Automating the Computer Forensic Triage Process With MantaRay

Senior Computer Forensic Analysts– Doug Koster & Kevin Murphy

Worlds best Summer Intern – Chapin Bryce

GMU RCFG Conference – August 2013

www.mantarayforensics.com
MantaRay Team

* Doug Koster
  * 13 years of experience in computer forensics
  * MS in Computer Science, MBA
  * EnCE, GCFA, GCFE, A+, PMP
  * Programming experience in Perl & Python

* Kevin Murphy
  * 11 years of experience in computer forensics
  * BS in Computer Forensics (Champlain College)
  * EnCE, A+
  * Shell scripting & Python

* Chapin Bryce
  * Pursuing BS Degree in Computer Forensics (Champlain College)
  * Web Master / System Tester / Researcher
Background

- We are forensic examiners
  - We happen to know some scripting languages
  - Not professional programmers
- Spent entire careers as government contractor employees
- High volume of media
- Bulk processing to identify interesting forensic artifacts
  - “See if there is anything bad on this media”
What is MantaRay?

- MantaRay – ManTech Automated Triage System
  - Set of Python modules that automate a number of open source forensic tools
  - Will be bundled into the upcoming SIFT 3.0 (release date October 2013)
    - [http://computer-forensics.sans.org/community/downloads](http://computer-forensics.sans.org/community/downloads)
  - Designed to allow examiner to select multiple tools, set options for each, click go and walk away
  - Website for updates, blog posts, user forum
    - [www.mantarayforensics.com](http://www.mantarayforensics.com)
Creating User Account: Click Register on Website under Users
Set up Username & Email
Login with temporary password

- Your password will be sent to the email you registered with
- Logon with your password
- To change password, left click on your username in upper right hand corner and select “Edit Profile”
Edit Profile to change password
Triage Steps Automated by MantaRay

1. Creating a Super Timeline
2. Running Bulk_Extractor
3. Extracting Registry Hives & running RegRipper
4. Extracting EXIF Data
5. Carving Unallocated space
6. Scanning for high entropy files
7. Review RAM using Volatility
8. Extract GPS data from JPEGs and create .KML file
9. Extract Jumplist data
10. Extract NTFS system files

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**Tool Description: SuperTimeline**

* Based on Log2timeline, written by Kristinn Guðjónsson
  * http://code.google.com/p/log2timeline/
  * http://log2timeline.net/
  * “log2timeline, a framework for automatic creation of a super timeline. The main purpose is to provide a single tool to parse various log files and artifacts found on suspect systems (and supporting systems, such as network equipment) and produce a timeline that can be analysed by forensic investigators/analysts.”
Tool Description: Bulk Extractor

- Written by Dr. Simson Garfinkel
- **bulk_extractor**…
  - A C++ program
  - Scans a disk image, a file, or a directory of files and extracts useful information without parsing the file system or file system structures
  - Stores the results in feature files that can be easily inspected, parsed, or processed with automated tools
  - Creates histograms of features that it finds, as features that are more common tend to be more important
Tool Description: Bulk Extractor

Extracts the following information (and provides histograms for some):

* Credit card number → histogram
* Domains → histogram
* Email addresses → histogram
* Ethernet MAC addresses → histogram
* EXIF data
* IP addresses → histogram
* Email message headers
* Telephone numbers → histogram
* TCP flow information
* URL searches (includes ability to pull out facebook id #s)
* Contents of zip files
* Creates a wordlist from media (useful for password cracking)
* JSON data
Bulk Extractor – Email Histogram no Whitelist – Top 20 in Histogram

* n=264 premium-server@thawte.com  (utf16=2)
* n=160 ance@certification.tn
* n=136 info@diginotar.nl
* n=128 certificate@trustcenter.de
* n=127 info@valicert.com
* n=117 testpilot@labs.mozilla.com
* n=99  dexamorgon23234@hotmail.com  (utf16=82)
* n=80  info@a-cert.at
* n=80  info@globaltrust.info
* n=76  user@domain.com   (utf16=12)
* n=70  rik@webkit.org
* n=62  defaultuser@defaultdomain.de   (utf16=62)
* n=56  user@contoso.com
* n=53  info@izenpe.com
* n=52  cps@netlock.net
* n=51  ellenorzes@netlock.net
* n=48  a-cert@argedaten.at
* n=48  ancert@ancert.com
* n=48  gold-certs@saunalahti.fi
* n=48  info@d-trust.net
Bulk Extractor – Email Histogram with Whitelist – Top 20 in Histogram

* n=117  testpilot@labs.mozilla.com
* n=99  dexiong023234@hotmail.com  (utf16=82)
* n=70  rik@webkit.org
* n=32  psirt@adobe.com
* n=32  secure@macromedia.com
* n=30  background@2x.pn  (utf16=30)
* n=30  buttons@2x.pn  (utf16=30)
* n=26  checkbox@2x.pn  (utf16=26)
* n=26  facebook@2x.pn  (utf16=26)
* n=26  fb@2x.pn  (utf16=26)
* n=26  loader@2x.pn  (utf16=26)
* n=26  messagebottom@2x.pn  (utf16=26)
* n=26  messagebottomshort@2x.pn  (utf16=26)
* n=26  messagetop@2x.pn  (utf16=26)
* n=26  msaccount@2x.pn  (utf16=26)
* n=26  skype@2x.pn  (utf16=26)
* n=25  icons@2x.pn(utf16=25)
* n=25  inputfields@2x.pn  (utf16=25)
* n=25  johndorian322@gmail.com  (utf16=4)
* n=25  msdefaultpicture@2x.pn  (utf16=25)
MantaRay is a triage tool

- We want to get a quick look at all the data on the drive of interest
- What is “Of Interest”? -> User interaction with the system
  - One gold mine for this type of information is the Windows Registry
- MantaRay extracts ALL registry hives from a system
  - OVERT
  - DELETED
  - UNALLOCATED
  - RESTORE POINTS
  - SHADOW VOLUMES
Extracted Registry Hives

How many Overt Registry Hives do we typically run regripper against:
- NTUSER.dat for each profile
- SYSTEM hive
- SOFTWARE hive
- SECURITY hive
- SAM hive
- USRCLASS for each profile

What are we not seeing:
- Deleted registry hives
- Hives in Unallocated
- Hives in Shadow Volumes (Vista/Win7)
- Hives in Restore Points (XP Systems)
Extracted Registry Hives

- NTUSER & USRCLASS hives are named with their Windows profile names in the filename
  - For Overt, Deleted, Shadow Volumes & Unallocated
  - Allows for quick triage of users that had accounts on the system
- Time/date stamps for the hives are set to the last accessed time, so that the regripper output can be organized by time
  - The last access time of a registry hive is contained in the hives header
Making sense of scripts output:

- 49-128-1_Partition_105906176_OVERT_John Dorian_NTUSER.DAT
  - 49-128-1 -> Inode number of the file in the filesystem
  - 49 is the File Identifier in Encase. This number can be duplicated between partitions, so make sure you only green homeplate the partition beginning at the offset specified

- Partition_105906176 -> offset of the partition this file was located in

- OVERT -> this hive was an OVERT file

- John Dorian -> Windows Profile Name

- NTUSER.DAT -> type of hive
Finding Inode number in Encase
Extract Registry Hive Output

* Making sense of script output
  * 49-128-1_Partition_0_SHADOW_VOLUME_vss1_OVERT_JohnDorian_NTUSER.DAT
    * 49-128-1 -> Inode number of the file in the filesystem
    * Partition_0 -> offset of partition file was located in (since this file was extracted from a shadow volume, the Partition offset is showing that the shadow volume was mounted with an offset of 0 bytes)
    * SHADOW_VOLUME -> this file was located in a Shadow Volume
    * Vss1 -> shadow volume number the file was found in
    * OVERT -> this hive was an OVERT file within Shadow Volume
    * John Dorian -> Windows Profile Name
    * NTUSER.DAT -> type of hive
Extract Registry Hive Output

* Making sense of scripts output:
  * **Partition_105906176_Unallocated_28119360.dat_systemprofile_NTUSER.DAT**
    * **Partition_105906176** -> offset of the partition this file was located in
    * **Unallocated** -> this hive was carved from unallocated using foremost
    * **28119360.dat** -> this is the filename from foremost (cluster offset)
    * **systemprofile** -> Windows Profile Name
    * **NTUSER.DAT** -> type of hive
Finding files carved by Foremost

If you need to find a file carved with Foremost using another forensic tool, follow these steps:

* Use fsstat to calculate the cluster size for your disk image (items in red are variables that will vary depending on the specifics of each disk image)

  * Fsstat –f <partition filesystem> -i <image type> -b <block size> -o <partition offset> <disk image> | grep ‘Cluster Size:’ | awk ‘{print $3}’ | sed s/-bytes//
  * Fsstat –f ntfs –i raw –b 512 –o 206848 /mnt/test/ewf1 | grep ‘Cluster Size:’ | awk ‘{print $3}’ | sed s/-bytes//
  * Results in cluster size of 4096
Finding files carved by Foremost

* Run blkcalc:
  * The cluster offset of your file is calculated as follows: foremost_file_offset/block_size (14399160320/4096=351420)
  * The foremost file offset is located in the audit.dat text file in the Extracted Registry Hives folder
  * Blkcalc –u <cluster offset of file> -f <file system> -l <type of image> -b <block size> -o <offset of partition> <path to image file>
  * Blkcalc –u 3515420 –f ntfs –l raw –b 512 –o 206848 /mnt/test/ewf1
  * Results in Cluster offset of 8396596

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Finding files carved by Foremost
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EXIF Information

- Uses ExifTool
  - Written by Phil Harvey
  - [http://www.sno.phy.queensu.ca/~phil/exiftool/](http://www.sno.phy.queensu.ca/~phil/exiftool/)
- Extracts metadata from every filetype Exiftool supports
  - Output written to single text file. Useful for keyword searching.
  - I have worked multiple cases where ExifTool extracted more EXIF information than various commercial tools
Carving Unallocated

• Uses foremost
  * http://foremost.sourceforge.net/

• Written by Jesse Kornblum, Kris Kendall
  * Modified by Nick Mikus

• Can carve for pre-defined signatures:
  * Jpg, gif, bmp, avi, exe, mpg, wav, mov, pdf, ole, doc, zip, rar, htm, wmv, png, mp4
  * Or use signatures in configuration file
Carving Unallocated

- Carves unallocated space from each partition
  - Uses signatures selected by user
- Writes output to individual folders based on partition where data was found
  - Audit file contains offset where file was carved from and confirmation that carve completed successfully.
    - 88 FILES EXTRACTED
    - dat:= 88

- Duplicate carved files are removed (md5 matches)
  - “Work smart not hard” – we all hate slogging through thousands of carved files
Entropy Calculation

- Quick way to look for encrypted files is to sort by entropy.
- Entropy levels over 7.95 out of 8.0 indicate possible encryption
  - Large files with high entropy could be encrypted volumes
  - Although lots of normal files have high entropy
    - JPEGs
    - Compressed files
    - MSI

<table>
<thead>
<tr>
<th>Entropy</th>
<th>File Name</th>
<th>File Size</th>
<th>File Path</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.96747</td>
<td>img23.jpg</td>
<td>1458275</td>
<td>/mnt/2013-07-21_15_30_12_089168/WIndows/Web/Wallpaper/Characters/img23.jpg</td>
</tr>
<tr>
<td>7.967119</td>
<td>Skype.msi</td>
<td>21532672</td>
<td>/mnt/2013-07-21_15_30_12_089168/ProgramData/Skype/(4E76FF7E-AEBA-4C87-B788-CD47E5425B9D)/Skype.msi</td>
</tr>
<tr>
<td>7.967119</td>
<td>9e801.msi</td>
<td>21532672</td>
<td>/mnt/2013-07-21_15_30_12_089168/Windows/Installer/9e801.msi</td>
</tr>
</tbody>
</table>
Volatility

- Open source tool for artifact extraction from memory images
- [https://www.volatilesystems.com/default/volatility/](https://www.volatilesystems.com/default/volatility/)
- Can be run against RAM images or decompressed hiberfil.sys
- Methods of decompressing hiberfil.sys
  - Blade v1.9
  - X-Ways Forensics
  - Moonsols
  - Volatility
    - Use `imagecopy` command to convert hiberfil.sys into DD image
Volatility

MantaRay volatility script

* Wait for script to provide “Suggested Profiles” choices
* Paste choice into text box
* Review output

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Create .KML file from GPS data in JPEGs

- Some .JPEG images contain GPS coordinates
  - Found in EXIF data
  - These coordinates can be extracted and with some massaging can be turned into a .kml file
  - .kml are Google Earth files
Viewing .KML file with Google Earth
Extract Jumplist Data

* MantaRay automates the process of running Harlan Carvey’s jumplist parser script (jl.pl) against all jumplist files found on a disk image
* Output is provided in various formats
  * TLN
  * MacTime
  * Harlan’s default output format
Extract NTFS Artifacts

- Mantaray will automatically extract the following files for each partition:
  - $MFT
  - $LOGFILE
  - $USRJRNЛ

- These scripts are required if you want to run David Cowen’s Advanced NTFS Journal Parser
  - [http://www.youtube.com/watch?v=obo5Qeb9rHA](http://www.youtube.com/watch?v=obo5Qeb9rHA)
MantaRay Workflow

- Workflow is cyclical
- Run MantaRay against target media
- Then you can re-run various tools via MantaRay against the MantaRay output:
  - Ex -> run MantaRay against disk image and Extract Registry Hives
    - Then if there is a specific user you are interested in you can copy those hives into a folder and run bulk_extractor (via MantaRay) against the folder to get a good idea of what that particular user was doing
  - You can also create a supertimeline from the extracted registry hives and then merge that timeline into the supertimeline for your entire drive
- Pull MantaRay output into Encase as single files and then run your keywords against all the output
**SIFT 3**

- Will be available for download in October from sans.org
  - [http://computer-forensics.sans.org/community/downloads](http://computer-forensics.sans.org/community/downloads)
- MantaRay will be bundled into SIFT 3.0
- Updates to MantaRay will be available at [www.mantarayforensics.com](http://www.mantarayforensics.com)
- Known issues with SIFT3_beta:
  - Does not mount HFS+ partitions within disk images
  - This is a bug with the Virtual kernel in Ubuntu 12.04
  - Will be fixed by October
sudo password is “forensics”
## Enter Case Information

![MantaRay Interface](image)

<table>
<thead>
<tr>
<th>Field</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Number</td>
<td>2013-1234</td>
</tr>
<tr>
<td>Evidence Number</td>
<td>001</td>
</tr>
<tr>
<td>Examiner Name</td>
<td>doug</td>
</tr>
<tr>
<td>Notes</td>
<td>Really Hard Case</td>
</tr>
</tbody>
</table>

- **OK** button
- **Cancel** button
Select Evidence Type

<table>
<thead>
<tr>
<th>Selection</th>
<th>Evidence Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bit-Stream Image</td>
<td>.dd, .img, .001, .E01</td>
</tr>
<tr>
<td></td>
<td>Directory</td>
<td>Logical Directory</td>
</tr>
<tr>
<td></td>
<td>EnCase Logical Evidence File</td>
<td>.L01</td>
</tr>
<tr>
<td></td>
<td>Memory Image</td>
<td>Forensic Image of RAM</td>
</tr>
<tr>
<td></td>
<td>Single File</td>
<td>Individual File</td>
</tr>
</tbody>
</table>
Select Output Directory
Select tools to run

<table>
<thead>
<tr>
<th>Selection</th>
<th>Processing Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️</td>
<td>BulkExtractor</td>
<td>Scans for a large number of pre-defined regular expressions</td>
</tr>
<tr>
<td>✔️</td>
<td>Calculate Entropy</td>
<td>Pseudorandom number sequence test (ENT)</td>
</tr>
<tr>
<td>✔️</td>
<td>Create KML from JPG EXIF Data</td>
<td>Create Google Earth .kml file from EXIF data found in JPG images</td>
</tr>
<tr>
<td>✔️</td>
<td>Foremost</td>
<td>Recover files from a disk image based on headers and footers (Unallocated Space)</td>
</tr>
<tr>
<td>✔️</td>
<td>Jumplist Parser</td>
<td>Windows Vista/7 Jumplist Exploitation</td>
</tr>
<tr>
<td>✔️</td>
<td>NTFS Artifact Extractor</td>
<td>SMFT/$LogFile/((SUSNJRN</td>
</tr>
<tr>
<td>✔️</td>
<td>Registry Hive Extractor/Regripper</td>
<td>Extract Registry from overt, deleted, unallocated, shadow volumes, restore-points &amp; process with RegRipper</td>
</tr>
<tr>
<td>✔️</td>
<td>Super Timeline</td>
<td>Parse various log files and artifacts for timeline analysis</td>
</tr>
<tr>
<td>✔️</td>
<td>EXIF Tool</td>
<td>Read meta information in files</td>
</tr>
</tbody>
</table>

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Select Evidence to Process
Select Debug Mode Setting

- **OFF**: Default mode, no verbose error logging
- **ON**: Debugging mode, verbose error logging. All processes will stop at first error
Debug Mode

* GUI Option (Default OFF)
* When set to ON the program will exit when it hits an error and print error to screen.
  * If you need to run with Debug Mode ON then run from command line (otherwise terminal will close after error)
* `sudo python3 /usr/local/src/Manta_Ray/Tools/Python/Manta_Ray_Master_GUI.py`
Select Bulk Extractor Options

<table>
<thead>
<tr>
<th>Selection</th>
<th>Processing Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Keyword List</td>
<td>Search for case specific keyword list</td>
</tr>
<tr>
<td></td>
<td>Whitelist</td>
<td>Remove known features (artifacts) from process output</td>
</tr>
</tbody>
</table>
## Select Bulk Extractor Speed

<table>
<thead>
<tr>
<th>Selection</th>
<th>Processor Performance</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Speed-Slow</td>
<td>Minimum Processing Cores</td>
</tr>
<tr>
<td>✔️</td>
<td>Speed-Med</td>
<td>Medium Processing Cores (Recommended)</td>
</tr>
<tr>
<td></td>
<td>Speed-Fast</td>
<td>Maximum Processing Cores (Warning - Processor Intensive)</td>
</tr>
</tbody>
</table>
## Select Foremost signatures

<table>
<thead>
<tr>
<th>Selection</th>
<th>Processing Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Default File Signatures</td>
<td>jpg, gif, png, bmp, avi, exe, mpg, wav, riff, wmv, mov, pdf, ole, doc, zip, rar, htm, cpp</td>
<td></td>
</tr>
<tr>
<td>Configuration File</td>
<td>Use configuration file - (/usr/local/src/Manta_Ray/foremost.conf)</td>
<td></td>
</tr>
</tbody>
</table>
## Select Registry Hives to Extract

<table>
<thead>
<tr>
<th>Selection</th>
<th>Processing Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>Overt, Deleted, Restore-Points</td>
<td>Overt/Deleted/Restore-Points (WinXP) Registry Hives</td>
</tr>
<tr>
<td>☐</td>
<td>Unallocated</td>
<td>Unallocated Registry Hives (regf Header - 50MB Length)</td>
</tr>
<tr>
<td>☐</td>
<td>Shadow Volumes</td>
<td>Shadow Volume Registry Hives (Windows Vista/7)</td>
</tr>
</tbody>
</table>
Set time zone manually?

Non-english unicode timezones must be set manually. If there is a chance the case has non-english timezones, verify timezone using other methods and set this option manually. A future release of MantaRay will provide automatic verification of all timezones prior to this selection option. Do you want to set the SuperTimeline timezone manually?
Manual time zone selection

![Timezone Selection](image.png)
Processing Begins

---

Terminal Output:

```
Timezone Option: UTC
BulkExtractor
This VM has 4 cores
Item to process is: Bit-Stream Image
Case number is: 2013-1234-001-MantaRay_2013-08-06_11_06_13_586314
Output folder is: /mnt/hgfs/STORAGE/MantaRay/2013-1234-001-MantaRay_2013-08-06_11_06_13_586314
Evidence type is: "/mnt/hgfs/STORAGE/Test Images/xp dblake.dd"
Whitelist location is: NONE
Processing speed is: Speed-Med
Keyword list is: NONE
The be command is: bulk_extractor -o "/mnt/hgfs/STORAGE/MantaRay/2013-1234-001-MantaRay_2013-08-06_11_06_13_586314/Test Images/xp dblake.dd"
bulk_extractor version: 1.4.0-beta4
Hostname: ubuntu
Input file: /mnt/hgfs/STORAGE/Test Images/xp dblake.dd
Output directory: /mnt/hgfs/STORAGE/MantaRay/2013-1234-001-MantaRay_2013-08-06_11_06_13_586314/Bulk_Extractor_Results
Disk Size: 1261822464
Threads: 2
11:20:22 Offset 67MB (5.32%) Done in 0:02:51 at 11:23:13
11:20:32 Offset 150MB (11.97%) Done in 0:02:25 at 11:22:57```

---
Evidence Type: Directory

![Evidence Type Selection](image)

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Tool Options: Directory

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<td>Create KML from JPG EXIF Data</td>
<td>Create Google Earth .kml file from EXIF data found in JPG Images</td>
</tr>
<tr>
<td></td>
<td>Delete Duplicate Files</td>
<td>Delete duplicate files from the selected directory (Recursive)</td>
</tr>
<tr>
<td></td>
<td>EXIF Tool</td>
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Evidence Type: Logical Evidence File

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## Tool Options: Logical Evidence File

### Processing Tool Selection

<table>
<thead>
<tr>
<th>Selection</th>
<th>Processing Tool</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BulkExtractor</td>
<td>Scans for a large number of pre-defined regular expressions.</td>
</tr>
<tr>
<td></td>
<td>Calculate Entropy</td>
<td>Pseudorandom number sequence test (ENT)</td>
</tr>
<tr>
<td></td>
<td>Create KML from JPG EXIF Data</td>
<td>Create Google Earth .kml file from EXIF data found in JPG images</td>
</tr>
<tr>
<td></td>
<td>Super Timeline</td>
<td>Parse various log files and artifacts for timeline analysis</td>
</tr>
</tbody>
</table>
Evidence Type: Memory Image
Tool Options: Memory Image

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<tr>
<td></td>
<td>Volatility</td>
<td>Extraction of digital artifacts from volatile memory - Requires user input - best run alone</td>
</tr>
</tbody>
</table>
# Evidence Type: Single File

<table>
<thead>
<tr>
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<th>Evidence Type</th>
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</tr>
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<tbody>
<tr>
<td></td>
<td>Bit-Stream Image</td>
<td>.dd, .img, .001, .E01</td>
</tr>
<tr>
<td></td>
<td>Directory</td>
<td>Logical Directory</td>
</tr>
<tr>
<td></td>
<td>EnCase Logical Evidence File</td>
<td>.L01</td>
</tr>
<tr>
<td></td>
<td>Memory Image</td>
<td>Forensic Image of RAM</td>
</tr>
<tr>
<td></td>
<td>Single File</td>
<td>Individual File</td>
</tr>
</tbody>
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![MantaRay - ManTech Triage & Analysis System](image-url)
Tool Options: Single File

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Review Output
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