CIRCL - DFIR 1.0.3

Introduction: Windows-, Memory- and File Forensics

CIRCL FORENSICS Training

CIRCL *TLP:WHITE*

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Overview

1. Windows Registry
2. Event Logs
3. Other Sources of Information
4. Malware Analysis
5. Analysing files
6. Live Response
7. Memory Forensics
8. Bibliography and Outlook

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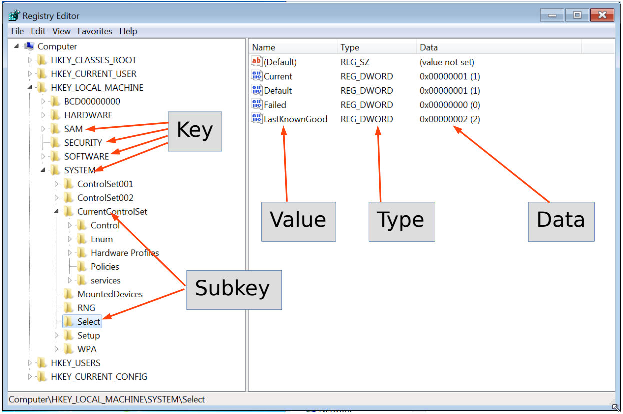
1. Windows Registry

1.1 About: Windows Registry

- MS DOS and old Windows
  - On system boot: What programs to load
  - How the system interact with the user
    - → `autoexec.bat`
    - → `config.sys`
    - → `system.ini`
    - → `win.ini`
- `https://support.microsoft.com/en-us/help/256986/`
  - A central hierarchical database
  - Replace text based config files
  - Contains information for operating
    - Hardware in the system
    - All aspects of MS Windows
    - Installed applications
    - Each user

→ A gold mine for forensics

1.1 About: Windows Registry



- Computer
  - HKEY_CLASSES_ROOT
  - HKEY_CURRENT_USER
  - HKEY_LOCAL_MACHINE
    - BCD00000000
    - HARDWARE
    - SAM
    - SECURITY
    - SOFTWARE
    - SYSTEM
      - ControlSet001
      - ControlSet002
      - CurrentControlSet
        - Control
        - Enum
        - Hardware Profiles
        - Policies
        - services
      - MountedDevices
      - RNG
      - Select
      - Setup
      - WPA
  - HKEY_USERS
  - HKEY_CURRENT_CONFIG

Name	Type	Data
(Default)	REG_SZ	(value not set)
Current	REG_DWORD	0x00000001 (1)
Default	REG_DWORD	0x00000001 (1)
Failed	REG_DWORD	0x00000000 (0)
LastKnownGood	REG_DWORD	0x00000002 (2)

Computer\HKEY_LOCAL_MACHINE\SYSTEM\Select

Key data structures contains a last write time stamp

1.1 About: Windows Registry

- Do you ever touch the Registry?
  - `regedit.exe`
  - Black Magic for many admins
    → Every user interacts with the Registry

- Location of the hive files

```
%SystemRoot%\system32\config
→ SAM, SECURITY, SYSTEM, SOFTWARE
%UserProfile%\NTUSER.DAT
%UserProfile%\AppData\Local\Microsoft\Windows\UsrClass.dat
```

- Timestamps → Timeline

1.2 Under the hood: Key Cell

```
0000:  a0ff ffff 6e6b 2000  6f0f 0e3b b78d d101   ....nk .o..;....
0010:  0200 0000 085e 0500  0000 0000 0000 0000   .....^..........
0020:  ffff ffff ffff ffff  0200 0000 0021 0500   ..............!..
0030:  102e 0000 ffff ffff  0000 0000 0000 0000   ................
0040:  1400 0000 1000 0000  0000 0000 0a00 0000   ................
0050:  496e 7465 7266 6163  6573 0080 0200 0000   Interfaces......
```

```
Offsets:    0x00      0      4       Size
            0x04      4      2       Node ID
            0x06      6      2       Node type
            0x08      8      8       Last write time
                ...      ...
            0x4c     76      2       Lenght of key name
            0x50     80    <76>      key name + padding
```

- Exercise: Calculate the size of the key cell

  `a0 ff ff ff`

- Exercise: Calculate the size of the key name

  `0a 00`

1.2 Under the hood: Value Cell

```
0000:                                 d8ff ffff  766b 0d00          ....vk..
0010:  0400 0080 0200 0000  0400 0000 0100 0000   ................
0020:  4c61 7374 4b6e 6f77  6e47 6f6f 6400 0000  LastKnownGood...
```

```
Offset:   0x00    0     4     Size
          0x04    4     2     Node ID
          0x06    6     2     Value name length
          0x08    8     4     Data lenght
          0x0c   12     4     Data offset
          0x10   16     4     value typw
```

- Exercise: Calculate the size of the value cell

  `d8 ff ff ff`

- Exercise: Calculate the size of the value name length

  `0d 00`

1.3 Hive files

- SAM
  - Local users
- Security
  - Audit settings
  - Machine, domain SID
- System
  - General system configuration
  - Networking, Auto run
  - Program execution
  - USB devices
- Software
  - Windows version, Profiles list
  - Networking, Auto run
  - Shell extensions, Browser helper objects
  - Scheduled Tasks
  - Program execution

1.3 Hive files

- Windows XP:

  ```
  C:\Documents and Settings\<username>\NTUSER.DAT
  C:\Documents and Settings\<username>\Local Settings\
     Application Data\Microsoft\Windows\UsrClass.dat
  ```

- Windows Vista and above:

  ```
  C:\Users\<user>\NTUSER.DAT
  C:\Users\<user>\AppData\Local\Microsoft\Windows\
     UsrClass.dat
  ```

- `C:\Windows\inf\setupapi.log`

1.4 RegRipper

- Extract specific key values

```
$ rip.pl -p compname -r SYSTEM
        ComputerName      = WIN7WS
        TCP/IP  Hostname = Win7WS
```

- Alternative method

```
$ wine rip.exe -p compname -r SYSTEM
        ComputerName      = WIN7WS
        TCP/IP  Hostname = Win7WS
```

- RegRipper plugins

```
$ ls -l /usr/share/regripper/plugins | wc -l
        397
```

- Ripping hive files with profiles

```
$ rip.exe -f sam -r SAM > out/sam.txt
$ rip.exe -f security -r SECURITY > out/security.txt
$ rip.exe -f system -r SYSTEM > out/system.txt
$ rip.exe -f software -r SOFTWARE > out/software.txt
$ rip.exe -f ntuser -r NTUser.dat > out/ntuser.txt
$ rip.exe -f usrclass -r UsrClass.dat > out/userClass.txt
```

1.5 RegRipper: Exercise

1. Extract Hive files from invected PC
2. Rip them with RegRipper profiles
3. Collect important general information
4. Try to find incident related artefacts
5. Add the information to report

1.6 Examples: System Hive

- Computer name
- Services
- Network configuration
- Devices / USB device
  - `SYSTEM/ControlSet001/Enum/USBStor`
    → Device class ID
    → Unique instance ID (SN)
    → First connect time stamp
  - `SYSTEM/ControlSet001/Enum/USB`
    → Last connect time stamp
  - `SYSTEM/MountedDevices`
    → Voume GUID
    → Mount Point

1.7 Examples: Software Hive

- OS version & configuration
- Applications installed & uninstalled
- Application configuration system wide
- Drivers
- Network lists & interfaces
- User profiles
- Schedules Tasks
- Auto start
- Example: Get Windows version:
    - `wine rip.exe -p winver -r SOFTWARE`

1.7 Examples: User Hive

- OS configuration user related
- Applications installed & uninstalled
- Application configuration user related
- Auto start
  - Run
    - Executed at user login
    - Provide *malware* persistence
    - No admin privileges required
  - RunOnce
  - Legacy and other AutoStart
    - `/Software/Microsoft/Windows/CurrentVersion/Policies/Explorer/Run/`
    - `/Software/Microsoft/Windows NT/CurrentVersion/Windows/'load','run'`
  - Much more auto start loctions...

1.7 Examples: User Hive

- WordWheelQuery
  - User search on localhost
  - MRU List

    → Consider VSS for histrorical data
- Shell Bags
  - User preferences for diplaying Explorer windows
  - Postion, size, view, icon

    → Folders accessed by the user
- UserAssist
  - User activities
    - Double-click icon
    - Launch application from 'START Menu'
  - Values stored:
    - Path, Run-Count, FileTime last access
    - ROT-13

1.7 Examples: User Hive

- MUICache
  - Program execution incl. called from CMD
- RecentDocs

  Example: '.png' files

```
Software\Microsoft\Windows\CurrentVersion\Explorer\RecentDocs\.png
LastWrite Time Fri Jan 12 15:00:52 2018 (UTC)
MRUListEx = 3,2,0,1
  3 = photo-123.png
  2 = paint.png
  0 = face.png
  1 = flower.png
```

- Common Dialogs

  Example: 'Open' and 'Save As...'

```
OpenSavePidlMRU\exe
LastWrite Time: Tue Jul  5 14:40:46 2016
Note: All value names are listed in MRUListEx order.

  Users\avast_free_antivirus_setup_online.exe
  Users\Thunderbird Setup 45.1.1.exe
  Users\Firefox Setup Stub 47.0.1.exe
```

1.8 Exercises

Identify computer name:

What services start during system boot:

Gather list of network connected:

What network cards are configured:

Get list of user profiles:

Get Windows version:

Detect Auto Start applications from the NTUser.dat hive:

.

1.8 Exercises

```
Identify computer name:
        $ wine rip.exe -p compname -r SYSTEM


What services start during system boot:
        $ wine rip.exe -p services -r SYSTEM


Gather list of network connected:
        $ wine rip.exe -p networklist -r SOFTWARE


What network cards are configured:
        $ wine rip.exe -p networkcards -r SOFTWARE


Get list of user profiles:
        $ wine rip.exe -p profilelist -r SOFTWARE


Get Windows version:
        $ wine rip.exe -p winver -r SOFTWARE


Detect Auto Start applications from the NTUser.dat hive:
        $ wine rip.exe -p user_run -r JohnNTUser.DAT
.
```

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2. Windows Event Logs

2.1 Inroduction

- Up to Windows XP
  - Binary Event Log file format
  - Mainly 3 categories:

    Security: `secevent.evt`

    System: `sysevent.evt`

    Application: `appevent.evt`

    ... maybe some server service specific

- Beginning with Vista
  - New binary XML format
  - New extension: `.evtx`
  - Location: `/Windows/System32/winevt/Logs/`
  - Many more files:

    `Security.evtx`

    `System.evtx`

    `Application.evtx`

    → 120 files ++

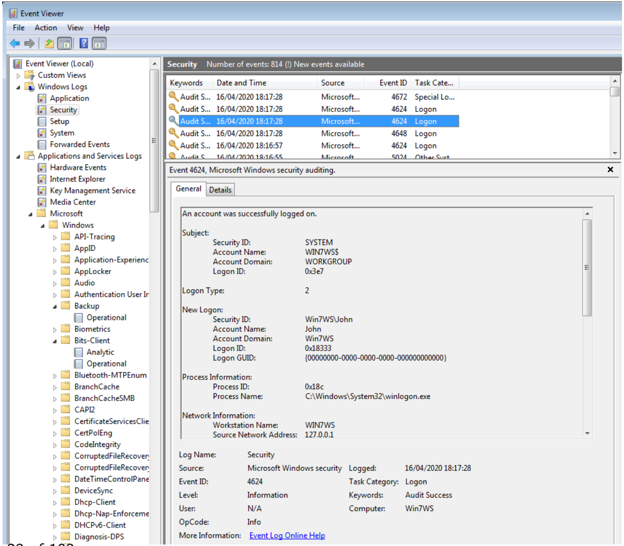
2.1 Inroduction

- Advantage
  - Full fledged logging
  - Logon Success: Importand events are logged
  - Detailed importand information

- Disadvantage
  - Cover only a limited period of time
  - Logon Fail: Importand events are not logged per default
  - Much information, hard to read

- Always interesting
  - Logon / Logoff
  - System boot
  - Services started

2.2 Example: Logon event



Security Number of events: 814 (!) New events available

Keywords	Date and Time	Source	Event ID	Task Cate...
Audit S...	16/04/2020 18:17:28	Microsoft...	4672	Special Lo...
Audit S...	16/04/2020 18:17:28	Microsoft...	4624	Logon
Audit S...	16/04/2020 18:17:28	Microsoft...	4624	Logon
Audit S...	16/04/2020 18:17:28	Microsoft...	4648	Logon
Audit S...	16/04/2020 18:16:57	Microsoft...	4624	Logon
Audit S...	16/04/2020 18:16:55	Microsoft...	5024	Other Syst...

Event 4624, Microsoft Windows security auditing.

```
An account was successfully logged on.

Subject:
        Security ID:              SYSTEM
        Account Name:             WIN7WS$
        Account Domain:           WORKGROUP
        Logon ID:                 0x3e7

Logon Type:                       2

New Logon:
        Security ID:              Win7WS\John
        Account Name:             John
        Account Domain:           Win7WS
        Logon ID:                 0x18333
        Logon GUID:               {00000000-0000-0000-0000-000000000000}

Process Information:
        Process ID:               0x18c
        Process Name:             C:\Windows\System32\winlogon.exe

Network Information:
        Workstation Name:         WIN7WS
        Source Network Address:   127.0.0.1
```

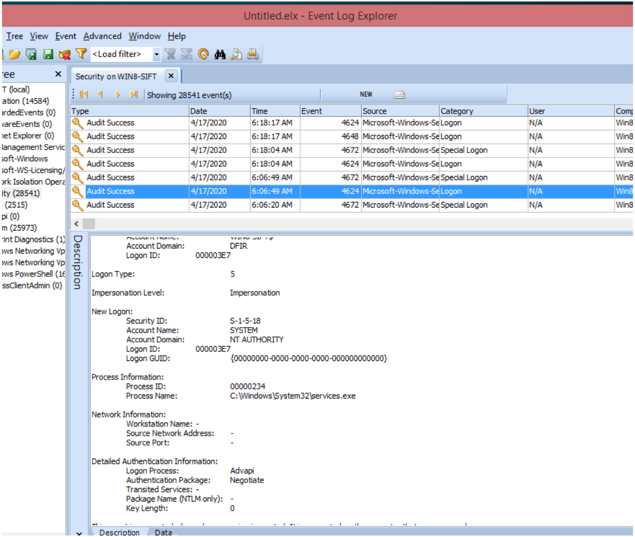
Log Name:	Security		
Source:	Microsoft Windows security	Logged:	16/04/2020 18:17:28
Event ID:	4624	Task Category:	Logon
Level:	Information	Keywords:	Audit Success
User:	N/A	Computer:	Win7WS
OpCode:	Info		
More Information:	Event Log Online Help		

2.3 In Forensics

- Get support online:
  - Microsoft TechNet
  - `https://www.ultimatewindowssecurity.com/securitylog/encyclopedia/`
  - `http://eventid.net/`
- Review logging policies

```
$ rip.pl -r SECURITY -p auditpol
.....
ystem:Other System Events                          S/F
Logon/Logoff:Logon                                  S
Logon/Logoff:Logoff                                 S
Logon/Logoff:Account Lockout                        S
Logon/Logoff:IPsec Main Mode                        N
Logon/Logoff:IPsec Quick Mode                       S
Logon/Logoff:IPsec Extended Mode                    N
Logon/Logoff:Special Logon                          N
Logon/Logoff:Other Logon/Logoff Events              N
Logon/Logoff:Network Policy Server                  S/F
Object Access:File System                           N
.....
```

12.4 Explore and extract evtx



Untitled.elx - Event Log Explorer
Tree View Event Advanced Window Help
<Load filter>
ree
Security on WIN8-SIFT
NEW
Description
Description Data

```
T (local)
ation (14584)
ardedEvents (0)
vareEvents (0)
net Explorer (0)
lanagement Servic
soft-Windows
soft-WS-Licensing/
ork Isolation Opera
ity (28541)
(2515)
pi (0)
m (25973)
rint Diagnostics (1)
ows Networking Vp
ows Networking Vp
ows PowerShell (16
ssClientAdmin (0)
```

Showing 28541 event(s)

Type	Date	Time	Event	Source	Category	User	Comp
Audit Success	4/17/2020	6:18:17 AM	4624	Microsoft-Windows-Se	Logon	N/A	Win8
Audit Success	4/17/2020	6:18:17 AM	4648	Microsoft-Windows-Se	Logon	N/A	Win8
Audit Success	4/17/2020	6:18:04 AM	4672	Microsoft-Windows-Se	Special Logon	N/A	Win8
Audit Success	4/17/2020	6:18:04 AM	4624	Microsoft-Windows-Se	Logon	N/A	Win8
Audit Success	4/17/2020	6:06:49 AM	4672	Microsoft-Windows-Se	Special Logon	N/A	Win8
Audit Success	4/17/2020	6:06:49 AM	4624	Microsoft-Windows-Se	Logon	N/A	Win8
Audit Success	4/17/2020	6:06:20 AM	4672	Microsoft-Windows-Se	Special Logon	N/A	Win8

```
        Account Domain:                 DFIR
        Logon ID:               000003E7

Logon Type:                             5

Impersonation Level:                    Impersonation

New Logon:
        Security ID:                    S-1-5-18
        Account Name:                   SYSTEM
        Account Domain:                 NT AUTHORITY
        Logon ID:               000003E7
        Logon GUID:                     {00000000-0000-0000-0000-000000000000}

Process Information:
        Process ID:                     00000234
        Process Name:                   C:\Windows\System32\services.exe

Network Information:
        Workstation Name: -
        Source Network Address:         -
        Source Port:                    -

Detailed Authentication Information:
        Logon Process:                  Advapi
        Authentication Package:         Negotiate
        Transited Services: -
        Package Name (NTLM only):       -
        Key Length:                     0
```

2.5 Example

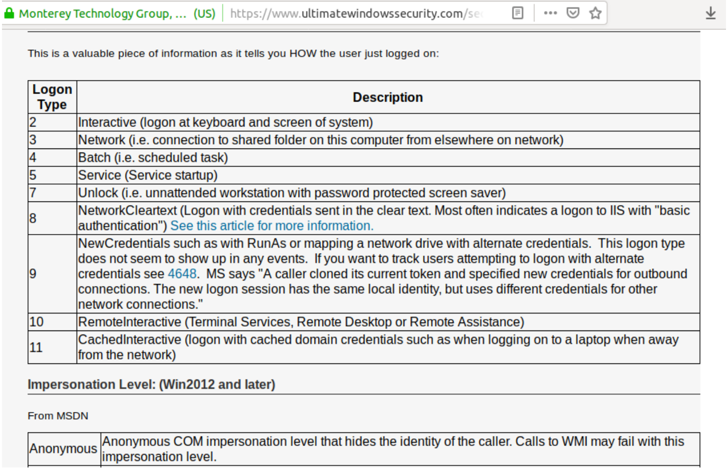
- Logon Success

```
$ evtxexport Security.evtx | less
.....
Event number             : 668
Written time             : Apr 15, 2019 12:58:33.650031000 UTC
Event level              : Information (0)
Computer name            : Win7WS
Source name              : Microsoft-Windows-Security-Auditing
Event identifier         : 0x00001210 (4624)
Number of strings        : 20
String: 1                : S-1-5-18
String: 2                : WIN7WS$
String: 3                : WORKGROUP
String: 4                : 0x00000000000003e7
String: 5                : S-1-5-21-3408732720-2018246097-660081352-1000
String: 6                : John
String: 7                : Win7WS
String: 9                : 2
.....
String: 17               : 0x0000018c
String: 18               : C:\Windows\System32\winlogon.exe
String: 19               : 127.0.0.1
```

- Logon Fail

```
$ evtxexport Security.evtx | grep 4625
```

2.5 Example



Monterey Technology Group, ... (US)
https://www.ultimatewindowssecurity.com/se

This is a valuable piece of information as it tells you HOW the user just logged on:

Logon Type	Description
2	Interactive (logon at keyboard and screen of system)
3	Network (i.e. connection to shared folder on this computer from elsewhere on network)
4	Batch (i.e. scheduled task)
5	Service (Service startup)
7	Unlock (i.e. unnattended workstation with password protected screen saver)
8	NetworkCleartext (Logon with credentials sent in the clear text. Most often indicates a logon to IIS with "basic authentication") See this article for more information.
9	NewCredentials such as with RunAs or mapping a network drive with alternate credentials. This logon type does not seem to show up in any events. If you want to track users attempting to logon with alternate credentials see 4648. MS says "A caller cloned its current token and specified new credentials for outbound connections. The new logon session has the same local identity, but uses different credentials for other network connections."
10	RemoteInteractive (Terminal Services, Remote Desktop or Remote Assistance)
11	CachedInteractive (logon with cached domain credentials such as when logging on to a laptop when away from the network)

Impersonation Level: (Win2012 and later)

From MSDN

Anonymous	Anonymous COM impersonation level that hides the identity of the caller. Calls to WMI may fail with this impersonation level.

2.6 Other log files

- /Windows/setuplog.txt
  - Untill WinXP, when Windows is installed
- /Windows//Debug/netsetup.log
  - Untill WinXP, when Windows is installed
- /Windows/setupact.log
  - Graphical part of setup process

```
2019-04-05 11:39:56, Info  CBS Starting the TrustedInstaller main loop.
2019-04-05 11:39:56, Info  CBS TrustedInstaller service starts successfully.
2019-04-05 11:39:56, Info  CBS Setup in progress, aborting startup processing check
2019-04-05 11:39:56, Info  CBS Startup processing thread terminated normally
```

- /Windows/setupapi.log

```
/Windows/inf/setupapi.dev.log
/Windows/inf/setupapi.app.log
/Windows/inf/setupapi.offline.log
```

- /Windows/Tasks/SCHEDLGU.TXT
  - Task Scheduler Log

2.7 Exercise: Event Log

1. Which .evtx files could be interesting for forensics?
2. Extract promising .evtx files
3. Try tools like `evtx_dump.py` to read some logs
4. Find general information like:
   - What time the system boot up
   - What user was logged on
   - Was there much user activity before infection
   - What time the system shut down
5. Search for other incident related artefacts in .evtx files
6. Are artefacts within the other log files?

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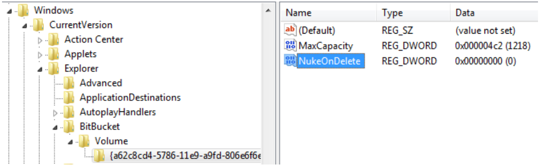
3. Other Sources of Information

3.1 Recycle Bin - User support to undelete

- Files move to Recycle Bin:
    - Moved by mouse
    - Right click: `Delete`
- Not move to Recycle Bin:
    - Right click: `Delete + SHIFT`
    - Command line: `del`
    - Files on network shares
- NukeOnDelete
    - `HKEY_USERS/_UUID_/Software/Microsoft/Windows/CurrentVersion/Explorer/BitBucket/Volume/{_Volume ID_}/NukeOnDelete`



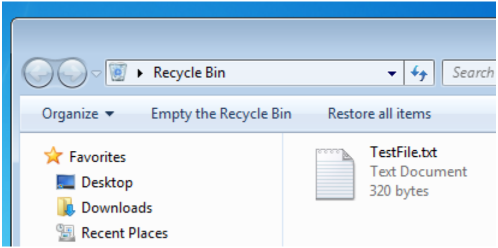
- Windows
    - CurrentVersion
        - Action Center
        - Applets
        - Explorer
            - Advanced
            - ApplicationDestinations
            - AutoplayHandlers
            - BitBucket
                - Volume
                    - {a62c8cd4-5786-11e9-a9fd-806e6f6e

Name	Type	Data
(Default)	REG_SZ	(value not set)
MaxCapacity	REG_DWORD	0x000004c2 (1218)
NukeOnDelete	REG_DWORD	0x00000000 (0)

3.1 Recycle Bin - Life-Investigate

- Play script: `TextFile.txt`
  - 2019-04-30 17:31:57 UTC+2: Born
  - 2019-04-30 17:34:44 UTC+2: Content Modified
  - 2019-04-30 17:35:32 UTC+2: Deleted

- Analyze Recycle.Bin:



TextFile.txt
Text Document
320 bytes

3.1 Recycle Bin - Forensics

- Play script: `TextFile.txt`
  - 2019-04-30 17:31:57 UTC+2: Born
  - 2019-04-30 17:34:44 UTC+2: Content Modified
  - 2019-04-30 17:35:32 UTC+2: Deleted

- Analyze `Recycle.Bin` directory:

```
/$Recycle.Bin/S-1-5-21-3408732720-2018246097-660081352-1000/
        129 Apr  5 11:46  desktop.ini
        544 Apr 30 17:35 '$IOMHI9A.txt'
        320 Apr 30 17:34 '$ROMHI9A.txt'

strings \$ROMHI9A.txt
                Test File
               ==========
        This is a test file. It is just created to test Forensic
        Artifacts for the 'Recycle Bin'.
        .....

strings -el \$IOMHI9A.txt
        C:\Users\John\Documents\recycleTest\TestFile.txt
```

3.1 Recycle Bin - Forensics

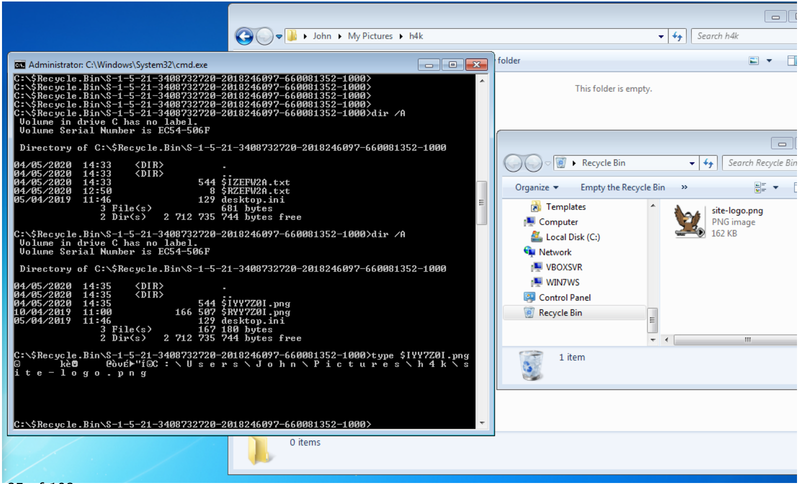
- Play script: `TextFile.txt`
  - 2019-04-30 17:31:57 UTC+2: Born
  - 2019-04-30 17:34:44 UTC+2: Content Modified
  - 2019-04-30 17:35:32 UTC+2: Deleted

- Analyze `Recycle.Bin` directory:

```
Fri Apr 05 2019 11:46:49
     328 m.c.      57-144-1 /$Recycle.Bin
     376 ...b    9632-144-1 /$Recycle.Bin/S-1-5-21- ..... -1000
     129 m.cb    9634-128-1 /$Recycle.Bin/S-1-5-21- ..... -1000/desktop.ini

Tue Apr 30 2019 17:31:57
     320 ...b   47164-128-1 /$Recycle.Bin/S-1-5-21- ..... -1000/$ROMHI9A.txt

Tue Apr 30 2019 17:34:44
     320 ma..   47164-128-1 /$Recycle.Bin/S-1-5-21- ..... -1000/$ROMHI9A.txt

Tue Apr 30 2019 17:35:32
     544 macb   44155-128-1 /$Recycle.Bin/S-1-5-21- ..... -1000/$IOMHI9A.txt
      48 mac.   47022-144-1 /Users/John/Documents/recycleTest
     320 ..c.   47164-128-1 /$Recycle.Bin/S-1-5-21- ..... -1000/$ROMHI9A.txt
     376 mac.    9632-144-1 /$Recycle.Bin/S-1-5-21- ..... -1000
```

3.1 Recycle Bin - Exercise

Invetigate extension of an index file `$I.....` for binary file:



```
C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000>
C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000>
C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000>
C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000>
C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000>dir /A
 Volume in drive C has no label.
 Volume Serial Number is EC54-506F

 Directory of C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000

04/05/2020  14:33    <DIR>          .
04/05/2020  14:33    <DIR>          ..
04/05/2020  14:33               544 $IZEFW2A.txt
04/05/2020  12:50                 8 $RZEFW2A.txt
05/04/2019  11:46               129 desktop.ini
               3 File(s)            681 bytes
               2 Dir(s)   2 712 735 744 bytes free

C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000>dir /A
 Volume in drive C has no label.
 Volume Serial Number is EC54-506F

 Directory of C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000

04/05/2020  14:35    <DIR>          .
04/05/2020  14:35    <DIR>          ..
04/05/2020  14:35               544 $IYY7Z0I.png
10/04/2019  11:00           166 507 $RYY7Z0I.png
05/04/2019  11:46               129 desktop.ini
               3 File(s)        167 180 bytes
               2 Dir(s)   2 712 735 744 bytes free

C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000>type $IYY7Z0I.png
☺      kè☻    @òvÉ►"í☺C : \ U s e r s \ J o h n \ P i c t u r e s \ h 4 k \ s
i t e - l o g o . p n g


C:\$Recycle.Bin\S-1-5-21-3408732720-2018246097-660081352-1000>
```

3.2 LNK Files

- Provide information about files accessed
  - Local
  - Network shares
  - Appached devices

```
Thu May 02 2019 14:54:02
     280  ...b        43701-144-1  /Users/John/Documents/prefetchTest

Thu May 02 2019 14:54:28
      66  macb        43702-128-1  /Users/John/Documents/prefetchTest/
                                   PreFetchTest.txt
    2779  macb        43716-128-4  /Users/John/AppData/Roaming/Microsoft/
                                   Windows/Recent/PreFetchTest.txt.lnk
    1573  macb        43922-128-4  /Users/John/AppData/Roaming/Microsoft/
                                   Windows/Recent/prefetchTest.lnk
```

3.2 LNK Files

- Provide information about files accessed
  - Local
  - Network shares
  - Appached devices

```
exiftool PreFetchTest.txt.lnk

        ...
        Create Date           : 2019:05:02 14:54:28+02:00
        Access Date           : 2019:05:02 14:54:28+02:00
        Modify Date           : 2019:05:02 14:54:28+02:00
        Target File Size      : 66
        Icon Index            : (none)
        Run Window            : Normal
        Hot Key               : (none)
        Drive Type            : Fixed Disk
        Volume Label          :
        Local Base Path       : C:\Users\John\Documents\prefetchTest\
                                  PreFetchTest.txt
        ...
```

3.3 XP Restore Points

- Backup of:
  - Critical system files
  - Registry partially
  - Local user profiles
  - But NO user data!
- Created automatically:
  - Every 24 hours
  - Windows Update
  - Installation of applications incl. driver
  - Manually
- For user: Useful to recover a broken system
- For analyst:
  - `rp.log`
  - Description of the cause
  - Time stamp
  - State of the system at different times

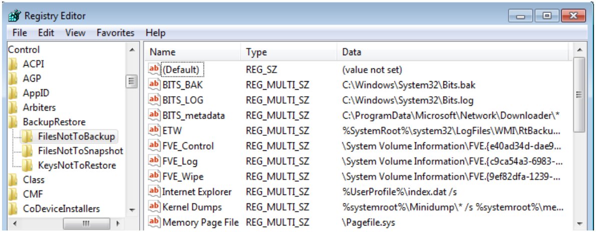
3.4 VSS - Volume Shadow Copy Service

- Backup Service
  - System files
  - User data files
  - Operates on block level
- On live system
  - Run CMD as administrator

```
>vssadmin list shadows /for=c:/
vssadmin 1.1 - Volume Shadow Copy Service administrative command-line tool
(C) Copyright 2001-2005 Microsoft Corp.

Contents of shadow copy set ID: {33eb3a7b-6d03-4045-aa70-37b714d49c72}
   Contained 1 shadow copies at creation time: 10/04/2019 16:06:30
      Shadow Copy ID: {34d9910b-ac1d-4b10-b282-89dde217d0fb}
         Original Volume: (C:)\\?\Volume{a62c8cd4-5786-11e9-a9fd-806e6f6e6963}\
         Shadow Copy Volume: \\?\GLOBALROOT\Device\HarddiskVolumeShadowCopy1
         Originating Machine: Win7WS
         Service Machine: Win7WS
         Provider: 'Microsoft Software Shadow Copy provider 1.0'
         Type: ClientAccessibleWriters
         Attributes: Persistent, Client-accessible, No auto release, Differential,
         Auto recovered
```

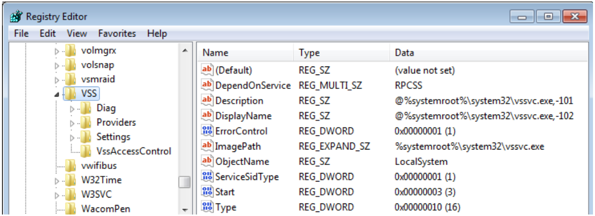
3.4 VSS - Configuration

HKEY_LOCAL_MACHINE/SYSTEM/CurrentControlSet/services/VSS



Name	Type	Data
(Default)	REG_SZ	(value not set)
BITS_BAK	REG_MULTI_SZ	C:\Windows\System32\Bits.bak
BITS_LOG	REG_MULTI_SZ	C:\Windows\System32\Bits.log
BITS_metadata	REG_MULTI_SZ	C:\ProgramData\Microsoft\Network\Downloader\*
ETW	REG_MULTI_SZ	%SystemRoot%\system32\LogFiles\WMI\RtBacku...
FVE_Control	REG_MULTI_SZ	\System Volume Information\FVE.{e40ad34d-dae9...
FVE_Log	REG_MULTI_SZ	\System Volume Information\FVE.{c9ca54a3-6983-...
FVE_Wipe	REG_MULTI_SZ	\System Volume Information\FVE.{9ef82dfa-1239-...
Internet Explorer	REG_MULTI_SZ	%UserProfile%\index.dat /s
Kernel Dumps	REG_MULTI_SZ	%systemroot%\Minidump\* /s %systemroot%\me...
Memory Page File	REG_MULTI_SZ	\Pagefile.sys

HKEY_LOCAL_MACHINE/SYSTEM/CurrentControlSet/Control/BackupRestore



Name	Type	Data
(Default)	REG_SZ	(value not set)
DependOnService	REG_MULTI_SZ	RPCSS
Description	REG_SZ	@%systemroot%\system32\vssvc.exe,-101
DisplayName	REG_SZ	@%systemroot%\system32\vssvc.exe,-102
ErrorControl	REG_DWORD	0x00000001 (1)
ImagePath	REG_EXPAND_SZ	%systemroot%\system32\vssvc.exe
ObjectName	REG_SZ	LocalSystem
ServiceSidType	REG_DWORD	0x00000001 (1)
Start	REG_DWORD	0x00000003 (3)
Type	REG_DWORD	0x00000010 (16)

3.4 VSS - Analysis

Analyze disk image

```
vshadowinfo -o $((512*206848)) 8d34ce.raw

    Volume Shadow Snapshot information:
        Number of stores:       1

    Store: 1
        Identifier              : 237c8de3-5b99-11e9-9925-080027062798
        Shadow copy set ID      : 33eb3a7b-6d03-4045-aa70-37b714d49c72
        Creation time           : Apr 10, 2019 14:06:30.365699200 UTC
        Shadow copy ID          : 34d9910b-ac1d-4b10-b282-89dde217d0fb
        Volume size             : 11 GiB (12777947136 bytes)
        Attribute flags         : 0x0042000d
```

Mounting VSC: A 2 step approach

```
sudo vshadowmount -o $((512*206848)) 8d34ce.raw /mount/vss/

sudo ls -l /mount/vss/
        -r--r--r-- 1 root root 12777947136 Jan  1  1970 vss1

sudo file /mount/vss/vss1
        /mount/vss/vss1: DOS/MBR boot sector, code offset 0x52+2, OEM-ID "NTFS

sudo mount -o ro /mount/vss/vss1 /mnt/
```

3.5 Prefetch Files & SuperFetch

- Boot prefetching for all Windows
- Application prefetching since XP
  - Monitor an application when it starts
  - Collect information about all resources needed
  - Wait 10sec after application started
    → Know where to find the resources
    → Better performance: App launch faster
    → Better user experience
- Forensics value:
  - Proof an application was started
    - Secondary artifact
    - Created by the OS
    - Not deleted by the attacker
  - Even if the application don't exists anymore
  - And more .....

3.5 Prefetch Files & SuperFetch

- Elements of the file name at `/Windows/Prefetch`
  - Application name
  - One way hash of path to the application
  - File extension: `.pf`
- Example: File system time line

```
Thu May 02 2019 14:52:40
    179712 .a..      10940-128-3  /Windows/notepad.exe

Thu May 02 2019 14:52:50
        56 mac.      42729-144-6  /Windows/Prefetch
     16280 macb      43700-128-4  /Windows/Prefetch/NOTEPAD.EXE-D8414F97.pf
```

- Information found inside a Prefetch file:
  - Run count: How often launched
  - Last time executed
  - Application name incl. parameter
  - Path to application and resources

3.5 Prefetch Files & SuperFetch

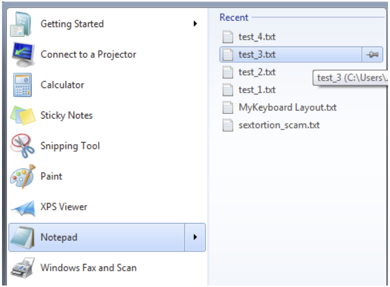
- Parsing a Prefetch file

```
prefetch.py -f NOTEPAD.EXE-D8414F97.pf

        Executable Name: NOTEPAD.EXE
        Run count: 1
        Last Executed: 2019-05-02 12:52:40.339584

        Resources loaded:
        1:      \DEVICE\HARDDISKVOLUME2\WINDOWS\SYSTEM32\NTDLL.DLL
        2:      \DEVICE\HARDDISKVOLUME2\WINDOWS\SYSTEM32\KERNEL32.DLL
        3:      \DEVICE\HARDDISKVOLUME2\WINDOWS\SYSTEM32\APISETSCHEMA.DLL
        4:      \DEVICE\HARDDISKVOLUME2\WINDOWS\SYSTEM32\KERNELBASE.DLL
        .....
        .....
```

- Additional benefits like:
  - User folder where the malware got executed
  - Compare Run count of different VSS could
    → Behavior of user

3.6 Jump Lists

- Since Windows 7
- Recently opened documents of an application
- Similar `RecentDocs` Registry Key



Recent

test_4.txt
test_3.txt
test_2.txt
test_1.txt
MyKeyboard Layout.txt
sextortion_scam.txt

test_3 (C:\Users\

- Rotate or Pin
- `AppData/Roaming/Microsoft/Windows/Recent/AutomaticDestinations`

3.6 Jump Lists

- Jump List file names start with 16 hex characters
- File names end with `.automaticDextinations-ms`

```
C:> dir \Users\John\AppData\Roaming\Microsoft\Windows\Recent\AutomaticDestinations

04/05/2020  12:50            33 792 1b4dd67f29cb1962.automaticDextinations-ms
14/06/2019  16:43             4 608 28c8b86deab549a1.automaticDextinations-ms
10/04/2019  14:32            29 696 6824f4a902c78fbd.automaticDextinations-ms
10/04/2020  14:12             9 216 7e4dca80246863e3.automaticDextinations-ms
04/05/2020  12:50             8 704 918e0ecb43d17e23.automaticDextinations-ms
10/04/2019  14:30             3 072 b74736c2bd8cc8a5.automaticDextinations-ms
09/04/2019  14:43             6 144 de48a32edcbe79e4.automaticDextinations-ms
```

- Each Hex value correspond to an application
- `918e0ecb43d17e23 = Notepad.exe`
- Hex values are fixed world wide
- Search for Jump List IDs

3.6 Jump Lists

- Exercise: Identify applications

```
$ cd JumpLists/AutomaticDestinations/
$ ll

    1b4dd67f29cb1962.automaticDestinations-ms ->
    28c8b86deab549a1.automaticDestinations-ms ->
    6824f4a902c78fbd.automaticDestinations-ms ->
    7e4dca80246863e3.automaticDestinations-ms ->
    918e0ecb43d17e23.automaticDestinations-ms ->
    b74736c2bd8cc8a5.automaticDestinations-ms ->
    de48a32edcbe79e4.automaticDestinations-ms ->
```

- Exercise: Analyze the Notepad Jump List file

3.6 Jump Lists

- Exercise: Identify applications

```
$ cd JumpLists/AutomaticDestinations/
$ ll

    1b4dd67f29cb1962.automaticDestinations-ms --> Windows Explorer
    28c8b86deab549a1.automaticDestinations-ms --> Internet Explorer 8
    6824f4a902c78fbd.automaticDestinations-ms --> Firefox 64.x
    7e4dca80246863e3.automaticDestinations-ms --> Control Panel
    918e0ecb43d17e23.automaticDestinations-ms --> Notepad (32-bit)
    b74736c2bd8cc8a5.automaticDestinations-ms --> WinZip
    de48a32edcbe79e4.automaticDestinations-ms --> Acrobat Reader 15.x
```

- Exercise: Analyze the Notepad Jump List file

3.6 Jump Lists

- Exercise: Identify applications

```
$ cd JumpLists/AutomaticDestinations/
$ ll

    1b4dd67f29cb1962.automaticDestinations-ms --> Windows Explorer
    28c8b86deab549a1.automaticDestinations-ms --> Internet Explorer 8
    6824f4a902c78fbd.automaticDestinations-ms --> Firefox 64.x
    7e4dca80246863e3.automaticDestinations-ms --> Control Panel
    918e0ecb43d17e23.automaticDestinations-ms --> Notepad (32-bit)
    b74736c2bd8cc8a5.automaticDestinations-ms --> WinZip
    de48a32edcbe79e4.automaticDestinations-ms --> Acrobat Reader 15.x
```

- Exercise: Analyze the Notepad Jump List file

```
$ 7z l 918e0ecb43d17e23.automaticDestinations-ms
      Date      Time    Attr         Size   Compressed  Name
------------------- ----- ------------ ------------  ------------
                    .....         1398         1408  2
                    .....         1368         1408  1
                    .....          436          448  4
                    .....          392          448  3

--> file
--> exiftool
--> strings                 --> $ strings -el DestList
```

CIRCL FORENSICS Training

4. Basic Malware Analysis

4.1 PE - Portable Execution format

- Describe program files
- Contain:
  - Meta data
  - Instructions
  - Text data
  - Pictures and alike
- Tell Windows how to load a program
- Provide resources to running program
- Provide resources like code signature

```
 ______________________________________________
|  1. DOS Header                               |
|  2. PE Header                                |
|  3. OPtional Header                          |
|  4. Section Headers                          |
|  5. .text Section (Program Code)             |
|  6. .idata Section (Importd Libs)            |
|  7. .rsrc Section (Strings, Images, ...)     |
|  8. .reloc Section (Memory Translation)      |
|______________________________________________|
```

4.2 PE - Basic Analysis

```
$ file 1.exe
    malware/1.exe: PE32 executable (GUI) Intel 80386, for MS Windows
```

```
$ exiftool 1.exe

    File Name                       : 1.exe
    File Size                       : 300 kB
    .....
    Machine Type                    : Intel 386 or later, and compatibles
    Time Stamp                      : 2007:08:29 02:37:01+02:00
    PE Type                         : PE32
    Linker Version                  : 8.0
    Code Size                       : 57344
    Initialized Data Size           : 3940352
    Uninitialized Data Size         : 0
    Entry Point                     : 0x80c0
    OS Version                      : 4.0
    Subsystem                       : Windows GUI
    File OS                         : Windows NT 32-bit
    Object File Type                : Executable application
    .....
    Company Name                    : iWin Inc.
    File Description                : Furnishings
    Internal Name                   : Gem
    Legal Copyright                 : Dissipates (C) 2014
    Original File Name              : Glittering.exe
```

4.2 PE - Basic Analysis

```
$ file Quotation.exe
     Quotation.exe: PE32 executable (GUI) Intel 80386, for MS Windows


$ exiftool Quotation.exe

     ...
     Machine Type                      : Intel 386 or later, and compatibles
     Time Stamp                        : 2005:08:14 14:47:46+02:00
     PE Type                           : PE32
     Linker Version                    : 6.0
     Code Size                         : 647168
     Initialized Data Size             : 32768
     Uninitialized Data Size           : 0
     Entry Point                       : 0x15f4
     OS Version                        : 4.0
     ...
     Character Set                     : Unicode
     Comments                          : Natcher
     Company Name                      : Glucosazone
     Legal Copyright                   : CRUSTER3
     Legal Trademarks                  : Forearming
     Product Name                      : UNKLE
     File Version                      : 1.02.0009
     Product Version                   : 1.02.0009
     Internal Name                     : Aurous
     Original File Name                : Aurous.exe
```

4.2 PE - Basic Analysis

```
$ python

    >>> import pefile
    >>> pe = pefile.PE("1.exe")
    >>> for section in pe.sections:
     ...      print(section.Name, section.VirtualAddress,
                    section.Misc_VirtualSize, section.SizeOfRawData)
('.text\x00\x00\x00', 4096, 54028, 57344)
('.rdata\x00\x00', 61440, 4360, 8192)
('.data\x00\x00\x00', 69632, 3695044, 4096)
('.rsrc\x00\x00\x00', 3768320, 230456, 233472)



    >>> for entry in pe.DIRECTORY_ENTRY_IMPORT:
     ...     print(entry.dll)
     ...     for function in entry.imports:
     ...         print "\t",function.name

ADVAPI32.dll
        RegOpenKeyExA
        MapGenericMask
        AdjustTokenGroups
        SetSecurityDescriptorDacl
        GetSecurityDescriptorLength
        StartServiceA
        OpenServiceA
.....
```

4.2 PE - Basic Analysis

```
$ strings 1.exe | less

      Microsoft Visual C++ Runtime Library
      ]]       ))
      ImageList_DragEnter
      ImageList_GetDragImage
      UninitializeFlatSB
      ImageList_SetOverlayImage
      ImageList_Merge
      COMCTL32.dll
      OLEAUT32.dll
      RegOpenKeyExA
      OpenServiceA
      StartServiceA
      GetSecurityDescriptorLength
      SetSecurityDescriptorDacl
      AdjustTokenGroups
      MapGenericMask
      ADVAPI32.dll
      .....


  mkdir images
$ wrestool -x 1.exe -o images/
```

4.2 PE - Basic Analysis

```
$ strings Quotation.exe | less

    .....
    Damenization
    royle6
    nonexpedience
    incorporating1
    PEAS
    SIMOONS
    extramarginal
    ursula
    floricultural
    brainstorms
    NODDIES
    SCALOPUS9
    DEADHEADED
    lushai5
    elenchi7
    k40[
    VB5!6&*


  mkdir images
$ wrestool -x Quotation.exe -o images/
```

4.3 Enrich Online

- Calculate hash values

```
$ md5sum 1.exe
     a3bd288dec191caaed2057590e0dc34f

$ md5sum Quotation.*
e3f0a2033a78e307a71320217ef738bc  Quotation.exe
84617d594af613f77deb32927123f779  Quotation.zip
```

- www.virustotal.com

  → Live Demo

  → Pro. Account

  → Why not uploading office documents?

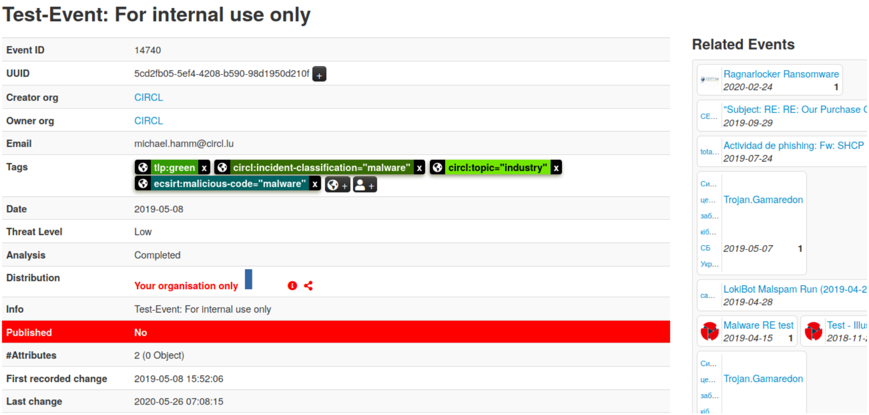
- MISP - Open Source Threat Intelligence Platform

  `https://www.misp-project.org/`

  `https://circl.lu/services/misp-malware-information-sharing-platform/`

  → Live Demo

4.3 Enrich Online



Test-Event: For internal use only

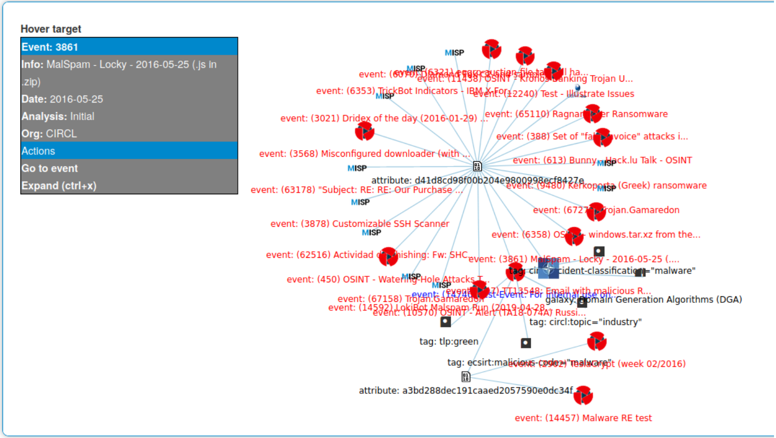
Event ID	14740
UUID	5cd2fb05-5ef4-4208-b590-98d1950d210f +
Creator org	CIRCL
Owner org	CIRCL
Email	michael.hamm@circl.lu
Tags	tlp:green x circl:incident-classification="malware" x circl:topic="industry" x ecsirt:malicious-code="malware" x + +
Date	2019-05-08
Threat Level	Low
Analysis	Completed
Distribution	Your organisation only
Info	Test-Event: For internal use only
Published	No
#Attributes	2 (0 Object)
First recorded change	2019-05-08 15:52:06
Last change	2020-05-26 07:08:15

Related Events

- Ragnarlocker Ransomware 2020-02-24 1
- CE… "Subject: RE: RE: Our Purchase C 2019-09-29
- tota… Actividad de phishing: Fw: SHCP 2019-07-24
- Си… це… заб… кіб… СБ Укр… Trojan.Gamaredon 2019-05-07 1
- ca… LokiBot Malspam Run (2019-04-2 2019-04-28
- Malware RE test 2019-04-15 1
- Test - Illus 2018-11-
- Си… це… заб… кіб… Trojan.Gamaredon

Event Overview: https://misppriv.circl.lu/

4.3 Enrich Online



Hover target

Event: 3861

Info: MalSpam - Locky - 2016-05-25 (.js in .zip)

Date: 2016-05-25

Analysis: Initial

Org: CIRCL

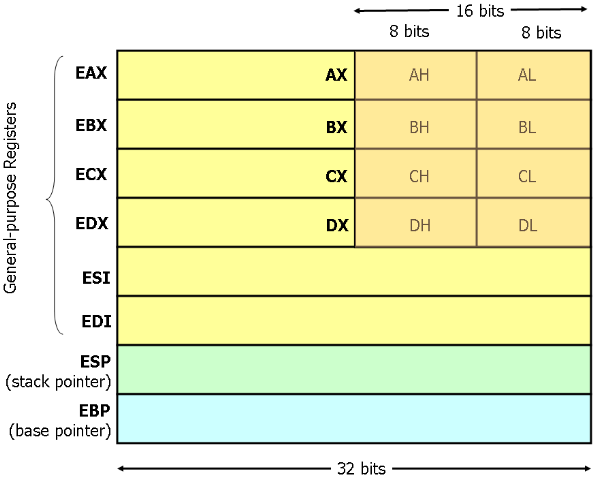
Actions
Go to event
Expand (ctrl+x)
event: (6070) Diamond Fox C2 sample
event: (6321) eggp-auction-file ta... ll ha...
event: (11438) OSINT - Kronos Banking Trojan U...
event: (6353) TrickBot Indicators - IBM X-For...
event: (12240) Test - Illustrate Issues
event: (3021) Dridex of the day (2016-01-29) ...
event: (65110) Ragnar... er Ransomware
event: (388) Set of "fa... voice" attacks i...
event: (3568) Misconfigured downloader (with ...
event: (613) Bunny - Hack.lu Talk - OSINT
attribute: d41d8cd98f00b204e9800998ecf8427e
event: (63178) "Subject: RE: RE: Our Purchase ...
event: (9480) Kerkoporta (Greek) ransomware
event: (6727... rojan.Gamaredon
event: (3878) Customizable SSH Scanner
event: (6358) OS... - windows.tar.xz from the...
event: (62516) Actividad d... hishing: Fw: SHC
event: (3861) MalSpam - Locky - 2016-05-25 (....
tag: ci... cident-classification="malware"
event: (450) OSINT - Watering-Hole Attacks T...
event: ...7) TT13548: Email with malicious R...
event: (14746) ...st-Event: For internal use on...
galaxy: Domain Generation Algorithms (DGA)
event: (67158) Trojan.Gamaredon
event: (14592) LokiBot Malspam Run (2019-04-28...
event: (10570) OSINT - Alert (TA18-074A) Russi...
tag: circl:topic="industry"
tag: tlp:green
tag: ecsirt:malicious-code="malware"
event: (2962) TeslaCrypt (week 02/2016)
attribute: a3bd288dec191caaed2057590e0dc34f
event: (14457) Malware RE test
MISP

Correlation Graph: https://misppriv.circl.lu/

4.4 Static Analysis

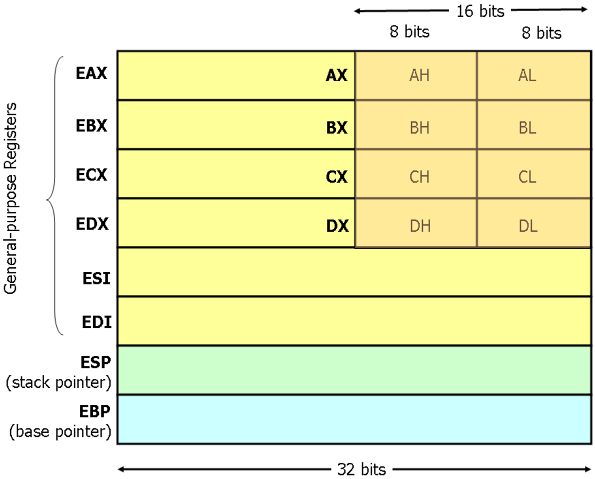
- Perfect disassembly → Unsolved problem
- Linear disassembly
  - Identify the program code
  - Decode the bytes
- Linear disassembly limitations
  - Don't know how instructions get decoded by CPU
  - Could not counter fight obfuscation
- Obfuscation techniques
  - Packing
  - Resource Obfuscation
  - Anti-Disassembly
  - Dynamic Data Download
- Counter fight obfuscation
  - Dynamic Analysis
  - Run malware in isolated environment

4.5 x86 Assembly: General-Purpose Registers



https://www.cs.virginia.edu/ evans/cs216/guides/x86.html

4.5 x86 Assembly: Stack and Control Flow Registers



16 bits

8 bits

8 bits

General-purpose Registers

EAX AX AH AL

EBX BX BH BL

ECX CX CH CL

EDX DX DH DL

ESI

EDI

ESP (stack pointer)

EBP (base pointer)

32 bits

https://www.cs.virginia.edu/ evans/cs216/guides/x86.html

4.5 x86 Assembly: Instructions

```
Arithmetic:       add ebx, 100        Adds 100 to the value in EBX
                  sub ecx, 123        Substract 123 from the value in ECX
                  inc ah              Increments value in AH by 1
                  dec al              Decrements value in AL by 1

Data Movement:    mov eax, ebx        Move value in EBX into register EAX
                  mov eax, [0x4711]   Move value at memory 0x4711 intp EAX
                  mov eax, 1          Move the value 1 into register EAX
                  mov [0x4711], eax   Move value of EAX into memory 0x4711

Stack:            push 1              Increment ESP; Store 1 on top of stack
                  pop eax             Store highest value in EAX; Decrement ESP

Control Flow:     call [address]      1. Put EIP on top of the stack
                                      2. Put [address] into EIP
                  ret                 1. Popped top of teh stack into EIP
                                      2. Resume execution
                  jmp 0x1234          Start executing progamm code at 0x1234
                  cmp eax, 100        1. Compares value in EAX with 100
                                      2. Based on result set EFLAGS register
                  jge 0x1234          1. Interpret EFLAGS register
                                      2. If 'greater' or 'equal' flag then jump
```

4.5 x86 Assembly: Control Flow Graphs

```
start:              Symbol for address of next instruction
mov eax, 3          Initialize a counter of 3 into EAX

loop:               Symbol for address of next instruction
sub eax, 1          Substract 1 from value in EAX
cmp 0, eax          Compare value in EAX with 0; Set EFLAGS
jne $loop           IF EFLAGS 'not equal' jump to 'loop'

end:                Symbol for address of next instruction
mov eax, 12
```

.

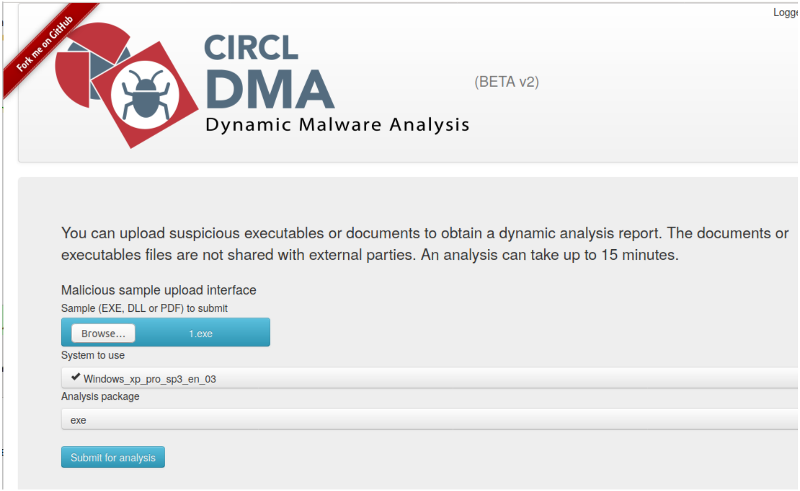
4.5 x86 Assembly: Control Flow Graphs

```
start:              Symbol for address of next instruction
mov eax, 3          Initialize a counter of 3 into EAX

loop:               Symbol for address of next instruction
sub eax, 1          Substract 1 from value in EAX
cmp 0, eax          Compare value in EAX with 0; Set EFLAGS
jne $loop           IF EFLAGS 'not equal' jump to 'loop'

end:                Symbol for address of next instruction
mov eax, 12
```

```
   ______________    ______>   ______________    ______>   ______________
  | start:       |     ___>   | loop:        |            | end:         |
  | ____________ |    |       | ____________ |            | ____________ |
  |              |    |       |              |            |              |
  | mov eax, 3   |    |       | sub eax, 1   |            | mov eax, 12  |
  |              |    |       | cmp 0, eax   |            |              |
   ______________     ____    | jne $loop    |             ______________
                              |              |
                               ______________
```

.

4.6 Dynamic Analysis



You can upload suspicious executables or documents to obtain a dynamic analysis report. The documents or executables files are not shared with external parties. An analysis can take up to 15 minutes.

Malicious sample upload interface

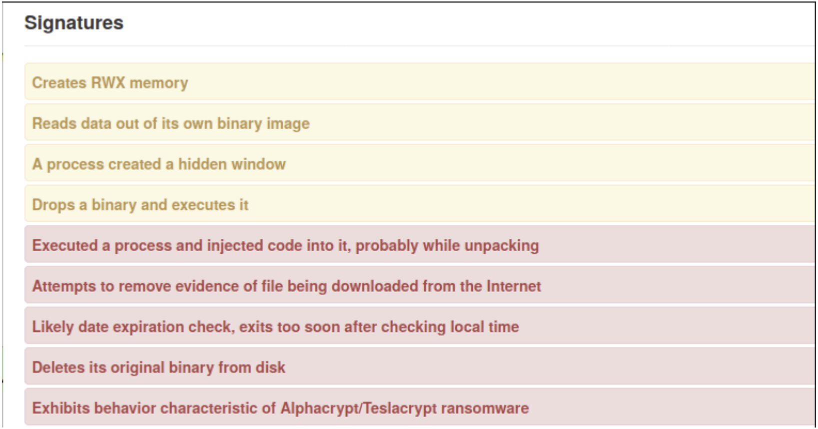
Sample (EXE, DLL or PDF) to submit: 1.exe

System to use: ✔ Windows_xp_pro_sp3_en_03

Analysis package: exe

Upload a 1.exe: https://circl.lu/services/dynamic-malware-analysis/

4.6 Dynamic Analysis

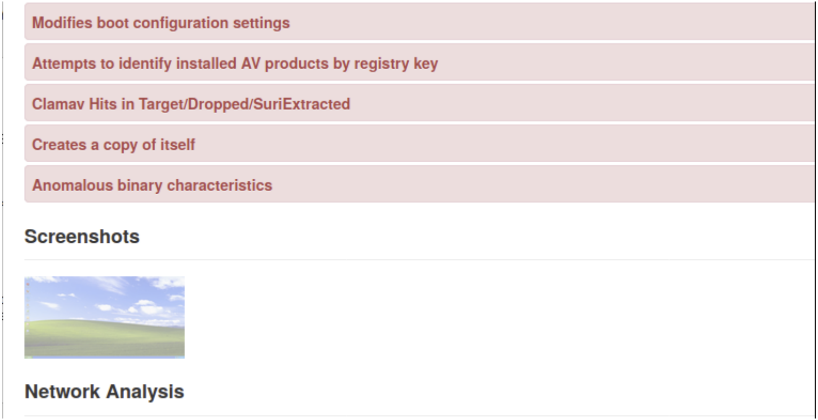


Signatures

- Creates RWX memory
- Reads data out of its own binary image
- A process created a hidden window
- Drops a binary and executes it
- Executed a process and injected code into it, probably while unpacking
- Attempts to remove evidence of file being downloaded from the Internet
- Likely date expiration check, exits too soon after checking local time
- Deletes its original binary from disk
- Exhibits behavior characteristic of Alphacrypt/Teslacrypt ransomware

Signatures and Screenshots: https://circl.lu/services/dynamic-malware-analysis/

4.6 Dynamic Analysis



Modifies boot configuration settings

Attempts to identify installed AV products by registry key

Clamav Hits in Target/Dropped/SuriExtracted

Creates a copy of itself

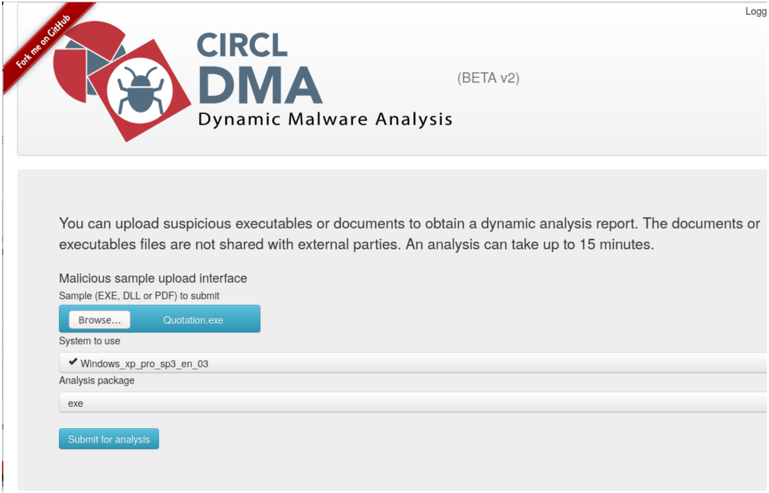
Anomalous binary characteristics

Screenshots

Network Analysis

Signatures and Screenshots: https://circl.lu/services/dynamic-malware-analysis/

4.6 Dynamic Analysis



You can upload suspicious executables or documents to obtain a dynamic analysis report. The documents or executables files are not shared with external parties. An analysis can take up to 15 minutes.

Malicious sample upload interface

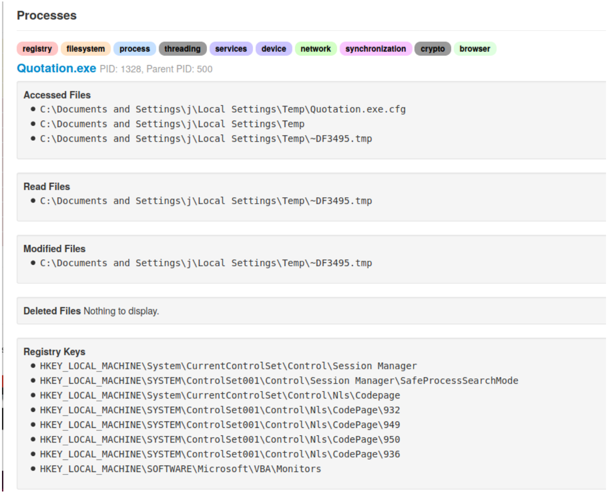
Sample (EXE, DLL or PDF) to submit: Quotation.exe

System to use: ✔ Windows_xp_pro_sp3_en_03

Analysis package: exe

Upload a Quotation.exe: https://circl.lu/services/dynamic-malware-analysis/

4.6 Dynamic Analysis



Processes

Quotation.exe PID: 1328, Parent PID: 500

Accessed Files

- C:\Documents and Settings\j\Local Settings\Temp\Quotation.exe.cfg
- C:\Documents and Settings\j\Local Settings\Temp
- C:\Documents and Settings\j\Local Settings\Temp\~DF3495.tmp

Read Files

- C:\Documents and Settings\j\Local Settings\Temp\~DF3495.tmp

Modified Files

- C:\Documents and Settings\j\Local Settings\Temp\~DF3495.tmp

Deleted Files Nothing to display.

Registry Keys

- HKEY_LOCAL_MACHINE\System\CurrentControlSet\Control\Session Manager
- HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Control\Session Manager\SafeProcessSearchMode
- HKEY_LOCAL_MACHINE\System\CurrentControlSet\Control\Nls\Codepage
- HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Control\Nls\CodePage\932
- HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Control\Nls\CodePage\949
- HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Control\Nls\CodePage\950
- HKEY_LOCAL_MACHINE\SYSTEM\ControlSet001\Control\Nls\CodePage\936
- HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\VBA\Monitors

Access to Files and Registry: https://circl.lu/services/dynamic-malware-analysis/

CIRCL
FORENSICS Training

5. Analysing files

5.1 Analysing files

- Standard Linux commands

```
file
strings
exiftool
md5sum, sha1sum
7z
.....
```

- Dedicated tools

```
oledump.py
pdfid.py, pdf-parser.py
VirusTotal tools
.....
```

- Exercise: Run `exiftool` on carving recovered documents

5.2 Analysing files

- Online resources

  NSRL - National Software Reference Library
  VirusTotal
  CIRCL: DMA
  CIRCL: MISP Threat Sharing Platform

- Demo: Search MD5

  ```
  A479C4E7ED87AEDAFAD7D9936DC80115
  81e9036aed5502446654c8e5a1770935
  ```

- Analysing files could become a training on it's own

CIRCL FORENSICS Training

6. Live Response

6.1 Volatile Data

- Memory dump
- Live analysis:
  → System time
  → Logged-on users
  → Open files
  → Network -connections -status
  → Process information -memory
  → Process / port mapping
  → Clipboard content
  → Services
  → Command history
  → Mapped drives / shares
  → !!! Do not store information on the subject system !!!
- Image of live system (Possible issues)
- Shutdown and image if possible

6.1 Collecting Volatile Data

```
https://docs.microsoft.com/en-us/sysinternals/
```

- System Time

```
> date /t & time /t              # Don't foget to note wall-clock-time
    Tue 03/26/2019               # Note timezone of PC
    01:31 PM
```

- Loggedon Users

```
> net session

> .\PsLoggedon.exe
    Users logged on locally:
         3/26/2019 1:30:23 PM       John-PC\John
    No one is logged on via resource shares.

> .\logonsessions.exe
    [5] Logon session 00000000:0001ad9d:
        User name:     John-PC\John
        Auth package: NTLM
        Logon type:    Interactive
        Session:       1
        Sid:           S-1-5-21-3031575581-801213887-4188682232-1001
        Logon time:    3/26/2019 1:30:23 PM
        Logon server: JOHN-PC
```

6.1 Collecting Volatile Data

- Open Files

```
> net file
```

```
> .\psfile.exe
```

- Network Connections and Status

```
> netstat -anob
    Proto  Local Address       Foreign Address     State          PID    RpcSs
    TCP    0.0.0.0:135         0.0.0.0:0           LISTENING      696    [svchost.exe]
    TCP    0.0.0.0:445         0.0.0.0:0           LISTENING      4
    TCP    0.0.0.0:554         0.0.0.0:0           LISTENING      2504   [wmpnetwk.exe]
    TCP    0.0.0.0:10243       0.0.0.0:0           LISTENING      4
    TCP    0.0.0.0:49152       0.0.0.0:0           LISTENING      364    [wininit.exe]
```

```
> netstat -rn
    Network Destination          Netmask          Gateway        Interface  Metric
              0.0.0.0            0.0.0.0         10.0.2.2        10.0.2.15      10
             10.0.2.0      255.255.255.0         On-link         10.0.2.15     266
            10.0.2.15    255.255.255.255         On-link         10.0.2.15     266
```

```
> ipconfig /all
```

6.1 Collecting Volatile Data

- Running Processes

```
> tasklist
  Image Name                     PID Session Name        Session#    Mem Usage
  ========================= ======== ================ =========== ============
  System                           4 Services                   0        600 K
  smss.exe                       252 Services                   0        792 K
  csrss.exe                      328 Services                   0      3,224 K
  wininit.exe                    364 Services                   0      3,316 K
  csrss.exe                      372 Console                    1      4,196 K
  winlogon.exe                   400 Console                    1      6,272 K
  services.exe                   460 Services                   0      6,628 K
  lsass.exe                      468 Services                   0      8,428 K
  lsm.exe                        476 Services                   0      3,040 K
  svchost.exe                    584 Services                   0      6,596 K
  cmd.exe                       3100 Console                    1      2,480 K

> tasklist /svc
  Image Name                     PID Services
  ========================= ======== ============================================
  svchost.exe                    584 DcomLaunch, PlugPlay, Power
  svchost.exe                    696 RpcEptMapper, RpcSs
  svchost.exe                    792 Audiosrv, Dhcp, eventlog,
                                     HomeGroupProvider, lmhosts, wscsvc
  svchost.exe                    844 AudioEndpointBuilder, CscService,
                                     HomeGroupListener, Netman, TrkWks, UxSms,
  svchost.exe                    876 EventSystem, fdPHost, FontCache, netprofm,
                                     nsi, WdiServiceHost
```

6.1 Collecting Volatile Data

- Running Processes

```
> .\pslist.exe -x

> .\pslist.exe -t
    Name                                Pid  Pri  Thd   Hnd      VM     WS   Priv
    explorer                           1252    8   26   912  212044  47672  36304
      VBoxTray                          360    8   12   153   61384   5624   1476
      cmd                               548    8    1    24   29256   2564   2628
        pslist                         3452   13    1   123   45908   3640   1652
      WzPreloader                      1244    8    6   119  109748   9064  11224
      cmd                              3100    8    1    20   27464   2480   1804

> .\Listdlls.exe

> .\handle.exe
```

- Processes/Port Mapping

```
> .\tcpvcon -n -c -a
    TCP,svchost.exe,692,LISTENING,0.0.0.0,0.0.0.0
    TCP,System,4,LISTENING,10.0.2.15,0.0.0.0
    TCP,wmpnetwk.exe,2428,LISTENING,0.0.0.0,0.0.0.0
    TCP,wininit.exe,364,LISTENING,0.0.0.0,0.0.0.0
    TCP,svchost.exe,776,LISTENING,0.0.0.0,0.0.0.0
    TCP,svchost.exe,896,LISTENING,0.0.0.0,0.0.0.0
    TCP,services.exe,460,LISTENING,0.0.0.0,0.0.0.0
```

6.1 Collecting Volatile Data

- Command History

```
> doskey /history
    netstat -anob
    .\Listdlls.exe
    .\handle.exe
    .\tcpvcon -n -c -a
    cls
    doskey /history
```

- Processes/Port Mapping

6.2 Non Volatile Data

- Clear Pagefile at shutdown

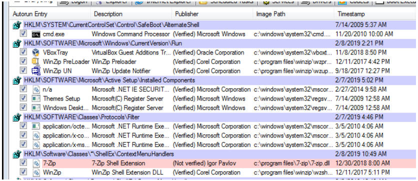
```
> reg QUERY "HKLM\SYSTEM\CurrentControlSet\Control\Session Manager\Memory Management"
  .....
  ClearPageFileAtShutdown    REG_DWORD    0x0
  .....
```

- Update Last Access disabled

```
> reg QUERY "HKLM\SYSTEM\CurrentControlSet\Control\FileSystem"
  .....
  NtfsDisableLastAccessUpdate    REG_DWORD    0x0
  .....
```

- Autostart locations

```
> .\Autoruns.exe
```



Autorun Entry	Description	Publisher	Image Path	Timestamp
HKLM\SYSTEM\CurrentControlSet\Control\SafeBoot\AlternateShell				7/14/2009 5:37 AM
☑ cmd.exe	Windows Command Processor	(Verified) Microsoft Windows	c:\windows\system32\cmd....	11/20/2010 10:00 AM
HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run				2/8/2019 2:21 PM
☑ VBoxTray	VirtualBox Guest Additions Tr...	(Verified) Oracle Corporation	c:\windows\system32\vboxt...	11/8/2018 8:50 PM
☑ WinZip PreLoader	WinZip Preloader	(Verified) Corel Corporation	c:\program files\winzip\wzpr...	12/11/2017 4:42 PM
☑ WinZip UN	WinZip Update Notifier	(Verified) Corel Corporation	c:\program files\winzip\wzup...	9/18/2017 12:27 PM
HKLM\SOFTWARE\Microsoft\Active Setup\Installed Components				2/7/2019 5:02 PM
☑ n/a	Microsoft .NET IE SECURIT...	(Verified) Microsoft Corporation	c:\windows\system32\mscor...	2/27/2014 9:58 AM
☑ Themes Setup	Microsoft(C) Register Server	(Verified) Microsoft Windows	c:\windows\system32\regsv...	7/14/2009 12:58 AM
☑ Windows Deskt...	Microsoft(C) Register Server	(Verified) Microsoft Windows	c:\windows\system32\regsv...	7/14/2009 12:58 AM
HKLM\SOFTWARE\Classes\Protocols\Filter				2/7/2019 4:46 PM
☑ application/octe...	Microsoft .NET Runtime Exe...	(Verified) Microsoft Corporation	c:\windows\system32\mscor...	3/5/2010 4:06 AM
☑ application/x-co...	Microsoft .NET Runtime Exe...	(Verified) Microsoft Corporation	c:\windows\system32\mscor...	3/5/2010 4:06 AM
☑ application/x-ms...	Microsoft .NET Runtime Exe...	(Verified) Microsoft Corporation	c:\windows\system32\mscor...	3/5/2010 4:06 AM
HKLM\Software\Classes\*\ShellEx\ContextMenuHandlers				2/8/2019 10:49 AM
☑ 7-Zip	7-Zip Shell Extension	(Not verified) Igor Pavlov	c:\program files\7-zip\7-zip.dll	12/30/2018 8:00 AM
☑ WinZip	WinZip Shell Extension DLL	(Verified) Corel Corporation	c:\program files\winzip\wzsh...	12/11/2017 5:11 PM

6.3 Across the network

- Get Nmap command-line zipfile

  `https://nmap.org/download.html`

- On Linux set up a netcat listener

```
nc -k -l 9999 >> logfile.txt
```

- Sending from subject system

```
ncat aaa.bbb.ccc.ddd 9999

echo "Date and Time" | ncat.exe aaa.bbb.ccc.ddd 9999
date /t | ncat.exe aaa.bbb.ccc.ddd 9999
time /t | ncat.exe aaa.bbb.ccc.ddd 9999
echo "————————————" | ncat.exe aaa.bbb.ccc.ddd 9999
```

CIRCL FORENSICS Training

7. Memory Forensics

7.1 About Memory Forensics

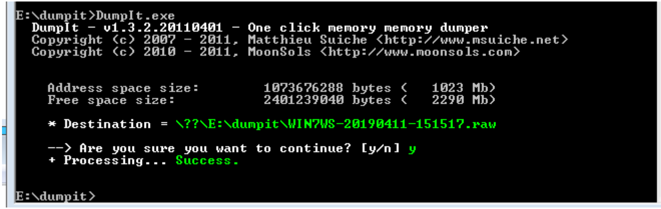
- Information expected
  - Network connections
  - Processes (hidden)
  - Services (listening)
  - Malware
  - Registry content
  - DLL analysis
  - Passwords in clear text
- History
  - 2005: String search
  - → EProcess structures
- Finding EProcess structures
  - Find the doubly linked list (ntoskrnl.exe)
  - Brute Force searching

7.2 Get your memory dump

- Page file, swap area: `pagefile.sys`
- Memory dump

  `http://www.msuiche.net`

  `DumpIt.exe`



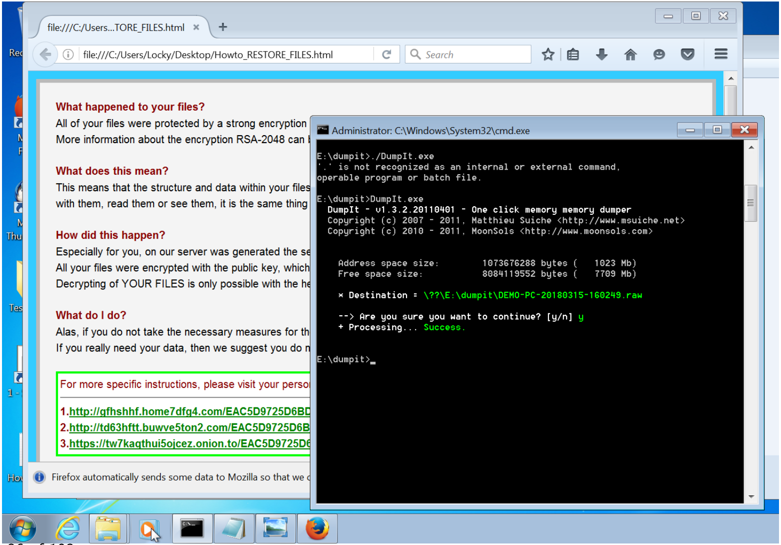
```
E:\dumpit>DumpIt.exe
  DumpIt - v1.3.2.20110401 - One click memory memory dumper
  Copyright (c) 2007 - 2011, Matthieu Suiche <http://www.msuiche.net>
  Copyright (c) 2010 - 2011, MoonSols <http://www.moonsols.com>


    Address space size:        1073676288 bytes (   1023 Mb)
    Free space size:           2401239040 bytes (   2290 Mb)

    * Destination = \??\E:\dumpit\WIN7WS-20190411-151517.raw

    --> Are you sure you want to continue? [y/n] y
    + Processing... Success.

E:\dumpit>
```

- Hibernation file: `hiberfil.sys`

  `powercfg /h[ibernate] [on|off]`

  `psshutdown -h`

7.2 DumpIt


file:///C:/Users...TORE_FILES.html
file:///C:/Users/Locky/Desktop/Howto_RESTORE_FILES.html
Search
Administrator: C:\Windows\System32\cmd.exe

What happened to your files?

All of your files were protected by a strong encryption
More information about the encryption RSA-2048 can b

What does this mean?

This means that the structure and data within your files
with them, read them or see them, it is the same thing

How did this happen?

Especially for you, on our server was generated the se
All your files were encrypted with the public key, which
Decrypting of YOUR FILES is only possible with the he

What do I do?

Alas, if you do not take the necessary measures for th
If you really need your data, then we suggest you do n

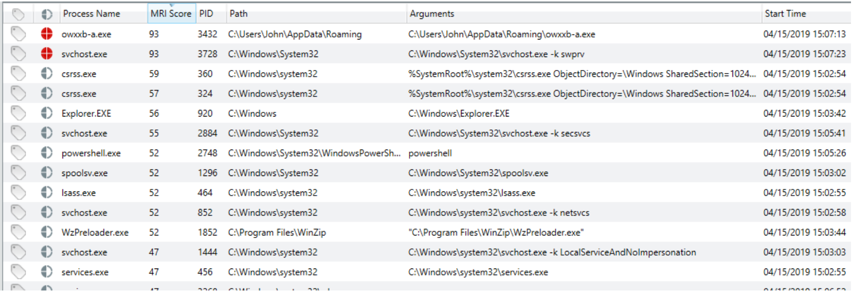
For more specific instructions, please visit your perso

1.http://gfhshhf.home7dfg4.com/EAC5D9725D6BD
2.http://td63hftt.buwve5ton2.com/EAC5D9725D6B
3.https://tw7kaqthui5ojcez.onion.to/EAC5D9725D6

Firefox automatically sends some data to Mozilla so that we c

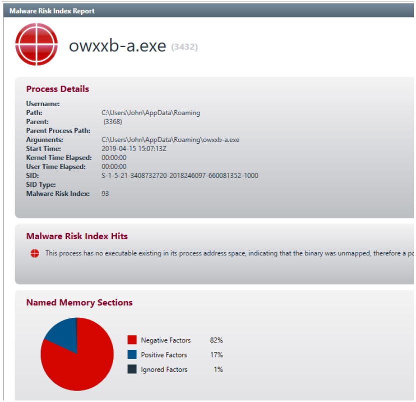
```
E:\dumpit>./DumpIt.exe
'.' is not recognized as an internal or external command,
operable program or batch file.

E:\dumpit>DumpIt.exe
  DumpIt - v1.3.2.20110401 - One click memory memory dumper
  Copyright (c) 2007 - 2011, Matthieu Suiche <http://www.msuiche.net>
  Copyright (c) 2010 - 2011, MoonSols <http://www.moonsols.com>


    Address space size:        1073676288 bytes (   1023 Mb)
    Free space size:           8084119552 bytes (   7709 Mb)

    * Destination = \??\E:\dumpit\DEMO-PC-20180315-160249.raw

    --> Are you sure you want to continue? [y/n] y
    + Processing... Success.


E:\dumpit>_
```

7.3 Mandiant Redline - Malware Risk Index



	Process Name	MRI Score	PID	Path	Arguments	Start Time
●	owxxb-a.exe	93	3432	C:\Users\John\AppData\Roaming	C:\Users\John\AppData\Roaming\owxxb-a.exe	04/15/2019 15:07:13
●	svchost.exe	93	3728	C:\Windows\System32	C:\Windows\System32\svchost.exe -k swprv	04/15/2019 15:07:23
◐	csrss.exe	59	360	C:\Windows\system32	%SystemRoot%\system32\csrss.exe ObjectDirectory=\Windows SharedSection=1024...	04/15/2019 15:02:54
◐	csrss.exe	57	324	C:\Windows\system32	%SystemRoot%\system32\csrss.exe ObjectDirectory=\Windows SharedSection=1024...	04/15/2019 15:02:54
◐	Explorer.EXE	56	920	C:\Windows	C:\Windows\Explorer.EXE	04/15/2019 15:03:42
◐	svchost.exe	55	2884	C:\Windows\System32	C:\Windows\System32\svchost.exe -k secsvcs	04/15/2019 15:05:41
◐	powershell.exe	52	2748	C:\Windows\System32\WindowsPowerSh...	powershell	04/15/2019 15:05:26
◐	spoolsv.exe	52	1296	C:\Windows\System32	C:\Windows\System32\spoolsv.exe	04/15/2019 15:03:02
◐	lsass.exe	52	464	C:\Windows\system32	C:\Windows\system32\lsass.exe	04/15/2019 15:02:55
◐	svchost.exe	52	852	C:\Windows\system32	C:\Windows\system32\svchost.exe -k netsvcs	04/15/2019 15:02:58
◐	WzPreloader.exe	52	1852	C:\Program Files\WinZip	"C:\Program Files\WinZip\WzPreloader.exe"	04/15/2019 15:03:44
◐	svchost.exe	47	1444	C:\Windows\system32	C:\Windows\system32\svchost.exe -k LocalServiceAndNoImpersonation	04/15/2019 15:03:03
◐	services.exe	47	456	C:\Windows\system32	C:\Windows\system32\services.exe	04/15/2019 15:02:55

7.3 Mandiant Redline - Malware Risk Index



Malware Risk Index Report

owxxb-a.exe (3432)

Process Details

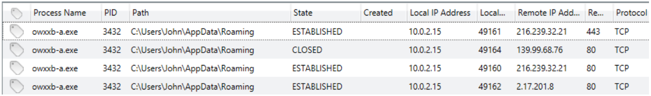
Username:
Path: C:\Users\John\AppData\Roaming
Parent: (3368)
Parent Process Path:
Arguments: C:\Users\John\AppData\Roaming\owxxb-a.exe
Start Time: 2019-04-15 15:07:13Z
Kernel Time Elapsed: 00:00:00
User Time Elapsed: 00:00:00
SID: S-1-5-21-3408732720-2018246097-660081352-1000
SID Type:
Malware Risk Index: 93

Malware Risk Index Hits

This process has no executable existing in its process address space, indicating that the binary was unmapped, therefore a po

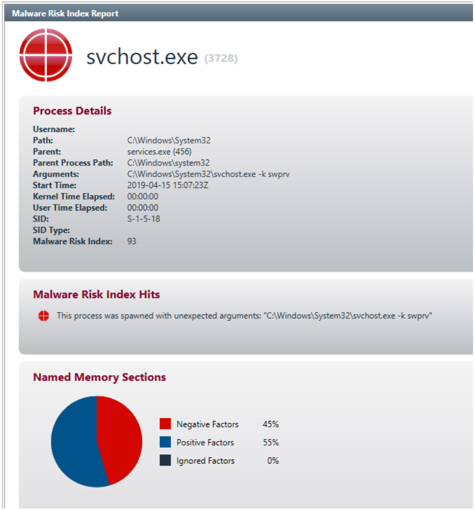
Named Memory Sections

🟥	Negative Factors	82%
🟦	Positive Factors	17%
■	Ignored Factors	1%



	Process Name	PID	Path	State	Created	Local IP Address	Local...	Remote IP Add...	Re...	Protocol
	owxxb-a.exe	3432	C:\Users\John\AppData\Roaming	ESTABLISHED		10.0.2.15	49161	216.239.32.21	443	TCP
	owxxb-a.exe	3432	C:\Users\John\AppData\Roaming	CLOSED		10.0.2.15	49164	139.99.68.76	80	TCP
	owxxb-a.exe	3432	C:\Users\John\AppData\Roaming	ESTABLISHED		10.0.2.15	49160	216.239.32.21	80	TCP
	owxxb-a.exe	3432	C:\Users\John\AppData\Roaming	ESTABLISHED		10.0.2.15	49162	2.17.201.8	80	TCP

7.3 Mandiant Redline - Malware Risk Index



Malware Risk Index Report

svchost.exe (3728)

Process Details

Username:	
Path:	C:\Windows\System32
Parent:	services.exe (456)
Parent Process Path:	C:\Windows\system32
Arguments:	C:\Windows\System32\svchost.exe -k swprv
Start Time:	2019-04-15 15:07:23Z
Kernel Time Elapsed:	00:00:00
User Time Elapsed:	00:00:00
SID:	S-1-5-18
SID Type:	
Malware Risk Index:	93

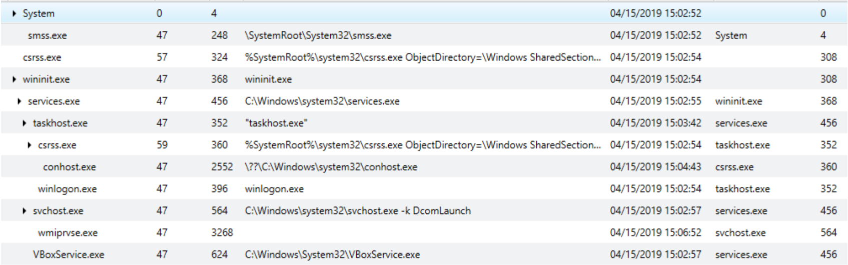
Malware Risk Index Hits

This process was spawned with unexpected arguments: "C:\Windows\System32\svchost.exe -k swprv"

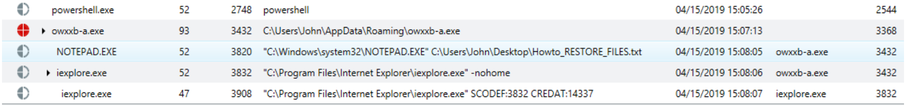
Named Memory Sections

🟥	Negative Factors	45%
🟦	Positive Factors	55%
⬛	Ignored Factors	0%

7.3 Mandiant Redline - Hierarchical

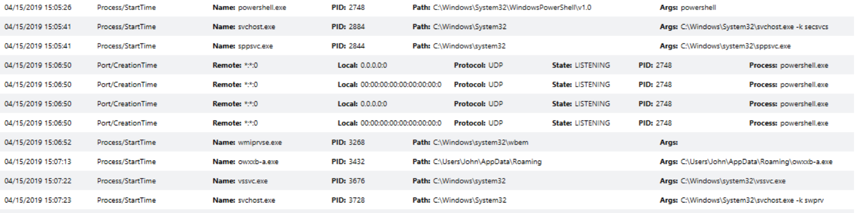


▸ System	0	4		04/15/2019 15:02:52		0
smss.exe	47	248	\SystemRoot\System32\smss.exe	04/15/2019 15:02:52	System	4
csrss.exe	57	324	%SystemRoot%\system32\csrss.exe ObjectDirectory=\Windows SharedSection...	04/15/2019 15:02:54		308
▸ wininit.exe	47	368	wininit.exe	04/15/2019 15:02:54		308
▸ services.exe	47	456	C:\Windows\system32\services.exe	04/15/2019 15:02:55	wininit.exe	368
▸ taskhost.exe	47	352	"taskhost.exe"	04/15/2019 15:03:42	services.exe	456
▸ csrss.exe	59	360	%SystemRoot%\system32\csrss.exe ObjectDirectory=\Windows SharedSection...	04/15/2019 15:02:54	taskhost.exe	352
conhost.exe	47	2552	\??\C:\Windows\system32\conhost.exe	04/15/2019 15:04:43	csrss.exe	360
winlogon.exe	47	396	winlogon.exe	04/15/2019 15:02:54	taskhost.exe	352
▸ svchost.exe	47	564	C:\Windows\system32\svchost.exe -k DcomLaunch	04/15/2019 15:02:57	services.exe	456
wmiprvse.exe	47	3268		04/15/2019 15:06:52	svchost.exe	564
VBoxService.exe	47	624	C:\Windows\System32\VBoxService.exe	04/15/2019 15:02:57	services.exe	456

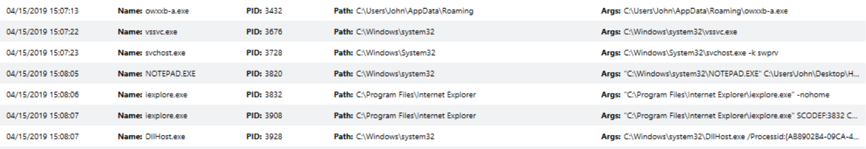


◐	powershell.exe	52	2748	powershell	04/15/2019 15:05:26		2544
⊕	▸ owxxb-a.exe	93	3432	C:\Users\John\AppData\Roaming\owxxb-a.exe	04/15/2019 15:07:13		3368
◐	NOTEPAD.EXE	52	3820	"C:\Windows\system32\NOTEPAD.EXE" C:\Users\John\Desktop\Howto_RESTORE_FILES.txt	04/15/2019 15:08:05	owxxb-a.exe	3432
◐	▸ iexplore.exe	52	3832	"C:\Program Files\Internet Explorer\iexplore.exe" -nohome	04/15/2019 15:08:06	owxxb-a.exe	3432
◐	iexplore.exe	47	3908	"C:\Program Files\Internet Explorer\iexplore.exe" SCODEF:3832 CREDAT:14337	04/15/2019 15:08:07	iexplore.exe	3832

7.3 Mandiant Redline - Timeline



```
04/15/2019 15:05:26  Process/StartTime  Name: powershell.exe  PID: 2748  Path: C:\Windows\System32\WindowsPowerShell\v1.0  Args: powershell
04/15/2019 15:05:41  Process/StartTime  Name: svchost.exe     PID: 2884  Path: C:\Windows\System32                         Args: C:\Windows\System32\svchost.exe -k secsvcs
04/15/2019 15:05:41  Process/StartTime  Name: sppsvc.exe      PID: 2844  Path: C:\Windows\system32                         Args: C:\Windows\system32\sppsvc.exe
04/15/2019 15:06:50  Port/CreationTime  Remote: *:*:0  Local: 0.0.0.0:0                    Protocol: UDP  State: LISTENING  PID: 2748  Process: powershell.exe
04/15/2019 15:06:50  Port/CreationTime  Remote: *:*:0  Local: 00:00:00:00:00:00:00:00:0    Protocol: UDP  State: LISTENING  PID: 2748  Process: powershell.exe
04/15/2019 15:06:50  Port/CreationTime  Remote: *:*:0  Local: 0.0.0.0:0                    Protocol: UDP  State: LISTENING  PID: 2748  Process: powershell.exe
04/15/2019 15:06:50  Port/CreationTime  Remote: *:*:0  Local: 00:00:00:00:00:00:00:00:0    Protocol: UDP  State: LISTENING  PID: 2748  Process: powershell.exe
04/15/2019 15:06:52  Process/StartTime  Name: wmiprvse.exe    PID: 3268  Path: C:\Windows\system32\wbem                    Args:
04/15/2019 15:07:13  Process/StartTime  Name: owxxb-a.exe     PID: 3432  Path: C:\Users\John\AppData\Roaming               Args: C:\Users\John\AppData\Roaming\owxxb-a.exe
04/15/2019 15:07:22  Process/StartTime  Name: vssvc.exe       PID: 3676  Path: C:\Windows\system32                         Args: C:\Windows\system32\vssvc.exe
04/15/2019 15:07:23  Process/StartTime  Name: svchost.exe     PID: 3728  Path: C:\Windows\System32                         Args: C:\Windows\System32\svchost.exe -k swprv
```



```
04/15/2019 15:07:13  Name: owxxb-a.exe   PID: 3432  Path: C:\Users\John\AppData\Roaming          Args: C:\Users\John\AppData\Roaming\owxxb-a.exe
04/15/2019 15:07:22  Name: vssvc.exe     PID: 3676  Path: C:\Windows\system32                    Args: C:\Windows\system32\vssvc.exe
04/15/2019 15:07:23  Name: svchost.exe   PID: 3728  Path: C:\Windows\System32                    Args: C:\Windows\System32\svchost.exe -k swprv
04/15/2019 15:08:05  Name: NOTEPAD.EXE   PID: 3820  Path: C:\Windows\system32                    Args: "C:\Windows\system32\NOTEPAD.EXE" C:\Users\John\Desktop\H...
04/15/2019 15:08:06  Name: iexplore.exe  PID: 3832  Path: C:\Program Files\Internet Explorer      Args: "C:\Program Files\Internet Explorer\iexplore.exe" -nohome
04/15/2019 15:08:07  Name: iexplore.exe  PID: 3908  Path: C:\Program Files\Internet Explorer      Args: "C:\Program Files\Internet Explorer\iexplore.exe" SCODEF:3832 C...
04/15/2019 15:08:07  Name: DllHost.exe   PID: 3928  Path: C:\Windows\system32                    Args: C:\Windows\system32\DllHost.exe /Processid:{AB8902B4-09CA-4...
```

7.4 Volatility: Overview

```
volatility --info
volatility -h
```

```
...
imagecopy        Copies a physical address space out as a raw DD image
imageinfo        Identify information for the image
...
pslist           Print all running processes by following the EPROCESS lists
psscan           Scan Physical memory for _EPROCESS pool allocations
pstree           Print process list as a tree
psxview          Find hidden processes with various process listings
...
sockets          Print list of open sockets
sockscan         Scan Physical memory for _ADDRESS_OBJECT objects (tcp sockets)
...
```

```
volatility -f [filename] [plugin] [options]
```

```
volatility -f memdump.raw imageinfo
```

7.4 Volatility: Overview

```
volatility -f memdump.raw imageinfo
```

```
Volatility Foundation Volatility Framework 2.6
INFO    : volatility.debug    : Determining profile based on KDBG search...

          Suggested Profile(s) : Win7SP1x86_23418, Win7SP0x86, Win7SP1x86
                     AS Layer1 : IA32PagedMemory (Kernel AS)
                     AS Layer2 : FileAddressSpace
                      PAE type : No PAE
                           DTB : 0x185000L
                          KDBG : 0x82968c28L
          Number of Processors : 1
     Image Type (Service Pack) : 1
                KPCR for CPU 0 : 0x82969c00L
             KUSER_SHARED_DATA : 0xffdf0000L
           Image date and time : 2019-04-15 15:08:11 UTC+0000
     Image local date and time : 2019-04-15 17:08:11 +0200
```

```
volatility -f memdump.raw kdbgscan
volatility --profile=Win7SP1x86 -f [filename] [plugin]
export VOLATILITY_PROFILE=Win7SP1x86
```

7.5 Volatility: Process Analysis

`pslist`

- Running processes
- Process IP - PID
- Parent PIP - PPID
- Start time

`pstree`

- Like `pslist`
- Visual child-parent relation

`psscan`

- Brute Force
- Find inactive and/or hidden processes

`psxview`

- Run and compare some tests
- Correlate `psscan` and `pslist`

7.5 Volatility: Process Analysis

```
volatility --profile=Win7SP1x86 -f Win-Enc-20190415.raw pslist
```

```
Offset(V)   Name                PID    PPID  Thds   Hnds  Ses  Wow64 Start
---------- ------------------ ------ ------ ------ ------ ---- ------ ------------------------------
0x84233af0 System                 4      0     70    505 ------      0 2019-04-15 15:02:52 UTC+0000
0x848d8288 smss.exe             248      4      2     29 ------      0 2019-04-15 15:02:52 UTC+0000
0x8487a700 csrss.exe            324    308      9    384      0      0 2019-04-15 15:02:54 UTC+0000
0x84fbb530 csrss.exe            360    352      7    274      1      0 2019-04-15 15:02:54 UTC+0000
0x84fc3530 wininit.exe          368    308      3     77      0      0 2019-04-15 15:02:54 UTC+0000
0x84fd0530 winlogon.exe         396    352      4    112      1      0 2019-04-15 15:02:54 UTC+0000
0x85048a18 services.exe         456    368      8    203      0      0 2019-04-15 15:02:55 UTC+0000
0x8505ac00 lsass.exe            464    368      7    580      0      0 2019-04-15 15:02:55 UTC+0000
0x8505caa0 lsm.exe              472    368     10    145      0      0 2019-04-15 15:02:55 UTC+0000
...
...
...
0x85050b60 WmiPrvSE.exe        3268    564      9    175      0      0 2019-04-15 15:06:52 UTC+0000
0x8438bd40 owxxb-a.exe         3432   3368     15    471      1      0 2019-04-15 15:07:13 UTC+0000
0x84394030 VSSVC.exe           3676    456      6    123      0      0 2019-04-15 15:07:22 UTC+0000
0x84394488 svchost.exe         3728    456      6     70      0      0 2019-04-15 15:07:23 UTC+0000
0x84a243c8 notepad.exe         3820   3432      1     64      1      0 2019-04-15 15:08:05 UTC+0000
0x846d8030 iexplore.exe        3832   3432     19    427      1      0 2019-04-15 15:08:06 UTC+0000
0x846d2d40 iexplore.exe        3908   3832     11    293      1      0 2019-04-15 15:08:07 UTC+0000
0x846e5a58 dllhost.exe         3928    564      6     94      1      0 2019-04-15 15:08:07 UTC+0000
0x84684d40 dllhost.exe         4012    564     10    212      1      0 2019-04-15 15:08:08 UTC+0000
```

7.5 Volatility: Process Analysis

```
volatility --profile=Win7SP1x86 -f Win-Enc-20190415.raw pslist
```

```
Offset(P)   Name              PID  pslist  psscan  thrdproc  pspcid  csrss  session  deskthrd
----------  ---------------- ----- ------- ------- --------- ------- ------ -------- --------
.....
.....
0x3f60f030  taskhost.exe       352 True    True    True      True    True   True     True
0x3fa84d40  dllhost.exe       4012 True    True    True      True    True   True     True
0x3ec23148  spoolsv.exe       1296 True    True    True      True    True   True     True
0x3f63f470  explorer.exe       920 True    True    True      True    True   True     True
0x3ff0bd40  owxxb-a.exe       3432 True    True    True      True    True   True     True
0x3f3d0530  winlogon.exe       396 True    True    True      True    True   True     True
0x3f3c3530  wininit.exe        368 True    True    True      True    True   True     True
0x3ec9f030  svchost.exe        688 True    True    True      True    True   True     True
0x3ef3d758  VBoxTray.exe      1832 True    True    True      True    True   True     True
0x3fae5a58  dllhost.exe       3928 True    True    True      True    True   True     True
0x3ec50b60  WmiPrvSE.exe      3268 True    True    True      True    True   True     True
0x3ec88b90  svchost.exe        564 True    True    True      True    True   True     True
0x3ecd3768  svchost.exe        820 True    True    True      True    True   True     True
0x3ef4f030  SearchIndexer.    2008 True    True    True      True    True   True     True
0x3ec08d40  svchost.exe       1444 True    True    True      True    True   True     True
0x3ed10d40  svchost.exe       1008 True    True    True      True    True   True     True
0x3f6243c8  notepad.exe       3820 True    True    True      True    True   True     True
0x3ecd95f8  svchost.exe        852 True    True    True      True    True   True     True
0x3fad2d40  iexplore.exe      3908 True    True    True      True    True   True     True
.....
.....
```

7.6 Volatility: Network Analysis

- Windows XP and 2003 Server
  - `connections`
  - `connscan`
  - `sockets`
- Windwos 7
  - `netscan`

```
volatility --profile=Win7SP1x86 -f Win-Enc-20190415.raw netscan
Proto    Local Address          Foreign Address      State          Pid      Owner
.....
UDPv4    0.0.0.0:0              *:*                                 2748     powershell.exe
UDPv6    :::0                   *:*                                 2748     powershell.exe
TCPv4    0.0.0.0:49155          0.0.0.0:0            LISTENING       456     services.exe
TCPv4    0.0.0.0:49156          0.0.0.0:0            LISTENING       464     lsass.exe
TCPv6    :::49156               :::0                 LISTENING       464     lsass.exe
TCPv4    10.0.2.15:49167        2.17.201.11:80       ESTABLISHED    1128     svchost.exe
TCPv4    10.0.2.15:49166        93.184.220.29:80     ESTABLISHED    1128     svchost.exe
TCPv4    10.0.2.15:49165        50.62.124.1:80       ESTABLISHED    3432     owxxb—a.exe
TCPv4    10.0.2.15:49160        216.239.32.21:80     ESTABLISHED    3432     owxxb—a.exe
TCPv4    10.0.2.15:49162        2.17.201.8:80        ESTABLISHED    3432     owxxb—a.exe
TCPv4    10.0.2.15:49168        13.107.21.200:80     ESTABLISHED    3832     iexplore.exe
TCPv4    10.0.2.15:49159        94.23.7.52:80        CLOSE_WAIT     2748     powershell.exe
.....
```

7.7 Volatility: Other plugins

- Exercise: Explore other useful plugins

```
volatility -f memdump.raw sessions
volatility -f memdump.raw privs | less
volatility -f memdump.raw hivelist
volatility -f memdump.raw filescan | less
volatility -f memdump.raw timeliner | less
volatility -f memdump.raw hashdump
```

- Exercise: Get SIDs

```
volatility --profile=Win7SP1x86 -f Win-Enc-20190415.raw getsids

powershell.exe (2748): S-1-5-21-3408732720-2018246097-660081352-1000 (John)
owxxb-a.exe (3432): S-1-5-21-3408732720-2018246097-660081352-1000 (John)
notepad.exe (3820): S-1-5-21-3408732720-2018246097-660081352-1000 (John)
iexplore.exe (3832): S-1-5-21-3408732720-2018246097-660081352-1000 (John)
iexplore.exe (3908): S-1-5-21-3408732720-2018246097-660081352-1000 (John)
dllhost.exe (3928): S-1-5-21-3408732720-2018246097-660081352-1000 (John)
```

7.8 Volatility: Exercise

- Exercise: Command line history

```
vol.py --profile=Win7SP1x86 -f memdump.raw cmdline
vol.py --profile=Win7SP1x86 -f memdump.raw cmdscan
vol.py --profile=Win7SP1x86 -f memdump.raw consoles
```

- Exercise: Find suspicious processes

```
volatility --profile=Win7SP1x86 -f Win-Enc-20190415.raw malfind

Process: owxxb-a.exe Pid: 3432 Address: 0x400000
Vad Tag: VadS Protection: PAGE_EXECUTE_READWRITE
Flags: CommitCharge: 134, MemCommit: 1, PrivateMemory: 1, Protection: 6

0x00400000  4d 5a 90 00 03 00 00 00 04 00 00 00 ff ff 00 00   MZ..............
0x00400010  b8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00   ........@.......
0x00400020  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00   ................
0x00400030  00 00 00 00 00 00 00 00 00 00 00 00 08 01 00 00   ................

0x00400000 4d                DEC EBP
0x00400001 5a                POP EDX
0x00400002 90                NOP
```

- Exercise: Dump suspicious process and anslyze!

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8. Bibliography and Outlook

8.1 Bibliography

- Windows Forensic Analysis 2E

  Harlan Carvey
  Syngress 2nd edition
  ISBN-13: 978-1-59-749422-9

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  Dr. Philip Polstra
  CreateSpace Independent Publishing
  ASIN: B01K3RPWIY

- Windows Forensic Analysis for Windows 7 3E

  Harlan Carvey
  Syngress
  ISBN-13: 978-1-59-749727-5

8.2 Outlook

- Scheduled Tasks
- Windows 8 analyzis
- Windows 10 analyzis
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- Mobile Forensics

Overview

1. Windows Registry
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