CIRCL - Digital Forensics 1.0.3

Introduction: Windows-, Memory- and File Forensics

CIRCL *TLP:CLEAR*

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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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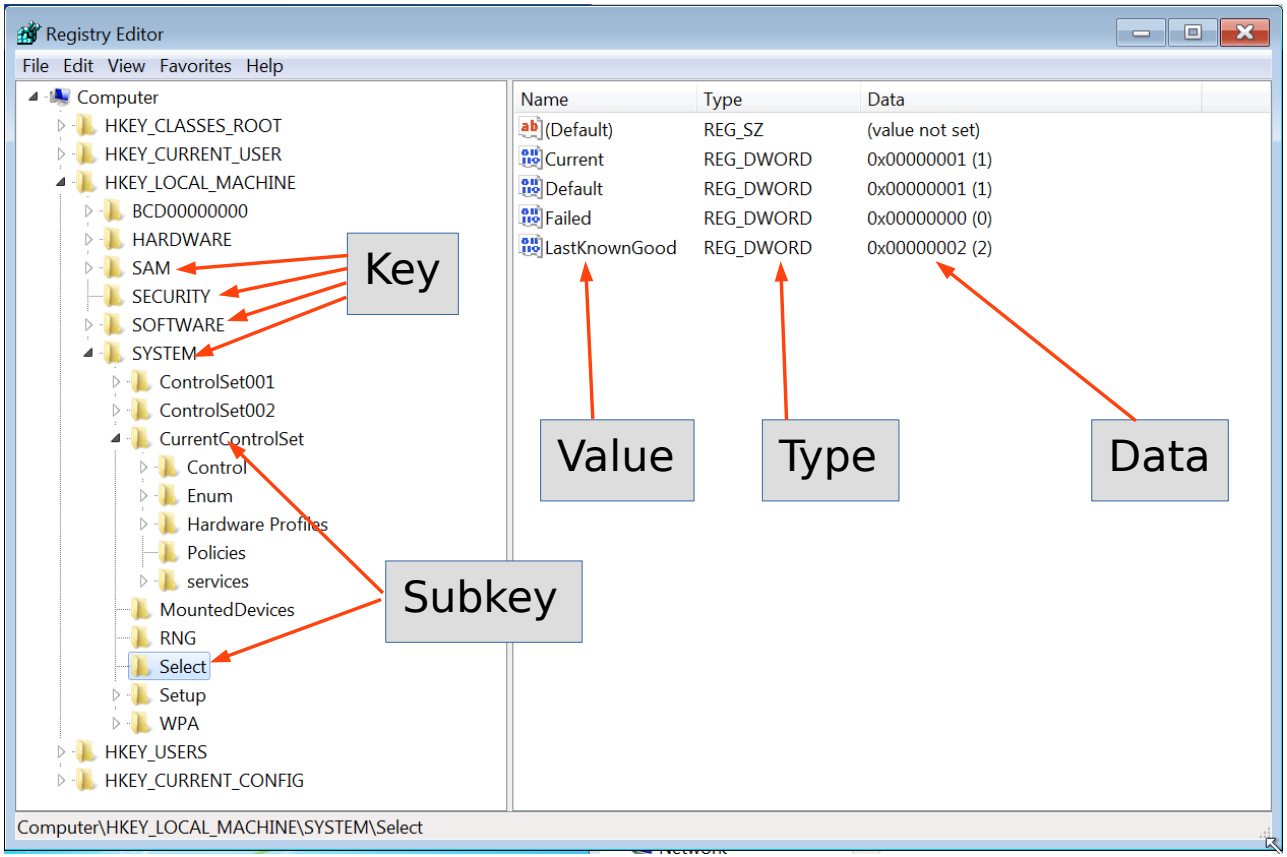
1. Windows Registry

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 system wide
    - OS all aspects
    - Applications installed
    - User preferences / behavior

  → A gold mine for forensics

1.1 About: Windows Registry



Key data structures contains a last write time stamp

1.1 About: Windows Registry

- Hive files: Location

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

  → Created during system boot

- How often do you manually edit the Registry?
  - `regedit.exe`
  - Black Magic for many admins
    → Every user interacts with the Registry

- 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:				
	0×00	0	4	Size
	0×04	4	2	Node ID
	0×06	6	2	Value name length
	0×08	8	4	Data lenght
	0×0c	12	4	Data offset
	0×10	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
  - Security Accounts Manager: Local users
- Security
  - Audit settings
  - Machine, domain SID
- System
  - Hardware configuration
  - System configuration
- Software
  - Windows settings
  - Application information
- NTUser.dat
  - User behavior and settings
- UsrClass.dat
  - Graphical User Interface information

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`
  (Plug and Play Log)

1.3 Hive files - Exercise: Get hive files

Extract registry hive files from forensic image

-

```
mkdir registry/out
```

1.3 Hive files - Exercise: Get hive files

Extract registry hive files from forensic image

1. Investigate Meta–Information

```
ewfinfo image.E01
ewfexport image.E01
```

-

```
mkdir registry/out
```

1.3 Hive files - Exercise: Get hive files

Extract registry hive files from forensic image

1. Investigate Meta–Information

```
ewfinfo image.E01
ewfexport image.E01
```

2. Mount evidences

```
sudo mkdir /media/case1
mmls image.raw
sudo mount -o ro,offset=$((512*63)) image.raw /media/case1/
```

-

1.3 Hive files - Exercise: Get hive files

Extract registry hive files from forensic image

1. Investigate Meta-Information

```
ewfinfo image.E01
ewfexport image.E01
```

2. Mount evidences

```
sudo mkdir /media/case1
mmls image.raw
sudo mount -o ro,offset=$((512*63)) image.raw /media/case1/
```

3. Copy files

```
mkdir registry
cp /media/case1/WINDOWS/system32/config/SAM registry
cp /media/case1/WINDOWS/system32/config/software registry
cp /media/case1/WINDOWS/system32/config/system registry
cp /media/case1/WINDOWS/system32/config/SECURITY registry
cp /media/case1/Documents\ and\ Settings/Jean/NTUSER.DAT registry
cp /media/case1//Documents\ and\ Settings/Jean/Local\ Settings/
   Application\ Data/Microsoft/Windows/UsrClass.dat registry/
ls registry/
mkdir registry/out
```

1.4 RegRipper

- https://github.com/keydet89/RegRipper4.0
- Plugins: 385

```
regripper -h
        Rip v.3.0 - CLI RegRipper tool
        Rip [-r Reg hive file] [-f profile] [-p plugin] [options]
        Parse Windows Registry files, using either a single module, or a profile.


ls /usr/lib/regripper/plugins | grep pl$ | wc -l
        249


ls /usr/lib/regripper/plugins | grep -v pl$
        all
        amcache
        ntuser
        sam
        security
        software
        syscache
        system
        usrclass
```

1.4 RegRipper - Examples

```
regripper -p compname -r software
   Select not found.


regripper -p compname -r system
   ComputerName    = JEAN-13FBF038A3
   TCP/IP Hostname = jean-13fbf038a3


regripper -p run -r NTUSER.DAT

   Software\Microsoft\Windows\CurrentVersion\Run
   LastWrite Time 2008-07-18 04:36:52Z
     MSMSGS - "C:\Program Files\Messenger\msmsgs.exe" /background
     Aim6 - "C:\Program Files\AIM6\aim6.exe" /d locale=en-US ee://aol/imApp


regripper -p run -r software

   Microsoft\Windows\CurrentVersion\Run
   LastWrite Time 2008-07-06 07:21:46Z
     VMware User Process - C:\Program Files\VMware\VMware Tools\VMwareUser.exe
     VMware Tools - C:\Program Files\VMware\VMware Tools\VMwareTray.exe

   Microsoft\Windows\CurrentVersion\Run\OptionalComponents
   LastWrite Time 2008-07-06 07:21:46Z
```

1.4 RegRipper - Examples

```
mkdir registry/out

regripper -f sam -r SAM > out/sam.txt
regripper -a     -r SAM > out/sam2.txt
less registry/out/sam.txt

     User Information
     ------------------------------

     Username        : Administrator [500]
     Full Name       :
     User Comment    : Built-in account for administering the computer/domain
     Account Type    : Default Admin User
     Account Created : 2008-05-13 22:20:14Z
     Name            :
     Last Login Date : 2008-07-21 01:22:18Z
     Pwd Reset Date  : 2008-05-13 22:23:39Z
     Pwd Fail Date   : Never
     Login Count     : 24
     Embedded RID    : 500
       --> Password does not expire
       --> Normal user account

     Username        : Guest [501]
     Full Name       :
     User Comment    : Built-in account for guest access to the computer/domain
     Account Type    : Default Guest Acct
     Account Created : 2008-05-13 22:20:14Z
```

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

-

1.5 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

```
mkdir registry/out

    regripper -a -r SAM          > out/sam.txt
    regripper -a -r SECURITY     > out/security.txt
    regripper -a -r software     > out/software.txt
    regripper -a -r system       > out/system.txt
    regripper -a -r NTUSER.DAT   > out/NTUser.txt
    regripper -a -r UsrClass.dat > out/UsrClass.txt

    ls -lh out/
     24K Nov 11 07:46 NTUser.txt
    7.1K Nov 11 07:47 sam.txt
     603 Nov 11 07:46 security.txt
    658K Nov 11 07:46 software.txt
    157K Nov 11 07:46 system.txt
    1.5K Nov 11 07:47 UsrClass.txt
```

1.6 General information: sam, security

```
less out/SAM.txt

    Username        : Administrator [500]
            Last Login Date : 2008-07-21 01:22:18Z
            Pwd Fail Date   : Never
            Login Count     : 24

    Username        : Jean [1004]
            Last Login Date : 2008-07-20 00:00:41Z
            Pwd Fail Date   : Never
            Login Count     : 80

    Group Name     : Administrators [7]
    LastWrite      : 2008-05-14 05:35:35Z
      S-1-5-21-484763869-796845957-839522115-1006
      S-1-5-21-484763869-796845957-839522115-1008
      S-1-5-21-484763869-796845957-839522115-1007
      S-1-5-21-484763869-796845957-839522115-1005
      S-1-5-21-484763869-796845957-839522115-1003
      S-1-5-21-484763869-796845957-839522115-500
      S-1-5-21-484763869-796845957-839522115-1004


less out/security.txt
```

1.6 General information: system, software

```
regripper -p winver -r software

    ProductName                 Microsoft Windows XP
    CSDVersion                  Service Pack 3
    BuildLab                    2600.xpsp.080413-2111
    RegisteredOrganization
    RegisteredOwner             Jean User
    InstallDate                 2008-05-13 21:29:32Z


regripper -p networkcards -r software

    Description                                 Key LastWrite time
    VMware Accelerated AMD PCNet Adapter        2008-05-14 05:31:26Z


regripper -p uninstall -r software

    2008-07-19 23:32:23Z
      VMware Tools v.3.2.0.1288
    .....


regripper -p ips -r system

    IPAddress           Domain
    192.168.117.129     localdomain
```

1.6 General information: system, software

```
regripper -p profilelist -r software

    Path       : %SystemDrive%\Documents and Settings\Jean
    SID        : S-1-5-21-484763869-796845957-839522115-1004
    LastWrite  : 2008-07-21 01:18:00Z

    Path       : %SystemDrive%\Documents and Settings\Devon
    SID        : S-1-5-21-484763869-796845957-839522115-1007
    LastWrite  : 2008-07-12 06:04:40Z

    Path       : %SystemDrive%\Documents and Settings\Administrator
    SID        : S-1-5-21-484763869-796845957-839522115-500
    LastWrite  : 2008-07-21 01:31:01Z


regripper -p shutdown -r system

    ControlSet001\Control\Windows key, ShutdownTime value
    LastWrite time: 2008-07-21 01:31:32Z
    ShutdownTime   : 2008-07-21 01:31:32Z


regripper -p timezone -r system

    ControlSet001\Control\TimeZoneInformation
    LastWrite Time 2008-05-14 06:55:57Z
      DaylightName    -> GMT Daylight Time
```

1.7 Tracing user activity

MRU - Most Recently Used

Open/Save As dialog box

```
regripper -p comdlg32 -r NTUSER.DAT
```

Recent Docs opened via Win. Explorer

```
regripper -p recentdocs -r NTUSER.DAT
```

ShellBags (Win7+)

Properties of folders

```
regripper -p shellbags -r UsrClass.dat
```

Program execution

UserAssist: GUI based launched

```
regripper -p userassist -r NTUSER.DAT
```

ShimCache: Track compatibility issues

```
regripper -p shimcache -r system
```

1.7 Tracing user activity

USB attached devices

USBStor: Attached devices

```
less /media/case1/WINDOWS/setupapi.log
regripper -p usbstor -r system
```

USBStor: Vendor & Product ID

```
regripper -p usb -r system
```

MountedDevices

```
regripper -p mountdev -r system
```

MountPoints

```
regripper -p mp2 -r NTUSER.DAT
```

SANS Posters:

https://www.sans.org/posters/windows-forensic-analysis/
https://www.sans.org/posters/hunt-evil/

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2. Windows Event Logs

2.1 Inroduction

- Up to Windows XP
  - Mainly 3 `.evt` files:
    Security: `secevent.evt`
    System: `sysevent.evt`
    Application: `appevent.evt`
    ... maybe some server service specific
  - Location: `/Windows/System32/config/`
  - Binary Event Log file format

- Beginning with Vista
  - Many `.evtx` files:
    `Security.evtx`
    `System.evtx`
    `Application.evtx`
    $\rightarrow$ 120 files $++$
  - Location: `/Windows/System32/winevt/Logs/`
  - New binary XML format

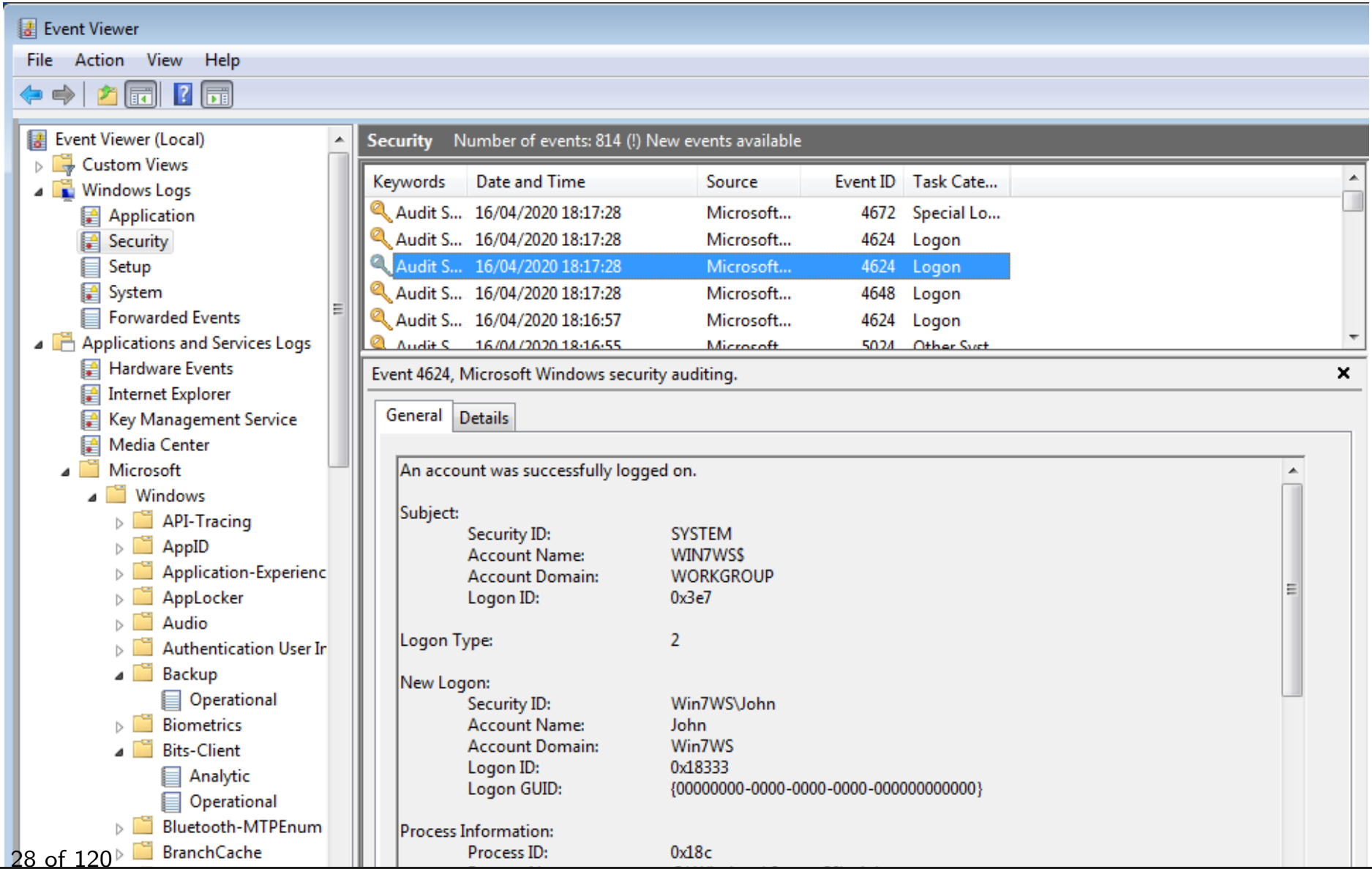
2.1 Inroduction

- Advantage
  - Full fledged logging
  - Logging important events: E.g. Logon Success, ...
  - Detailed information

- Disadvantage
  - Limited period of time
  - Importand events not logged by default: E.g. Logon Fail
  - Manny events, hard to find related information

- Always interesting
  - Logon / Logoff
  - System boot
  - Services started
  - Hardware (dis)connected

2.2 Example: Event Viewer



2.3 Get support

- 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
.....
```

- Online:
  - Microsoft TechNet
  - `https://www.ultimatewindowssecurity.com/securitylog/encyclopedia/`
  - `http://eventid.net/`

2.4 Extracting and exploring event logs: Exercise

Extracting event logs

-

2.4 Extracting and exploring event logs: Exercise

Extracting event logs

```
mkdir evtx
mkdir evtx/out

mmls nps-2008-jean.raw
sudo mount -o ro,offset=$((512*63)) nps-2008-jean.raw /media/sansforensics/casenps/

cp /media/sansforensics/casenps/WINDOWS/system32/config/AppEvent.Evt evtx/
cp /media/sansforensics/casenps/WINDOWS/system32/config/SecEvent.Evt evtx/
cp /media/sansforensics/casenps/WINDOWS/system32/config/SysEvent.Evt evtx/
ls -lh evtx/
```

Exploring event logs

-

2.4 Extracting and exploring event logs: Exercise

Extracting event logs

```
mkdir evtx
mkdir evtx/out

mmls image.raw
sudo mount=o ro,offset=$((512*63)) image.raw/media/case1/

cp /media/case1/WINDOWS/system32/config/AppEvent.Evt evtx/
cp /media/case1/WINDOWS/system32/config/SecEvent.Evt evtx/
cp /media/case1/WINDOWS/system32/config/SysEvent.Evt evtx/
ls -lh evtx/
```

Exploring event logs

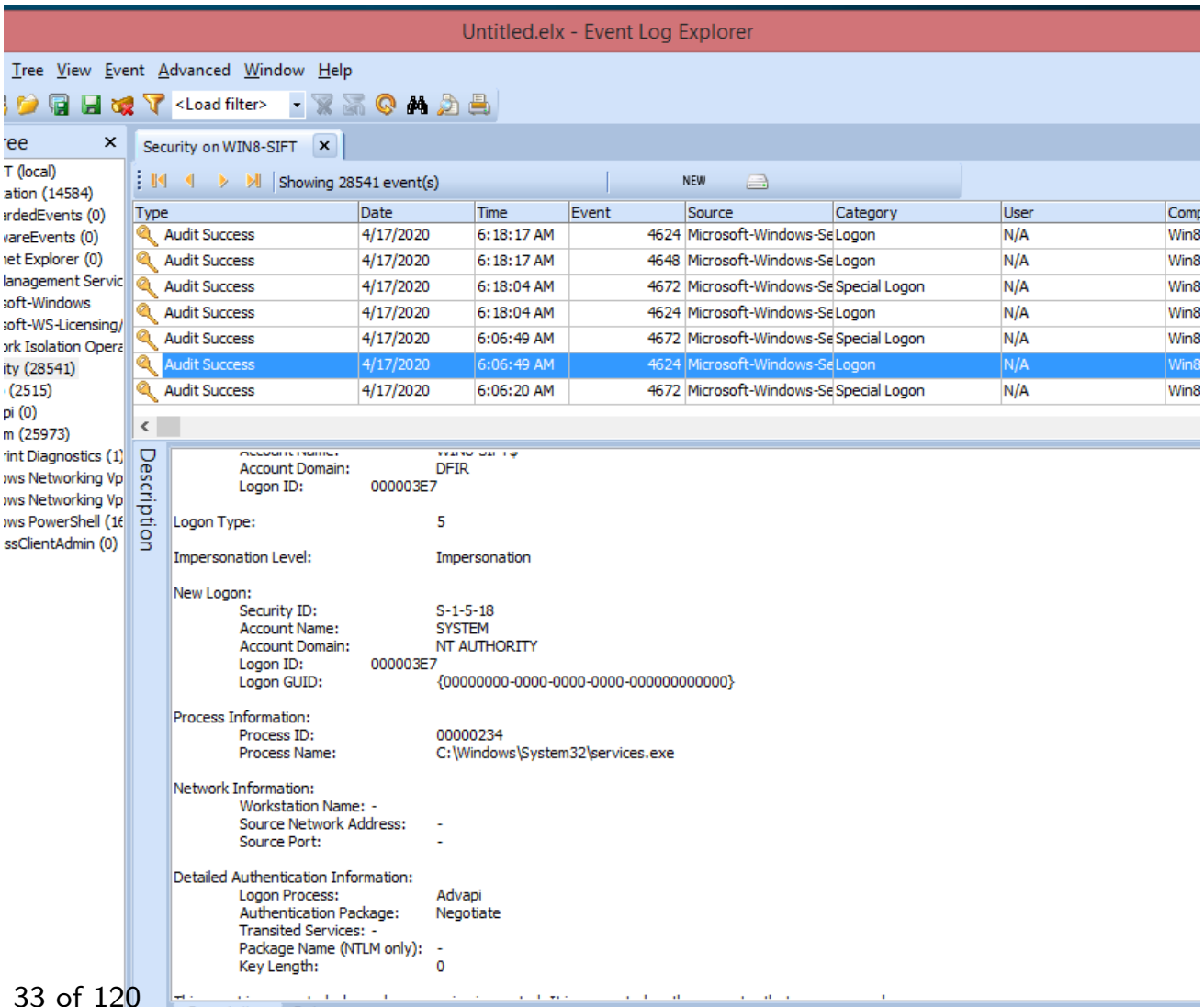
```
sudo apt install libevt-utils

evtinfo evtx/AppEvent.Evt
evtinfo evtx/SecEvent.Evt
evtinfo evtx/SysEvent.Evt

evtexport AppEvent.Evt | less
evtexport SysEvent.Evt | less
```

2.4 Extracting and exploring event logs

`https://eventlogxp.com/`



2.5 Example .evtx

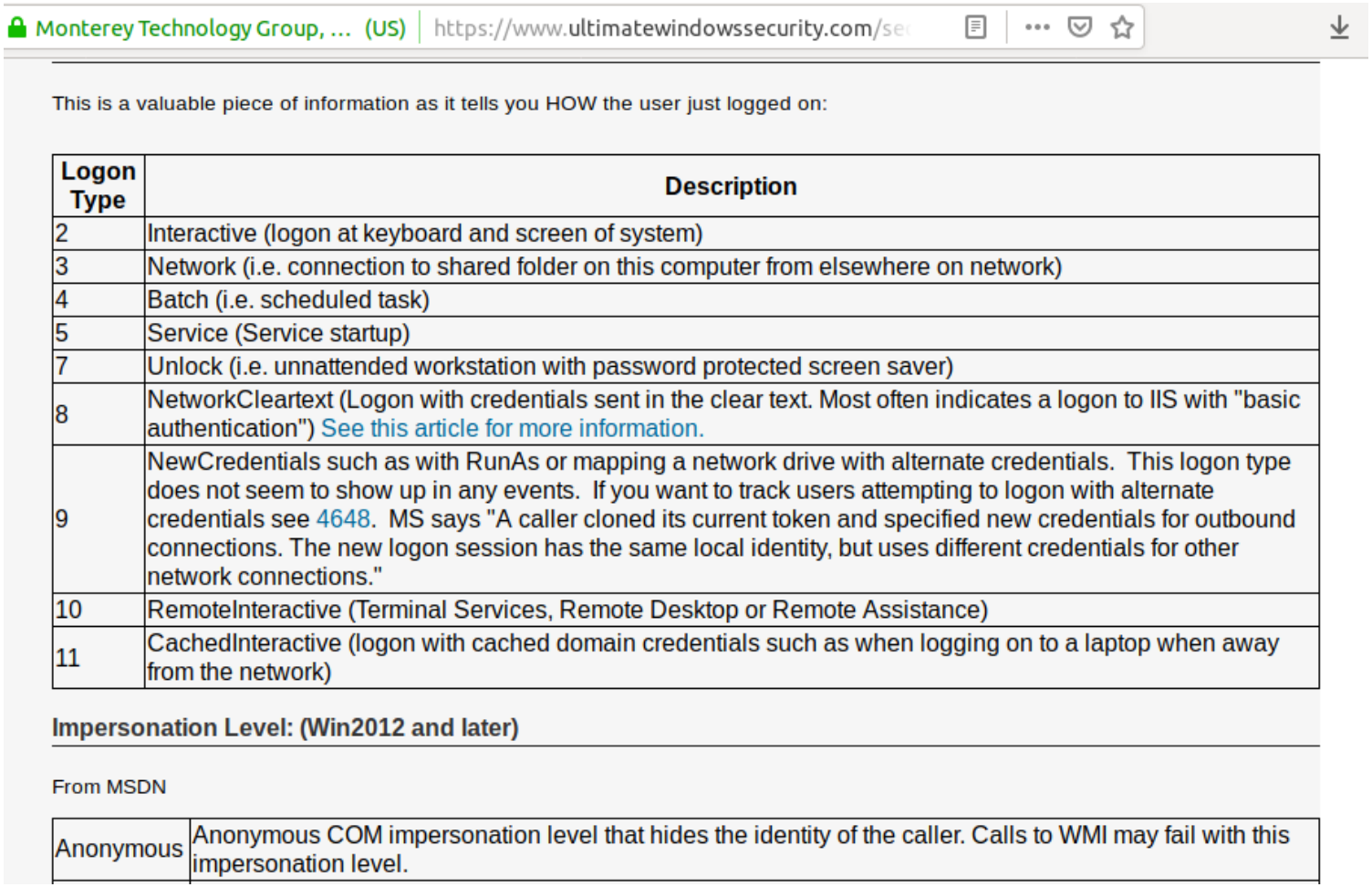
- Logon Success

```
$ 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 `.evtx`



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: Automated tools

Example: Chainsaw

```
wget https://github.com/WithSecureLabs/chainsaw/releases/
              download/v2.10.1/chainsaw_all_platforms+rules.zip

7z x chainsaw_all_platforms+rules.zip
cd chainsaw
chmod +x ./chainsaw_x86_64-unknown-linux-gnu
git clone https://github.com/sbousseaden/EVTX-ATTACK-SAMPLES.git

./chainsaw_x86_64-unknown-linux-gnu hunt EVTX-ATTACK-SAMPLES/ -s sigma/
     --mapping mappings/sigma-event-logs-all.yml | less


[+] Loading detection rules from: sigma/
[!] Loaded 3336 detection rules (490 not loaded)
[+] Loading forensic artefacts from: EVTX-ATTACK-SAMPLES/Command
    and Control, 2 (extensions: .evt, .evtx)
```

Challenge: Hayabusa

```
https://github.com/Yamato-Security/hayabusa
```

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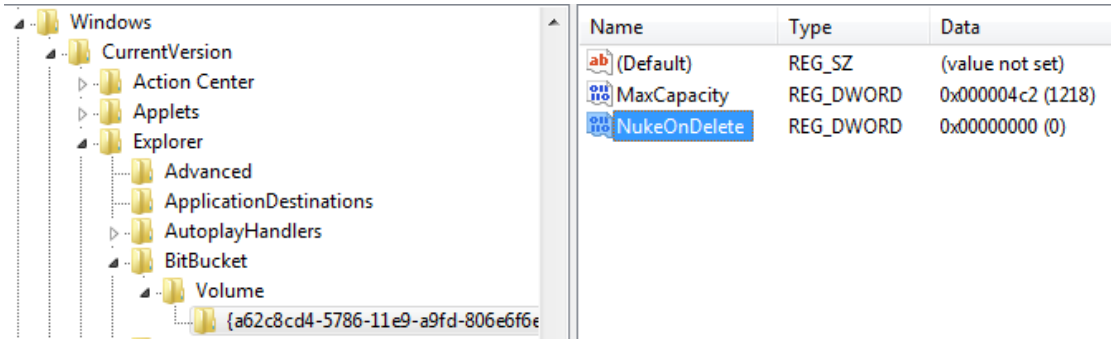
3. Other Windows Artifacts

3.1 Recycle Bin - User support to undelete

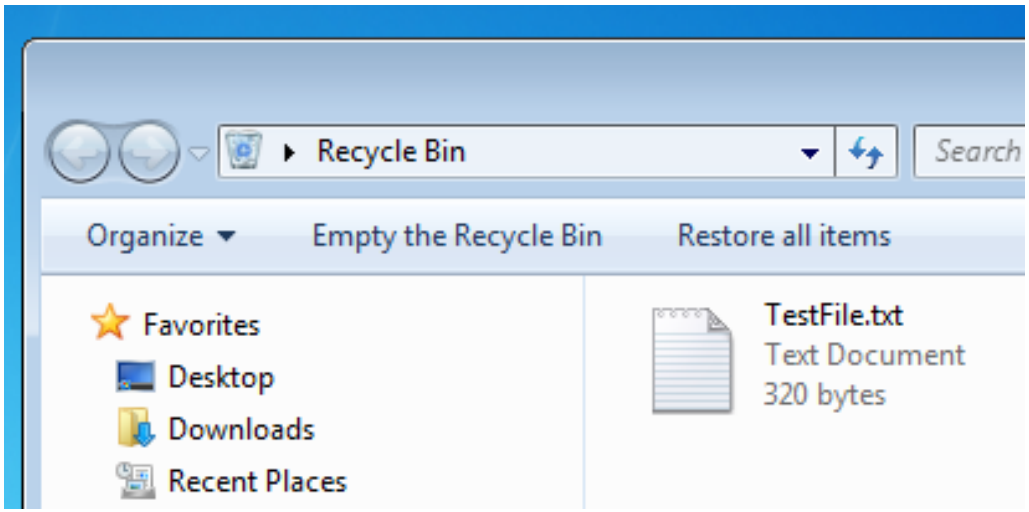
- Files move to Recycle Bin:
  - Moved by mouse
  - Right click: `Delete`
- Not move to Recycle Bin:
  - Right click: `Delete + SHIFT`
  - Command line: `del`
  - Files on network shares
- NukeOnDelete
  - `HKEY_USERS/_UUID_/Software/Microsoft/Windows/CurrentVersion/Explorer/BitBucket/Volume/{_Volume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



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:



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


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

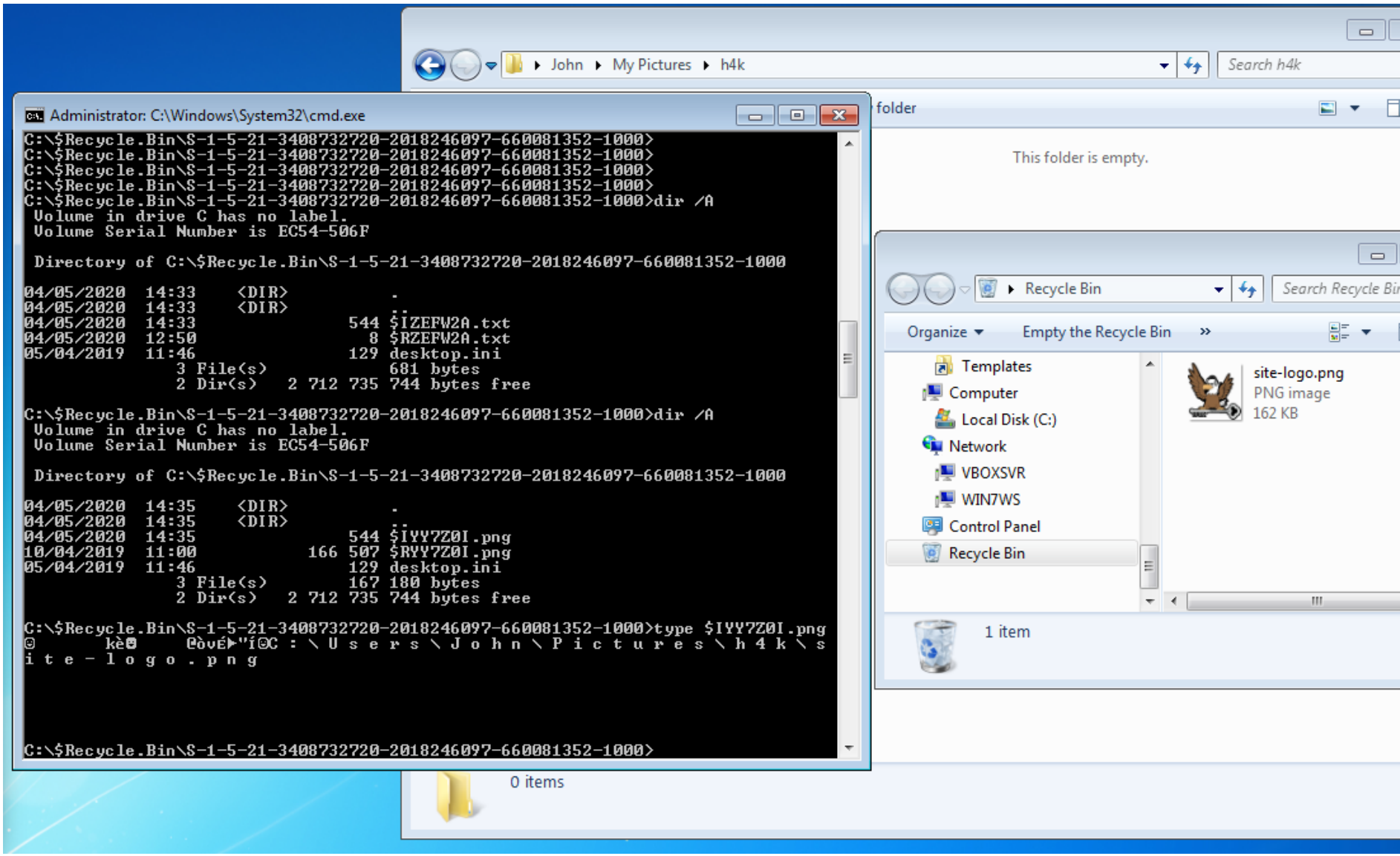
3.1 Recycle Bin - Forensics

- 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

- File system timeline `Recycle.Bin` directory:

```
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 - Filename & Extension



3.2 LNK Files

- Link or shortcut to files, applications, resources
- User activity: Files access
  - Local
  - Network shares
  - Appached devices
- LNK file remain after target file is deleted

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


Thu May 02 2019 14:54:28
      66 macb        43702-128-1 /Users/John/Documents/LNK/Test.txt

    1573 macb        43922-128-4 /Users/John/AppData/Roaming/Microsoft/
                                 Windows/Recent/LNK.lnk

    2779 macb        43716-128-4 /Users/John/AppData/Roaming/Microsoft/
                                 Windows/Recent/Test.txt.lnk
```

3.2 LNK Files

- Information inside LNK files
  - Target file MAC times
  - Target file size
  - Target file path
  - Volume information

```
exiftool Test.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\
        Net Name                : 8
        Net Provider Type       : Unknown (0x20000)
        Relative Path           : ..\..\..\..\..\Documents\Test\Test.txt
        Working Directory       : C:\Users\John\Documents\Test
        Machine ID              : john-pc
```

3.2 LNK Files: Exercise

Extract and investigate LNK file for document: 'm57biz.xls'

Prepration work:

-

3.2 LNK Files: Exercise

Extract and investigate LNK file for document: 'm57biz.xls'

Prepration work:

```
sudo mount -o ro,offset=$((512*63)) image.raw /media/case1
mkdir lnk
```

Copy LNK file:

-

3.2 LNK Files: Exercise

Extract and investigate LNK file for document: 'm57biz.xls'

Prepration work:

```
sudo mount -o ro,offset=$((512*63)) image.raw /media/case1
mkdir lnk
```

Copy LNK file:

```
cp /media/case1/Documents\ and\ Settings/Jean/Recent/m57biz.lnk lnk/
```

Investigate with exiftool:

-

3.2 LNK Files: Exercise

Extract and investigate LNK file for document: 'm57biz.xls'

Prepration work:

```
sudo mount -o ro,offset=$((512*63)) image.raw /media/case1
mkdir lnk
```

Copy LNK file:

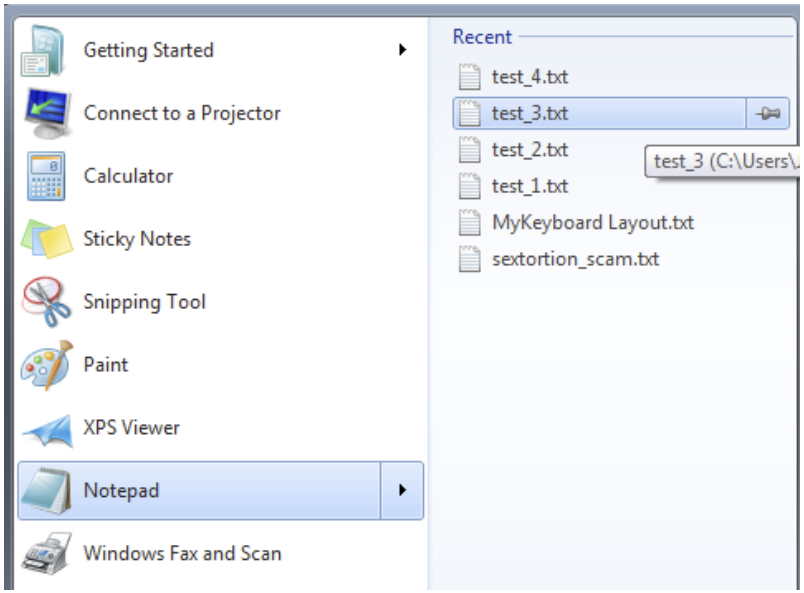
```
cp /media/case1/Documents\ and\ Settings/Jean/Recent/m57biz.lnk lnk/
```

Investigate with exiftool:

```
exiftool lnk/m57biz.lnk
    .....
    File Attributes                 : Archive
    Create Date                     : 2008:07:20 01:28:03+00:00
    Access Date                     : 2008:07:20 01:28:03+00:00
    Modify Date                     : 2008:07:20 01:28:03+00:00
    Target File Size                : 291840
    Drive Type                      : Fixed Disk
    Local Base Path                 : C:\Documents and Settings\Jean\Desktop\m57biz.xls
    Machine ID                      : jean-13fbf038a3
```

3.3 Jump Lists

- Introduced with Windows 7
- Similar `Recent` folder
- Recently opened documents / application
- Makes them accessible at Windows main menu



`AppData/Roaming/Microsoft/Windows/Recent/AutomaticDestinations`

`AppData/Roaming/Microsoft/Windows/Recent/CustomDestinations`

3.3 Jump Lists

- File names start with 16 hex characters → JumpList ID
- File names end with `.xxxDestinations-ms`

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

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

- Each Hex value correspond to an fixed application
- `918e0ecb43d17e23 = Notepad.exe`

→ `https://github.com/EricZimmerman/JumpList/blob/master/JumpList/Resources/AppIDs.txt`

3.3 Jump Lists

- Exercise: Identify applications

```
cd JumpLists/AutomaticDestinations/
ls -l
```

```
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

–

3.3 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

3.3 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
7z x 918e0ecb43d17e23.automaticDestinations-ms
strings -el DestList
```

3.4 Prefetch Files

- Application prefetching since XP
  - Monitor an application when it starts
  - Collect information about resources needed
  - Wait 10sec after application started
    $\rightarrow$ Know where to find the resources
    $\rightarrow$ Better performance: App launch faster
    $\rightarrow$ 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 .....

3.4 Prefetch Files

- Example: From 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
```

- Elements of the file name at `/Windows/Prefetch`
  - Application name
  - One way hash of path to the application
  - File extension: `.pf`
- Information found inside a Prefetch file:
  - Run count: How often application run
  - Last time executed
  - Application name incl. parameter
  - Path to application and resources

3.4 Prefetch Files

- 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
    $\rightarrow$ Behavior of user

3.4 Prefetch Files: Exercise

Extract and investigate the Excel prefetch file

Copy prefetch file:

```
mkdir prefetch
cp /media/sansforensics/casenps/WINDOWS/Prefetch/EXCEL.EXE-1C75F8D6.pf prefetch/
```

Investigate LNK file:

```
strings -el prefetch/EXCEL.EXE-1C75F8D6.pf | less
```

```
pref.pl -f prefetch/EXCEL.EXE-1C75F8D6.pf

    File      : prefetch/EXCEL.EXE-1C75F8D6.pf
    Exe Path  : \DEVICE\HARDDISKVOLUME1\PROGRAM FILES\MICROSOFT OFFICE\OFFICE\EXCEL.EXE
    Last Run  : Sun Jul 20 01:27:40 2008
    Run Count: 2
```

3.5 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

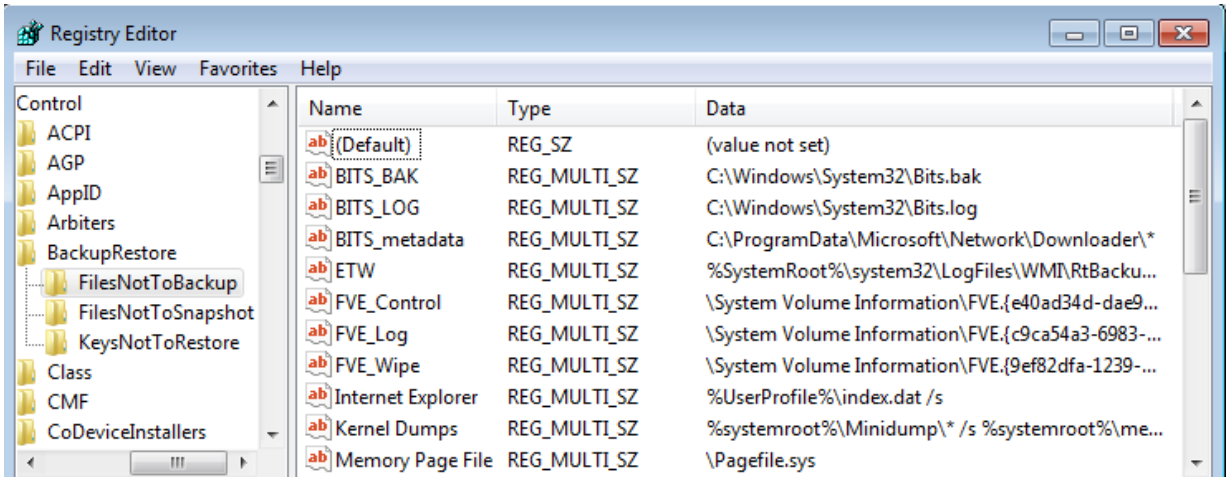
3.6 VSS - Volume Shadow Copy Service

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

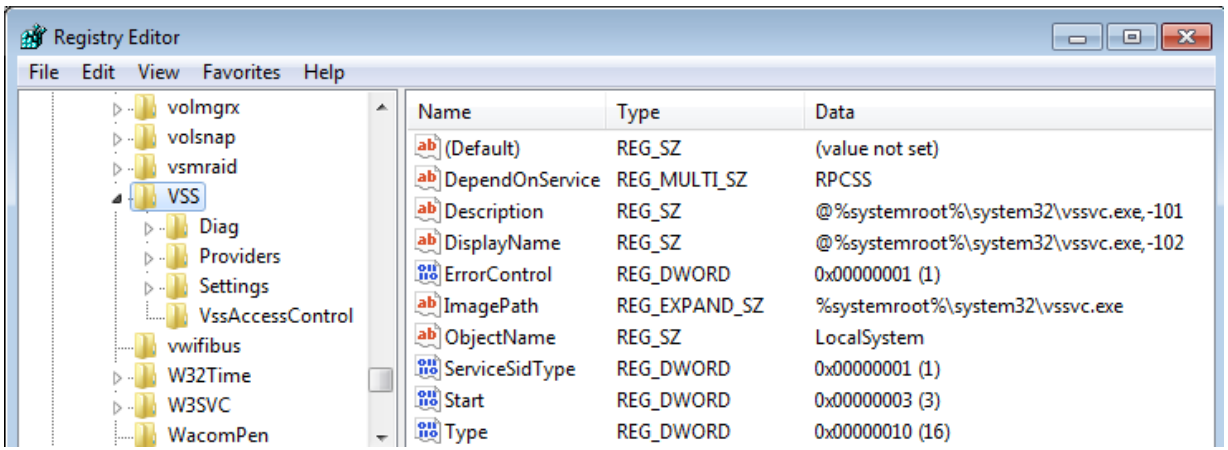
```
>vssadmin list shadows /for=c:/
vssadmin 1.1 — Volume Shadow Copy Service administrative command-line tool
(C) Copyright 2001-2005 Microsoft Corp.

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
```

3.6 VSS - Configuration

`HKEY_LOCAL_MACHINE/SYSTEM/CurrentControlSet/services/VSS`



`HKEY_LOCAL_MACHINE/SYSTEM/CurrentControlSet/Control/BackupRestore`



3.5 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/
```

CIRCL
FORENSICS Training

4. Basic Malware Analysis

4.1 Introduction

Take care: Self-Infection:

- Keep away from production
- Isolated machines (VMs)
- Network considerations

Exchange of malware via email:

- Password protected archive
- Password: `infected`

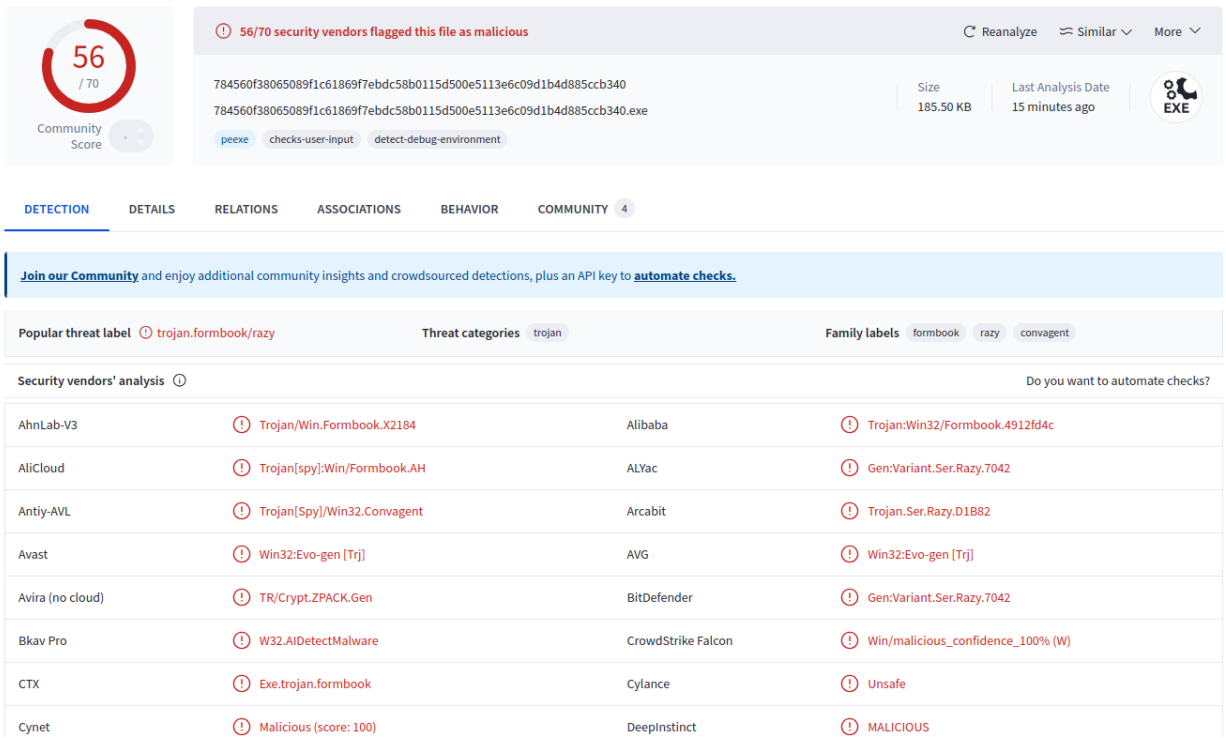
5 Phases of analysis

1. OSINT - Open Source Intelligence
2. Automatic Analysis (Sandbox)
3. Static Analysis
4. Dynamic Analysis (Behavioral Analysis)
5. Reverse Engineering

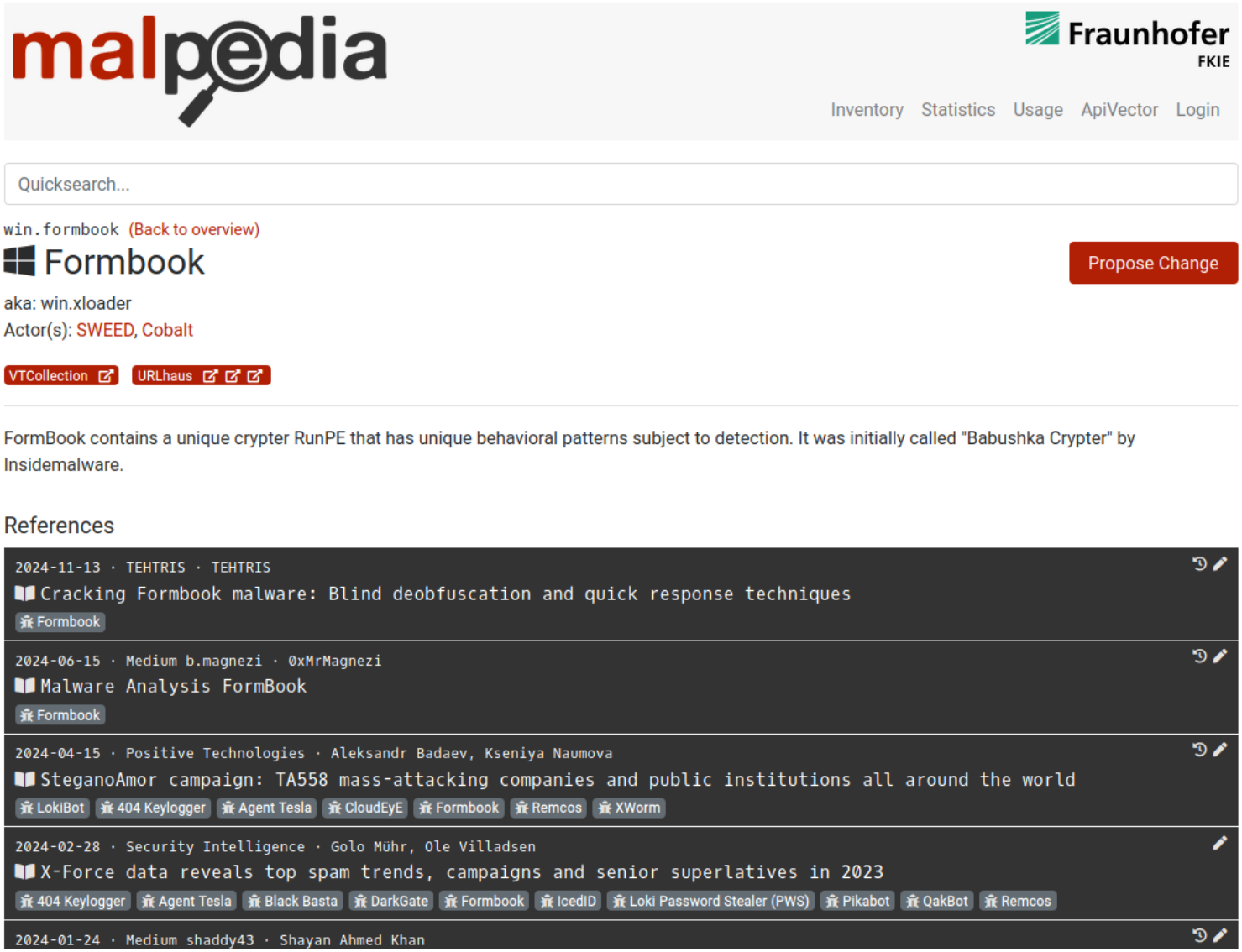
4.2 OSINT - IoCs

- Is the file `Form.exe` malicious?
- What it is doing?

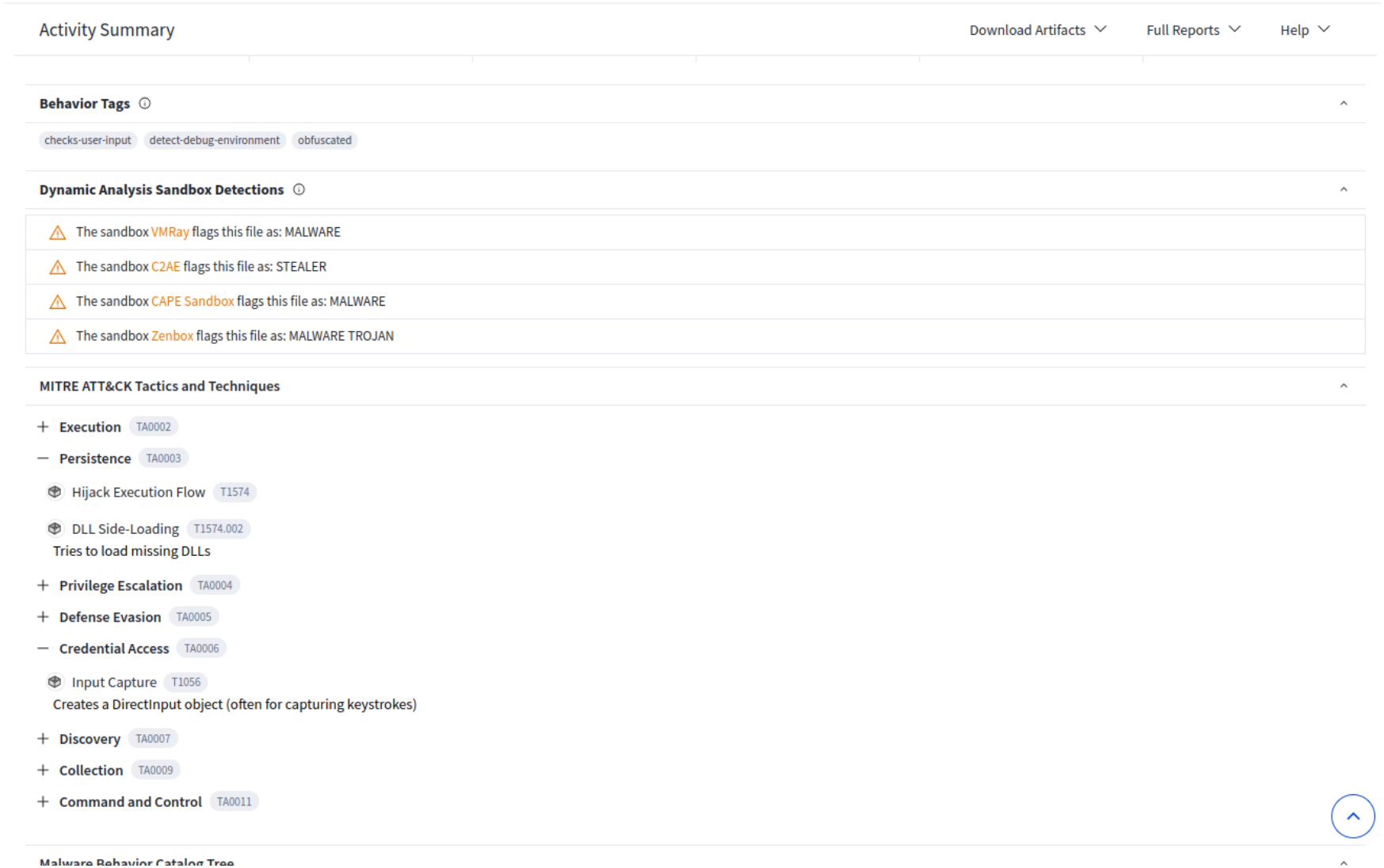
```
ls -l Form.exe                189952 Form.exe
md5sum Form.exe               a8371cb187d99711691ccbecf8f35657
sha1sum Form.exe              8dec32121d2f9f876c2b157451968796608d3dd5
sha256sum Form.exe 784560f38065089f1c61869f7ebdc58b0115d500e5113e6c09d1b4d885ccb340
```



4.2 OSINT - Malpedia



4.2 OSINT - VirusTotal Details



4.2 OSINT - abuse.ch - MalwareBazaar

MalwareBazaar Database

You are browsing the malware sample database of MalwareBazaar. If you would like to contribute malware samples to the corpus, you can do so through either using the web upload or the API.

504	Mirai	843'371
Submissions (past 24 hours)	Most seen malware family (past 24 hours)	Malware samples in corpus

Using the form below, you can search for malware samples by a hash (MD5, SHA256, SHA1), imphash, tlsh hash, ClamAV signature, tag or malware family.

Browse Database

md5:a8371cb187d99711691ccbecf8f35657 Search

Search Syntax

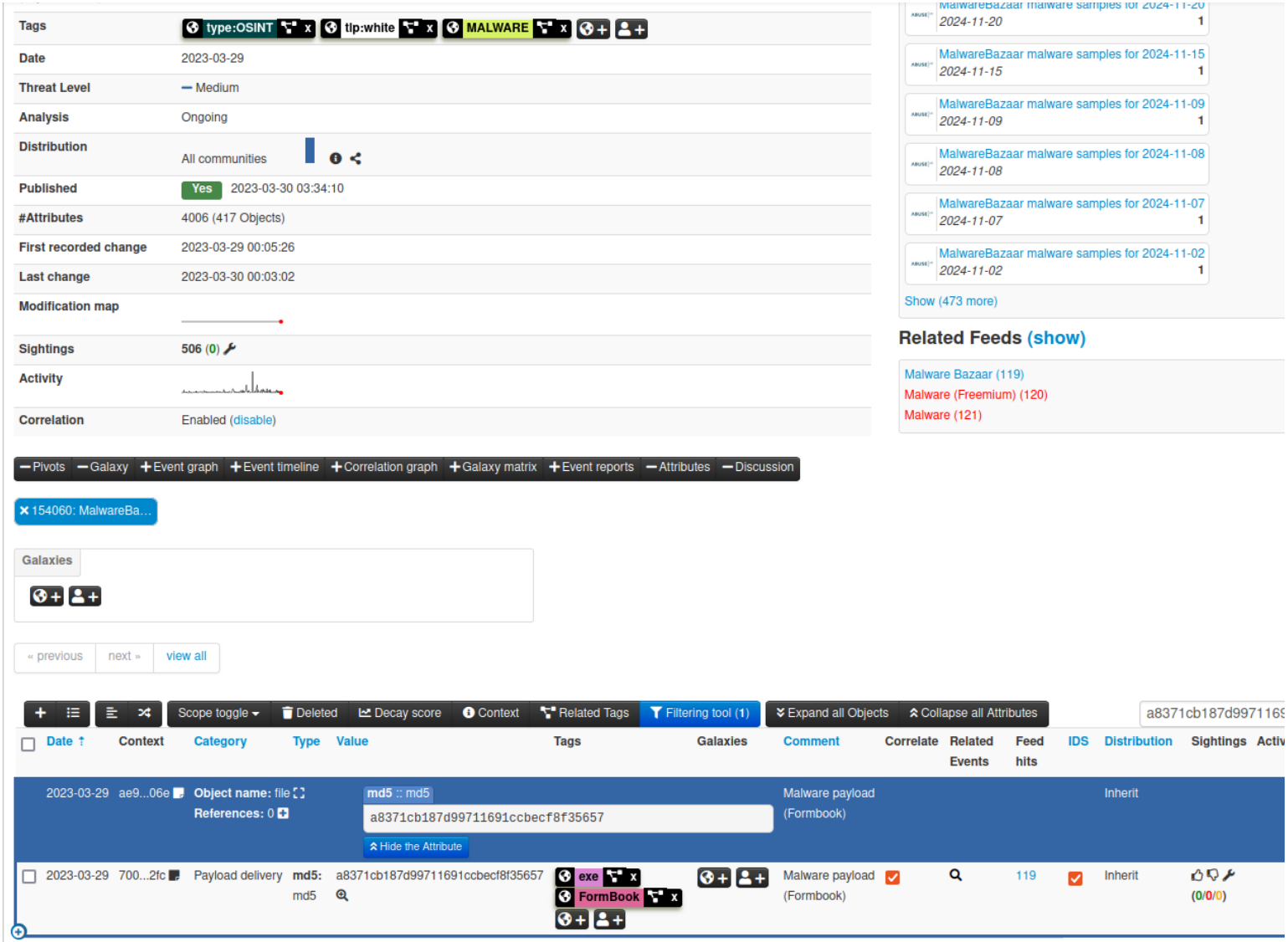
Search:

Date (UTC)	SHA256 hash	Type	Signature	Tags	Reporter	DL
2023-03-29 13:07	784560f38065089f1c61...	exe	Formbook	exe FormBook	*Anonymous*	

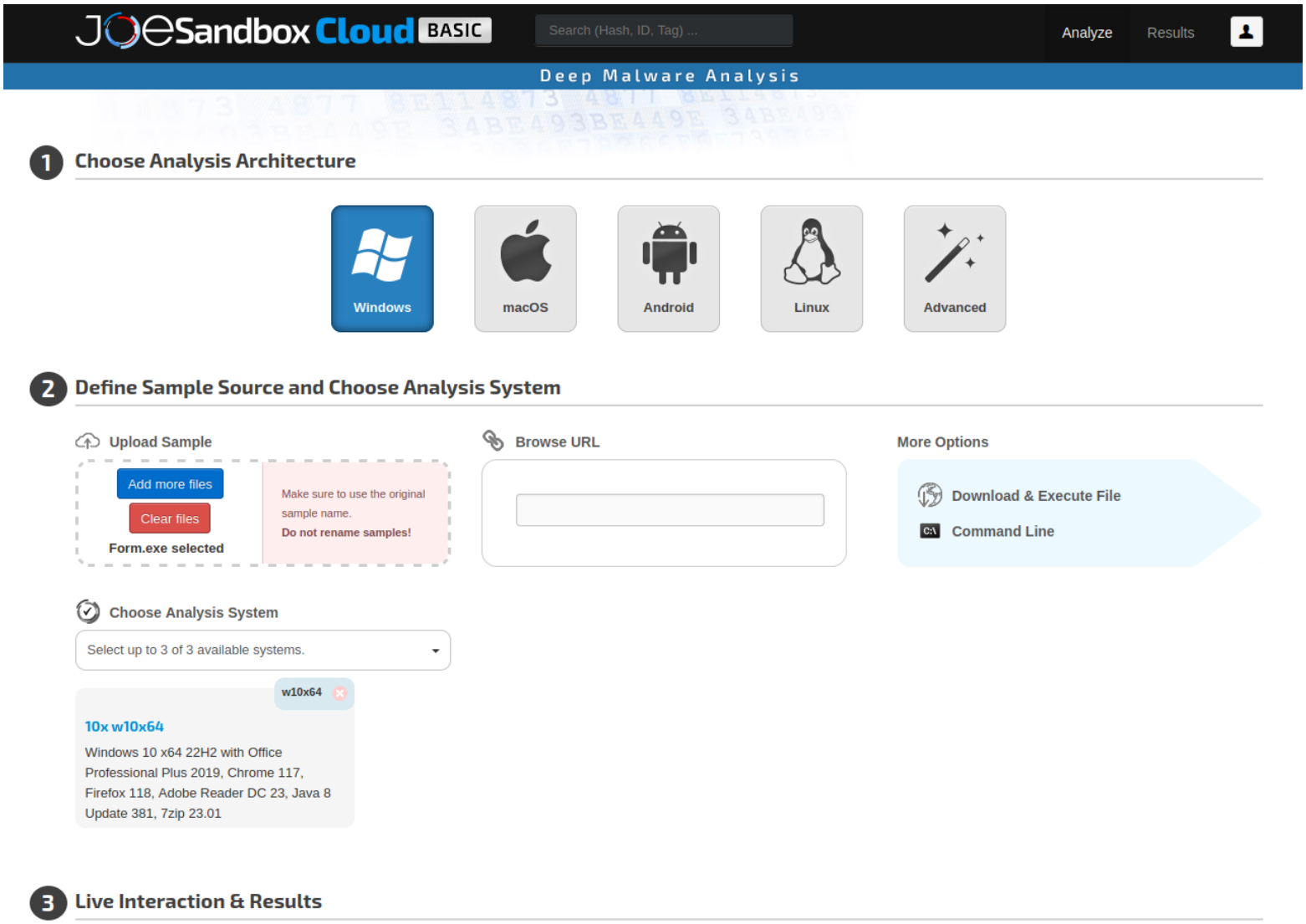
Showing 1 to 1 of 1 entries

Previous 1 Next

4.2 OSINT - MISPPriv



4.3 Sandbox - Joe



4.3 Sandbox - Joe

JoeSandbox Cloud BASIC — Overview | Signatures | Process Tree | Domains / IPs | Dropped | Static | Network | Stats | Behavior | Disassembly

Windows Analysis Report

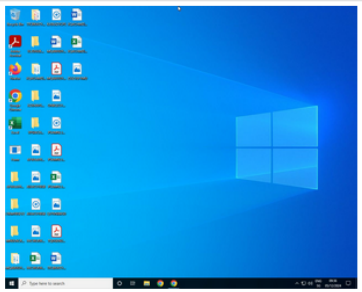
Create Interactive Tour

Form.exe

Overview

General Information

Sample name:	Form.exe
Analysis ID:	1569184
MD5:	a8371cb187d9971…
SHA1:	8dec32121d2f9f87…
SHA256:	784560f38065089f…
Infos:	



Detection

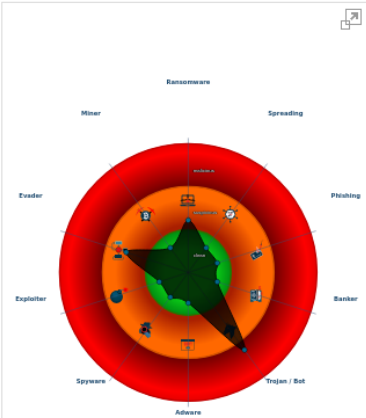
FormBook

Score:	80
Range:	0 - 100
Whitelisted:	false
Confidence:	100%

Signatures

- Antivirus / Scanner detection for submitted sa…
- Malicious sample detected (through communit…
- Multi AV Scanner detection for submitted file
- Yara detected FormBook
- AI detected suspicious sample
- Machine Learning detection for sample
- AV process strings found (often used to termin…
- Checks if the current process is being debugged
- Contains functionality for execution timing, ofte…
- Contains functionality to access loader functio…
- Detected potential crypto function
- One or more processes crash
- PE file does not import any functions

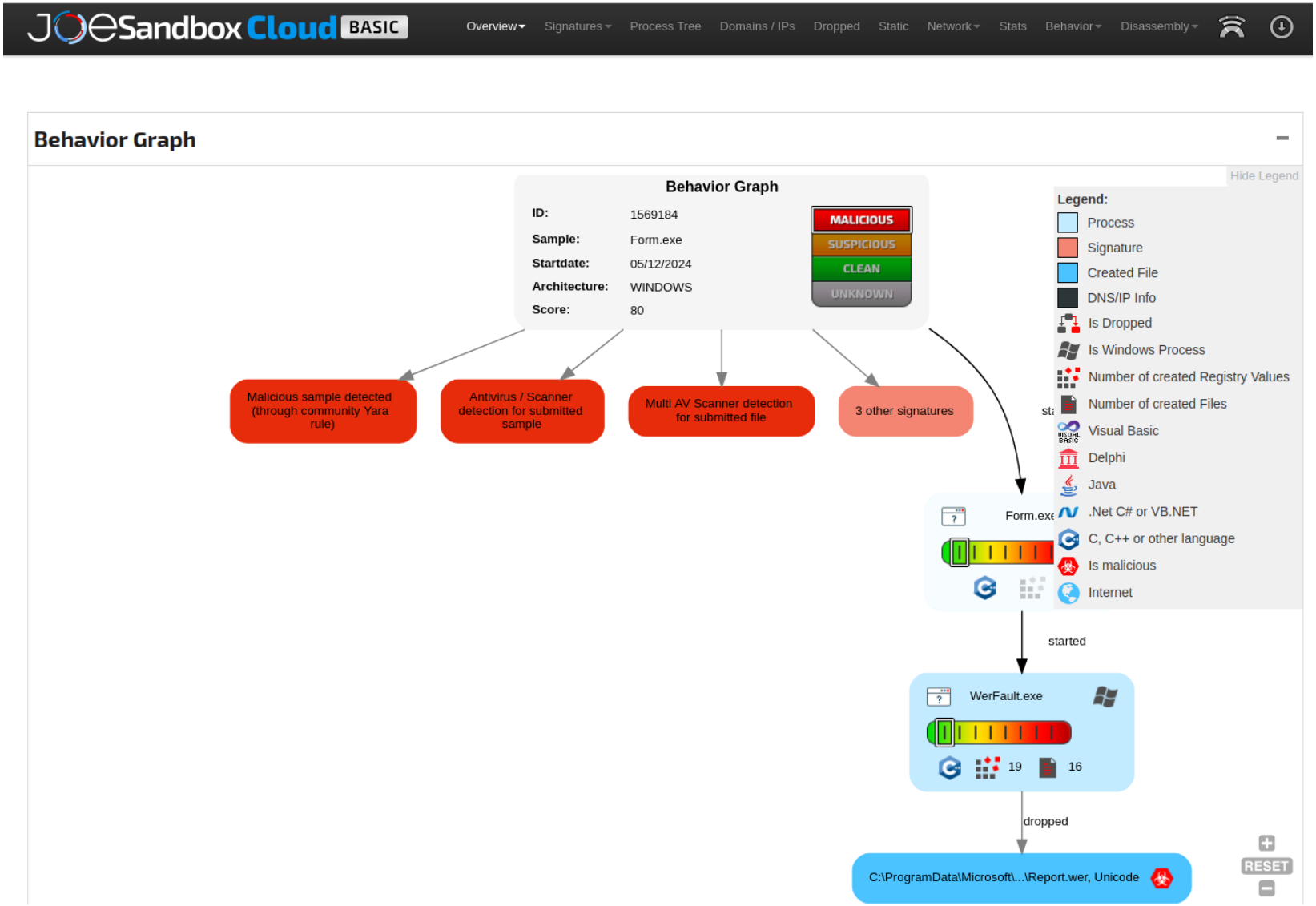
Classification



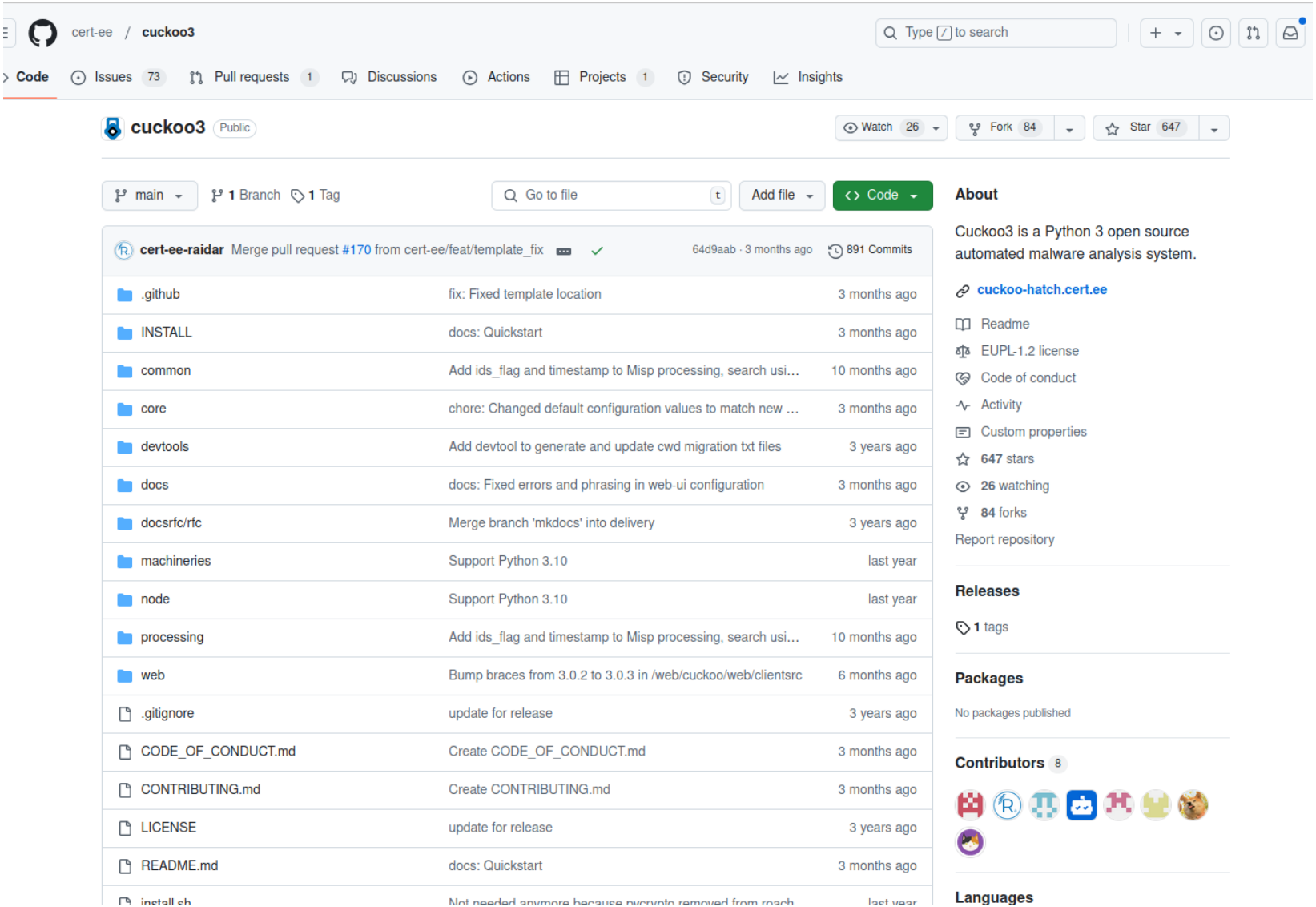
Process Tree

- System is w10x64
- Form.exe (PID: 3680 cmdline: "C:\Users\user\Desktop\Form.exe" MD5: A8371CB187D99711691CCBECF8F35657)
  - WerFault.exe (PID: 6776 cmdline: C:\Windows\SysWOW64\WerFault.exe -u -p 3680 -s 228 MD5: C31336C1EFC2CCB44B4326EA793040F2)
- cleanup

4.3 Sandbox - Joe



4.3 Sandbox - Cuckoo3



4.4 Static Analysis

- Malware delivery: Email
  - Office documents
  - PDF
  - .EXE
- Analyze:
  - Hash values
  - Strings
  - Resources
  - Imported functions
  - Exported functions
  - Certificate
  - .....

  $\rightarrow$ Capabilities of the malware

4.4 Static Analysis - Strings

```
pestr -n 7 Form.exe | less
```

```
!This program cannot be run in DOS mode.
<Ar5<zw1<Zv
EThis program cannot be run in DOS mode.
:Yf/yZjP
[)sk/Jo
X|e^BZ8
Rh%';,V
```

```
pescan Form.exe
```

```
file entropy:                   7.322160 (probably packed)
fpu anti-disassembly:           no
imagebase:                      normal
entrypoint:                     normal
DOS stub:                       normal
TLS directory:                  not found
timestamp:                      normal
section count:                  1 (low)
```

```
pesec Form.exe
```

```
ASLR:                           yes
DEP/NX:                         yes
SEH:                            yes
Stack cookies (EXPERIMENTAL):   yes
```

4.4 Static Analysis - PE - Portable Execution format

- Describe program files
- Contain:
  - Meta data
  - Instructions
  - Text data
  - Resources: 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)
```

4.4 Static Analysis - PE - Basic Analysis

```
file Form.exe
```

```
Form.exe: PE32 executable (GUI) Intel 80386, for MS Windows
```

```
exiftool Form.exe
```

```
File Name                       : Form.exe
File Size                       : 186 KiB
.....
File Type                       : Win32 EXE
File Type Extension             : exe
MIME Type                       : application/octet-stream
Machine Type                    : Intel 386 or later, and compatibles
Time Stamp                      : 2000:07:31 02:00:25+02:00
Image File Characteristics      : Executable, 32-bit
PE Type                         : PE32
Linker Version                  : 11.0
Code Size                       : 185856
Initialized Data Size           : 0
Uninitialized Data Size         : 0
Entry Point                     : 0x12e0
OS Version                      : 6.0
Image Version                   : 0.0
Subsystem Version               : 6.0
Subsystem                       : Windows GUI
Warning                         : Error processing PE data dictionary
```

4.4 Static Analysis - 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
```

4.4 Static Analysis - PE - Header

```
readpe -H Form.exe
```

```
DOS Header
    Magic number:                   0x5a4d (MZ)
    Bytes in last page:             144
    Pages in file:                  3
    .....

Optional/Image header
    Magic number:                   0x10b (PE32)
    Linker major version:           11
    Linker minor version:           0
    Size of .text section:          0x2d600
    Size of .data section:          0
    Size of .bss section:           0
    Entrypoint:                     0x12e0
    Address of .text section:       0x1000
    Address of .data section:       0x2f000
    ImageBase:                      0x400000
    Alignment of sections:          0x1000
    Alignment factor:               0x200
    .....
    Size of image:                  0x2f000
    Size of headers:                0x200
    Checksum:                       0
    Subsystem required:             0x2 (IMAGE_SUBSYSTEM_WINDOWS_GUI)
    DLL characteristics:            0x8140
    .....
```

4.4 Static Analysis - PE - Imported Functions

```
readpe -i ../1.exe
```

```
    Library
        Name:                       COMCTL32.dll
        Functions
                Name:                       ImageList_GetDragImage
                Name:                       ImageList_Merge
                Name:                       ImageList_SetOverlayImage
                Name:                       UninitializeFlatSB
                Name:                       ImageList_DragEnter
    Library
        Name:                       OLEAUT32.dll
        Functions
            Function
                Ordinal:                    294
    Library
        Name:                       ADVAPI32.dll
        Functions
                Name:                       RegOpenKeyExA
                Name:                       MapGenericMask
                Name:                       AdjustTokenGroups
                Name:                       SetSecurityDescriptorDacl
                Name:                       GetSecurityDescriptorLength
                Name:                       StartServiceA
                Name:                       OpenServiceA
    Library
        Name:                       MSVCRT.dll
        Functions
                Name:                       _mbsspnp
```

4.4 Static Analysis - PE - Resources

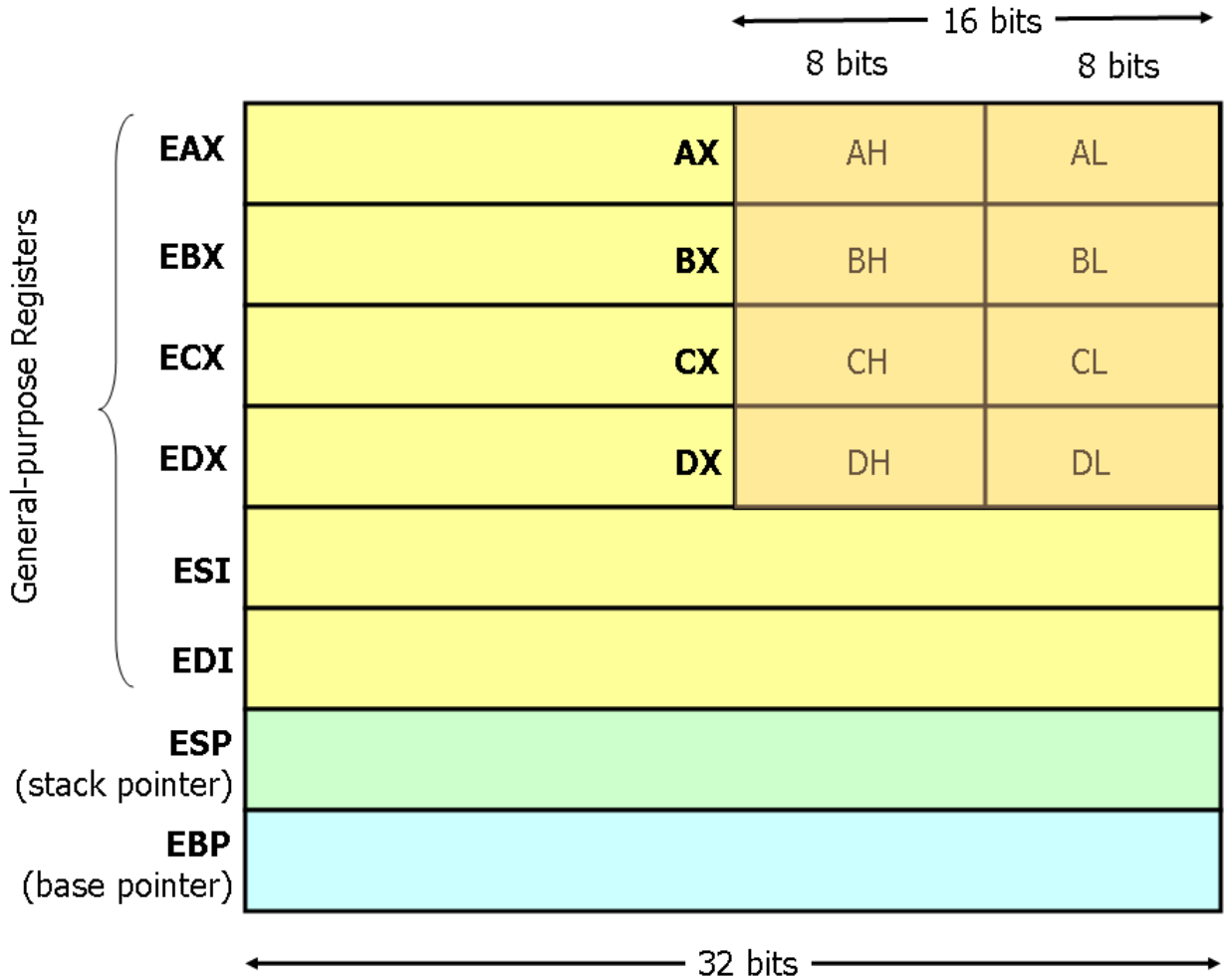
```
wrestool -l ../1.exe
```

```
--type=3 --name=23166 --language=2064 [type=icon offset=0x398cd8 size=455]
--type=3 --name=23167 --language=2064 [type=icon offset=0x398e78 size=648]
--type=3 --name=23168 --language=2064 [type=icon offset=0x398f78 size=642]
--type=3 --name=23169 --language=2064 [type=icon offset=0x399118 size=671]
--type=3 --name=23170 --language=2064 [type=icon offset=0x399358 size=1152]
--type=3 --name=23171 --language=2064 [type=icon offset=0x3995d8 size=1401]
--type=3 --name=23172 --language=2064 [type=icon offset=0x399a18 size=739]
--type=5 --name=34145 --language=2064 [type=dialog offset=0x398740 size=426]
--type=5 --name=34146 --language=2064 [type=dialog offset=0x3988f0 size=382]
--type=5 --name=34147 --language=2064 [type=dialog offset=0x398a70 size=562]
--type=9 --name=44061 --language=2064 [type=accelerator offset=0x3986e8 size=88]
--type=0 --name=5676 --language=2064 [offset=0x398ca8 size=11]
--type=0 --name=5677 --language=2064 [offset=0x398cb8 size=30]
--type=0 --name=5678 --language=2064 [offset=0x399c58 size=219344]
--type=0 --name=5679 --language=2064 [offset=0x3cf528 size=3852]
--type=14 --name=63607 --language=2064 [type=group_icon offset=0x398e60 size=20]
--type=14 --name=63608 --language=2064 [type=group_icon offset=0x398f60 size=20]
--type=14 --name=63609 --language=2064 [type=group_icon offset=0x399100 size=20]
--type=14 --name=63610 --language=2064 [type=group_icon offset=0x399340 size=20]
--type=14 --name=63611 --language=2064 [type=group_icon offset=0x3995c0 size=20]
--type=14 --name=63612 --language=2064 [type=group_icon offset=0x399a00 size=20]
--type=14 --name=63613 --language=2064 [type=group_icon offset=0x399c40 size=20]
```

4.4 Static Analysis - Considerations

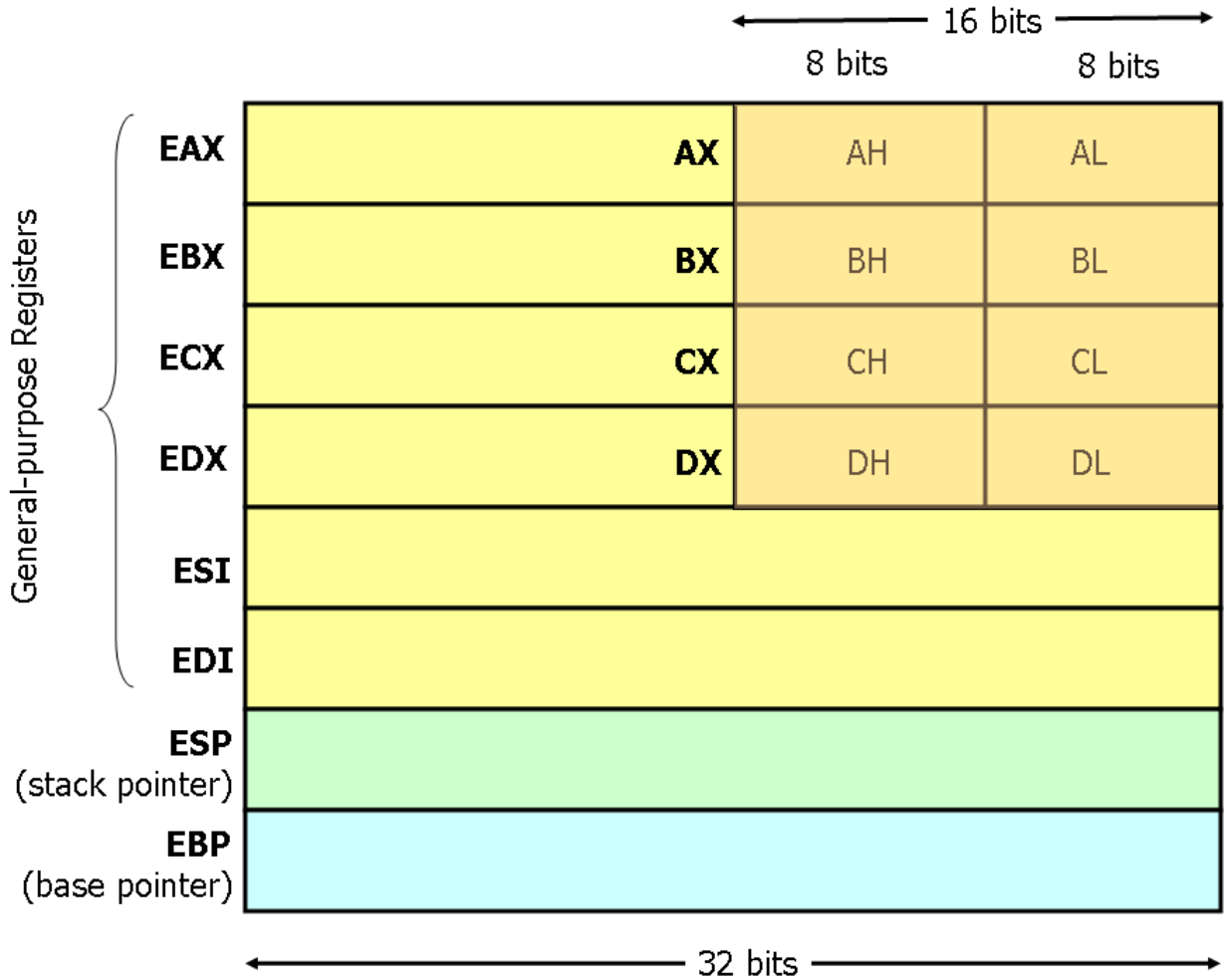
- Perfect disassembly $\rightarrow$ Unsolved problem
- Linear disassembly
  - Identify the program code
  - Decode the bytes
- Linear disassembly limitations
  - Don't know how instructions get decoded by CPU
  - Could not counter fight obfuscation
- Obfuscation techniques
  - Packing
  - Resource Obfuscation
  - 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



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

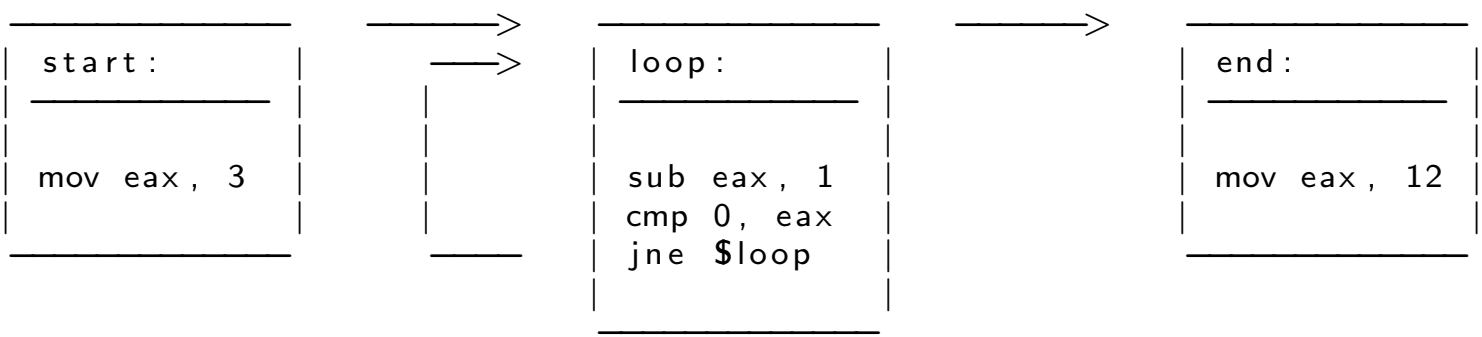
4.5 x86 Assembly: Control Flow Graphs

```
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
```



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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

5.2 Analysing files: Outlook PST

1. Preparation:

```
sudo mount -o ro,offset=$((512*63)) nps-2008-jean.raw /media/sansforensics/casenps/
mkdir outlook
mkdir outlook/out
```

2. Copy .pst file

```
cp /media/sansforensics/casenps/Documents\ and\ Settings/Jean/Local\ Settings/
        Application\ Data/Microsoft/Outlook/outlook.pst outlook/.
```

3. Extract Emails

```
file outlook/outlook.pst
    outlook/outlook.pst: Microsoft Outlook email folder (<=2002)

readpst outlook/outlook.pst -o outlook/out/

cd outlook/out/
ls
    Inbox.mbox    Outbox.mbox    'Sent Items.mbox'
```

5.2 Analysing files: Outlook PST

4. Analyze Emails

```
less Sent\ Items.mbox

    I've attached the information that you have requested to this email message.
    .....
    .....
    -----Original Message-----
    From: alison@m57.biz [mailto:tuckgorge@gmail.com]
    Sent: Sunday, July 20, 2008 2:23 AM
    To: jean@m57.biz
    Subject: Please send me the information now
    .....
    Hi, Jean.
    I'm sorry to bother you, but I really need that information now --
    .....
    ------boundary-LibPST-iamunique-1836211713_-_-
        filename="m57biz.xls"


less Inbox.mbox

    From "tuckgorge@gmail.com" Sun Jul 20 01:22:45 2008
    X-Original-To: jean@m57.biz
    To: jean@m57.biz
    From: tuckgorge@gmail.com (alison@m57.biz)
```

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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

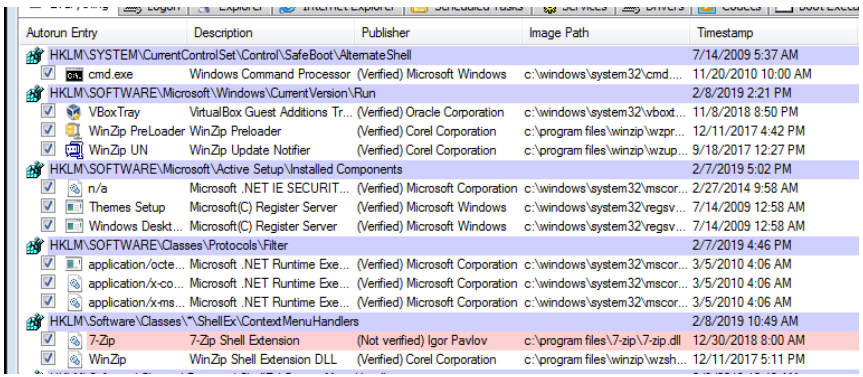
```
> reg QUERY "HKLM\SYSTEM\CurrentControlSet\Control\Session Manager\Memory Management"
    .....
    ClearPageFileAtShutdown    REG_DWORD    0x0
    .....
```

- 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
```

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7. Memory Forensics

7.1 About Memory Forensics

- History
  - 2005: String search
  - $\rightarrow$ EProcess structures
- Finding EProcess structures
  - Find the doubly linked list (ntoskrnl.exe)
  - Brute Force searching
- Information expected
  - Processes (hidden)
  - Services (listening)
  - Malware
  - Network connections
  - Registry content
  - Passwords
  - Cleartext data

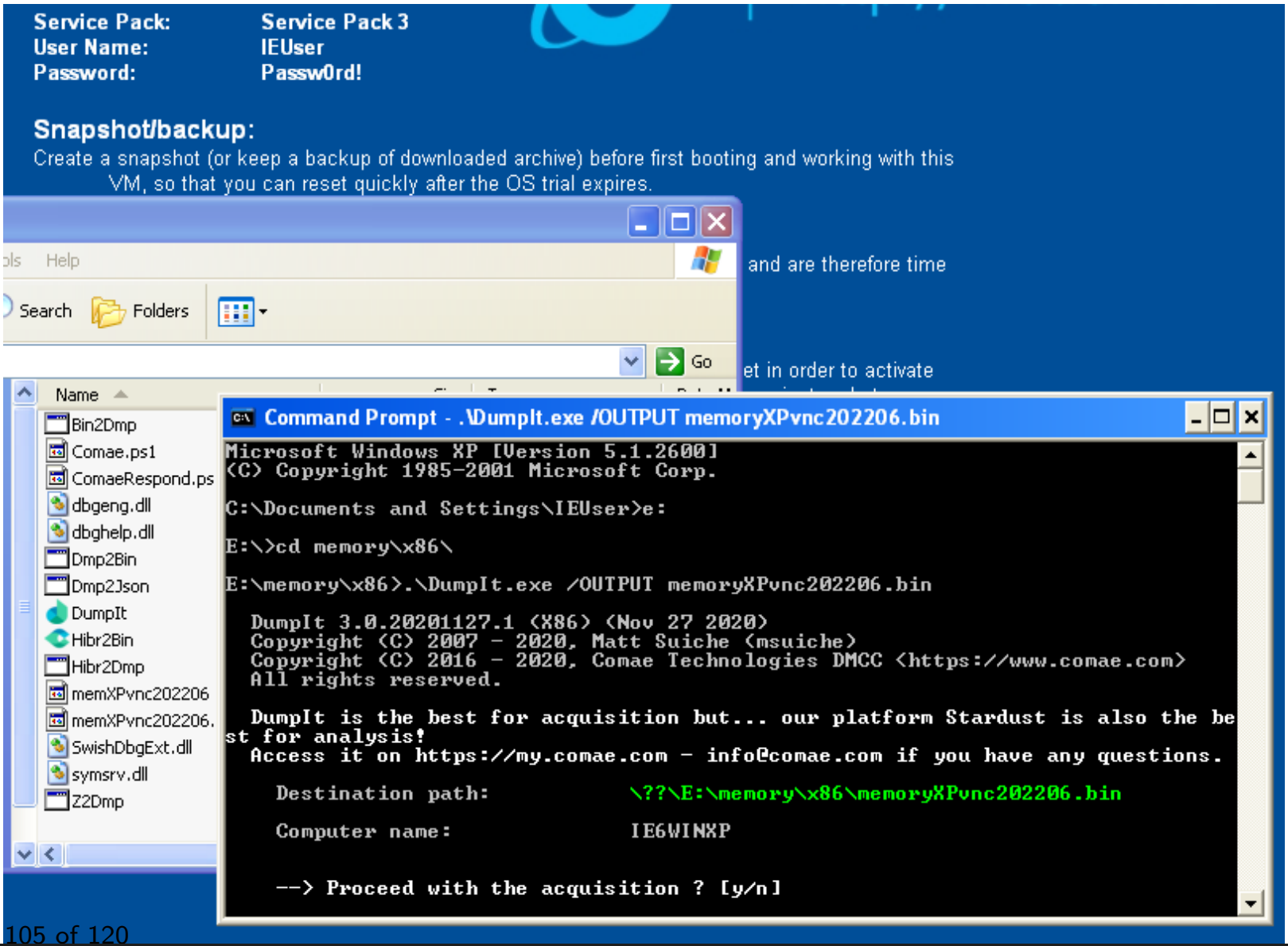
7.2 Capturing memory

- Prepare USB device
  - File system: ExFAT; NTFS
  - Executable capturing tool
  - No installation - Little impact as possible
  - Write capture on device
  - Administrator privileges required

- Capture memory from running system
  - DumpIt.exe
  - `DumpIt.exe` part of Comae-Toolkit
  - `https://www.comae.com/`
  - `https://github.com/Crypt2Shell/Comae-Toolkit/`

```
cd Z:\comae\x86\
DumpIt.exe /OUTPUT memory_20201215_1138.bin
-- Press y to write the memory dump into the working directory
```

7.2 Capturing memory



7.2 Capturing memory

- Hibernation file: `hiberfil.sys`
  - Created when going into hibernation mode
  - Fully fleded memory content
  - Compressed and slightly modified
  - Can be converted into raw memory dump
  - Force hibernation:

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

- Pagefile: `pagefile.sys`
- Swapfile: `swapfile.sys` (Windows 8)
- Crash dump: `memory.dmp` (Blue Screen)

7.3 BulkExtractor Exercise

1. Preparation

```
sudo mount -o ro,offset=$((512*2048)) circl-dfir.dd /media/case1

mkdir memory
mkdir memory/out

cp /media/case1/memory/* memory
cd memory
```

2. BulkExtractor

```
bulk_extractor -o out/ DEMO-PC-20180315-160249.raw
```

3. Investigate results

```
ls -lh out/

less out/url_histogram.txt
less out/email_histogram.txt
less out/aes_keys.txt
```

7.4 Volatility Overview

Volatility 2 or Volatility 3

```
python vol.py -h | less
python vol.py --info | less
```

```
    ...
    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)
    ...
```

```
vol.py -f <filename> <plugin [options]> --profile=<profile>
vol.py -f memdump.raw imageinfo
```

```
sudo apt install python3-pefile
git clone https://github.com/volatilityfoundation/volatility3.git
```

7.4 Volatility Overview: Exercise

Identify profile:

```
vol.py -f DEMO-PC-20180315-160249.raw imageinfo

      Suggested Profile(s) : Win7SP1x86_23418, Win7SP0x86, Win7SP1x86_24000, Win7SP1x86
                 AS Layer1 : IA32PagedMemory (Kernel AS)
                 AS Layer2 : FileAddressSpace (memory/DEMO-PC-20180315-160249.raw)
                  PAE type : No PAE
                       DTB : 0x185000L
                      KDBG : 0x82954c70L
       Number of Processors : 1
  Image Type (Service Pack) : 1
             KPCR for CPU 0 : 0x82955d00L
          KUSER_SHARED_DATA : 0xffdf0000L
        Image date and time : 2018-03-15 16:02:54 UTC+0000
  Image local date and time : 2018-03-15 17:02:54 +0100
```

```
    --> vol.py -f <filename> <plugin [options]> --profile=Win7SP1x86_23418
```

```
export VOLATILITY_PROFILE=Win7SP1x86_23418
```

```
    --> vol.py -f <filename> <plugin [options]>
```

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 > pslist.txt
```

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 psxview > psxview
```

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 > netscan.txt
```

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

- Other useful plugins

```
volatility -f memdump.raw sessions
volatility -f memdump.raw privs
volatility -f memdump.raw hivelist
volatility -f memdump.raw filescan
volatility -f memdump.raw timeline
volatility -f memdump.raw hashdump
```

- 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)
```

7.7 Volatility: Other plugins

- 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
```

- 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
```

7.8 Volatility Exercise

```
python volatility3/vol.py -q --help | less
mkdir out2


python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.pslist >out2/pslist
python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.pstree >out2/pstree
python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.psscan >out2/psscan
python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.psxview >out2/psxvie


python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.netscan.NetScan >out


python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.dumpfiles.DumpFiles
python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.filescan.FileScan >


python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw timeliner > out2/timeliner


python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.registry.hivelist.H


python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.consoles.Consoles >
python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.cmdline.CmdLine > ou
python volatility3/vol.py -q -f ./DEMO-PC-20180315-160249.raw windows.cmdline.CmdScan > ou
```

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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

- Windows Forensics

  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
- Internet artifacts
- Mobile Forensics

Overview

1. Windows Registry
2. Event Logs
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