Vortessence

Automating Volatility Memory Forensics

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Who we are…

- Beni is a security engineer at Swisscom
- Endre works at Security Engineering Lab of Bern Univ. of Applied Sciences

Thanks to Christian Bürgi, Thomas Ender and Patrick Harring

Why Vortessence?

- **Memory forensics is key technique to detect malware / attack tools, Volatility is THE tool for doing so**

- Detection by finding anomalies
  - Need to memorize normal state of clean system (hard / impossible to memorize)
  - Looking for anomalies can be **rather mechanical and boring task**

- Vortessence **partially automates Volatility based forensics**
  - Better detection
  - Quicker
  - Lower the skills required for first cut analysis
  - Will be open sourced in Winter 2014

- Vortessence is **not rocket science: simple but quite effective**

Agenda

- Illustrating the problem
- Vortessence basic idea
- Demo
- Release plan & outlook

```
$ vol.py -f image05.bin --profile=WinXPSP3x86 pstree
Volatility Foundation Volatility Framework 2.3.1
Name                                                  Pid   PPid   Thds   Hnds Time
-------------------------------------------------- ------ ------ ------ ------ ----
 0x825c8830:System                                      4      0     56    194 1970-01-01 00:00:00 UTC+0000
. 0x82172210:smss.exe                                 384      4      3     19 2013-12-06 09:48:00 UTC+0000
.. 0x82170878:csrss.exe                               608    384     13    377 2013-12-06 09:48:00 UTC+0000
.. 0x8221f7e8:winlogon.exe                            636    384     19    520 2013-12-06 09:48:02 UTC+0000
... 0x82162950:services.exe                           680    636     15    269 2013-12-06 09:48:02 UTC+0000
.... 0x824a9c08:vmacthlp.exe                          904    680      1     25 2013-12-06 09:48:02 UTC+0000

[snip]

.... 0x82499348:svchost.exe                          3148    680     44    840 2013-12-20 15:40:49 UTC+0000
.... 0x82043310:msiexec.exe                          1360    680      5    111 2013-12-20 15:41:04 UTC+0000
.... 0x8216f198:svchost.exe                           980    680     11    268 2013-12-06 09:48:02 UTC+0000
.... 0x82452248:svchost.exe                          1124    680      0 ------ 2013-12-06 09:48:02 UTC+0000
..... 0x82085020:wuauclt.exe                         1068   1124      8    258 2013-12-20 15:31:34 UTC+0000
..... 0x82113da0:wuauclt.exe                         1368   1124      4    123 2013-12-06 09:49:31 UTC+0000
... 0x82220da0:lsass.exe                              692    636     23    353 2013-12-06 09:48:02 UTC+0000
 0x821183d0:explorer.exe                             1780   1760     17    609 2013-12-06 09:48:07 UTC+0000
. 0x822352c8:vmtoolsd.exe                            1880   1780      3    245 2013-12-06 09:48:08 UTC+0000
. 0x82386438:ctfmon.exe                              1892   1780      1     78 2013-12-06 09:48:08 UTC+0000
. 0x84f0da88:explore.exe                             2400   1780      9    115 2013-12-20 15:40:44 UTC+0000
. 0x81f0da88:iexplore.exe                            2280   1780     13    387 2013-12-20 15:33:44 UTC+0000
.. 0x81eccb88:iexplore.exe                           2376   2280     23    648 2013-12-20 15:33:47 UTC+0000
```

Processes - Example of an anomaly


```
$ vol.py -f stuxnet.vmem --profile=WinXPSP3x86 pstree
Name                                                  Pid   PPid   Thds   Hnds Time
-------------------------------------------------- ------ ------ ------ ------ ----
0x823c8830:System                                       4      0     59    403 1970-01-01 00:00:00 UTC+0000
. 0x820df020:smss.exe                                 376      4      3     19 2010-10-29 17:08:53 UTC+0000
[SNIP]
.... 0x81f14938:ipconfig.exe                          304    968      0 ------ 2011-06-03 04:31:35 UTC+0000
.... 0x822843e8:svchost.exe                          1032    668     61   1169 2010-10-29 17:08:55 UTC+0000
..... 0x822b9a10:wuauclt.exe                          976   1032      3    133 2010-10-29 17:12:03 UTC+0000
..... 0x820ecc10:wscntfy.exe                         2040   1032      1     28 2010-10-29 17:11:49 UTC+0000
.... 0x81e61da0:svchost.exe                           940    668     13    312 2010-10-29 17:08:55 UTC+0000
.... 0x81db8da0:svchost.exe                           856    668     17    193 2010-10-29 17:08:55 UTC+0000
..... 0x81fa5390:wmiprvse.exe                        1872    856      5    134 2011-06-03 04:25:58 UTC+0000
.... 0x821a0568:VMUpgradeHelper                      1816    668      3     96 2010-10-29 17:09:08 UTC+0000
.... 0x81fee8b0:spoolsv.exe                          1412    668     10    118 2010-10-29 17:08:56 UTC+0000
.... 0x81ff7020:svchost.exe                          1200    668     14    197 2010-10-29 17:08:55 UTC+0000
.... 0x81c47c00:lsass.exe                            1928    668      4     65 2011-06-03 04:26:55 UTC+0000
.... 0x81e18b28:svchost.exe                          1080    668      5     80 2010-10-29 17:08:55 UTC+0000
.... 0x8205ada0:alg.exe                               188    668      6    107 2010-10-29 17:09:09 UTC+0000
.... 0x823315d8:vmacthlp.exe                          844    668      1     25 2010-10-29 17:08:55 UTC+0000
.... 0x81e0eda0:jqs.exe                              1580    668      5    148 2010-10-29 17:09:05 UTC+0000
.... 0x81c498c8:lsass.exe                             868    668      2     23 2011-06-03 04:26:55 UTC+0000
.... 0x82279998:imapi.exe                             756    668      4    116 2010-10-29 17:11:54 UTC+0000
... 0x81e70020:lsass.exe                              680    624     19    342 2010-10-29 17:08:54 UTC+0000
```

```
$ vol.py -f image02.vmss --profile=Win7SP1x86  dlllist -p 544
services.exe pid:    544
Command line : C:\Windows\system32\services.exe

Base             Size  LoadCount Path
---------- ---------- ---------- ----
0x00210000    0x41000     0xffff C:\Windows\system32\services.exe
0x77080000   0x13c000     0xffff C:\Windows\SYSTEM32\ntdll.dll
0x76690000    0xd4000     0xffff C:\Windows\system32\kernel32.dll
0x753b0000    0x4b000     0xffff C:\Windows\system32\KERNELBASE.dll
0x765e0000    0xac000     0xffff C:\Windows\system32\msvcrt.dll
0x76d50000    0xa2000     0xffff C:\Windows\system32\RPCRT4.dll
0x76c40000    0x1f000        0x2 C:\Windows\system32\IMM32.DLL
0x75080000    0x29000        0x1 C:\Windows\system32\WINSTA.dll
[SNIP]
0x76d10000    0x35000        0x8 C:\Windows\system32\WS2_32.dll
0x76c60000     0x6000        0x8 C:\Windows\system32\NSI.dll
0x74af0000    0x3c000        0x4 C:\Windows\system32\mswsock.dll
0x74640000     0x5000        0x1 C:\Windows\System32\wshtcpip.dll
0x74ae0000     0x6000        0x1 C:\Windows\System32\wship6.dll
0x72bd0000     0x3000        0x1 C:\Windows\system32\lz32.DLL
0x74b30000    0x16000        0x1 C:\Windows\system32\CRYPTSP.dll
0x748d0000    0x3b000        0x1 C:\Windows\system32\rsaenh.dll
```

Zeroaccess

Number of DLLs per process

Process priorities

…

…

Files

Network ports

Registry

Unknown drivers

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Vortessence – Basic idea

Mem. Images of clean systems

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White list DB

Rule engine
Tools / scripts using Volatility

Mem. Image of potentially infected system

Report containing real anomalies

- Web UI
- Text UI

Type of detection rules

- **Simple diff:** Value found in suspect image nut not in white list (“a simple diff per volatility tool”)
- **Range checks**
- **Reduction of false positives in some Volatility malware tools**

Base	0x85680550
Path	C:\Windows\system32\lsass.exe
Command line	"C:\Windows\\system32\\lsass.exe" Whitelist
Parent Process	544 services.exe Whitelist
# of instances	3 | 1
# Threads	6 | 7 - 14
# DLLs	46 | 60 - 63
Base priorities	8 | 9

`malfind` has false positives

```
Process: iexplore.exe Pid: 2376 Address: 0x1b10000
Vad Tag: VadS Protection: PAGE_EXECUTE_READWRITE
Flags: CommitCharge: 2, MemCommit: 1, PrivateMemory: 1, Protection: 6

0x01b10000  b0 00 eb 70 b0 01 eb 6c b0 02 eb 68 b0 03 eb 64   ...p...l...h...d
0x01b10010  b0 04 eb 60 b0 05 eb 5c b0 06 eb 58 b0 07 eb 54   ...`...\...X...T
0x01b10020  b0 08 eb 50 b0 09 eb 4c b0 0a eb 48 b0 0b eb 44   ...P...L...H...D
0x01b10030  b0 0c eb 40 b0 0d eb 3c b0 0e eb 38 b0 0f eb 34   ...@...<...8...4

0x1b10000 b000            MOV AL, 0x0
0x1b10002 eb70            JMP 0x1b10074
0x1b10004 b001            MOV AL, 0x1
0x1b10006 eb6c            JMP 0x1b10074
0x1b10008 b002            MOV AL, 0x2
0x1b1000a eb68            JMP 0x1b10074
0x1b1000c b003            MOV AL, 0x3
0x1b1000e eb64            JMP 0x1b10074
0x1b10010 b004            MOV AL, 0x4
0x1b10012 eb60            JMP 0x1b10074
```

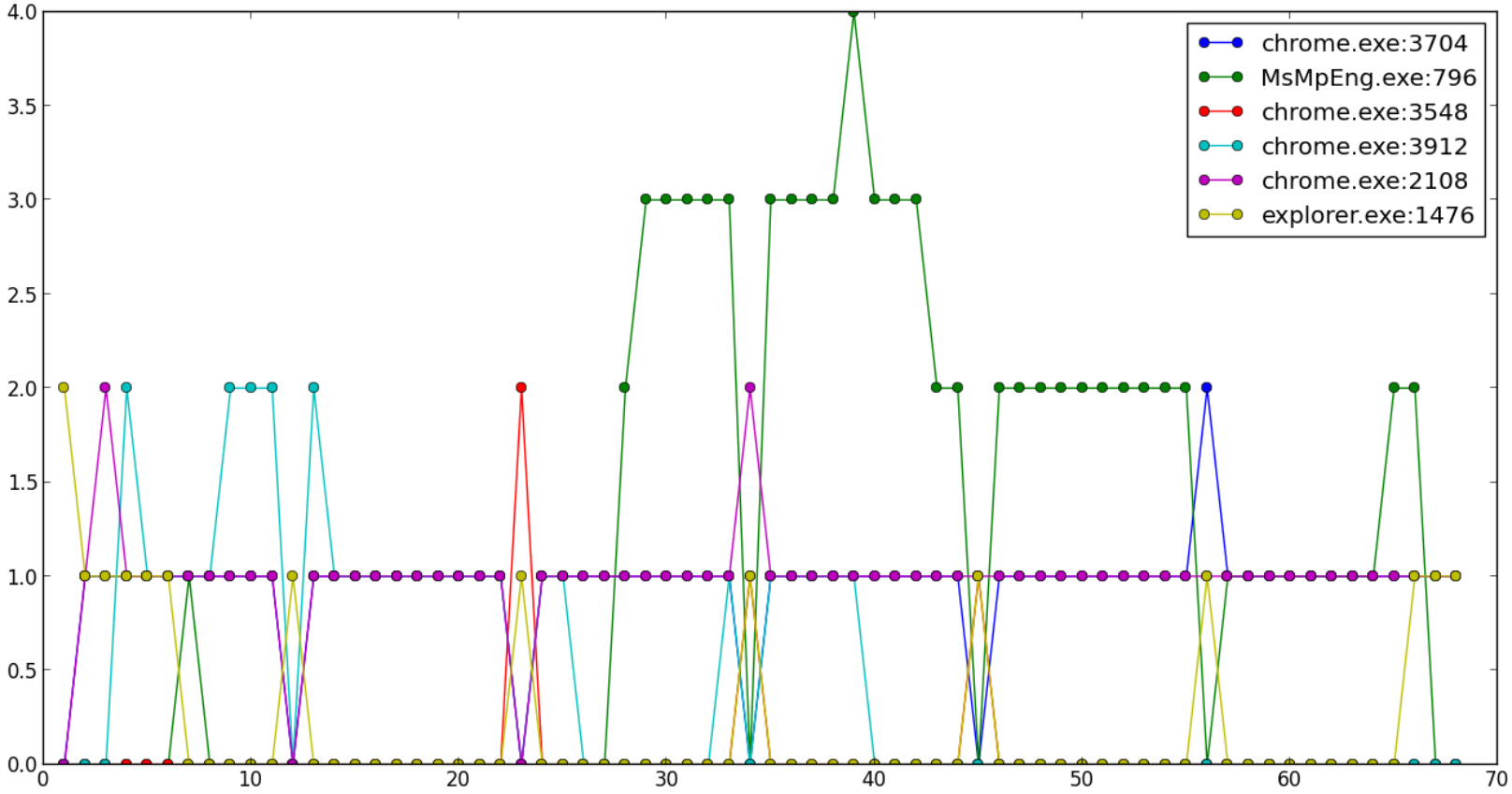
False positive

Sort them out manually….

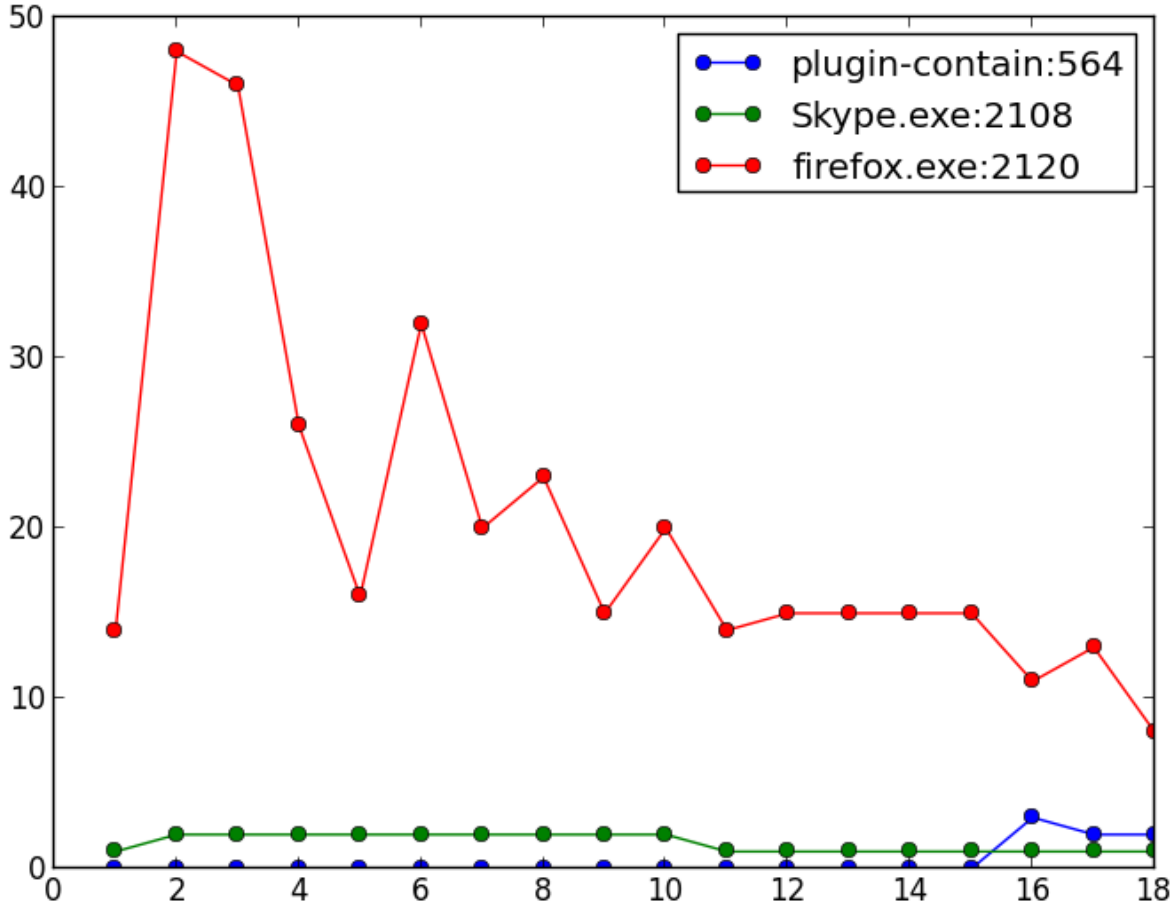
True positive

```
Process: chrome.exe Pid: 4052 Address: 0x130000
Vad Tag: VadS Protection: PAGE_EXECUTE_READWRITE
Flags: CommitCharge: 39, MemCommit: 1, PrivateMemory: 1, Protection: 6

0x00130000  4d 5a 00 00 00 00 00 00 00 00 00 00 00 00 00 00   MZ..............
0x00130010  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
0x00130020  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
0x00130030  00 00 00 00 00 00 00 00 00 00 00 00 d0 00 00 00   ................

0x130000 4d               DEC EBP
0x130001 5a               POP EDX
0x130002 0000             ADD [EAX], AL
0x130004 0000             ADD [EAX], AL
0x130006 0000             ADD [EAX], AL
0x130008 0000             ADD [EAX], AL
0x13000a 0000             ADD [EAX], AL
```

Understanding `malfind` false positives



Understanding `malfind` false positives



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Technical Overview

- Python 2.7
- Volatility 2.4, extended with JSON output
- 2 interfaces, CLI and web frontend
- Django for web frontend and DB abstraction layer for the CLI
- MySQL DB for backend, any DB supported by Django will work. Even SQLite ☺
- Runs on every plattform Volatility does
- Supports Win7 and newer, including 64bit

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Release Plan

Winter 2014: Version 0.1 *(will be available at http://vortessence.org)*

- Based on JSON output from Volatility 2.5
- Include the following plugins:

Processes and DLLs
- pslist
- dlllist
- handles
- getsids
- privs

Process Memory
- vadinfo

Kernel Memory and Objects
- modscan
- ssdt
- filescan
- unloadedmodules

Networking
- netscan

Registry (own plugin)

Windows Malware
- malfind
- svcscan
- ldrmodules
- apihooks
- idt
- gdt
- threads
- callbacks
- driverirp
- devicetree
- timers

Future releases

- **More Volatility plugins**
- **Rule framework:** hiding Vortessence internals, allowing to write rules with Python and Voaltility knowledge only
- **Rating / weighting anomalies:** Some anomalies are strong indicators, others are weak
- **PE file diffing**
- **Whitelist management:**
  - Import
  - Export --> sharing!
  - Etc.