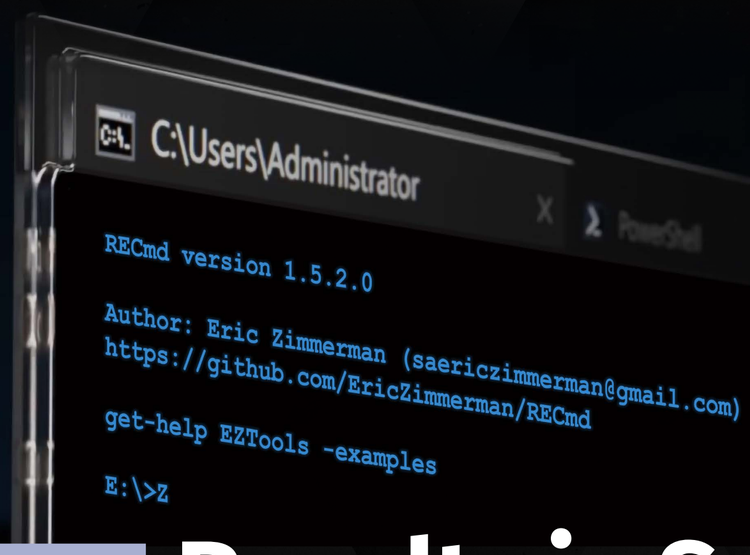


SANS DFIR
DIGITAL FORENSICS & INCIDENT RESPONSE

Results in Seconds at the Command Line

Eric Zimmerman's TOOLS

sans.org/eztools

DFPS_Command-Line_v1.3_09-21

DIGITAL FORENSICS & INCIDENT RESPONSE

Operating System & Device In-Depth

FOR308 Digital Forensics Essentials

FOR498 Battlefield Forensics & Data Acquisition
GBFA

FOR500 Windows Forensic Analysis
GCFE

FOR518 Mac and iOS Forensic Analysis and Incident Response

FOR585 Smartphone Forensic Analysis In-Depth
GASF

Incident Response & Threat Hunting

FOR508 Advanced Incident Response, Threat Hunting, and Digital Forensics
GCFA

FOR572 Advanced Network Forensics: Threat Hunting, Analysis, and Incident Response
GNFA

FOR578 Cyber Threat Intelligence
GCTI

FOR610 Reverse-Engineering Malware: Malware Analysis Tools and Techniques
GREM

SEC504 Hacker Tools, Techniques, Exploits, and Incident Handling
GCIH

digital-forensics.sans.org

Forensics the EZ Way:

With the wealth of data stored on Windows computers it is often difficult to know where to start. If you encounter a sizable hard drive, it could be hours or even days before you're ready to start your investigation, never mind reporting the results. Using the EZ tools provides scriptable, scalable, and repeatable results with astonishing speed and accuracy. Go from one investigation a week to several per day. This type of performance is common with the command line versions of EZ Tools. This poster will show you how.

Common CLI Options & Switches

Short options (single letter) are prefixed with a single dash.

Long options are prefixed with two dashes.

Options	Definition
-d	Dir to process
-f	File to process
-q	Quiet mode
--dt	Custom date/Time format
--mp	Higher precision timestamps are displayed and will also be reflected in any exported data
--csv --json --html	Data can be exported to several formats. You can request multiple formats at the same time.
--debug	Shows debug info during tool execution (more info)
--trace	Shows trace info during tool execution (most info) can be run with debug (--debug --trace)
--sync	Sync updates from GitHub for KAPE targets & module updates. For evtxecmd map updates
-vss	Process Volume Shadow Copies – Supported in EvtxECmd, MFTECmd, PECmd,and RECmd

AppCompatCacheParser – Shimcache Parser

Type of Artifact

Application Compatibility Cache allows for older applications to be run on newer versions of Windows. When an executable is found, Windows determines how best to run the program and stores that data. AppCompatCache can be used to determine what was run.

Basic Usage

AppCompatCacheParser, use the -f switch and point that to the SYSTEM registry hive.

In the example command below, AppCompatCacheParser is run against a SYSTEM hive. Output is stored on the G: drive to the "AppCompatCache" folder. The AppCompatCacheParser application creates an output file.

```
AppCompatCacheParser.exe -f E:\Windows\System32\config\SYSTEM
--csv G:\AppCompatCache
```

Key Data Returned

The columns of most significance are typically the "Path" (the location and name of the executable), "LastModifiedTimeUTC" (the last written time of the executable) and "Executed" (whether the executable was run). The most common mistake made by forensicators is that they'll assume that the LastModifiedTimeUTC value refers to the execution of the file. Don't fall into this trap!

Advanced Usage

PRO TIP: Watch for changes at the start of the "Path". Anything that shows "SYSVOL" ran from the host's OS volume. Other volumes will be recorded by their drive letter.

Path	Last Modified Time UTC	Executed
SYSVOL\Windows\System32\notepad.exe	8/22/2019 11:00:12	Yes
E:\TACTICAL Subject\f-response-tacsub.exe	8/12/2019 19:21:00	Yes

PRO TIP: As a file's last written time does not change when a file is moved, renamed or copied, it may be possible to track the same executable across a single or even multiple systems, as a new entry will be created in the AppCompatCache when the file is executed from a different location or with a different name. The table below shows the same executable being run in different scenarios. We know they are all the same executable because they share the same last written time.

Path	Last Modified Time UTC	Executed
SYSVOL\Windows\System32\spinlock.exe	10/23/2019 14:27:18	Yes
SYSVOL\Users\SRogers\AppData\Local\Temp\spinlock.exe	10/23/2019 14:27:18	Yes
SYSVOL\Windows\prune.exe	10/23/2019 14:27:18	Yes

RBCmd – Recycle Bin Artifact Parser

Type of Artifact

When a user deletes a file, it is sent to the Recycle Bin. During that process, it is renamed. For example, if cat.jpg was deleted, the deleted file would have a name such as $R7YQ28P.jpg. The $R prefix means that it contains the content (Resource) of the original file. In addition to the $R file, a new corresponding $I (Information) file is created in the Recycle Bin. The $I file contains the information about the original location of the file and the date and time of deletion. RBCmd takes this data and presents it in a human-readable format.

Basic Usage

In this example, RBCmd is being run against a single $I (information) file on a mounted drive (E:). The output is displayed in the window where the command was run.

```
RBCmd.exe -f E:\$Recycle.Bin\S-1-5-21-718126207-1171771683-
1750804747-1001\$I7YQ28P.jpg
```

```
Source file: .\$IG1VEXX.xls

Version: 1 (Pre-Windows 10)
File size: 16384 (16KB)
File name: C:\Users\Donald\SkyDrive\Documents\WACC Calc Spreadsheet -SECRET.xls
Deleted on: 2013-10-21 18:32:52.5320000
```

In the next example, RBCmd is being run against the parent folder of the $I file above, thereby parsing all of the $I files. This time, the output is stored in a CSV stored in G:\RBFiles with the date and time in the file name. Use of the -q switch prevents all of the output from being sent to the window, making processing faster.

```
RBCmd.exe -d F:\$Recycle.Bin\S-1-5-21-718126207-1171771683-
1750804747-1001 --csv G:\RBFiles -q
```

Key Data Returned

Processed Recycle Bin data is either output to the screen (if no output file is specified). The screenshot below shows an example of the output when run against a single file. The source file is shown, as is the file size, original file name and location and date of deletion.

Source Name	Deleted On	File Name	File Size
$IG1VEXX.xls	2013-10-21 18:32:52.5320000	C:\Users\Donald\SkyDrive\Documents\WACC Calc Spreadsheet -SECRET.xls	16384
$ISFHPA9.xls	2013-10-21 18:32:52.5550000	C:\Users\Donald\SkyDrive\Documents\WACC Calc Spreadsheet -SECRET-Bifrost.xls	16384

Advanced Usage

PRO TIP: Running RBCmd on a mounted drive will work, but remember that when doing so, Windows does not see deleted files, so RBCmd won't pick them up. It is often worth extracting deleted $I files using another tool and then running RBCmd over those recovered files.

bstrings – Extract Text From Binary Files

Type of Artifact

Bstrings can be used to search any type of file for potentially valuable information.

Basic Usage

```
bstrings.exe -f <file>
```

Option/Switch	Use	Example
--ls	Search for string	bstrings -f suspect.exe --ls password
--lr	Search with regular expression	bstrings -f suspect.exe --ls (ntos|win32k)
--p	List builtin regular expressions	bstrings -p
--lr XX	The XX represents a builtin regex	bstrings -f suspect.exe --lr ipv4
--fr	Read file containing regex's to use in search	bstrings -f suspect.exe -fr DFIR_RegExs.txt
-h	List all options	bstrings -h
--cp	Use a different ANSI code page	bstrings -f Powershell.evtx --ls download --cp 1201

note: Windows Event Log require the 1201 specific code page for bstrings to find the search string

A full listing of available code pages is available at **https://goo.gl/ig6DxW**

Interesting options and switches:

```
bstrings.exe -f <file> --ls "password"
```

Use the -x and -m switches to set maximum and minimum string lengths.

Use --off to show the offset for each search hit.

Advanced Usage

--lr Regular Expression searches bstrings and also contains over a dozen built-in regular expression patterns for things like credit card numbers, social security numbers, IP addresses, email addresses, and more.

-p shows a list of built-in regular expressions. When using a built-in expression, use the value in the Name column. For example, to look for email addresses, use this command:

```
bstrings.exe -f <some file> --lr email
```

bstrings also allows searching for several strings or regular expressions at once using the --fr and --fs switches.

In addition to Unicode strings, bstrings looks for strings encoded using Western (1252) code page. Use the --cp switch to search in any other code page supported by .net.

SRUMECmd – SRUM Parser

Type of Artifact

SRUM (System Resource Usage Manager) records application usage, network usage, power usage, etc. Investigation of this artifact can assist in determining what applications were used, while also providing context into the network connection (including names of wireless networks) that was in use at the time. SRUM can also determine how much data was uploaded and downloaded by the application and even whether a laptop was connected to power or running on battery at the time.

Basic Usage

SRUMECmd takes a SRUDB.dat database and the SOFTWARE registry hive as input. However, the SRUDB.dat file must first be repaired by copying the contents of the Windows\System32\sru and running the following two commands in the folder containing the copied files:

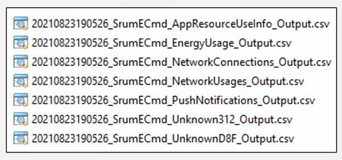
```
esentutl.exe /r sru /i /o
esentutl.exe /p SRUDB.dat /o
```

Once the repair is complete, SRUMECmd can be run. In the example below SRUMECmd is being run against our newly repaired SRUDB.dat file. The -r (registry) switch points to the SOFTWARE registry hive on a mounted evidence file (E:). The results are output to another folder.

```
SRUMECmd.exe -f G:\sru_fixed\SRUDB.dat -r E:\Windows\System32\
config\SOFTWARE --csv G:\SRUM_output
```

Key Data Returned

Several CSV files will be output from running the command. Each CSV represents a different aspect of SRUM, including application resource usage, energy usage, network usage, network connections, etc. Each table is named and formatted according to the data contained therein. Note that the results are provided in time segments of 30 to 60 minutes.



Advanced Usage

PRO TIP: As SRUM is recorded in 30-to-60-minute segments, the data can be opened in Excel and a graph plotted to show specific bandwidth and/or application usage over time. The graph output can then be used in reports to provide a clear visual of activity.

JLECmd – JumpList Explorer Command Line Edition

Type of Artifact

Jumplists store critical information about files and folders that have been used in Windows. Among other things, Jumplists contain information about the application used to open target files and folders and store metadata specific to them. Those metadata contain details such as file name and location, dates and times, etc. JLECmd makes parsing this data simple and quick.

Basic Usage

JLECmd takes either a single Jumplist file or a directory of Jumplists as input. If parsing a single Jumplist, use the -f option. If parsing a directory of Jumplists, use the -d option. It is also suggested that the -q switch be used to avoid dumping all results to the screen (which can dramatically slow down JLECmd's execution time).

In the example command below, JLECmd is being run against a single Jumplist. Output is stored on the G: drive to the "Jumplists" folder.

```
JLECmd.exe -f E:\Users\Donald\AppData\Microsoft\
Windows\Recent\AutomaticDestinations\ff103e2cc310d0d.
automaticDestinations-ms --csv G:\Jumplists -q
```

In the example command below, JLECmd is being run against all automatic jumplist files stored for the user "Donald".

```
JLECmd.exe -d E:\Users\Donald\AppData\Microsoft\Windows\
Recent\AutomaticDestinations --csv G:\Jumplists -q
```

A mapping of app_ids to app name can be found at **https://for500.com/appid.**

Key Data Returned

The JLECmd output contains two important categories of data, evidence of execution and evidence of file knowledge. The table below shows some of the more significant columns to include in your review.

Column Name	Forensic Value
AppIdDescription	Human readable name for AppID
DestListVersion	Used with MRU to detemine most recentely opened file in the Jump List
MRU	Used with DestListVersion to detemine most recentely opened file in the Jump List
Path	Location and name of file opened
TargetCreated	Creation Timestamp of file referenced in JL
TargetModified	Modification Timestamp of file referenced in JL

Advanced Usage

PRO TIP: Watch for changes in the "DriveType", "VolumeSerialNumber" and "VolumeLabel" columns as the data in these columns can indicate whether files have been opened from external devices. In the example below, the change in these columns shows that a file was opened from the USB device named "FILES".

Additionally, the local path may show the same drive letter for multiple removable devices (e.g., F:\) but you should also review the volume serial number and the volume label to determine if the drive letter is associated with the same or different devices.

Target Modified	Drive Type	Volume Serial Number	Volume Label	Local Path
9/1/2018 16:53	Fixed storage media (Hard drive)	7E58AAB0	Windows10_OS	C:\Users\srogers\Documents\NETFLIX SEC Filings\SEC-NFLX-1193125-12-53009.pdf
9/27/2018 17:42	Fixed storage media (Hard drive)	7E58AAB0	Windows10_OS	C:\Users\srogers\Documents\Netflix 3Q13 Conference Call Announcement 09 30 13.pdf
9/3/2018 14:13	Removable storage media (Floppy, USB)	B0A9FE90	FILES	F:\Forms\fy08-form-10k.pdf
9/1/2018 16:43	Fixed storage media (Hard drive)	7E58AAB0	Windows10_OS	C:\Users\srogers\Documents\NETFLIX SEC Filings\SEC-NFLX-1065280-13-8.pdf

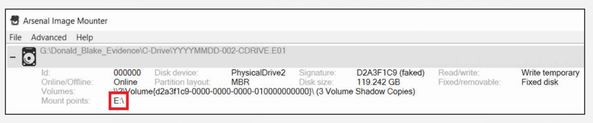
VSCMount – Volume Shadow Copy Mounter

Type of Artifact

Volume Shadow Copies are created periodically to capture the previous state of a system. This means that deleted and wiped files, or even older versions of a file or folder, can be recovered from volume shadow copies. VSCMount allows an investigator to mount each volume shadow copy.

Basic Usage

Before running the VSCMount tool, an evidence file must itself be mounted as a physical drive. Once mounted, note the drive letter. In the example below it is drive letter E.



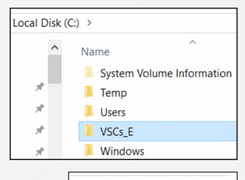
Open an Administrator PowerShell window and run VSCMount. In the example command below, the "--dl" switch stands for "drive letter". This is the drive letter from the evidence file mounted above. The "--mp" switch stands for "map point". In this example, the drive letter is "E". This is the location where VSCMount will create the links to all of the volume shadow copies found on the mounted evidence. In this instance, the volume shadow copies will be mapped to "C:\VSCs".

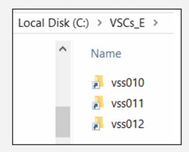
```
.\VSCMount.exe --dl E --mp C:\VSCs
```

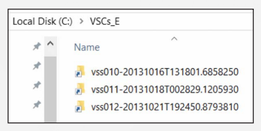
Key Data Returned

When run, VSCMount maps each shadow copy to a separate folder. From the example command given above, VSCMount found and mapped three volume shadow copies.

Inside the map point, there are three mapped volume shadow copies from the mounted E drive. Each of these can be expanded and viewed as needed.







Advanced Usage

PRO TIP: Looking at the mapped Volume Shadow Copies, it isn't immediately clear as to when they were created. Adding the "--ud" switch to the command adds the creation date of each mapped Volume Shadow Copy, as shown in the example below:

```
.\VSCMount.exe --dl E --mp C:\VSCs --ud
```

SQLECmd – SQLite Parser

Type of Artifact

SQLite databases are used to store data for many applications. On a Windows computer, the most common use of SQLite is web browser data such as history, cloud storage, chat applications, phone backups, etc.

As each SQLite database is different, SQLECmd makes use of custom maps. These maps are created to parse specific items. For example, when parsing the Google Chrome History database, SQLECmd recognizes the database schema (layout) for application and uses the relevant map file to interpret the data specific to Google Chrome.

Basic Usage

To parse a single SQLite database, point SQLECmd at a single database file using the -f switch.

```
SQLECmd.exe -f G:\databases\database.db --csv G:\SQLECmd_output
```

To parse a folder of SQLite databases, point SQLECmd at the folder and use the -d switch.

```
SQLECmd.exe -d G:\databases\ --csv G:\SQLECmd_output
```

Key Data Returned

Depending on the database being analyzed, several CSV files may be output. In the example of Google Chrome, pointing SQLECmd to the history database will result in history, downloads, and keyword search files, each containing their respective results.

Advanced Usage

PRO TIP: SQLECmd only parses a database if a map file exists for that schema. Due to the large number of SQLite-based applications, it is impossible to have maps for every eventuality. However, creating a custom map file is as simple as generating a SQL query and adding it to SQLECmd folder.

SumECmd – User Access Log Parser

Type of Artifact

User Access Logs are found in Windows Server operating systems. These logs records user requests related to a server. For example, if a user connects to a server, the username and client IP address are recorded with associated date and time. This can help track a user's lateral movement through the environment.

Basic Usage

SumECmd takes the contents of the C:\Windows\System32\LogFiles\SUM folder as input. However, the databases stored in this folder must first be repaired by copying the contents of the folder and running the following commands on the copied files:

```
esentutl.exe /r svc /i /o
esentutl.exe /p Current.mdb
esentutl.exe /p SystemIdentity.mdb
esentutl.exe /p <GUID>.mdb
```

Note that <GUID>.mdb is not actually named this way, the GUID will be different on every server. Once the repair is complete, SumECmd can be run. In the example below SumECmd is being run against the repaired files in the copied folder.

```
SumECmd.exe -d G:\sum_fixed\ --csv G:\sum_output
```

Key Data Returned

A series of files is output from running the command. Perhaps the most significant of the files is named ClientDetail. In this file we are provided with dates and times of when the activity occurred and Role Description (used to identify the service being accessed). In addition, the domain, username, and IP address of the incoming access is also recorded.

Advanced Usage

PRO TIP: Looking for domains, users and IP addresses that are not part of the organization will help to detect anomalous behavior and gives clues about the attacker.

PECmd – Prefetch Parser

Type of Artifact

Prefetch provides evidence of execution. Prefetch files are created or updated in the `C:\Windows\Prefetch` folder when a program attempts to run. Prefetch files are not automatically deleted if the related program is deleted and therefore can be a source of historical information.

Prefetch is limited to 128 files, meaning that older files may be overwritten when that limit is reached. The creation time of a prefetch file is typically done so 10 seconds after first run.

Basic Usage

Process a single Prefetch files and send results to screen

```
PECmd.exe -f C:\Windows\Prefetch\CMD.EXE-8E75B5BB.pf
```

Process a directory of Prefetch files and send results to a CSV file named prefetch.csv. The `--csvf` allows you to provide the name of the prefetch output csv.

```
PECmd.exe -d C:\Windows\Prefetch\ -q --csv G:\Prefetch --csvf
prefetch.csv
```

Process a directory of Prefetch files, including VSS, and send the results to a CSV file named prefetch.csv and higher precision timestamps

```
PECmd.exe -d C:\Windows\Prefetch\ -q --csv G:\Prefetch --csvf
prefetch.csv --vss --mp
```

Key Data Returned

`PECmd`, in csv mode, will output two CSV files, one of which is a timeline. The Timeline csv will have "_Timeline" in the file name. The main Prefetch ouptut file will contain important information such as:

- Executable name and full path from which it was executed
- Volume name and serial number from which the program ran
- Run Count – the number of time that the program was run, from that location
- Timestamps (UTC) for the last eight executions
- Volumes, files and directories accessed during execution.

Advanced Usage

KEYWORDS: Using comma-separated list of keywords will cause any hits to be shown in red.

```
PECmd.exe -d C:\Windows\Prefetch\ -q --csv G:\Prefetch --csvf
prefetch.csv -k "system32, downloads, fonts"
```

PRO TIP: `PECmd` can extract and process Prefetch files from Volume Shadow Copies by using the "`--vss`" option. This will process Prefetch from ALL Volume Shadow Copies. The output files will be separated by individual VSS numbers.

```
PECmd.exe -d C:\Windows\Prefetch\ -q --csv G:\Prefetch --csvf
prefetch.csv --vss
```

EvtxECmd – Windows Event Log Parser

Type of Artifact

There are many Event Logs in the evtx folder, some aimed at system-wide events like `Security.evtx`, `System.evtx` and `Application.evtx`. Others may contain more specific events. All Event Logs are stored in the same format but the actual data elements collected varies. It is this variation of data elements that makes correlation of Event Logs a challenge. This is where `EvtxECmd` shines. All events are normalized across all event types and across all Event Logs file types!

The `EvtxECmd` parser has custom maps and locked file support. EvtxECmd has a unique feature, "Maps," that allows for consistent output.

Event Log Location: Event Logs for Windows Vista or later are found in `%systemroot%\System32\winevt\logs`

Parsing all events could end in millions of results. Using `EvtxCMD`'s maps can help target specific artifacts.

Check out this PowerShell script that copies out the relevant Event Logs and processes only specific Event IDs (your list of relevant logs and Event IDs may vary).

https://for500.com/evtx2process

Basic Usage

Recursively parsing a directory of event logs is probably the most efficient way to use `EvtxECmd`. To parse a directory, copy Event Logs to a temporary directory and use the `-d` option. Additionally, use the `--inc` option to only include specific `Event _ IDs` in the processing.

You have extracted the Event Log to a folder named `e:\evtx\logs` and now you want to process all those logs in a single command.

```
EvtxECmd.exe -d E:\evtx\logs --csv G:\evtx\out --csvf
evtxecmd_out.csv
```

Process all event logs and only include event_id specified by the `--inc` option

```
EvtxECmd.exe -d E:\evtx\logs --csv G:\evtx\out --csvf
evtxecmd_out.csv --inc 4624,4625,4634,4647,4672
```

Exclude specific event_id's by using the `-exc` option

```
EvtxECmd.exe -d E:\evtx\logs --csv G:\evtx\out --csvf
evtxecmd_out.csv --exc 4656,4660,4663
```

Key Data Returned

Events without maps are still processed, but output format will vary. The normalized Event Log output makes it possible to analyze many different types of Event Logs in a single view. Timeline Explorer is perfect for this analysis.

Advanced Usage

PRO TIP: Process only the Event Logs and Event IDs that are relevant to your case.

AmcacheParser – Amcache Parser

Type of Artifact

Amcache is part of the Application Experience Service in Windows. As such, it stores information about what application was run and a hash value of the executable.

Basic Usage

AmcacheParser takes the `Amcache.hve` registry hive as input.

In the example command below, AmcacheParser is being run against an `Amcache.hve` registry hive. Output is stored on the `G:` drive to the "`Amcache`" folder.

```
\Programs\Amcache.hve --csv G:\Amcache
```

Key Data Returned

The columns of most significance are typically the "FileIDLastWriteTimestamp" (the first time the executable was run), "SHA1" (the SHA-1 hash of the file being executed) and FullPath (the location and name of the executable ran). Other data of potential interest include the Volume ID (used to determine from which volume the executable was run), `MFT Entry number and Sequence numbers` (used to determine if the executable was run from an NTFS volume) and information about the internal metadata of the executable itself.

Advanced Usage

PRO TIP: Watch for changes in the `VolumeID`, as these can be indicative of applications being run from external devices. In the example below, the `VolumeID` is different for each executable run, meaning that they were all run from different volumes even though two entries reference the `E:\` drive.

Volume ID	File ID Last-Write Timestamp	SHA1	Full Path
abcd082d-3b8e-11e3-be8d-24fd52566ede	10/23/2013 3:09	f107ec56d650bf2cb00b186cbfbd202f66209ecf	E:\FTK Imager\FTK Imager.exe
afd25598-3b2c-11e3-be8c-24fd52566ede	10/22/2013 21:42	ca5fd519a43ff95d1ec0bbdf3533e9392109af74	E:\TACTICAL Subject\f-response-tacsub.exe
dbcc2aeb-5826-41c0-8011-f0153438122b	10/13/2013 9:42	9fef303bedf84304039159515 64e0d9888f6f365	C:\Windows\System32\notepad.exe

PRO TIP: Looking for something specific in the Amcache? You can use the switches `-b` (blacklist) or `-w` (whitelist). Blacklisting will include only those Amcache entries that match the SHA-1 hashes specified in the file, while whitelisting will exclude those Amcache entries that match the SHA-1 hashes. In the example below, we've provided SHA-1 values in the Blacklist.txt, meaning that the output CSV will contain items that are only responsive to the SHA-1 values in the text file.

```
AmcacheParser.exe -f E:\Windows\AppCompat\Programs\Amcache.hve -b
G:\Blacklist.txt --csv G:\Amcache
```

SBECmd – Shellbags Explorer

Type of Artifact

Every time Windows Explorer interacts with a folder, an entry is created in the user's Shellbags. Folders also include other "Explorer Like" items like the Control Panel, zip files, ISOs, and mounted encrypted containers. The simple existence of a directory in Shellbags is evidence the specific user account once interacted with that folder. Shellbags may persist long after the original directories, files, and physical devices have since been removed.

ShellBags are a set of Windows Registry keys located in `NTUser.dat` and `USRClass.dat` Registry hives (primarily `USRClass.dat`) that maintain viewing preferences of folders when using Windows Explorer. We used to say the Shellbags tracked folders that a user opened.

Basic Usage

`SBECmd` uses `-d` for a directory to recursively process user registry hives. There is no `-f` option for `SBECmd`.

To process a single user's ShellBags data, use the following command:

```
SBECmd.exe -d E:\Users\nromanoff --csv G:\temp\sbe_out
```

PRO TIP: If you need to process several users ShellBags data, you might consider exporting their data first and then processing just folder containing the exported data. This is a performance decision. Recursively processing many user folder and be very slow.

To process all Users in the Users folder, use the following command.

```
SSBECmd.exe -d E:\Users --csv G:\tmp\sbe_out
```

Key Data Returned

File system dates and times for target folders and first and last folder interaction times. The Bag Path, Slot, Node Slot, and MRU position for each entry are also shown. These can initially be confusing to decipher in table form. Using the GUI verion of ShellBags Explorer to see the table view translated in a hierarchal tree format can be very useful.

Timestamps Shown in SBECmd output:

Because of the nature of how registry key timestamps have only a single last update value for each key, the hierarchal data in the BagMRU registry key can become stale. This means that there may be a value in the key but it could be outdated. Therefore if `SBECmd` is not positive that a date is current and accurate, that date will not be shown in the output. This why you will often see that an entry has a `Last Interacted Timestamp` an no `First Interacted Timestamp`. The `First Interacted Timestamp` is stale and can't be relied upon.

You will also notice that SBECmd will only show Last Interacted Timestamps for MRU values.

Advanced Usage

PRO TIP: `SBECmd` can pull data from a live system. This make for a great learning and testing feature. Pull some baseline Shellbags data, run a test like navigating into a folder, pull the data again and compare. See what you own activity does to the Shellbags data.

MFTECmd – MFT Explorer

Type of Artifact

`MFTECmd` parses a number of different files from NTFS-formatted drives. At a high level, `MFTECmd` parses each of these internal NTFS System files. At a lower level, the application dives deep into NTFS and helps uncover much data of interest.

File	Description	Contents
$MFT	Index of each file and folder on volume	File name timestamps, and other metadata
$Boot	Volume boor record	Volume serial nbr, volume signature, nbr of sectors
$SDS	File ownership	Contains a list of all the Security Descriptors on the volume
$J	USN Journal	Transaction log of all changes to a file (write, delete, rename, etc.) (file change journal)
$Logfile	Transaction Log File	Used by NTFS to maintain the integrity of the filesystem in the event of a crash (metadata change journal)

Basic Usage

`MFTECmd` takes a `$MFT, $J, $SDS, $Logfile or $Boot` as input. These input files can be in the form of an exported copy of the file(s) or by referencing them from within a mounted image. The example command below shows `MFTECmd` being run against a `$MFT` file that has been exported from an evidence file.

```
MFTECmd.exe -f 'G:\Exports\$MFT' --csv G:\MFT_Output
```

In the next example `MFTECmd` is run against a `$MFT file`.

```
MFTECmd.exe -f 'E:\$MFT' --csv G:\MFT_Output
```

Note the command line syntax for referencing the alternate data streams `$UsnJrnl` and `$Secure`.

```
MFTECmd.exe -f 'E:\$Extend\$UsnJrnl:$MFT' --csv G:\USN_Output
```

```
MFTECmd.exe -f 'E:\$Secure:$SDS' --csv G:\SDS_Output
```

Key Data Returned

The columns of most significance are highly dependent on the type of investigation and the reason for parsing the files in the first place. For example, the dates and times in the `$MFT` could provide an indication as to the copying of files from external devices. If the written/modification time precedes the creation time, there is a high degree of probability that the file was copied from another volume.

In the example below, the `$MFT` has been parsed to CSV and loaded into `Timeline Explorer`. In each row the `Last Modified` time precedes the Created time. This is a clear indication that these files were copied from another volume.

Parent Path	File Name	Created0x10	Last Modified0x10
donald			
.\Users\Donald\Pictures	WP_20130805_001.jpg	2013-08-12 01:11:19.3130517	2013-08-05 11:48:29.0000000
.\Users\Donald\Pictures	WP_20130804_006.jpg	2013-08-12 01:11:18.8755517	2013-08-05 00:55:58.0000000
.\Users\Donald\Pictures	WP_20130804_005.jpg	2013-08-12 01:11:18.4536393	2013-08-05 00:55:36.0000000
.\Users\Donald\Pictures	WP_20130804_004.jpg	2013-08-12 01:11:18.2192675	2013-08-04 16:41:50.0000000
.\Users\Donald\Pictures	WP_20130804_003.jpg	2013-08-12 01:11:17.9379831	2013-08-04 16:41:42.0000000
.\Users\Donald\Pictures	WP_20130804_002.jpg	2013-08-12 01:11:17.6410948	2013-08-04 13:53:58.0000000
.\Users\Donald\Pictures	WP_20130804_001.jpg	2013-08-12 01:11:17.2661017	2013-08-04 13:53:55.0000000
.\Users\Donald\Pictures	WP_20130731_001.jpg	2013-08-12 01:11:16.8754645	2013-07-31 14:38:46.0000000

The processed `$J` data can be used to determine the date and time that specific actions were taken on a file. **These actions include (but are not limited to) creating a new file, making changes to a file, deleting a file, overwriting a file, and renaming a file. The `$LogFile` tracks changes to the information found in the MFT such as timestamps and other metadata.** In the example below follow the flow of activity the files recorded in `$J`. The first entry is for the creation of a file named $IT74KUZ, then data is added to the file before it is closed. Immediately afterwards, the file sdelete64.exe is renamed to $RT74KUZ before also being closed. This all happens within the same hundredth of a second as sdeleted64.exe being sent to the $Recycle.bin

Update Timestamp	Name	Entry Number	Sequence Number	Update Reasons
2018-01-08 01:18:19.5829828	$IT74KUZ.exe	1161	63	FileCreate
2018-01-08 01:18:19.5829828	$IT74KUZ.exe	1161	63	DataExtend|FileCreate
2018-01-08 01:18:19.5860618	$IT74KUZ.exe	1161	63	DataExtend|FileCreate|Close
2018-01-08 01:18:19.5860618	sdelete64.exe	5899	13	RenameOldName
2018-01-08 01:18:19.5860618	$RT74KUZ.exe	5899	13	RenameNewName
2018-01-08 01:18:19.5985898	$RT74KUZ.exe	5899	13	RenameNewName|Close

A few moments later, both files are deleted as the $Recycle.bin is emptied.

2018-01-08 01:18:23.3099473	$RT74KUZ.exe	5899	13	FileDelete|Close
2018-01-08 01:18:23.3111809	$IT74KUZ.exe	1161	63	FileDelete|Close

The `$SDS` file allows us determine file ownership. For example, in the first screenshot below we see output from the parsed `$MFT` loaded into Timeline Explorer. Looking at the NTUSER.DAT entry we can see that the Security ID for this file is 8271.

If we then go to the `$SDS` output and search for that same Security ID, we find that the NTUSER.DAT file is owned by the user with the Relative ID of 1001. If needed, we can take the SID and tied it to a username via the SAM Registry Hive.

Security Id	Parent Path	File Name
=	users\stack	ntuser.dat
8271	.\Users\Stack	NTUSER.DAT

Id	Offset	Owner Sid	Group Sid
8271			
8271	6343136	S-1-5-21-3001495921-1769015868-3887507880-1001	S-1-5-18

Advanced Usage

PRO TIP: It is important to remember that NTFS stores two sets of dates and times in each `$MFT` entry. These are known as the `Standard Information Attributes (SIA)` and the `FILENAME attributes`. This means that each file and folder will have timestamps in both groups. These dates and times behave differently and can indicate when a file was truly created, not just what Windows reports. For example, in the table below we see a number of files stored under the Windows directory. The `Created0x10` is the created date and time as stored in the `SIA` and `Created0x30` relates to those stored in the `FILENAME` attributes.

As can be seen in the table, both dates and times are the same for the first two entries, but the third entry shows a `FILENAME creation` date that is much later than the creation date stored in the `SIA`. This may be an indication of manipulation of the `SIA` timestamp for the syncmon.exe file and would warrant further investigation.

Created0x10	Created0x30	Path (combined from Parent Path and File Name)
3/18/2019 09:17	3/18/2019 09:17	C:\Windows\System32\cmd.exe
3/18/2019 09:18	3/18/2019 09:18	C:\Windows\System32\mountvol.exe
3/18/2019 09:19	8/18/2019 01:12	C:\Windows\System32\syncmon.exe

PRO TIP: When an evidence file is mounted as a drive `MTFECmd` can also dive into the volume shadow copies and retrieve previous versions of the `$MFT`, the `$J` and `$SDS` files. This can be done by virtue of the switches --vss and --dedupe as demonstrated in the command below. The `--vss` switch tells `MFTECmd` to search in the volume shadow copies and the `--dedupe` switch stops `MFTECmd` from reporting duplicate entries found in the volume shadow copies.

```
MFTECmd.exe -f 'E:\$Extend\$UsnJrnl:$J' --csv
G:\MFT_Output --vss --dedupe
```

RECmd – Registry Explorer Command Line Edition

Type of Artifact

This command line tool is used to access, search and recover, and export any data found in the WIndows Registry. To grasp why this tool is so powerful, just think about searching and exporting registry in a consistent output format. It's no big deal to do this with other tools until you have to do exactly the same thing across tens, hundreds, or thousands of machines.

Basic Usage

Search `NTUSER.dat` for the key name that contains "Dropbox"

```
RECmd.exe -f "C:\Temp\NTUSER.dat" --sk Dropbox
```

Search `UsrClass.dat` for the key value that contains "Dropbox"

```
RECmd.exe -f "C:\Temp\UsrClass.dat" --sd Dropbox
```

Search the directory registry_files for the key value that contains "Dropbox". The `last write time is >= Startdate`, and the `value name` contains either "`AppName`" or "`DisplayName`", so don't recover deleted keys and don't process log files.

```
RECmd.exe --d "C:\Temp\registry_files" --sk "Dropbox"
--StartDate "11/13/2014 15:35:01" --RegEx --sv "(App|Display)
Name" --recover false --nl
```

`RECmd` will replay and apply all registry hive logs automatically. Use `--nl` to suppress this.

Search

- StartDate Start date: last write timestamps (UTC)
- EndDate End date: last write timestamps (UTC)
- MinSize Find values with data size >= MinSize (specified in bytes)
- sk Search for <string> in key names
- sv Search for <string> in value names
- sd Search for <string> in value record's value data
- ss Search for <string> in value record's value slack
- Regular expressions must of course be valid .net regular expressions
- If either the key or value has spaces in them, enclose in quotes
- To get default values, use a value name of "(default)"
- "--sX" are search options; they use the "contains" logic
- -sd will convert the compare values to ASCII and Unicode before doing comparison unless the"--l" literal switch is used

In the example command below, we are looking for large registry key (1MB and base64 encoded) that often contain malware. Deleted keys are also retrieved and parsed.

```
RECmd.exe -d "C:\Temp\registry_files" --minsize 1M --Base64
--recover true
```

To search for binary data in value data, simply string together the hex characters you want to find, separated by dashes (04-00-EF-BE, for example).

```
RECmd.exe -hive "C:\Temp\registry_files" --sd"
```

Batch Mode

By default, batch mode utilizes the same plugins as found in Registry Explorer and works the same way. When used by `RECmd`, the data from the plugin will be normalized into a standard format for CSV output. When a plugin is used to process a key or key/value, the data generated by the plugin are also saved out to a CSV. In this way, it is very similar to exporting the data from Registry Explorer (albeit to Excel vs. CSV).

Batch File

Header

- Description: A general description of what this batch file is going to find
- Author: Name of this batch file (can be more, too, like contact information)
- Version: A version number that should be incremented as changes happen
- Id: A unique (across all other batch files) GUID (Global Unique Identifier) that identifies this batch file

Keys collection – Each entry consists of:

- Description: A user-friendly description of what this key will find. Can be anything from the key name to a friendlier description of what it means, etc.
- HiveType: The type of hive this entry corresponds to. Valid choices are `NTUSER, SAM, SECURITY, SOFTWARE, SYSTEM, USRCLASS, COMPONENTS, BCD, DRIVERS, AMCACHE, SYSCACHE`
- `KeyPath`: The path to the key to look for
- `ValueName`: OPTIONAL value that, when present, is looked for under KeyPath
- `Recursive`: Whether or not to process KeyPath recursively
- `Comment:` Like Description in that you can add various things here that end up in the CSV

HiveType determines which kind of hive the entry corresponds to. This saves time in that `RECmd` won't search a SOFTWARE hive for keys that won't ever exist (because they are NTUSER-specific, for example).

Batch File Example

Detailed, fully functional example batch files can be found in the ZimmermanTools\RegistryExplorer\BatchExamples folder.

Wildcards are supported in the KeyPath within the batch file. Example:

```
SOFTWARE\Microsoft\Office\*\*\User MRU\*
```

To use batch mode, supply the file to the `--bn` switch, along with `--csv` to tell `RECmd` where to save results:

- Export `UserAssist` data via `RECmd` batch file that uses a Registry Explorer plugin

```
RECmd.exe --bn .\BatchExamples\BatchExampleUserAssist.reb -f
C:\Temp\NTUSER_dblake.DAT --nl --csv C:\Temp
```

- Export Registry many of the Registry Explorer Plugin CSVs using a batch file

```
RECmd.exe --bn .\BatchExamples\RECmd_Batch_MC.reb -d G:\blake\
Registry\E --nl --csv g:\blake\recmd_out
```

PRO TIP: Be as specific as possible about the directory to process as it can have a significant impact on performance. These two commands generate the same results but the second one runs much faster.

This is much slower because the `RECmd` has to process the entire drive.

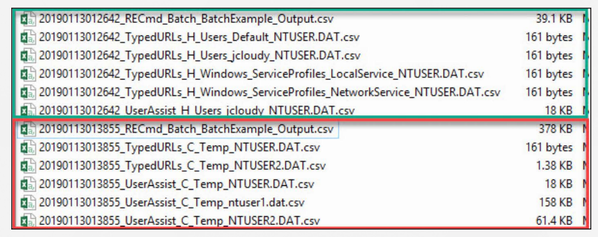
```
RECmd.exe --bn "C:\Forensic Program Files\ZimmermanTools\
RegistryExplorer\BatchExamples\UserActivity.reb" -d G:\blake\
Registry\E --nl --csv g:\blake\registry\recmd_out
```

This is much faster because `RECmd` is only processing a single user directory

```
RECmd.exe --bn "C:\Forensic Program Files\ZimmermanTools\
RegistryExplorer\BatchExamples\UserActivity.reb" -d G:\blake\
Registry\E\Users\Donald --nl --csv g:\blake\registry\recmd_out
```

PRO TIP: A `RECmd` batch file can contain instructions for processing different Hives & Keys. Using the `-f` option allows you to target a specific hive instead, if desired, all hives mentioned in the batch file.

When `RECmd` runs in batch mode, several files will get generated in the `--csv` directory (see the example below).



LECmd – LNK File Explorer

Type of Artifact

Shortcut files (`*.lnk`) are not entirely human-readable. Lnk files are most frequently created when a user opens a non-executable file by double-clicking. These shortcut files are stored under the user profile that opened the file and contain information relating to the opened target file. This includes information such as the target file dates and times, file name and path, the drive type, volume serial number, volume label and more. `LECmd` takes this data and presents it in a human-readable format.

Basic Usage

`LECmd` takes, as input, either a single lnk file or a folder containing several such files.

In the example command below, `LECmd` is being run against a single lnk file. When running this command the output is shown in the window running the command (command line window or PowerShell).

```
LECmd.exe -f E:\Users\srogers\AppData\Microsoft\Windows\
Recent\Peggy.jpg.lnk
```

In the next example, `LECmd` is being run against a folder of lnk files. This time, the output is stored in a CSV stored in `G:\LnkFiles`.

```
LECmd.exe -d E:\Users\srogers\AppData\Microsoft\Windows\Recent
--csv G:\LnkFiles -q
```

Key Data Returned

Column Name	Forensic Value
AppIdDescription	Human readable name for AppID
DestListVersion	Used with MRU to detemine most recentely opened file in the Jump List
MRU	Used with DestListVersion to detemine most recentely opened file in the Jump List
Path	Multiple Path Columns: Location and name of source and target files
SourceCreate	Creation Timestamp of the LNK itself
SourceModified	Modification Timestamp of the LNK itself
TargetCreated	Creation Timestamp of target file the LNK points to
TargetModified	Modification Timestamp of target file the LNK points to
DriveType	Network, fixed loal, ior Removable
VolumeSerialNumber	MFT Entry Number
MFT Nbr & Seq nbr	MFT - Seg nbr - If present then Voluome is NTFS

Advanced Usage

PRO TIP: Taking the data from key columns not only tells a forensic investigator when the file was opened, but may also provide details about the number of times a user accessed a file with that name. In the table below, the first row of results indicates that the file was only opened once, as `SourceCreated` and `SourceModified` contain the same time. The second instance indicates that the file has been opened at least twice, as the `SourceCreated` occurred around seven hours before the `SourceModified`. We also see that the Target dates are identical, suggesting that the file has not been changed since it was created. The last row indicates that the file was only opened once, since the Source entries are identical, However, the `TargetModified` precedes the `TargetCreated`, indicating that the file has been copied to the `F:` drive from another location.

Source Created	Source Modified	Target Created	Target Modified	Path (Combined from Local Path and Common Path)
9/1/2018 16:53	9/1/2018 16:53	8/27/2018 09:24	9/6/2018 14:43	C:\Users\Donald\Documents\NETFLIX SEC Filings\SEC-NFLX-1193125-12-53009.pdf
9/27/2018 10:42	9/27/2018 17:37	9/27/2018 10:28	9/27/2018 10:28	C:\Users\srogers\Documents\Netflix 3Q13 Conference Call Announcement 09 30 13.pdf
9/3/2018 14:13	9/3/2018 14:13	9/3/2018 14:11	9/1/2018 18:19	F:\Forms\fy08-form-10k.pdf

PRO TIP: LNK facts to keep in mind:

- The target file name extension is not always provided in the LNK name.
- The LNK file points to the last file of that name. Meaning, if there were two files named exactly the same, the link files point to the last one opened.

WxTCmd – Timeline Explorer

Type of Artifact

The 1803 update of Windows 10 introduced the Timeline feature. This keeps a record of the last 30 days of applications and files opened by a given user. The data for this are also synchronized from other computers where the user has logged in with their Microsoft account.

Basic Usage

`WxTCmd` takes a single `ActivitiesCache.db` file as input. Output for this command is not output to the screen, so a CSV needs to be specified.

In the example command below, `WxTCmd` is being run against the `ActivitiesCache.db` file. Note that the subfolder named "`a3936c317ac1474e`" is not consistent. An equivalent, differently named folder will be present for other users.

```
WxTCmd.exe -f E:\Users\srogers\AppData\Local\
ConnectedDevicesPlatform\a393c317ac1474e\ActivitiesCache.db
```

Key Data Returned

There are several columns of potential interest in a forensic investigation. The "Executable" column provides the name and the path of the executable in use.

For example, "`Program Files x86\Adobe\Acrobat Reader DC\Reader\Acrord32.exe`" would show that Acrobat Reader was opened. "Display Text" provides information regarding the content opened and the application used. For example, "`Tax Documents.pdf` (Acrobat Reader DC)" would indicate that the file "`Tax Documents.pdf`" was opened using Acrobat Reader. "Content Info" provides information relating to the location of the item that was opened. Following the same example as above, "`C:\Users\lee _ w\Desktop\Tax Documents.pdf`" would indicate the location of the file that was opened. There are also various dates and times recorded in the Timeline. "Start Time" indicates the first time, in the last 30 days, that this specific activity occurred.

Advanced Usage

PRO TIP: Among the parsed data provided by `WxTCmd` is the column named "`Content Info`". As described above, this column contains the location and name of the opened file or resource. However, it also contains another valuable piece of information. In the example below, a file was opened from a "`D:`" drive. This `ActivitiesCache.db` file contains information for all computers synchronized to this Microsoft account, so several linked computers could have a "`D:`" drive. The example below provides the `GUID` (Global Unique Identifier) for the volume that stores that file. This means that the file can be tied back to a specific volume on a specific device.

```
D:\Files\Cat.jpg (file:Unmapped GUID: //D:/Files/Cat.
jpgVolumeId={A98818E7-5868-4C06-807E-0F24C9746829}&ObjectId=
{AE26BE95-ACAC-11E9-B3FB-60F6770E22E2})
```


Eric Zimmerman's TOOLS
sans.org/eztools

This poster was created by Mark Hallman and Lee Whitfield with support from the SANS DFIR Faculty