Guide to Computer Forensics and Investigations
Sixth Edition

Chapter 3

Data Acquisition

Objectives (1 of 2)

- List digital evidence storage formats
- Explain ways to determine the best acquisition method
- Describe contingency planning for data acquisitions
- Explain how to use acquisition tools

Objectives (2 of 2)

- Explain how to validate data acquisitions
- Describe RAID acquisition methods
- Explain how to use remote network acquisition tools
- List other forensic tools available for data acquisitions

Understanding Storage Formats for Digital Evidence

- Data in a forensics acquisition tool is stored as an image file
- Three formats
  - Raw format
  - Proprietary formats
  - Advanced Forensics Format (AFF)

Raw Format

- Makes it possible to write bit-stream data to files
- Advantages
  - Fast data transfers
  - Ignores minor data read errors on source drive
  - Most computer forensics tools can read raw format
- Disadvantages
  - Requires as much storage as original disk or data
  - Tools might not collect marginal (bad) sectors

Proprietary Formats

- Most forensics tools have their own formats
- Features offered
  - Option to compress or not compress image files
  - Can split an image into smaller segmented files
  - Can integrate metadata into the image file
- Disadvantages
  - Inability to share an image between different tools
  - File size limitation for each segmented volume
- The Expert Witness Compression format is unofficial standard

Advanced Forensics Format

- Developed by Dr. Simson L. Garfinkel as an open-source acquisition format
- Design goals
  - Provide compressed or uncompressed image files
  - No size restriction for disk-to-image files
  - Provide space in the image file or segmented files for metadata
  - Simple design with extensibility
  - Open source for multiple platforms and Oss
  - Internal consistency checks for self-authentication
- File extensions include .afd for segmented image files and .afm for AFF metadata
- AFF is open source

Determining the Best Acquisition Method (1 of 4)

- Types of acquisitions
  - **Static acquisitions** and **live acquisitions**
- Four methods of data collection
  - Creating a disk-to-image file
  - Creating a disk-to-disk
  - Creating a logical disk-to-disk or disk-to-data file
  - Creating a sparse data copy of a file or folder
- Determining the best method depends on the circumstances of the investigation

Determining the Best Acquisition Method (2 of 4)

- Creating a disk-to-image file
  - Most common method and offers most flexibility
  - Can make more than one copy
  - Copies are bit-for-bit replications of the original drive
  - Compatible with many commercial forensics tools
- Creating a disk-to-disk
  - When disk-to-image copy is not possible
  - Tools can adjust disk’s geometry configuration
  - Tools: EnCase and X-Ways

Determining the Best Acquisition Method (3 of 4)

- **Logical acquisition** or **sparse acquisition**
  - Can take several hours; use when your time is limited
  - Logical acquisition captures only specific files of interest to the case
  - Sparse acquisition collects fragments of unallocated (deleted) data
  - For large disks
  - PST or OST mail files, RAID servers

Determining the Best Acquisition Method (4 of 4)

- When making a copy, consider:
  - Size of the source disk
    - Lossless compression might be useful
    - Use digital signatures for verification
  - When working with large drives, an alternative is using lossless compression
  - Whether you can retain the disk
  - Time to perform the acquisition
  - Where the evidence is located

CENGAGE

Contingency Planning for Image Acquisitions

- Create a duplicate copy of your evidence image file
- Make at least two images of digital evidence
  - Use different tools or techniques
- Copy **host protected area** of a disk drive as well
  - Consider using a hardware acquisition tool that can access the drive at the BIOS level
- Be prepared to deal with encrypted drives
  - **Whole disk encryption** feature in Windows called BitLocker makes static acquisitions more difficult
  - May require user to provide decryption key

Using Acquisition Tools

- Acquisition tools for Windows
  - Advantages
    - Make acquiring evidence from a suspect drive more convenient
      - Especially when used with hot-swappable devices
  - Disadvantages
    - Must protect acquired data with a well-tested write-blocking hardware device
    - Tools can’t acquire data from a disk’s host protected area
    - Some countries haven’t accepted the use of write-blocking devices for data acquisitions

Mini-WinFE Boot CDs and USB Drives

- Mini-WinFE
  - Enables you to build a Windows forensic boot CD/DVD or USB drive so that connected drives are mounted as read-only
- Before booting a suspect’s computer:
  - Connect your target drive, such as a USB drive
- After Mini-WinFE is booted:
  - You can list all connected drives and alter your target USB drive to read-write mode so you can run an acquisition program

Acquiring Data with a Linux Boot CD (1 of 6)

- Linux can access a drive that isn’t mounted
- Windows OSs and newer Linux automatically mount and access a drive
- Forensic Linux Live CDs don’t access media automatically
  - Which eliminates the need for a write-blocker
- Using Linux Live CD Distributions
  - Forensic Linux Live CDs
    - Contain additionally utilities

Acquiring Data with a Linux Boot CD (2 of 6)

- Using Linux Live CD Distributions (cont'd)
  - Forensic Linux Live CDs (cont'd)
    - Configured not to mount, or to mount as read-only, any connected storage media
    - Well-designed Linux Live CDs for computer forensics
      - Penguin Sleuth Kit
      - CAINE
      - Deft
      - Kali Linux
      - Knoppix
      - SANS Investigative Forensic Toolkit (SIFT)

Acquiring Data with a Linux Boot CD (3 of 6)

- Preparing a target drive for acquisition in Linux
  - Current Linux distributions can create Microsoft FAT and NTFS partition tables
  - **fdisk** command lists, creates, deletes, and verifies partitions in Linux
  - **mkfs.msdos** command formats a FAT file system from Linux
  - If you have a functioning Linux computer, follow steps starting on page 105 to learn how to prepare a target drive for acquisition

Acquiring Data with a Linux Boot CD (4 of 6)

- Acquiring data with `dd` in Linux
  - `dd` ("data dump") command
    - Can read and write from media device and data file
    - Creates raw format file that most computer forensics analysis tools can read
  - Shortcomings of `dd` command
    - Requires more advanced skills than average user
    - Does not compress data
  - `dd` command combined with the split command
    - Segments output into separate volumes

Acquiring Data with a Linux Boot CD (5 of 6)

- Acquiring data with `dd` in Linux (cont'd)
  - Follow the step starting on page 112 in the text to make an image of an NTFS disk on a FAT32 disk
- Acquiring data with `dcfldd` in Linux
  - The `dd` command is intended as a data management tool
    - Not designed for forensics acquisitions

Acquiring Data with a Linux Boot CD (6 of 6)

- Acquiring data with `dcfldd` in Linux (cont'd)
  - `dcfldd` additional functions
    - Specify hex patterns or text for clearing disk space
    - Log errors to an output file for analysis and review
    - Use several hashing options
    - Refer to a status display indicating the progress of the acquisition in bytes
    - Split data acquisitions into segmented volumes with numeric extensions
    - Verify acquired data with original disk or media data

Capturing an Image with AccessData FTK Imager Lite (1 of 8)

- Included with AccessData Forensic Toolkit
- Designed for viewing evidence disks and disk-to-image files
- Makes disk-to-image copies of evidence drives
  - At logical partition and physical drive level
  - Can segment the image file
- Evidence drive must have a hardware write-blocking device
  - Or run from a Live CD, such as Mini-WinFE

Capturing an Image with AccessData FTK Imager Lite (2 of 8)

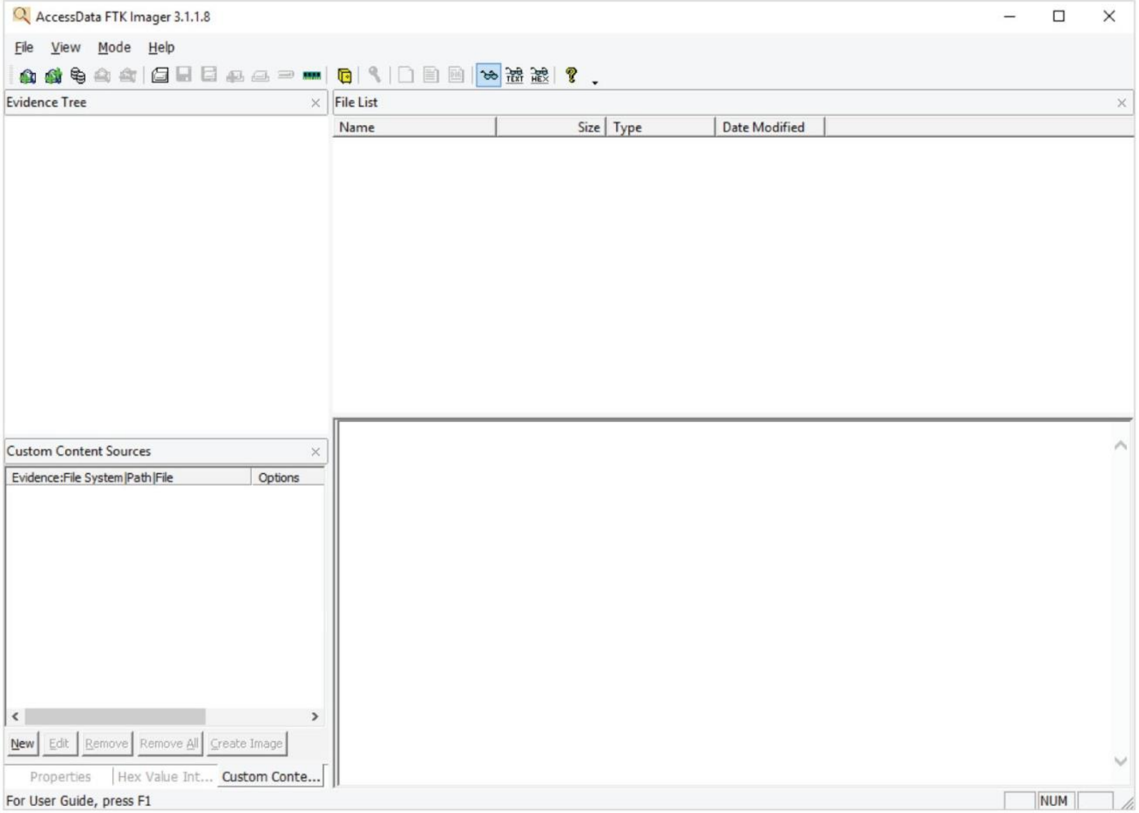


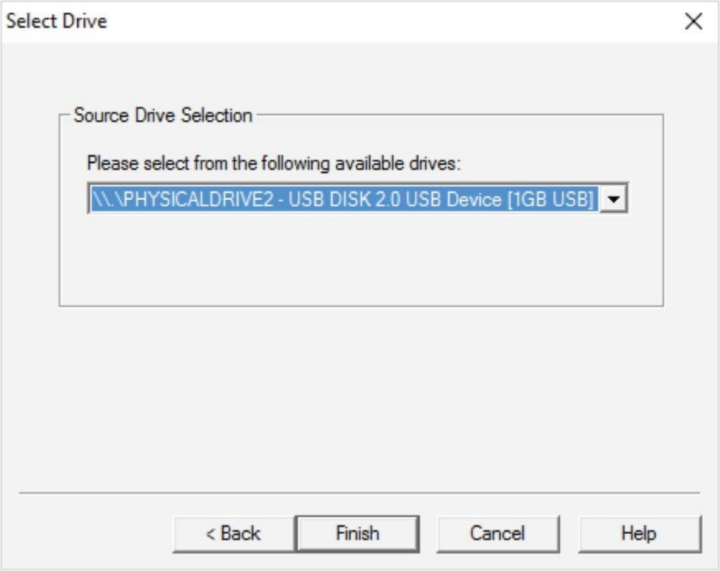
Figure 3-2 The FTK Imager main window

Source: AccessData Group, Inc.

Capturing an Image with AccessData FTK Imager Lite (3 of 8)

- FTK Imager can’t acquire a drive’s host protected area
- Use a write-blocking device and follow these steps
  - Boot to Windows
  - Connect evidence disk to a write-blocker
  - Connect target disk to write-blocker
  - Start FTK Imager Lite
  - Create Disk Image - use Physical Drive option
  - See Figures on the following slides for more steps

Capturing an Image with AccessData FTK Imager Lite (4 of 8)



Select Drive

Source Drive Selection

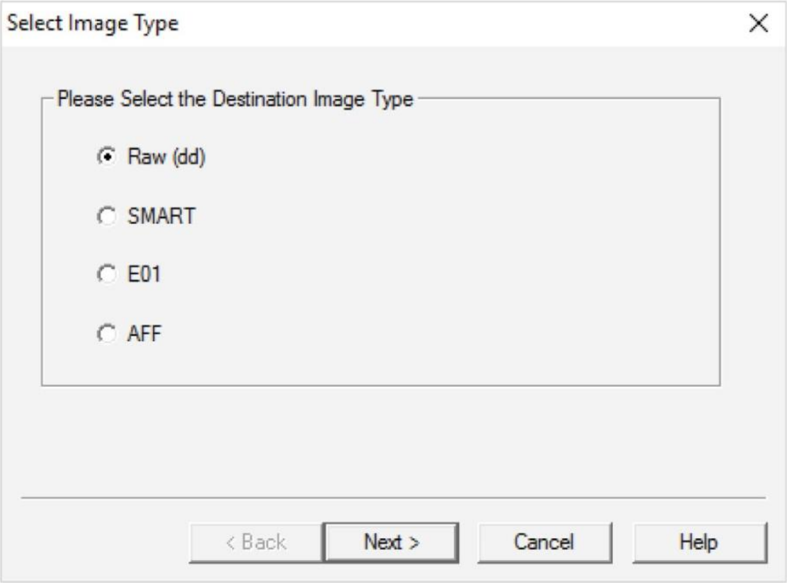
Please select from the following available drives:

\\.\PHYSICALDRIVE2 - USB DISK 2.0 USB Device [1GB USB]

Figure 3-3 The Select Drive dialog box

Source: AccessData Group, Inc.

Capturing an Image with AccessData FTK Imager Lite (5 of 8)



Select Image Type

Please Select the Destination Image Type

● Raw (dd)

○ SMART

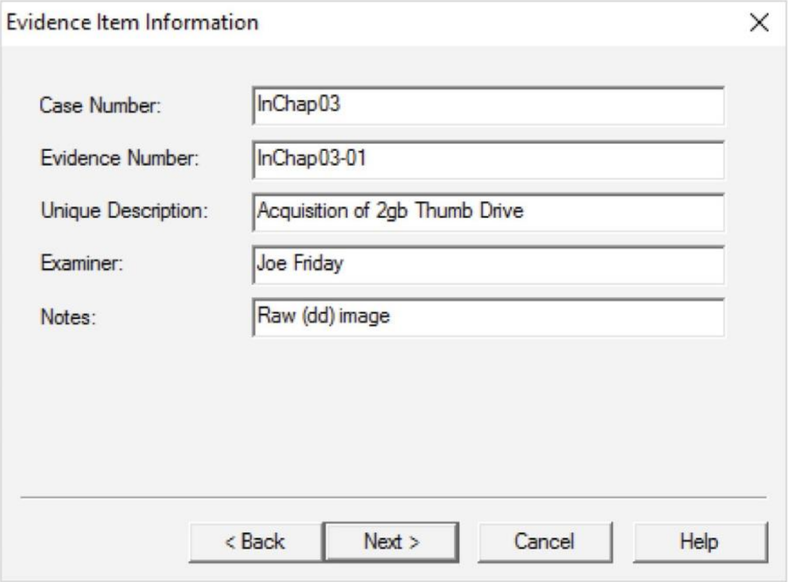
○ E01

○ AFF

Figure 3-4 The Select Image Type dialog box

Source: AccessData Group, Inc.

Capturing an Image with AccessData FTK Imager Lite (6 of 8)



Case Number: InChap03

Evidence Number: InChap03-01

Unique Description: Acquisition of 2gb Thumb Drive

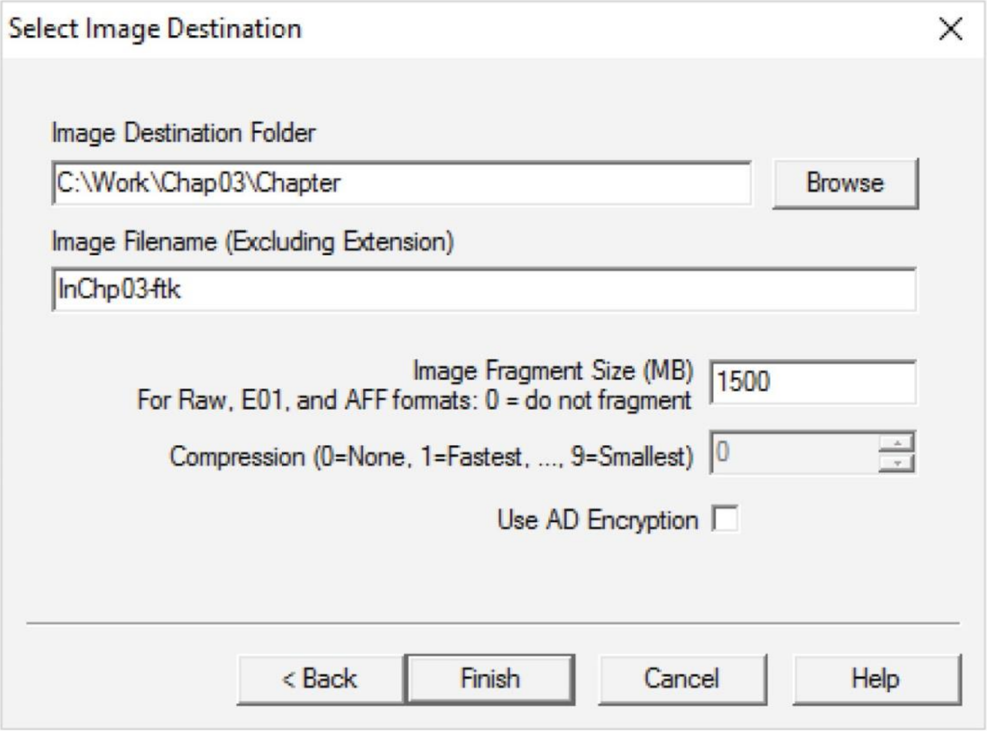
Examiner: Joe Friday

Notes: Raw (dd) image

Figure 3-5 The Evidence Item Information dialog box

Source: AccessData Group, Inc.

Capturing an Image with AccessData FTK Imager Lite (7 of 8)



Select Image Destination

Image Destination Folder: C:\Work\Chap03\Chapter

Image Filename (Excluding Extension): InChp03-ftk

Image Fragment Size (MB)
For Raw, E01, and AFF formats: 0 = do not fragment: 1500

Compression (0=None, 1=Fastest, ..., 9=Smallest): 0

Use AD Encryption ☐

Figure 3-6 Selecting where to save the image file

Source: AccessData Group, Inc.

Capturing an Image with AccessData FTK Imager Lite (8 of 8)

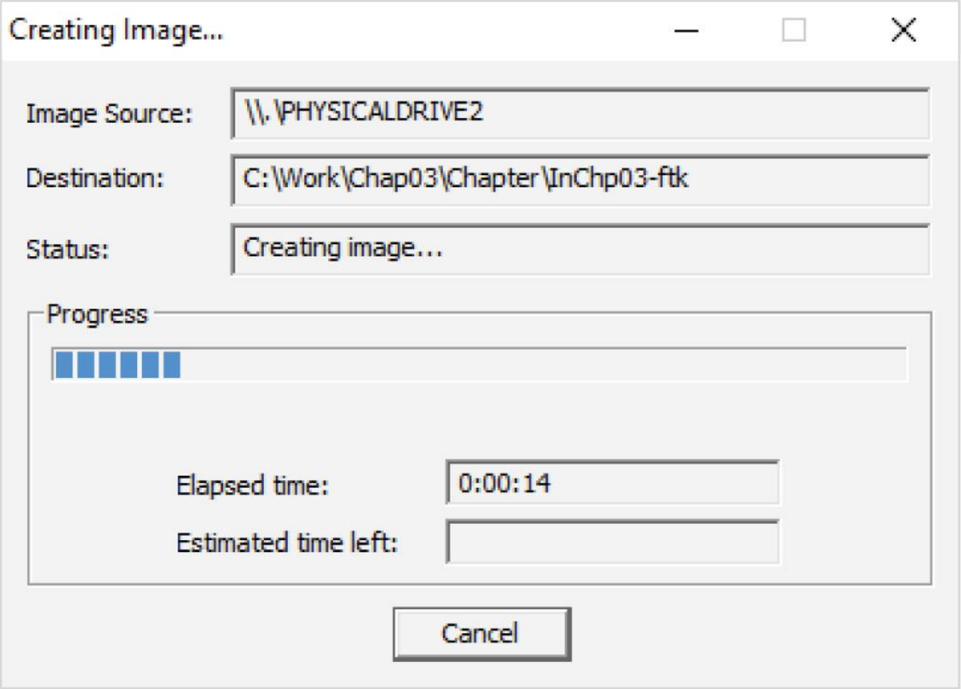

Creating Image...

Image Source: \\.\PHYSICALDRIVE2

Destination: C:\Work\Chap03\Chapter\InChp03-ftk

Status: Creating image...

Elapsed time: 0:00:14

Estimated time left:

Figure 3-7 An image save in progress

Source: AccessData Group, Inc.

Validating Data Acquisitions

- Validating evidence may be the most critical aspect of computer forensics
- Requires using a hashing algorithm utility
- Validation techniques
  - CRC-32, MD5, and SHA-1 to SHA-512

Linux Validation Methods

- Validating `dd`-acquired data
  - You can use `md5sum` or `sha1sum` utilities
  - `md5sum` or `sha1sum` utilities should be run on all suspect disks and volumes or segmented volumes
- Validating `dcfldd` acquired data
  - Use the `hash` option to designate a hashing algorithm of `md5`, `sha1`, `sha256`, `sha384`, or `sha512`
  - `hashlog` option outputs hash results to a text file that can be stored with the image files
  - `vf` (verify file) option compares the image file to the original medium

Windows Validation Methods

- Windows has no built-in hashing algorithm tools for computer forensics
  - Third-party utilities can be used
- Commercial computer forensics programs also have built-in validation features
  - Each program has its own validation technique
- Raw format image files don’t contain metadata
  - Separate manual validation is recommended for all raw acquisitions

Performing RAID Data Acquisitions

- Acquisition of RAID drives can be challenging and frustrating because of how RAID systems are
  - Designed
  - Configured
  - Sized
- Size is the biggest concern
  - Many RAID systems now have exabytes of data

Understanding RAID (1 of 7)

- **Redundant array of independent disks (RAID)**
  - Computer configuration involving two or more disks
  - Originally developed as a data-redundancy measure
- RAID 0
  - Provides rapid access and increased storage
  - Biggest disadvantage is lack of redundancy
- RAID 1
  - Designed for data recovery
  - More expensive than RAID 0

Understanding RAID (2 of 7)

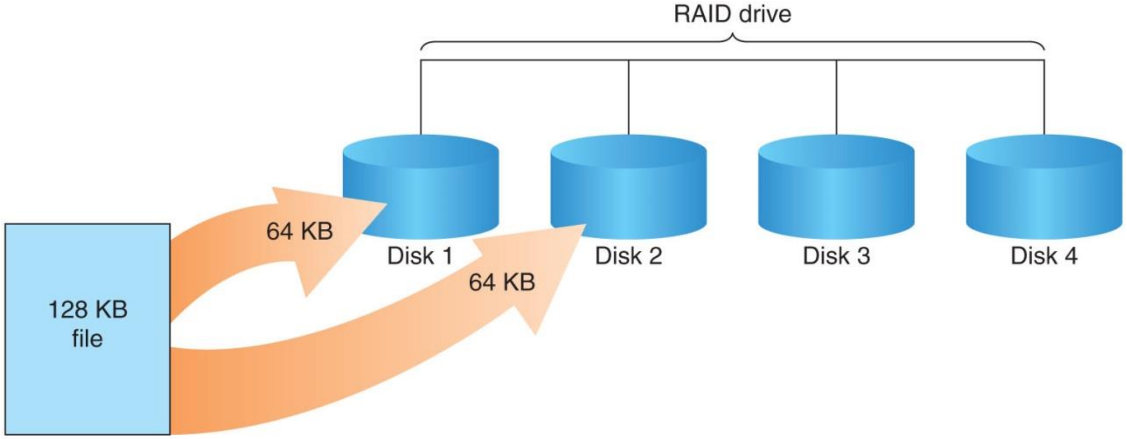


Figure 3-8 RAID 0: Striping

Understanding RAID (2 of 6)

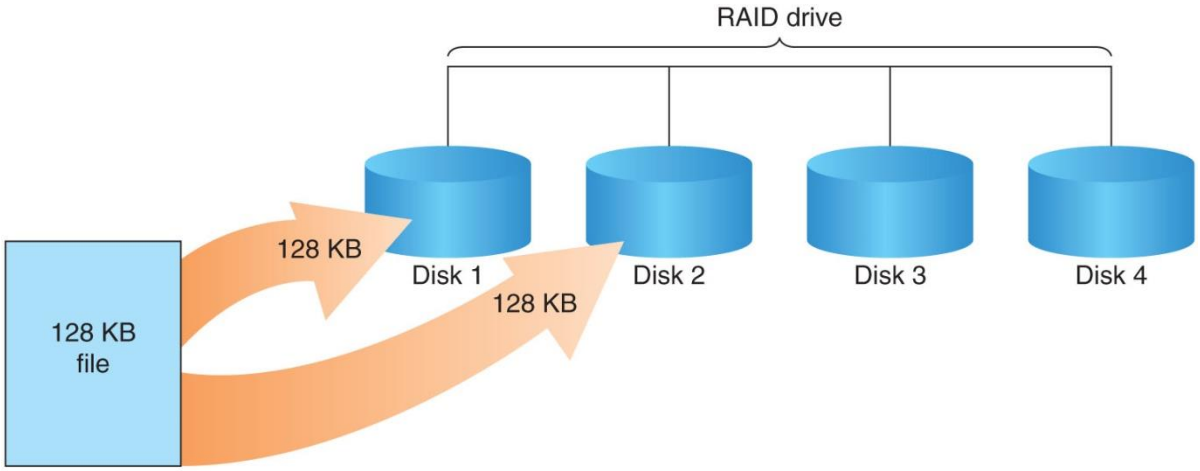


Figure 3-9 RAID 1: Mirroring

Understanding RAID (3 of 6)

- RAID 2
  - Similar to RAID 1
  - Data is written to a disk on a bit level
  - Has better data integrity checking than RAID 0
  - Slower than RAID 0
- RAID 3
  - Uses data stripping and dedicated parity
  - Requires at least three disks
- RAID 4
  - Similar to RAID 3
  - Data is written in blocks

Understanding RAID (4 of 6)

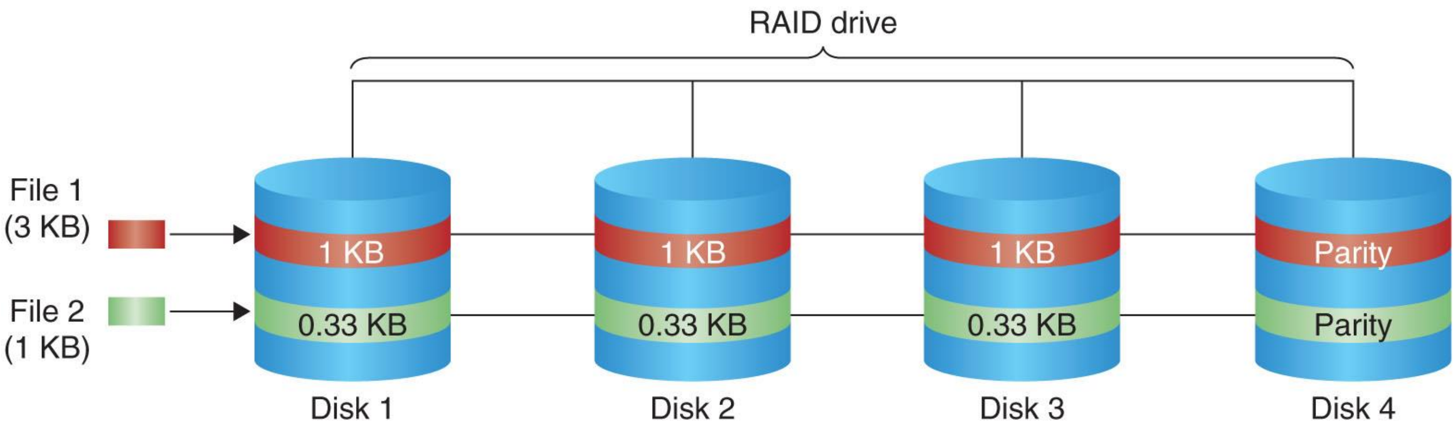


Figure 3-10 RAID 2: Striping (bit level)

Understanding RAID (5 of 6)

- RAID 5
  - Similar to RAIDs 0 and 3
  - Places parity recovery data on each disk
- RAID 6
  - Redundant parity on each disk
- RAID 10 (1+0), or mirrored striping
  - Combination of RAID 1 and RAID 0
  - Provides fast access and redundancy
- RAID 15 (1+5)
  - Combination of RAID 1 and RAID 5
  - More costly option

Understanding RAID (6 of 6)

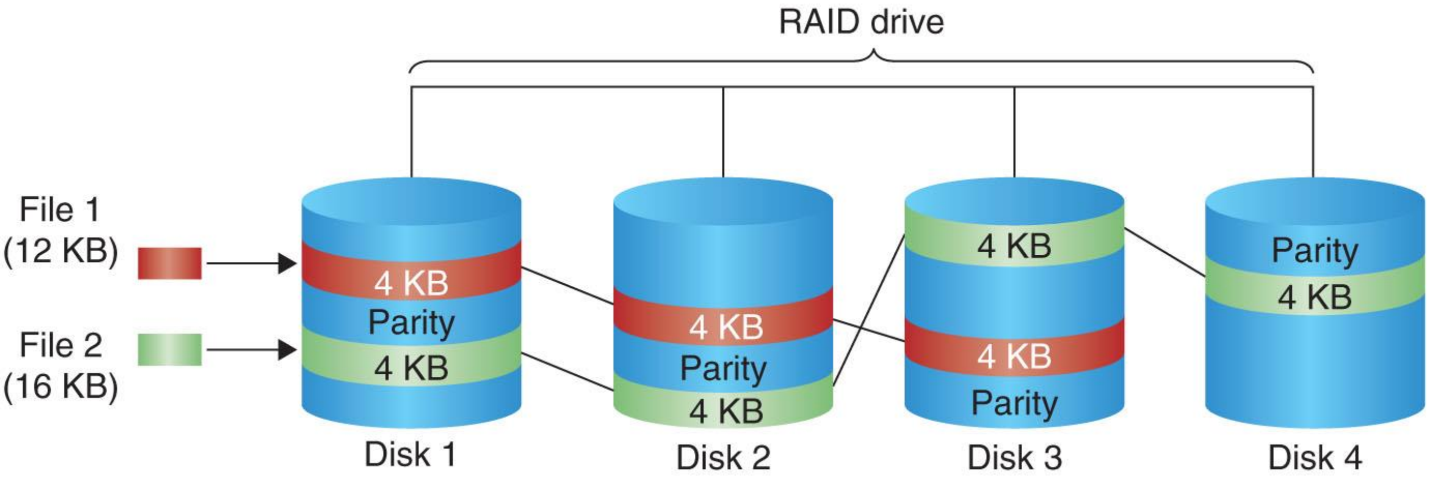


Figure 3-11 **RAID 5: Block-level striping with distributed parity**

Acquiring RAID Disks (1 of 2)

- Address the following concerns:
  - How much data storage is needed?
  - What type of RAID is used?
  - Do you need to have all drives connected?
  - Do you have the right acquisition tool?
  - Can the tool read a forensically copied RAID image?
  - Can the tool read split data saves of each RAID disk?
- Copying small RAID systems to one large disk is possible

Acquiring RAID Disks (2 of 2)

- Vendors offering RAID acquisition functions
  - Guidance Software EnCase
  - X-Ways Forensics
  - AccessData FTK
  - Runtime Software
  - R-Tools Technologies
- Occasionally, a RAID system is too large for a static acquisition
  - Retrieve only the data relevant to the investigation with the sparse or logical acquisition method

Using Remote Network Acquisition Tools

- You can remotely connect to a suspect computer via a network connection and copy data from it
- Remote acquisition tools vary in configurations and capabilities
- Drawbacks
  - Antivirus, antispyware, and firewall tools can be configured to ignore remote access programs
  - Suspects could easily install their own security tools that trigger an alarm to notify them of remote access intrusions

Remote Acquisition with ProDiscover (1 of 3)

- ProDiscover Incident Response functions:
  - Capture volatile system state information
  - Analyze current running processes
  - Locate unseen files and processes
  - Remotely view and listen to IP ports
  - Run hash comparisons
  - Create a hash inventory of all files remotely

Remote Acquisition with ProDiscover (2 of 3)

- PDServer remote agent
  - ProDiscover utility for remote access
  - Needs to be loaded on the suspect
- PDServer installation modes
  - Trusted CD
  - Preinstallation
  - Pushing out and running remotely
- PDServer can run in a stealth mode
  - Can change process name to appear as OS function

Remote Acquisition with ProDiscover (3 of 3)

- Remote connection security features
    - Password protection
    - Encryption
    - Secure communication protocol
    - Write-protected trusted binaries
    - Digital signatures

Remote Acquisition with EnCase Enterprise

- Remote acquisition features
  - Search and collect internal and external network systems over a wide geographical area
  - Support multiple Oss and file systems
  - Triage to help determine system’s relevance to an investigation
  - Perform simultaneous searches of up to five systems at a time

Remote Acquisition with R-Tools R-Studio

- R-Tools suite of software is designed for data recovery
- Can remotely access networked computer systems
- Creates raw format acquisitions
- Supports various file systems

Remote Acquisition with WetStone US-LATT PRO

- US-LATT PRO
  - Part of a suite of tools developed by WetStone
  - Can connect to a networked computer remotely and perform a live acquisition of all drives connected to it

Remote Acquisition with F-Response

- F-Response
  - A vendor-neutral remote access utility
  - Designed to work with any digital forensics program
  - Sets up a security read-only connection
    - Allows forensics examiners to access it
- Four different version of F-Response
  - Enterprise Edition, Consultant + Convert Edition, Consultant Edition, and TACTICAL Edition

Using Other Forensics-Acquisition Tools

- Other commercial acquisition tools
  - PassMark Software ImageUSB
  - ASRData SMART
  - Runtime Software
  - ILookIX Investigator IXimager
  - SourceForge

PassMark Software ImageUSB

- PassMark Software has an acquisition tool called ImageUSB for its OSForensics analysis product
- To create a bootable flash drive, you need:
  - Windows XP or later
  - ImageUSB downloaded from the OSForensics Web site

ASR Data SMART

- ASR Data SMART
  - A Linux forensics analysis tool that can make image files of a suspect drive
  - Can produce proprietary or raw format images
- Capabilities:
  - Data reading of bad sectors
  - Can mount drives in write-protected mode
  - Can mount target drives in read/write mode
  - Compression schemes to speed up acquisition or reduce amount of storage needed

Runtime Software

- Runtime Software offers shareware programs for data acquisition and recovery:
  - DiskExplorer for FAT and NTFS
- Features:
  - Create a raw format image file
  - Segment the raw format or compressed image for archiving purposes
  - Access network computers' drives

ILook Investigator IXimager

- IXimager
  - Runs from a bootable floppy or CD
  - Designed to work only with ILookIX
  - Can acquire single drives and RAID drives
  - Supports:
    - IDE (PATA)
    - SCSI
    - USB
    - FireWire

SourceForge

- SourceForge provides several applications for security, analysis, and investigations
- For a list of current tools, see:
  - SourceForge-Tools
- Windows version of `dcfldd`
  - SourceForge-dcfldd

Summary (1 of 3)

- Forensics data acquisitions are stored in three different formats:
  - Raw, proprietary, and AFF
- Data acquisition methods
  - Disk-to-image file
  - Disk-to-disk copy
  - Logical disk-to-disk or disk-to-data file
  - Sparse data copy

Summary (2 of 3)

- Several tools available
  - Lossless compression is acceptable
- Plan your digital evidence contingencies
  - Make a copy of each acquisition
- Write-blocking devices or utilities must be used with GUI acquisition tools
- Always validate acquisition
- A Linux Live CD, such as SIFT, Kali Linux, or Deft, provides many useful tools for digital forensics acquisitions

Summary (3 of 3)

- Preferred Linux acquisition tool is `dcfldd` (not `dd`)
- Use a physical write-blocker device for acquisitions
- To acquire RAID disks, determine the type of RAID
  - And then which acquisition tool to use
- Remote network acquisition tools require installing a remote agent on the suspect computer