Data Recovery

Determining Hard Drive Problems
Chapter 3
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Data Recovery Determining HD Problems

- Data recovery is the process of salvaging data from a damaged, failed, corrupted or inaccessible secondary storage media when it can not be accessed normally.

- The most common Data Recovery issues involve an operating system failure. The goal is to copy all needed files to another disk.

- In such a failure it is recommended to use a cloning tool to clone the patient drive to a new target drive before attempting to locate and move the needed data files.

Data Recovery Determining HD Problems

- The second type of data loss involved a disk level failure. This can include a corrupted file system, disk partition, or hard disk failure where data can not be easily read.

- In such a case this can involve repairing the file system, partition table, MBR, MFT, needing to physically repair the damaged drive HSA which is a one time repair to recovery lost files.

- The third type of data recovery involves finding and locating files that have been deleted.

Data Recovery Main Function

- Data recovery main function is to retrieve data from a damaged HDD or operating system

- These types of failures are referred to as logical and physical failures

- Physical failures such as the HDD overheating may cause programs to malfunction and eventually lead to the OS failure.

- Data recovery involves using different methods to enter into the computer's hard drive and retrieve lost, deleted, and corrupted files.

Data Recovery Main Function

- There are several techniques used in the recovery of data. Depending on the problem of the hard drive the techniques maybe used individually or in conjunction with other techniques.

- The first examination is the most important to determine what caused the disk to fail.

- If a file system, MBR, or boot record has been corrupted a disk image of the HDD is necessary.

- Once cloning is finished it is necessary to work on the partition table, MBR, or boot sector to try and gain access to the data files. At time it is not possible to repair such damage and it is necessary to do a RAW recovery of the data on the HDD. If data has shifted it is necessary to examine the sectors of the HDD. This method is called Data Carving. This is the process of examining the hard disk sector by sector searching for specific files and file structures. Data recovery programs exists that allow you to find certain files on the disk as long as they are still in tack and the disk is somewhat operable.

Recovering Data After Physical Damage

- A wide variety of failures can cause physical damage to storage units. CD ROMs can have their metallic substance or dye layer scratched off; hard disks can suffer several mechanical failures such as head crashes and failed motors.

- Most physical damage can not be repaired by the end user. For example opening a HDD in an uncontrolled environment can lead to contamination of the disks heads and platters. Further more end users do not have the technical expertise required to make such repairs.

Recovery Techniques

- Recovering data from physically damaged hardware can involve multiple techniques.

- Some damage can be repaired by replacing part of the HDD HDA

- Special disk imaging procedures are used to recover all readable sectors from the disk surface. One the image has been saved on a reliable disk the image can be analyzed for logical damage.

Examples of Physical Recovery Procedures

- Removing a damaged PCB and replacing it with a matching PCB from a healthy drive
- Removing a damaged PCB and repairing the damage to the PCB
- Performing a hot swap on the damaged drive, hot swap is the process of using a working target drive and moving the PCB to the patient drive. Hot swapping allows access to the patient drive SA.
- Changing the Head Stack Assembly
- Swapping platter to a new chassis
- Often a combination of all of these procedures

Common Causes of Data Loss

- Error messages stating that your hard drive is not recognized by BIOS

- Previously accessible important data and information is now invisible

- Rattling or scrapping sounds coming from your hard drive

- Computer won't boot and faces logical crash

Common Causes of Data Loss

- Hard drive won't spin
- Cannot see or access hard drive partitions/volumes
- The computer user deleted a data file or computer program thinking that it is no longer needed
- The user deletes files or programs without fully being aware of what he is doing. A large blanket deletion for a large number of files could result in deleting some important files that are needed

Common Causes of Data Loss

- Power failure can lead to data loss. The power failed and the data was not saved to permanent memory

- Errors made by network administrator and other administrative persons could lead to the loss of important files or programs

- Hardware failure such as contact of the read/write heads and the rotating platters. During normal operations there is a small cushion of air that keeps the heads off the platters and floats them above the disk surface. If the heads loose the air pocket they will touch down on the disk surface

- A software program freezes or hangs during the middle of an operation. The operating system suddenly gets stuck through work session. The system has to be soft booted in order to restore normal operations

Common Causes of Data Loss

- Data corruption to a file system or data base. The file system or data base becomes corrupted and the data in the files become unreadable or inaccessible
- A natural disaster like an earthquake, flood, or tornado destroys the equipment including the data storage unit
- A worm or virus attacks results in damage to data
- A hacker intrudes into the system and erases or damages the data files

Common Causes of Data Loss

- In most of the situations, data loss occurs due to hard drive failure. Hardware failure and human errors reportedly account for 75% of data loss or incidents. Data loss through natural disaster is rare. Considering hard drives rotate at extremely high speeds which can cause physical malfunctions. Sometimes corrupted MBR and file system could also be the reason.
- Depending upon the cause of data loss, there are two forms of data recovery:
- Logical data recovery
- Physical data recovery

Logical Recovery

- Logical damage is primarily caused by power outages which prevent the HDD from completely writing to the platters.

- Virus attacks, formatted HDD, and accidental deletion all fall under logical recovery

- Some HDD damage is mistakenly attributed to physical damage. When the HDD starts to click most think this is from the read/write heads. This is not always the case. It could be that the HDD is not getting enough power, the FW of the HDD is damaged, or the PCB is damaged and need to be rebuilt in order to access data

Logical Recovery

- Logical failures are less severe because the HDD still works but some files or data are unavailable.

- Logical failure can usually be resolved without clean room work or changing mechanical parts of the HDD

- There are many causes for logical failure

Causes of Logical Failure

- Partition Table
- File system corrupted
- Deleting files or erasing data
- Loss of hard drive partition
- Computer virus; corrupts system following a virus attack
- Master File table (MFT)
- Master Boot Record (MBR)
- Corrupted boot sector
- Loss of file structure after virus attack

Physical Recovery

- Physical failures are considered the most severe because generally they need a part changed in the HDD in order to access the data area.
- Common physical failures
- The drive is no longer recognized by the computer
- A slamming metal is head during operations
- The drive vibrated during use
- The speed of data transfer is very slow

Physical Recovery

- A musical sound is coming from the HDD when you try to start it
- The HDD spins up then down several times before finally stopping
- The heads are making a clicking sound
- There is no power to the disk at all
- Power loss and the heads stick to the platters
- Power surges that burn the PCB and peramp

Types of Physical Failures

- Scored or scratched platters
- Electronic discharge
- Friction of internal parts
- Read /Write heads and slider failure
- Hard disk spindle motor failure
- Parts deterioration
- Temperature changes
- Power surges
- Head crash

Data Recovery Classification

- Data Recovery can be divided into two classifications: Logical and Physical

- Stage 1: Examining the HDD

- During the first stages of data recovery it is important to find out as much information from the person as to why or what has happened to the HDD. This is the most important stage and needs to be taken before attaching a failed HDD to your computer to start stage 2.

Stage 1 Data Recovery What to Ask

- Speak with the client to determine the exact problem wit the HDD
- Is the HDD recognized in the BIOS
- Do you have problems wit the OS
- Did you delete a file
- How long ago was the file deleted
- Have you used your system since the file was deleted
- Get as much information as possible from the client as to the nature of the drives failure before the drive was brought to your shop

Stage 1 Data Recovery What to Ask

- Examine the PCB for any signs of damage or failure. This could be a burned TVS or MCU that has signs of damage

- Determine if the HDD had the wrong power supply plugged into it

- Find out if the HDD was dropped and the client tried to use it

- Find out if they heard any unusual noise from the HDD when it was running on their system

Stage 1 Data Recovery What to Ask

- Ask if they tried to do a logical recovery, defragment the HDD or run CHKDSK

- Did they try to install any logical recovery software to the drive attempting to retrieve the lost file or repair the problem

- Find out if the client tried to put the HDD in the freezer. There is a myth on Internet and you would be surprised how many people actually do this

Stage 2 Attaching the HDD to Determine the Problem

- During the 2nd stage the HDD is attached to a power supply to power on the HDD
- The HDD maybe attached direct to your MB to power on the HDD
- It is not recommended to attach the HDD direct to your MB because you do not have an idea of exactly what is wrong wit the HDD
- I recommend during the 2nd stage to use the Data compass to attach the HDD to and see if you can identify the HDD, the correct SN, LBA, and FW. Check the file structure to see if it is intact.

Stage 2 Attaching the HDD to Determine the Problem

- The HDD can be attached to the HD Doctor to give you a better idea about the HDD. If you have a corrupted module, SMART problems, G-List is over flowing and if you can enter the data area

- The second stage determines if the HDD has logical or physical problems that need to be addressed.

- If the HDD has logical problem attach the HDD to the HD Doctor and make a complete FW back up of the HDD before cloning the drive to a new drive.

Fundamentals for Searching for Malfunctions

- The HDD is a sophisticated software and hardware device combining electronic and mechanical parts.

- HDD repair is impossible without specialized knowledge, special equipment, instruments and tools.

- Physical problems a clean room is need to prevent dust entering into the chassis of the HDD and contaminating the platters and causing a head crash

Steps To Take During Diagnosing the Problem

- Attach the HDD to the DC or one of the HD Doctor suit tools. Power on the HDD and see if the drive become ready

- At power up the HDD spins p the spindle motor, the sound level increases from 4 – 7 seconds. A click is heard as the heads are moved from the landing zone or parking zone.

- After a very specific recalibration cracking noise that last 1 – 2 seconds.

- In order to become accustom to such sounds listen to a know good drive at power on

Steps To Take During Diagnosing the Problem

- Recalibration procedures performed by the drive demonstrate that the HDD reset circuit, clock, microcontroller, spindle motor control circuit, positioning system, data conversion channel, normal operations to the magnetic heads are in operational condition.

- To further diagnose the HDD it has to be attached to a IDE port an automatically detected in the BIOS through the setup procedure.

- If the DC or HD Doctor suit is available attach the HDD to one of these units to read the drives name, serial number, FW revision and LBA. This indicates if your drive is accessible and can read the SA of the HDD.

Steps To Take During Diagnosing the Problem

- If the HDD does not spin up a problems exists with the spindle motor. It is possible to test the spindle motor by first examining the PCB board for any signs of burned components.

- A simple test for the spindle motor is to swap the PCB board with one of a known good drive. If the spindle motor spins up the problems is with the PCB board. If the spindle motor does not spin up the problem is internal to the HDD and needs to be opened in a clean room.

- If you have a compatible PCB board it is possible to check the resistance of coils (phases) of the spindle motor. It should correspond to ~ 2 – 0hm relatively to middle output. If the spindle motor is correct further examination of the PCB is necessary. Inability to start the spindle motor frequently results from sticking of magnetic heads to the platters.

- In order to check a PCB for failed components, remove the PCB board, connect to an external power supply and position it on the work table with the electronic components side facing up.

Steps To Take During Diagnosing the Problem

- Check PCB +5V and +12V voltages outputs from the U3 and U6 chips. Check the U6 chips excitation quartz resonator or an output between 24 and 33.
- Check for the presence of the clock pulses supplied to the U9 and the control microprocessor and the U11 reading channels range from 57 and 13 output.
- After checking these chips make sure there is no reset signal present an active level 0
- If the entire electronic components test are met then the controller microprocessor will start the HDD and perform the initialization procedure which requires programming all the chips connected to the internal data bus

Steps To Take During Diagnosing the Problem

- To check the spindle motor control circuit you should trigger 10 ms/div oscilloscope sweep with 2V/div amplification. Note it is advisable to use 1:10 multiplier.

- After power up check for presence of motor start pulse with 11 – 12 V amplitude for three phases with connections J14, J13, and J12. The controller circuit should try to start the motor for 1 – 2 minutes after a failure it will stop and discontinue the attempts to start the spindle motor. If this happens switch power off/on or send a RESET command by short circuiting of the line 1 and 2 in the IDE interface connector using tweezers.

- If voltage is lower than 10V for any phase then the U3 chip is malfunctioning. As a result of such failure the spindle motor attempts to spin up but remains unable to gain rated rotations speed and consequently the magnetic heads cannot be shifted from the landing zone.

- Rotational speed of the spindle motor can be controlled using the INDEX pulses ~12 ms, the width of the INDEX pulses is - 140 nanoseconds. The U3 chip is controlled by the U6 synchronization controller chip and the SPINDLE START signal of the spindle motor. For the motor to start the SPINDLE START = 1, and fro the motor to stop = 0.

Steps To Take During Diagnosing the Problem

- Phase distribution is controlled by the U6 chip through the Fcl – Fc6 outputs. It uses TTL range to control the signals. Feedback of rotational speed is accomplished through the 23P4910A U11 reading channel chip using the SERVO READ DATA line. The U6 synchronization controller chip generates the signal from the servo field search SERVO GATE of the U11 chip.

- The image indicates the servo signals and number of control points. The signal can be viewed conveniently using an oscilloscope with 100 MHz or greater sweep range since the INDEX pulses and servo marker last for about ~140 nanoseconds. Monitoring should be performed using two sauces, synchronization the oscilloscope by INDEX or by servo marker.

Typical Malfunctions of HDD and Methods of Repair

- The HDD consists of two main parts: a mechanical part; heads and disk assembly and an electronic part; the controller printed circuit board.

- The two components need internal firmware which is stored in the ROM on the PCB and in the FW zone or service area of the drive.

- The FW from the SA is loaded to the RAM on the microcontroller during drive initializations

- The three components have to interact very closely for the HDD to function normally.

Typical Malfunctions of HDD and Methods of Repair

- When a HDD malfunctions it may result in failure from the mechanical parts, electronic parts, or firmware stored in the service area.

- Different HDD models from various manufactures the failure rate of these components and the degree of damage is different for each drive family

- Failure to the internal mechanics of the HDD have to be repaired in a clean room. Failure to the internal firmware needs specialized tools capable of reading the service are of the HDD

Typical Malfunctions of HDD and Methods of Repair

- One of the easier repairs is replacing the firmware in the service area with compatible firmware modules from a donor drive

- Corruption of firmware modules in the service area is one of more common malfunctions because they are used each time the HDD starts

- When the HDD FW modules become corrupted the HDD is no longer visual in the BIOS and any attempt to access the HDD ends in a ABRT error

- The HDD can no longer issue commands and commands can not be executed

- Repair of such malfunction can require you to over write the corrupted modules in the SA with modules from a donor drive that is compatable

Typical Malfunctions of HDD and Methods of Repair

- When the HDD is powered on the drive produces periodic knocking sounds hitting its HAS against the limiting stop. This indicates the drive is unable to read servo information from the disks surface. There are various causes and reason for this failure
- Malfunctioning magnet heads
- Malfunctioning preamp lifter/commutator located inside the HAD near the heads
- Malfunctioning PCB/reading/data conversion channel
- Malfunctioning PCB positioned controller microchip
- Malfunctioning PCB supply current

Typical Malfunctions of HDD and Methods of Repair

- In addition such malfunction may be caused by the incorrect recording of FW modules when a non-existent head is selected and as a result the stream of servo data is missing

- Precise diagnostics of such a malfunction is complicated and difficult even for an expert. There are a few tricks that can simplify the diagnostic process to determine the HAS, PCB or FW modules are causing these problems

Typical Malfunctions of HDD and Methods of Repair

1. Remove the PCB board and replace it with a known good board from the same model with an identical firmware version. This is not possible in all drive families. Recent Seagate models, Fujitsu MP G3xxxAT and Western Digital store unique drive parameters in the ROM which are unique adaptive used by the PCB to start the drive. ROM on such models will need to be moved to the donor PCB board in order to test the drive for mechanical or firmware module problems. After swapping the PCB the HDD stops knocking and reports on readiness the PCB board needs to be examined for damage. If the HDD keeps knocking after testing the donor PCB board the cause of malfunction is inside the HDD.

-   I have listed different malfunctions for drive families and the most common problem that we encounter. Some of the malfunctions are for older model HDD but we still see these coming into our repair shops. I have given you details on these problems and how we can repair the problems and retrieve data of the HDD