

Data Recovery

Introduction to Hard Drive Storage

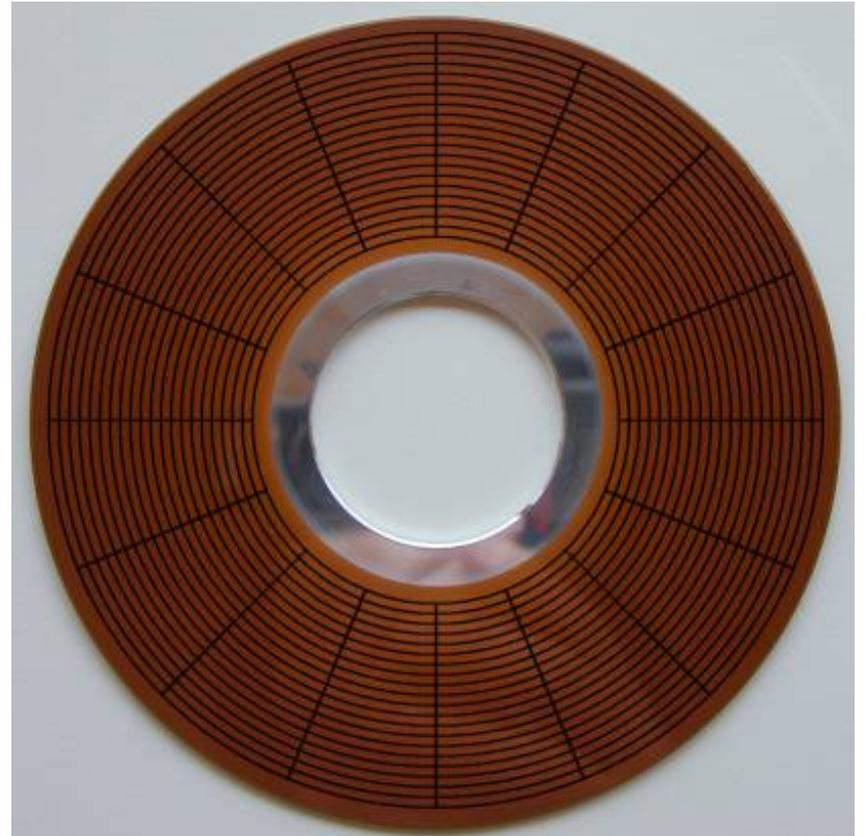
Chapter 2

Written by

Ann LeFlore

Hard Disk Track, Cylinders and Sectors

- All information stored on a hard disk is recorded in tracks – concentric circles placed on the surface of each platter
- Tracks are numbered starting from zero – starting from the outside of the platter

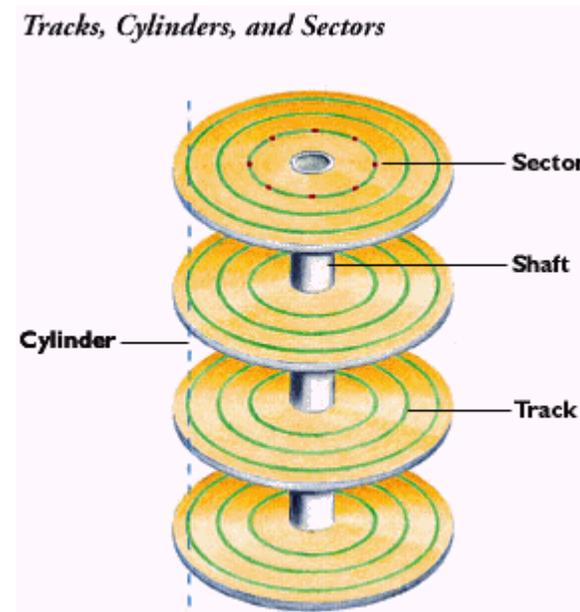


Tracks and Cylinders

- Each track holds thousands of bytes of data.
- Tracks are broken into smaller units of storage called sectors. Each Sectors hold 512 bytes of data.
- A cylinder is basically the set of all tracks that all the heads are currently located at.
- Address of individual sectors of the disk refers to cylinders, heads, and sectors (CHS)
- Cylinders are a collection of track numbers located at all of the heads of the disk.

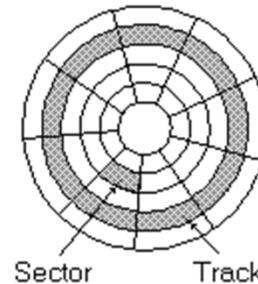
Tracks, Cylinders, and Sectors

- Track number plus head number is equal to cylinder number plus head number.
- Same as track number plus head number



Sectors

- Each sector store 512 bytes of user data.
- Sectors include ID Information which status information about the sector
- Synchronization Fields are used to internally by the controller to guide the read process



Sectors

- Data is the actual data in the sector
- ECC is the error correcting code used to ensure data integrity
- Gaps are one or more spacers added as necessary to separate other areas of the sector or provide time for the controller to process what it has read before reading more bits.

Byte

- A Byte is a basic unit of measurement of information storage in computer science
- A Byte is an ordered collection of bits. Each bit is a single binary value of 1 and 0

Décimal		
Value	SI	
1000	k	kilo
1000 ²	M	mega
1000 ³	G	giga
1000 ⁴	T	tera
1000 ⁵	P	peta
1000 ⁶	E	exa
1000 ⁷	Z	zetta
1000 ⁸	Y	yotta

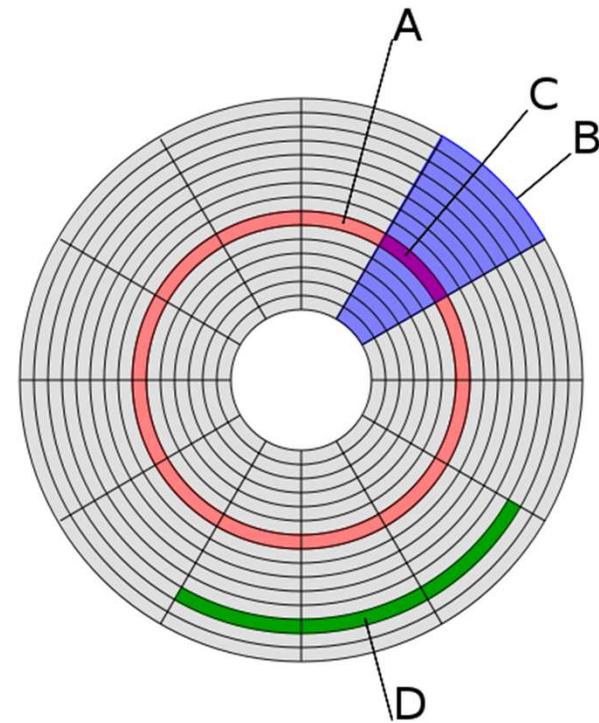
Byte

- Bytes consists of 8 bits
- Understanding the importance of Bytes and bits is important in recovering data. At times data is corrupted and has to be reconstructed manually.

Binary				
Value	IEC		JEDEC	
1024	Ki	kibi	K	kilo
1024 ²	Mi	mebi	M	mega
1024 ³	Gi	gibi	G	giga
1024 ⁴	Ti	tebi		
1024 ⁵	Pi	pebi		
1024 ⁶	Ei	exbi		
1024 ⁷	Zi	zebi		
1024 ⁸	Yi	yobi		

Clusters

- A cluster is a unit of disk space allocated for files and directories.
- File system do not allocate individual disk sectors. They allocate groups of sectors called clusters.



Clusters

- The HDD uses 512-byte sectors. A 512-byte cluster contains one sector. 4-kilobyte clusters contain eight sectors
- Sectors range from 1 sector 512 B to 128 sectors 64 KiB
- The smallest unit of space on a hard disk that any software can access is a sector which normally contains 512 bytes.

Clusters

- HPFS file system assigns as many individual sectors as needed for storage. For example a 1 MB file will require approximately 2,048 individual sectors to store its data.
- FAT file system does not use individual sectors for storing data. FAT groups sectors into large blocks called clusters.
- In FAT file system the cluster size is determined by the size of the disk volume.
- Cluster size is determined when the disk volume is partitioned.

Blocks

- Blocks are sequences of bytes or bits
- When data is structured it is said to be blocked
- Blocking is the process of putting data into blocks
- Blocking facilitates the handling of data stream

Blocks

- File systems are based on block device where the hardware is responsible for storing and retrieving specified blocks of data.
- A single block may contain only part of a single file.
- Blocks lead to inefficiency of space and internal fragmentation

Disk Formatting

- The process to prepare a hard disk for storage medium or use.
- Large disk can be partitioned or divided into distinct section that are formatted with their own file systems.
- A corrupted operating system can be reverted to a clean state by formatting the disk and reinstalling the OS.

Two levels of Formatting

- Two quite different processes for formatting a disk
- High level formatting
- Low level formatting
- Low level formatting deals with formatting the disk surface and installing characteristic like sectors numbers which are used by the disk controller

Two Levels of Formatting

- High level formatting deal with specific information written by the operating system

Disk Reinitialization

- It is impossible to Low Level Format modern hard drives outside of the factory
- Reinitialization of a hard drive reformats the hard drive to its factory configuration
- Reinitialization identifies any sectors which cannot be written to and read back from the drive correctly

Disk Reinitialization

- The term low level formatting is highly misused. Some believe that any process below a high level file system format must be called a low level format.
- It is possible in Data Recovery to do an actual low level format of the HDD. This is known as Self Scan and uses the drives internal Service and factory commands to perform such a task.

High Level Formatting

- When the disk leaves the factory it has been low leveled formatted. The disk has tracks and sectors but nothing written on it.
- High level formatting is the process of writing the file system structure to the disk that lets the disk be used for storing programs and data.

High Level Formatting

- High level formatting sets up the empty file system on the disk and installs the boot sector
- This process alone takes little time and is often called “Quick Format”
- High level format may also be scanned for defects which takes considerably more time

Low Level Formatting

- Older hard disk required low level formatting by the system configuration.
- In such cases low level formatting utilities were created to control the low level formatting process
- The manufacture included these program in a ROM chip enabling access to the software

Low Level Formatting

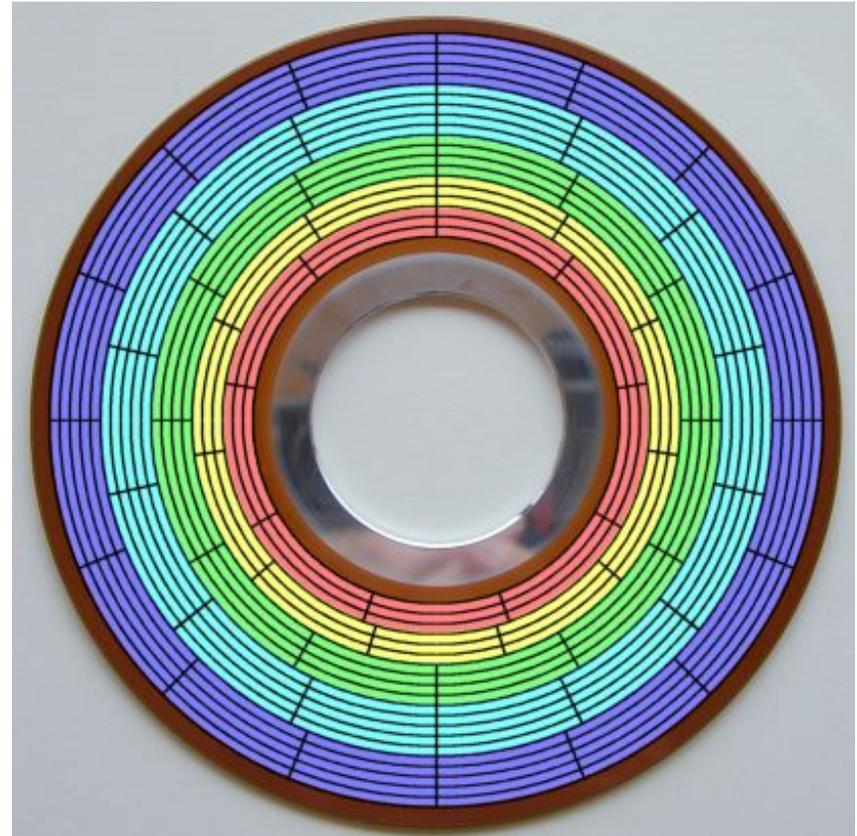
- Low level formatting scans the drive for bad sectors and analyzes the drive to determine optimal settings.
- Low level formatting handles the defect mapping and setting the interleave factors
- Modern hard drive do not need to be low leveled formatted by the end user

Low Level Formatting

- With the tools and special commands it is possible to low level format a hard drive. In data recovery. Low level formatting will refurbish a hard drive, remapping bad sectors and setting the drive back to factory standards. After a low level format the drive has been refurbished and can be used again after a high level format is preformed

Zone Bit Recording

- Modern hard drive employ zone bit recording (ZBR) or also called multiple zone recording
- Tracks are grouped into zones based on the distance from the center of the disk



Zone Bit Recording

- Zones are assigned a number of sectors per track
- When you move from the innermost part of the disk to the outer edges you move through different zones
- Each zone containing more sectors per track than the one before

Zone Bit Recording

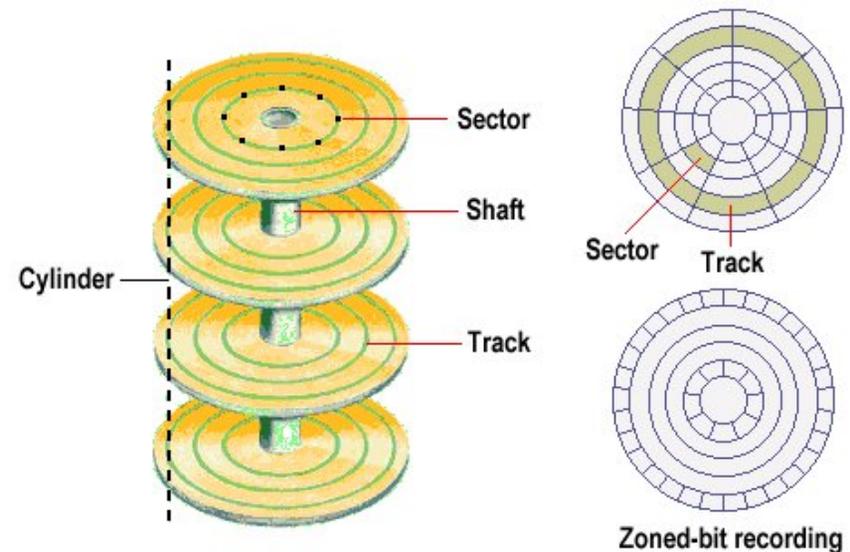
- If a hard disk has 20 tracks it is divided into 5 zones. The zones are shown in different colors. The blue zone has 5 tracks each with 16 sectors, the cyan zone has 5 tracks each with 14 sectors, the green zone has 4 tracks each with 12 sectors, the yellow zone has 3 tracks each with 11 sectors, and the red zone has 3 tracks each with 9 sectors

Zone Bit Recording

- Media transfer rate when reading the outside cylinders is much higher than when reading the inside ones
- The outer cylinders contain more data
- Some hard disk are filled from the outside in where fastest data transfer occurs when the drive is first used

Zone Bit Recording

- Hard disk over 8.4GB can not have their parameters expressed using the IDE BIOS geometry parameters. Regular BIOS limit is 8.4GB. Hard disk are accessed using logical block addressing



Data Recovery from Formatted Disk

- As with regular deleted files on a disk data is not destroyed during high level format.
- The area on the disk is only marked as available and retains the old data until it is over written.
- If the HDD is formatted with a different file system than the original file system some data maybe over written

Data Recovery from Formatted Disk

- Under the NTFS file system the file indexes \$MFTs and “inodes” under ext2/3 may not be written to the same exact location on the disk. This will cause data loss during high level formatting.
- If the partition size is increased the file signature will over write more data at the beginning of the new partition.