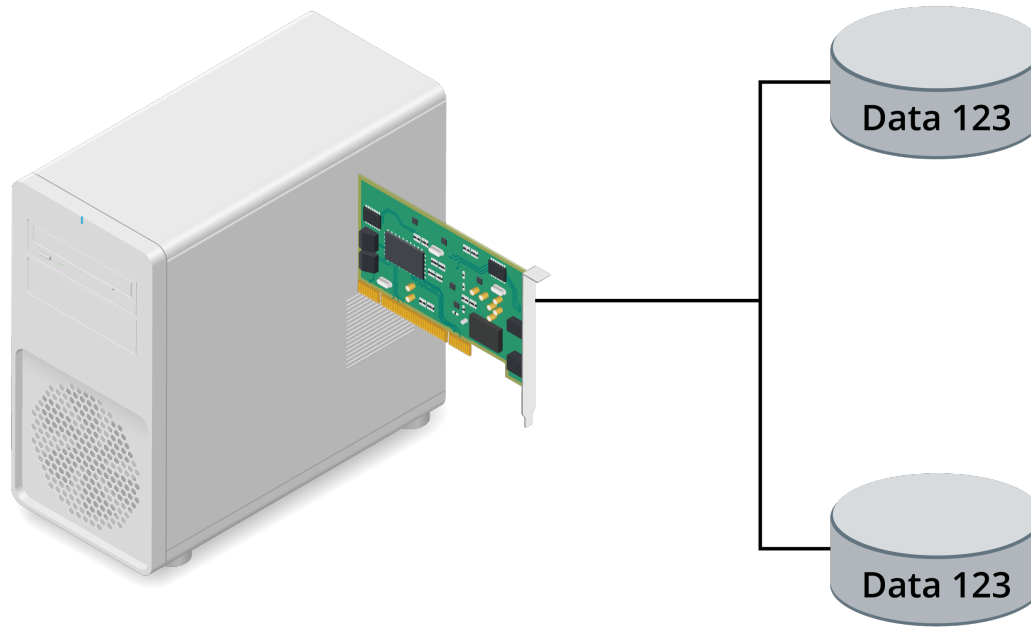
RAID Levels (Slide 3 of 9)



Disk mirroring: A type of RAID (RAID 1) that uses two hard disks, providing the simplest way of protecting a single disk against failure.

- RAID 1 (Mirroring):
 - Requires two hard disks, one being a duplicate of the other.
 - Each write operation is duplicated on the second disk, creating a small performance overhead.
 - Read operations can use either disk, which boosts performance slightly.
 - If one disk fails, the other takes over.
 - When a failed disk is replaced, performance suffers during the resync operation.
 - More expensive per gigabyte than other RAID levels (only 50% of space is available for storage).
 - Total volume size cannot exceed available disk capacity.

RAID Levels (Slide 4 of 9)



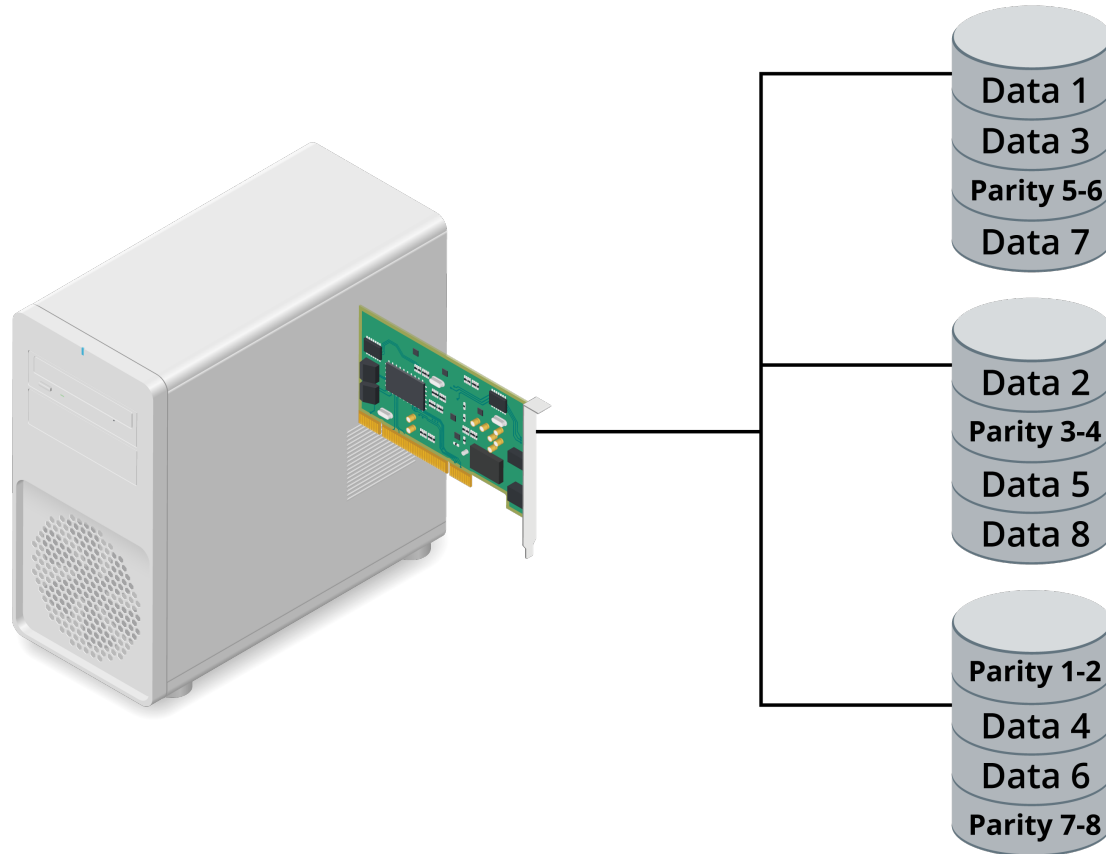
RAID Levels (Slide 5 of 9)

- RAID 5 (Striping with Distributed Parity):
 - Writes error checking data across all disks in the array.
 - Data and parity are managed so they are always on different disks.
 - If a single disk fails, information spread on the other disks allows data to be completely reconstructed.
 - Performance considerations:
 - Offers the best read operation performance.
 - Read performance is degraded if a drive fails and data needs to be reconstructed.
 - Write operations suffer reduced performance due to the parity calculation.
 - Requires at least 3 drives.
 - Allows flexibility for overall array capacity.
 - Maximum number of drives determined by controller or OS.
 - Adding more disks increases chance of failure.

RAID Levels (Slide 6 of 9)

- RAID 5 (continued):
 - Level of fault tolerance and available disk space is inverse.
 - Adding disks to the set, fault tolerance decreases.
 - Usable disk space increases.
 - Parity requirements vary with the number of disks.
 - RAID 5 with 3 disks requires 1/3 of each disk for parity, so using three 80-GB disks provides 160 GB usable disk space.
 - RAID 5 with 4 disks requires 1/4 of each disk for parity.

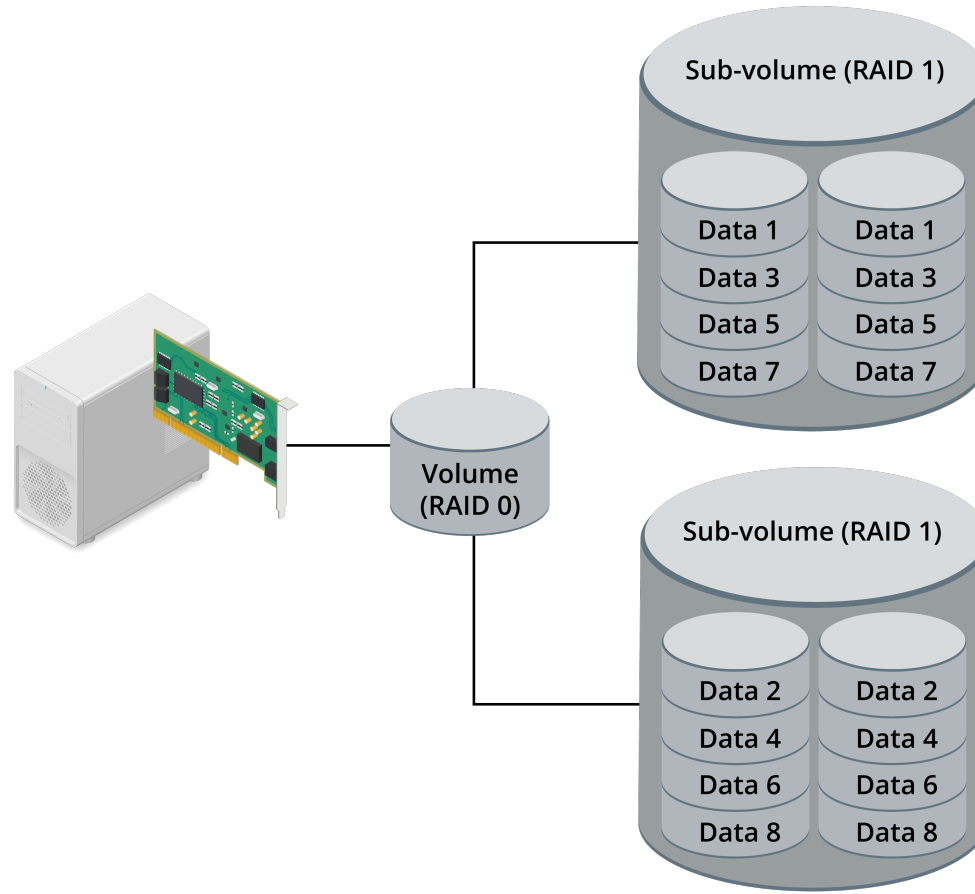
RAID Levels (Slide 7 of 9)



RAID Levels (Slide 8 of 9)

- RAID 1+0 (RAID 10):
 - Combination of RAID 1 and RAID 0 provides high fault tolerance.
 - Considered a nested array.
 - Requires at least 4 disks.
 - More disks can be used, but there must be an even number of disks.
 - Suffers the same 50% disk overhead as mirroring.

RAID Levels (Slide 9 of 9)



RAID Configuration Options (Slide 1 of 4)



Hardware RAID solution: A method of creating volumes from an array of physical disks by using a plug-in controller card or the motherboard, independently of the installed operating system.

- Entry-level controllers typically support only RAID 0 or RAID 1.
 - Typically use SATA drives.
- Mid-level controllers might add support for RAID 5 or RAID 10.
- Hot swap features are typically only available with high-end hardware.
 - Requires compatible controllers and disk units.
 - New disks are transparently synchronized with other disks in the set.
 - Typically uses SCSI (SAS).
- More expensive than a software RAID solution.

RAID Configuration Options (Slide 2 of 4)

- Hardware RAID (continued):
 - Usually configured through firmware configuration utility.
 - Sometimes RAID controller configuration tools are available within the OS.

```
LSI Corp Config Utility For Dell PERC H200 v7.01.09.00 (2010.03.22)
Create New Volume -- SAS2008
Volume Type: RAID 1
Volume Size(GB): -----

Slot Device Identifier RAID Hot Drive Pred Size
Num Disk Spr Status Fail (GB)
0 ATA WDC WD2502ABYS-13B05 [No] [No] ----- No 232
1 ATA WDC WD2502ABYS-13B05 [No] [No] RAID No 232

Esc = Exit Menu F1/Shift+1 = Help
Space/+/- = Select disk for volume or hot spare C = Create volume
```

RAID Configuration Options (Slide 3 of 4)

- Software RAID:
 - Windows provides options to set up software RAID.
 - Uses standard disks and controllers.
 - Windows Server and Windows Professional/Enterprise editions support RAID 1 and RAID 5.
 - Can use internal disks on varying interfaces.
 - Typically cannot use external disks connected through USB or Thunderbolt.
 - Windows 10 Storage Spaces feature provides RAID-like functionality for external disks.
 - Linux uses Logical Volume Manager to implement various RAID levels.
 - Software RAID is typically less expensive than hardware RAID controller cards.

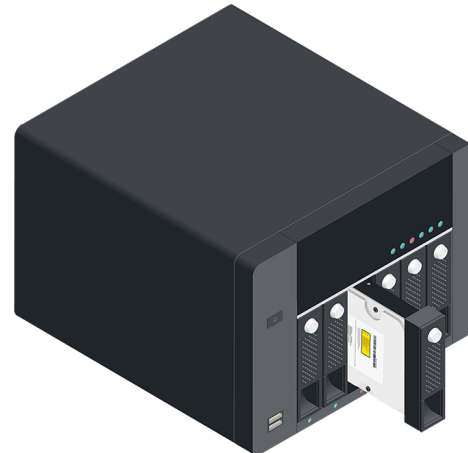
RAID Configuration Options (Slide 4 of 4)



Hot swappable drive: A device that can be added or removed without having to restart the operating system.

- Hot swappable drives:
 - Usually a server-level or high-end workstation feature.
 - Drives mate into combined data/power port.
 - Drives can be added from the front of the case without opening the chassis.
 - Drives are secured and released with a latch.

Hot swap drive enclosure



Activity



Discussing RAID Configuration (PBQ Section 3)

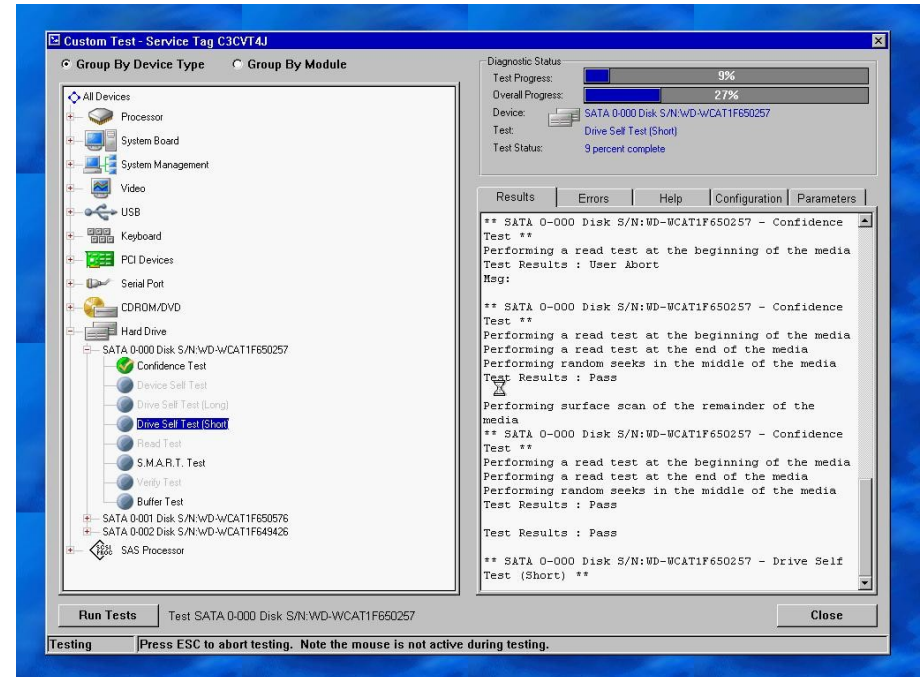
Configuring RAID: <https://www.youtube.com/watch?v=1A9f7XZWxlg>

Disk Failures

- A hard drive that is failing might display the following symptoms:
 - Read/write failure
 - Blue Screen of Death (BSoD)
 - Bad sectors
 - Constant LED activity
 - Noise

Disk Integrity Testing (Slide 1 of 2)

- Disk Integrity Tools
 - chkdsk
 - S.M.A.R.T.
`wmic /node:localhost diskdrive get status`
 - Run advanced diagnostic tests
 - Obtain from hard drive vendor or PC manufacturer



Disk Integrity Testing (Slide 2 of 2)

SpeedFan 4.51

Readings | Clock | Info | Exotics | S.M.A.R.T. | Charts

Hard disk: HDO - 500.1GB - ST500LM000-1EJ162

Model: ST500LM000-1EJ162 | Firmware: SM11

Perform an in-depth online analysis of this hard disk ?

Extended test | Short test | Status: no error

Attribute	Value	Worst	Warn	Raw
OK Raw Read Error Rate	117	99	6	000008A48628
OK Spin Up Time	99	99	0	000000000000
Start/Stop Count	99	99	20	00000000062A
OK Reallocated Sector Count	100	100	10	000000000000
OK Seek Error Rate	71	60	30	000B09EF5DEB
Power On Hours Count	96	96	0	000000000EB7
OK Spin Retry Count	100	100	97	000000000000
Power Cycle Count	99	99	20	00000000060E
End-to-End error	100	100	99	000000000000
Reported Uncorrectable Er...	100	100	0	000000000000
Command Timeout	100	100	0	000000000000
High Fly Writes	66	66	0	000000000022
Airflow Temperature	64	51	45	000024130024
GSense Error Rate	100	100	0	000000000000
Power Off Retract Count	100	100	0	000000000016

Fitness: [Progress Bar] Performance: [Progress Bar]

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Boot Failures (Slide 1 of 2)

- If the hard drive is not detected at boot (or if a second hard drive is not shown under Windows):
 - Verify that the storage device is powering up.
 - If inactive, check that the drive has a power connector attached.
 - If drive is powered up:
 - Check that the boot sequence is set correctly in the PC firmware system setup program.
 - Check that there are no removable disks in floppy or optical drives.
 - Check the data cables.
 - Check that it has not been disabled by a jumper or via system setup.

Boot Failures (Slide 2 of 2)

- For correctly configured drives:
 - If a boot hard drive is detected by the POST but not by Windows, there is probably a problem with the file system.
 - Boot into the recovery environment using the Windows setup disc and enter C: at the command prompt. If this produces the error message **Invalid media type**, try running `bootrec`. You can also try to reformat the disk (at the expense of any data, of course).
 - If this produces the error message **Invalid drive specification**, check the drive's partition structure with `diskpart`.

Boot Block Repair (Slide 1 of 2)



MBR: (master boot record) Sector on a hard disk storing information about partitions configured on the disk.

GPT: (globally unique ID partition table) Modern disk partitioning system allowing large numbers of partitions and very large partition sizes.

- Drive not detected at bootup.
- Second drive not recognized or shown in Windows File Explorer.
- Malware:
 - Damage to the boot information on the drive.
- Two methods of formatting boot information:
 - MBR (next slide for repairs)
 - GPT

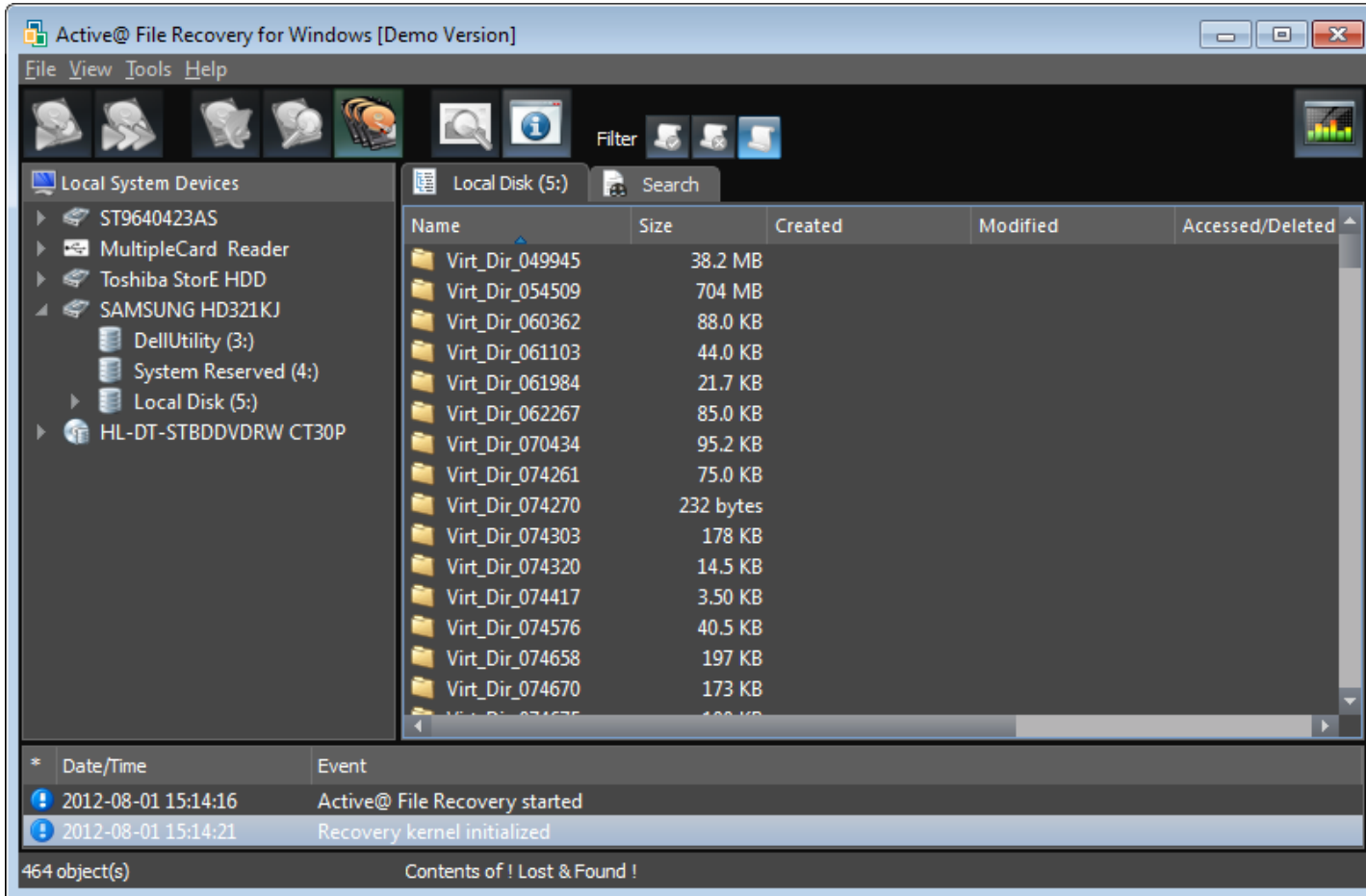
Boot Block Repair (Slide 2 of 2)

- Damage to boot information results in boot errors, including:
 - OS not found.
 - Invalid drive specification boot using anti-virus software to detect virus that caused the problem.
- Try booting using the repair options on the Windows product disk.
 1. Boot from the product disk and select **Repair**.
 2. Try using the **Startup Repair** option.
 3. If necessary, select the **Command Prompt** option.
 1. Enter **bootrec /fixmbr** to attempt repair of the MBR.
 2. Enter **bootrec /fixboot** to attempt repair of the boot sector.
 3. Enter **bootrec /rebuildbcd** to add missing Windows installations to the Boot Configuration Database (BCD).
 4. Reboot the PC.

File Recovery Options (Slide 1 of 2)

- Remove the hard disk from the computer and insert into an external enclosure.
- Connect external enclosure to a PC via a USB port.
- Mount the externally connected drive through Disk Management or analyze through file recovery software.
- Try using chkdsk to restore file fragments from bad sectors.
 - Files saved as file####.chk files on the root of the volume.
 - file####.chk files are rarely directly usable.
 - Third-party software might be more successful in accessing the data.

File Recovery Options (Slide 2 of 2)



The screenshot displays the Active@ File Recovery for Windows [Demo Version] interface. The window title bar includes standard minimize, maximize, and close buttons. The menu bar contains 'File', 'View', 'Tools', and 'Help'. Below the menu bar is a toolbar with various icons for file operations and a 'Filter' button. The main area is divided into three panes:

- Local System Devices:** A tree view showing 'ST9640423AS', 'MultipleCard Reader', 'Toshiba StorE HDD', 'SAMSUNG HD321KJ', 'DellUtility (3:)', 'System Reserved (4:)', 'Local Disk (5:)', and 'HL-DT-STBDDVDRW CT30P'.
- Local Disk (5:):** A table listing virtual directories with columns for Name, Size, Created, Modified, and Accessed/Deleted.
- Search:** A search bar with a magnifying glass icon.

Name	Size	Created	Modified	Accessed/Deleted
Virt_Dir_049945	38.2 MB			
Virt_Dir_054509	704 MB			
Virt_Dir_060362	88.0 KB			
Virt_Dir_061103	44.0 KB			
Virt_Dir_061984	21.7 KB			
Virt_Dir_062267	85.0 KB			
Virt_Dir_070434	95.2 KB			
Virt_Dir_074261	75.0 KB			
Virt_Dir_074270	232 bytes			
Virt_Dir_074303	178 KB			
Virt_Dir_074320	14.5 KB			
Virt_Dir_074417	3.50 KB			
Virt_Dir_074576	40.5 KB			
Virt_Dir_074658	197 KB			
Virt_Dir_074670	173 KB			
Virt_Dir_074675	100 KB			

At the bottom, an event log shows:

- 2012-08-01 15:14:16 Active@ File Recovery started
- 2012-08-01 15:14:21 Recovery kernel initialized

Below the event log, it indicates '464 object(s)' and 'Contents of ! Lost & Found !'.

Disk Performance Issues



Disk defragmentation: A software routine that compacts files back into contiguous areas of the disk.

- Slow disk performance can be a bottleneck.
- Often improved by adding more RAM (virtual memory load reduced)
- Ensure file fragmentation is minimized.
- Low disk capacity can cause slow performance.
 - Windows warns users in notification area when space is under 200 MB.
 - Use Disk Cleanup program to free up space.
 - Manually move or delete files.
 - Uninstall unnecessary applications.

Guidelines for Troubleshooting Optical Drives (Slide 1 of 2)

- Troubleshooting read problems in optical drives:
 - Most problems related to dirt are caused by dirt on the disc itself. Special cleaning kits are available for cleaning optical drives.
 - If the CD drive is not able to read any CDs, it is likely a hardware problem.
 - DVD-Video requires MPEG decoding hardware or software (codecs) to be installed for playback (included in Windows 7, except Starter and Home Basic).
 - A DVD-ROM cannot be read from a CD-ROM drive.
 - There is currently no native support for Blu-ray in any version of Windows.

Guidelines for Troubleshooting Optical Drives (Slide 2 of 2)

- Troubleshooting write errors in optical drives:
 - Where Windows does not support a particular recordable or rewritable format directly, third-party software is required.
 - Check that you are using the write speed recommended for the brand of discs you have purchased.
 - Most problems are connected to buffer underruns. To prevent these:
 - Burn discs at a lower write speed.
 - Copy source files to the local hard disk (rather than removable or network drives).
 - Avoid using other applications when burning a disc.

Common RAID Configuration Issues

- RAID not found
- RAID stops working

Guidelines for Troubleshooting RAID Issues (Slide 1 of 2)

- If Windows doesn't detect RAID during setup or at boot:
 - Verify RAID controller drivers are installed.
 - Use the RAID configuration utility to verify the status.
 - If the configuration utility cannot be accessed, the controller may have failed.

```
F10 = System Services
F11 = BIOS Boot Manager
F12 = PXE Boot

One 2.40 GHz Quad-core Processor, Bus Speed:4.80 GT/s, L2/L3 Cache:1 MB/8 MB

System Memory Size: 4.0 GB, System Memory Speed: 1067 MHz

Broadcom NetXtreme II Ethernet Boot Agent v5.0.5
Copyright (C) 2000-2009 Broadcom Corporation
All rights reserved.
Press Ctrl-S to Configure Device (MAC Address - 842B2B19E291)

Dell PERC H200/6Gbps SAS HBA BIOS
MPT2BIOS-7.01.09.00 (2010.03.22)
Copyright 2000-2009 LSI Corporation.

Integrated RAID exception detected:
Volume (Hdl:079) is currently in state INACTIVE/OPTIMAL
Enter the Dell PERC H200/HBA Configuration Utility to investigate!

Press Ctrl-C to start Dell PERC H200/HBA Configuration Utility..
```

Guidelines for Troubleshooting RAID Issues (Slide 2 of 2)

- If RAID stops working:
 - Volume is listed as degraded, but the data on the volume is still accessible.
 - Examine event logs in the OS system log.
 - Replace failed disks as soon as possible.
 - If the volume is unavailable, too many disks may have failed or the controller may have failed.

```
LSI Corp Config Utility For Dell PERC H200 v7.01.09.00 (2010.03.22)
View Volume -- SAS200B
Volume 1 of 1
Identifier
Type RAID 1
Size(GB) 232
Status Inactive

Manage Volume

Slot Device Identifier RAID Hot Drive Pred Size
Num Device Identifier Disk Spr Status Fail (GB)
--- ---
1 ATA WDC WD2502ABYS-13B05 Yes No Inactive No 232
--- ---
Yes No Missing --- -----

Esc = Exit Menu F1/Shift+1 = Help
Enter=Select Item Alt+N=Next Volume
```

Activity



Discussing Storage Device Troubleshooting

30bird 10.1.4

What is Defragmentation: <https://www.youtube.com/watch?v=AtRIOUZul2c>

Activity



Troubleshooting Storage Devices

How to Defragment: <https://www.youtube.com/watch?v=uHQdqV6mOzU>

Reflective Questions

1. Which types of storage devices have you worked with? Have you installed additional hard drives or replaced hard drives?
2. What sorts of issues have you experienced with storage devices? How will the troubleshooting tools and guidelines presented in this lesson help with future issues?

