Malware Analysis using Rekall

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Acknowledgement

Before we start with the report, I just want to make a note that the Rekall Project has not been maintained since 2017 and does not provide full support for python 3.x, so before we start the process of downloading rekall I would definitely recommend downloading python 3.6 for this.

Rekall has many dependencies and the developers made it easier for us to know what they are, and so , if for some reason the download fails, if you look at the error log they will provide a link to the file you need to continue with the installation process.

I would also recommend using a virtual environment to download rekall as that is the easiest way to keep the integrity of your main python dir.

What is Rekal and why do we use it?

Rekall is an advanced forensic and incident response framework, while it began as a memory forensic framework, it has now evolved into a complete platform, although not currently managed like it was a couple years ago. Rekall implements the most advanced analysis techniques in the field, while still being developed in the open, with a free and open source license.

Downloading Rekall

Before we start with downloading rekall, I will show how to download python 3.6 for windows, for MacOS and linux, the process will be the same but the only difference will be the file we download.

Installing Python 3.6

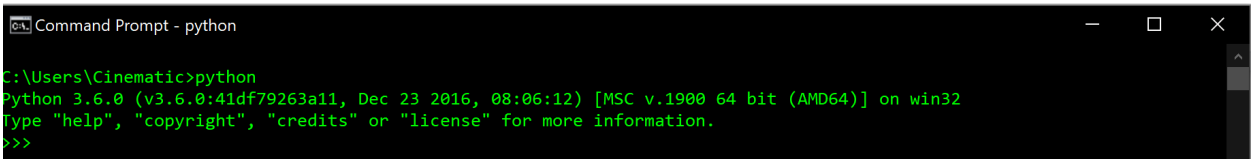
Steps to install python on your machine

1. Go to this link : https://www.python.org/downloads/release/python-360/
2. Scroll all the way down until you see this:

Files

Version	Operating System	Description	MD5 Sum	File Size	GPG
Gzipped source tarball	Source release		3f7062ccf8be76491884d0e47ac8b251	22256403	SIG
XZ compressed source tarball	Source release		82b143ebbf4514d7e05876bed7a6b1f5	16805836	SIG
Mac OS X 64-bit/32-bit installer	macOS	for Mac OS X 10.6 and later	72acb0175e7622dec7e1b160a43b8c42	27442222	SIG
Windows help file	Windows		6a842a15ab3b4aa316c91a9779db82ec	7940890	SIG
Windows x86-64 embeddable zip file	Windows	for AMD64/EM64T/x64	0ec0caeea75bae5d2771cf619917c71f	6925798	SIG
Windows x86-64 executable installer	Windows	for AMD64/EM64T/x64	71c9d30c1110abf7f80a428970ab8ec2	31505640	SIG
Windows x86-64 web-based installer	Windows	for AMD64/EM64T/x64	25b8b6c93a098dfade3b014630f9508e	1312376	SIG
Windows x86 embeddable zip file	Windows		1adf2fb735c5000af32d42c39136727c	6315855	SIG
Windows x86 executable installer	Windows		38d9b036b25725f6acb553d4aece4db4	30566536	SIG
Windows x86 web-based installer	Windows		f71f4590be2cc5cdc43069594d4ea98d	1286984	SIG

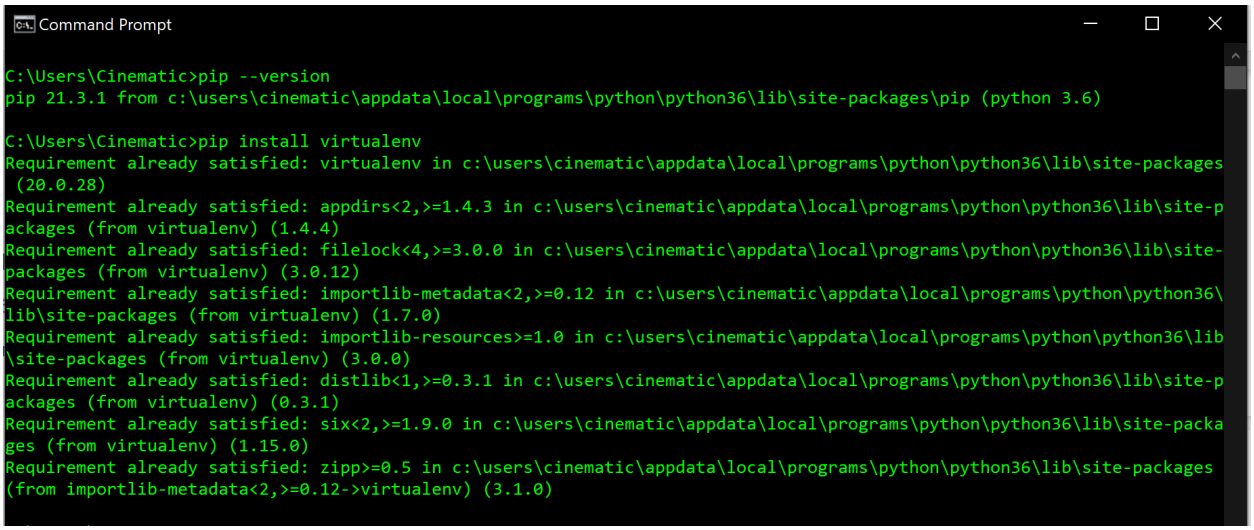
3. Select the file you need, for windows it's usually "**Windows x86-64 executable installer**".
4. After Downloading it, On the first window you see, there should be an "ADD TO PATH" option, make sure to click it.
5. After finishing the installation process, open command prompt and type "python".
6. If everything went smoothly this should be the output



Congrats you now have python 3.6 on your machine.

Setting up a Virtual Environment

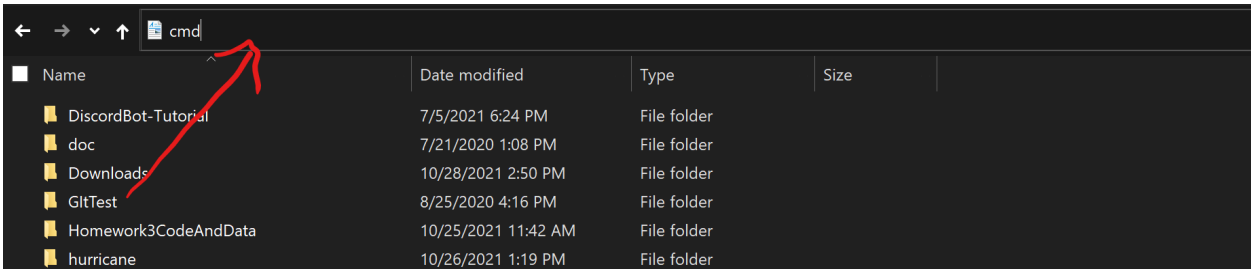
After downloading python, we now move on to installing rekall. But before installing rekall we need to set up a virtual environment to download rekall in. To do this open command prompt then “pip install virtualenv”



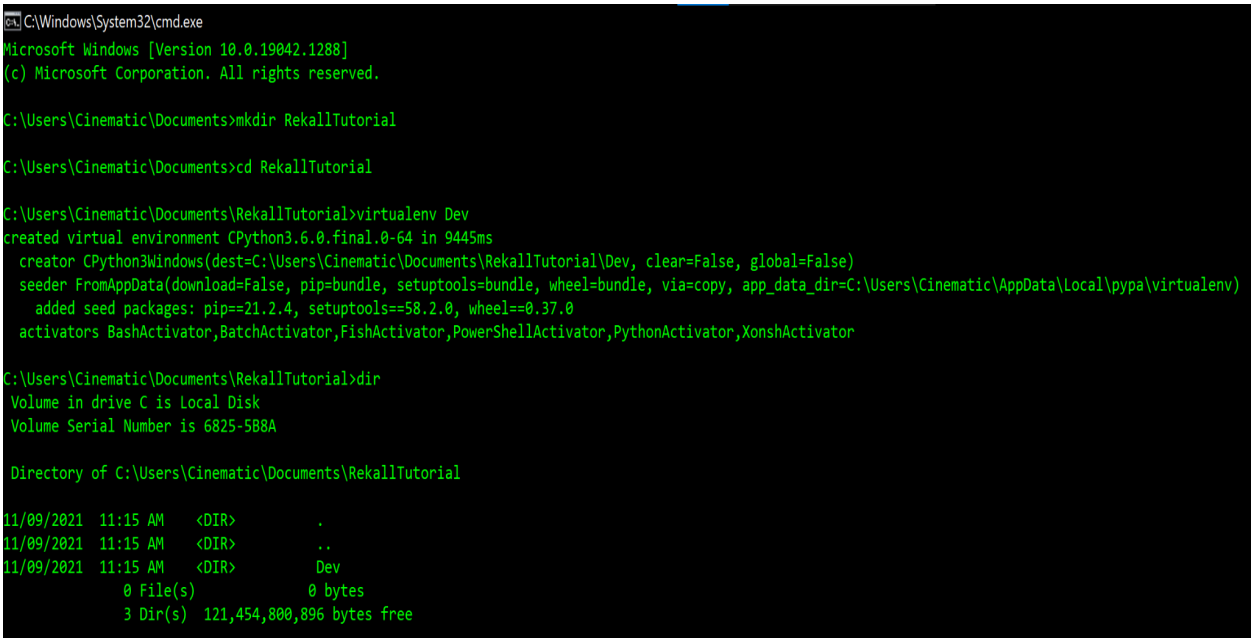
Since I already have virtualenv downloaded on my machine the requirements for the pip request have already been satisfied.

Onto the next step, now we will create our project where we will install rekall and setup the virtualenv.

Go to the directory where you would want to create the project.
Click on the address bar and type cmd and hit enter to open the command prompt to the same dir.



Create a new folder here using the mkdir command
Once created, cd into that folder and run the command “virtualenv Dev” , to create a virtualenv called Dev. (This can be called whatever you want)



Now cd into Dev and run Scripts\activate to activate the virtualenv

```
C:\Users\Cinematic\Documents\RekallTutorial>cd Dev

C:\Users\Cinematic\Documents\RekallTutorial\Dev>Scripts\activate

(Dev) C:\Users\Cinematic\Documents\RekallTutorial\Dev>
```

Now we are ready to install Rekall

Installing Rekall From Github

We will now need the rekall api from github, for everything to go like mint in this process you will need to have git. You can download the files here. Git clone it to the project dir.

Once downloaded, cd into Rekall / Recall-core, there should be a setup.py file in there, to execute it just run “python setup.py install”.

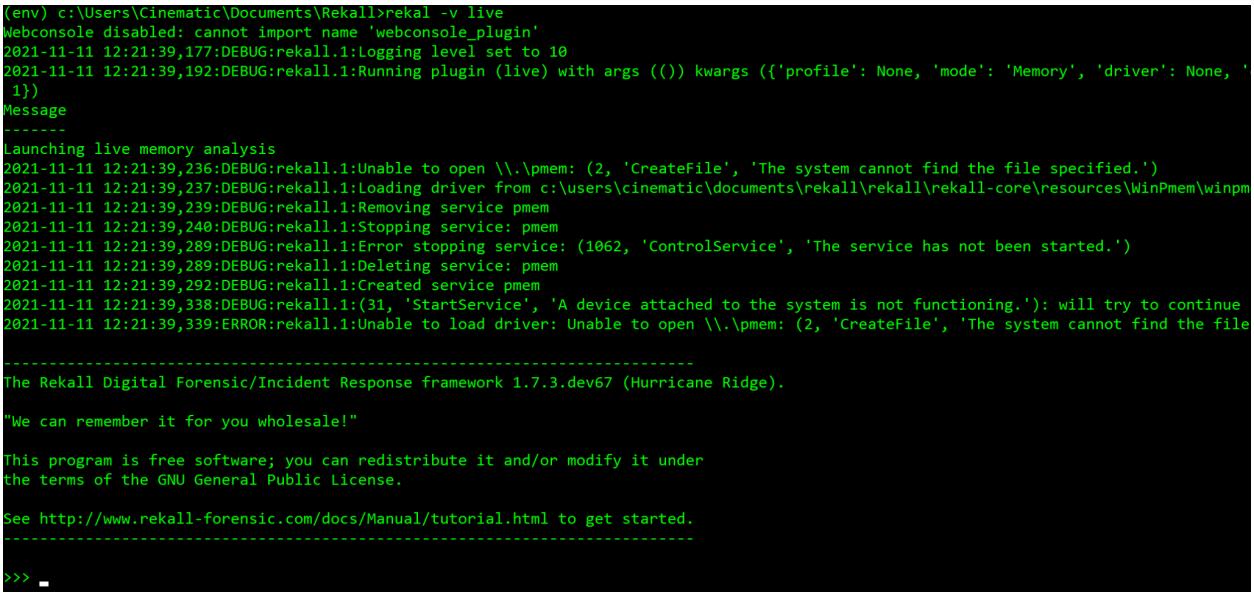
If you encounter any errors, pip install whatever module is missing. If there's an executable file missing they will let you know where to download it.

Once Successfully downloaded you should see this

```
Using c:\python27\lib\site-packages\artifacts-20170909-py2.7.egg
Searching for arrow==0.10.0
Best match: arrow 0.10.0
Processing arrow-0.10.0-py2.7.egg
arrow 0.10.0 is already the active version in easy-install.pth

Using c:\python27\lib\site-packages\arrow-0.10.0-py2.7.egg
Searching for acora==2.1
Best match: acora 2.1
Processing acora-2.1-py2.7-win-amd64.egg
acora 2.1 is already the active version in easy-install.pth

Using c:\python27\lib\site-packages\acora-2.1-py2.7-win-amd64.egg
Searching for six==1.16.0
Best match: six 1.16.0
Adding six 1.16.0 to easy-install.pth file

Using c:\python27\lib\site-packages
Finished processing dependencies for rekall-core==1.7.3.dev67

(Dev) C:\Users\Cinematic\Documents\RekallTutorial\rekall\rekall-core>
```

Using Rekall for Memory Analysis

To run rekall in live mode run " rekall -v live", -v is the flag for verbosity.



List of Definitions

There are a few functions that we need to be familiar with before moving forward.

1. Pslist - The pslist plugin lists all the processes on windows using a variety of methods. Since it is required by all plugins which has process selectors, this plugin will, by default, list processes using all methods

2. Pstree - This plugin displays all known processes in a tree form. This is useful to see which processes launched another process
3. Procinfo - This plugin displays basic info about a process. It takes all the usual process selectors and prints information about the PE file (using peinfo) as well as the process environment strings.
4. Threads - This plugin iterates over all processes and lists all threads in all processes. This is the list walking version of the third scan plugin.
5. Malfind - This command helps find hidden or injected code/DLLs in user mode memory, based on characteristics such as VAD tag and page permissions.
6. Netstat - Shows current network connections.
7. Netscan - Shows current and past connections.

8. Moddump - To extract a kernel module from memory and dump it to disk for analysis we use the moddump command. A regular expression can be specified for the module name to dump.

Analyzing Stuxnet using Rekall

After installing rekall, we now know some of the functions the library provides. For our first malware we will be using stuxnet, in this first part we will be using functions calls like pslist, pstree, and we will also be using WMI queries to get the list of programs.

What is Stuxnet?

Stuxnet is a computer worm that was originally aimed at Iran's nuclear facilities and has since mutated and spread to other industrial and energy-producing facilities, the original stuxnet malware attack targeted the programmable logic controllers used to automate machine processes.The most recent stuxnet attack struck an unspecified network infrastructure in Iran in October 2018.

Connecting stuxnet to Rekal

To start stuxnet in rekal we run rekal --filename stuxnet.vmem

```
(env) c:\Users\Cinematic\Documents\Rekall>rekall --filename stuxnet.vmem
Webconsole disabled: cannot import name 'webconsole_plugin'

----------------------------------------------------------------------------
The Rekall Digital Forensic/Incident Response framework 1.7.3.dev67 (Hurricane Ridge).

"We can remember it for you wholesale!"

This program is free software; you can redistribute it and/or modify it under
the terms of the GNU General Public License.

See http://www.rekall-forensic.com/docs/Manual/tutorial.html to get started.
----------------------------------------------------------------------------

>>>
```

To look at the processes which are running we use pstree

```
>>> pstree()
2021-12-01 12:39:37,162:WARNING:rekall.1:Inventory for repository "http://profiles.rekall-forensi
d you forget to create an inventory? You must use the tools/profiles/build_profile_repo.py tool w
2021-12-01 12:39:37,163:WARNING:rekall.1:Repository http://profiles.rekall-forensic.com will be d
_EPROCESS                                ppid  thd_count hnd_count       create_time
---------------------------------------- ------ --------- --------- ------------------------
  0x823c8830 System (4)                      0        59       403 -
. 0x820df020 smss.exe (376)                  4         3        19 2010-10-29 17:08:53Z
.. 0x821a2da0 csrss.exe (600)              376        11       395 2010-10-29 17:08:54Z
.. 0x81da5650 winlogon.exe (624)           376        19       570 2010-10-29 17:08:54Z
... 0x82073020 services.exe (668)          624        21       431 2010-10-29 17:08:54Z
.... 0x8205ada0 alg.exe (188)              668         6       107 2010-10-29 17:09:09Z
.... 0x82279998 imapi.exe (756)            668         4       116 2010-10-29 17:11:54Z
.... 0x823315d8 vmacthlp.exe (844)         668         1        25 2010-10-29 17:08:55Z
.... 0x81db8da0 svchost.exe (856)          668        17       193 2010-10-29 17:08:55Z
..... 0x81fa5390 wmiprvse.exe (1872)       856         5       134 2011-06-03 04:25:58Z
.... 0x81c498c8 lsass.exe (868)            668         2        23 2011-06-03 04:26:55Z
.... 0x81e61da0 svchost.exe (940)          668        13       312 2010-10-29 17:08:55Z
.... 0x822843e8 svchost.exe (1032)         668        61      1169 2010-10-29 17:08:55Z
..... 0x822b9a10 wuauclt.exe (976)        1032         3       133 2010-10-29 17:12:03Z
..... 0x820ecc10 wscntfy.exe (2040)       1032         1        28 2010-10-29 17:11:49Z
.... 0x81e18b28 svchost.exe (1080)         668         5        80 2010-10-29 17:08:55Z
.... 0x81ff7020 svchost.exe (1200)         668        14       197 2010-10-29 17:08:55Z
.... 0x81fee8b0 spoolsv.exe (1412)         668        10       118 2010-10-29 17:08:56Z
.... 0x81e0eda0 jqs.exe (1580)             668         5       148 2010-10-29 17:09:05Z
.... 0x81fe52d0 vmtoolsd.exe (1664)        668         5       284 2010-10-29 17:09:05Z
..... 0x81c0cda0 cmd.exe (968)            1664         0         - 2011-06-03 04:31:35Z
...... 0x81f14938 ipconfig.exe (304)       968         0         - 2011-06-03 04:31:35Z
.... 0x821a0568 VMUpgradeHelper (1816)     668         3        96 2010-10-29 17:09:08Z
.... 0x81c47c00 lsass.exe (1928)           668         4        65 2011-06-03 04:26:55Z
... 0x81e70020 lsass.exe (680)             624        19       342 2010-10-29 17:08:54Z
  0x820ec7e8 explorer.exe (1196)          1728        16       582 2010-10-29 17:11:49Z
. 0x81e86978 TSVNCache.exe (324)          1196         7        54 2010-10-29 17:11:49Z
. 0x81c543a0 Procmon.exe (660)            1196        13       189 2011-06-03 04:25:56Z
. 0x81e6b660 VMwareUser.exe (1356)        1196         9       251 2010-10-29 17:11:50Z
. 0x8210d478 jusched.exe (1712)           1196         1        26 2010-10-29 17:11:50Z
. 0x81fc5da0 VMwareTray.exe (1912)        1196         1        50 2010-10-29 17:11:50Z
Plugin: pstree (PSTree)
```

In the picture above we see 3 lsass.exe processes. One has a parent of "Winlogon.exe" and the other two have a parent of "services.exe". So now we can go ahead and take a closer look at these 3 processes.

```
>>> processes = tokens(proc_regex=("lsass.exe"))
                Process                                          Sid                              Comment
---------------------------------------- ---------------------------------------------------- -------
0x81e70020 lsass.exe                  680 S-1-5-18                                             Local System
0x81e70020 lsass.exe                  680 S-1-5-32-544                                         Administrators
0x81e70020 lsass.exe                  680 S-1-1-0                                              Everyone
0x81e70020 lsass.exe                  680 S-1-5-11                                             Authenticated Users
0x81c498c8 lsass.exe                  868 S-1-5-18                                             Local System
0x81c498c8 lsass.exe                  868 S-1-5-32-544                                         Administrators
0x81c498c8 lsass.exe                  868 S-1-1-0                                              Everyone
0x81c498c8 lsass.exe                  868 S-1-5-11                                             Authenticated Users
0x81c47c00 lsass.exe                 1928 S-1-5-18                                             Local System
0x81c47c00 lsass.exe                 1928 S-1-5-32-544                                         Administrators
0x81c47c00 lsass.exe                 1928 S-1-1-0                                              Everyone
0x81c47c00 lsass.exe                 1928 S-1-5-11                                             Authenticated Users
>>>
```

As we can see, al the "lsass.exe" processes have the same SID's

We can now identify the priority of the 3 processes, we know one of them is legit and so that process needs to have a higher priority and the other 2 that we think are suspicious need to have the same priority

```
>>> dlllist([680, 868, 1928])
2021-12-01 12:55:45,689:WARNING:rekall.1:Inventory for repository "http://profiles.rekall-forer
d you forget to create an inventory? You must use the tools/profiles/build_profile_repo.py tool
2021-12-01 12:55:45,690:WARNING:rekall.1:Repository http://profiles.rekall-forensic.com will be
     base       size               reason             dll_path
  ---------- ---------- ---------------------------- --------
----------------------------------------
lsass.exe pid: 680
Command line : C:\WINDOWS\system32\lsass.exe
Service Pack 3
----------------------------------------
   0x1000000     0x6000 65535                        C:\WINDOWS\system32\lsass.exe
  0x7c900000    0xaf000 65535                        C:\WINDOWS\system32\ntdll.dll
  0x7c800000    0xf6000 65535                        C:\WINDOWS\system32\kernel32.dll
  0x77dd0000    0x9b000 65535                        C:\WINDOWS\system32\ADVAPI32.dll
  0x77e70000    0x92000 65535                        C:\WINDOWS\system32\RPCRT4.dll
  0x77fe0000    0x11000 65535                        C:\WINDOWS\system32\Secur32.dll
  0x75730000    0xb5000 65535                        C:\WINDOWS\system32\LSASRV.dll
  0x71b20000    0x12000 65535                        C:\WINDOWS\system32\MPR.dll
  0x7e410000    0x91000 65535                        C:\WINDOWS\system32\USER32.dll
  0x77f10000    0x49000 65535                        C:\WINDOWS\system32\GDI32.dll
  0x77b20000    0x12000 65535                        C:\WINDOWS\system32\MSASN1.dll
  0x77c10000    0x58000 65535                        C:\WINDOWS\system32\msvcrt.dll
  0x5b860000    0x55000 65535                        C:\WINDOWS\system32\NETAPI32.dll
  0x767a0000    0x13000 65535                        C:\WINDOWS\system32\NTDSAPI.dll
  0x76f20000    0x27000 65535                        C:\WINDOWS\system32\DNSAPI.dll
  0x71ab0000    0x17000 65535                        C:\WINDOWS\system32\WS2_32.dll
  0x71aa0000     0x8000 65535                        C:\WINDOWS\system32\WS2HELP.dll
  0x76f60000    0x2c000 65535                        C:\WINDOWS\system32\WLDAP32.dll
  0x71bf0000    0x13000 65535                        C:\WINDOWS\system32\SAMLIB.dll
  0x74440000    0x6a000 65535                        C:\WINDOWS\system32\SAMSRV.dll
  0x76790000     0xc000 65535                        C:\WINDOWS\system32\cryptdll.dll
  0x5cb70000    0x26000 1                            C:\WINDOWS\system32\ShimEng.dll
  0x6f880000   0x1ca000 1                            C:\WINDOWS\AppPatch\AcGenral.DLL
  0x76b40000    0x2d000 2                            C:\WINDOWS\system32\WINMM.dll
  0x774e0000   0x13d000 4                            C:\WINDOWS\system32\ole32.dll
  0x77120000    0x8b000 2                            C:\WINDOWS\system32\OLEAUT32.dll
  0x77be0000    0x15000 1                            C:\WINDOWS\system32\MSACM32.dll
  0x77c00000     0x8000 1                            C:\WINDOWS\system32\VERSION.dll
  0x7c9c0000   0x817000 2                            C:\WINDOWS\system32\SHELL32.dll
  0x77f60000    0x76000 4                            C:\WINDOWS\system32\SHLWAPI.dll
  0x769c0000    0xb4000 15                           C:\WINDOWS\system32\USERENV.dll
  0x5ad70000    0x38000 3                            C:\WINDOWS\system32\UxTheme.dll
  0x773d0000   0x103000 1                            C:\WINDOWS\WinSxS\x86_Microsoft.Windows
  0x5d090000    0x9a000 1                            C:\WINDOWS\system32\comctl32.dll
  0x4d200000     0xe000 1                            C:\WINDOWS\system32\msprivs.dll
  0x71cf0000    0x4c000 2                            C:\WINDOWS\system32\kerberos.dll
  0x77c70000    0x24000 5                            C:\WINDOWS\system32\msv1_0.dll
  0x76d60000    0x19000 8                            C:\WINDOWS\system32\iphlpapi.dll
  0x744b0000    0x65000 2                            C:\WINDOWS\system32\netlogon.dll
  0x767c0000    0x2c000 2                            C:\WINDOWS\system32\w32time.dll
  0x76080000    0x65000 2                            C:\WINDOWS\system32\MSVCP60.dll
  0x767f0000    0x27000 7                            C:\WINDOWS\system32\schannel.dll
  0x77a80000    0x95000 9                            C:\WINDOWS\system32\CRYPT32.dll
  0x74380000     0xf000 1                            C:\WINDOWS\system32\wdigest.dll
  0x68000000    0x36000 1                            C:\WINDOWS\system32\rsaenh.dll
  0x74410000    0x2f000 1                            C:\WINDOWS\system32\scecli.dll
  0x77920000    0xf3000 1                            C:\WINDOWS\system32\SETUPAPI.dll
```

```
lsass.exe pid: 868
Command line : "C:\WINDOWS\\system32\\lsass.exe"
Service Pack 3
------------------------------------------------
   0x1000000     0x6000 65535                     C:\WINDOWS\system32\lsass.exe
  0x7c900000    0xaf000 65535                     C:\WINDOWS\system32\ntdll.dll
  0x7c800000    0xf6000 65535                     C:\WINDOWS\system32\kernel32.dll
  0x77dd0000    0x9b000 65535                     C:\WINDOWS\system32\ADVAPI32.dll
  0x77e70000    0x92000 65535                     C:\WINDOWS\system32\RPCRT4.dll
  0x77fe0000    0x11000 65535                     C:\WINDOWS\system32\Secur32.dll
  0x7e410000    0x91000 65535                     C:\WINDOWS\system32\USER32.dll
  0x77f10000    0x49000 65535                     C:\WINDOWS\system32\GDI32.dll
------------------------------------------------
lsass.exe pid: 1928
Command line : "C:\WINDOWS\\system32\\lsass.exe"
Service Pack 3
------------------------------------------------
   0x1000000     0x6000 65535                     C:\WINDOWS\system32\lsass.exe
  0x7c900000    0xaf000 65535                     C:\WINDOWS\system32\ntdll.dll
  0x7c800000    0xf6000 65535                     C:\WINDOWS\system32\kernel32.dll
  0x77dd0000    0x9b000 65535                     C:\WINDOWS\system32\ADVAPI32.dll
  0x77e70000    0x92000 65535                     C:\WINDOWS\system32\RPCRT4.dll
  0x77fe0000    0x11000 65535                     C:\WINDOWS\system32\Secur32.dll
  0x7e410000    0x91000 65535                     C:\WINDOWS\system32\USER32.dll
  0x77f10000    0x49000 65535                     C:\WINDOWS\system32\GDI32.dll
    0x870000   0x138000 1                         C:\WINDOWS\system32\KERNEL32.DLL.A
  0x76f20000    0x27000 2                         C:\WINDOWS\system32\DNSAPI.dll
  0x77c10000    0x58000 39                        C:\WINDOWS\system32\msvcrt.dll
  0x71ab0000    0x17000 10                        C:\WINDOWS\system32\WS2_32.dll
  0x71aa0000     0x8000 8                         C:\WINDOWS\system32\WS2HELP.dll
  0x76d60000    0x19000 2                         C:\WINDOWS\system32\IPHLPAPI.DLL
  0x5b860000    0x55000 2                         C:\WINDOWS\system32\NETAPI32.dll
  0x774e0000   0x13d000 5                         C:\WINDOWS\system32\ole32.dll
  0x77120000    0x8b000 4                         C:\WINDOWS\system32\OLEAUT32.dll
  0x76bf0000     0xb000 2                         C:\WINDOWS\system32\PSAPI.DLL
  0x7c9c0000   0x817000 2                         C:\WINDOWS\system32\SHELL32.dll
  0x77f60000    0x76000 8                         C:\WINDOWS\system32\SHLWAPI.dll
  0x769c0000    0xb4000 2                         C:\WINDOWS\system32\USERENV.dll
  0x77c00000     0x8000 2                         C:\WINDOWS\system32\VERSION.dll
  0x771b0000    0xaa000 2                         C:\WINDOWS\system32\WININET.dll
  0x77a80000    0x95000 2                         C:\WINDOWS\system32\CRYPT32.dll
  0x77b20000    0x12000 2                         C:\WINDOWS\system32\MSASN1.dll
  0x71ad0000     0x9000 2                         C:\WINDOWS\system32\WSOCK32.dll
  0x773d0000   0x103000 2                         C:\WINDOWS\WinSxS\x86_Microsoft.Wi
  0x5d090000    0x9a000 1                         C:\WINDOWS\system32\comctl32.dll
Plugin: dlllist (WinDllList)
```

Looking at the output we can see that the suspicious processes have a fewer amount of DLLs associated with them. We also see that for both these processes the command line arguments, the backslash is being escaped (\\ instead of \). Now lets look at the handles associated with the 3 PIDs using the handles plugin.

```
>>> handles([680, 868, 1928])
_OBJECT_HEADER _EPROCESS          name          pid    handle     access      obj_type     details
-------------- ---------- -------------------- ----- ---------- ---------- ---------------- -------
0xe10096c8     0x81e70020 lsass.exe             680       0x4    0xf0003 KeyedEvent       CritSecOutOfMemoryEvent
0xe16008e0     0x81e70020 lsass.exe             680       0x8       0x3 Directory        KnownDlls
0x8225bce0     0x81e70020 lsass.exe             680       0xc   0x100020 File             \Device\HarddiskVolume1\WINDOWS\system32
0x8205ac18     0x81e70020 lsass.exe             680      0x10   0x100003 Semaphore
0xe1613960     0x81e70020 lsass.exe             680      0x14    0xf000f Directory        Windows
0xe1a5a340     0x81e70020 lsass.exe             680      0x18  0x21f0001 Port
0x81d9ee78     0x81e70020 lsass.exe             680      0x1c   0x100003 Semaphore
0xe1623520     0x81e70020 lsass.exe             680      0x20    0x2000f Directory        BaseNamedObjects
0x81ee3968     0x81e70020 lsass.exe             680      0x24   0x1f0001 Mutant           SHIMLIB_LOG_MUTEX
0xe19d7b28     0x81e70020 lsass.exe             680      0x28  0x20f003f Key              MACHINE
0xe1ed81f0     0x81e70020 lsass.exe             680      0x2c   0x1f0001 Port
0x81d9c658     0x81e70020 lsass.exe             680      0x30    0xf016e WindowStation    Service-0x0-3e7$
0x822563d8     0x81e70020 lsass.exe             680      0x34    0xf00cf Desktop          Default
0x81d9c658     0x81e70020 lsass.exe             680      0x38    0xf016e WindowStation    Service-0x0-3e7$
0x81db9d38     0x81e70020 lsass.exe             680      0x3c   0x1f0003 Semaphore
0x820e0110     0x81e70020 lsass.exe             680      0x40   0x1f0003 Event
0xe19b5758     0x81e70020 lsass.exe             680      0x44    0x20019 Key              MACHINE\SYSTEM\CONTROLSET001\CONTROL\NETWORKPROVIDER\HWORDER
0x821052d8     0x81e70020 lsass.exe             680      0x48   0x100003 Semaphore
0x820651d8     0x81e70020 lsass.exe             680      0x4c   0x100003 Semaphore
0x81ea5b50     0x81e70020 lsass.exe             680      0x50   0x1f0003 Event
0x81db9d08     0x81e70020 lsass.exe             680      0x54   0x1f0003 Event
0x81eb4f48     0x81e70020 lsass.exe             680      0x58   0x100003 Semaphore
0x82339e10     0x81e70020 lsass.exe             680      0x5c   0x100003 Semaphore
0xe1a66240     0x81e70020 lsass.exe             680      0x60    0x20019 Key              MACHINE\SOFTWARE\MICROSOFT\WINDOWS NT\CURRENTVERSION\DRIVERS32
0x81ef5d08     0x81e70020 lsass.exe             680      0x64   0x1f0003 Event            DINPUTWINMM
0x8225bae8     0x81e70020 lsass.exe             680      0x68   0x100001 File             \Device\KsecDD
0x821052a8     0x81e70020 lsass.exe             680      0x6c   0x1f0003 Event
0x820651a8     0x81e70020 lsass.exe             680      0x70   0x1f0003 Event
0xe1a3b1c8     0x81e70020 lsass.exe             680      0x74    0x20019 Key              MACHINE\SOFTWARE\MICROSOFT\WINDOWS NT\CURRENTVERSION\DRIVERS32
0x8208cf30     0x81e70020 lsass.exe             680      0x78   0x1f0003 Semaphore        shell.{A48F1A32-A340-11D1-BC6B-00A0C90312E1}
0x8209a588     0x81e70020 lsass.exe             680      0x7c   0x1f0003 Event            userenv:  User Profile setup event
0x8225b8f0     0x81e70020 lsass.exe             680      0x80   0x100020 File             \Device\HarddiskVolume1\WINDOWS\WinSxS\x86_Microsoft.Windows.Commo
```

```
0x81eddc00     0x81c498c8 lsass.exe             868      0x7a4   0x1f03ff Thread           TID 592 PID 940
0x82083a48     0x81c498c8 lsass.exe             868      0x7ac   0x1f0003 IoCompletion
0x81c42790     0x81c498c8 lsass.exe             868      0x7b0   0x1f0003 IoCompletion
0x82083a48     0x81c498c8 lsass.exe             868      0x7b4   0x1f0003 IoCompletion
0x822bbd90     0x81c498c8 lsass.exe             868      0x7b8   0x1f03ff Thread           TID 1884 PID 868
0x81f9ead0     0x81c498c8 lsass.exe             868      0x7bc   0x1f0003 Event
0x81c36ee0     0x81c498c8 lsass.exe             868      0x7c0   0x1f0003 Event
0x81c8ede8     0x81c498c8 lsass.exe             868      0x7c4   0x1f0003 Event
0x81f6cfd8     0x81c498c8 lsass.exe             868      0x7c8   0x1f0003 Event
0x81e61d88     0x81c498c8 lsass.exe             868      0x7cc   0x1f0fff Process          svchost.exe(940)
0x822bbd90     0x81c498c8 lsass.exe             868      0x7d0   0x1f03ff Thread           TID 1884 PID 868
0x81d9c658     0x81c498c8 lsass.exe             868      0x7d4    0xf016e WindowStation    Service-0x0-3e7$
0x822563d8     0x81c498c8 lsass.exe             868      0x7d8    0xf00cf Desktop          Default
0x81d9c658     0x81c498c8 lsass.exe             868      0x7dc    0xf016e WindowStation    Service-0x0-3e7$
0x821a4660     0x81c498c8 lsass.exe             868      0x7e0  0x21f0003 Event
0xe2a6e818     0x81c498c8 lsass.exe             868      0x7e4  0x20f003f Key              MACHINE
0x81c68440     0x81c498c8 lsass.exe             868      0x7e8   0x100003 Semaphore
0xe2b19ac8     0x81c498c8 lsass.exe             868      0x7ec  0x21f0001 Port
0xe1613960     0x81c498c8 lsass.exe             868      0x7f0    0xf000f Directory        Windows
0x81fb0a70     0x81c498c8 lsass.exe             868      0x7f4   0x100003 Semaphore
0xe16008e0     0x81c498c8 lsass.exe             868      0x7f8       0x3 Directory        KnownDlls
0xe10096c8     0x81c498c8 lsass.exe             868      0x7fc    0xf0003 KeyedEvent       CritSecOutOfMemoryEvent
```

```
0x8225b6f8     0x81c47c00 lsass.exe            1928        0xc   0x100020 File             \Device\HarddiskVolume1\WINDOWS\system32
0x81be6378     0x81c47c00 lsass.exe            1928      0x700   0x1f0003 Event            WkssvcShutdownEvent2
0x81fed2a8     0x81c47c00 lsass.exe            1928      0x704   0x1f03ff Thread           TID 780 PID 1928
0xe2995c10     0x81c47c00 lsass.exe            1928      0x708   0x1f0001 Port
0x81f5f380     0x81c47c00 lsass.exe            1928      0x70c   0x1f0003 Event
0x81e22d90     0x81c47c00 lsass.exe            1928      0x710   0x1f03ff Thread           TID 404 PID 1928
0x81f60260     0x81c47c00 lsass.exe            1928      0x714   0x1f0003 Event
0xe29fa838     0x81c47c00 lsass.exe            1928      0x718    0xf0007 Section          {4A9A9FA4-5292-4607-B3CB-EE6A87A008A3}
0x81fc3cc0     0x81c47c00 lsass.exe            1928      0x71c   0x1f0001 Mutant           {5EC171BB-F130-4a19-B782-B6E655E091B2}
0x81c73940     0x81c47c00 lsass.exe            1928      0x720   0x1f0003 Event
0x81f402a0     0x81c47c00 lsass.exe            1928      0x724   0x1f0003 Event            {CAA6BD26-6C7B-4af0-95E2-53DE46FDDF26}
0x81f64378     0x81c47c00 lsass.exe            1928      0x728   0x1f0001 Mutant
0x81f63b60     0x81c47c00 lsass.exe            1928      0x72c   0x1f0001 Mutant
0x81e22d90     0x81c47c00 lsass.exe            1928      0x730   0x1f03ff Thread           TID 404 PID 1928
0x81f8cdf0     0x81c47c00 lsass.exe            1928      0x734   0x1f0001 Mutant
0x81f8ce30     0x81c47c00 lsass.exe            1928      0x738   0x1f0001 Mutant
0x81f9d298     0x81c47c00 lsass.exe            1928      0x73c   0x1f0001 Mutant
0x81f90478     0x81c47c00 lsass.exe            1928      0x740   0x1f0001 Mutant
0x81f9cbe8     0x81c47c00 lsass.exe            1928      0x744   0x1f0001 Mutant
0x81c685c0     0x81c47c00 lsass.exe            1928      0x748   0x1f0001 Mutant
0x821318b8     0x81c47c00 lsass.exe            1928      0x74c   0x1f0001 Mutant
0x81fa2b90     0x81c47c00 lsass.exe            1928      0x750   0x1f0001 Mutant
0x81ea9328     0x81c47c00 lsass.exe            1928      0x754   0x1f0001 Mutant
0xe247ecd0     0x81c47c00 lsass.exe            1928      0x758    0x2001f Key              USER\.DEFAULT\SOFTWARE\MICROSOFT\WINDOWS\
0x82062728     0x81c47c00 lsass.exe            1928      0x75c   0x100020 File             \Device\HarddiskVolume1\WINDOWS\WinSxS\x8
```

When we look at the handles we see that PID 680 has a significant amount of handles while 868 and 1928 does not have much, 680 has been truncated to fit this page.

Now lets run malfind against these PIDs to see if there is anything suspicious with the processes.

```
>>> malfind([680, 868, 1928])
****************************************f pid 680
Process: lsass.exe Pid: 868 Address: 0x80000
Vad Tag: Vad  Protection: EXECUTE_READWRITE
Protection: 6

   0x80000 4d 5a 90 00 03 00 00 00 04 00 00 00 ff ff 00 00  MZ.............. vad_0x80000
   0x80010 b8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00  ........@.......
   0x80020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
   0x80030 00 00 00 00 00 00 00 00 00 00 00 00 08 01 00 00  ................

Process: lsass.exe Pid: 1928 Address: 0x80000
Vad Tag: Vad  Protection: EXECUTE_READWRITE
Protection: 6

   0x80000 4d 5a 90 00 03 00 00 00 04 00 00 00 ff ff 00 00  MZ.............. vad_0x80000
   0x80010 b8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00  ........@.......
   0x80020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
   0x80030 00 00 00 00 00 00 00 00 00 00 00 00 08 01 00 00  ................
```

We we ran the command we can see malfind return results for the 2 suspicious processes and both of these offsets start with 0x80000.

Using the ldrmodules plugin we can gain a bit more insight into the 2 suspicious processes

```
>>> ldrmodules(1928)
     base    in_load in_init in_mem mapped
  ---------- ------- ------- ------ ------
--------------------------
0x81c47c00 lsass.exe  1928
--------------------------
     0x80000 False   False   False
  0x7c900000 True    True    True   C:\WINDOWS\system32\ntdll.dll
   0x1000000 True    False   True
    0x6f0000 False   False   False
    0x680000 False   False   False
    0x870000 True    True    True
  0x7c800000 True    True    True   C:\WINDOWS\system32\kernel32.dll
  0x77dd0000 True    True    True   C:\WINDOWS\system32\advapi32.dll
  0x76f20000 True    True    True   C:\WINDOWS\system32\dnsapi.dll
  0x71ab0000 True    True    True   C:\WINDOWS\system32\ws2_32.dll
  0x71aa0000 True    True    True   C:\WINDOWS\system32\ws2help.dll
```

From here we can see, there are no paths information for the 3 entries for module 1928, also the offset matches the one we saw in malfind and that is why the dll is hidden as it may be unlinked from one or more lists within the PEB

Using the plugins given we can see how malwares react with rekal

Analyzing Zeus using Rekall

What is the Zeus malware?

Zeus, ZeuS, or Zbot is a Trojan horse malware package that runs on version of Microsoft Windows. While it can be used to carry out many malicious attacks it is often used to steal banking info by man-in-the-browser keystroke logging and form grabbing. It is spread through drive-by downloads and phishing schemes.

Running Zeus on Rekal

Running Zeus on Rekal is the same as stuxnet we run `rekal -filename zeus.vmem`

```
(env) c:\Users\Cinematic\Documents\Rekall>rekall --filename zeus2x4.vmem
Webconsole disabled: cannot import name 'webconsole_plugin'

---------------------------------------------------------------------------
The Rekall Digital Forensic/Incident Response framework 1.7.3.dev67 (Hurricane Ridge).

"We can remember it for you wholesale!"

This program is free software; you can redistribute it and/or modify it under
the terms of the GNU General Public License.

See http://www.rekall-forensic.com/docs/Manual/tutorial.html to get started.
---------------------------------------------------------------------------

>>> pstree()
2021-12-09 20:04:22,949:WARNING:rekall.1:Inventory for repository "http://profiles.rekall-fore
d you forget to create an inventory? You must use the tools/profiles/build_profile_repo.py too
2021-12-09 20:04:22,949:WARNING:rekall.1:Repository http://profiles.rekall-forensic.com will b
_EPROCESS                              ppid  thd_count hnd_count       create_time
-------------------------------------- ------ --------- --------- -----------------------
  0x823c8a00 System (4)                    0        57       671 -
. 0x82292da0 smss.exe (596)                4         3        19 2010-09-02 12:25:18Z
.. 0x821f2978 csrss.exe (668)            596        14       471 2010-09-02 12:25:21Z
.. 0x822c09f8 winlogon.exe (692)         596        21       588 2010-09-02 12:25:22Z
... 0x821a5da0 services.exe (744)        692        15       279 2010-09-02 12:25:22Z
.... 0x82129370 svchost.exe (364)        744         4        88 2010-09-02 12:25:33Z
.... 0x82189530 prl_tools_servi (436)    744         3        78 2010-09-02 12:25:36Z
..... 0x82086798 prl_tools.exe (632)     436         9       107 2010-09-02 12:25:36Z
.... 0x82089558 jqs.exe (472)            744         5       146 2010-09-02 12:25:33Z
.... 0x8208abf0 sqlservr.exe (488)       744        25       306 2010-09-02 12:25:33Z
.... 0x82077da0 coherence.exe (572)      744         4        51 2010-09-02 12:25:36Z
.... 0x821aa7e8 sqlwriter.exe (660)      744         4        84 2010-09-02 12:25:36Z
.... 0x82150b90 svchost.exe (912)        744        20       202 2010-09-02 12:25:22Z
.... 0x822c8bf8 svchost.exe (992)        744        10       277 2010-09-02 12:25:22Z
.... 0x82151da0 svchost.exe (1084)       744        58      1327 2010-09-02 12:25:22Z
..... 0x8205dda0 wuauclt.exe (940)      1084         4       126 2010-09-02 12:26:40Z
..... 0x8213dda0 wscntfy.exe (2180)     1084         3        48 2010-09-02 12:25:41Z
..... 0x82311648 rundll32.exe (3768)    1084         1        53 2010-09-09 19:56:33Z
..... 0x81eab2f8 wuauclt.exe (3984)     1084         8       325 2010-09-09 19:52:45Z
.... 0x821521b0 svchost.exe (1140)       744         6        81 2010-09-02 12:25:22Z
.... 0x8214f488 svchost.exe (1192)       744        13       175 2010-09-02 12:25:23Z
.... 0x8221e278 iscsiexe.exe (1436)      744         6        78 2010-09-02 12:25:24Z
.... 0x82095500 spoolsv.exe (1616)       744        13       140 2010-09-02 12:25:24Z
.... 0x81e8a368 alg.exe (2588)           744         6       107 2010-09-02 12:25:44Z
... 0x822c8798 lsass.exe (756)           692        24       437 2010-09-02 12:25:22Z
  0x821b2020 explorer.exe (1752)        1720        22       520 2010-09-02 12:25:25Z
. 0x822b96c0 SharedIntApp.ex (1900)     1752         3        75 2010-09-02 12:25:25Z
. 0x820ee580 prl_cc.exe (1908)          1752        14       133 2010-09-02 12:25:25Z
. 0x82282380 ImmunityDebugge (1932)     1752         2        86 2010-09-08 19:23:02Z
.. 0x8223c020 vaelh.exe (952)           1932         2        40 2010-09-08 19:23:02Z
. 0x8212ada0 jusched.exe (1936)         1752         1        43 2010-09-02 12:25:26Z
. 0x82066478 ImmunityDebugge (2404)     1752         2        85 2010-09-09 19:56:19Z
.. 0x81f4bb28 b98679df6defbb3 (3772)    2404         1        46 2010-09-09 19:56:19Z
... 0x81e87da0 ihah.exe (3276)          3772         1        45 2010-09-09 19:56:32Z
. 0x82001ad0 ImmunityDebugge (2972)     1752         2        87 2010-09-08 19:14:36Z
.. 0x8207bda0 nifek_locked.ex (2204)    2972         2        38 2010-09-08 19:14:36Z
. 0x81ffb6d8 ImmunityDebugge (3788)     1752         2       103 2010-09-08 22:39:40Z
```

As you can see when we were dealing with stuxnet we got 3 instances of the lsass.exe file, now we do not. But when dealing with Zeus we need to look at the connections that it is making so to look at the connections my files are making I simply run the connscan() plugin

```
>>> connscan()
 tcpip/GUID/F43034C3D7D24BB5A88C36C1672CE1541 matched offset 0x31553+0xb2ef3000= offset_p
---------- ------------------------ ------------------------ ----------
 0x20f5410 10.211.55.5:1427          65.54.81.89:80                1084
 0x2125008 10.211.55.5:1423          207.46.21.123:80              1084
 0x22ace08 10.211.55.5:1432          193.43.134.14:80              1752
Plugin: connscan (ConnScan)
```

Looking at the pids and comparing them to the pstree output above we can see that the ip 192.43.134.14 is connected to the internet through port 80 and had the 1752 pid which does not correspond to a web browser so that is a red flag, when I look up the ip address on ipvoid.com I get the following result.

Analysis Date	2021-11-03 21:12:24
Elapsed Time	3 seconds
Blacklist Status	BLACKLISTED 1/115
IP Address	**193.43.134.14** Find Sites | IP Whois
Reverse DNS	Unknown
ASN	Unknown
ASN Owner	Unknown
ISP	Unknown
Continent	Unknown
Country Code	Unknown
Latitude / Longitude	Unknown
City	Unknown
Region	Unknown

As you can see the ip is blacklisted. Sometimes trojans adds a registry key to make sure that it is running every time the computer is restarted.

To check if the malware has added itself to the register we run

```
printkey("Microsoft\Windows NT\CurrentVersion\Winlogon")
```

```
0xcd5521fc REG_DWORD AutoRestartShell : (S) 1
0xcd552224 REG_SZ DefaultDomainName : (S) JASONRESACC69
0xcd552274 REG_SZ DefaultUserName : (S) Administrator
0xcd5522bc REG_SZ LegalNoticeCaption : (S)
0xcd552304 REG_SZ LegalNoticeText : (S)
0xcd55232c REG_SZ PowerdownAfterShutdown : (S) 0
0xcd55237c REG_SZ ReportBootOk : (S) 1
0xcd5523a4 REG_SZ Shell : (S) Explorer.exe
0xcd55240c REG_SZ ShutdownWithoutLogon : (S) 0
0xcd55235c REG_SZ System : (S)
0xcd5523e4 REG_SZ Userinit : (S) C:\WINDOWS\system32\userinit.exe,
0xcd5524b4 REG_SZ VmApplet : (S) rundll32 shell32,Control_RunDLL "sysdm.cpl"
0xcd55243c REG_DWORD SfcQuota : (S) 4294967295
0xcd55256c REG_SZ allocatecdroms : (S) 0
0xcd552534 REG_SZ allocatedasd : (S) 0
0xcd5525d4 REG_SZ allocatefloppies : (S) 0
0xcd552594 REG_SZ cachedlogonscount : (S) 10
0xcd552644 REG_DWORD forceunlocklogon : (S) 0
0xcd5525fc REG_DWORD passwordexpirywarning : (S) 14
0xcd5526bc REG_SZ scremoveoption : (S) 0
0xcd55266c REG_DWORD AllowMultipleTSSessions : (S) 1
0xcd55269c REG_EXPAND_SZ UIHost : (S) logonui.exe
0xcd5526e4 REG_DWORD LogonType : (S) 1
0xcd55270c REG_SZ Background : (S) 0 0 0
0xcd55275c REG_SZ AutoAdminLogon : (S) 1
0xcd5527ac REG_SZ DebugServerCommand : (S) no
0xcd5527dc REG_DWORD SFCDisable : (S) 0
0xcd56991c REG_SZ WinStationsDisabled : (S) 0
0xcd56b144 REG_DWORD HibernationPreviouslyEnabled : (S) 1
0xcd56a2dc REG_DWORD ShowLogonOptions : (S) 0
0xcd56a304 REG_SZ AltDefaultUserName : (S) Administrator
0xcd56b1cc REG_SZ AltDefaultDomainName : (S) JASONRESACC69
Plugin: printkey (PrintKey)
```

Looking at the output, if you notice when we only have one value to print out it doesn't add a comma at the end but for REG_SZ Userinit there is a comma after C:\Windows\system32\userinit.exe. It seems like there is something wrong with the userinit register. Lets dive deeper

We can now look for hidden or injected code in the user mode memory dump and see if the firewall was shut down.
To do this we run

```
printkey("ControlSet001\Services\SharedAccess\Parameters\FirewallPolicy\StandardProfile")
```

After running this we can see that the firewall has no value meaning it was disabled. This is evident that the computer was infected with the Zeus Trojan

```
>>> printkey("ControlSet001\Services\SharedAccess\Parameters\FirewallPolicy\StandardProfile")
Legend: (S) = Stable   (V) = Volatile

 Printing $$$PROTO.HIV/ControlSet001/Services/SharedAccess/Parameters/FirewallPo---------------------------
Registry: C:\WINDOWS\system32\config\system @ 0xe1035b60
Key name: StandardProfile (S) @ 0xd74a27ac
Last updated: 2009-04-04 02:24:53Z

Subkeys:
  (S) AuthorizedApplications

Values:
```

Analyzing SpyEye Malware using Rekal

What is the SpyEye Malware?

SpyEye is a malware program that attacks user running Google Chrome, Opera Firefox and Internet Explorer on Microsoft Windows operating Systems. This malware uses keystroke logging and form grabbing to steal user credentials for malicious use.

As usual we start with running the SpyEye malware with rekall and to do that we run
`Rekal -filename spyeye.vmem`

Once We have spyeye running we can use pstree to list the current services running

```
>>> pstree()
_EPROCESS                              ppid  thd_count hnd_count       create_time
-------------------------------------- ------ --------- --------- -------------------
  0x825c8830 System (4)                   0        58       387 -
. 0x823fe020 smss.exe (572)               4         3        19 2010-11-11 22:02:08Z
.. 0x82503220 csrss.exe (636)           572        13       399 2010-11-11 22:02:13Z
.. 0x81f4c550 winlogon.exe (660)        572        21       596 2010-11-11 22:02:14Z
... 0x8207d5f0 services.exe (704)       660        17       285 2010-11-11 22:02:15Z
.... 0x8230c5f8 vmacthlp.exe (872)      704         2        26 2010-11-11 22:02:16Z
.... 0x8226cda0 svchost.exe (904)       704        16       191 2010-11-11 22:02:16Z
.... 0x823f2020 svchost.exe (972)       704         9       264 2010-11-11 22:02:17Z
.... 0x824578b0 imapi.exe (1040)        704         5       114 2010-11-11 22:03:54Z
.... 0x822a0758 svchost.exe (1068)      704        58      1256 2010-11-11 22:02:17Z
..... 0x8236d7a0 wuauclt.exe (536)     1068         4       107 2010-11-11 22:03:33Z
..... 0x82389020 wscntfy.exe (2772)    1068         2        29 2010-11-11 22:03:56Z
.... 0x81f4b020 svchost.exe (1108)      704         7        82 2010-11-11 22:02:17Z
.... 0x82406da0 svchost.exe (1232)      704        13       169 2010-11-11 22:02:18Z
.... 0x82436a48 spoolsv.exe (1456)      704        12       121 2010-11-11 22:02:19Z
.... 0x82067858 svchost.exe (1540)      704         6        95 2010-11-11 22:02:26Z
.... 0x82072660 jqs.exe (1612)          704         6       149 2010-11-11 22:02:27Z
.... 0x82284b80 vmtoolsd.exe (1816)     704         6       268 2010-11-11 22:02:30Z
.... 0x822e69f8 VMUpgradeHelper (1872)  704         4       100 2010-11-11 22:02:30Z
.... 0x82458020 alg.exe (2108)          704         7       107 2010-11-11 22:03:54Z
.... 0x81f7a708 WPFFontCache_v0 (3084)  704         7        70 2010-11-11 22:05:04Z
... 0x824264c0 lsass.exe (716)          660        20       356 2010-11-11 22:02:15Z
  0x823e32f8 explorer.exe (1008)        680        15       468 2010-11-11 22:02:55Z
. 0x81ec2020 TSVNCache.exe (1252)      1008         9        58 2010-11-11 22:02:58Z
. 0x81ebd300 VMwareTray.exe (1484)     1008         2        51 2010-11-11 22:03:00Z
. 0x82159958 VMwareUser.exe (1588)     1008         7       230 2010-11-11 22:03:00Z
. 0x8214ba18 jusched.exe (1672)        1008         2        97 2010-11-11 22:03:00Z
.. 0x81f5e020 jucheck.exe (3892)       1672         3       105 2010-11-11 22:08:01Z
. 0x82226b48 cleansweep.exe (2268)     1008         0         - 2011-01-06 14:36:52Z
. 0x820bd760 gmer.exe (2728)           1008         2        33 2011-01-06 14:37:41Z
Plugin: pstree (PSTree)
```

Nothing out of the ordinary except Explorer.exe is a separate service running on its own, we can now look at what it is doing, since we are expecting the spyeye to latch itself to the web browser and not send any requests back when I run connscan, it should return 2 ip addresses.

```
>>> connscan()
 offset_p      local_net_address        remote_net_address        pid
---------- ------------------------- ------------------------- ----------
 0x1eacc00 192.168.16.129:1039       65.55.185.26:443               1068
 0x1fd3170 192.168.16.129:1040       207.46.21.58:80                1068
Plugin: connscan (ConnScan)
>>>
```

As expected no malicious calls are being made from the computer, since it is a keylogger when I run malfind for the explorer it should return null results if there is no malware

```
>>> malfind(1008)
**********************************************f pid 1008
Process: explorer.exe Pid: 1008 Address: 0x26b0000
Vad Tag: VadS Protection: EXECUTE_READWRITE
CommitCharge: 1, MemCommit: 1, PrivateMemory: 1, Protection: 6

 0x26b0000 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................ vad_0x26b0000
 0x26b0010 00 00 6b 02 00 00 00 00 00 00 00 00 00 00 00 00  ..k.............
 0x26b0020 10 00 6b 02 00 00 00 00 00 00 00 00 00 00 00 00  ..k.............
 0x26b0030 20 00 6b 02 00 00 00 00 00 00 00 00 00 00 00 00  ..k.............

------ vad_0x26b0000 ------: 0x26b0000
   0x26b0000   0x0 0000                add byte ptr [eax], al
   0x26b0002   0x2 0000                add byte ptr [eax], al
   0x26b0004   0x4 0000                add byte ptr [eax], al
   0x26b0006   0x6 0000                add byte ptr [eax], al
   0x26b0008   0x8 0000                add byte ptr [eax], al
   0x26b000a   0xa 0000                add byte ptr [eax], al
   0x26b000c   0xc 0000                add byte ptr [eax], al
   0x26b000e   0xe 0000                add byte ptr [eax], al
   0x26b0010  0x10 0000                add byte ptr [eax], al
```

```
 0xea00000 4d 5a 90 00 03 00 00 00 04 00 00 00 ff ff 00 00  MZ.............. vad_0xea0000
 0xea00010 b8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00  ........@.......
 0xea00020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
 0xea00030 00 00 00 00 00 00 00 00 00 00 00 00 f8 00 00 00  ................

------ vad_0xea00000 ------
   0xea00000   0x0 4d                  dec ebp
   0xea00001   0x1 5a                  pop edx
   0xea00002   0x2 90                  nop
   0xea00003   0x3 0003                add byte ptr [ebx], al
   0xea00005   0x5 0000                add byte ptr [eax], al
   0xea00007   0x7 000400              add byte ptr [eax + eax], al
   0xea0000a   0xa 0000                add byte ptr [eax], al
   0xea0000c   0xc ff                  db 0xff
```

```
Process: explorer.exe Pid: 1008 Address: 0xea50000
Vad Tag: VadS Protection: EXECUTE_READWRITE
CommitCharge: 58, MemCommit: 1, PrivateMemory: 1, Protection: 6

 0xea50000 4d 5a 90 00 03 00 00 00 04 00 00 00 ff ff 00 00  MZ.............. vad_0xea50000
 0xea50010 b8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00  ........@.......
 0xea50020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
 0xea50030 00 00 00 00 00 00 00 00 00 00 00 00 01 00 00 00  ................

------ vad_0xea50000 ------: 0xea50000
   0xea50000   0x0 4d                  dec ebp
   0xea50001   0x1 5a                  pop edx
   0xea50002   0x2 90                  nop
   0xea50003   0x3 0003                add byte ptr [ebx], al
   0xea50005   0x5 0000                add byte ptr [eax], al
   0xea50007   0x7 000400              add byte ptr [eax + eax], al
   0xea5000a   0xa 0000                add byte ptr [eax], al
   0xea5000c   0xc ff                  db 0xff
   0xea5000d   0xd ff00                inc dword ptr [eax]
```

```
Process: explorer.exe Pid: 1008 Address: 0xeab0000
Vad Tag: VadS Protection: EXECUTE_READWRITE
CommitCharge: 54, MemCommit: 1, PrivateMemory: 1, Protection: 6

 0xeab0000 4d 5a 90 00 03 00 00 00 04 00 00 00 ff ff 00 00  MZ.............. vad_0xeab0000
 0xeab0010 b8 00 00 00 00 00 00 00 40 00 00 00 00 00 00 00  ........@.......
 0xeab0020 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00  ................
 0xeab0030 00 00 00 00 00 00 00 00 00 00 00 00 01 00 00 00  ................

------ vad_0xeab0000 ------: 0xeab0000
   0xeab0000   0x0 4d                  dec ebp
   0xeab0001   0x1 5a                  pop edx
   0xeab0002   0x2 90                  nop
   0xeab0003   0x3 0003                add byte ptr [ebx], al
   0xeab0005   0x5 0000                add byte ptr [eax], al
   0xeab0007   0x7 000400              add byte ptr [eax + eax], al
   0xeab000a   0xa 0000                add byte ptr [eax], al
   0xeab000c   0xc ff                  db 0xff
   0xeab000d   0xd ff00                inc dword ptr [eax]
   0xeab000f   0xf 00b800000000        add byte ptr [eax], bh
   0xeab0015  0x15 0000                add byte ptr [eax], al
   0xeab0017  0x17 004000              add byte ptr [eax], al
   0xeab001a  0x1a 0000                add byte ptr [eax], al
```

If we look closely all the processes start with 0xeab we saw something similar when we were dealing with stuxnet. This means the malware has attached itself to the Web Browser.

References

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