PowerShell and Python Together

Targeting Digital Investigations

Chet Hosmer

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Longs, SC, USA

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To the latest addition of our family – "Cousin Vinny" – one of the sweetest, very loving, and curious Yellow Labs ever, who constantly interrupts our daily lives in the most wonderful ways.

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About the Author

Chet Hosmer is the founder of Python Forensics, Inc., a nonprofit organization focused on the collaborative development of open-source investigative technologies using Python and other popular scripting languages. Chet has been researching and developing technology and training surrounding forensics, digital investigation, and steganography for decades. He has made numerous appearances to discuss emerging cyber threats, including National Public Radio's *Kojo Nnamdi Show*, ABC's *Primetime Thursday*, and *ABC News* (Australia). He has also been a frequent contributor to technical and news stories relating to cybersecurity and forensics with IEEE, *The New York Times*, *The Washington Post*, Government Computer News, Salon.com, and *Wired* magazine.

Chet is the author of *Defending IoT Infrastructures with the Raspberry Pi* (Apress, 2018), *Passive Python Network Mapping* (Syngress, 2015), *Python Forensics* (Syngress, 2014), and *Integrating Python with Leading Computer Forensics Platforms* (Syngress, 2016). He coauthored *Data Hiding* (Syngress, 2012) with Mike Raggo and *Executing Windows Command Line Investigation* (Syngress, 2016) with Joshua Bartolomie and Rosanne Pelli.

Chet serves as a visiting professor at Utica College in the Cybersecurity graduate program, where his research and teaching focus on advanced steganography/data hiding methods and the latest active cyber defense methods and techniques. Chet is also an adjunct professor at Champlain

College, where his research and teaching focus on applying Python and other scripting languages to solve challenging problems in digital investigation and forensics.

Chet resides in the Grand Strand area of South Carolina with his wife Janet, son Matthew, two Labrador Retrievers (Bailey and Vinny), and feline tenants Lucy, Rosie, and Evander.

About the Technical Reviewer

Gary C. Kessler, PhD, CCE, CISSP, is a Professor of Cybersecurity and Chair of the Security Studies & International Affairs Department at Embry-Riddle Aeronautical University in Daytona Beach, Florida. His academic background is in mathematics and computer science, and his research interests include network protocols, digital forensics, and cybersecurity management and policy, particularly related to maritime and aviation. Gary is also an adjunct professor at Edith Cowan University (Perth, WA) and American Marine University (Sarasota, FL).

Gary started the undergraduate and graduate digital forensics programs at Champlain College (Burlington, VT) and has been affiliated with the National Internet Crimes Against Children (ICAC) program and Vermont, Northern Florida, and Hawaii Task Forces since 1999. He is also a frequent speaker at national and international conferences, notably the annual National Cyber Crime Conference.

Gary is also a member of the advisory board of the Maritime and Port Security Information Sharing & Analysis Organization (MPS_ISAO), holds a USCG master merchant mariner certificate, and is a Master SCUBA Diver Trainer. More information about Gary can be found at www.garykessler.net.

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I'm deeply appreciative of Joe Giordano, the driving force behind cybersecurity research and development, and ultimately education for the past four decades. Your quiet, humble, and persistent work has and is making a true impact on the security of our nation.

I want to thank Scott vonFischer, Tony Ombrellaro, and Dave Bang for providing the catalyst for this book. Your forward thinking, ensuring that your teams learn and apply the latest scripting environments to solve challenging problems in forensics and incident response, has been a true inspiration.

To my students at Utica and Champlain colleges, who constantly surprise, challenge, and inspire me to find new ways to share my decades of experience in software and scripting development to tackle the challenges of cybercrime investigation.

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To my wonderful wife Janet, who always provides me with insights and a point of view about a challenge that I never thought of. These insights often, if not always, lead to new solutions and approaches that constantly improve my work.

Introduction

The endeavor to integrate PowerShell and Python came about a couple of years ago. I was providing training for a large utility and began by teaching the members of the secure operations center, or SOC, on how to apply Python scripts during investigations and incident response. A few months later, they asked for similar training – this time using PowerShell as the scripting engine for the SOC team. Based on this, I quickly realized that PowerShell was perfect for acquisition of information across the enterprise, and Python was good at performing analysis of data that had been acquired by other tools.

Now, of course, PowerShell advocates will say that PowerShell scripts can be developed to perform detailed analysis. Likewise, Python advocates will say Python scripts can be developed to perform very capable evidence acquisition. I agree with both advocates – but only to a point. The real question is… if we combine the best of both environments, does 1 + 1 = 2 or does 1 + 1 = 11? I believe that the answer falls somewhere in the middle.

Thus, the purpose of the book along with the research and experimentation that went into it was to build a model, in fact two models, to integrate and leverage the best capabilities of Python and PowerShell and apply the result to digital investigation. It is important to note that this is a work in progress. I believe that the continued development of advanced PowerShell and Python capabilities that leverage the models provided here has great potential and should be pursued.

Therefore, I encourage you to experiment with the models that I have presented here and use them to develop new solutions that are desperately needed to acquire and analyze evidence collected before, during, and after a cyber incident, a cyber breach, as well as physical or cybercrimes. I also encourage you to share your work and innovations with others in our field to benefit those that fight cybercrime every day.

CHAPTER 1

An Introduction to PowerShell for Investigators

PowerShell provides a great acquistion engine for obtaining a vast array of information from live systems, servers, peripherals, mobile devices, and data-driven applications like Active Directory.

Because of Microsoft's decision to open PowerShell and provide the ability to acquire information from other non-Microsoft platforms such as Mac and Linux, the breadth of information that can be accessed is virtually limitless (with the proper credentials). Combine that with a plethora of built-in and third-party CmdLets (pronounced "command let") that can be filtered, sorted, and piped together, and you have the ultimate acquistion engine.

By adding a bridge from PowerShell to Python, we can now leverage the rich logical machine learning and deep analysis of the raw information acquired by PowerShell. Figure 1-1 depicts the core components that we will integrate in this book. The result will be a workbench for developing new innovative approaches to live investigations and incident response applications.

C. Hosmer, *PowerShell and Python Together*, https://doi.org/10.1007/978-1-4842-4504-0_1

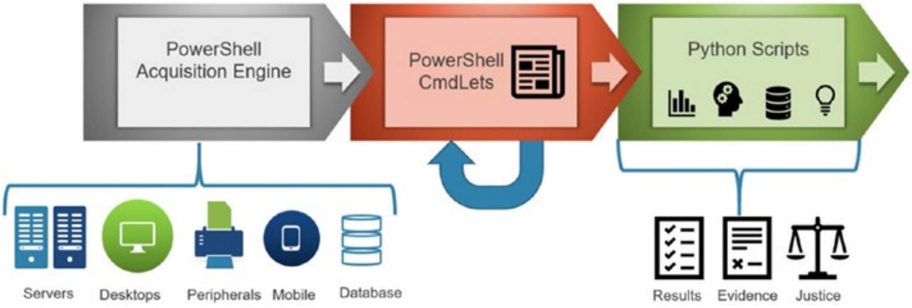


Figure 1-1. *PowerShell and Python*

A Little PowerShell History

PowerShell is a Microsoft framework that includes a command shell and a scripting language. PowerShell has traditionally been used by system administrators, IT teams, incident response groups, and forensic investigators to gain access to operational information regarding the infrastructures they manage. Signifcant evolution has occurred over the past decade as depicted in Figure 1-2.

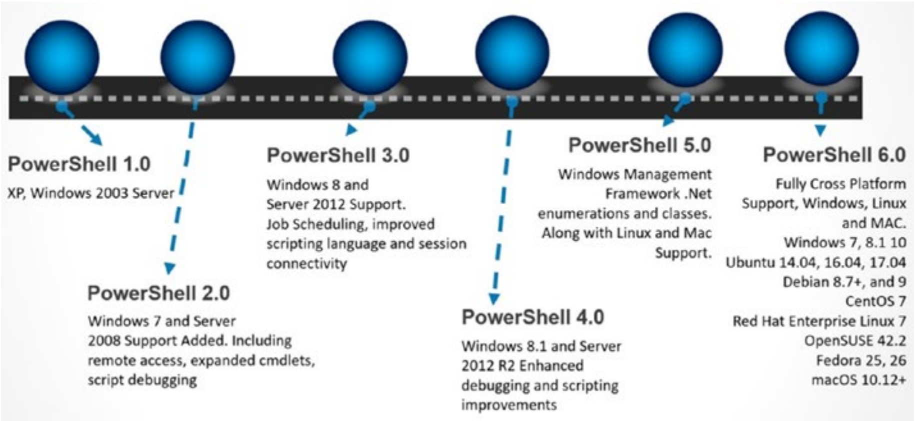

PowerShell 1.0
XP, Windows 2003 Server
PowerShell 2.0
Windows 7 and Server 2008 Support Added. Including remote access, expanded cmdlets, script debugging
PowerShell 3.0
Windows 8 and Server 2012 Support. Job Scheduling, improved scripting language and session connectivity
PowerShell 4.0
Windows 8.1 and Server 2012 R2 Enhanced debugging and scripting improvements
PowerShell 5.0
Windows Management Framework .Net enumerations and classes. Along with Linux and Mac Support.
PowerShell 6.0
Fully Cross Platform Support, Windows, Linux and MAC.
Windows 7, 8.1 10
Ubuntu 14.04, 16.04, 17.04
Debian 8.7+, and 9
CentOS 7
Red Hat Enterprise Linux 7
OpenSUSE 42.2
Fedora 25, 26
macOS 10.12+

Figure 1-2. *PowerShell evolution*

How Is PowerShell Used Today?

PowerShell is most typically used to automate administrative tasks and examine the details of running desktops, servers, and mobile devices. It is used to examine both local and remote systems using the Common-Object-Model (COM) and the Windows Management Interface (WMI). Today, it can be used to examine and manage remote Linux, Mac, and Network devices using the Common Information Model (CIM).

How Do You Experiment with PowerShell?

PowerShell is typically already installed on modern Windows desktop and server platforms. If not, you can simply open your favorite browser and search for “Windows Management Framework 5” and then download and install PowerShell. PowerShell and PowerShell ISE (the Integrated Scripting Environment) are free.

I prefer using PowerShell ISE as it provides:

1. An integrated environment that aids in the discovery and experimentation with CmdLets
2. The ability to write, test, and debug scripts
3. Easy access to context-sensitive help
4. Automatic completion of commands that speed both the development and learning

Navigating PowerShell ISE

Once you have PowerShell ISE installed, you can launch it on a Windows Platform by clicking the Start Menu (bottom left corner for Windows 8-10) and then search for PowerShell ISE and click the App as shown in Figure 1-3.

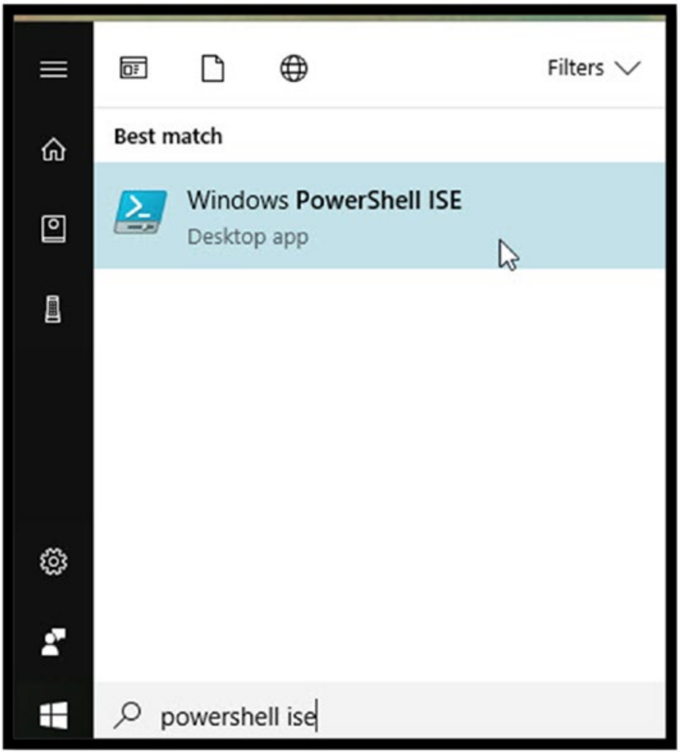


Figure 1-3. *Launching PowerShell on Windows 10*

Note You can run PowerShell and PowerShell ISE with **User** privledge; however, to gain access to many of the rich acquisition functions needed, running PowerShell as **Administrator** is required. A word of caution as well. Running as Adminstrator or User and executing CmdLets can damage your system or delete important files! Proceed with caution!

I typically add this to my Windows Taskbar for easy access as shown in Figure 1-4. I have added both PowerShell and PowerShell ISE. The icon on the right in the highlighted box is ISE, and the one on the left is PowerShell.

By right-clicking the PowerShell ISE icon, then right-clicking again on the Windows PowerShell ISE selection you can choose to run PowerShell ISE as administrator. By doing so, you will have the ability to execute the widest range of PowerShell CmdLets and scripts.

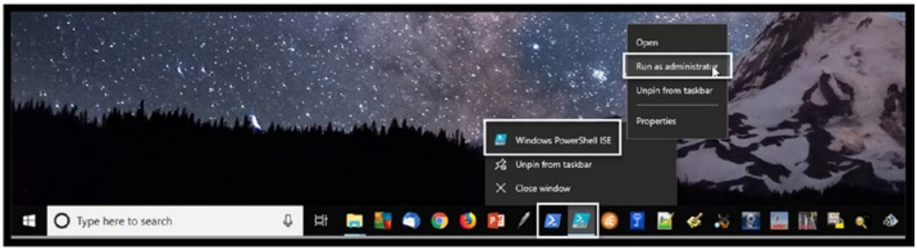


Figure 1-4. *Windows taskbar launching PowerShell ISE as administrator*

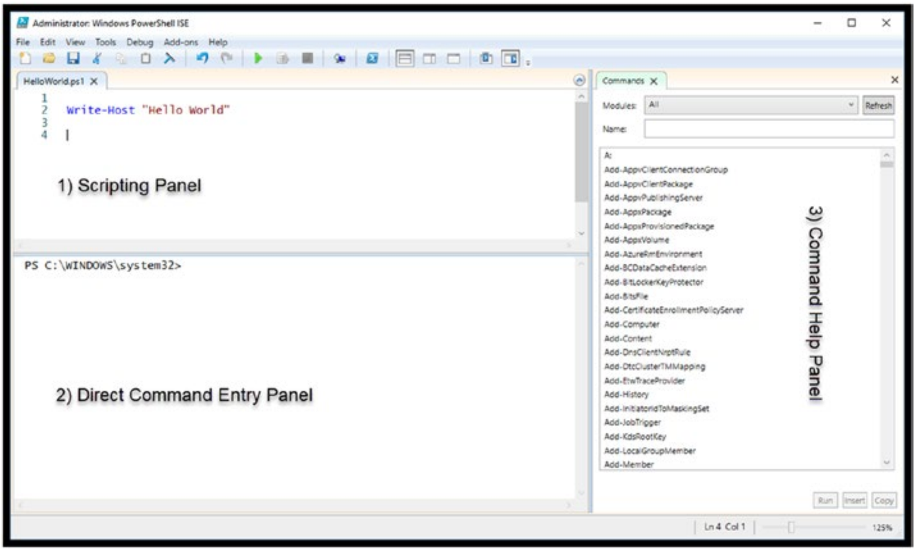
Once launched, ISE has three main windows as shown in Figure 1-5. Note that the scripting pane is not displayed by default but can be selected for view from the toolbar. I have annotated the three main sections of the application:

1. Scripting Panel: This panel provides the ability to create PowerShell Scripts that incorporate multiple commands using the included PowerShell scripting language. Note that this is not where we typically start when developing PowerShell Scripts. Rather, we experiment in the Direct Command Entry Panel first; then once we have perfected our approach, we can then create scripts.

2. Direct Command Entry Panel: This panel is used to execute PowerShell CmdLets. The commands entered here are much more powerful than the ancestor Windows Command Line or DOS commands. In addition, the format and structure

of these commands is much different and follows some strict rules. I will be explaining the verb–noun format and structure and providing more details and some examples in the next section.

3. Command Help Panel: This panel provides detailed help and information regarding every CmdLet available to us. However, I rarely use this area and instead request direct help using the Get-Help CmdLet to get information regarding CmdLets of interest, to learn how they operate, get examples of their use, and get details of all the options that are available.



```

Write-Host "Hello World"

```

```
PS C:\WINDOWS\system32>
```

__Figure 1-5.__ PowerShell ISE interface

PowerShell CmdLets

Before we dive directly into entering PowerShell CmdLets, a few words of warning:

1. There are literally thousands of possible CmdLets.
2. There are hundreds of thousands of possible options if you consider all the possible variations.
3. There are new CmdLets, variations, and updates to existing CmdLets being created every day.
4. Each CmdLet contains detailed help and examples.

It is important to update CmdLet Help every day to ensure you have access to the latest information regarding CmdLets that you are using or plan to use.

What Is a CmdLet?

A CmdLet is typically a lightweight Windows PowerShell script that performs a specific function. The reason I state typically here is that some CmdLets are quite extensive, and with the ability to create your own CmdLet, their complexity and use of system resources can vary based on the developer's objective.

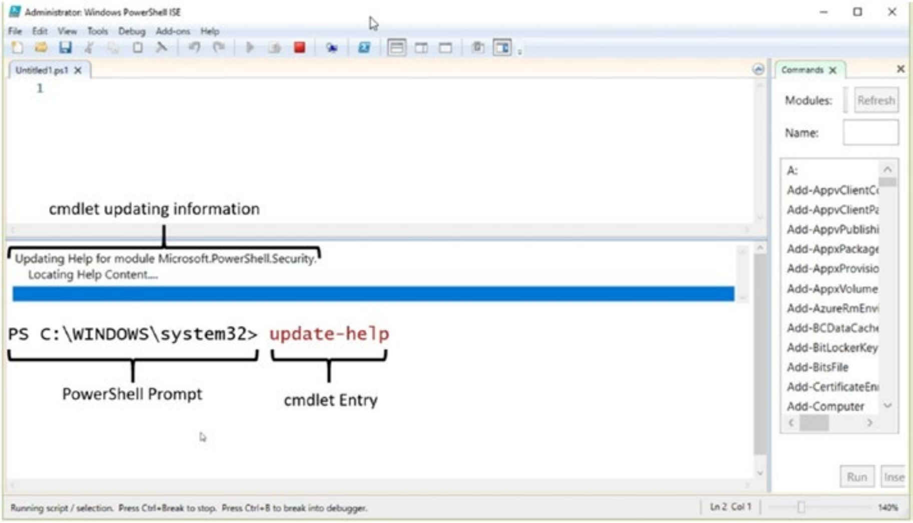
A CmdLet then is a specific order from a user to the operating system, or to an application to perform a service, such as "display all the currently running processes" or "show me all the services that are currently stopped."

All CmdLets are expressed as a **verb–noun** pair and have a help file that can be accessed using the verb–noun pair `Get-Help <CmdLet name>`. So yes, even help is just another CmdLet. Updating help is vital to keep help associated with current all the currently installed CmdLets and to install help for new CmdLets that are created and updated every day.

As you might guess, this is just another CmdLet and this is the first CmdLet you should use. Specifically:

```
Update-Help
```

You can execute this CmdLet from the Direct Command Entry Panel as shown in Figure 1-6. The help files will be updated for all installed modules. We will discuss modules in a future chapter, but for now this will update all the standard PowerShell modules. Additional modules such as Active Directory, VMWare, SharePoint, and hundreds of others allow acquisition to numerous devices and services.



```
Updating Help for module Microsoft.PowerShell.Security.
  Locating Help Content...

PS C:\WINDOWS\system32> update-help
```

Running script / selection. Press Ctrl+Break to stop. Press Ctrl+B to break into debugger.

Figure 1-6. *Update-Help CmdLet execution*

Introduction to Some Key CmdLets

One of the first questions you might ask is, “What CmdLets are available?” Or more specifically, “What CmdLets are available targeting specific information?” This section will introduce you to a few key CmdLets:

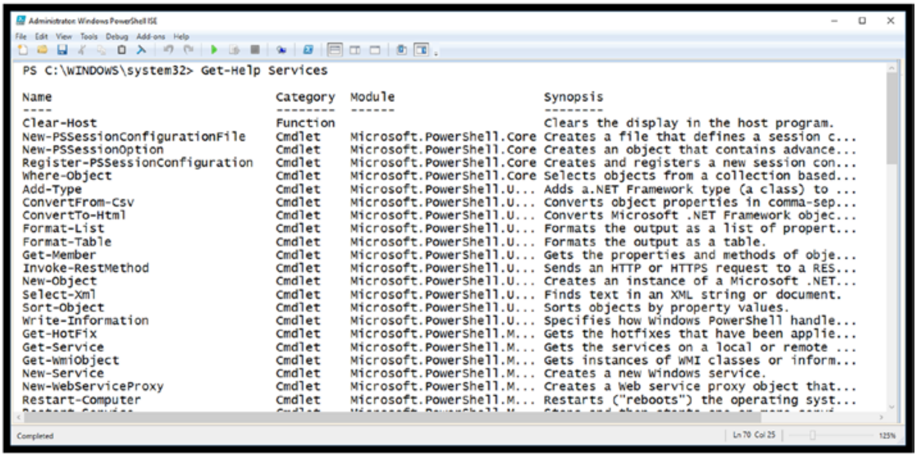
`Get-Help`, `Get-Process`, and `Get-Member`.

Get-Help

Let’s say we are interested in getting information about currently running services. In order to find the CmdLets that relate to this topic I would enter:

```
Get-Help services
```

Note that I did not request information about a specific CmdLet, rather I asked the help system to provide me with information regarding any CmdLet that could relate to services. Figure 1-7 displays an abbreviated output.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 70 Col 25
125%

```
PS C:\WINDOWS\system32> Get-Help Services

Name                              Category  Module                    Synopsis
----                              --------  ------                    --------
Clear-Host                        Function                            Clears the display in the host program.
New-PSSessionConfigurationFile    Cmdlet    Microsoft.PowerShell.Core Creates a file that defines a session c...
New-PSSessionOption               Cmdlet    Microsoft.PowerShell.Core Creates an object that contains advance...
Register-PSSessionConfiguration   Cmdlet    Microsoft.PowerShell.Core Creates and registers a new session con...
Where-Object                      Cmdlet    Microsoft.PowerShell.Core Selects objects from a collection based...
Add-Type                          Cmdlet    Microsoft.PowerShell.U... Adds a.NET Framework type (a class) to ...
ConvertFrom-Csv                   Cmdlet    Microsoft.PowerShell.U... Converts object properties in comma-sep...
ConvertTo-Html                    Cmdlet    Microsoft.PowerShell.U... Converts Microsoft .NET Framework objec...
Format-List                       Cmdlet    Microsoft.PowerShell.U... Formats the output as a list of propert...
Format-Table                      Cmdlet    Microsoft.PowerShell.U... Formats the output as a table.
Get-Member                        Cmdlet    Microsoft.PowerShell.U... Gets the properties and methods of obje...
Invoke-RestMethod                 Cmdlet    Microsoft.PowerShell.U... Sends an HTTP or HTTPS request to a RES...
New-Object                        Cmdlet    Microsoft.PowerShell.U... Creates an instance of a Microsoft .NET...
Select-Xml                        Cmdlet    Microsoft.PowerShell.U... Finds text in an XML string or document.
Sort-Object                       Cmdlet    Microsoft.PowerShell.U... Sorts objects by property values.
Write-Information                 Cmdlet    Microsoft.PowerShell.U... Specifies how Windows PowerShell handle...
Get-HotFix                        Cmdlet    Microsoft.PowerShell.M... Gets the hotfixes that have been applie...
Get-Service                       Cmdlet    Microsoft.PowerShell.M... Gets the services on a local or remote ...
Get-WmiObject                     Cmdlet    Microsoft.PowerShell.M... Gets instances of WMI classes or inform...
New-Service                       Cmdlet    Microsoft.PowerShell.M... Creates a new Windows service.
New-WebServiceProxy               Cmdlet    Microsoft.PowerShell.M... Creates a Web service proxy object that...
Restart-Computer                  Cmdlet    Microsoft.PowerShell.M... Restarts ("reboots") the operating syst...
```

Figure 1-7. *Search for CmdLets related to services*

Note that depending on what version of PowerShell you are working with, the current version of the help file, and what CmdLets are installed, your list may differ.

The next step is to select one or more CmdLets and Get-Help for those CmdLets. Looking through the abbreviated list, Get-Service sounds promising, so I will request help on that specific CmdLet by typing:

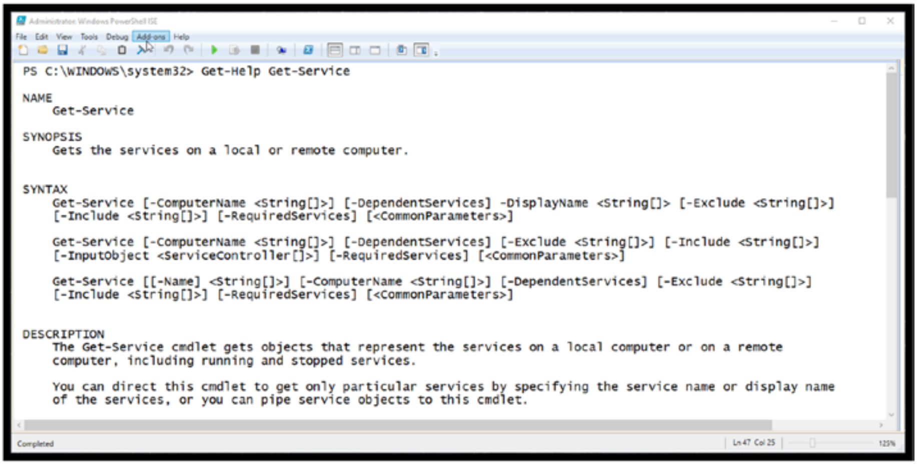
```
Get-Help Get-Service
```

Figure 1-8 displays the abbreviated output. Note that there are multiple options related to the execution of the Get-Help CmdLet. For this example, I used the simplest form. However, optionally I could have used other forms of the CmdLet such as:

```
Get-Help Get-Service -Detailed
```

or

```
Get-Help Get-Service -Examples
```


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 47 Col 25
125%

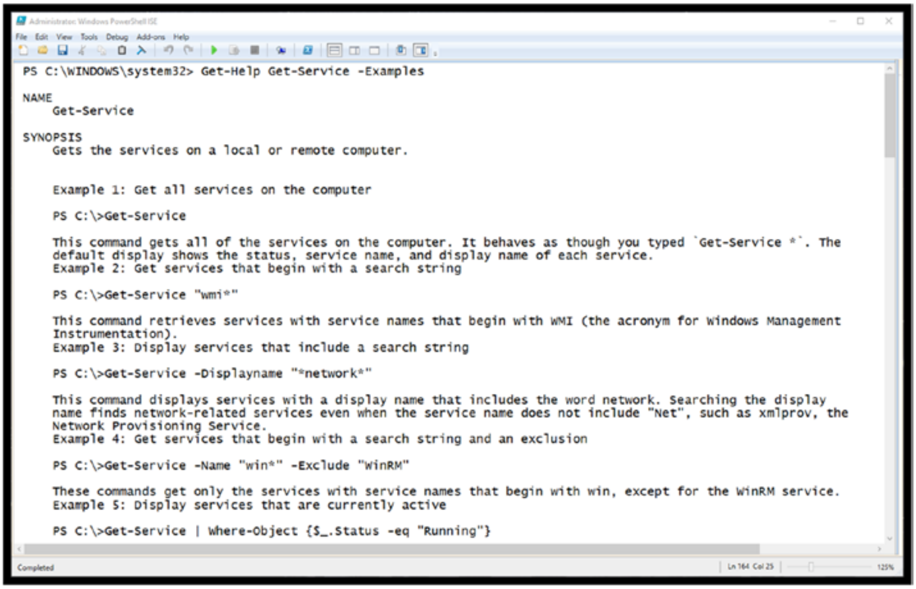
```
PS C:\WINDOWS\system32> Get-Help Get-Service

NAME
    Get-Service

SYNOPSIS
    Gets the services on a local or remote computer.


SYNTAX
    Get-Service [-ComputerName <String[]>] [-DependentServices] -DisplayName <String[]> [-Exclude <String[]>]
    [-Include <String[]>] [-RequiredServices] [<CommonParameters>]

    Get-Service [-ComputerName <String[]>] [-DependentServices] [-Exclude <String[]>] [-Include <String[]>]
    [-InputObject <ServiceController[]>] [-RequiredServices] [<CommonParameters>]

    Get-Service [[-Name] <String[]>] [-ComputerName <String[]>] [-DependentServices] [-Exclude <String[]>]
    [-Include <String[]>] [-RequiredServices] [<CommonParameters>]


DESCRIPTION
    The Get-Service cmdlet gets objects that represent the services on a local computer or on a remote
    computer, including running and stopped services.

    You can direct this cmdlet to get only particular services by specifying the service name or display name
    of the services, or you can pipe service objects to this cmdlet.
```

Figure 1-8. *Get-Help Get-Service abbreviated output*

Examining the output, we notice the detailed syntax presented to us for each command. This CmdLet allows us to obtain information regarding services on a local or remote computer. The option `-ComputerName` allows us to specify more than one computer, each separated by a comma. By using:

```
Get-Help Get-Service -Examples
```

the help system will provide numerous examples demonstrating the use of the CmdLet (Figure 1-9).

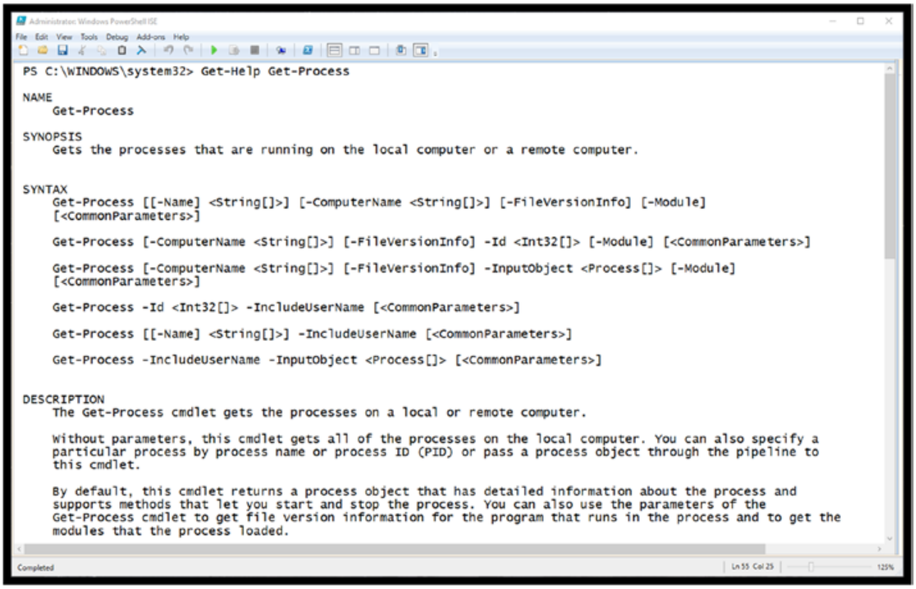

Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 164 Col 25
125%

```
PS C:\WINDOWS\system32> Get-Help Get-Service -Examples

NAME
    Get-Service

SYNOPSIS
    Gets the services on a local or remote computer.


    Example 1: Get all services on the computer

    PS C:\>Get-Service

    This command gets all of the services on the computer. It behaves as though you typed `Get-Service *`. The
    default display shows the status, service name, and display name of each service.
    Example 2: Get services that begin with a search string

    PS C:\>Get-Service "wmi*"

    This command retrieves services with service names that begin with WMI (the acronym for Windows Management
    Instrumentation).
    Example 3: Display services that include a search string

    PS C:\>Get-Service -Displayname "*network*"

    This command displays services with a display name that includes the word network. Searching the display
    name finds network-related services even when the service name does not include "Net", such as xmlprov, the
    Network Provisioning Service.
    Example 4: Get services that begin with a search string and an exclusion

    PS C:\>Get-Service -Name "win*" -Exclude "WinRM"

    These commands get only the services with service names that begin with win, except for the WinRM service.
    Example 5: Display services that are currently active

    PS C:\>Get-Service | Where-Object {$_.Status -eq "Running"}
```

Figure 1-9. *Get-Help with examples*

Get-Process

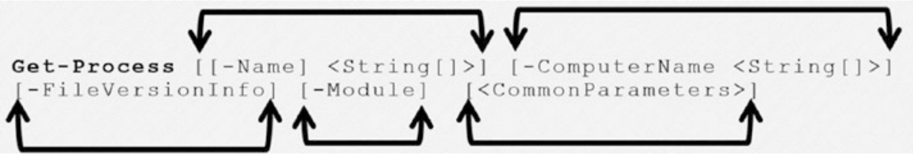
Another useful CmdLet is Get-Process; much like Get-Service it returns information regarding processes running on a local or remote computer. Taking a deeper look at Get-Process using Get-Help (see Figure 1-10), we first notice six different fundamental variants of Get-Process. Technically these are called parameter sets, which allow us to run the Get-Process CmdLet six separate ways.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 55 Col 25
125%

```
PS C:\WINDOWS\system32> Get-Help Get-Process

NAME
    Get-Process

SYNOPSIS
    Gets the processes that are running on the local computer or a remote computer.


SYNTAX
    Get-Process [[-Name] <String[]>] [-ComputerName <String[]>] [-FileVersionInfo] [-Module]
    [<CommonParameters>]

    Get-Process [-ComputerName <String[]>] [-FileVersionInfo] -Id <Int32[]> [-Module] [<CommonParameters>]

    Get-Process [-ComputerName <String[]>] [-FileVersionInfo] -InputObject <Process[]> [-Module]
    [<CommonParameters>]

    Get-Process -Id <Int32[]> -IncludeUserName [<CommonParameters>]

    Get-Process [[-Name] <String[]>] -IncludeUserName [<CommonParameters>]

    Get-Process -IncludeUserName -InputObject <Process[]> [<CommonParameters>]


DESCRIPTION
    The Get-Process cmdlet gets the processes on a local or remote computer.

    Without parameters, this cmdlet gets all of the processes on the local computer. You can also specify a
    particular process by process name or process ID (PID) or pass a process object through the pipeline to
    this cmdlet.

    By default, this cmdlet returns a process object that has detailed information about the process and
    supports methods that let you start and stop the process. You can also use the parameters of the
    Get-Process cmdlet to get file version information for the program that runs in the process and to get the
    modules that the process loaded.
```

Figure 1-10. *Get-Help Get-Process*

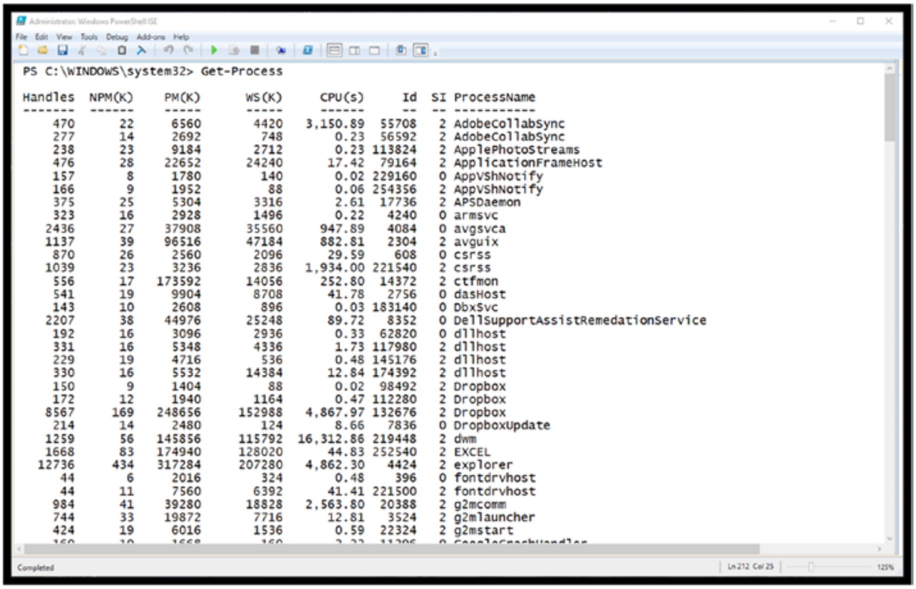
Examining the first parameter set (see Figure 1-11), we find that all the parameters are optional. This is signified by the square brackets that surround each parameter.



```
Get-Process [[-Name] <String[]>] [-ComputerName <String[]>]
[-FileVersionInfo] [-Module] [<CommonParameters>]
```

Figure 1-11. *Get-Process*

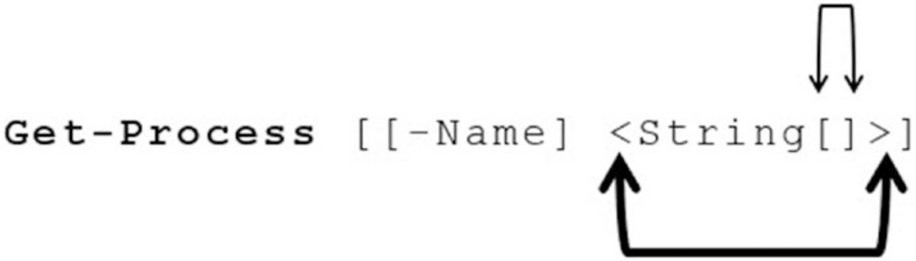
This allows us to simply type the command without including any additional parameters as shown in Figure 1-12 with abbreviated output.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 212 Col 25
125%

```
PS C:\WINDOWS\system32> Get-Process

Handles  NPM(K)    PM(K)      WS(K)     CPU(s)     Id  SI ProcessName
-------  ------    -----      -----     ------     --  -- -----------
    470      22     6560       4420   3,150.89  55708   2 AdobeCollabSync
    277      14     2692        748       0.23  56592   2 AdobeCollabSync
    238      23     9184       2712       0.23 113824   2 ApplePhotoStreams
    476      28    22652      24240      17.42  79164   2 ApplicationFrameHost
    157       8     1780        140       0.02 229160   0 AppVShNotify
    166       9     1952         88       0.06 254356   2 AppVShNotify
    375      25     5304       3316       2.61  17736   2 APSDaemon
    323      16     2928       1496       0.22   4240   0 armsvc
   2436      27    37908      35560     947.89   4084   0 avgsvca
   1137      39    96516      47184     882.81   2304   2 avguix
    870      26     2560       2096      29.59    608   0 csrss
   1039      23     3236       2836   1,934.00 221540   2 csrss
    556      17   173592      14056     252.80  14372   2 ctfmon
    541      19     9904       8708      41.78   2756   0 dasHost
    143      10     2608        896       0.03 183140   0 DbxSvc
   2207      38    44976      25248      89.72   8352   0 DellSupportAssistRemedationService
    192      16     3096       2936       0.33  62820   0 dllhost
    331      16     5348       4336       1.73 117980   2 dllhost
    229      19     4716        536       0.48 145176   2 dllhost
    330      16     5532      14384      12.84 174392   2 dllhost
    150       9     1404         88       0.02  98492   2 Dropbox
    172      12     1940       1164       0.47 112280   2 Dropbox
   8567     169   248656     152988   4,867.97 132676   2 Dropbox
    214      14     2480        124       8.66   7836   0 DropboxUpdate
   1259      56   145856     115792  16,312.86 219448   2 dwm
   1668      83   174940     128020      44.83 252540   2 EXCEL
  12736     434   317284     207280   4,862.30   4424   2 explorer
     44       6     2016        324       0.48    396   0 fontdrvhost
     44      11     7560       6392      41.41 221500   2 fontdrvhost
    984      41    39280      18828   2,563.80  20388   2 g2mcomm
    744      33    19872       7716      12.81   3524   2 g2mlauncher
    424      19     6016       1536       0.59  22324   2 g2mstart
```

Figure 1-12. *Get-Process with no additional parameters*

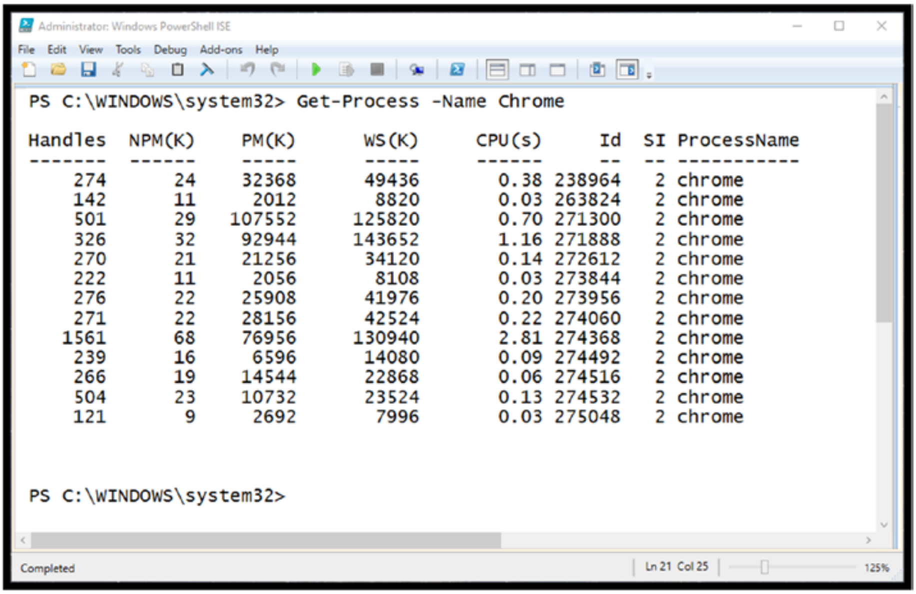
What if I would like to obtain information only related to the process associated with the Google Chrome browser? In Figure 1-13, I break out the specific -Name Parameter that we need to utilize in order to accomplish this.



```
Get-Process [[-Name] <String[]>]
```

Figure 1-13. *Get-Process -Name parameter*

You notice that the -Name Parameter is optional; however, if it is specified, you must specify a String indicating the specific type of data you must provide (the content of which would be the name of the process). You also notice that following the word String there are two square brackets. This indicates that you can optionally include a list of names. Each name needs to be separated by a comma. Figure 1-14 shows an example.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 21 Col 25
125%

```
PS C:\WINDOWS\system32> Get-Process -Name Chrome

Handles  NPM(K)    PM(K)      WS(K)     CPU(s)     Id  SI ProcessName
-------  ------    -----      -----     ------     --  -- -----------
    274      24    32368      49436       0.38 238964   2 chrome
    142      11     2012       8820       0.03 263824   2 chrome
    501      29   107552     125820       0.70 271300   2 chrome
    326      32    92944     143652       1.16 271888   2 chrome
    270      21    21256      34120       0.14 272612   2 chrome
    222      11     2056       8108       0.03 273844   2 chrome
    276      22    25908      41976       0.20 273956   2 chrome
    271      22    28156      42524       0.22 274060   2 chrome
   1561      68    76956     130940       2.81 274368   2 chrome
    239      16     6596      14080       0.09 274492   2 chrome
    266      19    14544      22868       0.06 274516   2 chrome
    504      23    10732      23524       0.13 274532   2 chrome
    121       9     2692       7996       0.03 275048   2 chrome


PS C:\WINDOWS\system32>
```

Figure 1-14. *Get-Process example using -Name parameter*

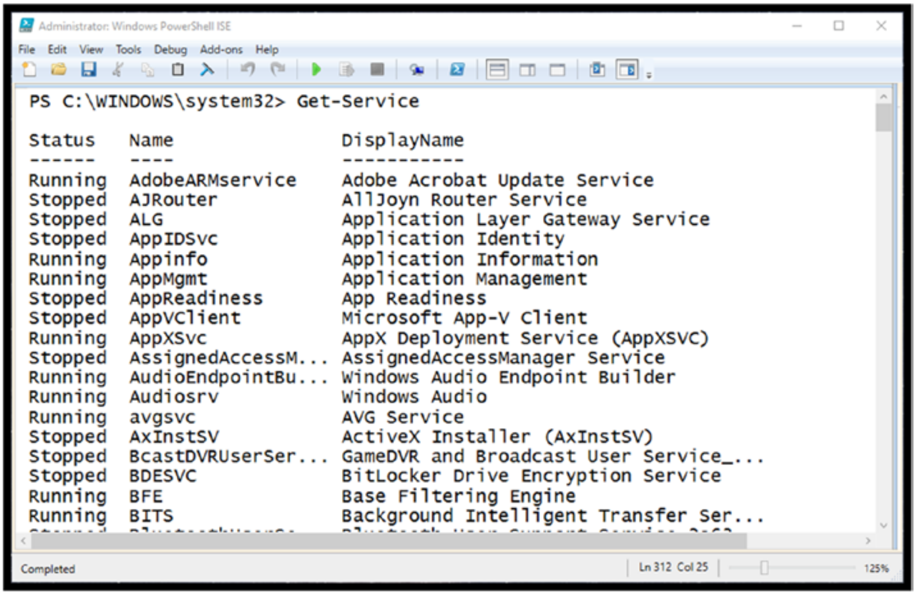
Get-Member

As you have seen, PowerShell CmdLets provide useful results when using them to obtain information (or evidence) from a target system. In addition to the simple output, each CmdLet also returns an object that provides access to additional properties and methods. The Get-Member CmdLet will display the available properties and methods for a CmdLet.

Note that as with any CmdLet, you can utilize the Get-Help CmdLet to obtain details and examples regarding Get-Member. For example, the command would be:

```
Get-Help Get-Member
```

To illustrate the value of obtaining additional properties of a CmdLet, look at the standard output of the Get-Service CmdLet as shown in Figure 1-15.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 312 Col 25
125%

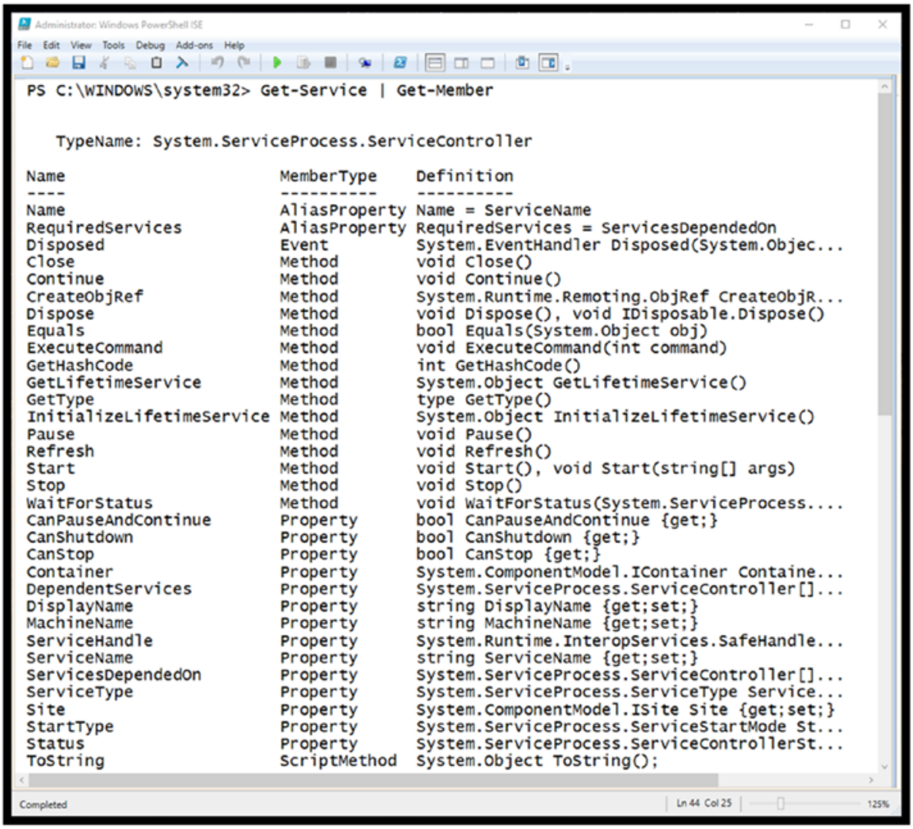
```
PS C:\WINDOWS\system32> Get-Service

Status   Name               DisplayName
------   ----               -----------
Running  AdobeARMservice    Adobe Acrobat Update Service
Stopped  AJRouter           AllJoyn Router Service
Stopped  ALG                Application Layer Gateway Service
Stopped  AppIDSvc           Application Identity
Running  Appinfo            Application Information
Running  AppMgmt            Application Management
Stopped  AppReadiness       App Readiness
Stopped  AppVClient         Microsoft App-V Client
Running  AppXSvc            AppX Deployment Service (AppXSVC)
Stopped  AssignedAccessM... AssignedAccessManager Service
Running  AudioEndpointBu... Windows Audio Endpoint Builder
Running  Audiosrv           Windows Audio
Running  avgsvc             AVG Service
Stopped  AxInstSV           ActiveX Installer (AxInstSV)
Stopped  BcastDVRUserSer... GameDVR and Broadcast User Service_...
Stopped  BDESVC             BitLocker Drive Encryption Service
Running  BFE                Base Filtering Engine
Running  BITS               Background Intelligent Transfer Ser...
```

Figure 1-15. *Standard output of the Get-Service CmdLet*

What if additional information evidence is required? For example, what if it was important to know how the service was started? In order to answer this question, we need to interrogate and obtain additional properties from the object.

To extract the method and property details of an object, we need to utilize a pipe to direct the output object to the Get-Member CmdLet. Pipes operate similarly in most command line and shell environments. However, in PowerShell they are object and context specific.

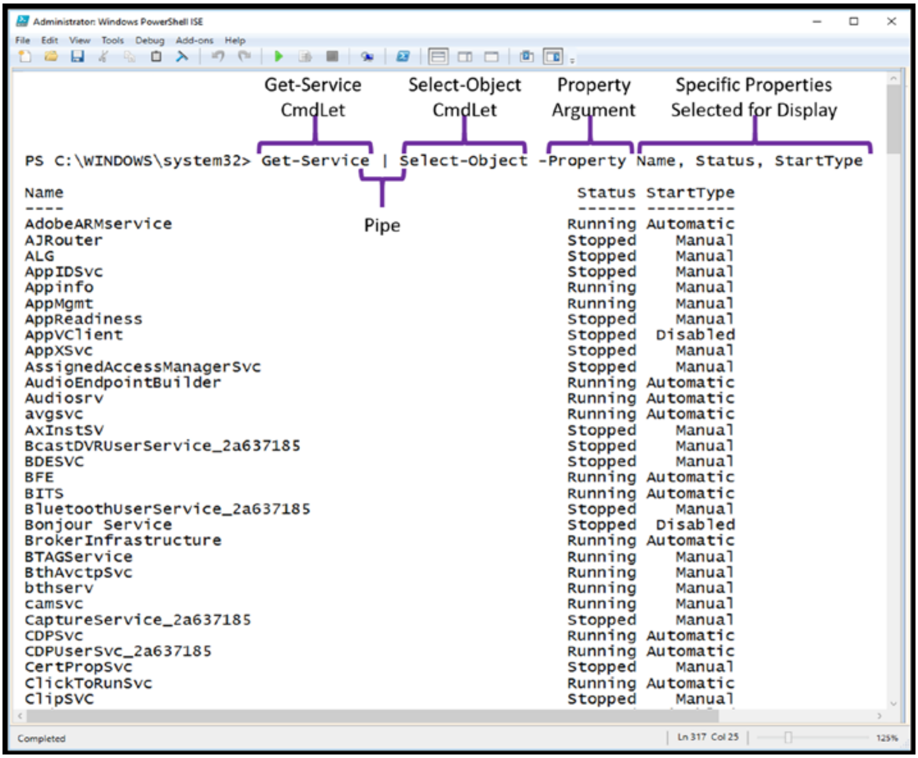
The CmdLet that we wish to interrogate in this example, Get-Service, is not executed, but rather the object information is passed to the Get-Member CmdLet as shown in Figure 1-16. Note the name of the property we are looking for is StartType.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 44 Col 25
125%

```
PS C:\WINDOWS\system32> Get-Service | Get-Member


   TypeName: System.ServiceProcess.ServiceController

Name                      MemberType    Definition
----                      ----------    ----------
Name                      AliasProperty Name = ServiceName
RequiredServices          AliasProperty RequiredServices = ServicesDependedOn
Disposed                  Event         System.EventHandler Disposed(System.Objec...
Close                     Method        void Close()
Continue                  Method        void Continue()
CreateObjRef              Method        System.Runtime.Remoting.ObjRef CreateObjR...
Dispose                   Method        void Dispose(), void IDisposable.Dispose()
Equals                    Method        bool Equals(System.Object obj)
ExecuteCommand            Method        void ExecuteCommand(int command)
GetHashCode               Method        int GetHashCode()
GetLifetimeService        Method        System.Object GetLifetimeService()
GetType                   Method        type GetType()
InitializeLifetimeService Method        System.Object InitializeLifetimeService()
Pause                     Method        void Pause()
Refresh                   Method        void Refresh()
Start                     Method        void Start(), void Start(string[] args)
Stop                      Method        void Stop()
WaitForStatus             Method        void WaitForStatus(System.ServiceProcess....
CanPauseAndContinue       Property      bool CanPauseAndContinue {get;}
CanShutdown               Property      bool CanShutdown {get;}
CanStop                   Property      bool CanStop {get;}
Container                 Property      System.ComponentModel.IContainer Containe...
DependentServices         Property      System.ServiceProcess.ServiceController[]...
DisplayName               Property      string DisplayName {get;set;}
MachineName               Property      string MachineName {get;set;}
ServiceHandle             Property      System.Runtime.InteropServices.SafeHandle...
ServiceName               Property      string ServiceName {get;set;}
ServicesDependedOn        Property      System.ServiceProcess.ServiceController[]...
ServiceType               Property      System.ServiceProcess.ServiceType Service...
Site                      Property      System.ComponentModel.ISite Site {get;set;}
StartType                 Property      System.ServiceProcess.ServiceStartMode St...
Status                    Property      System.ServiceProcess.ServiceControllerSt...
ToString                  ScriptMethod  System.Object ToString();
```

Figure 1-16. *Get-Member example*

Now that we know the name, we can specify that property `StartType` displays a customized output as shown in Figure 1-17. This is the simplest form of piping we can perform. The Get-Service CmdLet is executed, and the results are piped to the Select-Object CmdLet.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Get-Service CmdLet
Select-Object CmdLet
Property Argument
Specific Properties Selected for Display
Pipe
Completed
Ln 317 Col 25
125%

```
PS C:\WINDOWS\system32> Get-Service | Select-Object -Property Name, Status, StartType

Name                                     Status StartType
----                                     ------ ---------
AdobeARMservice                         Running Automatic
AJRouter                                Stopped    Manual
ALG                                     Stopped    Manual
AppIDSvc                                Stopped    Manual
Appinfo                                 Running    Manual
AppMgmt                                 Running    Manual
AppReadiness                            Stopped    Manual
AppVClient                              Stopped  Disabled
AppXSvc                                 Stopped    Manual
AssignedAccessManagerSvc                Stopped    Manual
AudioEndpointBuilder                    Running Automatic
Audiosrv                                Running Automatic
avgsvc                                  Running Automatic
AxInstSV                                Stopped    Manual
BcastDVRUserService_2a637185            Stopped    Manual
BDESVC                                  Stopped    Manual
BFE                                     Running Automatic
BITS                                    Running Automatic
BluetoothUserService_2a637185           Stopped    Manual
Bonjour Service                         Stopped  Disabled
BrokerInfrastructure                    Running Automatic
BTAGService                             Running    Manual
BthAvctpSvc                             Running    Manual
bthserv                                 Running    Manual
camsvc                                  Running    Manual
CaptureService_2a637185                 Stopped    Manual
CDPSvc                                  Running Automatic
CDPUserSvc_2a637185                     Running Automatic
CertPropSvc                             Stopped    Manual
ClickToRunSvc                           Running Automatic
ClipSVC                                 Stopped    Manual
```

***Figure 1-17.** Get-Service with name, status, and StartType*

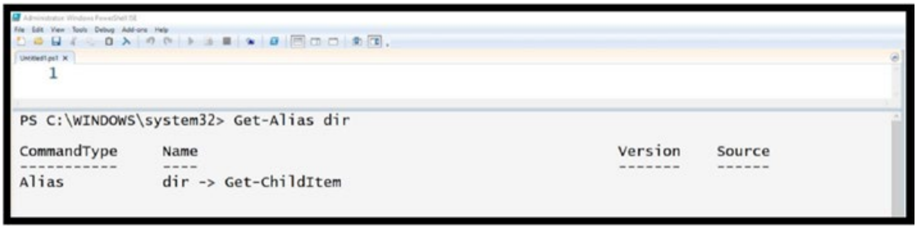
The Select-Object CmdLet then displays the specific properties specified. The `-Property` argument of the Select-Object CmdLet accepts string names that are to be displayed. Again, each is separated by a comma.

Challenge Problems: Investigative CmdLets to Explore

To become comfortable with PowerShell, the ISE, and the CmdLets that you are likely to utilize during investigations, you need to experiment with them directly. To help this process along, I have put together a set of challenge problems at the end of each chapter. Remember to use Get-Help with each of the CmdLets, and make sure you use `-Detailed` and `-Examples` options when examining the CmdLets. I have also provided solutions to each of the challenge problems in the Appendix, so try these on your own and then check your results.

Challenge One: Executing a "Find" Based on File Extension

Many of you may be familiar with Windows Command Line dir command, which will list the contents of a specific directory. All traditional Windows and DOS commands have equivalent PowerShell commands. An effortless way to find the equivalent is to **use** a PowerShell CmdLet to find the associated PowerShell CmdLet as shown in Figure 1-18. To learn more about Get-Alias and Get-ChildItem, use the PowerShell Help system.



```
PS C:\WINDOWS\system32> Get-Alias dir

CommandType     Name                                               Version    Source
-----------     ----                                               -------    ------
Alias           dir -> Get-ChildItem
```

Figure 1-18. *Using Get-Alias*

Now that you know about the Get-ChildItem CmdLet, use this to find all files on your system with the .jpg extension.

Feel free to experiment with other parameters provided with Get-ChildItem. Also, make sure you access Get-Help using the -Examples switch and study those examples.

Challenge Two: Examining Network Settings

At this point you might be thinking, "If PowerShell simply replaces Windows Command Line, then why not just use the Windows Command Line?" As was learned earlier in this chapter, the help system can provide a list of available commands surrounding a specific word or phrase.

Try typing:

```
Get-Help ip
```

This will provide all PowerShell CmdLets that involve IP. You will see a number of possible CmdLets that allow you to examine your network configuration. Notice that this is much more powerful than using Windows Command Line. For this challenge, take a deep look at just three of these CmdLets:

```
Get-NetIPAddress
Get-NetIPConfiguration
Get-NetIPInterface
```

Start by using the PowerShell help system to understand the capabilities of each CmdLet and examine the examples provided. Then experiment with each of the commands and take a close look at your own network settings. Were you aware of all the settings?

Challenge Three: Examining Firewall Settings

For this challenge problem, find possible firewall related CmdLets. Specifically get information regarding the firewall settings on your system. Once you have examined the basic information find and execute a CmdLet that will examine any "Service Filters" that are enabled. Did you discover any surprises?

Challenge Four: Your Chance to Explore

For this challenge, use the help system and keywords that you would be interested in probing your system for.

Summary

This chapter introduced the goals of this book, specifically how the integration of PowerShell and Python would provide value to investigators.

In addition, a brief evolution of PowerShell was covered to better understand how PowerShell today is relevant to investigations. The basic setup and execution of PowerShell and where to obtain the latest trusted version were provided. An overview of PowerShell ISE and the PowerShell help system was provided along with the importance of updating the help system. Next, PowerShell CmdLets and the verb–noun vernacular were introduced followed by a brief discussion and examples of how to identify specific CmdLets of interest. Several CmdLets were demonstrated to provide details regarding the depth of information that can be acquired with PowerShell. Finally, a set of challenge problems were presented to encourage you to dive in and experiment with PowerShell.

Looking forward to Chapter 2, we'll find that one of the key elements of PowerShell CmdLets is the ability to create PowerShell variables and string together multiple commands in a method called Pipelining. We will establish several investigative challenges and solve them with PowerShell variables and Pipelining. In addition, we will introduce several new CmdLets that will allow us to sort, filter, and format the output. Chapter 2 is key as it provides a prelude to how we will be integrating PowerShell with Python.

CHAPTER 2

PowerShell Pipelining

Pipelining is the key feature within PowerShell that will help us facilitate the integration of Python and PowerShell. The examples and illustrations in this chapter were chosen to explain pipelining and provide insight into CmdLet and methods that are useful during investigations.

What Is CmdLet Pipelining?

CmdLet Pipelining creates an assembly line of commands to be executed in a specific sequence while moving the data or results from each CmdLet as well. The best way to describe this is with a couple of investigation-related examples.

Example 1: Get-Service

Assume that we want to see what services are currently **running** on a system we are investigating. The filtering down of the output from one CmdLet to another is one of the most common uses of the pipeline. In addition, we would like to display the output in a table format. Figure 2-1 is a sample pipeline that will solve this challenge.

C. Hosmer, *PowerShell and Python Together*, https://doi.org/10.1007/978-1-4842-4504-0_2

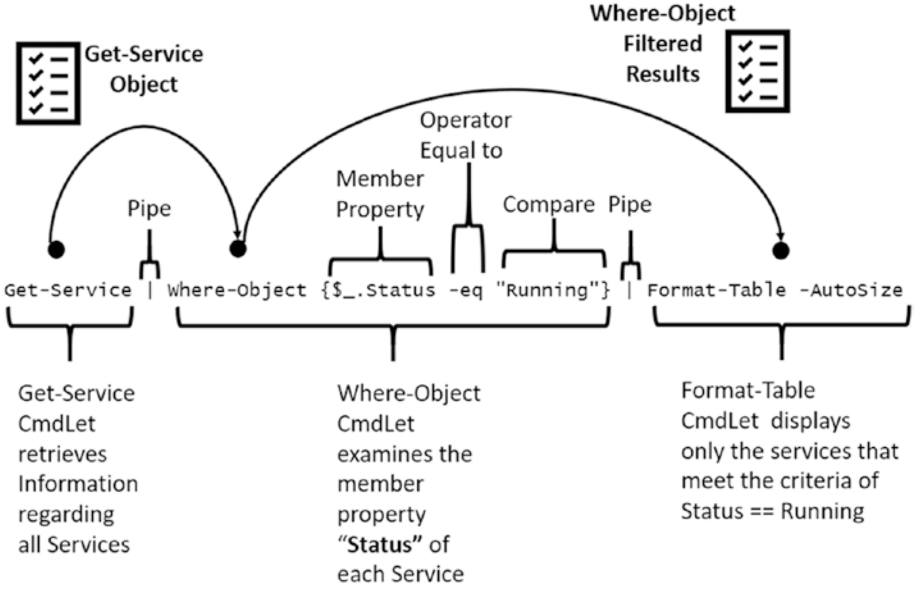

Get-Service Object
Where-Object Filtered Results
Operator Equal to
Member Property
Pipe
Compare
Pipe
Get-Service | Where-Object {$_.Status -eq "Running"} | Format-Table -AutoSize
Get-Service CmdLet retrieves Information regarding all Services
Where-Object CmdLet examines the member property "Status" of each Service
Format-Table CmdLet displays only the services that meet the criteria of Status == Running

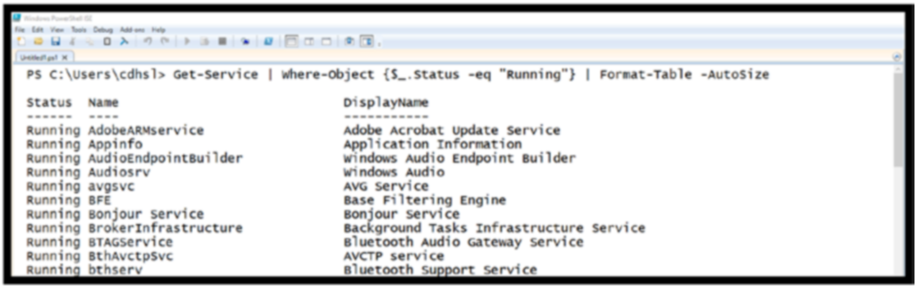
Figure 2-1. *Pipeline illustration for display of running services*

As you can see, the pipeline starts with the Get-Service CmdLet without any command line parameters.

Note You could of course add command line parameters before the pipe symbol **|** such as -ComputerName which would allow the Get-Service CmdLet to execute a remotely on the specified computer.

The Get-Service CmdLet produces an object that is passed across the Pipeline to the next Cmdlet in the chain.

The Where-Object CmdLet performs a filtering action that evaluates the Get-Service CmdLet Object Property **Status** equal to "Running." The resulting output of the Where-Object CmdLet filters the results to only include those services that are currently running. The result is then passed to the next Pipeline CmdLet.



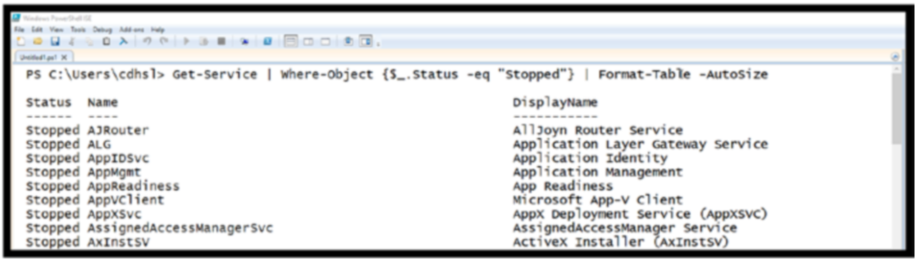
```
PS C:\Users\cdhsl> Get-Service | Where-Object {$_.Status -eq "Running"} | Format-Table -AutoSize

Status  Name                                  DisplayName
------  ----                                  -----------
Running AdobeARMservice                       Adobe Acrobat Update Service
Running Appinfo                               Application Information
Running AudioEndpointBuilder                  Windows Audio Endpoint Builder
Running Audiosrv                              Windows Audio
Running avgsvc                                AVG Service
Running BFE                                   Base Filtering Engine
Running Bonjour Service                       Bonjour Service
Running BrokerInfrastructure                  Background Tasks Infrastructure Service
Running BTAGService                           Bluetooth Audio Gateway Service
Running BthAvctpSvc                           AVCTP service
Running bthserv                               Bluetooth Support Service
```

Figure 2-2. *Challenge solution*

Finally, Format-Table CmdLet produces a table result display with the filter services using the default output associated with Get-Service. Figure 2-2 depicts the actual command in action – the results were truncated for brevity.

Note By using the Get-Service | Get-Member operation, you can reveal all the methods and properties available within the Get-Service CmdLet object allowing for additional filtering options.

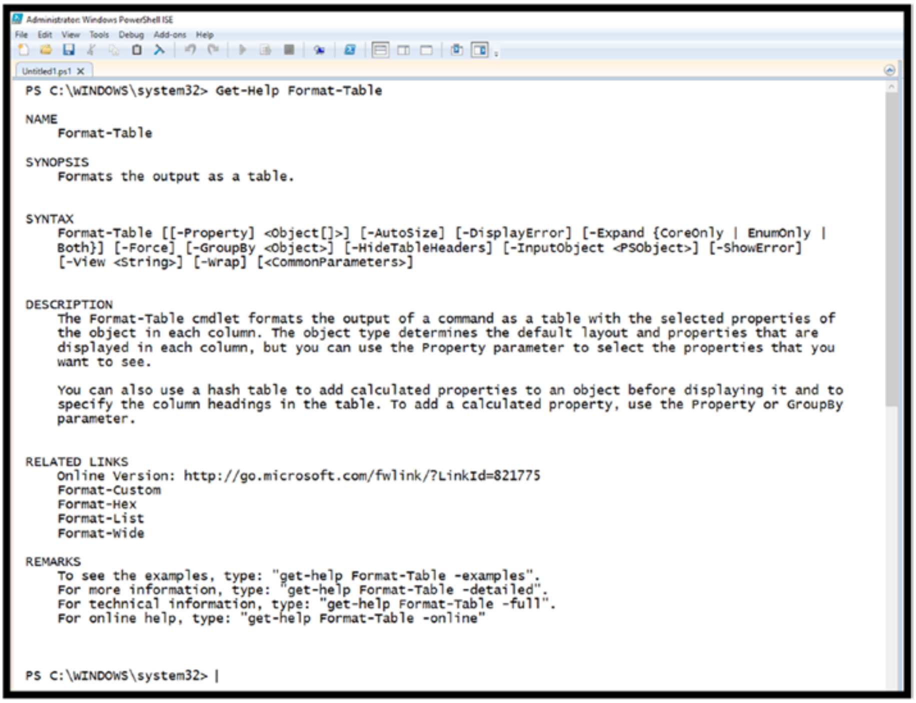
Reporting which services are stopped can be equally important during an investigation. For example, sophisticated malicious software will disable virus protection, firewalls, and other defensive services designed for protection. Figure 2-3 changes the command to display only the services that are currently stopped. Again, the results were truncated for brevity.



```
PS C:\Users\cdhsl> Get-Service | Where-Object {$_.Status -eq "Stopped"} | Format-Table -AutoSize

Status  Name                                                   DisplayName
------  ----                                                   -----------
Stopped AJRouter                                               AllJoyn Router Service
Stopped ALG                                                    Application Layer Gateway Service
Stopped AppIDSvc                                               Application Identity
Stopped AppMgmt                                                Application Management
Stopped AppReadiness                                           App Readiness
Stopped AppVClient                                             Microsoft App-V Client
Stopped AppXSvc                                                AppX Deployment Service (AppXSVC)
Stopped AssignedAccessManagerSvc                               AssignedAccessManager Service
Stopped AxInstSV                                               ActiveX Installer (AxInstSV)
```

Figure 2-3. *Displaying stopped services*

One final note: If you want more information regarding Format-Table, remember to use Get-Help as shown in Figure 2-4.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Untitled1.ps1

```
PS C:\WINDOWS\system32> Get-Help Format-Table

NAME
    Format-Table

SYNOPSIS
    Formats the output as a table.


SYNTAX
    Format-Table [[-Property] <Object[]>] [-AutoSize] [-DisplayError] [-Expand {CoreOnly | EnumOnly |
    Both}] [-Force] [-GroupBy <Object>] [-HideTableHeaders] [-InputObject <PSObject>] [-ShowError]
    [-View <String>] [-Wrap] [<CommonParameters>]


DESCRIPTION
    The Format-Table cmdlet formats the output of a command as a table with the selected properties of
    the object in each column. The object type determines the default layout and properties that are
    displayed in each column, but you can use the Property parameter to select the properties that you
    want to see.

    You can also use a hash table to add calculated properties to an object before displaying it and to
    specify the column headings in the table. To add a calculated property, use the Property or GroupBy
    parameter.


RELATED LINKS
    Online Version: http://go.microsoft.com/fwlink/?LinkId=821775
    Format-Custom
    Format-Hex
    Format-List
    Format-Wide

REMARKS
    To see the examples, type: "get-help Format-Table -examples".
    For more information, type: "get-help Format-Table -detailed".
    For technical information, type: "get-help Format-Table -full".
    For online help, type: "get-help Format-Table -online"


PS C:\WINDOWS\system32> |
```

Figure 2-4. *Format-Table CmdLet overview*

Example 2: Get-Process

Details related to running processes are also important and can provide additional information regarding what processes are connected to.
For example, it might be important in a live investigation to determine what active Internet connections are in use by Google Chrome. For this example, let's first break this down into the individual components and introduce the concept of variables in PowerShell.

PowerShell Variables

What are PowerShell variables: A variable in PowerShell is simply a named place in memory assigned to hold data values. All variable names in PowerShell begin with a **$** making them easy to identify. One additional note: Variable names in PowerShell are NOT case sensitive; thus, $ipAddress and $IPaddress represent the same variable. You can assign values to variables such as:

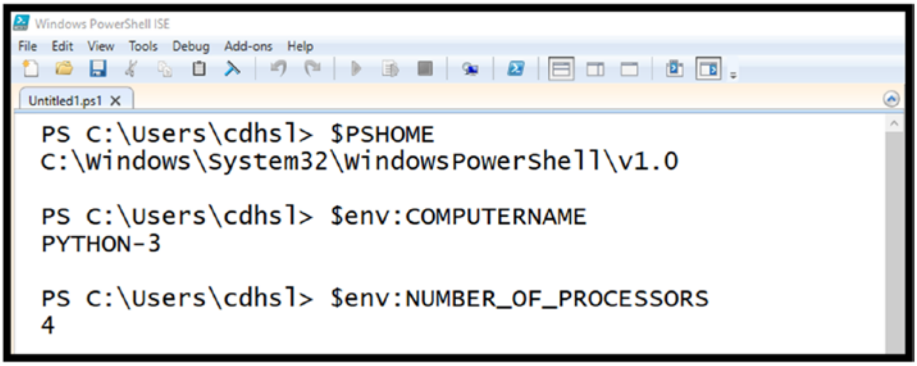
```
$InvestigatorName = "Chet Hosmer"
```

or

```
$CaseNumber = "BC-0234"
```

PowerShell Automatic Variables

In addition, there are several built-in or automatic variables that are available but cannot be changed by the user. Several examples are shown in Figure 2-5.



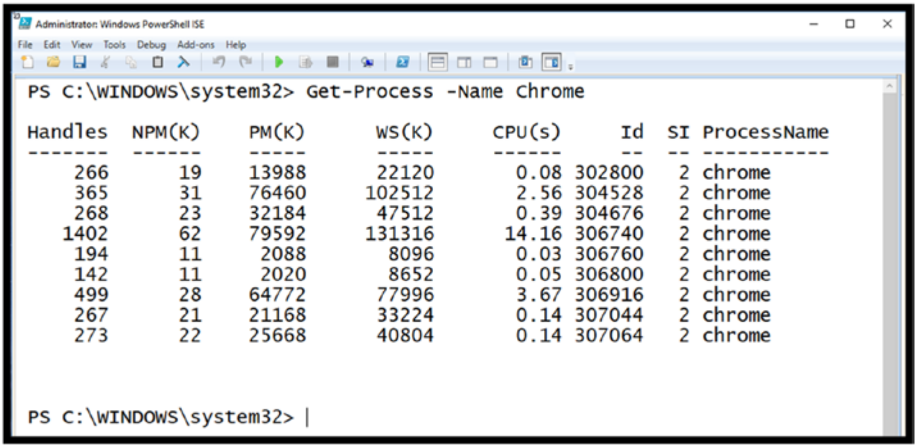
```
PS C:\Users\cdhsl> $PSHOME
C:\Windows\System32\WindowsPowerShell\v1.0

PS C:\Users\cdhsl> $env:COMPUTERNAME
PYTHON-3

PS C:\Users\cdhsl> $env:NUMBER_OF_PROCESSORS
4
```

Figure 2-5. *Example of automatic variables*

Breaking Down the CmdLet Usage for Example 2

Now that we have a general idea about variables, we will put them to use in gather information from Get-Process. In order to reduce the output from Get-Process, let's focus on just one running process. On my test system I have Google Chrome installed and running. On your system you may be using other browsers such as Internet Explorer or Firefox. Substitute the name of your browser to target the processes that are created by them. Also, the process named svchost is always running, therefore you can substitute that as well. The command within PowerShell to do this is as follows, and the results are shown in Figure 2-6.

```
Get-Process -Name chrome
```


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help

```
PS C:\WINDOWS\system32> Get-Process -Name Chrome

Handles  NPM(K)    PM(K)      WS(K)     CPU(s)     Id  SI ProcessName
-------  ------    -----      -----     ------     --  -- -----------
    266      19    13988      22120       0.08 302800   2 chrome
    365      31    76460     102512       2.56 304528   2 chrome
    268      23    32184      47512       0.39 304676   2 chrome
   1402      62    79592     131316      14.16 306740   2 chrome
    194      11     2088       8096       0.03 306760   2 chrome
    142      11     2020       8652       0.05 306800   2 chrome
    499      28    64772      77996       3.67 306916   2 chrome
    267      21    21168      33224       0.14 307044   2 chrome
    273      22    25668      40804       0.14 307064   2 chrome


PS C:\WINDOWS\system32> |
```

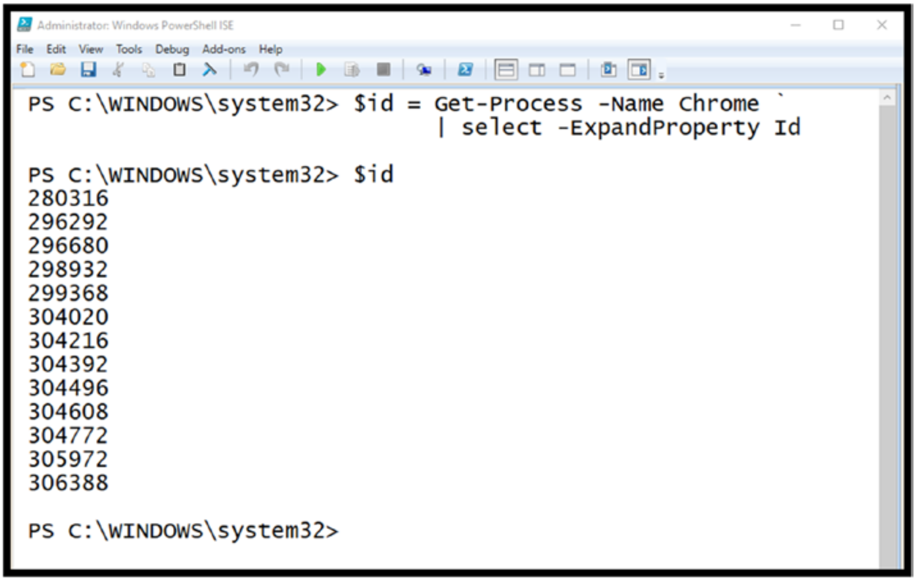
Figure 2-6. *Get-Process -Name Chrome*

A key piece of information that is needed from the Get-Process CmdLet is the Process ID associated in my example with Google Chrome. We can use this Process ID to correlate the process with associated Internet activity. As you probably guessed we will be using yet another CmdLet in PowerShell to examine the connections between Google Chrome and the Internet. In order to accomplish this, a command will be constructed to store the results of the CmdLet into a variable, named $id, instead of simply displaying the results:

```
$id = Get-Process -Name Chrome `
   | select -ExpandProperty Id
```

Notice that I used the tick (`) character and then Shift+Enter to continue the command on the next line for easy display. The results of the Get-Process -Name Chrome command are then piped to select the -ExpandProperty command to specify only the Id field. You can of course enter this command on a single line, but it is a nice way to make this more readable.

Figure 2-7 stores the results of the Get-Process ID value into the variable $id. Then by specifying the $id variable name on the next line (followed by the Enter key of course), the content of the $id variable is displayed.

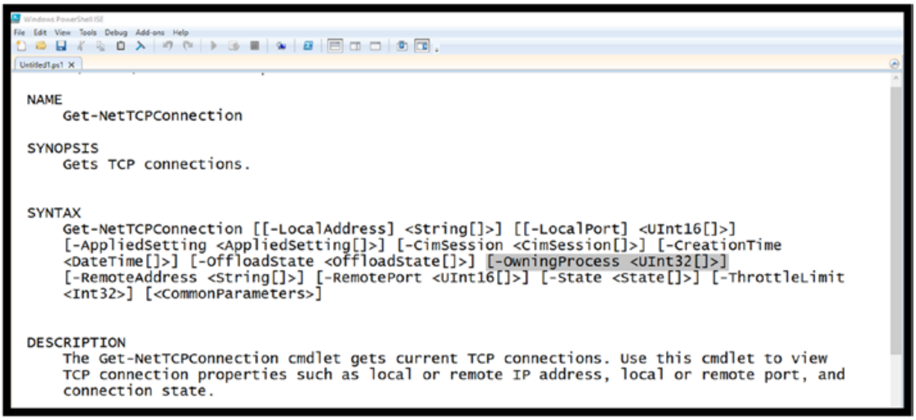

Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help

```
PS C:\WINDOWS\system32> $id = Get-Process -Name Chrome `
                           | select -ExpandProperty Id

PS C:\WINDOWS\system32> $id
280316
296292
296680
298932
299368
304020
304216
304392
304496
304608
304772
305972
306388

PS C:\WINDOWS\system32>
```

Figure 2-7. *Store the Get-Process CmdLet results in the variable $id*

Adding the NetTCPConnections CmdLet

The $id variable can now be utilized as a parameter to other CmdLets. For example, the CmdLet Get-NetTCPConnections has a parameter -OwningProcess, which allows us to restrict the output of the CmdLet to target specific Process IDs. Examining Get-NetTCPConnections using Get-Help, the following information is obtained (see Figure 2-8).

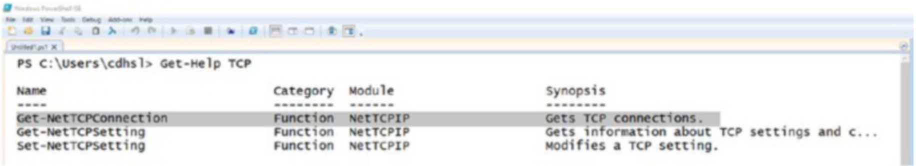


```
NAME
    Get-NetTCPConnection

SYNOPSIS
    Gets TCP connections.


SYNTAX
    Get-NetTCPConnection [[-LocalAddress] <String[]>] [[-LocalPort] <UInt16[]>]
    [-AppliedSetting <AppliedSetting[]>] [-CimSession <CimSession[]>] [-CreationTime
    <DateTime[]>] [-OffloadState <OffloadState[]>] [-OwningProcess <UInt32[]>]
    [-RemoteAddress <String[]>] [-RemotePort <UInt16[]>] [-State <State[]>] [-ThrottleLimit
    <Int32>] [<CommonParameters>]


DESCRIPTION
    The Get-NetTCPConnection cmdlet gets current TCP connections. Use this cmdlet to view
    TCP connection properties such as local or remote IP address, local or remote port, and
    connection state.
```

Figure 2-8. *Get-NetTCPConnections help*

How to Discover CmdLets?

One of the questions you might be asking is with thousands of CmdLets how would I know which one to use to obtain and associated TCP connections with the Owning Process? The answer is using Get-Help. The design of the help system built into PowerShell is key to getting the most out of PowerShell and the associated CmdLets. Since the Help system is updated everyday it is designed to keep pace with new CmdLets that are created along with any updates to existing CmdLets. However, you can also find CmdLets that are related to specific keywords. For example, see how to use Get-Help using a keyword instead of a CmdLet in Figure 2-9.



```
PS C:\Users\cdhsl> Get-Help TCP

Name                              Category  Module                    Synopsis
----                              --------  ------                    --------
Get-NetTCPConnection              Function  NetTCPIP                  Gets TCP connections.
Get-NetTCPSetting                 Function  NetTCPIP                  Gets information about TCP settings and c...
Set-NetTCPSetting                 Function  NetTCPIP                  Modifies a TCP setting.
```

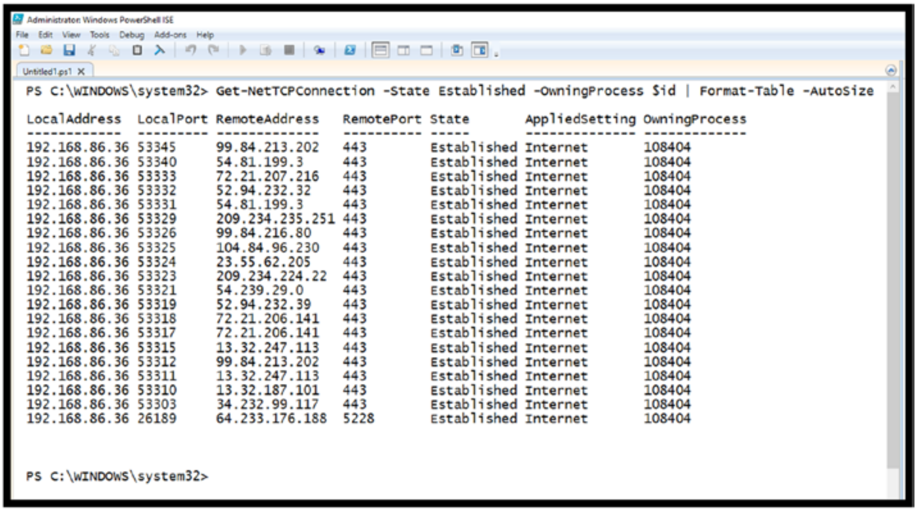
Figure 2-9. *Get-Help using a keyword instead of a CmdLet*

When you provide Get-Help with a keyword as in this case **TCP** it will report known CmdLets that have any association with TCP. As you can see, Get-NetTCPConnection is the first hit. Once you know the name of the CmdLet, you can then use Get-Help with the CmdLet name to determine how to use it as I did in Figure 2-8.

Using PowerShell Variables with CmdLets

Executing the Get-NetTCPConnection CmdLet using the -OwningProcess parameter and specifying $id will generate only the TCP Connections associated with the Google Chrome id values discovered earlier using Get-Process. The command to accomplish this is as follows, with an example output shown in Figure 2-10.

```
Get-NetTCPConnection -State Established -OwningProcess $id |
Format-Table -Autosize
```



Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Untitled1.ps1

```
PS C:\WINDOWS\system32> Get-NetTCPConnection -State Established -OwningProcess $id | Format-Table -AutoSize

LocalAddress  LocalPort RemoteAddress   RemotePort State       AppliedSetting OwningProcess
------------  --------- -------------   ---------- -----       -------------- -------------
192.168.86.36 53345     99.84.213.202   443        Established Internet       108404
192.168.86.36 53340     54.81.199.3     443        Established Internet       108404
192.168.86.36 53333     72.21.207.216   443        Established Internet       108404
192.168.86.36 53332     52.94.232.32    443        Established Internet       108404
192.168.86.36 53331     54.81.199.3     443        Established Internet       108404
192.168.86.36 53329     209.234.235.251 443        Established Internet       108404
192.168.86.36 53326     99.84.216.80    443        Established Internet       108404
192.168.86.36 53325     104.84.96.230   443        Established Internet       108404
192.168.86.36 53324     23.55.62.205    443        Established Internet       108404
192.168.86.36 53323     209.234.224.22  443        Established Internet       108404
192.168.86.36 53321     54.239.29.0     443        Established Internet       108404
192.168.86.36 53319     52.94.232.39    443        Established Internet       108404
192.168.86.36 53318     72.21.206.141   443        Established Internet       108404
192.168.86.36 53317     72.21.206.141   443        Established Internet       108404
192.168.86.36 53315     13.32.247.113   443        Established Internet       108404
192.168.86.36 53312     99.84.213.202   443        Established Internet       108404
192.168.86.36 53311     13.32.247.113   443        Established Internet       108404
192.168.86.36 53310     13.32.187.101   443        Established Internet       108404
192.168.86.36 53303     34.232.99.117   443        Established Internet       108404
192.168.86.36 26189     64.233.176.188  5228       Established Internet       108404


PS C:\WINDOWS\system32>
```

Figure 2-10. *Executing Get-NetTCPConnection with a variable for Process ID*

As you can see, the command line parameters -State and -OwningProcess are utilized:

- For -State, **Established** is specified as the argument. This will list only the TCP connections that are currently connected, as I'm only interested in current connections right now.
- For -OwningProcess, instead, the variable $id is specified, which contains a list of Process IDs associated with Google Chrome. The reason this works is that the definition provided by Get-Help for the parameter -OwningProcess is stated as follows:

```
[-OwningProcess <UInt32[]>]
```

The definition states that -OwningProcess requires an Unsigned Integer with a length of 32 bits. The two brackets [] following UInt32 indicate that it can accept a list of values.

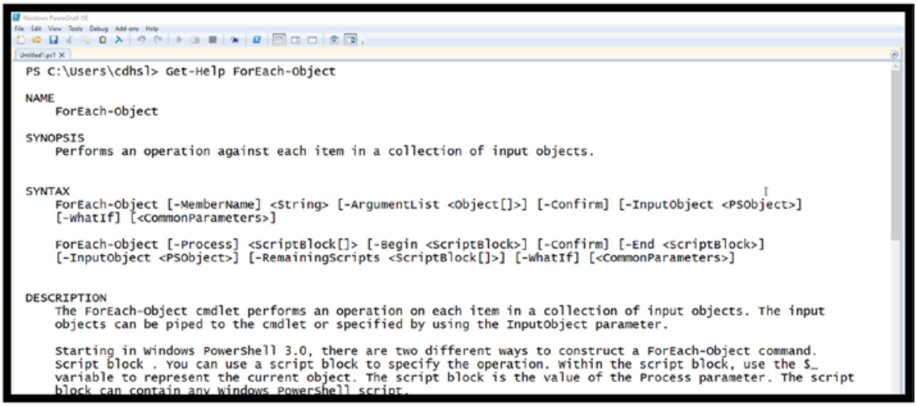
As you can see, only one of the Chrome Process IDs (specifically, 108404) is associated with established Internet connections. Therefore, the other Google Chrome processes that were identified do not make direct Internet connections, only 108404 does.

This is a great example of how to use an intermediate variable to store the contents of a command. However, we can perform this operation using a single command. Armed with the knowledge of the workings of Get-Process, PowerShell variables, and Get-NetTCPConnections, a single command can be created that eliminates the need for the $id variable. In order to take this next step, the ForEach-Object CmdLet is needed.

ForEach-Object

ForEach-Object allows the processing of each subsequent result from the previous command on the pipeline. In this example, that would be each result generated by the Get-Process -Name Chrome command.

Figure 2-11 uses Get-Help to provide an explanation of the For-Each-Object.



```
PS C:\Users\cdhsl> Get-Help ForEach-Object

NAME
    ForEach-Object

SYNOPSIS
    Performs an operation against each item in a collection of input objects.


SYNTAX
    ForEach-Object [-MemberName] <String> [-ArgumentList <Object[]>] [-Confirm] [-InputObject <PSObject>]
    [-WhatIf] [<CommonParameters>]

    ForEach-Object [-Process] <ScriptBlock[]> [-Begin <ScriptBlock>] [-Confirm] [-End <ScriptBlock>]
    [-InputObject <PSObject>] [-RemainingScripts <ScriptBlock[]>] [-WhatIf] [<CommonParameters>]


DESCRIPTION
    The ForEach-Object cmdlet performs an operation on each item in a collection of input objects. The input
    objects can be piped to the cmdlet or specified by using the InputObject parameter.

    Starting in Windows PowerShell 3.0, there are two different ways to construct a ForEach-Object command.
    Script block . You can use a script block to specify the operation. Within the script block, use the $_
    variable to represent the current object. The script block is the value of the Process parameter. The script
    block can contain any Windows PowerShell script.
```

Figure 2-11. *Get-Help overview of ForEach-Object*

Creating a Single Pipeline Solution to Example 2

```
Get-Process -Name Chrome | ForEach-Object {Get-NetTCPConnection
-State Established -OwningProcess $_.Id -ErrorAction
SilentlyContinue}| Format-Table -Autosize
```

In this example (see the results of the operation in Figure 2-12), the components are broken down as follows:

```
Get-Process -Name Chrome
```

- Obtains process details for all processes named Chrome.

  ```
  ForEach-Object { }
  ```

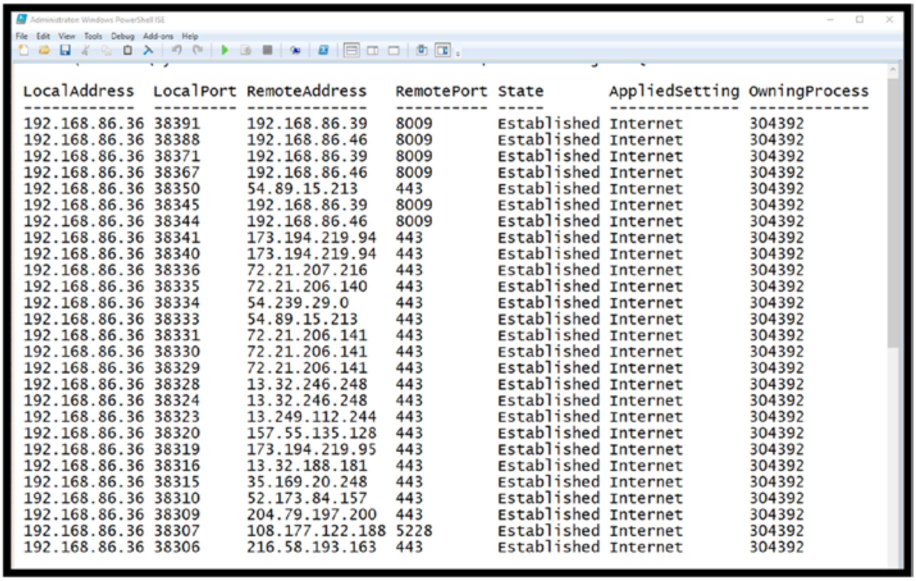
- Processes each iteration (in simpler terms each output supplied by Get-Process via the pipe.

  ```
  {Get-NetTCPConnection -State Established
  -OwningProcess $_.Id -ErrorAction SilentlyContinue}
  ```

- Executes the Get-NetTCPConnection CmdLet for each result.
- -State Established filters the output to only include currently established connections.
- -OwningProcess $_.Id specifies the Process ID that connection information will be extracted. The $_.Id syntax is used to obtain the Process ID of the Owning Process from each iterative result of the Get-Process CmdLet. The specific property is addressed using the following syntax:
  - $_.Id

    This syntax breaks down as follows:

    - $_ represents the current object passed over the pipe.
    - .Id specifies which specific property value is associated with the operation.
- -ErrorAction -SilentlyContinue is used to ignore any errors that may occur during the Get-NetTCPConnection CmdLet. For example, if the Process ID is not linked to a specified TCPConnection the CmdLet will throw and exception. This parameter allows those exceptions to be ignored.
- Format-Table -Autosize is used to format the output in a more compact format.



```
LocalAddress  LocalPort RemoteAddress   RemotePort State       AppliedSetting OwningProcess
------------  --------- -------------   ---------- -----       -------------- -------------
192.168.86.36 38391     192.168.86.39   8009       Established Internet       304392
192.168.86.36 38388     192.168.86.46   8009       Established Internet       304392
192.168.86.36 38371     192.168.86.39   8009       Established Internet       304392
192.168.86.36 38367     192.168.86.46   8009       Established Internet       304392
192.168.86.36 38350     54.89.15.213    443        Established Internet       304392
192.168.86.36 38345     192.168.86.39   8009       Established Internet       304392
192.168.86.36 38344     192.168.86.46   8009       Established Internet       304392
192.168.86.36 38341     173.194.219.94  443        Established Internet       304392
192.168.86.36 38340     173.194.219.94  443        Established Internet       304392
192.168.86.36 38336     72.21.207.216   443        Established Internet       304392
192.168.86.36 38335     72.21.206.140   443        Established Internet       304392
192.168.86.36 38334     54.239.29.0     443        Established Internet       304392
192.168.86.36 38333     54.89.15.213    443        Established Internet       304392
192.168.86.36 38331     72.21.206.141   443        Established Internet       304392
192.168.86.36 38330     72.21.206.141   443        Established Internet       304392
192.168.86.36 38329     72.21.206.141   443        Established Internet       304392
192.168.86.36 38328     13.32.246.248   443        Established Internet       304392
192.168.86.36 38324     13.32.246.248   443        Established Internet       304392
192.168.86.36 38323     13.249.112.244  443        Established Internet       304392
192.168.86.36 38320     157.55.135.128  443        Established Internet       304392
192.168.86.36 38319     173.194.219.95  443        Established Internet       304392
192.168.86.36 38316     13.32.188.181   443        Established Internet       304392
192.168.86.36 38315     35.169.20.248   443        Established Internet       304392
192.168.86.36 38310     52.173.84.157   443        Established Internet       304392
192.168.86.36 38309     204.79.197.200  443        Established Internet       304392
192.168.86.36 38307     108.177.122.188 5228       Established Internet       304392
192.168.86.36 38306     216.58.193.163  443        Established Internet       304392
```

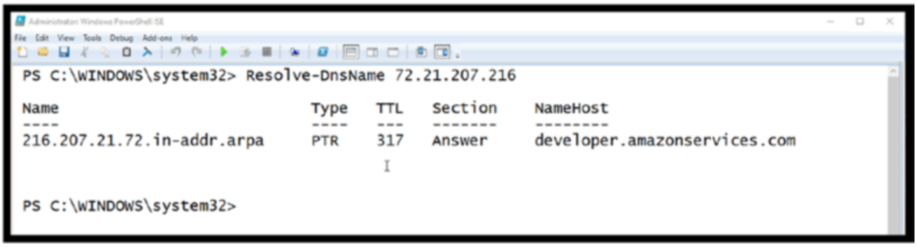
Figure 2-12. *Final solution to map Google Chrome IP connections*

Resolving Remote IP Addresses

These results bring up the next investigative question, what do the IP addresses referenced by the Chrome browser refer to? There is of course a CmdLet that can discover this information directly. The IP address 72.21.207.216 was arbitrarily selected from the list in Figure 2-12. The Resolve-DnsName CmdLet was then used to obtain information regarding this remote IP address.

```
Resolve-DnsName 72.21.207.216
```

The Resolve-DnsName CmdLet successfully resolved the IP address with developer.amazonservices.com (see Figure 2-13).


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help

```
PS C:\WINDOWS\system32> Resolve-DnsName 72.21.207.216

Name                        Type   TTL   Section    NameHost
----                        ----   ---   -------    --------
216.207.21.72.in-addr.arpa  PTR    317   Answer     developer.amazonservices.com


PS C:\WINDOWS\system32>
```

Figure 2-13. *Resolve DnsName*

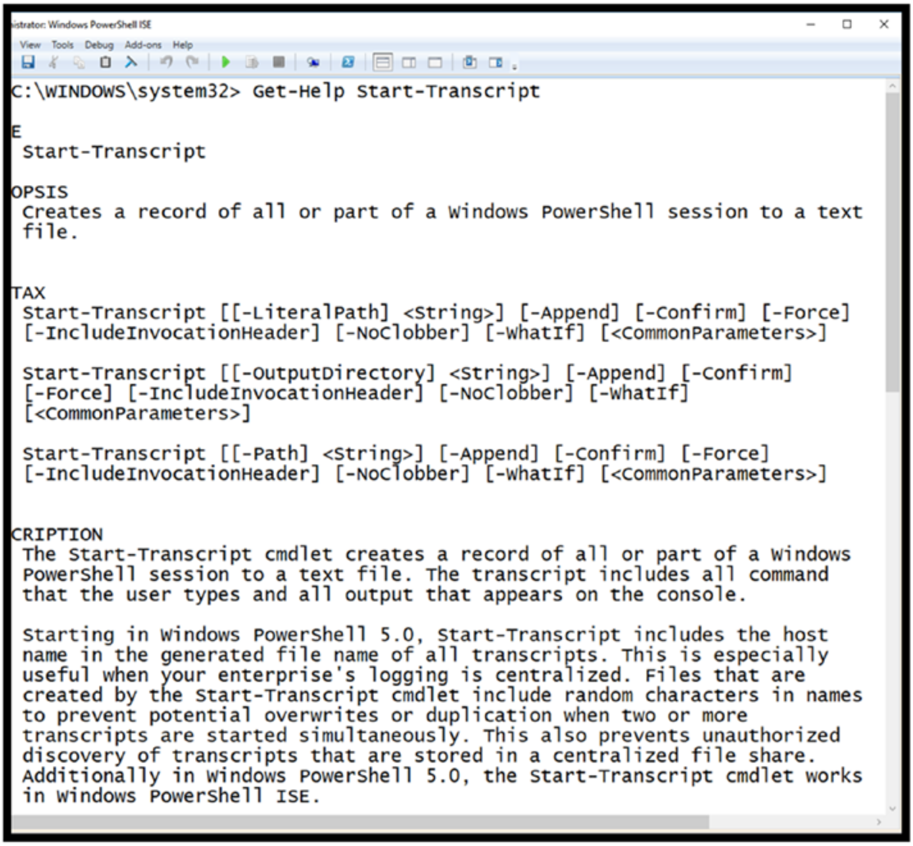
To find out more information regarding Resolve-DnsName, try your hand at using Get-Help.

Adding a Transcript to Track Your Activities

Documentation of your investigative actions is important (to say the least). One of the simple methods of capturing your actions and the result data is to use yet another CmdLet in PowerShell:

```
Start-Transaction
Stop-Transaction
```

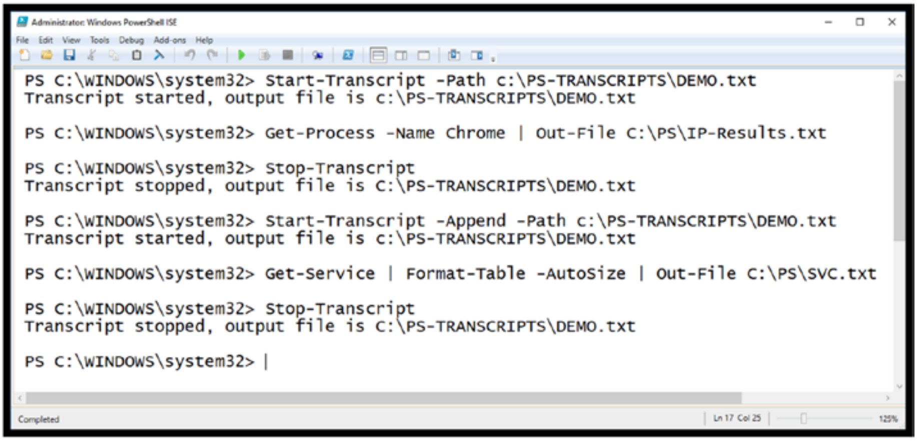
As with all CmdLets in PowerShell obtaining information regarding the use and options associated with CmdLets is by using Get-Help. This may sound a bit redundant; however, many people still turn to Google or other search engines to obtain this knowledge. This is certainly useful in certain circumstances, but the Help system in PowerShell is not only powerful and well thought out, but is also updated daily. Therefore, in order to get the latest, most up-to-date, and accurate information about CmdLets, use Get-Help. Figure 2-14 provides the results relating to Start-Transcript.


istrator: Windows PowerShell ISE
View Tools Debug Add-ons Help

```
C:\WINDOWS\system32> Get-Help Start-Transcript

E
 Start-Transcript

OPSIS
 Creates a record of all or part of a Windows PowerShell session to a text
 file.


TAX
 Start-Transcript [[-LiteralPath] <String>] [-Append] [-Confirm] [-Force]
 [-IncludeInvocationHeader] [-NoClobber] [-WhatIf] [<CommonParameters>]

 Start-Transcript [[-OutputDirectory] <String>] [-Append] [-Confirm]
 [-Force] [-IncludeInvocationHeader] [-NoClobber] [-WhatIf]
 [<CommonParameters>]

 Start-Transcript [[-Path] <String>] [-Append] [-Confirm] [-Force]
 [-IncludeInvocationHeader] [-NoClobber] [-WhatIf] [<CommonParameters>]


CRIPTION
 The Start-Transcript cmdlet creates a record of all or part of a Windows
 PowerShell session to a text file. The transcript includes all command
 that the user types and all output that appears on the console.

 Starting in Windows PowerShell 5.0, Start-Transcript includes the host
 name in the generated file name of all transcripts. This is especially
 useful when your enterprise's logging is centralized. Files that are
 created by the Start-Transcript cmdlet include random characters in names
 to prevent potential overwrites or duplication when two or more
 transcripts are started simultaneously. This also prevents unauthorized
 discovery of transcripts that are stored in a centralized file share.
 Additionally in Windows PowerShell 5.0, the Start-Transcript cmdlet works
 in Windows PowerShell ISE.
```

Figure 2-14. *Get-Help Start-Transcript*

For this example, the -Path parameter is specified in order to direct the output of the transcript to a specific file as shown in Figure 2-15. To demonstrate the -Append parameter of Start-Transcript, the Stop-Transcript CmdLet was used, and then Transcript was restarted. To accomplish this, just start the second Start-Transcript CmdLet using the same -Path parameter, and then add the -Append option as shown in Figure 2-15. This allows you to concatenate PowerShell sessions in the same output file.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 17 Col 25
125%

```
PS C:\WINDOWS\system32> Start-Transcript -Path c:\PS-TRANSCRIPTS\DEMO.txt
Transcript started, output file is c:\PS-TRANSCRIPTS\DEMO.txt

PS C:\WINDOWS\system32> Get-Process -Name Chrome | Out-File C:\PS\IP-Results.txt

PS C:\WINDOWS\system32> Stop-Transcript
Transcript stopped, output file is C:\PS-TRANSCRIPTS\DEMO.txt

PS C:\WINDOWS\system32> Start-Transcript -Append -Path c:\PS-TRANSCRIPTS\DEMO.txt
Transcript started, output file is c:\PS-TRANSCRIPTS\DEMO.txt

PS C:\WINDOWS\system32> Get-Service | Format-Table -AutoSize | Out-File C:\PS\SVC.txt

PS C:\WINDOWS\system32> Stop-Transcript
Transcript stopped, output file is C:\PS-TRANSCRIPTS\DEMO.txt

PS C:\WINDOWS\system32> |
```

Figure 2-15. *PowerShell Start- and Stop-Transcript*

Listing 2-1 depicts the resulting transcript file. Note that yet another new CmdLet was added here, Out-File – this directs the output of the Get-Process CmdLet to the IP-Result.txt file on the desktop. Thus, the transcript does not include the Get-Process or Get-Service output, but rather that result is stored in the designated output files. This would likely be your case folder. The Start and End Time strings of each appended transaction are highlighted. Note that PowerShell uses local time; in this example, the transcript started on November 27, 2018, at 16:09:03, or 4:09 PM.

Listing 2-1. PowerShell Transcript

```
**********************
Windows PowerShell transcript start
Start time: 20181127160903
Username: PYTHON-3\cdhsl
RunAs User: PYTHON-3\cdhsl
Configuration Name:
Machine: PYTHON-3 (Microsoft Windows NT 10.0.17134.0)
Host Application: C:\WINDOWS\system32\WindowsPowerShell\v1.0\
PowerShell_ISE.exe
```

```
Process ID: 148432
PSVersion: 5.1.17134.407
PSEdition: Desktop
PSCompatibleVersions: 1.0, 2.0, 3.0, 4.0, 5.0, 5.1.17134.407
BuildVersion: 10.0.17134.407
CLRVersion: 4.0.30319.42000
WSManStackVersion: 3.0
PSRemotingProtocolVersion: 2.3
SerializationVersion: 1.1.0.1
**********************
Transcript started, output file is C:\Users\cdhsl\PS-
TRANSCRIPTS\DEMO.txt
PS C:\WINDOWS\system32> Get-Process -Name chrome | Out-File
C:\Users\cdhsl\Desktop\IP-Result.txt
PS C:\WINDOWS\system32> Stop-Transcript
**********************
Windows PowerShell transcript end
End time: 20181127160930
**********************
**********************
Windows PowerShell transcript start
Start time: 20181127161013
Username: PYTHON-3\cdhsl
RunAs User: PYTHON-3\cdhsl
Configuration Name:
Machine: PYTHON-3 (Microsoft Windows NT 10.0.17134.0)
Host Application: C:\WINDOWS\system32\WindowsPowerShell\v1.0\
PowerShell_ISE.exe
Process ID: 148432
PSVersion: 5.1.17134.407
PSEdition: Desktop
```

```
PSCompatibleVersions: 1.0, 2.0, 3.0, 4.0, 5.0, 5.1.17134.407
BuildVersion: 10.0.17134.407
CLRVersion: 4.0.30319.42000
WSManStackVersion: 3.0
PSRemotingProtocolVersion: 2.3
SerializationVersion: 1.1.0.1
**********************
Transcript started, output file is C:\Users\cdhsl\PS-
TRANSCRIPTS\DEMO.txt
PS C:\WINDOWS\system32> Get-Service | Format-Table -AutoSize |
Out-File C:\Users\cdhsl\Desktop\Services.txt
PS C:\WINDOWS\system32> Stop-Transcript
**********************
Windows PowerShell transcript end
End time: 20181127161306
**********************
```

Challenge Problem: CmdLet Experimentation

Working with PowerShell cannot be learned by simply reading this text or any other for that matter. Instead, you must experience PowerShell by interacting with it. Table 2-1 provides a short list of some popular CmdLets that are useful during an investigation. I have only chosen CmdLets that retrieve or acquire information for you to experiment with.

***Table 2-1.** Challenge Problem CmdLets*

Get-Process	Get-Service
Get-NetIPAddress	Get-NetIPConfiguration
Get-NetIPv4Protocol	Get-NetIPv6Protocol
Get-NetTCPConnection	Test-NetConnection
Get-NetRoute	Get-MpComputerStatus
Get-MpThreat	Get-NetFirewallSetting
Get-NetFirewallPortFilter	Get-Volume
Get-ChildItem	Get-ItemProperty
Get-EventLog	Get-LocalUser
Get-LocalGroup	Get-Content
Get-Location	Set-Location
Start-Transcript	Stop-Transcript
Format-Table	

Warning If you decide to experiment with other CmdLets that modify the system, do so at your own risk. PowerShell CmdLets can modify, damage, delete, and even destroy your system.

For each of the CmdLets specified in Table 2-1, do the following:

1. Review the help for each CmdLet including Details and Examples, that is,

   a. Get-Help -Detailed

   b. Get-Help -Examples

2. After review, describe what the CmdLet does and consider how it could be valuable during an investigation.

3. Execute each CmdLet with a minimum of one parameter, experiment with others as well.

4. Use Pipelining to assemble CmdLets, start with something simple like piping the CmdLet output to the Format-Table CmdLet, then try other options as well.

5. Make sure that your Start, and Stop the transcript during your experimentation, this will serve as a record of your actions and result. These can be referenced later when you are trying to duplicate a complex command.

Solutions to this Challenge Problem can be found in the Appendix and in the book's source code, available at `www.apress.com/9781484245033`.

Summary

This chapter focused on several key areas of PowerShell and introduced several new CmdLets and their application. In addition, the creation and use of PowerShell variables was introduced. Two example pipelines were created to demonstrate how to approach pipelining within PowerShell. In Chapter 3, new CmdLets will be introduced, and the development of multiple complete PowerShell scripts will be developed.

CHAPTER 3

PowerShell Scripting Targeting Investigation

This chapter will move beyond single line commands and pipelining, in order to create actual PowerShell scripts. PowerShell scripts deliver the ability to automate repetitive tasks that require specific CmdLets, Pipelines, Variables, Structures, etc. Another simple way to describe PowerShell scripts is that they allow you to create new and more powerful and targeted CmdLets to solve a specific challenge. Once you have developed a command that does exactly what you need, it is quite beneficial to create a script that encapsulates or abstracts the complexity of the command.

In this chapter, we will go through two examples. One will be to create a specific and ultimately useful investigation script that will acquire and process system event logs. The second example will be a scenario where we examine USB device usage.

C. Hosmer, *PowerShell and Python Together*, https://doi.org/10.1007/978-1-4842-4504-0_3

Basic Facts About PowerShell Scripts

Before we begin, here are some basic facts about PowerShell scripts:

1. Scripts are a simple text file that contains a series of PowerShell commands.
2. To prevent the execution of malicious scripts, PowerShell enforces an execution policy, which by default is set to "restricted" such that PowerShell scripts will NOT execute by default. Thus, you must set the execution policy to allow script execution.
3. To execute a PowerShell script, you either must execute them within the PowerShell ISE and provide the full path to the script or the directory containing the script must be in your Windows path.

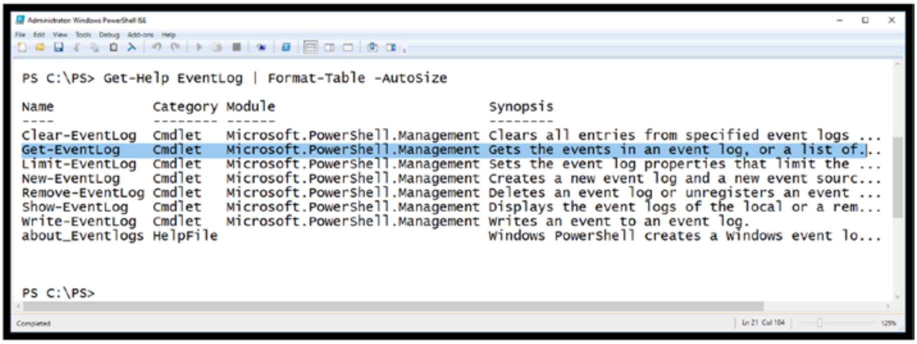
Example 1: The EventProcessor PowerShell Script

The acquisition of data from event logs is a common practice during forensic investigations and incident response activities. This is also a useful activity for system administrators to perform daily.

The collection of meaningful data from log files that are likely distributed across the investigation environment can be time consuming, and if not done consistently and completely, it will lead to problems. Therefore, developing a targeted PowerShell script to perform this operation would yield significant value to investigators.

EventLog CmdLets

Of course, PowerShell already contains general-purpose CmdLets that address basic collection of data from event logs; thus, identifying and selecting one of the available CmdLets is the first step. To do this we once again turn to the built-in PowerShell Help system. Requesting Help using the keyword EventLog returns the CmdLet list as shown in Figure 3-1.

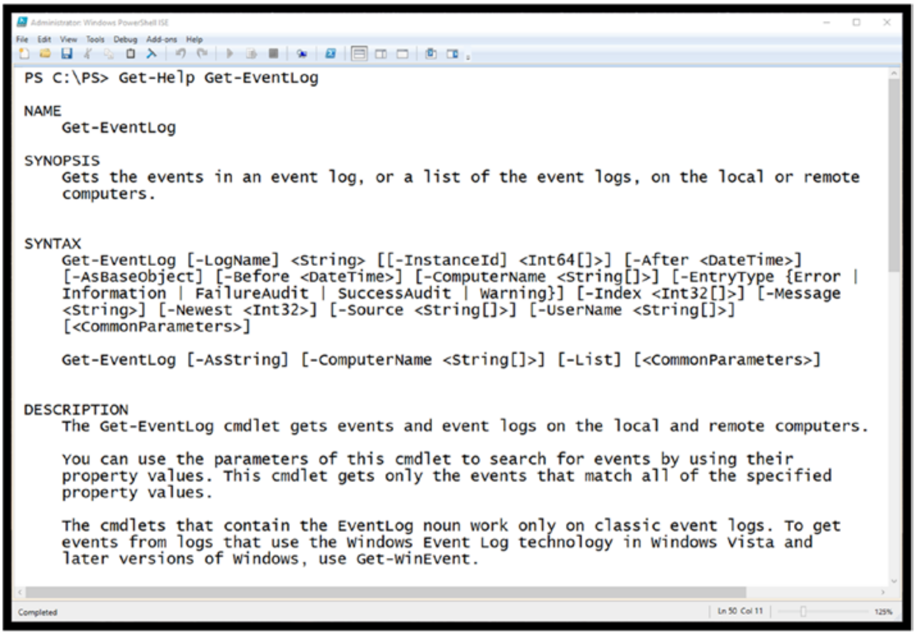

Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 21 Col 104
125%

```
PS C:\PS> Get-Help EventLog | Format-Table -AutoSize

Name             Category Module                          Synopsis
----             -------- ------                          --------
Clear-EventLog   Cmdlet   Microsoft.PowerShell.Management Clears all entries from specified event logs ...
Get-EventLog     Cmdlet   Microsoft.PowerShell.Management Gets the events in an event log, or a list of...
Limit-EventLog   Cmdlet   Microsoft.PowerShell.Management Sets the event log properties that limit the ...
New-EventLog     Cmdlet   Microsoft.PowerShell.Management Creates a new event log and a new event sourc...
Remove-EventLog  Cmdlet   Microsoft.PowerShell.Management Deletes an event log or unregisters an event ...
Show-EventLog    Cmdlet   Microsoft.PowerShell.Management Displays the event logs of the local or a rem...
Write-EventLog   Cmdlet   Microsoft.PowerShell.Management Writes an event to an event log.
about_Eventlogs  HelpFile                                 Windows PowerShell creates a Windows event lo...


PS C:\PS>
```

Figure 3-1. *CmdLets referring to the keyword EventLog*

After reviewing the Synopsis, Get-EventLog seems to be a likely target CmdLet for acquiring events from event logs.

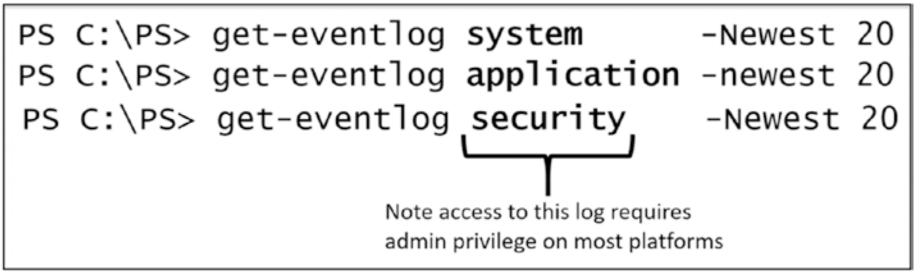
Figure 3-2 displays the basic help information and usage associated with the Get-EventLog CmdLet.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 50 Col 11
125%

```
PS C:\PS> Get-Help Get-EventLog

NAME
    Get-EventLog

SYNOPSIS
    Gets the events in an event log, or a list of the event logs, on the local or remote
    computers.


SYNTAX
    Get-EventLog [-LogName] <String> [[-InstanceId] <Int64[]>] [-After <DateTime>]
    [-AsBaseObject] [-Before <DateTime>] [-ComputerName <String[]>] [-EntryType {Error |
    Information | FailureAudit | SuccessAudit | Warning}] [-Index <Int32[]>] [-Message
    <String>] [-Newest <Int32>] [-Source <String[]>] [-UserName <String[]>]
    [<CommonParameters>]

    Get-EventLog [-AsString] [-ComputerName <String[]>] [-List] [<CommonParameters>]


DESCRIPTION
    The Get-EventLog cmdlet gets events and event logs on the local and remote computers.

    You can use the parameters of this cmdlet to search for events by using their
    property values. This cmdlet gets only the events that match all of the specified
    property values.

    The cmdlets that contain the EventLog noun work only on classic event logs. To get
    events from logs that use the Windows Event Log technology in Windows Vista and
    later versions of Windows, use Get-WinEvent.
```

Figure 3-2. *Get-Help Get-EventLog results*

Figure 3-3 depicts several usage examples. Each identifies a different log file and requests the newest 20 events. Note that if the ***security*** event log is requested, you must have administrative privileges in order to access this.



```
PS C:\PS> get-eventlog system      -Newest 20
PS C:\PS> get-eventlog application -newest 20
PS C:\PS> get-eventlog security    -Newest 20
```

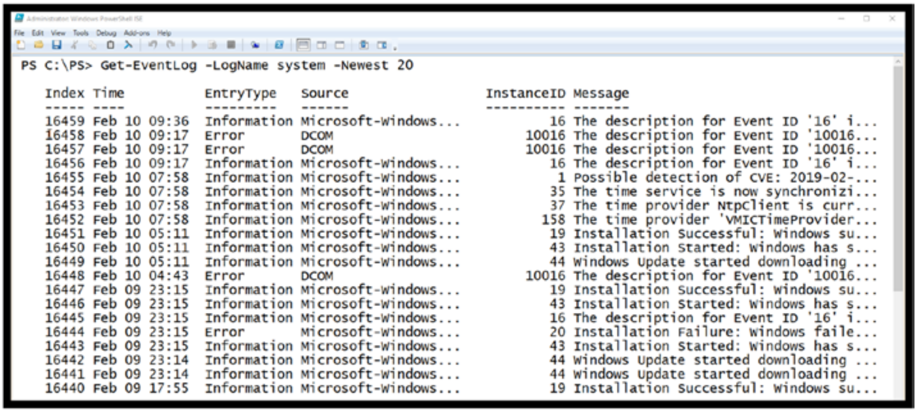
Note access to this log requires
admin privilege on most platforms

Figure 3-3. *Sample Get-EventLog requests*

Retrieving More Specific Eventlog Information

Figure 3-4 shows the results after the execution of Get-EventLog.

```
Get-EventLog -logName system -Newest 20
```


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help

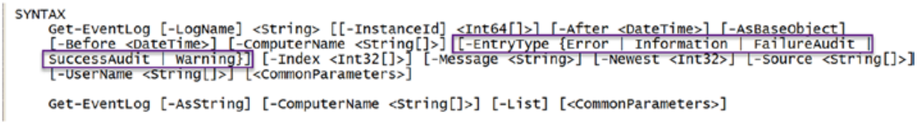
```
PS C:\PS> Get-EventLog -LogName system -Newest 20

   Index Time          EntryType   Source                 InstanceID Message
   ----- ----          ---------   ------                 ---------- -------
   16459 Feb 10 09:36  Information Microsoft-Windows...           16 The description for Event ID '16' i...
   16458 Feb 10 09:17  Error       DCOM                        10016 The description for Event ID '10016...
   16457 Feb 10 09:17  Error       DCOM                        10016 The description for Event ID '10016...
   16456 Feb 10 09:17  Information Microsoft-Windows...           16 The description for Event ID '16' i...
   16455 Feb 10 07:58  Information Microsoft-Windows...            1 Possible detection of CVE: 2019-02-...
   16454 Feb 10 07:58  Information Microsoft-Windows...           35 The time service is now synchronizi...
   16453 Feb 10 07:58  Information Microsoft-Windows...           37 The time provider NtpClient is curr...
   16452 Feb 10 07:58  Information Microsoft-Windows...          158 The time provider 'VMICTimeProvider...
   16451 Feb 10 05:11  Information Microsoft-Windows...           19 Installation Successful: Windows su...
   16450 Feb 10 05:11  Information Microsoft-Windows...           43 Installation Started: Windows has s...
   16449 Feb 10 05:11  Information Microsoft-Windows...           44 Windows Update started downloading ...
   16448 Feb 10 04:43  Error       DCOM                        10016 The description for Event ID '10016...
   16447 Feb 09 23:15  Information Microsoft-Windows...           19 Installation Successful: Windows su...
   16446 Feb 09 23:15  Information Microsoft-Windows...           43 Installation Started: Windows has s...
   16445 Feb 09 23:15  Information Microsoft-Windows...           16 The description for Event ID '16' i...
   16444 Feb 09 23:15  Error       Microsoft-Windows...           20 Installation Failure: Windows faile...
   16443 Feb 09 23:15  Information Microsoft-Windows...           43 Installation Started: Windows has s...
   16442 Feb 09 23:14  Information Microsoft-Windows...           44 Windows Update started downloading ...
   16441 Feb 09 23:14  Information Microsoft-Windows...           44 Windows Update started downloading ...
   16440 Feb 09 17:55  Information Microsoft-Windows...           19 Installation Successful: Windows su...
```

Figure 3-4. *Get-EventLog sample results*

Based on what we learned in Chapter 2 regarding PowerShell pipelining, we can perform more specific or targeted acquisitions of event log data. For example, what if we only want to see events that are of type *error* or *warning* and filter out the general informational messages?

Taking into consideration the excerpt of the Get-Help Get-EventLog result shown in Figure 3-5, the possible EntryTypes listed are:

- Error
- Information
- FailureAudit
- SuccessAudit
- Warning



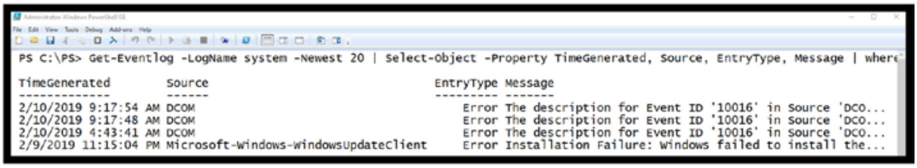
```
SYNTAX
    Get-EventLog [-LogName] <String> [[-InstanceId] <Int64[]>] [-After <DateTime>] [-AsBaseObject]
    [-Before <DateTime>] [-ComputerName <String[]>] [-EntryType {Error | Information | FailureAudit |
    SuccessAudit | Warning}] [-Index <Int32[]>] [-Message <String>] [-Newest <Int32>] [-Source <String[]>]
    [-UserName <String[]>] [<CommonParameters>]

    Get-EventLog [-AsString] [-ComputerName <String[]>] [-List] [<CommonParameters>]
```

Figure 3-5. *Get-Help excerpt for Get-EventLog*

Based on this, a more refined command could be created that will extract only the target events *Warning* or *Error* and specify specific properties associated with the event log to be displayed.

```
Get-Eventlog -LogName system -Newest 20 | Select-Object
-Property TimeGenerated, Source, EntryType, Message | where
{$_.EntryType -eq "warning" -or $_.EntryType -eq "error"}
```

This command yields the result shown in Figure 3-6.



Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help

```
PS C:\PS> Get-Eventlog -LogName system -Newest 20 | Select-Object -Property TimeGenerated, Source, EntryType, Message | where

TimeGenerated         Source                                    EntryType Message
-------------         ------                                    --------- -------
2/10/2019 9:17:54 AM  DCOM                                          Error The description for Event ID '10016' in Source 'DCO...
2/10/2019 9:17:48 AM  DCOM                                          Error The description for Event ID '10016' in Source 'DCO...
2/10/2019 4:43:41 AM  DCOM                                          Error The description for Event ID '10016' in Source 'DCO...
2/9/2019 11:15:04 PM  Microsoft-Windows-WindowsUpdateClient         Error Installation Failure: Windows failed to install the...
```

Figure 3-6. *Get-EventLog with specific fields and EntryTypes warning or error*

Creating the Script

Based on this fundamental understanding of Get-EventLog, let's define a challenge problem.

Step One: Define the Challenge

Before you write the script, consider what are the basic challenges that investigators face when retrieving event logs, and how could a PowerShell script be developed that will address these challenges. Ask yourself:

1. What event log or logs need to be collected? Based on the investigation, will specific event log(s) need to be acquired?

2. From what computer or computers should the log files be collected?

3. How many of the most recent records should be collected?

4. Is an optional filter based on *EventType* useful?

5. What specific fields should be generated from the event log?

    - By using Get-Member we can see the common properties of interest include: Category, EntryType, EventID, MachineName, Message, Source, TimeGenerated, TimeWritten and UserName.

6. Where is the output to be generated, that is, the standard output for a file?

7. How will others use the script?

    a. Do we need to provide help?

    b. How will they enter the parameters?

Once you have identified the challenges and are able to answer them, you will now have a working definition for your script and can proceed to step two.

Step Two: Create the Script in Stages

Based on the definition created in Step One, specific parameters need to be defined for our script:

- TargetLog
- TargetComputer
- TargetCount
- TargetEntryType
- ReportTitle

Listing 3-1 shows the complete EventProcessor script. I'll also show the Get-Help results, the sample execution, and the resulting report later on.

Listing 3-1. EventProcessor Script

```
<#
.synopsis
EventProcessor EventLog Capture Automation Version 1.0

- User Specified Target EventLog
- User Specifies the number of newest Log Entries to Report
- User Specifies the Entry Type to target, for example warning,
  error, information etc.
- User Specifies the target computer or computers to extract
  the logs
- User Specifies the HTML Report Title

The script will produce an HTML output file containing details
of the EventLog acquisition.

.Description
This script automates the extraction of information from the
specified log file
```

```
.parameter targetLogName
Specifies the name of the log file to process
.parameter eventCount
Specifies the maximum number of newest events to consider in
the search
.parameter eventType
Specifies the eventType of interest
.parameter targetComputer
Specifies the computer or computers to obtain the logs from
.parameter reportTitle
Specifies the HTML Report Title

.example
EventProcessor
Execution of EventProcessor without parameters uses the default
settings of
eventLog system
eventType warning
eventCount 20
targetComputer the computer running the script

.example
EventProcessor -targetLogName security
This example specifies the target eventLog security
and uses the default parameters
eventType warning
eventCount 20
targetComputer the computer running the script

.example
EventProcessor -reporTitle "ACME Computer Daily Event Log
Report"
This example provides a custom Report Title
```

```
.example
EventProcessor -targetLogName security -eventCount 20
-entryType warning -targetComputer Python-3
This example specifies all the parameters, targetLogName,
eventCount, entryType and targetComputer
#>

# Parameter Definition Section
param(
    [string]$targetLogName = "system",
    [int]$eventCount = 20,
    [string]$eventType="Error",
    [string]$reportTitle="Event Log Daily Report",
    [string[]]$targetComputer=$env:COMPUTERNAME
)

# Get the current date and tme
$rptDate=Get-Date
$epoch=([DateTimeOffset]$rptDate).ToUnixTimeSeconds()

# Create HTML Header Section
$Header = @"
<style>
TABLE {border-width: 1px; border-style: solid; border-color:
black; border-collapse: collapse;}
TD {border-width: 1px; padding: 3px; border-style: solid;
border-color: black;}
</style>
<p>
<b> $reportTitle $rptDate </b>
<p>
Event Log Selection: <b>$targetLogName </b>
<p>
```

```
Target Computer(s) Selection: <b> $targetComputer </b>
<p>
Event Type Filter: <b> $eventType </b>
<p>
"@

# Report Filename Creation
$ReportFile = ".\Report-"+$epoch+".HTML"

# CmdLet Pipeline execution
Get-Eventlog -ComputerName $targetComputer -LogName
$targetLogName -Newest $eventCount -EntryType $eventType |
 ConvertTo-HTML -Head $Header -Property TimeGenerated,
EntryType, Message |
 Out-File $ReportFile
```

The EventProcessor script is broken down into four major sections. The development of PowerShell scripts should include each of these sections for completeness.

1. Script Header (including Help and Examples)
2. Parameter Definition
3. Local Variable Definition
4. CmdLet Execution Using Parameters and Local Variables

Let's take a deeper look at the script construction.

Note You can use this sample as a baseline since it provides a good boilerplate for a PowerShell script.

Script Header

The script header contains key information used to define the script and conforms to a strict format in order to deliver help details when processed by the Get-Help CmdLet.

.Synopsis Section

The .synopsis section provides a quick overview of the purpose of the script and what is expected from the user (Listing 3-2).

Listing 3-2. .Synopsis Section

```
<#
.synopsis
EventProcessor EventLog Capture Automation Version 1.0

- User Specified Target EventLog
- User Specifies the number of newest Log Entries to Report
- User Specifies the Entry Type to target, for example warning,
  error, information etc.
- User Specifies the target computer or computers to extract
  the logs
- User Specifies the HTML Report Title

The script will produce an HTML output file containing details
of the EventLog acquisition.
```

.Description Section

The .description section provides a succinct definition of the script (Listing 3-3).

Listing 3-3. .Description Section

```
.Description
This script automates the extraction of information from the
specified log file
```

.Parameters Section

This section defines of each command line parameter utilized by the script in detail (Listing 3-4).

Listing 3-4. .Parameters Section

```
.parameter targetLogName
Specifies the name of the log file to process
.parameter eventCount
Specifies the maximum number of newest events to consider in
the search
.parameter eventType
Specifies the eventType of interest
.parameter targetComputer
Specifies the computer or computers to obtain the logs from
.parameter reportTitle
Specifies the HTML Report Title
```

Note that in this script, all the parameters are optional since during the definition, as you will see later, the default values for each parameter are provided. This allows the user to execute the script by typing:

```
 .\EventProcessor
```

.Examples Section

In this section several sample script command line executions are provided along with a definition of what each variant provides (Listing 3-5).

Listing 3-5. .Examples Section

```
.example
EventProcessor
Execution of EventProcessor without parameters uses the default
settings of
eventLog system
eventType warning
eventCount 20
targetComputer the computer running the script

.example
EventProcessor -targetLogName security
This example specifies the target eventLog security
and uses the default parameters
eventType warning
eventCount 20
targetComputer the computer running the script

.example
EventProcessor -reporTitle "ACME Computer Daily Event Log
Report"
This example provides a custom Report Title

.example
EventProcessor -targetLogName security -eventCount 20
-entryType warning -targetComputer Python-3
This example specifies all the parameters, targetLogName,
eventCount, entryType and targetComputer
#>
```

Parameter Definition

The parameter definition section of the script defines the details of each available parameter for the script (Listing 3-6).

Listing 3-6. Parameter Definition Section

```
# Parameter Definition Section
param(
    [string]$targetLogName = "system",
    [int]$eventCount = 20,
    [string]$eventType="Error",
    [string]$reportTitle="Event Log Daily Report",
    [string[]]$targetComputer=$env:COMPUTERNAME
)
```

Each parameter defines a type, name, and the default value assigned. For example:

- The $reportTitle parameter is of type string and has a default value of "Event Log Daily Report".
- The $targetComputer parameter is also of type string, but a set of values is possible. In other words, the user could enter multiple computer names, each separated by a comma. This also contains a default value. This is a PowerShell automatic variable that defines the name of the computer the script is executing on.
- The $targetLogName parameter defines the event log to be targeted. Note that this could have been defined as with $targetComputer to accept a list of log names. However, the standard CmdLet Get-EventLog only supports a single target log. To support a list, the Get-EventLog CmdLet would need to be executed

multiple times once for each identified log. This would certainly make the script more complicated, but also potentially even more useful.

- The $EventType parameter allows for the specification of what event type the report should contain. In other words, filter in just the desired event type.
- Finally, the $eventCount parameter is defined as an integer value. It specifies the maximum number of log entries to display that meet the criteria specified.

Local Variable Definition

The local variable section is used to create a few local variables needed for this script (Listing 3-7).

Listing 3-7. Local Variable Definition Section

```
# Get the current date and tme
$rptDate=Get-Date
$epoch=([DateTimeOffset]$rptDate).ToUnixTimeSeconds()

# Create HTML Header Section
$Header = @"
<style>
TABLE {border-width: 1px; border-style: solid; border-color:
black; border-collapse: collapse;}
TD {border-width: 1px; padding: 3px; border-style: solid;
border-color: black;}
</style>
<p>
<b> $reportTitle $rptDate </b>
<p>
```

```
Event Log Selection: <b>$targetLogName </b>
<p>
Target Computer(s) Selection: <b> $targetComputer </b>
<p>
Event Type Filter: <b> $eventType </b>
<p>
"@

# Report Filename Creation
$ReportFile = ".\Report-"+$epoch+".HTML"
```

The local variables are as follows:

- $ReportDate: Obtains the current system date to be used in the report.
- $epoch: Obtains the number of seconds that have elapsed since the current epoch. Note that this is different for each operating system. This variable will be used to create a unique HTML filename.
- $Header: Defines a standard HTML header section to be used when generating the resulting HTML file. Note that this variable uses the parameter ReportTitle in order to customize the report heading.
- $ReportFile: This variable combines the string "Report-" with the epoch value and the extension .html.

CmdLet Pipeline Execution

The core of the script is the execution of the Get-EventLog CmdLet using a pipeline to include the parameters specified (Listing 3-8).

Listing 3-8. CmdLet Pipeline Execution

```
# CmdLet Pipeline execution
Get-Eventlog -ComputerName $targetComputer -LogName
$targetLogName -Newest $eventCount -EntryType $eventType |
 ConvertTo-html -Head $Header -Property TimeGenerated,
EntryType, Message |
 Out-File $ReportFile
```

The pipeline has several key components and transitions:

1. The Get-EventLog CmdLet specifies the -ComputerName, -LogName, -Newest and EntryType using the parameters $targetComputer, $targetLogName, $eventCount, and $eventType.
2. The output of the Get-EventLog CmdLet is piped to the ConvertTo-html CmdLet which utilizes the local variable $Header, and the properties passed from the Get-EventLog CmdLet TimeGenerated, EntryType, and Message to form the columns of the HTML report.
3. Finally, the output from ConvertTo-html is piped to the Out-File CmdLet which utilizes the local variable $ReportFile as the filename to write the results.

EventProcessor Get-Help Result

Since the script contains a detailed header section it is possible to use the Get-Help CmdLet to provide help to those who will be using the newly created script. The following example provides the output from the Get-Help CmdLet using the -Full option which provides all the details and examples (Listing 3-9).

Listing 3-9. EventProcessor Get-Help

```
PS C:\PS> Get-Help .\EventProcessor.ps1 -Full

NAME
    C:\PS\EventProcessor.ps1

SYNOPSIS
    EventLog Automation Version 1.0
    Step One
    - User Specified Target EventLog
    - User Specifies the number of newest Log Entries to Report
    - User Specifies the Entry Type to target, for example
      warning, error, information etc.
    - User Specifies the target computer or computers to
      extract the logs
    - User Specifies the HTML Report Title

SYNTAX
    C:\PS\EventProcessor.ps1 [[-targetLogName] <String>]
    [[-eventCount] <Int32>] [[-eventType] <String>]
    [[-reportTitle]
    <String>] [[-targetComputer] <String[]>]
[<CommonParameters>]

DESCRIPTION
    This script automates the extraction of information from
    the specified log file

PARAMETERS
    -targetLogName <String>
        Specifies the name of the log file to process

        Required?                    false
        Position?                    1
        Default value                system
        Accept pipeline input?       false
        Accept wildcard characters?  false

    -eventCount <Int32>
        Specifies the maximum number of newest events to
        consider in the search

        Required?                    false
        Position?                    2
        Default value                20
        Accept pipeline input?       false
        Accept wildcard characters?  false

    -eventType <String>
        Specifies the eventType of interest

        Required?                    false
        Position?                    3
        Default value                Error
        Accept pipeline input?       false
        Accept wildcard characters?  false

    -reportTitle <String>
        Specifies the HTML Report Title

        Required?                    false
        Position?                    4
        Default value                Event Log Daily Report
        Accept pipeline input?       false
        Accept wildcard characters?  false
    -targetComputer <String[]>
        Specifies the computer or computers to obtain the
        logs from

        Required?                    false
        Position?                    5
        Default value                $env:COMPUTERNAME
        Accept pipeline input?       false
        Accept wildcard characters?  false

    <CommonParameters>
        This cmdlet supports the common parameters: Verbose,
        Debug, ErrorAction, ErrorVariable, WarningAction,
        WarningVariable, OutBuffer, PipelineVariable, and
        OutVariable. For more information, see about_Common
        Parameters (https:/go.microsoft.com/fwlink/?LinkID=113216).

INPUTS

OUTPUTS

    ------------------------ EXAMPLE 1 ------------------------

    PS C:\>EventProcessor

    Execution of EventProcessor without parameters uses the
    default settings of
    eventLog system
    eventType warning
    eventCount 20
    targetComputer the computer running the script
    ------------------------ EXAMPLE 2 ------------------------

    PS C:\>EventProcessor -targetLogName security

    This example specifies the target eventLog security
    and uses the default parameters
    eventType warning
    eventCount 20
    targetComputer the computer running the script

    ------------------------ EXAMPLE 3 ------------------------

    PS C:\>EventProcessor -reporTitle "ACME Computer Daily
    Event Log Report"

    This example provides a custom Report Title

    ------------------------ EXAMPLE 4 ------------------------

    PS C:\>EventProcessor -targetLogName security -eventCount
    20 -entryType warning -targetComputer Python-3

    This example specifies all the parameters, targetLogName,
    eventCount, entryType and targetComputer
```

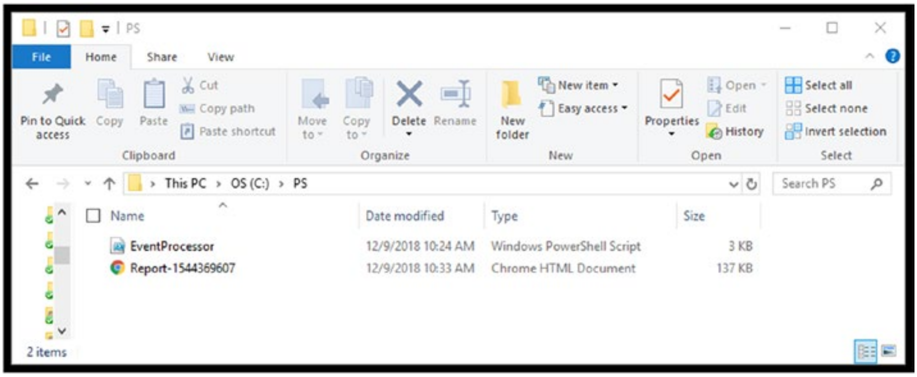
EventProcessor Script Execution

To illustrate the script execution, a sample command and results are provided here:

```
PS C:\PS> .\EventProcessor.ps1 -reportTitle "Python Forensics
Daily Log Report" -eventCount 100 -eventType error
```

Resulting Directory

As designed, the script produces an HTML Report File with the appended Epoch value denoting when the script was executed (see Figure 3-7). Since the .html extension was added, the file system properly identifies the resulting file as a Google Chrome HTML Document.

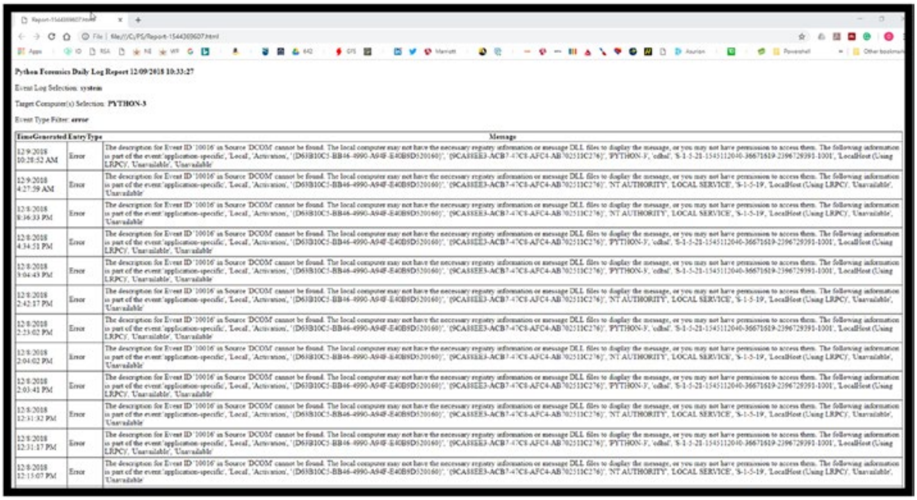


Name	Date modified	Type	Size
EventProcessor	12/9/2018 10:24 AM	Windows PowerShell Script	3 KB
Report-1544369607	12/9/2018 10:33 AM	Chrome HTML Document	137 KB

Figure 3-7. *Resulting report HTML file*

HTML Output Report

Examining the report file `Report-1544369607` using a browser provides sample results from the PowerShell script execution. The output includes the defined report title, the event log that was selected, the target computer, and the event type that was selected along with the resulting last 100 events with an event type of error. Note that the results were truncated here for brevity.



Python Forensics Daily Log Report 12/09/2018 10:33:27

Event Log Selection: **system**

Target Computer(s) Selection: **PYTHON-3**

Event Type Filter: **error**

TimeGenerated	EntryType	Message
12/9/2018 10:28:52 AM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'PYTHON-3', 'cdhsl', 'S-1-5-21-1545112040-36671619-2396729391-1001', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/9/2018 4:27:59 AM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'NT AUTHORITY', 'LOCAL SERVICE', 'S-1-5-19', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 8:36:33 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'NT AUTHORITY', 'LOCAL SERVICE', 'S-1-5-19', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 4:34:51 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'PYTHON-3', 'cdhsl', 'S-1-5-21-1545112040-36671619-2396729391-1001', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 3:04:43 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'PYTHON-3', 'cdhsl', 'S-1-5-21-1545112040-36671619-2396729391-1001', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 2:42:17 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'NT AUTHORITY', 'LOCAL SERVICE', 'S-1-5-19', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 2:23:02 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'PYTHON-3', 'cdhsl', 'S-1-5-21-1545112040-36671619-2396729391-1001', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 2:04:02 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'NT AUTHORITY', 'LOCAL SERVICE', 'S-1-5-19', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 2:03:41 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'PYTHON-3', 'cdhsl', 'S-1-5-21-1545112040-36671619-2396729391-1001', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 12:31:32 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'NT AUTHORITY', 'LOCAL SERVICE', 'S-1-5-19', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 12:31:17 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'PYTHON-3', 'cdhsl', 'S-1-5-21-1545112040-36671619-2396729391-1001', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'
12/8/2018 12:15:07 PM	Error	The description for Event ID '10016' in Source 'DCOM' cannot be found. The local computer may not have the necessary registry information or message DLL files to display the message, or you may not have permission to access them. The following information is part of the event:'application-specific', 'Local', 'Activation', '{D63B10C5-BB46-4990-A94F-E40B8D520160}', '{9CA88EE3-ACB7-47C8-AFC4-AB702511C276}', 'NT AUTHORITY', 'LOCAL SERVICE', 'S-1-5-19', 'LocalHost (Using LRPC)', 'Unavailable', 'Unavailable'

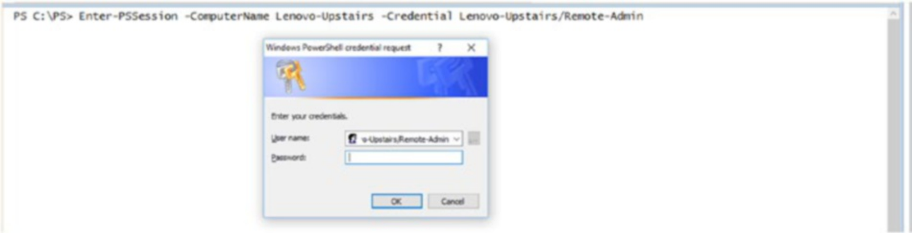
Figure 3-8. *Resulting HTML report*

Remote Access

> **Note** Setting up access to remote systems using the -ComputerName option (that is available for many CmdLets) can be difficult to setup within a workgroup. It is much easier when a Domain Controller is present, or your environment utilizes active directory. So please consult your system administrator when attempting to use the -ComputerName CmdLet parameter.

There is an easier method that can provide even greater flexibility and is more secure. The method is to create a remote PowerShell session with the target machine. Once the session is established, the commands that you enter from within PowerShell or PowerShell ISE are executed on the remotely connected machine. The advantage is not only simplicity, but it also allows you to execute any CmdLet, even those that don't support -ComputerName as a parameter.

Here is a simple example that creates a PowerShell session with a machine on my local network with the computer name Levovo-Upstairs. In order to create the session, you must provide the credentials for a user on the remote machine with Admin rights. The command will pop up a dialog box requesting the password for the specified account, as shown in Figure 3-9.



```
PS C:\PS> Enter-PSSession -ComputerName Lenovo-Upstairs -Credential Lenovo-Upstairs/Remote-Admin
```

Windows PowerShell credential request

Enter your credentials.

User name: o-Upstairs\Remote-Admin

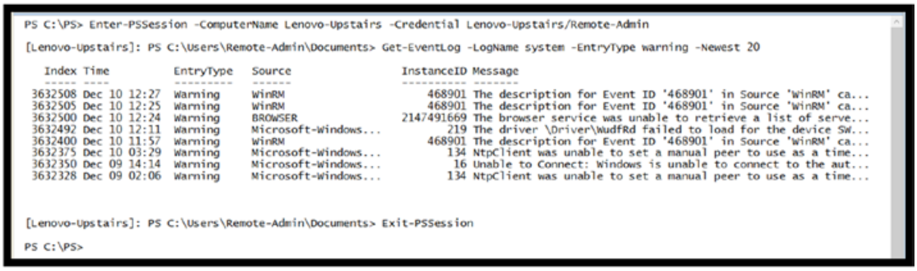
Password:

Figure 3-9. *Enter-PSSession credential request*

Once the connection is made, you can see that the PowerShell prompt has changed to:

```
[Lenovo-Upstairs]: PS C:\Users\Remote-Admin\Documents>
```

At this point, PowerShell commands that are typed are being executed on the remote computer Lenovo-Upstairs not on the local machine. In the example shown in Figure 3-10, the newest 20 warning messages contained in the system event log on the Lenovo-Upstairs machine are acquired.



```
PS C:\PS> Enter-PSSession -ComputerName Lenovo-Upstairs -Credential Lenovo-Upstairs/Remote-Admin

[Lenovo-Upstairs]: PS C:\Users\Remote-Admin\Documents> Get-EventLog -LogName system -EntryType warning -Newest 20

   Index Time          EntryType   Source                 InstanceID Message
   ----- ----          ---------   ------                 ---------- -------
 3632508 Dec 10 12:27  Warning     WinRM                      468901 The description for Event ID '468901' in Source 'WinRM' ca...
 3632505 Dec 10 12:25  Warning     WinRM                      468901 The description for Event ID '468901' in Source 'WinRM' ca...
 3632500 Dec 10 12:24  Warning     BROWSER                2147491669 The browser service was unable to retrieve a list of serve...
 3632492 Dec 10 12:11  Warning     Microsoft-Windows...          219 The driver \Driver\WudfRd failed to load for the device SW...
 3632400 Dec 10 11:57  Warning     WinRM                      468901 The description for Event ID '468901' in Source 'WinRM' ca...
 3632375 Dec 10 03:29  Warning     Microsoft-Windows...          134 NtpClient was unable to set a manual peer to use as a time...
 3632350 Dec 09 14:14  Warning     Microsoft-Windows...           16 Unable to Connect: Windows is unable to connect to the aut...
 3632328 Dec 09 02:06  Warning     Microsoft-Windows...          134 NtpClient was unable to set a manual peer to use as a time...


[Lenovo-Upstairs]: PS C:\Users\Remote-Admin\Documents> Exit-PSSession

PS C:\PS>
```

Figure 3-10. *Remote access of the system event log*

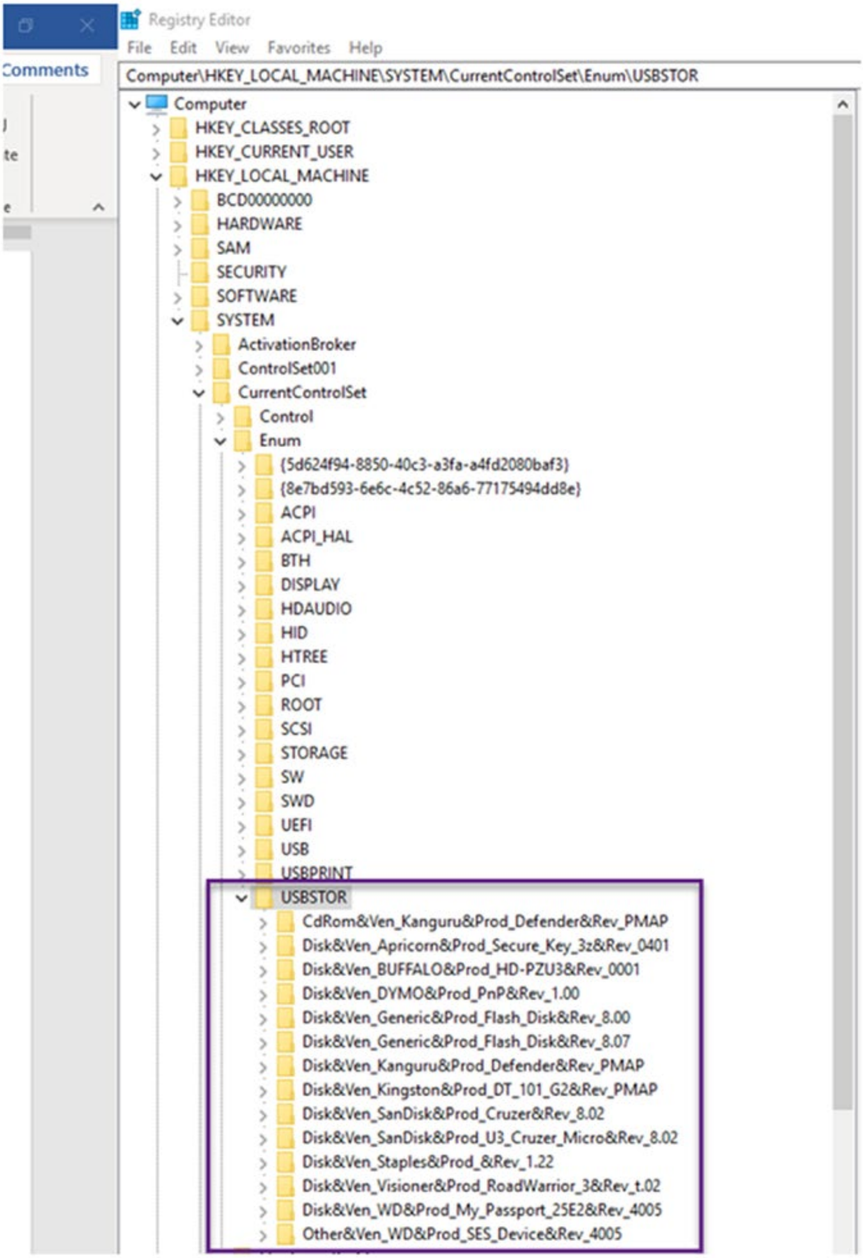
To exit the remote session the CmdLet Exit-PSSession is issued and PowerShell is now back operating on the local machine again. This is shown in Figure 3-10.

Example 2: USB Device Usage Discovery

Obtaining the recent USB devices used can certainly be important when performing forensic investigations or incident response actions. This can either help determine if information was exfiltrated from the system, or if USB insertion could be the cause of malware infection.

The first part of that process is to determine what USB devices have been detected. On Microsoft Windows systems, the registry provides a history of devices attached by examining details kept under HKEY_Local_Machine. Figure 3-11 shows the specific USBSTOR keys found on my local machine.

Note On different versions of Windows the registry key of interest may be different. If so, you will need to change the registry key definitions used in this example.



```
Computer\HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Enum\USBSTOR
```

```
Computer
  HKEY_CLASSES_ROOT
  HKEY_CURRENT_USER
  HKEY_LOCAL_MACHINE
    BCD00000000
    HARDWARE
    SAM
    SECURITY
    SOFTWARE
    SYSTEM
      ActivationBroker
      ControlSet001
      CurrentControlSet
        Control
        Enum
          {5d624f94-8850-40c3-a3fa-a4fd2080baf3}
          {8e7bd593-6e6c-4c52-86a6-77175494dd8e}
          ACPI
          ACPI_HAL
          BTH
          DISPLAY
          HDAUDIO
          HID
          HTREE
          PCI
          ROOT
          SCSI
          STORAGE
          SW
          SWD
          UEFI
          USB
          USBPRINT
          USBSTOR
            CdRom&Ven_Kanguru&Prod_Defender&Rev_PMAP
            Disk&Ven_Apricorn&Prod_Secure_Key_3z&Rev_0401
            Disk&Ven_BUFFALO&Prod_HD-PZU3&Rev_0001
            Disk&Ven_DYMO&Prod_PnP&Rev_1.00
            Disk&Ven_Generic&Prod_Flash_Disk&Rev_8.00
            Disk&Ven_Generic&Prod_Flash_Disk&Rev_8.07
            Disk&Ven_Kanguru&Prod_Defender&Rev_PMAP
            Disk&Ven_Kingston&Prod_DT_101_G2&Rev_PMAP
            Disk&Ven_SanDisk&Prod_Cruzer&Rev_8.02
            Disk&Ven_SanDisk&Prod_U3_Cruzer_Micro&Rev_8.02
            Disk&Ven_Staples&Prod_&Rev_1.22
            Disk&Ven_Visioner&Prod_RoadWarrior_3&Rev_t.02
            Disk&Ven_WD&Prod_My_Passport_25E2&Rev_4005
            Other&Ven_WD&Prod_SES_Device&Rev_4005
```

Figure 3-11. *Registry history of USB access*

Create the Script

Now that we understand the scenario, let's go through the two steps again to create the script we need.

Step One: Recent Accessing USB Activity

The question is how can evidence of USB activity be collected using PowerShell? Also, could a script be developed that would aggregate USB usage across our network?

Let's start by accessing the registry and USBSTOR on a local machine.

PowerShell provides a general-purpose CmdLet that can be applied to many items including the registry: The CmdLet is Get-ItemProperty.

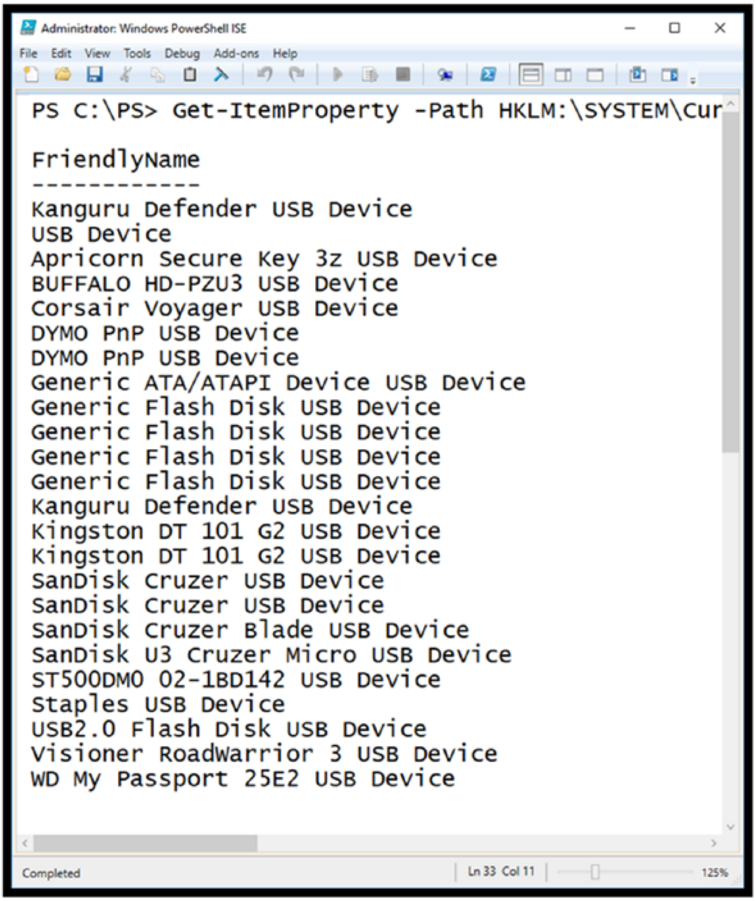
The Get-Help for Get-ItemProperty is shown in Listing 3-10.

Listing 3-10. Get-Help Get-ItemProperty

```
PS C:\PS> Get-Help Get-ItemProperty

NAME
    Get-ItemProperty

SYNOPSIS
    Gets the properties of a specified item.

SYNTAX
    Get-ItemProperty [[-Name] <String[]>] [-Credential
    <PSCredential>] [-Exclude <String[]>] [-Filter <String>]
    [-Include
    <String[]>] -LiteralPath <String[]> [-UseTransaction]
    [<CommonParameters>]

    Get-ItemProperty [-Path] <String[]> [[-Name] <String[]>]
    [-Credential <PSCredential>] [-Exclude <String[]>] [-Filter
    <String>] [-Include <String[]>] [-UseTransaction]
[<CommonParameters>]

DESCRIPTION
    The Get-ItemProperty cmdlet gets the properties of the
    specified items. For example, you can use this cmdlet to
    get the value
    of the LastAccessTime property of a file object. You can
    also use this cmdlet to view registry entries and their
    values.

RELATED LINKS
    Online Version: http://go.microsoft.com/fwlink/?LinkId=821588
    Clear-ItemProperty
    Copy-ItemProperty
    Move-ItemProperty
    New-ItemProperty
    Remove-ItemProperty
    Rename-ItemProperty
    Set-ItemProperty

REMARKS
    To see the examples, type: "get-help Get-ItemProperty
    -examples".
    For more information, type: "get-help Get-ItemProperty
    -detailed".
    For technical information, type: "get-help Get-ItemProperty
    -full".
    For online help, type: "get-help Get-ItemProperty -online"
```

Using this CmdLet to acquire recent USB activity can be accomplished like this. In order to make this easier to understand, for this example the "Friendly Name" Property of the USB device will be acquired. Please see Figure 3-12.

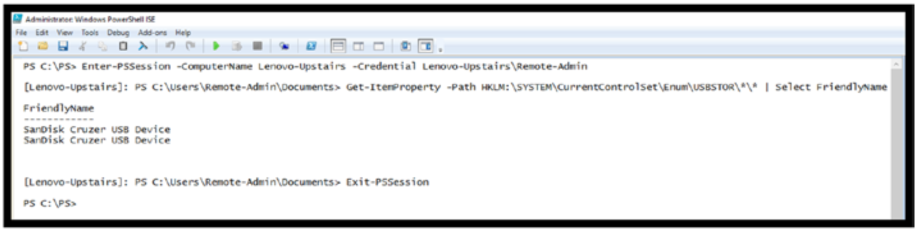
```
PS C:\PS> Get-ItemProperty -Path HKLM:\SYSTEM\
CurrentControlSet\Enum\USBSTOR\*\* | Select FriendlyName
```


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 33 Col 11
125%

```
PS C:\PS> Get-ItemProperty -Path HKLM:\SYSTEM\Cur

FriendlyName
------------
Kanguru Defender USB Device
USB Device
Apricorn Secure Key 3z USB Device
BUFFALO HD-PZU3 USB Device
Corsair Voyager USB Device
DYMO PnP USB Device
DYMO PnP USB Device
Generic ATA/ATAPI Device USB Device
Generic Flash Disk USB Device
Generic Flash Disk USB Device
Generic Flash Disk USB Device
Generic Flash Disk USB Device
Kanguru Defender USB Device
Kingston DT 101 G2 USB Device
Kingston DT 101 G2 USB Device
SanDisk Cruzer USB Device
SanDisk Cruzer USB Device
SanDisk Cruzer Blade USB Device
SanDisk U3 Cruzer Micro USB Device
ST500DM0 02-1BD142 USB Device
Staples USB Device
USB2.0 Flash Disk USB Device
Visioner RoadWarrior 3 USB Device
WD My Passport 25E2 USB Device
```

Figure 3-12. *Using Get-ItemProperty CmdLet to acquire USB activity*

Using the Remote Access method, we now acquire the USB activity on the remote computer Lenovo-Upstairs. For this, the Enter and Exit PSSession method is used and the command is executed on the remote computer. As you can see, the SanDisk Cruzer USB device was identified on both the local and remote computers.



Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help

```
PS C:\PS> Enter-PSSession -ComputerName Lenovo-Upstairs -Credential Lenovo-Upstairs\Remote-Admin

[Lenovo-Upstairs]: PS C:\Users\Remote-Admin\Documents> Get-ItemProperty -Path HKLM:\SYSTEM\CurrentControlSet\Enum\USBSTOR\*\* | Select FriendlyName

FriendlyName
------------
SanDisk Cruzer USB Device
SanDisk Cruzer USB Device


[Lenovo-Upstairs]: PS C:\Users\Remote-Admin\Documents> Exit-PSSession

PS C:\PS>
```

Figure 3-13. *Access USB activity on a remote computer*

Invoke-Command PowerShell CmdLet

In cases where only a single remote command needs to be executed, this can be accomplished by using the Invoke-Command PowerShell CmdLet instead of setting up a remote PowerShell session. This can be useful when developing scripts that will acquire evidence from multiple computers. As always using Get-Help will provide the details on how to utilize the Invoke-Command CmdLet (Listing 3-11).

Listing 3-11. Invoke-Command

```
PS C:\PS> Get-Help Invoke-Command

NAME
    Invoke-Command

SYNOPSIS
    Runs commands on local and remote computers.

SYNTAX
```

```
Invoke-Command [[-ConnectionUri] <Uri[]>] [-ScriptBlock]
<ScriptBlock> [-AllowRedirection] [-ArgumentList
<Object[]>] [-AsJob]
[-Authentication {Default | Basic | Negotiate |
NegotiateWithImplicitCredential | Credssp | Digest |
Kerberos}] [-CertificateThumbprint
<String>] [-ConfigurationName <String>] [-Credential
<PSCredential>] [-EnableNetworkAccess] [-HideComputerName]
[-InDisconnectedSession]
[-InputObject <PSObject>] [-JobName <String>]
[-SessionOption <PSSessionOption>] [-ThrottleLimit <Int32>]
[<CommonParameters>]

Invoke-Command [[-ConnectionUri] <Uri[]>] [-FilePath]
<String> [-AllowRedirection] [-ArgumentList <Object[]>]
[-AsJob] [-Authentication
{Default | Basic | Negotiate |
NegotiateWithImplicitCredential | Credssp | Digest |
Kerberos}] [-ConfigurationName <String>] [-Credential
<PSCredential>] [-EnableNetworkAccess] [-HideComputerName]
[-InDisconnectedSession] [-InputObject <PSObject>]
[-JobName <String>]
[-SessionOption <PSSessionOption>] [-ThrottleLimit <Int32>]
[<CommonParameters>]

Invoke-Command [[-ComputerName] <String[]>] [-ScriptBlock]
<ScriptBlock> [-ApplicationName <String>] [-ArgumentList
<Object[]>] [-AsJob]
[-Authentication {Default | Basic | Negotiate |
NegotiateWithImplicitCredential | Credssp | Digest |
Kerberos}] [-CertificateThumbprint
<String>] [-ConfigurationName <String>] [-Credential
<PSCredential>] [-EnableNetworkAccess] [-HideComputerName]
[-InDisconnectedSession]
[-InputObject <PSObject>] [-JobName <String>] [-Port
<Int32>] [-SessionName <String[]>] [-SessionOption
<PSSessionOption>] [-ThrottleLimit
<Int32>] [-UseSSL] [<CommonParameters>]

Invoke-Command [[-ComputerName] <String[]>] [-FilePath]
<String> [-ApplicationName <String>] [-ArgumentList
<Object[]>] [-AsJob]
[-Authentication {Default | Basic | Negotiate |
NegotiateWithImplicitCredential | Credssp | Digest |
Kerberos}] [-ConfigurationName
<String>] [-Credential <PSCredential>]
[-EnableNetworkAccess] [-HideComputerName]
[-InDisconnectedSession] [-InputObject <PSObject>]
[-JobName <String>] [-Port <Int32>] [-SessionName
<String[]>] [-SessionOption <PSSessionOption>]
[-ThrottleLimit <Int32>] [-UseSSL]
[<CommonParameters>]

Invoke-Command [[-Session] <PSSession[]>] [-ScriptBlock]
<ScriptBlock> [-ArgumentList <Object[]>] [-AsJob]
[-HideComputerName]
[-InputObject <PSObject>] [-JobName <String>]
[-ThrottleLimit <Int32>] [<CommonParameters>]

Invoke-Command [[-Session] <PSSession[]>] [-FilePath]
<String> [-ArgumentList <Object[]>] [-AsJob]
[-HideComputerName] [-InputObject
<PSObject>] [-JobName <String>] [-ThrottleLimit <Int32>]
[<CommonParameters>]
```

```
Invoke-Command [-VMId] <Guid[]> [-ScriptBlock]
<ScriptBlock> [-ArgumentList <Object[]>] [-AsJob]
[-ConfigurationName <String>] -Credential
<PSCredential> [-HideComputerName] [-InputObject
<PSObject>] [-ThrottleLimit <Int32>] [<CommonParameters>]
```

```
Invoke-Command [-ScriptBlock] <ScriptBlock> [-ArgumentList
<Object[]>] [-AsJob] [-ConfigurationName <String>]
-Credential <PSCredential>
[-HideComputerName] [-InputObject <PSObject>]
[-ThrottleLimit <Int32>] -VMName <String[]>
[<CommonParameters>]
```

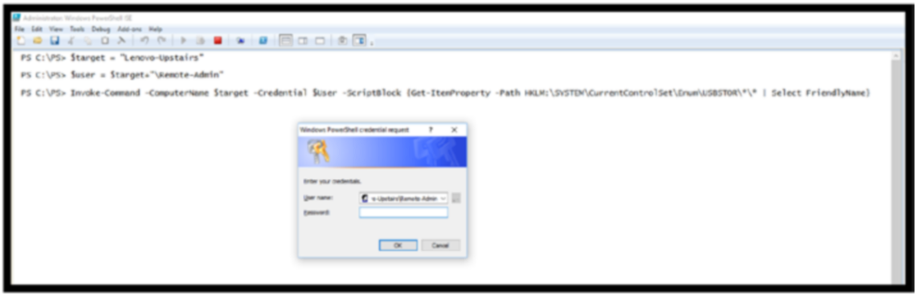
```
Invoke-Command [-VMId] <Guid[]> [-FilePath] <String>
[-ArgumentList <Object[]>] [-AsJob] [-ConfigurationName
<String>] -Credential
<PSCredential> [-HideComputerName] [-InputObject
<PSObject>] [-ThrottleLimit <Int32>] [<CommonParameters>]
```

```
Invoke-Command [-FilePath] <String> [-ArgumentList
<Object[]>] [-AsJob] [-ConfigurationName <String>]
-Credential <PSCredential>
[-HideComputerName] [-InputObject <PSObject>]
[-ThrottleLimit <Int32>] -VMName <String[]>
[<CommonParameters>]
```

```
Invoke-Command [-ScriptBlock] <ScriptBlock> [-ArgumentList
<Object[]>] [-AsJob] [-ConfigurationName <String>]
-ContainerId <String[]>
[-HideComputerName] [-InputObject <PSObject>] [-JobName
<String>] [-RunAsAdministrator] [-ThrottleLimit <Int32>]
[<CommonParameters>]
```

```
    Invoke-Command [-FilePath] <String> [-ArgumentList
    <Object[]>] [-AsJob] [-ConfigurationName <String>]
    -ContainerId <String[]>
    [-HideComputerName] [-InputObject <PSObject>] [-JobName
    <String>] [-RunAsAdministrator] [-ThrottleLimit <Int32>]
    [<CommonParameters>]

    Invoke-Command [-ScriptBlock] <ScriptBlock> [-ArgumentList
    <Object[]>] [-InputObject <PSObject>] [-NoNewScope]
    [<CommonParameters>]

DESCRIPTION
    The Invoke-Command cmdlet runs commands on a local or
    remote computer and returns all output from the commands,
    including errors. By using a single Invoke-Command command,
    you can run commands on multiple computers.

    To run a single command on a remote computer, use the
    ComputerName parameter. To run a series of related commands
    that share data, use the New-PSSession cmdlet to create a
    PSSession (a persistent connection) on the remote computer,
    and then use the Session parameter of Invoke-Command to run
    the command in the PSSession. To run a command in a
    disconnected session, use the InDisconnectedSession
    parameter. To run a command in a background job, use the
    AsJob parameter.

    You can also use Invoke-Command on a local computer to
    evaluate or run a string in a script block as a command.
    Windows PowerShell converts the script block to a command
    and runs the command immediately in the current scope,
    instead of just echoing the string at the command line.
    To start an interactive session with a remote computer,
    use the Enter-PSSession cmdlet. To establish a persistent
    connection to a remote computer, use the New-PSSession
    cmdlet.

    Before using Invoke-Command to run commands on a remote
    computer, read about_Remote (http://go.microsoft.com/
    fwlink/?LinkID=135182).

RELATED LINKS
    Online Version: http://go.microsoft.com/fwlink/?LinkId=821493
    Enter-PSSession
    Exit-PSSession
    Get-PSSession
    New-PSSession
    Remove-PSSession
```

Using the USB activity acquisition method as a starting point, the Invoke-Command method can be used to perform this command remotely. In this example, target and user are first created as variables. The command is embedded in the -ScriptBlock. As before, the user must enter the Admin credentials for the remote computer (Figure 3-14).



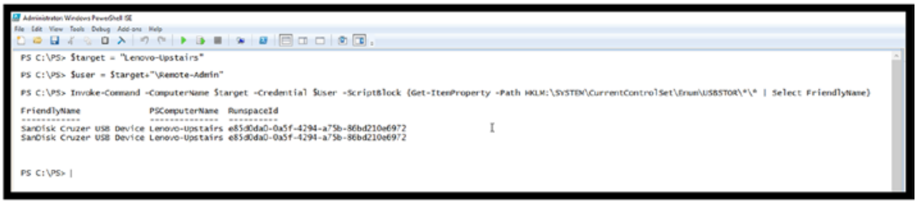
Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help

```
PS C:\PS> $target = "Lenovo-Upstairs"
PS C:\PS> $user = $target+"\Remote-Admin"
PS C:\PS> Invoke-Command -ComputerName $target -Credential $user -ScriptBlock {Get-ItemProperty -Path HKLM:\SYSTEM\CurrentControlSet\Enum\USBSTOR\*\* | Select FriendlyName}
```

Windows PowerShell credential request
Enter your credentials.
User name:
s-Upstairs\Remote-Admin
Password:
OK
Cancel

***Figure 3-14.** Invoke-Command method USBAcquire*

The results to the Invoke command are shown in Figure 3-15.



Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help

```
PS C:\PS> $target = "Lenovo-Upstairs"
PS C:\PS> $user = $target+"\Remote-Admin"
PS C:\PS> Invoke-Command -ComputerName $target -Credential $user -ScriptBlock {Get-ItemProperty -Path HKLM:\SYSTEM\CurrentControlSet\Enum\USBSTOR\*\* | Select FriendlyName}

FriendlyName           PSComputerName  RunspaceId
------------           --------------  ----------
SanDisk Cruzer USB Device Lenovo-Upstairs e85d0da0-0a5f-4294-a75b-86bd210e6972
SanDisk Cruzer USB Device Lenovo-Upstairs e85d0da0-0a5f-4294-a75b-86bd210e6972


PS C:\PS> |
```

***Figure 3-15.** Invoke-Command method USBAcquire results*

Step Two: Create the USBAcquire PowerShell Script

Now that we have perfected the method, a simple PowerShell script can be created to perform this operation for us, with the user supplying the target computer name and the Admin user. The full script is listed here as Listing 3-12. I'll show the Get-Help result and a sample execution later as well.

Listing 3-12. USBAcquire Script

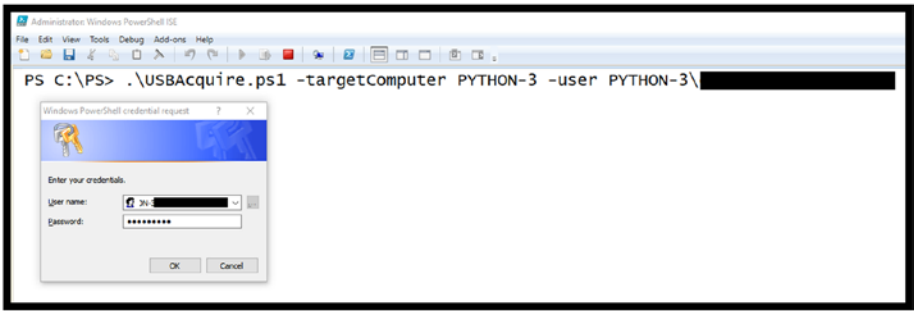
```
<#
.synopsis
Collect USB Activity from target computer

- User Specifies the target computer

The script will produce details of USB Activity
on the specified target computer

.Description
This script collects USB Activity and target computers

.parameter targetComputer
Specifies the computer to collect the USB Activity

.parameter UserName
Specifies the Administrator UserName on the Target Computer

.example

USBAcquire ComputerName
Collects the USB Activity on the target Computer
#>

# Parameter Definition Section
param(
    [string]$User,
    [string]$targetComputer
)

Invoke-Command -ComputerName $targetComputer -Credential
$User -ScriptBlock {Get-ItemProperty -Path HKLM:\SYSTEM\
CurrentControlSet\Enum\USBSTOR\*\* | Select FriendlyName}
```

As you can see, the USBAcquire has the same four major sections as the EventProcessor script from Example One: Script Header parameter definition, Local variable definitions, and cmdlet execution using parameters and local variables. Refer back to that section if you need a refresher.

USBAcquire Script Execution

The execution and results of the script are demonstrated in Figures 3-16 and 3-17.

```
PS C:\PS> .\USBAcquire.ps1 -targetComputer PYTHON-3 -user
PYTHON-3\USER-NAME-HIDDEN
```



Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help

```
PS C:\PS> .\USBAcquire.ps1 -targetComputer PYTHON-3 -user PYTHON-3\[redacted]
```

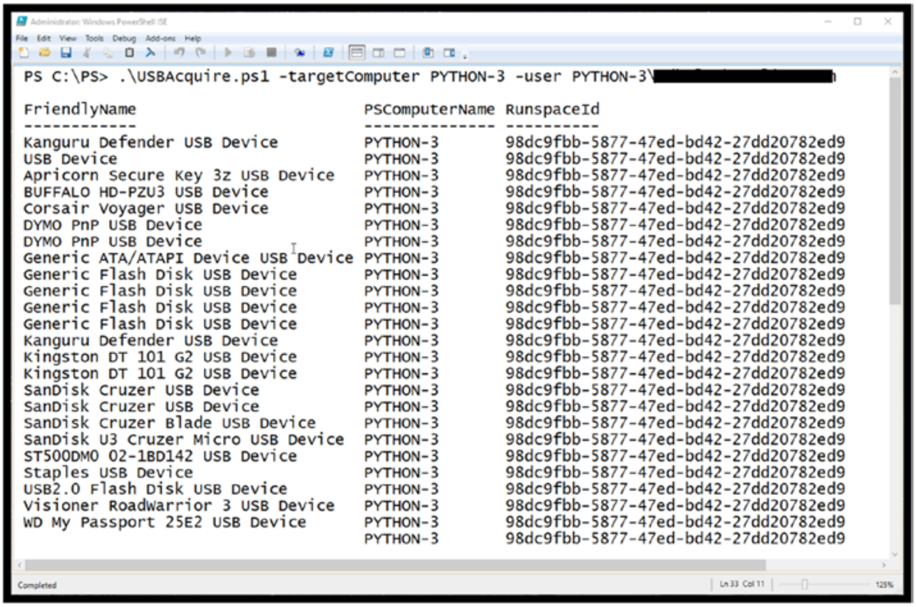
Windows PowerShell credential request ? ×

Enter your credentials.

User name: ƎN-[redacted]

Password: ••••••••••

Figure 3-16. *USBAcquire script execution requesting credentials*


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 33 Col 11
125%

```
PS C:\PS> .\USBAcquire.ps1 -targetComputer PYTHON-3 -user PYTHON-3\[redacted]

FriendlyName                         PSComputerName RunspaceId
------------                         -------------- ----------
Kanguru Defender USB Device          PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
USB Device                           PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Apricorn Secure Key 3z USB Device    PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
BUFFALO HD-PZU3 USB Device           PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Corsair Voyager USB Device           PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
DYMO PnP USB Device                  PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
DYMO PnP USB Device                  PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Generic ATA/ATAPI Device USB Device  PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Generic Flash Disk USB Device        PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Generic Flash Disk USB Device        PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Generic Flash Disk USB Device        PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Generic Flash Disk USB Device        PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Kanguru Defender USB Device          PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Kingston DT 101 G2 USB Device        PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Kingston DT 101 G2 USB Device        PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
SanDisk Cruzer USB Device            PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
SanDisk Cruzer USB Device            PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
SanDisk Cruzer Blade USB Device      PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
SanDisk U3 Cruzer Micro USB Device   PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
ST500DM0 02-1BD142 USB Device        PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Staples USB Device                   PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
USB2.0 Flash Disk USB Device         PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
Visioner RoadWarrior 3 USB Device    PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
WD My Passport 25E2 USB Device       PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
                                     PYTHON-3       98dc9fbb-5877-47ed-bd42-27dd20782ed9
```

Figure 3-17. *Results USBAcquire PowerShell script*

USBAcquire Get-Help Result

The script contains a proper heading section; thus, user help can be obtained using the Get-Help CmdLet, shown in Listing 3-13.

Listing 3-13. USBAcquire Get-Help

```
PS C:\PS> Get-Help .\USBAcquire.ps1

NAME
    C:\PS\USBAcquire.ps1

SYNOPSIS
    Collect USB Activity from target computer

    - User Specifies the target computer
    The script will produce details of USB Activity
    on the specified target computer

SYNTAX
    C:\PS\USBAcquire.ps1 [[-User] <String>] [[-targetComputer]
    <String>] [<CommonParameters>]

DESCRIPTION
    This script collects USB Activity and target computers

RELATED LINKS

REMARKS
    To see the examples, type: "get-help C:\PS\USBAcquire.ps1
    -examples".
    For more information, type: "get-help C:\PS\USBAcquire.ps1
    -detailed".
    For technical information, type: "get-help C:\PS\
    USBAcquire.ps1 -full".
```

Challenge Problem: Create File Inventory List with Hashes

Based on what you have learned about PowerShell scripts and Remote Access methods, your challenge is to leverage this knowledge to solve the following problem.

Develop a PowerShell script that will create an inventory of a computer detailing all directories and files found. The script will allow the user to specify:

- Target Computer
- Starting Directory
- Output File

Your script should produce an HTML file that contains the following information:

- Directory
- FileName
- FileSize
- LastWriteTime
- Owner
- FileAttributes (i.e., ReadOnly, Hidden, System, Archive)

The script will recurse all the folders beginning with the Starting Directory.

Hint You will be focusing on the CmdLet Get-ChildItem.

Finally, your script will contain full Help information.

A sample script solution can be found in Appendix A and at www.apress.com/9781484245033.

Summary

This chapter focused on the construction of PowerShell scripts that can be used by investigators to obtain information from event logs and recent USB activity. The Get-EventLog CmdLet and Get-ItemProperty were the focus of our acquisitions.

In addition, the creation of PowerShell sessions was covered as an additional method to obtain evidence from remote computers when proper credentials are available using the Enter-PSSession CmdLet. Also, the Invoke-Command PowerShell CmdLet was covered that allows for the execution of a single command or script without creating a persistent session.

Chapter 4 will introduce, compare, and contrast PowerShell and Python and begin the process of combining these two powerful scripting languages.

CHAPTER 4

Python and Live Investigation/Acquisition

Searching is the mainstay of digital investigation. What has changed over the past decade is the vast amount of data to search, the various types of content to search, and the type of information that is needed to connect the dots of specific criminal activity.

Today, digital data is connected to all criminal activity. Using this data to understand (and potentially prove) the motive, opportunity, and/or means to commit the crime is paramount. In many cases, we can utilize this data to develop a profile of a suspect(s) and predict future activities. In addition, we can discover the location, behaviors, and content of specific digital devices whether they be phones, tablets, computers, drones, watches, or a wide range of IoT devices.

Currently, many still think about digital evidence as static data that is examined after we image digital media. This is changing of course, especially in Digital Forensic Incident Response, or DFIR, activities. Collecting, examining, and reasoning about "live" evidence is not new – I began writing about this and developing solutions as far back as 2006.[1]

[1] https://gcn.com/Articles/2006/07/27/Special-Report%2D%2DLive-forensics-is-the-future-for-law-enforcement.aspx

C. Hosmer, *PowerShell and Python Together*, https://doi.org/10.1007/978-1-4842-4504-0_4

As the need for immediate response, early indications and warning, detection of aberrant behavior, and anticipation of bad actions before they occur becomes vital in society, “live” forensics will eventually work hand in hand with traditional postmortem practices. Thus, by leveraging PowerShell to acquire specific targeted evidence, we can take the next step in processing and reasoning about actions as they happen.

All of this provides significant opportunities to develop new methods of detection, reasoning, analysis, and of course evidence of criminal activity. However, before we can fly, run, walk, or even crawl, we need to tackle some basic challenges and develop software that integrates PowerShell-driven acquisition with the power of Python. There are two fundamental ways to approach this:

- Method 1: Launch PowerShell CmdLets or scripts and then collect and post-process the results in Python.
- Method 2: Execute PowerShell CmdLets or scripts and pipe the results to waiting Python scripts.

Method 1 will be examined in this chapter and Method 2 will be addressed in Chapter 5. In both cases, the methods will be explored by example.

What Is “By Example”?

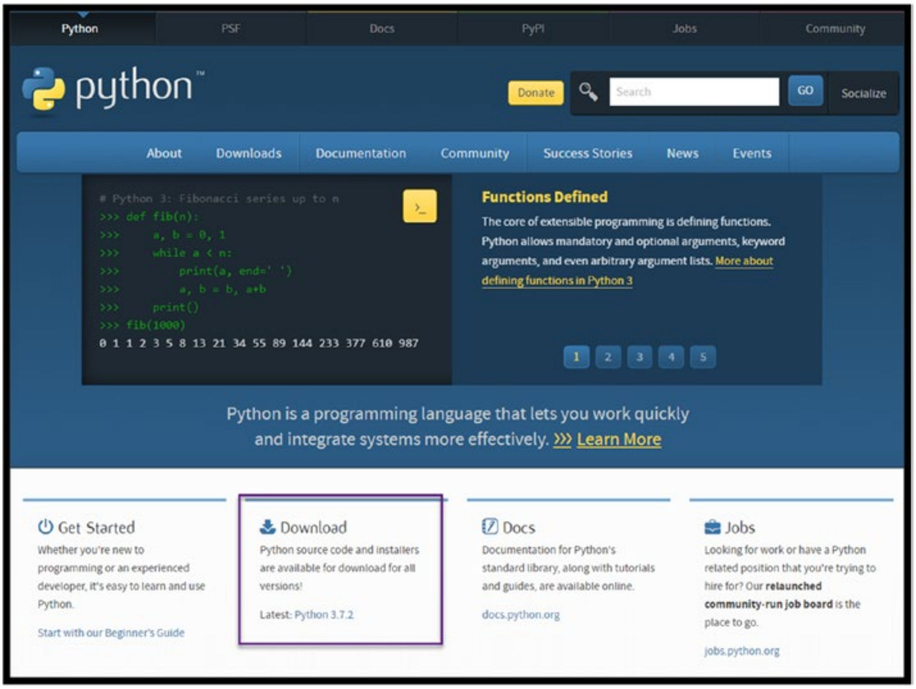
There are literally hundreds of books on Python in existence, and most are focused on how to program and typically take the approach of teaching you the intricacies of the language. These texts are designed for those pursuing a career in computer science, software engineering, web development, or Big Data processing.

Our goal here is to apply Python to specific digital investigation challenges and combine Python and PowerShell to create solutions. Interestingly enough, along the way you will learn new scripting techniques.

The best analogy I can think of is learning about a new culture. You can read about the Mayan culture, watch movies about their history, and examine maps of the countries where they resided. Or you can travel there and walk through their world, speak with the Maya people, explore their sacred sites, and experience the culture firsthand.

Directing PowerShell with Python

Since the end date of Python 2.7 is approaching, Python 3.7 will be used for all the Python-based examples for this book. Python 2 and 3 contain a formidable amount of built-in standard libraries along with thousands of third-party libraries. Whenever possible, Python standard libraries will be used in order to ensure the broadest cross-platform compatibility. You can obtain Python 3.7 directly from `www.python.org`. As of this writing, the latest version available is Python 3.7.2, as shown in Figure 4-1.



```
# Python 3: Fibonacci series up to n
>>> def fib(n):
>>>     a, b = 0, 1
>>>     while a < n:
>>>         print(a, end=' ')
>>>         a, b = b, a+b
>>>     print()
>>> fib(1000)
0 1 1 2 3 5 8 13 21 34 55 89 144 233 377 610 987
```

Functions Defined

The core of extensible programming is defining functions. Python allows mandatory and optional arguments, keyword arguments, and even arbitrary argument lists. More about defining functions in Python 3

Python is a programming language that lets you work quickly and integrate systems more effectively. >>> Learn More

Get Started

Whether you're new to programming or an experienced developer, it's easy to learn and use Python.

Start with our Beginner's Guide

Download

Python source code and installers are available for download for all versions!

Latest: Python 3.7.2

Docs

Documentation for Python's standard library, along with tutorials and guides, are available online.

docs.python.org

Jobs

Looking for work or have a Python related position that you're trying to hire for? Our **relaunched community-run job board** is the place to go.

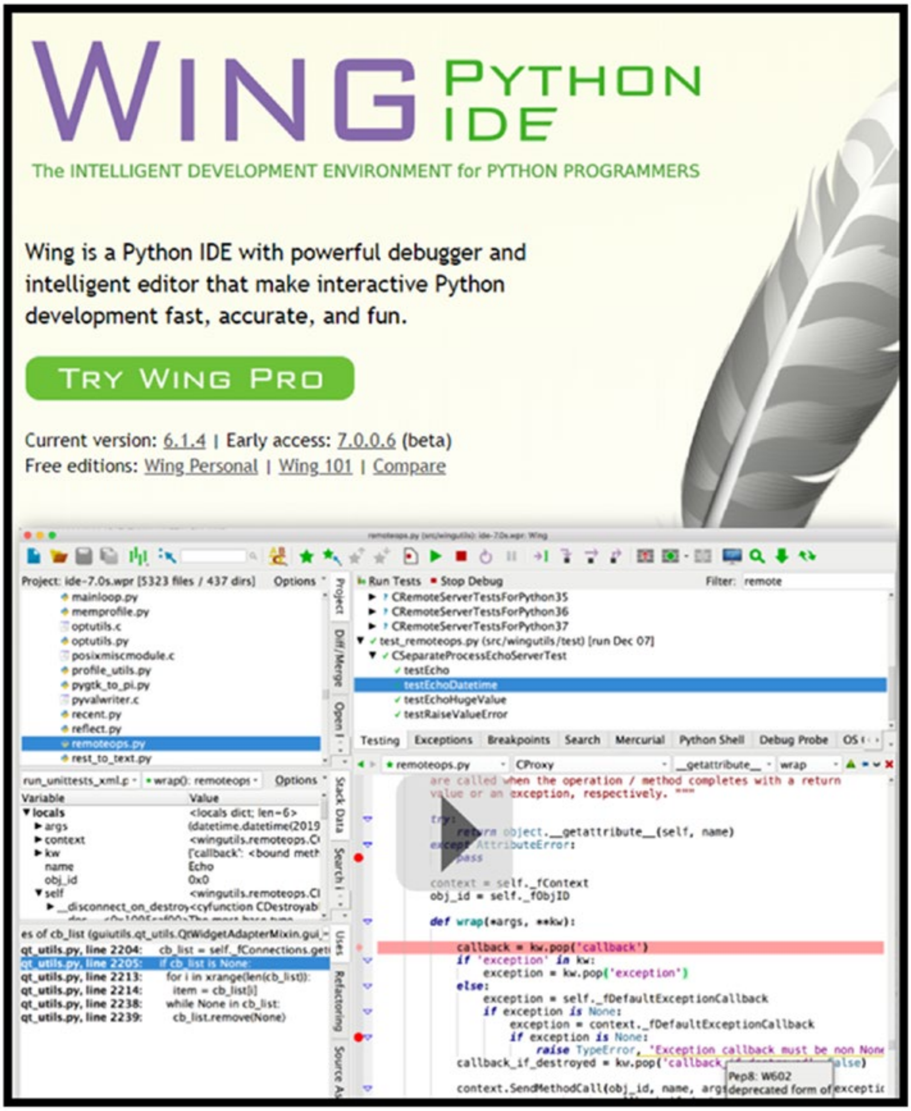
jobs.python.org

Figure 4-1. *Download Python 3.7.2 (www.python.org)*

In addition to the latest version of Python, I highly recommend the use of a Python Integrated Development Environment. My favorite is WingIDE.

The personal edition is free and works fine for most Python development and scripting challenges. The web site provides great tutorials on how to configure and use WingIDE can be found at:

www.wingware.com



WING PYTHON IDE

The INTELLIGENT DEVELOPMENT ENVIRONMENT for PYTHON PROGRAMMERS

Wing is a Python IDE with powerful debugger and intelligent editor that make interactive Python development fast, accurate, and fun.

TRY WING PRO

Current version: 6.1.4 | Early access: 7.0.0.6 (beta)
Free editions: Wing Personal | Wing 101 | Compare

```
Variable                         Value
▼ locals                         <locals dict; len=6>
  ► args                         (datetime.datetime(2019
  ► context                      <wingutils.remoteops.C
  ► kw                           {'callback': <bound meth
    name                         Echo
    obj_id                       0x0
  ▼ self                         <wingutils.remoteops.Cl
    ► __disconnect_on_destroy<cyfunction CDestroyab
```

```
es of cb_list (guiutils.qt_utils.QtWidgetAdapterMixin.gui_
qt_utils.py, line 2204:    cb_list = self._fConnections.get
qt_utils.py, line 2205:    if cb_list is None:
qt_utils.py, line 2213:      for i in xrange(len(cb_list)):
qt_utils.py, line 2214:        item = cb_list[i]
qt_utils.py, line 2238:      while None in cb_list:
qt_utils.py, line 2239:        cb_list.remove(None)
```

```
are called when the operation / method completes with a return
value or an exception, respectively. """

try:
    return object.__getattribute__(self, name)
except AttributeError:
    pass

context = self._fContext
obj_id = self._fObjID

def wrap(*args, **kw):

    callback = kw.pop('callback')
    if 'exception' in kw:
        exception = kw.pop('exception')
    else:
        exception = self._fDefaultExceptionCallback
        if exception is None:
            exception = context._fDefaultExceptionCallback
            if exception is None:
                raise TypeError, 'Exception callback must be non None
    callback_if_destroyed = kw.pop('callback_if_destroyed', False)

    context.SendMethodCall(obj_id, name, args, exceptic
```

Figure 4-2. *Wingware/WingIDE home page (www.wingware.com)*

Launching PowerShell CmdLets from Python

Now that you have the basic tools available (PowerShell installed and running, Python installed and running, and WingIDE to experiment), you are set to perform the first integration of Python and PowerShell.

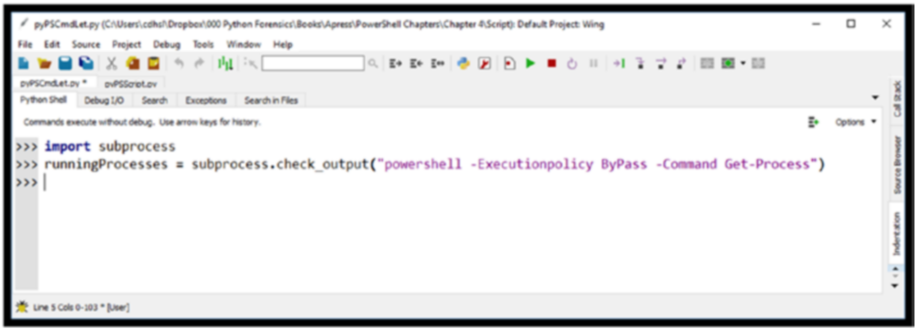
In Chapters 1 and 2, the discovery, use, and forensic applications of CmdLets were covered. I'm sure that you have already experimented with an assortment of additional CmdLets. Therefore, what if we could execute a PowerShell CmdLet from Python and capture the results? Since PowerShell is an executable process, so we will use Python's standard library providing the ability to launch processes. This is done using the subprocess standard library. In Python in order to utilize any standard or third-party libraries, you must import them. This is done with a simple import statement. In this case, the statement simply is:

```
import subprocess
```

This provides access to the methods and properties contained in the subprocess library. Many options are available – the most popular is using the check.output method which executes the specified process and returns the result. Here is an example:

```
runningProcesses = subprocess.check_output("powershell
-Executionpolicy ByPass -Command Get-Process")
```

One of the nice features of the WingIDE Python Integrated Development is the ability to experiment with commands within the interactive shell as shown in Figure 4-3. The three greater-than signs (>>>) are the interactive shell prompt. This is the same prompt you would receive if you launched Python from the command line or terminal window.



pyPSCmdLet.py (C:\Users\cdhs\Dropbox\000 Python Forensics\Books\Apress\PowerShell Chapters\Chapter 4\Script): Default Project: Wing
File Edit Source Project Debug Tools Window Help
pyPSCmdLet.py * pyPSScript.py
Python Shell Debug I/O Search Exceptions Search in Files
Options
Call Stack
Source Browser
Indentation
Line 5 Cols 0-103 * [User]

Commands execute without debug. Use arrow keys for history.

```
>>> import subprocess
>>> runningProcesses = subprocess.check_output("powershell -Executionpolicy ByPass -Command Get-Process")
>>> |
```

Figure 4-3. *Executing a PowerShell CmdLet from the Python shell*

The breakdown of each of the elements of the subprocess code is as follows and in Figure 4-4.

- **A.** The result of the command will be stored in the variable named `runningProcesses`. You can, of course, use any allowable variable name. I use camel case when defining variables in Python starting with a lowercase letter and then capitalizing each subsequent word. This makes it easy to identify variables in your code.

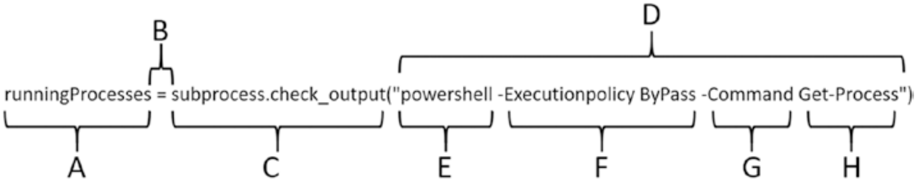
- **B.** The assignment operator or = equal sign assigns the results of the subprocess command to the variable `runningProcesses`.

- **C.** `subprocess.check_output` is the selected method from the subprocess library. It takes a single parameter enclosed in quotes and defines the command line you wish to execute.

- **D.** The quoted string inside the parenthesis specifies the command to execute. E-H defines each element of the powershell command to execute.

- **E.** `powershell` is the command, or in this case the process to execute.

- **F.** `-Executionpolicy ByPass`, by default, PowerShell will not execute scripts or CmdLets without explicit permission. The parameter `-Executionpolicy` specifies the policy for the PowerShell command. The parameter `ByPass` tells PowerShell to block nothing and issue no warnings or prompts.
- **G.** `-Command` specifies that what follows is a PowerShell Command. In this case it is a simple CmdLet, but could be a more complex pipeline-based command. If you desire to execute a PowerShell script, this would be changed to `-File` and would be followed by a valid .ps1 filename.
- **H.** `Get-Process` is the specific CmdLet that is to be executed. In this example the Get-Process CmdLet is executed with no parameters.



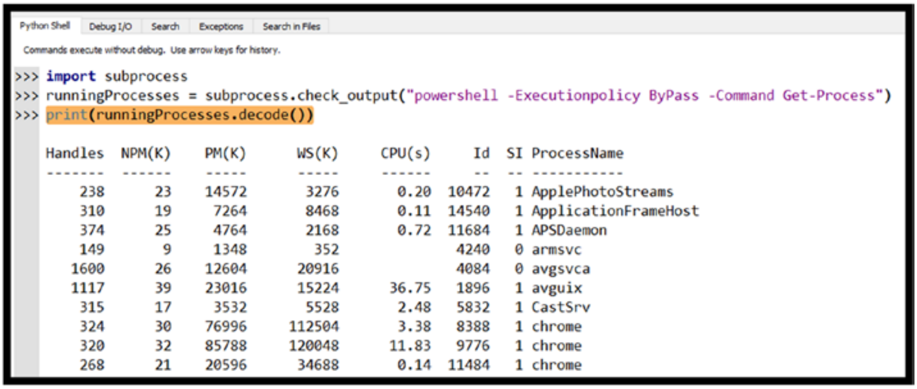
```
runningProcesses = subprocess.check_output("powershell -Executionpolicy ByPass -Command Get-Process")
```

***Figure 4-4.** Python subprocess command breakdown*

In Python 3.x, the subprocess.check_output() method returns a byte string, where in Python 2.7 it returned a simple string. Therefore, to display the output from the Command, the runningProcesses variable needs to be decoded as shown here:

```
print(runningProcesses.decode())
```

Executing this command within the WingIDE Python interactive shell delivers the results shown in Figure 4-5. Note the results are truncated for brevity.



Commands execute without debug. Use arrow keys for history.

```
>>> import subprocess
>>> runningProcesses = subprocess.check_output("powershell -Executionpolicy ByPass -Command Get-Process")
>>> print(runningProcesses.decode())

Handles  NPM(K)    PM(K)      WS(K)     CPU(s)     Id  SI ProcessName
-------  ------    -----      -----     ------     --  -- -----------
    238      23    14572       3276       0.20  10472   1 ApplePhotoStreams
    310      19     7264       8468       0.11  14540   1 ApplicationFrameHost
    374      25     4764       2168       0.72  11684   1 APSDaemon
    149       9     1348        352              4240   0 armsvc
   1600      26    12604      20916              4084   0 avgsvca
   1117      39    23016      15224      36.75   1896   1 avguix
    315      17     3532       5528       2.48   5832   1 CastSrv
    324      30    76996     112504       3.38   8388   1 chrome
    320      32    85788     120048      11.83   9776   1 chrome
    268      21    20596      34688       0.14  11484   1 chrome
```

Figure 4-5. *Printing out the contents of the runningProcesses variable*

At this point you might be saying why would I go through the trouble to execute a PowerShell Command or CmdLet from Python? In order to answer that question let's take this example to the next level.

Creating a System Files Baseline with PowerShell and Python

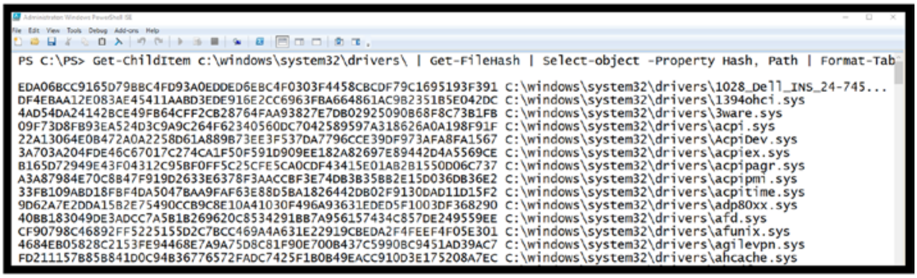
Let's say you wish to establish a baseline of what drivers are currently installed under Windows, specifically c:\windows\system32\drivers\. You could target any directory, subdirectories, or the whole system for that matter, but system drivers run with privilege, and detecting new drivers, modifications of existing drivers, or removal of a driver could be useful during an investigation.

Obtaining information regarding files is accomplished using the Get-ChildItem CmdLet within PowerShell. This CmdLet has many features, properties, and methods associated with it. What we are interested in to create the baseline is:

1. The hash of each file for creating a known good hashset used by forensic software
2. The name of each file

It is quite straightforward to obtain this information from PowerShell using the Pipeline command shown as follows. The truncated results are depicted in Figure 4-6 and the command breakdown is described in detail in Figure 4-7.

```
Get-ChildItem c:\windows\system32\drivers\ |
Get-FileHash | Select-object -Property Hash, Path | Format-
Table -HideTableHeaders
```



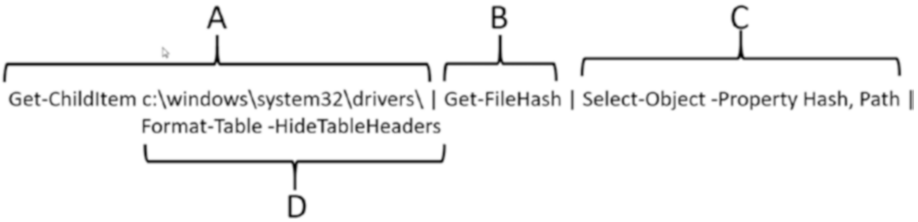
```
PS C:\PS> Get-ChildItem c:\windows\system32\drivers\ | Get-FileHash | Select-object -Property Hash, Path | Format-Tab

EDA06BCC9165D79BBC4FD93A0EDDED6EBC4F0303F4458CBCDF79C1695193F391 C:\windows\system32\drivers\1028_Dell_INS_24-745...
DF4EBAA12E083AE45411AABD3EDE916E2CC6963FBA664861AC9B2351B5E042DC C:\windows\system32\drivers\1394ohci.sys
4AD54DA24142BCE49FB64CFF2CB28764FAA93827E7DB02925090B68F8C73B1FB C:\windows\system32\drivers\3ware.sys
09F73D8FB93EA524D3C9A9C264F62340560DC7042589597A318626A0A198F91F C:\windows\system32\drivers\acpi.sys
22A13064E0B472A0A2258D61A889B73EE3F537DA7796CCE39DF973AFA8FA1567 C:\windows\system32\drivers\AcpiDev.sys
3A703A204FDE46C67017C274CA1F50F591D909EE182A82697E89442D4A5569CE C:\windows\system32\drivers\acpiex.sys
B165D72949E43F04312C95BF0FF5C25CFE5CA0CDF43415E01AB2B1550D06C737 C:\windows\system32\drivers\acpipagr.sys
A3A87984E70C8B47F919D2633E6378F3AACCBF3E74DB3B35BB2E15D036DB36E2 C:\windows\system32\drivers\acpipmi.sys
33FB109ABD18FBF4DA5047BAA9FAF63E88D5BA1826442DB02F9130DAD11D15F2 C:\windows\system32\drivers\acpitime.sys
9D62A7E2DDA15B2E75490CCB9C8E10A41030F496A93631EDED5F1003DF368290 C:\windows\system32\drivers\adp80xx.sys
40BB183049DE3ADCC7A5B1B269620C8534291BB7A956157434C857DE249559EE C:\windows\system32\drivers\afd.sys
CF90798C46892FF5225155D2C7BCC469A4A631E22919CBEDA2F4FEEF4F05E301 C:\windows\system32\drivers\afunix.sys
4684EB05828C2153FE94468E7A9A75D8C81F90E700B437C5990BC9451AD39AC7 C:\windows\system32\drivers\agilevpn.sys
FD211157B85B841D0C94B36776572FADC7425F1B0B49EACC910D3E175208A7EC C:\windows\system32\drivers\ahcache.sys
```

Figure 4-6. *Obtain file hash and path using PowerShell (note output is truncated)*

The breakdown of the Pipeline command is shown as follows and in Figure 4-7.

- **A.** Get-ChildItem CmdLet specifying the target folder windows\system32\drivers.

- **B.** The output of the Get-ChildItem CmdLet is piped to the Get-FileHash CmdLet which will, by default, generate the SHA-256 hash of each file.
- **C.** The result of the Get-FileHash CmdLet will be piped to the Select-Object CmdLet which will extract just the SHA-256 hash value and the File Path of the two outputs that are needed.
- **D.** The results of the Select-Object CmdLet are then passed to the Format-Table CmdLet which removes the Table Header from the output.



```
Get-ChildItem c:\windows\system32\drivers\ | Get-FileHash | Select-Object -Property Hash, Path |
Format-Table -HideTableHeaders
```

Figure 4-7. *PowerShell Pipeline breakdown Get-ChildItem, Get-FileHash, Select-Object, and Format-Table*

Creating a PowerShell script with input parameters will make this command a bit more useful and re-useable. The complete script is shown in Listing 4-1.

Listing 4-1. HashAquire.ps1 Script

```
<#
.synopsis
Collect Hash and Filenames from specified folder

- User Specifies the target computer
- User Specifies the target folder
```

```
The script will produce a simple ascii output file containing
SHA-256Hash and FilePath

.Description
This script collects Hash and Filenames from specified computer
and folder

.parameter targetComputer
Specifies the computer to collect the specified file hash
information

.parameter UserName
Specifies the Administrator UserName on the Target Computer

.parameter outFile
Specifies the full path of the output file

.example

HashAcquire
Collects the file hashes on the target Computer
#>

# Parameter Definition Section
param(
    [string]$TargetFolder="c:/windows/system32/drivers/",
    [string]$ResultFile="c:/PS/baseline.txt"
)

Get-ChildItem $TargetFolder | Get-FileHash | Select-Object
-Property Hash, Path | Format-Table -HideTableHeaders | Out-
File $ResultFile -Encoding ascii
```

The script has the standard sections in order to provide the proper Get-Help support, as shown in Listing 4-2.

Listing 4-2. Get-Help Results for the HashAquire.ps1 PowerShell Script

```
PS C:\PS> Get-Help .\HashAcquire.ps1

NAME
    C:\PS\HashAcquire.ps1

SYNOPSIS
    Collect Hash and Filenames from specified folder

    - User Specifies the target computer
    - User Specifies the target folder

    The script will produce a simple ascii output file
    containing
    SHA-256Hash and FilePath

SYNTAX
    C:\PS\HashAcquire.ps1 [[-TargetFolder] <String>]
   [[-ResultFile] <String>] [<CommonParameters>]

DESCRIPTION
    This script collects Hash and Filenames from specified
    computer and folder

RELATED LINKS

REMARKS
    To see the examples, type: "get-help C:\PS\HashAcquire.ps1
    -examples".
    For more information, type: "get-help C:\PS\HashAcquire.ps1
    -detailed".
    For technical information, type: "get-help C:\PS\
    HashAcquire.ps1 -full".
```

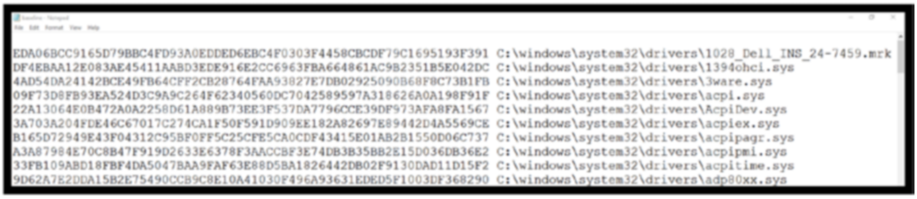
The script contains two input parameters TargetFolder and ResultFile.

```
# Parameter Definition Section
param(
    [string]$TargetFolder="c:/windows/system32/drivers/",
    [string]$ResultFile="c:/PS/baseline.txt"
)
```

Using the default parameters, the script creates the baseline.txt file. The abbreviated results are shown in Figure 4-8. By supplying a parameter for specifying the target folder, this script can now be applied to any legitimate folder.

Note Access to certain folders will require administrator privilege. Make sure that you are running PowerShell as Admin.

```
PS C:\PS> .\HashAcquire.ps1
```



```
EDA06BCC9165D79BBC4FD93A0EDDED6EBC4F0303F4458CBCDF79C1695193F391 C:\windows\system32\drivers\1028_Dell_INS_24-7459.mrk
DF4EBAA12E083AE45411AABD3EDE916E2CC6963FBA664861AC9B2351B5E042DC C:\windows\system32\drivers\1394ohci.sys
4AD54DA24142BCE49FB64CFF2CB28764FAA93827E7DB02925090B68F8C73B1FB C:\windows\system32\drivers\3ware.sys
09F73D8FB93EA524D3C9A9C264F62340560DC7042589597A318626A0A198F91F C:\windows\system32\drivers\acpi.sys
22A13064E0B472A0A2258D61A889B73EE3F537DA7796CCE39DF973AFA8FA1567 C:\windows\system32\drivers\AcpiDev.sys
3A703A204FDE46C67017C274CA1F50F591D909EE182A82697E89442D4A5569CE C:\windows\system32\drivers\acpiex.sys
B165D72949E43F04312C95BF0FF5C25CFE5CA0CDF43415E01AB2B1550D06C737 C:\windows\system32\drivers\acpipagr.sys
A3A87984E70C8B47F919D2633E6378F3AACCBF3E74DB3B35BB2E15D036DB36E2 C:\windows\system32\drivers\acpipmi.sys
33FB109ABD18FBF4DA5047BAA9FAF63E88D5BA1826442DB02F9130DAD11D15F2 C:\windows\system32\drivers\acpitime.sys
9D62A7E2DDA15B2E75490CCB9C8E10A41030F496A93631EDED5F1003DF368290 C:\windows\system32\drivers\adp80xx.sys
```

Figure 4-8. *baseline.txt abbreviated results*

Creating the Baseline with Python

Now that we have a reliable method of extracting the hash and filename using the HashAcquire.ps1 PowerShell script, we can use Python to create a baseline from these results. However, for this we will create a Python script/program instead of using the interactive shell.

The plan is to launch the PowerShell script from Python and extract the results from the created text file. You can specify the name and location of the resulting file by using the ResultFile parameter provided by the script.

Note The current PowerShell script only processes the specified directory. However, the Get-ChildItem CmdLet has an optional parameter that could be used to specify sub-folder acquisition as well. That parameter is -recurse, by using:

```
Get-Help Get-ChildItem
```

You will find that Get-ChildItem has many options and example usage.

The next step is to store the extracted results in a Python dictionary to produce a baseline. Once the dictionary baseline is created, the resulting dictionary can be stored and used for comparison. This way you can detect any new, modified, or deleted files from a target folder.

Note Python dictionaries, much like traditional Webster-style dictionaries, have a Key and a Value, which are typically referred to as a Key/Value pair. In Python, both the Key and the Value can be complex, the only rule being that the Key must be a hashable type such as an integer, long, string, or tuple. The Value part of the Key/Value pair can be a list or other nonhashable data type. In addition, the dictionary's keys must be unique (much like real dictionaries).

The complete CreateBaseline.py script is shown in Listing 4-3.

Note For the PowerShell and Python scripts throughout the rest of the book, the directory c:\PS was created to hold the scripts and results.

Also, do not try to copy and paste the Python scripts from the book text. Python uses a method of strict indentation that can be corrupted through the copy and paste process. The publisher has provided access to the source code files at: www.apress.com/9781484245033.

Listing 4-3. CreateBaseLine Python Script

```
'''
Step One Create a baseline hash list of target folder
December 2018, Python Forensics

'''

''' LIBRARY IMPORT SECTION '''

import subprocess       # subprocess library
import argparse         # argument parsing library
import os               # Operating System Path
import pickle           # Python object serialization

'''ARGUMENT PARSING SECTION '''

def ValidatePath(thePath):
    ''' Validate the Folder thePath
        it must exist and we must have rights
        to read from the folder.
        raise the appropriate error if either
        is not true
    '''
    # Validate the path exists
    if not os.path.exists(thePath):
        raise argparse.ArgumentTypeError('Path does
        not exist')

    # Validate the path is readable
    if os.access(thePath, os.R_OK):
        return thePath
    else:
        raise argparse.ArgumentTypeError('Path is not readable')

#End ValidatePath

''' Specify and Parse the command line, validate the arguments
and return results'''

parser = argparse.ArgumentParser('File System Baseline Creator
with PowerShell- Version 1.0 December 2018')

parser.add_argument('-b', '--baseline',
required=True,
help="Specify the resulting dictionary baseline file")

parser.add_argument('-p', '--Path',
required=True, type= ValidatePath,
help="Specify the target folder to baseline")

parser.add_argument('-t', '--tmp',
required=True,
help="Specify a temporary result file for the PowerShell Script")
```

```
args = parser.parse_args()

baselineFile = args.baseline
targetPath   = args.Path
tmpFile      = args.tmp

''' MAIN SCRIPT SECTION '''
if __name__ == '__main__':

    try:
        ''' POWERSHELL EXECUTION SECTION '''
         command = "powershell -ExecutionPolicy ByPass
-File C:/PS/HashAcquire.ps1"+"
-TargetFolder "+ targetPath+" -ResultFile "+ tmpFile

        print(command)

        powerShellResult = subprocess.run(command,
        stdout=subprocess.PIPE)

        if powerShellResult.stderr == None:

            ''' DICTIONARY CREATION SECTION '''
            baseDict = {}

            with open(tmpFile, 'r') as inFile:
                for eachLine in inFile:
                    lineList = eachLine.split()
                    if len(lineList) == 2:
                        hashValue = lineList[0]
                        fileName  = lineList[1]
                        baseDict[hashValue] = fileName
                    else:
                        continue
            with open(baselineFile, 'wb') as outFile:
                pickle.dump(baseDict, outFile)

                print("Baseline: ", baselineFile,
" Created with:", "{:,}".format(len(baseDict)), "Records")
                print("Script Terminated Successfully")
        else:
            print("PowerShell Error:", p.stderr)

    except Exception as err:
        print ("Cannot Create Output File: "+str(err))
        quit()
```

Those new to Python might find this script a bit complicated. Therefore, the script has been broken down into the following sections here:

1. LIBRARY IMPORT
2. ARGUMENT PARSING
3. MAIN
4. POWERSHELL EXECUTION
5. DICTIONARY CREATION

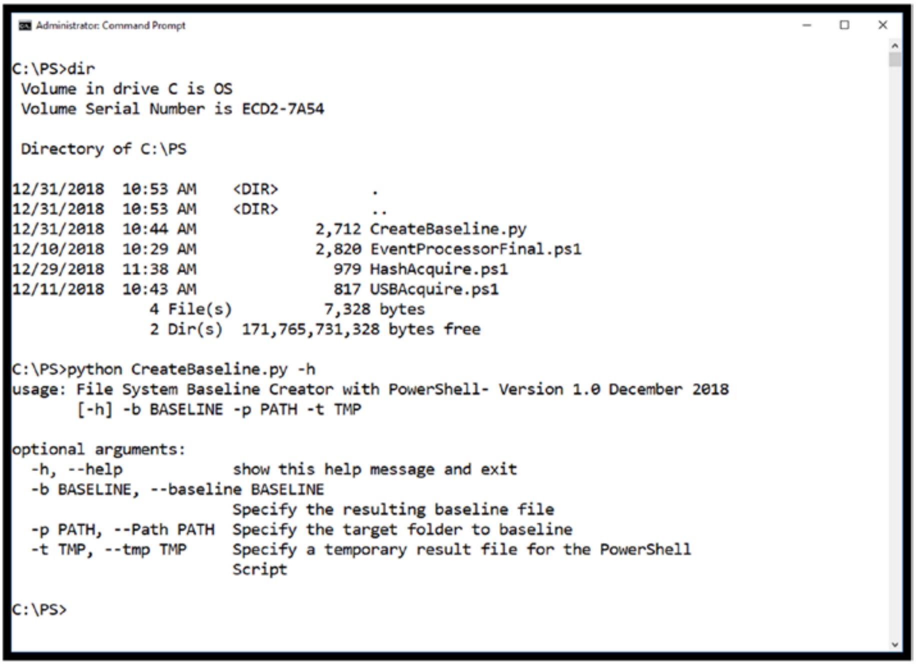
LIBRARY IMPORT: As the name implies, this is where the needed Python libraries are loaded. They include:

- subprocess: Used to launch the PowerShell script
- os: Used for file and folder validation
- argparse: Used for parsing the command line arguments
- pickle: Used to store the resulting dictionary to a file for later use

ARGUMENT PARSING: This section sets up and then processes user command line arguments. For this script, the required arguments include the following:

- -b specifies the resulting dictionary baseline filename.
- -p specifies the target path to be used by the PowerShell script to store the extracted hash and filenames.
- -t specifies the tmp file that will be used by the PowerShell script to store the hash data.

The argparse library in Python automatically processes the command line and validates that the user has entered all the required arguments and will provide help if requested. Figure 4-9 depicts the test folder and the result of executing the script with only the -h option.



```
C:\PS>dir
 Volume in drive C is OS
 Volume Serial Number is ECD2-7A54

 Directory of C:\PS

12/31/2018  10:53 AM    <DIR>          .
12/31/2018  10:53 AM    <DIR>          ..
12/31/2018  10:44 AM             2,712 CreateBaseline.py
12/10/2018  10:29 AM             2,820 EventProcessorFinal.ps1
12/29/2018  11:38 AM               979 HashAcquire.ps1
12/11/2018  10:43 AM               817 USBAcquire.ps1
               4 File(s)          7,328 bytes
               2 Dir(s)  171,765,731,328 bytes free

C:\PS>python CreateBaseline.py -h
usage: File System Baseline Creator with PowerShell- Version 1.0 December 2018
       [-h] -b BASELINE -p PATH -t TMP

optional arguments:
  -h, --help            show this help message and exit
  -b BASELINE, --baseline BASELINE
                        Specify the resulting baseline file
  -p PATH, --Path PATH  Specify the target folder to baseline
  -t TMP, --tmp TMP     Specify a temporary result file for the PowerShell
                        Script

C:\PS>
```

Figure 4-9. *Execution of the CreateBaseline.py script requesting help*

The argument processing section results in the creation of three variables:

1. [-b] baselineFile: Which specifies the resulting baseline dictionary file. This file will be created by the Python script.
2. [-p] targetPath: Which is passed to the PowerShell script to specify which folder to baseline. This is used by the PowerShell script.
3. [-t] tmpFile: Which is passed to the PowerShell script to specify the resulting temporary text file that will hold the intermediate results. The Python script uses this temporary file once generated by the PowerShell script.

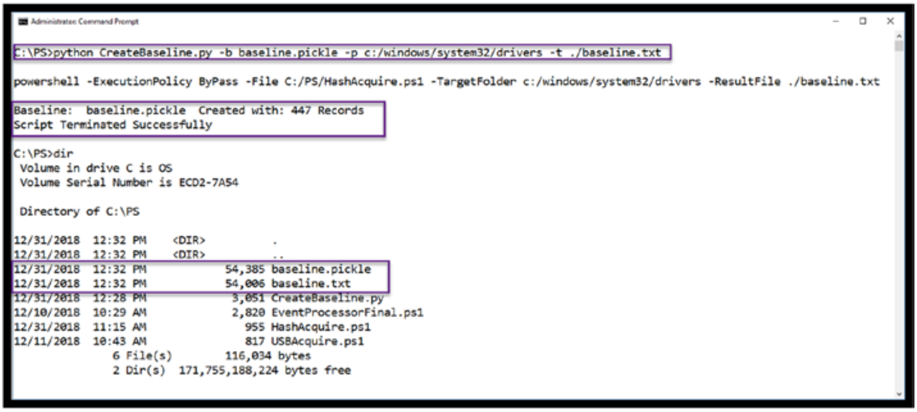
MAIN: The main section performs the core elements of the script once the preliminary setup is complete.

POWERSHELL EXECUTION: This section launches the PowerShell script. It first creates a variable named **command** that will be used by the subprocess.run() method to launch the PowerShell script. Note that the execution in this case specifies a file, -File vs. a command, -Command that was used in the previous examples. It specifies the PowerShell script HashAcquire.ps1. Upon completion of the subprocess command, the standard error or stderr result is checked for successful completion. The result should be None. If not, the Python script will report the error returned.

DICTIONARY CREATION: If the PowerShell command was completed successfully, the temporary result file is then processed by the Python script in order to create the dictionary. Since the format of the resulting file is defined in the PowerShell script, processing each line of the file to extract the hash value and file path can be accomplished using a Python iteration loop. A dictionary entry is created for each line using the Hash

Value as the **Key** and the File Path as the **Value** of the KEY/VALUE pair. Once all the lines have been processed, the Python pickle library is used to store the created dictionary in the file specified on the command line which is now contained in the variable baselineFile. The Python script will then report details of the script. If any errors or exceptions occur during the Python script, the script will report the exception.

Figure 4-10 shows a successful execution of the CreateBaseline.py Python combined with the HashAcquire.ps1 PowerShell script. As you can see, the script produced 447 dictionary entries for the files contained in the c:/windows/system32/drivers/ folder. In addition, the two specified files baseline.txt and baseline.pickle were created in the c:/PS/ folder.



```
C:\PS>python CreateBaseline.py -b baseline.pickle -p c:/windows/system32/drivers -t ./baseline.txt

powershell -ExecutionPolicy ByPass -File C:/PS/HashAcquire.ps1 -TargetFolder c:/windows/system32/drivers -ResultFile ./baseline.txt

Baseline:  baseline.pickle  Created with: 447 Records
Script Terminated Successfully

C:\PS>dir
 Volume in drive C is OS
 Volume Serial Number is ECD2-7A54

 Directory of C:\PS

12/31/2018  12:32 PM    <DIR>          .
12/31/2018  12:32 PM    <DIR>          ..
12/31/2018  12:32 PM            54,385 baseline.pickle
12/31/2018  12:32 PM            54,006 baseline.txt
12/31/2018  12:28 PM             3,051 CreateBaseline.py
12/10/2018  10:29 AM             2,820 EventProcessorFinal.ps1
12/31/2018  11:15 AM               955 HashAcquire.ps1
12/11/2018  10:43 AM               817 USBAcquire.ps1
               6 File(s)        116,034 bytes
               2 Dir(s)  171,755,188,224 bytes free
```

Figure 4-10. *Python/PowerShell script combined script execution*

Verifying the Baseline with Python

The next step is to create a Python Script that will verify that the current version of the selected folder has not changed. Basically, we are creating a simple tripwire of sorts. What are the specific validations that should be accomplished by the verification script?

1. Have any files been added?
2. Have any files been deleted?
3. Have any files been changed?

We are going to reuse the HashAcquire.ps1 PowerShell script and make some modifications to the processing of each entry returned by HashAcquire.ps1. For the most part, the VerifyBaseline.py script looks almost identical to the CreateBaseline.py script. The only modifications include:

1. Addition of the BASELINE DICTIONARY LOAD SECTION
2. Addition of the DICTIONARY TEST SECTION and associated dictionary validation functions

Listing 4-4 contains the full verification Python script. Note the HashAcquire.ps1 PowerShell script is unchanged.

Listing 4-4. Verify Baseline Python Script

```
'''
Step Two Verify a baseline hash list against a target folder
December 2018, Python Forensics
'''

''' LIBRARY IMPORT SECTION '''

import subprocess       # subprocess library
import argparse         # argument parsing library
import os               # Operating System Path
import pickle           # Python object serialization

"'ARGUMENT PARSING SECTION "'
```

```
def ValidatePath(thePath):
    ''' Validate the Folder thePath
        it must exist and we must have rights
        to read from the folder.
        raise the appropriate error if either
        is not true
    '''
    # Validate the path exists
    if not os.path.exists(thePath):
        raise argparse.ArgumentTypeError('Path does not exist')

    # Validate the path is readable
    if os.access(thePath, os.R_OK):
        return thePath
    else:
        raise argparse.ArgumentTypeError('Path is not readable')

#End ValidatePath ===================================

''' Specify and Parse the command line, validate the arguments
and return results'''

parser = argparse.ArgumentParser('File System Baseline
Validation with PowerShell- Version 1.0 December 2018')

parser.add_argument('-b', '--baseline',required=True,
help="Specify the source baseline file to verify")

parser.add_argument('-p', '--Path',
type= ValidatePath, required=True,
help="Specify the target folder to verify")

parser.add_argument('-t', '--tmp', required=True,
help="Specify a temporary result file for the PowerShell Script")
```

```
args = parser.parse_args()

baselineFile = args.baseline
targetPath   = args.Path
tmpFile      = args.tmp

def TestDictEquality(d1,d2):
    """ return True if all keys and values are the same
        otherwise return False """
    if all(k in d2 and d1[k] == d2[k] for k in d1):
        if all(k in d1 and d1[k] == d2[k] for k in d2):
            return True
        else:
            return False
    else:
        return False

    '''
    return all(k in d2 and d1[k] == d2[k]
               for k in d1) \
        and all(k in d1 and d1[k] == d2[k]
               for k in d2)
    '''

def TestDictDiff(d1, d2):
    """ return the subset of d1 where the keys don't exist in
    d2 or the values in d2 are different, as adict """
    diff = {}

    for k,v in d1.items():
        if k in d2 and v in d2[k]:
            continue
        else:
            diff[k+v] = "Baseline Missmatch"

    return diff

''' MAIN SCRIPT SECTION '''
if __name__ == '__main__':

    try:
        ''' POWERSHELL EXECUTION SECTION '''
        print()
        command = "powershell -ExecutionPolicy ByPass -File
        C:/PS/HashAcquire.ps1"+" -TargetFolder "+ targetPath+"
        -ResultFile "+ tmpFile
        print(command)
        print()

        powerShellResult = subprocess.run(command,
        stdout=subprocess.PIPE)
        if powerShellResult.stderr == None:

            ''' BASELINE DICTIONARY LOAD SECTION '''
            # Load in the baseline dictionary

            with open(baselineFile, 'rb') as baseIn:
                baseDict = pickle.load(baseIn)

            ''' DICTIONARY CREATION SECTION '''

            # Create a new dictionary for the target folder
            newDict  = {}

            with open(tmpFile, 'r') as inFile:
                for eachLine in inFile:
                    lineList = eachLine.split()
                if len(lineList) == 2:
                    hashValue = lineList[0]
                    fileName  = lineList[1]
                    newDict[hashValue] = fileName
                else:
                    continue

        ''' DICTIONARY TEST SECTION '''
        if TestDictEquality(baseDict, newDict):
            print("No Changes Detected")
        else:
            diff = TestDictDiff(newDict, baseDict)
            print(diff)

    else:
        print("PowerShell Error:", p.stderr)

except Exception as err:
    print ("Cannot Create Output File: "+str(err))
    quit()
```

Overview of the New Code Sections in VerifyBaseline.py

DICTIONARY LOAD: This section loads the specified dictionary from the saved pickle file that was created in the CreateBaseline.py script. The pickle.load() method is used to restore the dictionary from the specified file.

DICTIONARY TEST: This section utilizes two newly created functions:

- TestDictEquality()
- TestDictDiff()

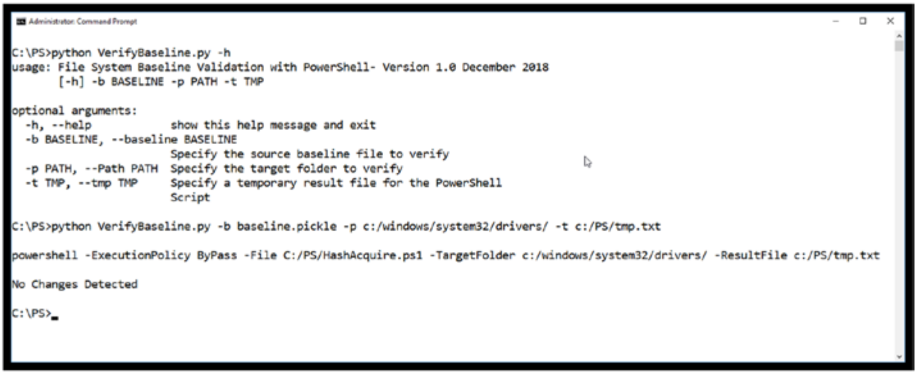
The TestDictEquality function compares the newly created dictionary of the target folder with the saved dictionary that was loaded using the pickle.load() method. The two dictionaries

- baseDict
- newDict

contain the dictionaries to compare. The dictionaries contain the SHA-256 Hash (key) and Filename (Value) for each dictionary. Python provides many useful built-in mechanisms to compare and iterate through dictionaries. The TestDictEquality function verifies that the two dictionaries are an exact match. And if they are, True is returned by the function. If they are not equivalent, then the function returns False. To determine what discrepancies exist, the TestDictDiff() function is called only when inequality exists.

The TestDictDiff function compares the contents of the baseDict with the newDict and creates a new dictionary to hold any mismatching values. The dictionary containing any differences is returned by the TestDictDiff function. Once returned, the contents of the diffDictionary are displayed.

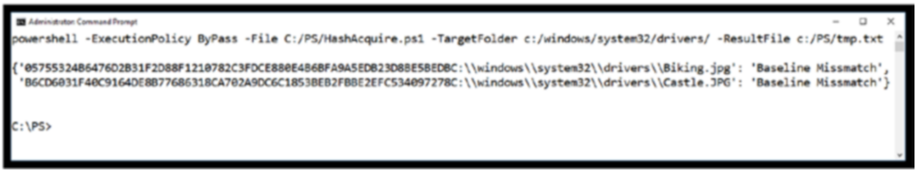
Figure 4-11 displays the execution of the VerifyBaseline.py script including the new help results and no changes detected.



```
C:\PS>python VerifyBaseline.py -h
usage: File System Baseline Validation with PowerShell- Version 1.0 December 2018
       [-h] -b BASELINE -p PATH -t TMP

optional arguments:
  -h, --help            show this help message and exit
  -b BASELINE, --baseline BASELINE
                        Specify the source baseline file to verify
  -p PATH, --Path PATH  Specify the target folder to verify
  -t TMP, --tmp TMP     Specify a temporary result file for the PowerShell
                        Script

C:\PS>python VerifyBaseline.py -b baseline.pickle -p c:/windows/system32/drivers/ -t c:/PS/tmp.txt

powershell -ExecutionPolicy ByPass -File C:/PS/HashAcquire.ps1 -TargetFolder c:/windows/system32/drivers/ -ResultFile c:/PS/tmp.txt

No Changes Detected

C:\PS>_
```

Figure 4-11. *Verify baseline execution and help with no changes*

Figure 4-12 shows the execution of the VerifyBaseline.py script which identifies two innocuous files added to the c:/windows/system32/drivers directory.



```
powershell -ExecutionPolicy ByPass -File C:/PS/HashAcquire.ps1 -TargetFolder c:/windows/system32/drivers/ -ResultFile c:/PS/tmp.txt

{'05755324B6476D2B31F2D88F1210782C3FDCE880E4B6BFA9A5EDB23D8BE5BEDBC:\\windows\\system32\\drivers\\Biking.jpg': 'Baseline Missmatch',
 'B6CD6031F40C9164DE8B77686318CA702A9DC6C1853BEB2FBBE2EFC534097278C:\\windows\\system32\\drivers\\Castle.JPG': 'Baseline Missmatch'}


C:\PS>
```

__Figure 4-12.__ Verify baseline execution with detected changes

Overview of Python Execution with PowerShell

This example provides a nice model for the execution and post-processing of PowerShell results from Python. More importantly, this model can be extended for several other uses. For example:

1. By modifying the PowerShell script and parameters, the target ComputerName could be added. The PowerShell Script could next add the Invoke-Command CmdLet and then perform remote acquisitions, something that would be much more difficult to do from Python only. Thus, we're using PowerShell as the acquisition engine and Python as the backed processor. Here is an example of the modified PowerShell Command that would be necessary:

   ```
   Invoke-Command -ComputerName $targetComputer
   -Credential $User
   -ScriptBlock {Get-ChildItem $TargetFolder |
   Get-FileHash | Select-Object -Property Hash,
   Path | Format-Table -HideTableHeaders | Out-File
   $ResultFile -Encoding ascii}
   ```

2. The acquisition CmdLet Get-ChildItem could be replaced with a plethora of other acquisition-oriented CmdLets such as:

    - Get-Process
    - Get-Service
    - Get-NetTCPConnections
    - Get-NetFirewallSetting
    - Or any other local or network values of investigative interest

    Then, without modification the Python CreateBaseline and VerifyBaseline scripts can be applied to create baselines and then detect any changes across your environment.

3. The interface model using subprocess.run() can be applied to other acquisitions of PowerShell scripts. Using the model of creating simple ASCII result files that can ingested line by line from Python, establish a solid interface between Python and PowerShell. You could of course return the data via standard out. However, this method is less stable when generating significant output from PowerShell.

Challenge Problem: Perform Remote Script Execution

Utilizing what you have learned about the execution of PowerShell scripts from Python and the model that has been provided:

1. Expand upon the solution provided by exploring other PowerShell CmdLets that provide investigative or incident response value. Adjust the PowerShell and Python scripts as required.

    a. Get-Process

    b. Get-Service

    c. Get-NETTCPConnections

    d. Get-FirewallSettings

2. Modify the PowerShell and Python scripts to include access to other computers. This will require changes to both scripts in order to provide the name(s) of the additional computer. In addition, the PowerShell script will need to add the appropriate Invoke-Command CmdLet.

Summary

This chapter focused on the execution of PowerShell CmdLets and scripts directed via Python. The chapter covered the key method for interfacing with PowerShell using the Python subprocess library.

In addition, methods for delivering PowerShell results to Python for post-processing were discussed. A reusable model for this integration delivers a baseline for the integration of PowerShell and Python.

Finally, the Python language, libraries, and data types were discussed by example. These included argument parsing, subprocess usage, dictionaries, functions, and the general Python program structure.

Chapter 5 will expand on PowerShell and Python integration with additional examples and methods.

CHAPTER 5

PowerShell/Python Investigation Example

The ability to gather remote activities during incident response situations is one of the key strengths of PowerShell. The infrastructure provided with the latest version of PowerShell significantly reduces the network setup required and offers significant security.

Integrating PowerShell and Python provides a viable platform for local and remote investigations. The “old” way of connecting to machines remotely is by using DCOM (Distributed Component Object Model) and/or RPCs (Remote Procedure Calls). These methods of integration involve significant complexities, and in some cases vulnerabilities, based upon the number of ports that need configuration.

The new method is called PowerShell Remoting. Remember, we saw the basics of this in Chapter 3, using the Invoke-Command CmdLet. In this chapter, we will take a much deeper look at PowerShell Remoting. However, before using the new PowerShell Remoting capability, it may need to be enabled in your environment. One of the nice features of PowerShell Remoting is that it runs over HTTPS, and it is done over a single port – port 5985.

C. Hosmer, *PowerShell and Python Together*, https://doi.org/10.1007/978-1-4842-4504-0_5

Enable PowerShell Remoting

The first step is to enable PowerShell Remoting on your investigative machine (the one you are performing the investigation from). You probably already guessed that we are going to do this with a PowerShell CmdLet. Interestingly enough, this one is titled Enable-PSRemoting. As always, you start with Get-Help in order to understand the parameters and options (Listing 5-1).

Listing 5-1. Get-Help Enable-PSRemoting

```
PS C:\PS> Get-Help Enable-PSRemoting

NAME
    Enable-PSRemoting

SYNOPSIS
    Configures the computer to receive remote commands.

SYNTAX
    Enable-PSRemoting [-Confirm] [-Force]
    [-SkipNetworkProfileCheck] [-WhatIf] [<CommonParameters>]

DESCRIPTION
    The Enable-PSRemoting cmdlet configures the computer to
    receive Windows PowerShell remote commands that are sent by
    using the WS-Management technology.

    By default, on Windows Server® 2012, Windows PowerShell
    remoting is enabled. You can use Enable-PSRemoting to
    enable Windows PowerShell remoting on other supported
    versions of Windows and to re-enable remoting on Windows
    Server 2012 if it becomes disabled.
```

```
You have to run this command only one time on each
computer that will receive commands. You do not have to
run it on computers that only send commands. Because the
configuration starts listeners, it is prudent to run it
only where it is needed.

Beginning in Windows PowerShell 3.0, the Enable-PSRemoting
cmdlet can enable Windows PowerShell remoting on client
versions of Windows when the computer is on a public
network.
For more information, see the description of the
SkipNetworkProfileCheck parameter.

The Enable-PSRemoting cmdlet performs the following
operations:

- Runs the Set-WSManQuickConfighttp://go.microsoft.
  com/fwlink/?LinkID=141463 cmdlet, which performs the
  following tasks:

----- Starts the WinRM service.

----- Sets the startup type on the WinRM service to
      Automatic.

----- Creates a listener to accept requests on any IP
      address, if one does not already exist.

----- Enables a firewall exception for WS-Management
      communications.

----- Registers the Microsoft.PowerShell and Microsoft.
      PowerShell.Workflow session configurations, if it
      they are not already registered.
```

```
    ----- Registers the Microsoft.PowerShell32 session
          configuration on 64-bit computers, if it is not
          already registered.

    ----- Enables all session configurations.

    ----- Changes the security descriptor of all session
          configurations to allow remote access.

    ----- Restarts the WinRM service to make the preceding
          changes effective.

    To run this cmdlet, start Windows PowerShell by using the
    Run as administrator option.
    CAUTION: On systems that have both Windows PowerShell 3.0
    and Windows PowerShell 2.0, do not use Windows PowerShell
    2.0 to run the Enable-PSRemoting and Disable-PSRemoting
    cmdlets. The commands might appear to succeed, but the
    remoting is not configured correctly. Remote commands and
    later attempts to enable and disable remoting, are likely
    to fail.

RELATED LINKS
    Online Version: http://go.microsoft.com/fwlink/?LinkId=821475
    Disable-PSSessionConfiguration
    Enable-PSSessionConfiguration
    Get-PSSessionConfiguration
    Register-PSSessionConfiguration
    Set-PSSessionConfiguration
    Disable-PSRemoting
```

```
REMARKS
    To see the examples, type: "get-help Enable-PSRemoting
    -examples".
    For more information, type: "get-help Enable-PSRemoting
    -detailed".
    For technical information, type: "get-help Enable-
    PSRemoting -full".
    For online help, type: "get-help Enable-PSRemoting -online"
```

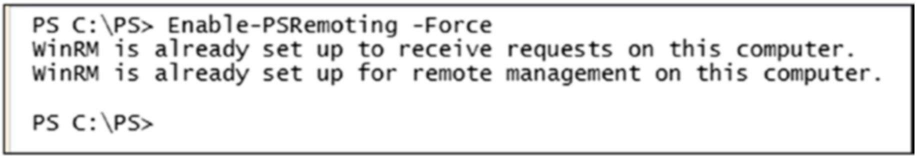
When executing PSRemoting, use the -Force option to eliminate the need for user confirmation throughout the process. Figure 5-1 depicts the CmdLet execution.

Note Since this is already enabled on the local machine, it provides the following feedback. Windows Remote Management (WinRM) is likely to be required when Enabling PSRemoting. Each system, network, and OS configuration is different, so consult your system administrator for assistance. Microsoft and third parties provide information on proper setup. Please consult these guides for more information. Also, this setup needs to be done on the computers that you wish to investigate as well.

https://docs.microsoft.com/en-us/powershell/module/microsoft.powershell.core/enable-psremoting?view=powershell-6

https://docs.microsoft.com/en-us/windows/desktop/winrm/winrm-powershell-commandlets

www.howtogeek.com/117192/how-to-run-powershell-commands-on-remote-computers/



```
PS C:\PS> Enable-PSRemoting -Force
WinRM is already set up to receive requests on this computer.
WinRM is already set up for remote management on this computer.

PS C:\PS>
```

Figure 5-1. *Enable PowerShell Remoting*

Note One final note regarding the enabling of PowerShell Remoting. The network configuration for all of your adapters must be set to Private not Public for security reasons. Please again contact your system administrator to make these changes, as parameters depend upon the operating system and version you are using.

Gathering and Analyzing Remote Evidence

Utilizing a combination of PowerShell and Python to gather evidence from systems other than the one we are running on is critical in order to expand the scope of our investigations. Let's first look at a very useful PowerShell CmdLet for both local and remote investigations: Get-DNSClientCache.

DNS Client cache, or DNS *resolver* cache, is a local database maintained by the operating system. It contains evidence of recent visits to web sites and other Internet locations. Simply put, DNS Client cache is just a record of recent DNS lookups that speeds access to already resolved web site IP addresses. Note that clearing the history of your web browser to hide your activity does not include the Operating Systems DNS resolver cache. Many cleaning programs will clear this cache, but it can be overlooked by users and it may provide important evidence of recent activity.

The DNS, or Doman Name System, provides a translation from friendly names like microsoft.com, google.com, and python-forensic.org to the IP addresses they reside at. Each time you enter an address in your browser like www.amazon.com, a DNS lookup is performed to translate the human readable address into an IP address that can be accessed.

Starting the Get DNSClientCache process after clearing the cache produces the following results.

```
PS C:\WINDOWS\system32> Get-DnsClientCache | Select-Object
-Property Entry
```

Of course, nothing is returned from the CmdLet because the cache is empty.

In order to add data to the DnsClientCache open a web browser and load the Google home page as shown in Figure 5-2.

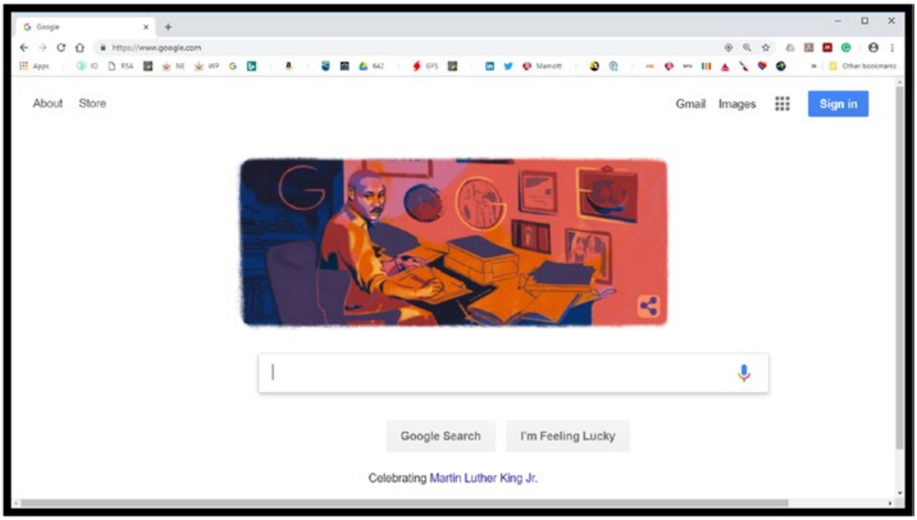


***Figure 5-2.** Launch browser and navigate to the Google home page*

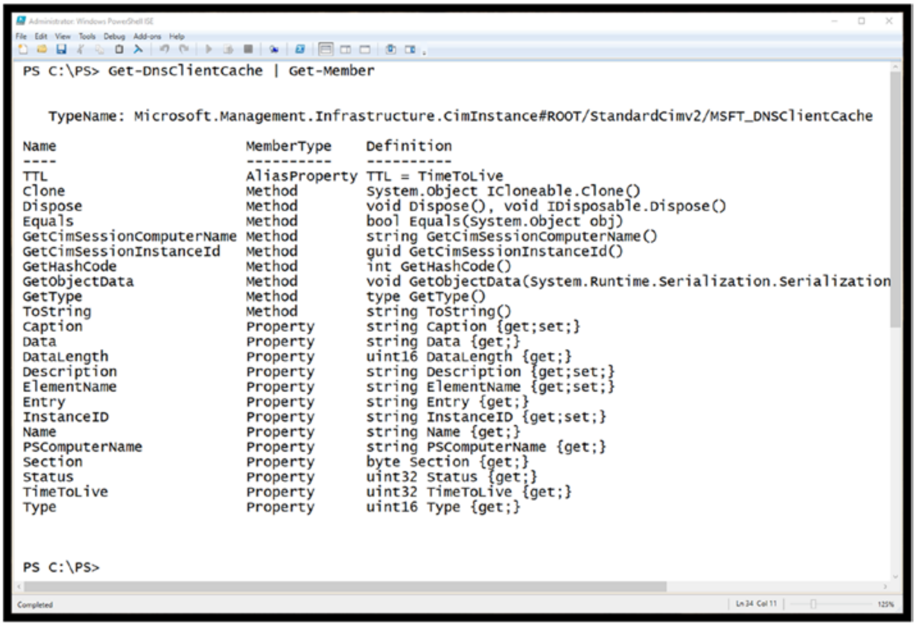
Executing the CmdLet now delivers some expected and not-expected results (Listing 5-2).

Listing 5-2. Results from the Get-DnsClientCache CmdLet

```
PS C:\WINDOWS\system32> Get-DnsClientCache | Select-Object
-Property Entry

Entry
-----
beacons.gcp.gvt2.com
beacons.gcp.gvt2.com
beacons.gcp.gvt2.com
google.com
google.com
google.com
google.com
google.com
google.com
bolt.dropbox.com
```

The stored DNS locations for google.com would of course be expected since the google.com page was opened. However, what is the beacons.gcp.gvt.com lookup? It is owned by google according to online research and is used by google to track activity and to provide automated assist when you type in the Google search window. The bolt.dropbox.com is unrelated to the `www.google.com` access, rather it was accessed due to a routine sync as Dropbox is running on the system.

As with other CmdLets, Get-ClientDnsCache has additional properties and member functions associated with it. They can be examined by piping the output of Get-ClientDnsCache to Get-Member as shown in Figure 5-3.



Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
Completed
Ln 34 Col 11
125%

```
PS C:\PS> Get-DnsClientCache | Get-Member


   TypeName: Microsoft.Management.Infrastructure.CimInstance#ROOT/StandardCimv2/MSFT_DNSClientCache

Name                         MemberType     Definition
----                         ----------     ----------
TTL                          AliasProperty  TTL = TimeToLive
Clone                        Method         System.Object ICloneable.Clone()
Dispose                      Method         void Dispose(), void IDisposable.Dispose()
Equals                       Method         bool Equals(System.Object obj)
GetCimSessionComputerName    Method         string GetCimSessionComputerName()
GetCimSessionInstanceId      Method         guid GetCimSessionInstanceId()
GetHashCode                  Method         int GetHashCode()
GetObjectData                Method         void GetObjectData(System.Runtime.Serialization.Serialization
GetType                      Method         type GetType()
ToString                     Method         string ToString()
Caption                      Property       string Caption {get;set;}
Data                         Property       string Data {get;}
DataLength                   Property       uint16 DataLength {get;}
Description                  Property       string Description {get;set;}
ElementName                  Property       string ElementName {get;set;}
Entry                        Property       string Entry {get;}
InstanceID                   Property       string InstanceID {get;set;}
Name                         Property       string Name {get;}
PSComputerName               Property       string PSComputerName {get;}
Section                      Property       byte Section {get;}
Status                       Property       uint32 Status {get;}
TimeToLive                   Property       uint32 TimeToLive {get;}
Type                         Property       uint16 Type {get;}


PS C:\PS>
```

Figure 5-3. *Member methods and properties for Get-DnsClientCache*

One good example is the TimeToLive property, which provides information regarding how long the DNS Client cache entry will persist in seconds. The knowledge that these entries only exist for a specific period certainly requires some urgency in collecting this information during an investigation. See Listing 5-3.

Listing 5-3. Obtaining the Time to Live for Each DnsClientCache Entry

```
PS C:\WINDOWS\system32> Get-DnsClientCache | Select-Object
-Property Entry, TimetoLive

Entry                        TimetoLive
-----                        ----------
www.gstatic.com                      17
ssl.gstatic.com                     292
```

```
www.google.com                    244
apis.google.com                   131
apis.google.com                   131
apis.google.com                   131
apis.google.com                   131
apis.google.com                   131
apis.google.com                   131
apis.google.com                   131
google.com                        292
google.com                        292
google.com                        292
google.com                        292
google.com                        292
google.com                        292
fonts.gstatic.com                 292
fonts.gstatic.com                 292
encrypted-tbn0.gstatic.com        292
```

Invoking Remote Access

A more significant application of Get-DnsClientCache is of course to execute this CmdLet remotely targeting systems under investigation. Using the Invoke-Command, targeting of the Lenovo-Upstairs computer in order to capture the recent DnsClientCaches is shown in Listing 5-4. The output was abbreviated in order to highlight more interesting locations, specifically the access to dfinews.com, forensicsmag.com, and steganography.com.

Listing 5-4. Remote Invocation of Get-DnsClientCache

```
PS C:\WINDOWS\system32> Invoke-Command -ComputerName Lenovo-
Upstairs -Credential Lenovo-Upstairs\Remote-Admin -ScriptBlock
{Get-DnsClientCache | Select-Object -Property Entry |Out-String}

Entry
-----

www.dfinews.com
www.dfinews.com
www.forensicmag.com
www.forensicmag.com
www.forensicmag.com
www.forensicmag.com
www.forensicmag.com

...
... reduced results for brevity
...

steganography.com
steganography.com
www.wired.com
www.wired.com
www.wired.com
www.wired.com
```

Building a PowerShell Script for DnsCache Acquisition

Unfortunately, there were hundreds of cached entries to sort through when this CmdLet was launched. Filtering or searching these results would be a tedious process for investigators. Therefore, why not create a Python script that leverages a PowerShell script to search the results based on a list of suspicious web sites or keywords of interest? Using the PowerShell script model that was created in Chapter 4, only a few simple tweaks are necessary to have application here:

1. Change the synopsis
2. Change the description
3. Modify the input parameters
4. Utilize the Get-ClientDnsCache CmdLet

Listing 5-5 shows the PowerShell script.

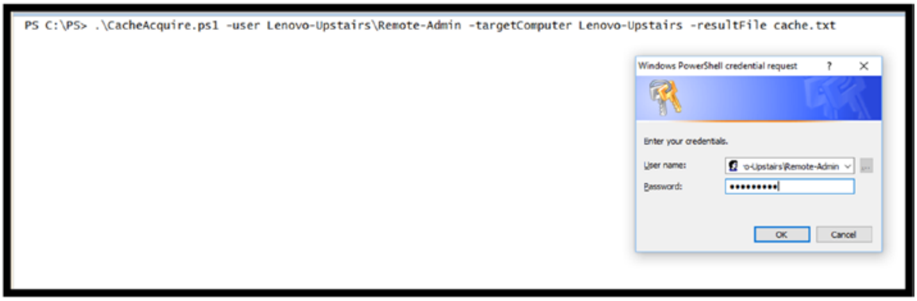
Listing 5-5. CacheAcquire.ps1 PowerShell Script

```
<#
.synopsis
Collect ClientDnsCache

- User Specifies the target computer

The script will produce a simple ascii output file containing
the recent DnsCache from the target computer

.Description
This script collects DnsCache from the Target Computer

.parameter targetComputer
Specifies the computer to collect the USB Activity

.parameter user
Specifies the Administrator UserName on the Target Computer

.parameter resultFile
Specifies the full path of the output file
```

```
.example

./CacheAcquire.ps1 -user Lenovo-Upstairs\Remote-Admin
-targetComputer Lenovo-Upstairs -resultFile cache.txt

Collects the recent DnsCache from the target computer
#>

# Parameter Definition Section
param(
    [string]$user,
    [string]$targetComputer,
    [string]$resultFile
)

# Obtain the ClientDnsCache from target computer and store the
result in a local variable
$r = Invoke-Command -ComputerName $targetComputer -Credential
$user -ScriptBlock {Get-DnsClientCache | Select-Object
-Property Entry | Out-String}

# Write the resulting list in simple ascii to a specified
local file
$r | Out-File $resultFile -Encoding ascii
```

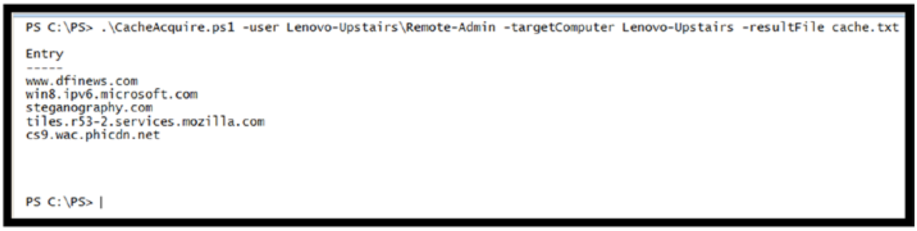
One important note: When using the Invoke-Command, any output file creation takes place on the remote system. Therefore, capture the result of the script in a variable ($r in this example) and then pipe the variable to the requested local file.

Sample execution of the script from within PowerShell ISE is shown in Figures 5-4 to 5-6.



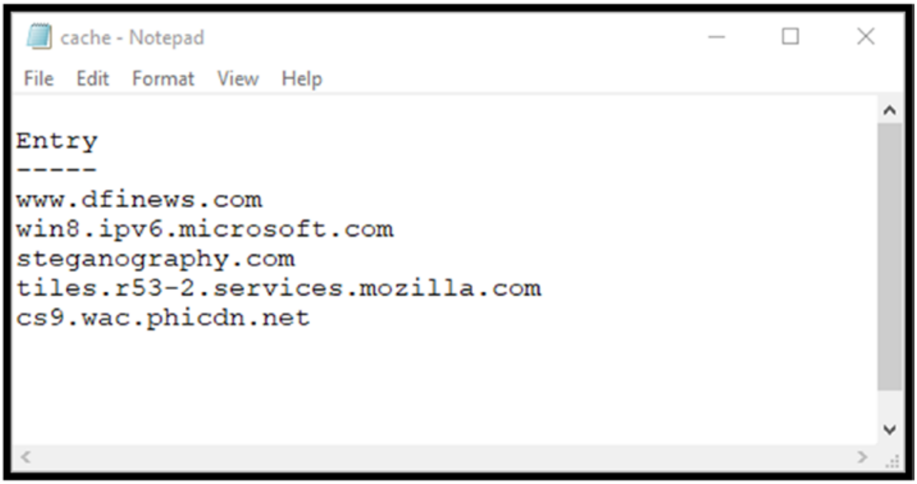
```
PS C:\PS> .\CacheAcquire.ps1 -user Lenovo-Upstairs\Remote-Admin -targetComputer Lenovo-Upstairs -resultFile cache.txt
```

***Figure 5-4.** CacheAcquire.ps1 execution and credential entry*



```
PS C:\PS> .\CacheAcquire.ps1 -user Lenovo-Upstairs\Remote-Admin -targetComputer Lenovo-Upstairs -resultFile cache.txt

Entry
-----
www.dfinews.com
win8.ipv6.microsoft.com
steganography.com
tiles.r53-2.services.mozilla.com
cs9.wac.phicdn.net


PS C:\PS> |
```

***Figure 5-5.** Resulting cache list*



```
Entry
-----
www.dfinews.com
win8.ipv6.microsoft.com
steganography.com
tiles.r53-2.services.mozilla.com
cs9.wac.phicdn.net
```

***Figure 5-6.** Resulting cache.txt file*

As with previous PowerShell scripts, using Get-Help will provide the details necessary to allow other users to also leverage the script (Listing 5-6).

Listing 5-6. Display Help for the CacheAcquire PowerShell Script

```
PS C:\PS> Get-Help .\CacheAcquire.ps1

NAME
    C:\PS\CacheAcquire.ps1

SYNOPSIS
    Collect ClientDnsCache

    - User Specifies the target computer

    The script will produce a simple ascii output file
    containing the recent DnsCache from the target computer

SYNTAX
    C:\PS\CacheAcquire.ps1 [[-user] <String>]
    [[-targetComputer] <String>] [[-resultFile] <String>]
    [<CommonParameters>]

DESCRIPTION
    This script collects DNS cache from the Target Computer

RELATED LINKS

REMARKS
    To see the examples, type: "get-help C:\PS\CacheAcquire.ps1
    -examples".
    For more information, type: "get-help C:\PS\CacheAcquire.
    ps1 -detailed".
    For technical information, type: "get-help C:\PS\
    CacheAcquire.ps1 -full".
```

Python Script and PowerShell CacheAquire Script

Now that we have a reliable PowerShell script to acquire DNS cache from remote computers, the next step is to build a Python script that will launch the PowerShell script, then search the subsequent results. The general concept is to search the acquired DNS cache using a set of keywords that are provided to the Python script from a file. See Listing 5-7.

Listing 5-7. AcquireDNS.py

```
'''
Acquire DNS Scripts from a Remote Computer
Version 1.0 January 2018
Author: Chet Hosmer
PYTHON Version 3.x is Required
'''

''' LIBRARY IMPORT SECTION '''

import subprocess       # subprocess library
import argparse         # argument parsing library
import os               # Operating System Path

''' ARGUMENT PARSING SECTION '''

def ValidateFile(theFile):
    ''' Validate the File exists
        it must exist and we must have rights
        to read from the folder.
        raise the appropriate error if either
        is not true
    '''
    # Validate the file exists
    if not os.path.exists(theFile):
        raise argparse.ArgumentTypeError('File does not exist')

    # Validate the file is readable
    if os.access(theFile, os.R_OK):
        return theFile
    else:
        raise argparse.ArgumentTypeError('File is not
        readable')

#End ValidateFile ===================================

''' Specify and Parse the command line, validate the arguments
and return results'''

parser = argparse.ArgumentParser('Remote Client DNS Cache with
PowerShell  - Version 1.0 January 2018')

parser.add_argument('-c', '--computer',  required=True,
                    help="Specify a target Computer for
                    Aquistion")

parser.add_argument('-u', '--user',      required=True,
                    help="Specify the remote user account")

parser.add_argument('-t', '--tmp',       required=True,
                    help="Specify a temporary result file for
                    the PowerShell Script")

parser.add_argument('-s', '--srch',      required=True,
                    type=ValidateFile, help="Specify the
                    keyword search file")
```

```
args = parser.parse_args()

computer = args.computer
user     = args.user
tmp      = args.tmp
srch     = args.srch

print("DNS Cache Acquisition\n")

print("Target:       ", computer)
print("User:         ", user)
print("Keyword File: ", srch)

'''KEYWORD LOADING SECTION '''

print("Processing Keyword Input")
try:
    with open(srch, 'r') as keywordFile:
        words = keywordFile.read()
        word = words.lower()
        words = words.strip()
        wordList = words.split()
        wordSet = set(wordList)
        keyWordList = list(wordSet)
        print("\nKeywords to search")
        for eachKeyword in keyWordList:
            print(eachKeyword)
        print()
except Exception as err:
    print("Error Processing Keyword File: ", str(err))
    quit()
```

```
''' MAIN SCRIPT SECTION '''
if __name__ == '__main__':

    try:
        "' POWERSHELL EXECUTION SECTION "'
        print()
        command = "powershell -ExecutionPolicy ByPass -File
        C:/PS/CacheAcquire.ps1"+" -targetComputer "+
        computer+ " -user "+user+ "
        -resultFile "+tmp

        print("Executing: ", command)
        print()

        powerShellResult = subprocess.run(command,
        stdout=subprocess.PIPE)

        if powerShellResult.stderr == None:

            '''DNS CACHE SEARCHING SECTION '''

            hitList = []
            try:
                with open(tmp, 'r') as results:
                    for eachLine in results:
                        eachLine = eachLine.strip()
                        eachLine = eachLine.lower()
                        for eachKeyword in keyWordList:
                            if eachKeyword in eachLine:
                                hitList.append(eachLine)
            except Exception as err:
                print("Error Processing Result File: ", str(err))
        '''RESULT OUTPUT SECTION '''

        print("Suspicous DNS Cache Entries Found")
        for eachEntry in hitList:
            print(eachEntry)

        print("\nScript Complete")
    else:
        print("PowerShell Error:", p.stderr)

except Exception as err:
    print ("Cannot Create Output File: "+str(err))
    quit()
```

The script has been broken down into the following sections. Each will be explained:

- LIBRARY IMPORT
- ARGUMENT PARSING
- KEYWORD LOADING
- POWERSHELL EXECUTION
- DNS CACHE SEARCHING
- RESULT OUTPUT

LIBRARY IMPORT: As the name implies, this is where the needed Python libraries are loaded. They include:

- subprocess: Used to launch the PowerShell script
- os: Used for file and folder validation
- argparse: Used for parsing the command line arguments

ARGUMENT PARSING: This section sets up and then processes user command line arguments. For this script the required arguments include the following:

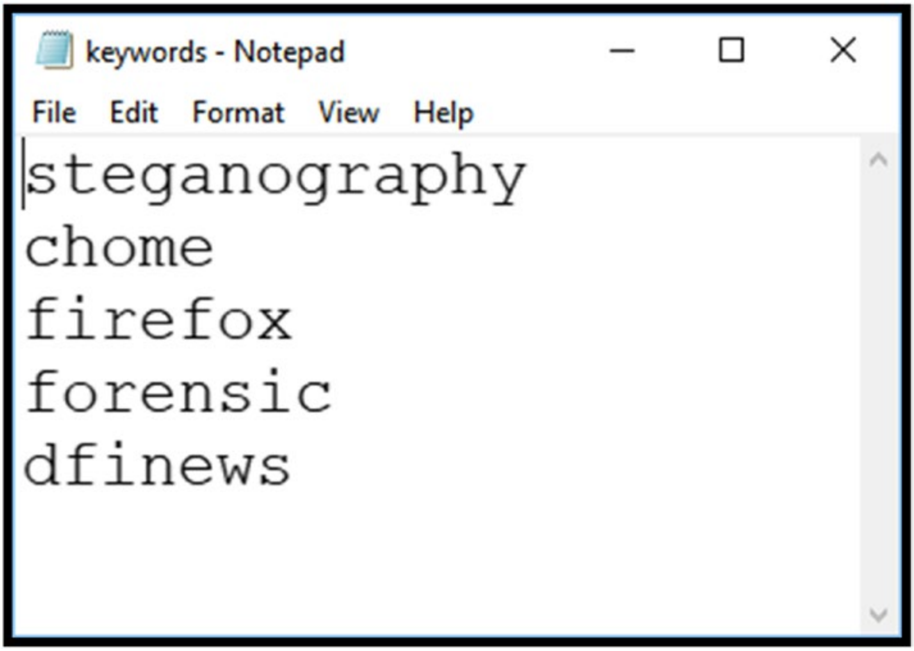
- -c specifies the target computer name.
- -u specifies the remote computer user name.
- -t specifies the tmp file that will be used by the PowerShell script to store the acquired DNS cache data.
- -s specifies the local file that contains keywords to search.

The argparse library in Python automatically processes the command line and validates that the user has entered all the required arguments. The library will also provide help if requested. To obtain the help, simply execute the script with only the -h option as shown in Listing 5-8.

Listing 5-8. Python Script Help Output Using the -h Switch

```
usage: Remote Client DNS Cache with PowerShell- Version 1.0
January 2018
       [-h] -c COMPUTER -u USER -t TMP -s SRCH

optional arguments:
  -h, --help            show this help message and exit
  -c COMPUTER, --computer COMPUTER
                        Specify a target Computer for Aquistion
  -u USER, --user USER  Specify the remote user account
  -t TMP, --tmp TMP     Specify a temporary result file for the
                        PowerShell Script
  -s SRCH, --srch SRCH  Specify the keyword search file
```

KEYWORD LOADING: This section opens the designated keyword file and creates a list of unique keywords found in the file (Figure 5-7). The section strips any extraneous characters from each entry, and ensures that all entries are in lowercase to enable the best search matching.



```
steganography
chome
firefox
forensic
dfinews
```

Figure 5-7. *Sample keywords file*

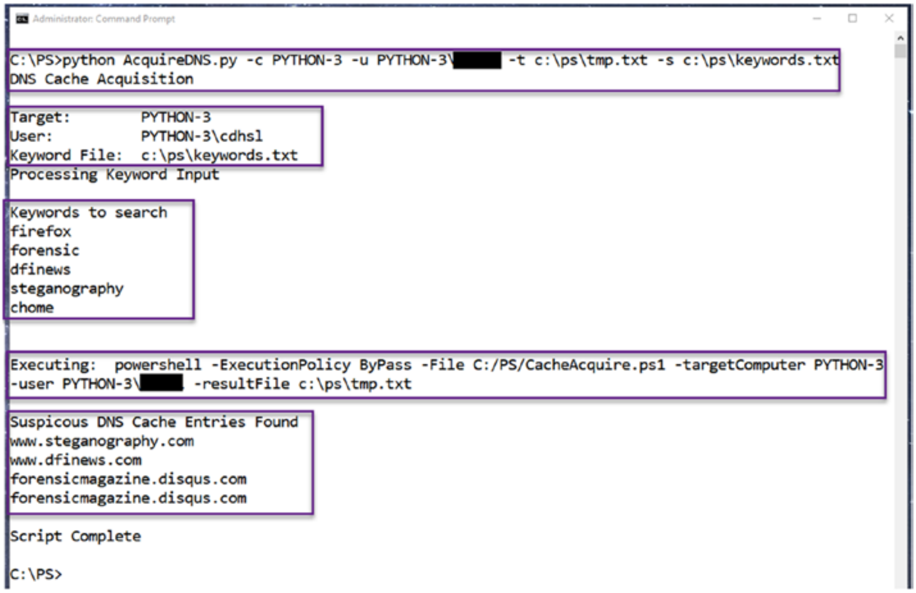
POWERSHELL EXECUTION: This section launches the PowerShell script. It first creates a variable named **command** that will be used by the subprocess.run() method to launch the PowerShell script. It specifies the PowerShell script CacheAcquire.ps1. Upon completion of the subprocess command, the standard error or stderr result is checked for successful completion. The result should be None. If not, the Python script will report the error generated by PowerShell.

DNS CACHE SEARCHING: This section processes each line from the cache results generated by PowerShell. Each line is then checked to determine if any of the unique keywordsv are found. If a keyword is detected, that entire line is stored in the Python *hitList* variable.

RESULT OUTPUT: This section iterates through each entry of the Python *hitList* variable and prints each result to the screen.

Figure 5-8 depicts the successful execution of the AcquireDNS.py Python script that leverages the CacheAcquire.ps1 PowerShell script. The script was executed from the Windows command line with administrator privilege.

```
C:\PS>python AcquireDNS.py -c PYTHON-3
-u PYTHON-3\USER-HIDDEN -t c:\ps\tmp.txt -s c:\ps\keywords.txt
```



```
C:\PS>python AcquireDNS.py -c PYTHON-3 -u PYTHON-3\[redacted] -t c:\ps\tmp.txt -s c:\ps\keywords.txt
DNS Cache Acquisition

Target:        PYTHON-3
User:          PYTHON-3\cdhsl
Keyword File:  c:\ps\keywords.txt
Processing Keyword Input

Keywords to search
firefox
forensic
dfinews
steganography
chome


Executing:  powershell -ExecutionPolicy ByPass -File C:/PS/CacheAcquire.ps1 -targetComputer PYTHON-3
-user PYTHON-3\[redacted] -resultFile c:\ps\tmp.txt

Suspicous DNS Cache Entries Found
www.steganography.com
www.dfinews.com
forensicmagazine.disqus.com
forensicmagazine.disqus.com

Script Complete

C:\PS>
```

Figure 5-8. *Acquire DNS remote in action*

The script output first shows:

1. Details of the extracted command line arguments:
    a. Target Computer
    b. Remote User Name
    c. Local Keyword File
2. The decoded list of keywords that were extracted from the local keyword file
3. The details of the PowerShell command line generated from the inputs
4. The matching DNS cache entries that contain keywords from the keyword list

Overview of Client DNS Cache Acquisition and Search

This example expands on the model that leverages the PowerShell acquisition strengths with a Python script that can search the results. More importantly, this model was used to acquire Client DNS cache data from a specified remote computer using the Invoke-Command CmdLet.

The Python script could be expanded to include a list of computers and relevant user accounts in order to automate the acquisition and the automated search of Client DNS cache on demand.

Challenge Problem: Multiple Target Computer DNSCache Acquisition

Utilizing what you have learned about the execution of PowerShell scripts from Python and the model that has been provided:

- Expand upon the solution provided by loading a list of target computes along with the required user accounts.
- In addition to searching each of the resulting Client DNS cache results, determine which DNS entries were common across all the computers that were accessed.

Summary

This chapter focused on the execution of PowerShell CmdLets and scripts directed via Python to acquire Client DNS cache from both the local computer and a specified remote device. The chapter delivered yet another PowerShell script that can be used either standalone or driven by the accompanying Python script to access, process, and search the results.

Finally, the Python language, libraries, and data types were discussed by example. These included argument parsing, subprocess usage, dictionaries, functions, and the general Python program structure.

Chapter 6 will discuss some future considerations that can expand upon the combination of PowerShell and Python for investigative use. In addition, the included appendix provides both PowerShell and Python/PowerShell combined examples that deliver a solid baseline for future investigations and expansion.

CHAPTER 6

Launching Python from PowerShell

So far, the approach to integrating Python with PowerShell has been to launch PowerShell scripts from Python as a subprocess. In this chapter, the roles will be reversed, and PowerShell will feed data to Python scripts. One of the key elements of PowerShell is pipelining the process of transferring the results of one CmdLet to the next. With that in mind, why not treat Python as just another pipeline element and execute Python scripts driven by data acquired by PowerShell?

Reversing Roles from PowerShell to Python

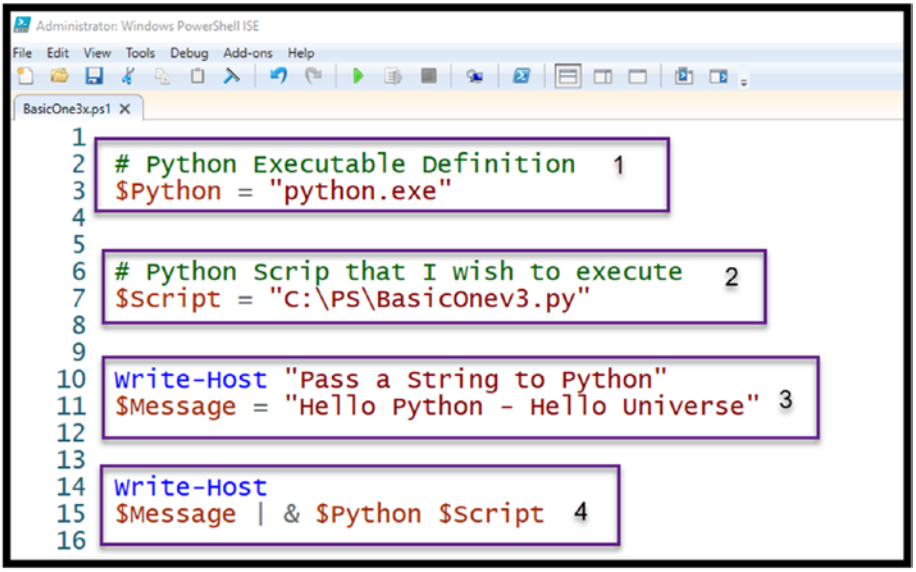
A PowerShell script and a Python script are both necessary to illustrate this method. We will start with a simple PowerShell script to pass a string of data across the pipe and display that data from the Python script.

C. Hosmer, *PowerShell and Python Together*, https://doi.org/10.1007/978-1-4842-4504-0_6

Examine the PowerShell Script

Let's examine the details of the PowerShell script shown in Figure 6-1. The script is broken down into four simple steps:

1. Define a local variable $Python with the full path to the Python executable of your choice. For this example, Python 3.x will be again used.
2. Define a local variable $Script that defines the full path to the Python script that will be executed.
3. Define a local variable $Message that will be passed via the pipeline to the Python script.
4. This line passes the contents of the variable message to the Python script. The key element here is the ampersand (&) that directs PowerShell to launch the external program.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
BasicOne3x.ps1
1
2
3
4

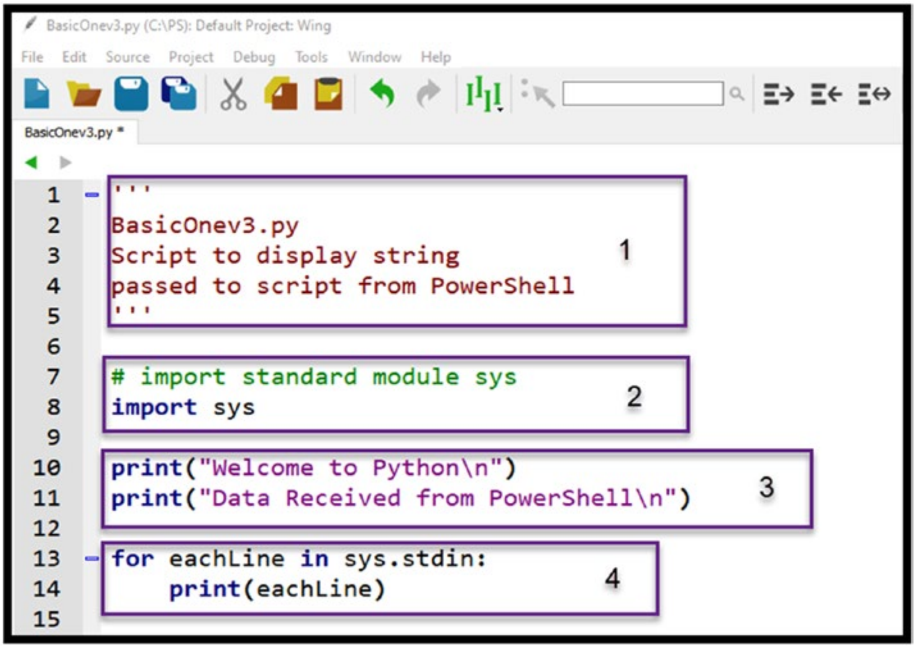
```

# Python Executable Definition
$Python = "python.exe"

# Python Scrip that I wish to execute
$Script = "C:\PS\BasicOnev3.py"

Write-Host "Pass a String to Python"
$Message = "Hello Python - Hello Universe"

Write-Host
$Message | & $Python $Script

```

__Figure 6-1.__ BasicOne.ps1 PowerShell script

Examine the Corresponding Python Script

Examining the corresponding Python script shown in Figure 6-2, we see that it is broken down into four sections as well:

1. A comment block that defines what the script will perform.
2. Import of the Python Standard Library sys. This is needed to process the data passed across the pipeline.
3. Print messages delivered from Python to demonstrate that the Python script is executing.
4. Processes each line delivered to the script via the pipeline and print the contents of each line. Note that in this example there is only one line passed.

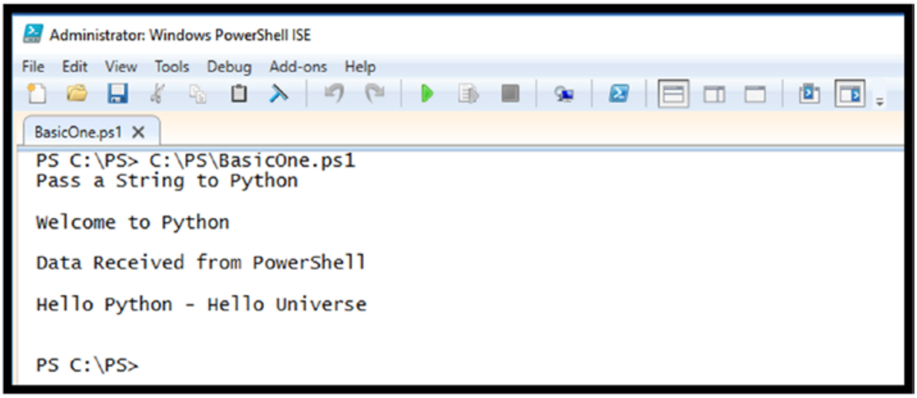

BasicOnev3.py (C:\PS): Default Project: Wing
File Edit Source Project Debug Tools Window Help
BasicOnev3.py *
1
2
3
4

```
'''
BasicOnev3.py
Script to display string
passed to script from PowerShell
'''

# import standard module sys
import sys

print("Welcome to Python\n")
print("Data Received from PowerShell\n")

for eachLine in sys.stdin:
    print(eachLine)
```

Figure 6-2. *BasicOne.py Python script*

Executing the Combined PowerShell to Python Scripts

Figure 6-3 depicts the resulting output generated by the PowerShell script driving the Python script. You'll notice that that the output from both the PowerShell script (write-host CmdLet) and the Python (print) statements appear in the PowerShell output.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
BasicOne.ps1

```
PS C:\PS> C:\PS\BasicOne.ps1
Pass a String to Python

Welcome to Python

Data Received from PowerShell

Hello Python - Hello Universe


PS C:\PS>
```

Figure 6-3. *Execution of BasicOne.ps1 driving BasicOne.py*

Using this method, now let's examine a more interesting use of the BasicOne method shown here.

Extracting Possible Proper Names from Text Documents

In this example, the PowerShell script will utilize the Get-ChildItem CmdLet and Get-Content CmdLet to obtain the contents of text files and pass the entire contents to a Python script. The Python script will process the content passed, again using the BasicOne method and attempt to extract possible proper names.

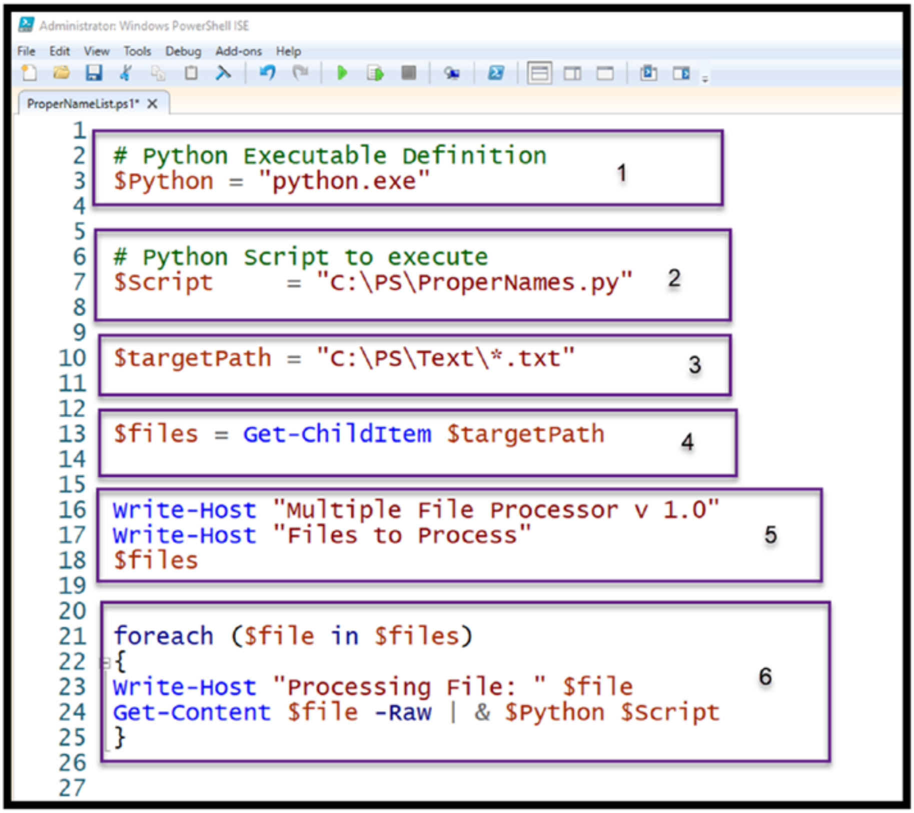
When examining simple text data during a forensic investigation, it is often useful to extract and rank proper names by the highest number of occurrences. The Python language has built-in capabilities that will perform this extraction swiftly and easily.

BUT FIRST, WHAT IS A PROPER NAME?

Linguistics defines proper names as those words that represent a person, place, group, organization, or thing that typically begins with a capital letter. For example, proper names in a single word (such as David, Smith, Carol, Washington, Canada, Pentagon, Congress, or Apple) can provide context and value to the investigation. In normal texts, these proper names are *most likely* capitalized and quite easy to strip, identify, count, and sort. It should be noted that not everyone would routinely capitalize proper names; however, smartphones, text messaging apps, e-mail programs, word processors, and even the Skype chat window automatically capitalize these for us. Thus, extracting and ranking them can provide a quick look and provide perspective to an investigation.

Examine the PowerShell Script

Figure 6-4 shows the PowerShell script that will deliver the content of these files to the more complex Python script that will perform the extraction and ranking of the possible proper names. Note, for this example, a new element has been added to allow the processing of multiple files.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
ProperNameList.ps1*
1
2
3
4
5
6

```
# Python Executable Definition
$Python = "python.exe"


# Python Script to execute
$Script      = "C:\PS\ProperNames.py"


$targetPath = "C:\PS\Text\*.txt"


$files = Get-ChildItem $targetPath


Write-Host "Multiple File Processor v 1.0"
Write-Host "Files to Process"
$files


foreach ($file in $files)
{
Write-Host "Processing File: " $file
Get-Content $file -Raw | & $Python $Script
}
```

Figure 6-4. *PowerShell ProperNames script*

The script has been broken down into six steps. Each step is defined here:

1. Define a local variable $Python with the full path to the Python executable of your choice.

2. Define a local variable $Script that identifies the full path to the Python script that will be executed.

3. Define a local variable $targetPath that identifies the target path and file types to process.

4. Utilize the Get-ChildItem CmdLet to obtain the names of the files that match the extension provided.

5. Write information to the host that includes the list of files that were discovered by the Get-ChildItem CmdLet.

6. Using a ForEach loop, process each file listed in the local variable $files. Within the loop the script prints out the name of each file, then extracts the raw content of the file and pipes the resulting content to the Python script.

Examine the Corresponding Python ProperNames Script

The Python script shown in Listing 6-1 is broken down into six major sections described here:

1. LIBRARY IMPORT
2. STOP WORDS LIST DEFINITION
3. DEFINING PSEUDO CONSTANTS
4. EXTRACT PROPER NAMES
5. MAIN PROGRAM ENTRY
6. PRINT RESULTING POSSIBLE PROPER NAMES

LIBRARY IMPORT: As the name implies, this is where the needed Python libraries are loaded. They include:

- sys: As demonstrated in BasicOne, this library allows us to process command line input delivered by PowerShell.
- re: The Python regular expression library is used in this script to strip out extraneous character from the text in order to simplify the search for proper names.

- datetime: As the name implies, this library provides methods for display and calculating time and date details.

STOP WORDS LIST DEFINITION: This section creates a list of stop words that are used to within the script eliminate words that do not provide probative value when assessing proper names. They are in fact words that commonly start sentences that would be capitalized. Thus, eliminating these words from the results produces improved results.

DEFINING PSEUDO CONSTANTS: Traditional constants do not exist in the Python language, however, by capitalizing these variable alerts the reader that these variables should not be altered. In this case the variables MIN_SIZE and MAX_SIZE define the limits on possible proper names. By changing these values, you can widen or narrow the range of possible proper names.

EXTRACT PROPER NAMES FUNCTION: This is the core function of the script that processes the content piped from the PowerShell script. The function will be called for each line processed from standard input. The function extract possible proper names from the string input and add them to the dictionary. If the name already exists in the dictionary the function updates the dictionary value which contains the occurrences for that specific possible proper name.

MAIN PROGRAM ENTRY: The main program first prints several heading messages. Then creates an empty properNamesDictionary. Then as in the BasicOne.py example the script processes each line from the system standard input provided by the PowerShell script. Each line is then converted using the regular expression to eliminate any non-alpha characters. Each converted string is passed the ExtractProperNames function along with the current properNamesDictionary. This process is then repeated for each line provided to the script.

PRINT RESULTING POSSIBLE PROPER NAMES: The final section sorts the resulting dictionary by occurrences (highest first) and then prints out each proper name and the associated counts.

Listing 6-1. Python ProperNames.py Script

```
'''
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obtaining a copy of this softwareand associated documentation
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restriction, including without limitation the rights to use, copy,
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of the Software, and to permit persons to whom the Software is
furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be
included in all copies or substantial
portions of the Software.

 ProperNames Demonstration
 Version 1.3
 January 2019

 Requirement: Python 3.x

 usage:
 stdin | python properNames.py

 Script will process the piped data

'''

''' LIBRARY IMPORT SECTION '''

# import standard module sys
import sys

# import the regular expression library
# in order to filter out unwanted characters
import re
```
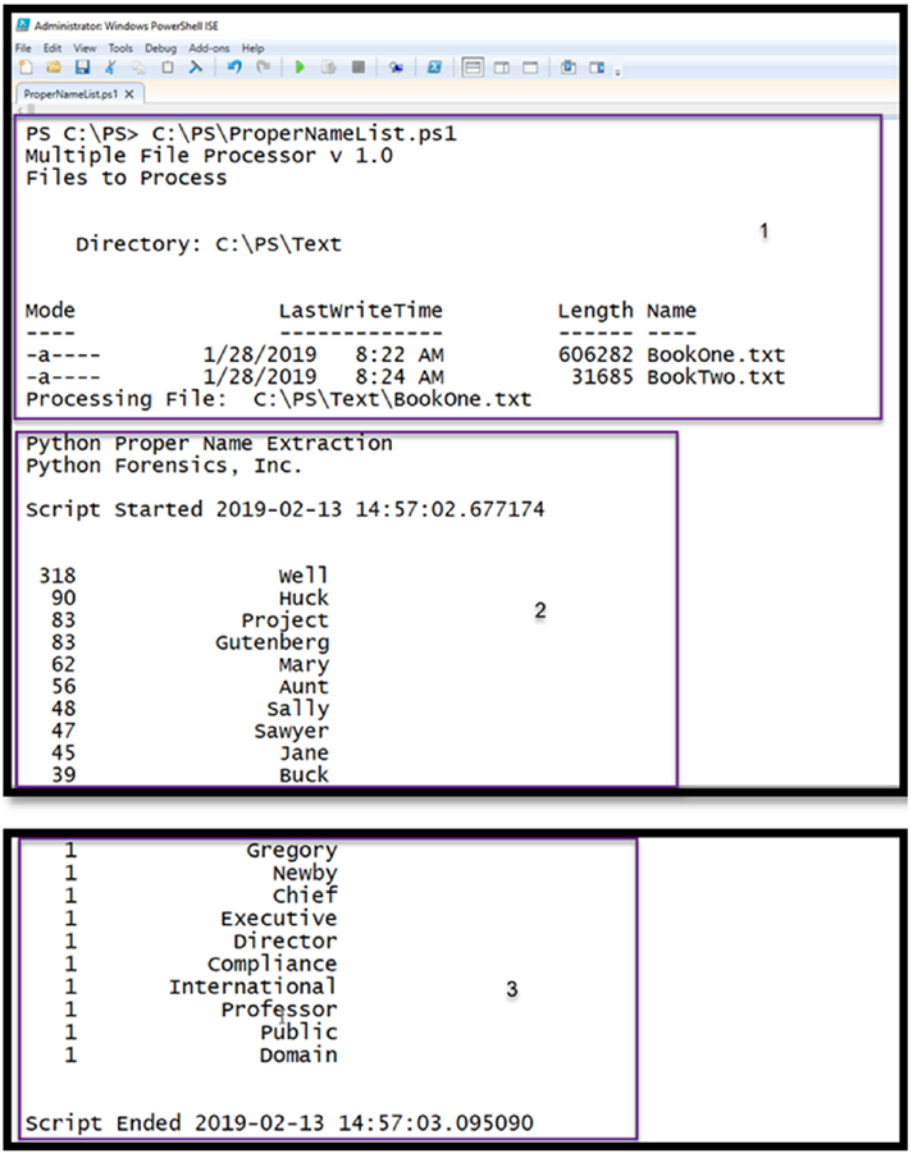

```
# import datetime method from Standard Library
from datetime import datetime

''' STOP WORDS LIST DEFINITION SECTION '''

# COMMON STOP WORDS LIST
# What are stop_words: Words which are
# typically filtered
# out when processing natural language data (text)
# feel free to add additional words to the list

STOP_WORDS = [
"able","about","above","accordance","according",
"accordingly","across","actually","added","affected",
"affecting","affects","after","afterwards","again",
"against","almost","alone","along","already","also",
"although","always","among","amongst","announce",
"another","anybody","anyhow","anymore","anyone",
"anything","anyway","anyways","anywhere","apparently",
"approximately","arent","arise","around","aside",
"asking","auth","available","away","awfully","back",
"became","because","become","becomes","becoming",
"been","before","beforehand","begin","beginning",
"beginnings","begins","behind","being",
"believe","below","beside","besides","between",
"beyond","both","brief","briefly","came","cannot",
"cause","causes","certain","certainly","come",
"comes","contain","containing","contains","could",
"couldnt","date","different","does","doing","done",
"down","downwards","during","each","effect","eight",
"eighty","either","else","elsewhere","end",
"ending","enough","especially","even","ever",
"every","everybody","everyone","everything",
"everywhere","except","fifth","first","five",
"followed","following","follows","former","formerly",
"forth","found","four","from","further",
"furthermore","gave","gets","getting",
"give","given","gives","giving","goes",
"gone","gotten","happens","hardly","has","have",
"having","hence","here","hereafter","hereby",
"herein","heres","hereupon","hers","herself",
"himself","hither","home","howbeit","however",
"hundred","immediate","immediately","importance",
"important","indeed","index","information",
"instead","into","invention","inward","itself",
"just","keep","keeps","kept","know","known",
"knows","largely","last","lately","later","latter",
"latterly","least","less","lest","lets","like",
"liked","likely","line","little","look","looking",
"looks","made","mainly","make","makes","many",
"maybe","mean","means","meantime","meanwhile",
"merely","might","million","miss","more","moreover",
"most","mostly","much","must","myself","name",
"namely","near","nearly","necessarily","necessary",
"need","needs","neither","never","nevertheless",
"next","nine","ninety","nobody","none","nonetheless",
"noone","normally","noted","nothing","nowhere",
"obtain","obtained","obviously","often","okay",
"omitted","once","ones","only","onto","other",
"others","otherwise","ought","ours","ourselves",
"outside","over","overall","owing","page","pages",
"part","particular","particularly","past","perhaps",
"placed","please","plus","poorly","possible","possibly",
"potentially","predominantly","present","previously",
"primarily","probably","promptly","proud","provides",
"quickly","quite","rather","readily","really","recent",
"recently","refs","regarding","regardless",
"regards","related","relatively","research",
"respectively","resulted","resulting","results","right",
"run","said","same","saying","says","section","see",
"seeing","seem","seemed","seeming","seems","seen",
"self","selves","sent","seven","several","shall",
"shed","shes","should","show","showed","shown",
"showns","shows","significant","significantly",
"similar","similarly","since","slightly","some",
"somebody","somehow","someone","somethan",
"something","sometime","sometimes","somewhat",
"somewhere","soon","sorry","specifically","specified",
"specify","specifying","still","stop","strongly",
"substantially","successfully","such","sufficiently",
"suggest","sure","take","taken","taking","tell",
"tends","than","thank","thanks","thanx","that",
"thats","their","theirs","them","themselves","then",
"thence","there","thereafter","thereby","thered",
"therefore","therein","thereof","therere",
"theres","thereto","thereupon","there've","these",
"they","think","this","those","thou","though","thought",
"thousand","through","throughout","thru","thus",
"together","took","toward","towards","tried","tries",
"truly","trying","twice","under","unfortunately",
"unless","unlike","unlikely","until","unto","upon",
"used","useful","usefully","usefulness","uses","using",
"usually","value","various","very","want","wants",
"was","wasnt","welcome","went","were","what","whatever",
"when","whence","whenever","where","whereafter","whereas",
"whereby","wherein","wheres","whereupon","wherever",
"whether","which","while","whim","whither","whod",
"whoever","whole","whom","whomever","whos","whose",
"widely","will","willing","wish","with","within","without",
"wont","words","world","would","wouldnt",
"your","youre","yours","yourself","yourselves"]

''' DEFINING PSEUDO CONSTANTS SECTION '''

# PSEUDO CONSTANTS,
# Feel Free to change the minimum and
# maximum name length
MIN_SIZE = 3      # Minimum length of a proper name
MAX_SIZE = 20     # Maximum length of a proper name

''' EXTRACT PROPER NAMES SECTION '''

def ExtractProperNames(theString, dictionary):
    ''' Input String to search,
        Output Dictionary of Proper Names
    '''
    # Extract each continuous string of characters

    wordList = theString.split()

    # Now, let's determine which words are possible
    # proper names and create a list of them.

    '''
    For this example words are considered possible
    proper names if they are:
    1) Title case
    2) Meet the minimum and maximum length criteria
    3) The word is NOT in the stop word list

    The Python built in string method string.istitle()
    is used to identify title case
    '''

    for eachWord in wordList:

        if eachWord.istitle() and len(eachWord) >=
              MIN_SIZE and len(eachWord) <= MAX_SIZE and
              eachWord.lower() not in STOP_WORDS:

            '''
            if the word meets the specified conditions
              it is added to the properNamesDictionary
            '''
            try:
                # if the word exists in the dictionary
                  # then add 1 to the occurances
                cnt = properNamesDictionary[eachWord]
                properNamesDictionary[eachWord] =
                   cnt + 1
            except:
                # If the word is not yet in the
                  # dictionary
                # add it and set the number of
                # occurances to 1
                properNamesDictionary[eachWord] = 1
        else:
            # otherwise loop to the next possible word
            continue

    # the function returns the created
    #   properNamesDictionary

    return properNamesDictionary
```

```
# End Extract Proper Names Function

''' MAIN PROGRAM ENTRY SECTION '''

'''
Main program for Extract Proper Names
'''
if __name__ == "__main__":

    ''' Main Program Entry Point '''

    print("\nPython Proper Name Extraction ")
    print("Python Forensics, Inc. \n")
    print("Script Started", str(datetime.now()))
    print()

    # Create empty dictionary
    properNamesDictionary = {}

    for eachLine in sys.stdin:

        txt = re.sub("[^A-Za-z']", ' ', eachLine)

        '''
        Call the ExtractProperNames function
        which returns a Python dictionary of possible
        proper names along with the number of occurances
        of that name.

        This function performs all the heavy lifting
        of extracting out each possible proper name
        '''
        properNamesDictionary =
           ExtractProperNames(txt,
           properNamesDictionary)
    # Once all the standard input lines are read
    # the value is the number of occurrences of the
    # proper name

    # This approach will print out the possible
    # proper names with
    # the highest occurrence first

    '''
    PRINT RESULTING POSSIBLE PROPER NAMES
    SECTION '''

    print()

    for eachName in sorted(properNamesDictionary,
        key=properNamesDictionary.get, reverse=True):

        print('%4d'  %
             properNamesDictionary[eachName],end="")

        print( '%20s' % eachName)

    print("\n\nScript Ended", str(datetime.now()))
    print()

# End Main Function
```

Executing the Combined PowerShell to Python ProperNames Scripts

The PowerShell script was then executed against a small directory of text files. The files were stored in the C:\PS\Text folder for ease of access. You can change the target folder variable $targetPath to modify the target folder. See Figure 6-5.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
ProperNameList.ps1
1
2
3

```
PS C:\PS> C:\PS\ProperNameList.ps1
Multiple File Processor v 1.0
Files to Process


    Directory: C:\PS\Text


Mode                LastWriteTime         Length Name
----                -------------         ------ ----
-a----        1/28/2019   8:22 AM         606282 BookOne.txt
-a----        1/28/2019   8:24 AM          31685 BookTwo.txt
Processing File:  C:\PS\Text\BookOne.txt
Python Proper Name Extraction
Python Forensics, Inc.

Script Started 2019-02-13 14:57:02.677174


 318                 Well
  90                 Huck
  83              Project
  83            Gutenberg
  62                 Mary
  56                 Aunt
  48                Sally
  47               Sawyer
  45                 Jane
  39                 Buck
```

```
   1              Gregory
   1                Newby
   1                Chief
   1            Executive
   1             Director
   1           Compliance
   1        International
   1            Professor
   1               Public
   1               Domain


Script Ended 2019-02-13 14:57:03.095090
```

Figure 6-5. *Resulting output PowerShell/Python combination (output reduced for brevity)*

The output is broken down into three sections:

> Section 1: This is the output generated by the Write-Host CmdLet within the PowerShell script.
>
> Sections 2–3: These are the results generated by the Python script processing of the BookOne.txt. The output is repeated for BookTwo.txt as the PowerShell loops through all the text files found in the specified directory.

After examining the output of the combined PowerShell/Python scripts even with the abbreviated output, you will likely be able to determine the text that these possible proper names were extracted from. This is only one possibility of processing the content of files acquired by PowerShell and then delivering that output to Python for post-processing.

This combination provides a baseline model that can be duplicated for additional results. Also, by inserting Invoke-Command sequences in the PowerShell script, you can collect files and file contents throughout the enterprise. Now let's look at another approach that passes a list of file names to the Python script vs. the content of the files themselves.

Extracting EXIF Data from Photographs

For this example, the PowerShell script will be kept small and the heavy lifting will be off-loaded to the Python script where we will leverage key libraries to extract EXIF data including the geo-location information contained in the EXIF headers of JPEG images.

PowerShell Script

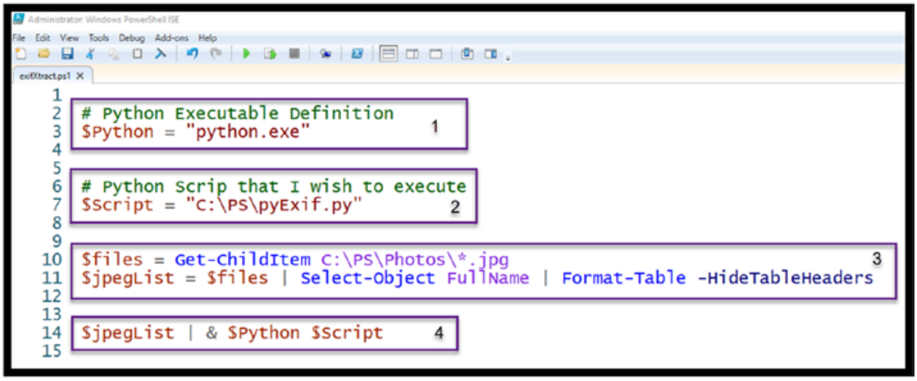
The PowerShell script in Figure 6-6 is broken down into four common elements with a slight twist.

1. Define a local variable $Python with the full path to the Python executable of your choice.

2. Define a local variable $Script that defines the full path to the Python script that will be executed.

3. Define a local variable $files that stores the set of files that match the search criteria *.jpg. The $jpegList local variable extracts the full path of each file and eliminates the headers leaving just the list of files that we intend to process.

4. This line passes the contents of the local variable $jpegList to the Python script. The key element here is the ampersand (&) that directs PowerShell to launch the external program. The Python script will receive each full pathname acquired by the PowerShell script, one per line passed via stdin.


Administrator: Windows PowerShell ISE
File Edit View Tools Debug Add-ons Help
exifXtract.ps1
1
2
3
4

```

# Python Executable Definition
$Python = "python.exe"

# Python Scrip that I wish to execute
$Script = "C:\PS\pyExif.py"

$files = Get-ChildItem C:\PS\Photos\*.jpg
$jpegList = $files | Select-Object FullName | Format-Table -HideTableHeaders

$jpegList | & $Python $Script

```

Figure 6-6. *PowerShell PhotoMap.ps1 script*

pyGeo.py Python Script

The Python script depicted in Listing 6-2 is broken down into eight major sections described here:

1. LIBRARY IMPORT
2. DEFINING PSEUDO CONSTANTS
3. EXTRACT GPS DICTIONARY
4. EXTRACT LATTITUDE AND LONGITUDE
5. CONVERT GPS COORDINATES TO DEGRESS
6. MAIN PROGRAM ENTRY
7. GENERATE RESULTS TABLE
8. GENERATE CSV FILE

LIBRARY IMPORT: As the name implies, this is where the needed Python libraries are loaded. They include:

- os**:** The Python standard os library is used to access operating system methods such as to validate the existence of files or directories.
- sys**:** As demonstrated in BasicOne, this library allows us to process command line input delivered by PowerShell.
- datetime**:** As the name implies, this library provides methods for display and calculating time and date details.
- PIL**:** The third-party Python Image library provides methods to access and extract EXIF data including geolocation information.

- prettytable**:** The third-party Python library provides the ability to tabularize data within a simple text-based table structure.

EXTRACT GPS DICTIONARY: This function is passed a filename to process, and verifies that the file is a valid image, and contains geolocation information. If it does, the geolocation information is collected, with GPS Dictionary and basic EXIF data is returned.

EXTRACT LATITUDE AND LONGITUDE: This function extracts the GPSLatitude and GPSLongitude and the associated reference from the GPS Dictionary provided. These values are not stored as degrees which most mapping programs require. Therefore, they are converted to degrees using the ConvertToDegress function. The orientation is then set accordingly. For example, if the latitude reference is South, then the latitude in degrees must be set to a negative value.

CONVERT TO DEGRESS: This function converts the GPS Coordinates stored in the EXIF data to degrees.

MAIN PROGRAM ENTRY: The main program first prints several heading messages. Then creates an empty picture list. Then as in the BasicOne.py example, the script processes each line from the system standard input provided by the PowerShell script. Each line contains the full path of files identified by the associated PowerShell script. Each filename is then appended to the picture list.

Next, an empty latLonList is created to hold the results of the GPS extraction from each picture. Each file is verified to exist, then the Extract GPS Dictionary is called. If the resulting GPS Dictionary contains data, the Extract Latitude Longitude function is called. Providing that valid latitude / longitude data is found, the base name of the file, the latitude and Longitude data are appended to the latLonList.

GENERATE RESULTS TABLE: The generate results table section produces a pretty table of results from the latLonList. Once the table is created, it is printed so the results of the extraction can be displayed in PowerShell.

GENERATE CSV FILE: Finally, the script generates a comma separated value (CSV) file LatLon.csv. This is formatted such that it can be imported into a Web-based mapping tool.

Listing 6-2. pyGeo.py Python Script

```
'''
EXIF Data Acquistion
January 2019
Version 1.1
'''

'''
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files (the "Software"), to deal in the Software without
restriction, including without limitation the rights to use,
copy, modify, merge, publish, distribute, sublicense, and/
or sell copies of the Software, and to permit persons to whom
the Software is furnished to do so, subject to the following
conditions:

The above copyright notice and this permission notice shall be
included in all copies or substantial
portions of the Software.
'''

# Usage Example:
# fileList | python pyExif.py
#
# Requirement: Python 3.x
#
```

```
# Requirement: 3rd Party Library that is
#              utilized is: PILLOW
#              to install PILLOW utilize the follow CMD
#              from the command line
#
#              pip install PILLOW
#
# The Script will extract the EXIF/GEO data from jpeg
# files piped into the script and generate tabular list # of
the extracted EXIF and geo location data along with # the
creation of a CSV file with LAT/LON Data
#

''' LIBRARY IMPORT SECTION '''
# Python Standard: Operating System Methods
import os

# Python Standard : System Methods
import sys

# Python Standard  datetime method from Standard Library
from datetime import datetime

# import the Python Image Library
# along with TAGS and GPS related TAGS
# Note you must install the PILLOW Module
# pip install PILLOW

from PIL import Image
from PIL.ExifTags import TAGS, GPSTAGS

# Import the PrettyTable Library to produce
# tabular results

from prettytable import PrettyTable
```

```
''' EXTRACT GPS DICTIONARY SECTION '''

#
# Extract EXIF Data
#
# Input: Full Pathname of the target image
#
# Return: gps Dictionary and selected exifData list
#
def ExtractGPSDictionary(fileName):

    try:
        pilImage = Image.open(fileName)
        exifData = pilImage._getexif()

    except Exception:
        # If exception occurs from PIL processing
        # Report the
        return None, None

    # Interate through the exifData
    # Searching for GPS Tags

    imageTimeStamp = "NA"
    cameraModel = "NA"
    cameraMake = "NA"
    gpsData = False

    gpsDictionary = {}

    if exifData:

        for tag, theValue in exifData.items():

            # obtain the tag
            tagValue = TAGS.get(tag, tag)
            # Collect basic image data if available

            if tagValue == 'DateTimeOriginal':
                imageTimeStamp =
                              exifData.get(tag).strip()

            if tagValue == "Make":
                cameraMake = exifData.get(tag).strip()

            if tagValue == 'Model':
                cameraModel = exifData.get(tag).strip()

            # check the tag for GPS
            if tagValue == "GPSInfo":

                gpsData = True;

                # Found it !
                # Use a Dictionary to hold the GPS Data

                # Loop through the GPS Information
                for curTag in theValue:
                    gpsTag = GPSTAGS.get(curTag, curTag)
                    gpsDictionary[gpsTag] =
                                     theValue[curTag]

        basicExifData = [imageTimeStamp,
                         cameraMake, cameraModel]

        return gpsDictionary, basicExifData

    else:
        return None, None

# End ExtractGPSDictionary ============================

''' EXTRACT LATTITUDE AND LONGITUDE SECTION '''

#
```

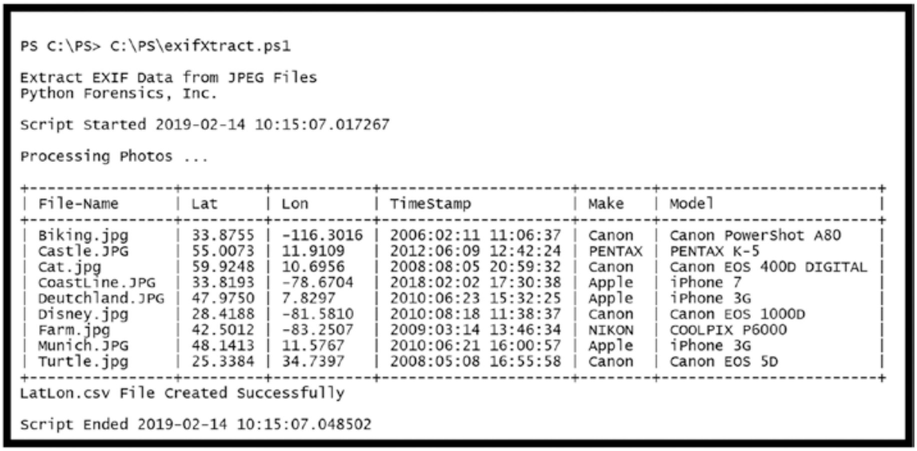
```
# Extract the Lattitude and Longitude Values
# From the gpsDictionary
#

def ExtractLatLon(gps):

    # to perform the calcuation we need at least
    # lat, lon, latRef and lonRef

    try:
        latitude     = gps["GPSLatitude"]
        latitudeRef  = gps["GPSLatitudeRef"]
        longitude    = gps["GPSLongitude"]
        longitudeRef = gps["GPSLongitudeRef"]

        lat = ConvertToDegrees(latitude)
        lon = ConvertToDegrees(longitude)

        # Check Latitude Reference
        # If South of the Equator then
             lat value is negative

        if latitudeRef == "S":
            lat = 0 - lat

        # Check Longitude Reference
        # If West of the Prime Meridian in
        # Greenwich then the Longitude value is negative

        if longitudeRef == "W":
            lon = 0- lon

        gpsCoor = {"Lat": lat,
                   "LatRef":latitudeRef,
                   "Lon": lon,
                   "LonRef": longitudeRef}
        return gpsCoor

    except:
        return None

# End Extract Lat Lon =======================================

''' CONVERT GPS COORDINATES TO DEGRESS '''

#
# Convert GPSCoordinates to Degrees
#
# Input gpsCoordinates value from in EXIF Format
#

def ConvertToDegrees(gpsCoordinate):

    d0 = gpsCoordinate[0][0]
    d1 = gpsCoordinate[0][1]
    try:
        degrees = float(d0) / float(d1)
    except:
        degrees = 0.0

    m0 = gpsCoordinate[1][0]
    m1 = gpsCoordinate[1][1]
    try:
        minutes = float(m0) / float(m1)
    except:
        minutes=0.0

    s0 = gpsCoordinate[2][0]
    s1 = gpsCoordinate[2][1]
    try:
        seconds = float(s0) / float(s1)
    except:
        seconds = 0.0

    floatCoordinate = float (degrees + (minutes / 60.0) +
    (seconds / 3600.0))

    return floatCoordinate

''' MAIN PROGRAM ENTRY SECTION '''

if __name__ == "__main__":
    '''
    pyExif Main Entry Point
    '''
    print("\nExtract EXIF Data from JPEG Files")
    print("Python Forensics, Inc. \n")

    print("Script Started", str(datetime.now()))
    print()

    ''' PROCESS PIPED DATA FROM POWERSHELL SECTION '''

    pictureList = []

    # Process data from standard input as a file list

    for eachLine in sys.stdin:
        entry = eachLine.strip()
        if entry:
            pictureList.append(entry)

    print("Processing Photos ...")
    print()

    # CDH
# Created a mapping object

''' PROCESS EACH JPEG FILE SECTION '''

latLonList = []

for targetFile in pictureList:

    if os.path.isfile(targetFile):

        gpsDictionary, exifList =
                ExtractGPSDictionary(targetFile)

        if exifList:
            TS = exifList[0]
            MAKE = exifList[1]
            MODEL = exifList[2]
        else:
            TS = 'NA'
            MAKE = 'NA'
            MODEL = 'NA'

        if (gpsDictionary != None):

            # Obtain the Lat Lon values from
            # the gpsDictionary
            #   Converted to degrees
            # The return value is a dictionary
            #   key value pairs

            dCoor = ExtractLatLon(gpsDictionary)

            if dCoor:
                lat = dCoor.get("Lat")
                latRef = dCoor.get("LatRef")
                lon = dCoor.get("Lon")
```

```
                    lonRef = dCoor.get("LonRef")

                    if ( lat and lon and
                         latRef and lonRef):

                        latLonList.append(
                          [os.path.basename(targetFile),
                          '{:4.4f}'.format(lat),
                          '{:4.4f}'.format(lon),
                          TS, MAKE, MODEL])

                    else:
                        print("WARNING",
                              "No GPS EXIF Data for ",
                              targetFile)
                else:
                    continue
            else:
                continue
        else:
            print("WARNING", " not a valid file", targetFile)

    # Create Result Table Display using PrettyTable

    ''' GENERATE RESULTS TABLE SECTION '''

    ''' Result Table Heading '''
    resultTable = PrettyTable(['File-Name',
                  'Lat','Lon',
                  'TimeStamp',
                  'Make', 'Model'])

    for loc in latLonList:
```

```
    resultTable.add_row( [loc[0], loc[1],
                          loc[2], loc[3],
                          loc[4], loc[5] ])

resultTable.align = "l"
print(resultTable.get_string(sortby="File-Name"))

''' GENERATE CSV FILE SECTION '''

# Create Simple CSV File Result
with open("LatLon.csv", "w") as outFile:
    # Write Heading
    outFile.write("Name, Lat, Long\n")

    # Process All entries and write
    # each line comma separated

    for loc in latLonList:
        outFile.write(loc[0]+","+
                      loc[1]+","+
                      loc[2]+"\n")

print("LatLon.csv File Created Successfully")

print("\nScript Ended", str(datetime.now()))
print()
```

Executing the Combined PowerShell to Python exifxtract Scripts

The final step is to execute the PowerShell script which will pass the identified filenames to the Python script. The folder C:\PS\Photos contains a set of JPEG photographs to examine. By changing the $files variable in the PowerShell script, you can specify an alternative directory to examine. See Figure 6-7.



```
PS C:\PS> C:\PS\exifXtract.ps1

Extract EXIF Data from JPEG Files
Python Forensics, Inc.

Script Started 2019-02-14 10:15:07.017267

Processing Photos ...

+----------------+---------+-----------+---------------------+--------+------------------------+
| File-Name      | Lat     | Lon       | TimeStamp           | Make   | Model                  |
+----------------+---------+-----------+---------------------+--------+------------------------+
| Biking.jpg     | 33.8755 | -116.3016 | 2006:02:11 11:06:37 | Canon  | Canon PowerShot A80    |
| Castle.JPG     | 55.0073 | 11.9109   | 2012:06:09 12:42:24 | PENTAX | PENTAX K-5             |
| Cat.jpg        | 59.9248 | 10.6956   | 2008:08:05 20:59:32 | Canon  | Canon EOS 400D DIGITAL |
| CoastLine.JPG  | 33.8193 | -78.6704  | 2018:02:02 17:30:38 | Apple  | iPhone 7               |
| Deutchland.JPG | 47.9750 | 7.8297    | 2010:06:23 15:32:25 | Apple  | iPhone 3G              |
| Disney.jpg     | 28.4188 | -81.5810  | 2010:08:18 11:38:37 | Canon  | Canon EOS 1000D        |
| Farm.jpg       | 42.5012 | -83.2507  | 2009:03:14 13:46:34 | NIKON  | COOLPIX P6000          |
| Munich.JPG     | 48.1413 | 11.5767   | 2010:06:21 16:00:57 | Apple  | iPhone 3G              |
| Turtle.jpg     | 25.3384 | 34.7397   | 2008:05:08 16:55:58 | Canon  | Canon EOS 5D           |
+----------------+---------+-----------+---------------------+--------+------------------------+
LatLon.csv File Created Successfully

Script Ended 2019-02-14 10:15:07.048502
```

Figure 6-7. *Execution of photoMap.ps1*

The script processed a sample directory with nine JPEG image files. The results included the table of filenames associated with extracted Lat/Lon values. The LatLon.csv file was also created. The resulting Lat/Lon results can be then imported into web resources such as Google Maps to provide a visual mapping of the results.

Summary

This chapter focused on the development of a model to execute Python scripts from PowerShell. The model used the standard PowerShell piping model to acquire specific data and provide the output to the specified Python scripts using the PowerShell piping method.

These examples focused on small PowerShell scripts that perform discrete acquisitions, and then ultimately used Python's rich capabilities to perform the heavy lifting to process the results.

This model provides a rich baseline for experimentation, acquisition, and combination of PowerShell and Python. In some ways, this model seems slightly more streamlined than the subprocess method used to execute PowerShell scripts from Python. Both have their place of course, whether to control and automate existing PowerShell scripts or to drive output from PowerShell to Python.

CHAPTER 7

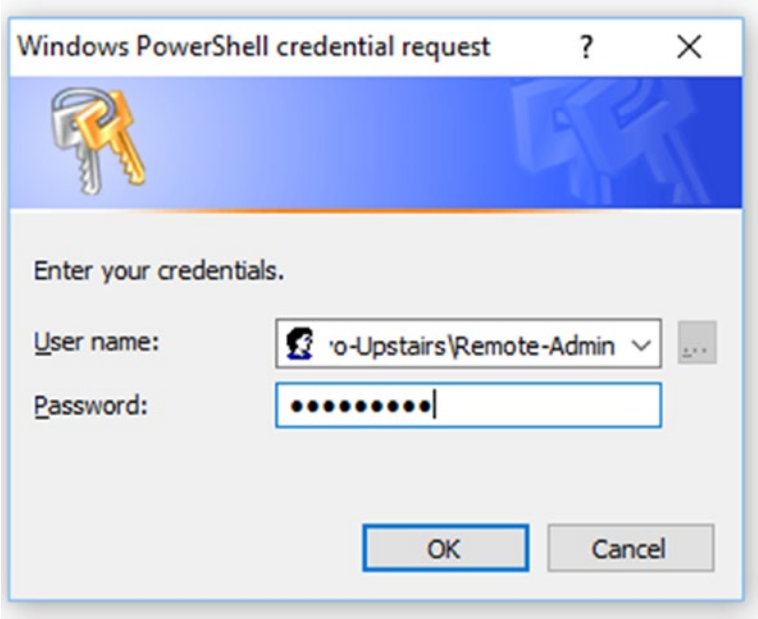
Loose Ends and Future Considerations

Having developed two solid approaches for the integration of PowerShell and Python (i.e., Python subprocessing and PowerShell pipelining), there are a couple of loose ends and future considerations that need to be addressed.

Loose Ends

The first involves using the PowerShell Invoke-Command CmdLet without needing to respond to a login pop-up each time, as shown in Figure 7-1.

C. Hosmer, *PowerShell and Python Together*, https://doi.org/10.1007/978-1-4842-4504-0_7



Enter your credentials.

User name: 'o-Upstairs\Remote-Admin

Password: ●●●●●●●●●●

Figure 7-1. *Windows PowerShell credential request*

This can be accomplished by creating a new credential object using the PowerShell System Management Automation PSCredential system. Figure 7-2 shows a simple PowerShell script that acquires the system event log from the computer PLUTO, using the Remote-Admin user credentials. This requires only four steps:

1. Create two local PowerShell variables: $targetComputer (the computer name you wish to access) and $userName (the username on the remote computer).

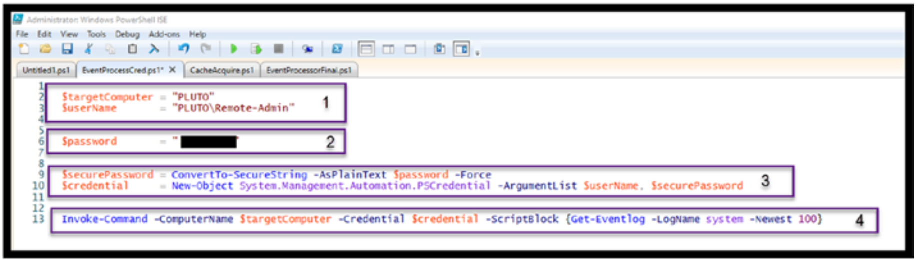
2. Create a plaintext string, $password, with the password associated with the remote user. Note the password is blacked out here. When embedding passwords in PowerShell scripts, it is vital that you keep the script secure from unauthorized access.

3. This step contains two important parts:

    a. First, the plaintext password is converted to the secure string, $securePassword. The secure string created by the ConvertTo-SecureString CmdLet can then be utilized with other CmdLets or functions that require a parameter with the type SecureString.

    b. Next, the secure credential object, $credential, is created. This requires $userName and the newly created $securePassword as parameters.

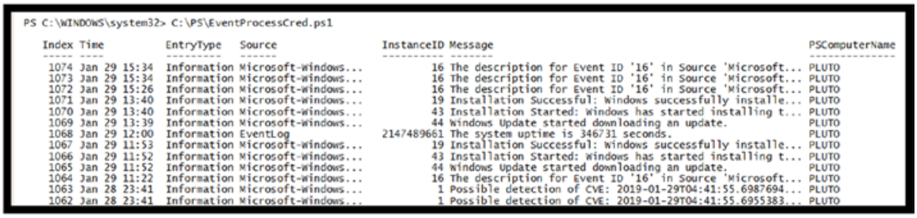
4. Finally, the newly created $credential PowerShell variable can be passed as the -Credential parameter within the Invoke-Command CmdLet.



```
$targetComputer  = "PLUTO"
$userName        = "PLUTO\Remote-Admin"

$password        = "[redacted]"

$securePassword = ConvertTo-SecureString -AsPlainText $password -Force
$credential     = New-Object System.Management.Automation.PSCredential -ArgumentList $userName, $securePassword

Invoke-Command -ComputerName $targetComputer -Credential $credential -ScriptBlock {Get-Eventlog -LogName system -Newest 100}
```

Figure 7-2. *PowerShell script to collect a remote event log with embedded credentials*

Execution of the script acquires the system event log from the PLUTO computer as shown in Figure 7-3. Note the output was truncated for brevity.

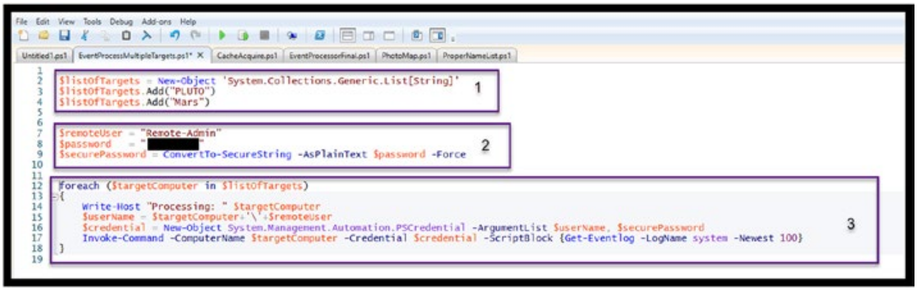


```
PS C:\WINDOWS\system32> C:\PS\EventProcessCred.ps1

   Index Time          EntryType   Source                 InstanceID Message                                              PSComputerName
   ----- ----          ---------   ------                 ---------- -------                                              --------------
    1074 Jan 29 15:34  Information Microsoft-Windows...           16 The description for Event ID '16' in Source 'Microsoft... PLUTO
    1073 Jan 29 15:34  Information Microsoft-Windows...           16 The description for Event ID '16' in Source 'Microsoft... PLUTO
    1072 Jan 29 15:26  Information Microsoft-Windows...           16 The description for Event ID '16' in Source 'Microsoft... PLUTO
    1071 Jan 29 13:40  Information Microsoft-Windows...           19 Installation Successful: Windows successfully installe... PLUTO
    1070 Jan 29 13:40  Information Microsoft-Windows...           43 Installation Started: Windows has started installing t... PLUTO
    1069 Jan 29 13:39  Information Microsoft-Windows...           44 Windows Update started downloading an update.             PLUTO
    1068 Jan 29 12:00  Information EventLog               2147489661 The system uptime is 346731 seconds.                      PLUTO
    1067 Jan 29 11:53  Information Microsoft-Windows...           19 Installation Successful: Windows successfully installe... PLUTO
    1066 Jan 29 11:52  Information Microsoft-Windows...           43 Installation Started: Windows has started installing t... PLUTO
    1065 Jan 29 11:52  Information Microsoft-Windows...           44 Windows Update started downloading an update.             PLUTO
    1064 Jan 29 11:22  Information Microsoft-Windows...           16 The description for Event ID '16' in Source 'Microsoft... PLUTO
    1063 Jan 28 23:41  Information Microsoft-Windows...            1 Possible detection of CVE: 2019-01-29T04:41:55.6987694... PLUTO
    1062 Jan 28 23:41  Information Microsoft-Windows...            1 Possible detection of CVE: 2019-01-29T04:41:55.6955383... PLUTO
```

Figure 7-3. *EventProcessCred.ps1 sample execution*

The second improvement leveraged the embedded credential approach. The main reason for embedding credentials (beyond convenience) is so that scripts can acquire data from multiple remote computers from the same script without the requirement for interaction. One method to accomplish this is to create a list of target computer names to access. PowerShell lists are useful and can be used to loop through multiple selections using the *foreach* operator. Figure 7-4 shows an example that acquires system logs from two computers defined in a PowerShell list.

Note For this example, the username and password for each target will be the same to keep the illustration simple. The example can be expanded to include unique usernames and passwords for each target as well, of course.



```

$listOfTargets = New-Object 'System.Collections.Generic.List[String]'
$listOfTargets.Add("PLUTO")
$listOfTargets.Add("Mars")


$remoteUser = "Remote-Admin"
$password   = "[redacted]"
$securePassword = ConvertTo-SecureString -AsPlainText $password -Force


foreach ($targetComputer in $listOfTargets)
{
    Write-Host "Processing: " $targetComputer
    $userName = $targetComputer+'\'+$remoteUser
    $credential = New-Object System.Management.Automation.PSCredential -ArgumentList $userName, $securePassword
    Invoke-Command -ComputerName $targetComputer -Credential $credential -ScriptBlock {Get-Eventlog -LogName system -Newest 100}
}

```

Figure 7-4. *Acquiring system event logs from multiple target computers with embedded credentials*

This script is broken down into three steps:

1. This section creates a PowerShell object $listOfTargets which is a simple list of strings. Each string represents the name of a target computer. The newly created list has no elements. The $listOfTargets is then populated using the Add method that is associated with the PowerShell list object that was created.

2. The default $remoteUser variable is created and set to "Remote-Admin" which is the remote user Admin account that will be used. In addition, the $securePassword is created that will be used to access each remote target. Note the $credential is not created yet because it needs to be created uniquely for each target acquisition.

3. Finally, a loop is created that will do the following:

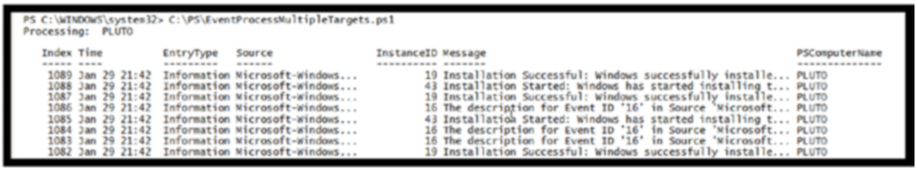
    a. Display the name of the Host being processed each time through the loop.

    b. Combine the current $targetComputer and the default $remoteUser name to create the unique $userName for this target. For example: **PLUTO\Remote-Admin**.

    c. Using the PowerShell System.Management. Automation capability, the unique $credential is then created each time through the loop, using the $userName and $securePassword PowerShell variables.

d. Then the Invoke-Command to acquire the system event log is executed with the current $targetComputer and the associated $credential required for access.

The abbreviated script output is shown in Figure 7-5.



```
PS C:\WINDOWS\system32> C:\PS\EventProcessMultipleTargets.ps1
Processing:  PLUTO

   Index Time          EntryType   Source                 InstanceID Message                                                PSComputerName
   ----- ----          ---------   ------                 ---------- -------                                                --------------
    1089 Jan 29 21:42  Information Microsoft-Windows...           19 Installation Successful: Windows successfully installe... PLUTO
    1088 Jan 29 21:42  Information Microsoft-Windows...           43 Installation Started: Windows has started installing t... PLUTO
    1087 Jan 29 21:42  Information Microsoft-Windows...           19 Installation Successful: Windows successfully installe... PLUTO
    1086 Jan 29 21:42  Information Microsoft-Windows...           16 The description for Event ID '16' in Source 'Microsoft... PLUTO
    1085 Jan 29 21:42  Information Microsoft-Windows...           43 Installation Started: Windows has started installing t... PLUTO
    1084 Jan 29 21:42  Information Microsoft-Windows...           16 The description for Event ID '16' in Source 'Microsoft... PLUTO
    1083 Jan 29 21:42  Information Microsoft-Windows...           16 The description for Event ID '16' in Source 'Microsoft... PLUTO
    1082 Jan 29 21:42  Information Microsoft-Windows...           19 Installation Successful: Windows successfully installe... PLUTO
```

Figure 7-5. *Multiple target computer system event log execution*

Future Considerations

Integrating PowerShell and Python and combining two very powerful scripting environments has been a joy to work on. The research, experimentation, and model creation have been trying at times; however, the result is two viable and useful methods that will allow for the expansion of investigative solutions.

A rich basis for digital investigators can be found with the literally thousands of PowerShell CmdLets available to acquire material evidence from target computers locally or remotely. Combining that with the versatility and power of the Python environment brings forth the opportunity for boundless innovations and solutions.

Given these two models for integration, I challenge you to develop and expand new solutions that combine the best of both environments. I still think of PowerShell as a potent acquisition engine and Python as the backend analysis and processing component. However, that’s only my view – you may have different ideas. So, run with those as well, the models provided here can support a wide range of possibilities.

Summary

This chapter focused on a couple of loose ends that will improve the automation aspects of PowerShell by embedding credentials with PowerShell scripts. This embedding enables multiple simultaneous acquisitions of evidence that can then be delivered to or driven by Python elements. This will certainly expand the reach of investigators and speed the acquisition and analysis of acquired evidence.

Good luck, and I look forward to communicating and collaborating on new investigative solutions that combine PowerShell and Python in unique ways.

APPENDIX A

Challenge Problem Solutions

The appendix contains solutions to several of the challenge problems presented in Chapter 1 through Chapter 5. Note that not all challenge problems are solved here as this is not meant to be a crossword puzzle cheat section. Rather, it provides key insights that will be needed to solve the challenges.

I firmly believe the only way to become proficient with Python, PowerShell, or the combination of both is to practice. One of the best ways to do this is to define a challenge you would like to solve, then start small and try different approaches. Then, and only then, integrate your experiments into scripts or programs. Note that this is slightly counter to traditional computer science approaches to waterfall or even spiral development; however, I believe this is the best way to learn. In one of my first books *Python Forensics*[1] I coined the phrase "test then code." At the time this was very fitting for the development of Python scripts, and I strongly believe that it still aligns well today for both PowerShell and Python.

[1] Syngress, 2014.

C. Hosmer, *PowerShell and Python Together*, https://doi.org/10.1007/978-1-4842-4504-0

The appendix is broken down by chapter for easy reference.

Note Just a reminder that many of the CmdLets and scripts require administrator privilege.

Chapter 1: Investigative CmdLets to Explore

Challenge One: Executing a "Find" Based on File Extension

```
PS C:\WINDOWS\system32> Get-Help Get-ChildItem

NAME
    Get-ChildItem

SYNOPSIS
    Gets the files and folders in a file system drive.
```

Example A: Find All Files with .jpg Extension

```
PS C:\WINDOWS\system32> get-childitem C:\ -include *.jpg
-recurse -force

Directory: C:\$Recycle.Bin\S-1-5-21-1545112040-36671619-
2396729391-1001\$RPSE7Z2\PHOTO

Mode                LastWriteTime         Length Name
----                -------------         ------ ----
-a----        8/15/2018  11:24 AM         26903 20-fake-
                                          images-10.jpg
-a----        8/15/2018  11:21 AM         37651 20-fake-
                                          images-20.jpg
```

```
-a----        8/21/2018   8:01 AM         85175 area-51-
                                          caller.jpg
-a----        7/30/2018   9:52 AM         177153 jets.JPG
-a----        8/21/2018   7:54 AM         137948 moon_landing_
                                          hoax.jpg
Directory: C:\IMAGES

Mode                LastWriteTime        Length Name
----                -------------        ------ ----
-a----         9/3/2018   2:58 PM        624744 Biking.jpg
-a----         9/3/2018   2:58 PM       1224201 Castle.JPG
-a----         9/3/2018   2:58 PM        446759 Cat.jpg
-a----         9/3/2018   2:58 PM        600630 Deutchland.JPG
-a----         9/3/2018   2:58 PM        304930 Disney.jpg
-a----         9/3/2018   2:58 PM         96831 dscn0011.jpg
-a----         9/3/2018   2:58 PM         98012 kinderscout.jpg
-a----         9/3/2018   2:58 PM        252607 Munich.JPG
-a----         9/3/2018   2:58 PM       3352190 Rome.jpg
-a----         9/3/2018   2:58 PM         91329 Turtle.jpg
-a----         9/3/2018   2:58 PM          5459 zzz.jpg

--- OUTPUT truncated for brevity
```

Example B: Display Hidden System Files in C:\

```
PS C:\WINDOWS\system32> Get-ChildItem c:\ -Hidden -System

Directory: C:\

Mode                LastWriteTime        Length  Name
----                -------------        ------  ----
d--hs-         2/5/2017   1:43 PM                $Recycle.Bin
d--hs-        1/21/2019   4:09 PM                Config.Msi
d--hsl         2/5/2017   1:49 PM                Documents and
                                                 Settings
```

```
d--hs-        1/31/2019   8:05 AM                System Volume
                                                 Information
-arhs-        7/16/2016   7:43 AM         384322 bootmgr
-a-hs-        7/16/2016   7:43 AM              1 BOOTNXT
-a-hs-        1/12/2019  11:32 AM     5111406592 hiberfil.sys
-a-hs-        1/28/2019  11:20 PM     3891789824 pagefile.sys
-a-hs-       12/20/2018   1:56 PM      268435456 swapfile.sys
```

Challenge Two: Examining Network Settings

Example A: Get Basic TCP Network Settings

```
PS C:\WINDOWS\system32> Get-Help Get-NetIPConfiguration

NAME
    Get-NetIPConfiguration

SYNOPSIS
    Gets IP network configuration.

PS C:\WINDOWS\system32> Get-NetIPConfiguration -All


InterfaceAlias       : Ethernet
InterfaceIndex       : 8
InterfaceDescription : Realtek PCIe GBE Family Controller
NetProfile.Name      : hoz  3
IPv4Address          : 192.168.86.36
IPv6DefaultGateway   :
IPv4DefaultGateway   : 192.168.86.1
DNSServer            : 192.168.86.1
```

Example B: Get Current TCP Connections

```
PS C:\WINDOWS\system32> Get-NetTCPConnection | select-object
-Property LocalAddress, RemoteAddress, State, OwningProcess |
Format-Table -AutoSize
LocalAddress  RemoteAddress        State OwningProcess
------------  -------------        ----- -------------
192.168.86.36 52.114.74.45   Established         67228
192.168.86.36 162.125.9.3      CloseWait        132676
192.168.86.36 162.125.33.7     CloseWait        132676
192.168.86.36 23.32.68.10    Established        156280
192.168.86.36 162.125.18.133 Established        132676
192.168.86.36 162.125.34.129 Established        132676
192.168.86.36 162.125.9.7      CloseWait        132676
192.168.86.36 17.249.156.16  Established         17736
192.168.86.36 162.125.18.133 Established        132676
192.168.86.36 162.125.9.4      CloseWait        132676
192.168.86.36 162.125.34.129 Established        132676
```

Challenge Three: Examining Firewall Settings

Example A: Check the Current Local Firewall State

```
PS C:\WINDOWS\system32> get-Help Get-NetFirewallProfile

NAME
    Get-NetFirewallProfile

SYNOPSIS
    Displays settings that apply to the per-profile configurations
    of the Windows Firewall with Advanced Security.

PS C:\WINDOWS\system32> Get-NetFirewallProfile | Select-Object
-Property Enabled, Profile
```

```
Enabled Profile
------- -------
   True Domain
   True Private
   True Public
```

Chapter 2: CmdLet Experimentation

In Chapter 2, the Start and Stop Transcript CmdLets will be used to capture the results of each CmdLet output. The resulting transcript is included at the end of this section with a selection of CmdLets that were experimented with.

```
PS C:\WINDOWS\system32> Get-Help Start-Transcript

NAME
    Start-Transcript

SYNOPSIS
    Creates a record of all or part of a Windows PowerShell
    session to a text file.

PS C:\WINDOWS\system32> Get-Help Stop-Transcript

NAME
    Stop-Transcript

SYNOPSIS
    Stops a transcript.

PS C:\WINDOWS\system32> Start-Transcript c:\PS\Transcript\
transcript.txt

Transcript started, output file is c:\PS\Transcript\transcript.
txt
```

Transcript of Commands and Responses

Note: Some output was abbreviated.

```
**********************
Windows PowerShell transcript start
Start time: 20190131103013
Username: PYTHON-3\cdhsl
RunAs User: PYTHON-3\cdhsl
Configuration Name:
Machine: PYTHON-3 (Microsoft Windows NT 10.0.17134.0)
Host Application: C:\WINDOWS\system32\WindowsPowerShell\v1.0\
PowerShell_ISE.exe
Process ID: 41620
PSVersion: 5.1.17134.407
PSEdition: Desktop
PSCompatibleVersions: 1.0, 2.0, 3.0, 4.0, 5.0, 5.1.17134.407
BuildVersion: 10.0.17134.407
CLRVersion: 4.0.30319.42000
WSManStackVersion: 3.0
PSRemotingProtocolVersion: 2.3
SerializationVersion: 1.1.0.1
**********************
Transcript started, output file is c:\PS\Transcript\transcript.txt
```

```
PS C:\WINDOWS\system32> Get-Process -ComputerName .
```

```
Handles  NPM(K)    PM(K)    WS(K)     CPU(s)     Id  SI ProcessName
-------  ------    -----    -----     ------     --  -- -----------
    470      22     6524     4172   2,793.53  55708   2 AdobeCollabSync
    277      14     2692      708       0.17  56592   2 AdobeCollabSync
    238      23     9184      156       0.23 113824   2 ApplePhoto
                                                        Streams
    487      28    19988    22108      14.77  79164   2 Application
                                                        FrameHost
    166       9     2084      100       0.09 183548   2 AppVShNotify
    157       8     1804      104       0.02 209908   0 AppVShNotify
    375      25     5160     2020       2.17  17736   2 APSDaemo
   1326      74   232108   173896      43.73 184112   2 POWERPNT
   1210      86   380800   397292     240.86  41620   2 powershell_ise
    941      91    50384    10732       3.31 166420   0 PRSvc
    307      28    31836     1536       1.66  35788   2 QtWebEngine
                                                        Process
    339      15     6444     3408       3.67  12076   2 RAVBg64
    345      16     7136     4712       3.77  23452   2 RAVBg64
    608      26    19760     1536       0.41   6204   0 RealSenseDCM
      0      14     1388    20876     167.36     96   0 Registry
    449      20    10136    15780       9.48  17068   2 RemindersServer
    220       9     1792      160       0.08   2540   0 RtkAudio
                                                        Service64
    126       9     1532      528       0.05 216496   2 rundll32
    120       7     1384     6136       0.00 168436   0 SearchFilterHost
   1241      83    57844    54048      52.45 161508   0 SearchIndexer
     52       3      504      208       0.41    452   0 smss
    220      13     5172     5116     223.39   2364   0 svchost
    155       9     1696      424       0.09  14104   2 TUAuto
                                                        Reactivator64
    329      20     6296    11196     851.14   60052  2 TuneUpUtilities
                                                         App64
   1167      34    46024    32928  12,831.14   63708  0 TuneUpUtilities
                                                         Service64
    198      14     2912     3408       2.34    4224  0 UploaderService
    124       8     1400      316       0.52   15912  2 WavesSvc64
    110       8     2624      156       0.02    4380  0 WavesSysSvc64
    156      10     1528       36       0.02     724  0 wininit
    247      10     2668     2528       3.83  215952  2 winlogon
   1754      91   200124   197816     415.23   67228  2 WINWORD
    343      14    15340    13956     971.41   15696  0 WmiPrvSE
    308      17    11144     8360     319.03   24228  0 WmiPrvSE
    237      10     2348      764       0.61  132372  0 WUDFHost

PS C:\WINDOWS\system32> Get-Process -Name chrome

Handles  NPM(K)    PM(K)    WS(K)     CPU(s)      Id SI ProcessName
-------  ------    -----    -----     ------      -- -- -----------
    271      21    18696    24180       0.16   26420  2 chrome
    338      32    94600    49056      11.11   48132  2 chrome
    273      25    36024    36760       1.44   76284  2 chrome
    558      30    92792    67576      26.75   83340  2 chrome
    343      30    80788    87232       3.33   88260  2 chrome
    266      19    13940    17364       0.08  115852  2 chrome
    142      11     1988     7236       0.05  128480  2 chrome
    356      33    97140    78868       3.84  128952  2 chrome
    223      10     2100     7252       0.03  148004  2 chrome
    267      21    21652    23044       0.25  149520  2 chrome
    273      22    26964    26600       0.30  197144  2 chrome
   1639      73   115292   110896      64.27  214792  2 chrome
```

```
PS C:\WINDOWS\system32> Get-MpThreat
None reported

PS C:\WINDOWS\system32> get-service | where-object {$_.Status
-eq "Stopped"}

Status   Name               DisplayName
------   ----               -----------
Stopped  AJRouter           AllJoyn Router Service
Stopped  ALG                Application Layer Gateway Service
Stopped  AppIDSvc           Application Identity
Stopped  AppReadiness       App Readiness
Stopped  AppVClient         Microsoft App-V Client
Stopped  AppXSvc            AppX Deployment Service (AppXSVC)
Stopped  AssignedAccessM... AssignedAccessManager Service
Stopped  AxInstSV           ActiveX Installer (AxInstSV)
Stopped  BcastDVRUserSer... GameDVR and Broadcast User
                            Service_...
Stopped  BDESVC             BitLocker Drive Encryption Service
Stopped  BluetoothUserSe... Bluetooth User Support
                            Service_2a63...
Stopped  Bonjour Service    Bonjour Service
Stopped  CaptureService_... CaptureService_2a637185
Stopped  CertPropSvc        Certificate Propagation
Stopped  ssh-agent          OpenSSH Authentication Agent
Stopped  SupportAssistAgent Dell SupportAssist Agent
Stopped  svsvc              Spot Verifier
Stopped  swprv              Microsoft Software Shadow Copy
                            Prov...
Stopped  TermService        Remote Desktop Services
Stopped  TieringEngineSe... Storage Tiers Management
Stopped  TrustedInstaller   Windows Modules Installer
Stopped  tzautoupdate       Auto Time Zone Updater
Stopped  UevAgentService    User Experience Virtualization
                            Service
Stopped  UmRdpService       Remote Desktop Services UserMode
                            Po...
Stopped  upnphost           UPnP Device Host
Stopped  VacSvc             Volumetric Audio Compositor Service
Stopped  vds                Virtual Disk
Stopped  VMAuthdService     VMware Authorization Service
Stopped  vmicguestinterface Hyper-V Guest Service Interface
Stopped  vmicheartbeat      Hyper-V Heartbeat Service
Stopped  vmickvpexchange    Hyper-V Data Exchange Service
Stopped  vmicrdv            Hyper-V Remote Desktop
                            Virtualizati...
Stopped  vmicshutdown       Hyper-V Guest Shutdown Service
Stopped  vmictimesync       Hyper-V Time Synchronization
                            Service
Stopped  vmicvmsession      Hyper-V PowerShell Direct Service
Stopped  vmicvss            Hyper-V Volume Shadow Copy
                            Requestor
Stopped  VMnetDHCP          VMware DHCP Service
Stopped  VMUSBArbService    VMware USB Arbitration Service
Stopped  VMware NAT Service VMware NAT Service

PS C:\WINDOWS\system32> Get-Location

Path
----
C:\WINDOWS\system32

PS C:\WINDOWS\system32> Set-Location C:\PS
PS C:\PS> Test-NetConnection

ComputerName           : internetbeacon.msedge.net
RemoteAddress          : 13.107.4.52
InterfaceAlias         : Ethernet
SourceAddress          : 192.168.86.36
PingSucceeded          : True
PingReplyDetails (RTT) : 24 ms

PS C:\PS> Get-Disk | Format-List *

DiskNumber            : 0
PartitionStyle        : GPT
ProvisioningType      : Fixed
OperationalStatus     : Online
HealthStatus          : Healthy
BusType               : SATA
UniqueIdFormat        : FCPH Name
OfflineReason         :
UniqueId              : 5000039751D8A26D
AdapterSerialNumber   :
AllocatedSize         : 1000203837440
BootFromDisk          : True
FirmwareVersion       : AX0P3D
FriendlyName          : TOSHIBA MQ01ABD100
Guid                  : {ea267102-e3e3-4a17-b349-e5e0161bc012}
IsBoot                : True
IsClustered           : False
IsHighlyAvailable     : False
IsOffline             : False
IsReadOnly            : False
IsScaleOut            : False
IsSystem              : True
```

```
LargestFreeExtent      : 1048576
Location               : Integrated : Adapter 0 : Port 0
LogicalSectorSize      : 512
Manufacturer           :
Model                  : TOSHIBA MQ01ABD100
Number                 : 0
NumberOfPartitions     : 6
Path                   : \\?\scsi#disk&ven_toshiba&prod_mq01abd1
                         00#4&1b6d0cbc&0&000000#{53f56307-b6bf-
                         11d0-94f2-00a0c91efb8b}
PhysicalSectorSize     : 4096
SerialNumber           :           X6LSTAXNT
Signature              :
Size                   : 1000204886016
PSComputerName         :
CimClass               : ROOT/Microsoft/Windows/Storage:MSFT_
                         Disk
CimInstanceProperties  : {ObjectId, PassThroughClass,
                         PassThroughIds,
                         PassThroughNamespace...}
CimSystemProperties    : Microsoft.Management.Infrastructure.
                         CimSystemProperties
DiskNumber             : 2
PartitionStyle         : MBR
ProvisioningType       : Fixed
OperationalStatus      : Online
HealthStatus           : Healthy
BusType                : USB
UniqueIdFormat         : Vendor Specific
OfflineReason          : USBSTOR\DISK&VEN_DYMO&PROD_PNP&REV_1.00\
                         7&347EDADD&0&15314622032011&0:PYTHON-3
```

```
AdapterSerialNumber   :
AllocatedSize         : 4193792
BootFromDisk          : False
FirmwareVersion       : 1.00
FriendlyName          : DYMO PnP
Guid                  :
IsBoot                : False
IsClustered           : False
IsHighlyAvailable     : False
IsOffline             : False
IsReadOnly            : False
IsScaleOut            : False
IsSystem              : False
LargestFreeExtent     : 0
Location              : Integrated : Adapter 0 : Port 0
LogicalSectorSize     : 512
Manufacturer          : DYMO
Model                 : PnP
Number                : 2
NumberOfPartitions    : 1
PhysicalSectorSize    : 512
SerialNumber          : 15314622032011
Signature             : 6975421
Size                  : 4193792
PSComputerName        :
CimClass              : ROOT/Microsoft/Windows/Storage:MSFT_
                        Disk
CimInstanceProperties : {ObjectId, PassThroughClass,
                        PassThroughIds,
                        PassThroughNamespace...}
```

```
CimSystemProperties   : Microsoft.Management.Infrastructure.
                        CimSystemProperties
PS C:\PS> Stop-Transcript
**********************
Windows PowerShell transcript end
End time: 20190131103856
**********************
```

Chapter 3: Create File Inventory List with Hashes

```
#
# Simple file Inventory Script
#

# Function to convert size values to human readable
function GetMBSize($num)
{
    $suffix = "MB"
    $MB = 1048576

    $num = $num / $MB


    "{0:N2} {1}" -f $num, $suffix
}

# Set Report Title
$rptTitle = "File Inventory"
# Get the current date and tme
$rptDate=Get-Date

# Set the target Directory and parameters
$targetDirectory = "c:\"
```

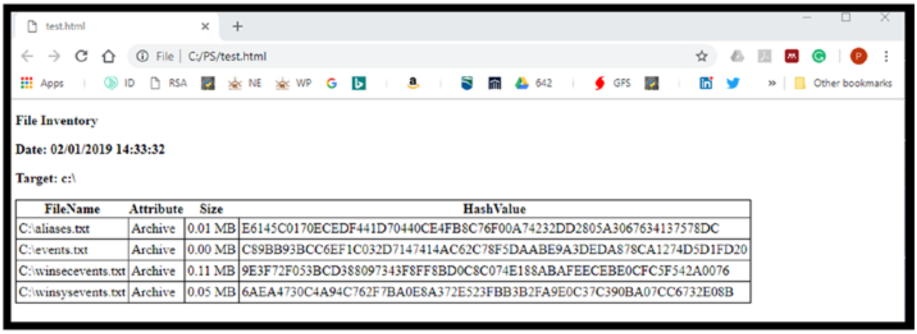
```
# Create HTML Header Section
$Header = @"
<style>
TABLE {border-width: 1px; border-style: solid; border-color:
black; border-collapse: collapse;}
TD {border-width: 1px; padding: 3px; border-style: solid;
border-color: black;}
</style>
<p>
<b> $rptTitle</b>
<p>
<b> Date: $rptDate </b>
<p>
<b> Target: $targetDirectory </b>
<p>
"@

# Provide script output for user
Write-Host "Create Simple File Inventory"

$dir = Get-ChildItem $targetDirectory -File

# Create an empty array to hold values
$outArray = @()

# Loop through each file found
foreach ($item in $dir)
{
    # create and object to hold item values from separate
    CmdLets
    $tempObj = "" | Select "FileName", "Attribute", "Size",
    "HashValue"
    # Get the fullname including path
    $fullName  = $item.FullName

    # Get the attributes assoicated with this file
    $attributes = $item.Attributes
    $size       = GetMBSize($item.Length)

    # Generate the SHA-256 Hash of the file
    $hashObj = Get-FileHash $fullName -ErrorAction Silently
    Continue
    # Get just the Hash Value
    $hashValue = $hashObj.Hash

    # if hash value could not be generated set to Not Available
    if ([string]::IsNullOrEmpty($hashValue))
    {
        $hashValue = "Not Available"
    }

    # Fill in the tempObj
    $tempObj.FileName  = $fullName
    $tempObj.Attribute = $attributes
    $tempObj.Size      = $size
    $tempObj.HashValue = $hashValue

    # Add the tempObj to the outArray
    $outArray += $tempObj

    # Clear the output array
    $tempObj = $null
}

$outArray | ConvertTo-Html -Head $Header -Property FileName,
Attribute, Size, HashValue |
 Out-File test.html
```

```
#$outArray | ConvertTo-Html | out-file test.html
Write-Host "Script Completed"
Write-Host "test.html created"
```

Sample PowerShell Script Output

```
PS C:\PS> C:\PS\testInventory.ps1
Create Simple File Inventory
Scan the C: Drive for Hidden and System Files Only
Script Completed
test.html created

PS C:\PS>
```

HTML Screenshots



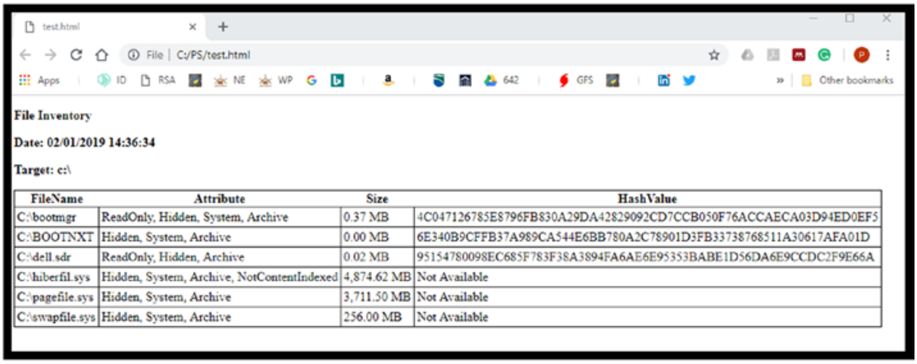
File Inventory

Date: 02/01/2019 14:33:32

Target: c:\

FileName	Attribute	Size	HashValue
C:\aliases.txt	Archive	0.01 MB	E6145C0170ECEDF441D70440CE4FB8C76F00A74232DD2805A3067634137578DC
C:\events.txt	Archive	0.00 MB	C89BB93BCC6EF1C032D7147414AC62C78F5DAABE9A3DEDA878CA1274D5D1FD20
C:\winsecevents.txt	Archive	0.11 MB	9E3F72F053BCD388097343F8FF8BD0C8C074E188ABAFEECEBE0CFC5F542A0076
C:\winsysevents.txt	Archive	0.05 MB	6AEA4730C4A94C762F7BA0E8A372E523FBB3B2FA9E0C37C390BA07CC6732E08B

Note By adding the -System argument to the Get-ChildItem command, you would obtain the system files in the c:\ directory.



File Inventory

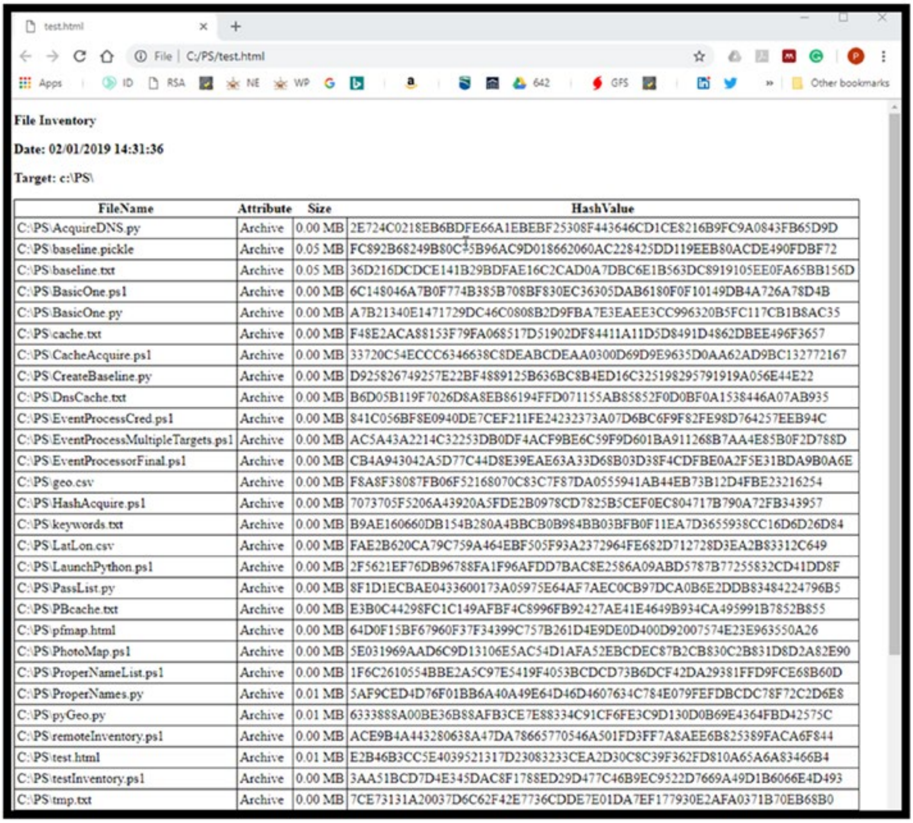
Date: 02/01/2019 14:36:34

Target: c:\

FileName	Attribute	Size	HashValue
C:\bootmgr	ReadOnly, Hidden, System, Archive	0.37 MB	4C047126785E8796FB830A29DA42829092CD7CCB050F76ACCAECA03D94ED0EF5
C:\BOOTNXT	Hidden, System, Archive	0.00 MB	6E340B9CFFB37A989CA544E6BB780A2C78901D3FB33738768511A30617AFA01D
C:\dell.sdr	ReadOnly, Hidden, Archive	0.02 MB	95154780098EC685F783F38A3894FA6AE6E95353BABE1D56DA6E9CCDC2F9E66A
C:\hiberfil.sys	Hidden, System, Archive, NotContentIndexed	4,874.62 MB	Not Available
C:\pagefile.sys	Hidden, System, Archive	3,711.50 MB	Not Available
C:\swapfile.sys	Hidden, System, Archive	256.00 MB	Not Available

Note By changing the script $targetFolder and adding the -Recurse to the Get-ChildItem command, you can process the entire C:\ drive. Running the script against the c:\PS\ folder including the -Recurse Parameter we get the following result (truncated for brevity).

Note By changing the $MB variable to $KB = 1024 you can then produce results in Kilobytes, modify the script, and give that a try.



File Inventory

Date: 02/01/2019 14:31:36

Target: c:\PS\

FileName	Attribute	Size	HashValue
C:\PS\AcquireDNS.py	Archive	0.00 MB	2E724C0218EB6BDFE66A1EBEBF25308F443646CD1CE8216B9FC9A0843FB65D9D
C:\PS\baseline.pickle	Archive	0.05 MB	FC892B68249B80C[illegible]5B96AC9D018662060AC228425DD119EEB80ACDE490FDBF72
C:\PS\baseline.txt	Archive	0.05 MB	36D216DCDCE141B29BDFAE16C2CAD0A7DBC6E1B563DC8919105EE0FA65BB156D
C:\PS\BasicOne.ps1	Archive	0.00 MB	6C148046A7B0F774B385B708BF830EC36305DAB6180F0F10149DB4A726A78D4B
C:\PS\BasicOne.py	Archive	0.00 MB	A7B21340E1471729DC46C0808B2D9FBA7E3EAEE3CC996320B5FC117CB1B8AC35
C:\PS\cache.txt	Archive	0.00 MB	F48E2ACA88153F79FA068517D51902DF84411A11D5D8491D4862DBEE496F3657
C:\PS\CacheAcquire.ps1	Archive	0.00 MB	33720C54ECCC6346638C8DEABCDEAA0300D69D9E9635D0AA62AD9BC132772167
C:\PS\CreateBaseline.py	Archive	0.00 MB	D925826749257E22BF4889125B636BC8B4ED16C325198295791919A056E44E22
C:\PS\DnsCache.txt	Archive	0.00 MB	B6D05B119F7026D8A8EB86194FFD071155AB85852F0D0BF0A1538446A07AB935
C:\PS\EventProcessCred.ps1	Archive	0.00 MB	841C056BF8E0940DE7CEF211FE24232373A07D6BC6F9F82FE98D764257EEB94C
C:\PS\EventProcessMultipleTargets.ps1	Archive	0.00 MB	AC5A43A2214C32253DB0DF4ACF9BE6C59F9D601BA911268B7AA4E85B0F2D788D
C:\PS\EventProcessorFinal.ps1	Archive	0.00 MB	CB4A943042A5D77C44D8E39EAE63A33D68B03D38F4CDFBE0A2F5E31BDA9B0A6E
C:\PS\geo.csv	Archive	0.00 MB	F8A8F38087FB06F52168070C83C7F87DA0555941AB44EB73B12D4FBE23216254
C:\PS\HashAcquire.ps1	Archive	0.00 MB	7073705F5206A43920A5FDE2B0978CD7825B5CEF0EC804717B790A72FB343957
C:\PS\keywords.txt	Archive	0.00 MB	B9AE160660DB154B280A4BBCB0B984BB03BFB0F11EA7D3655938CC16D6D26D84
C:\PS\LatLon.csv	Archive	0.00 MB	FAE2B620CA79C759A464EBF505F93A2372964FE682D712728D3EA2B83312C649
C:\PS\LaunchPython.ps1	Archive	0.00 MB	2F5621EF76DB96788FA1F96AFDD7BAC8E2586A09ABD5787B77255832CD41DD8F
C:\PS\PassList.py	Archive	0.00 MB	8F1D1ECBAE0433600173A05975E64AF7AEC0CB97DCA0B6E2DDB83484224796B5
C:\PS\PBcache.txt	Archive	0.00 MB	E3B0C44298FC1C149AFBF4C8996FB92427AE41E4649B934CA495991B7852B855
C:\PS\pfmap.html	Archive	0.00 MB	64D0F15BF67960F37F34399C757B261D4E9DE0D400D92007574E23E963550A26
C:\PS\PhotoMap.ps1	Archive	0.00 MB	5E031969AAD6C9D13106E5AC54D1AFA52EBCDEC87B2CB830C2B831D8D2A82E90
C:\PS\ProperNameList.ps1	Archive	0.00 MB	1F6C2610554BBE2A5C97E5419F4053BCDCD73B6DCF42DA29381FFD9FCE68B60D
C:\PS\ProperNames.py	Archive	0.01 MB	5AF9CED4D76F01BB6A40A49E64D46D4607634C784E079FEFDBCDC78F72C2D6E8
C:\PS\pyGeo.py	Archive	0.01 MB	6333888A00BE36B88AFB3CE7E88334C91CF6FE3C9D130D0B69E4364FBD42575C
C:\PS\remoteInventory.ps1	Archive	0.00 MB	ACE9B4A443280638A47DA78665770546A501FD3FF7A8AEE6B825389FACA6F844
C:\PS\test.html	Archive	0.01 MB	E2B46B3CC5E4039521317D23083233CEA2D30C8C39F362FD810A65A6A83466B4
C:\PS\testInventory.ps1	Archive	0.00 MB	3AA51BCD7D4E345DAC8F1788ED29D477C46B9EC9522D7669A49D1B6066E4D493
C:\PS\tmp.txt	Archive	0.00 MB	7CE73131A20037D6C62F42E7736CDDE7E01DA7EF177930E2AFA0371B70EB68B0

Also, utilizing the Invoke-Command CmdLet, you can extend this example to collect file inventories of remote systems.

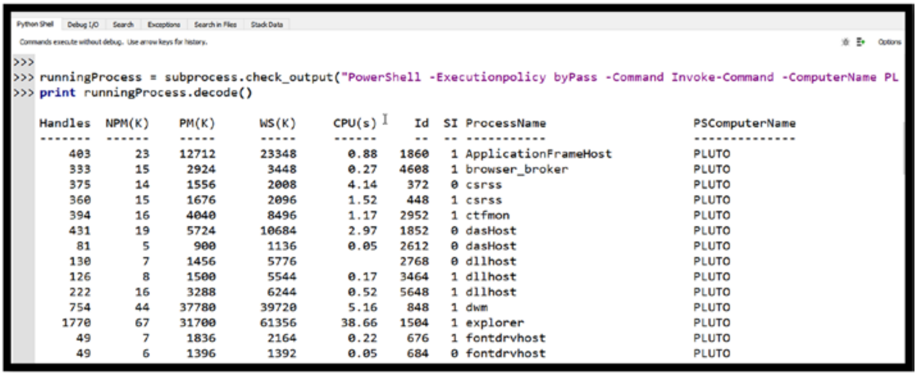
Chapter 4: Perform Remote Script Execution

Remote PowerShell Command Execution directly from Python:

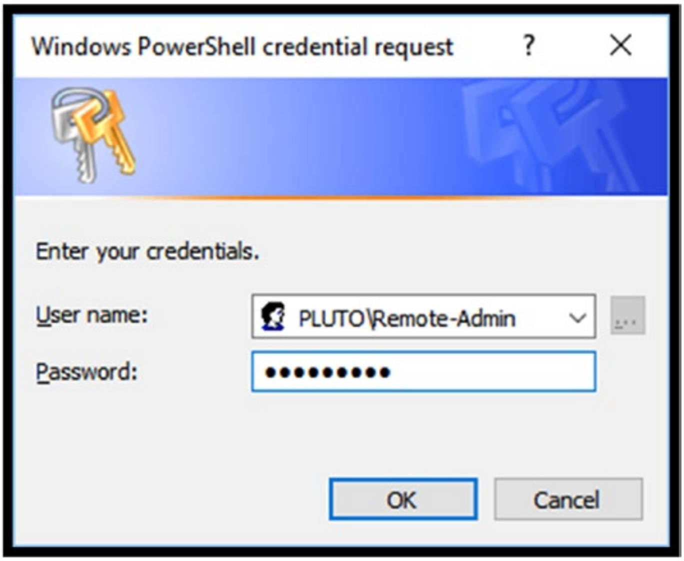
Example A: Acquire Remote Processes from PLUTO

```
import subprocess
runningProcess = subprocess.check_output("PowerShell
-Executionpolicy byPass
                 -Command Invoke-Command -ComputerName PLUTO
-Credential PLUTO\Remote-Admin -ScriptBlock {Get-Process}")

print runningProcess.decode()
```

Sample Execution



```
>>>
>>> runningProcess = subprocess.check_output("PowerShell -Executionpolicy byPass -Command Invoke-Command -ComputerName PL
>>> print runningProcess.decode()

Handles  NPM(K)    PM(K)      WS(K)     CPU(s)     Id  SI ProcessName                    PSComputerName
-------  ------    -----      -----     ------     --  -- -----------                    --------------
    403      23    12712      23348       0.88   1860   1 ApplicationFrameHost           PLUTO
    333      15     2924       3448       0.27   4608   1 browser_broker                 PLUTO
    375      14     1556       2008       4.14    372   0 csrss                          PLUTO
    360      15     1676       2096       1.52    448   1 csrss                          PLUTO
    394      16     4040       8496       1.17   2952   1 ctfmon                         PLUTO
    431      19     5724      10684       2.97   1852   0 dasHost                        PLUTO
     81       5      900       1136       0.05   2612   0 dasHost                        PLUTO
    130       7     1456       5776              2768   0 dllhost                        PLUTO
    126       8     1500       5544       0.17   3464   1 dllhost                        PLUTO
    222      16     3288       6244       0.52   5648   1 dllhost                        PLUTO
    754      44    37780      39720       5.16    848   1 dwm                            PLUTO
   1770      67    31700      61356      38.66   1504   1 explorer                       PLUTO
     49       7     1836       2164       0.22    676   1 fontdrvhost                    PLUTO
     49       6     1396       1392       0.05    684   0 fontdrvhost                    PLUTO
```



Windows PowerShell credential request

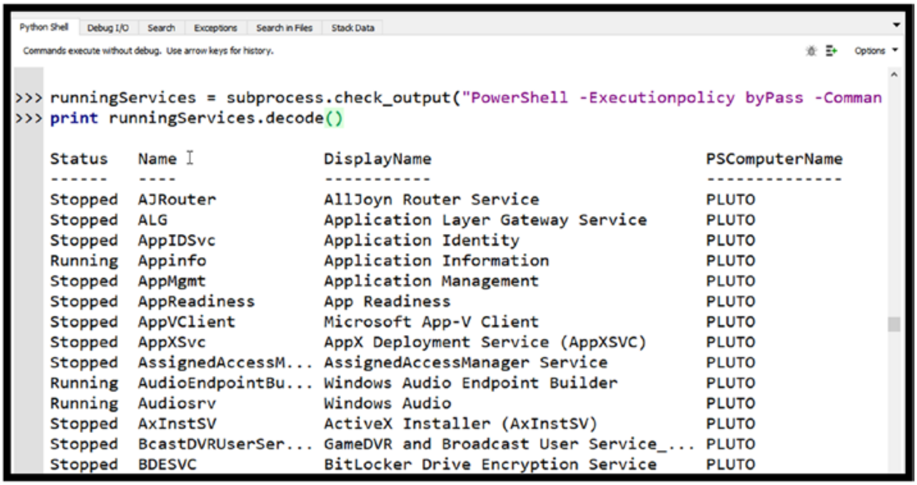
Enter your credentials.

User name: PLUTO\Remote-Admin

Password: ••••••••••

Example B: Acquire Remote Services from PLUTO

```
import subprocess
runningServices = subprocess.check_output("PowerShell
-Executionpolicy byPass
                 -Command Invoke-Command -ComputerName PLUTO
-Credential PLUTO\Remote-Admin -ScriptBlock {Get-Service}")

print runningServices.decode()
```

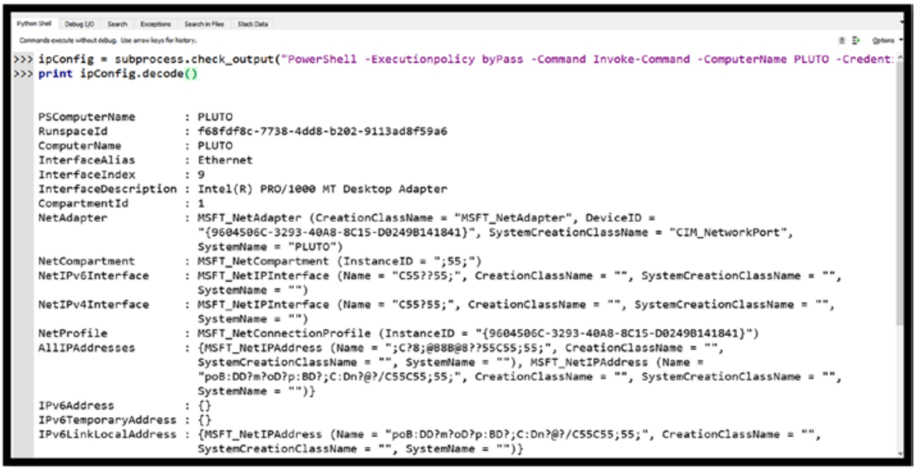


Commands execute without debug. Use arrow keys for history.

```
>>> runningServices = subprocess.check_output("PowerShell -Executionpolicy byPass -Comman
>>> print runningServices.decode()

Status   Name                DisplayName                           PSComputerName
------   ----                -----------                           --------------
Stopped  AJRouter            AllJoyn Router Service                PLUTO
Stopped  ALG                 Application Layer Gateway Service     PLUTO
Stopped  AppIDSvc            Application Identity                  PLUTO
Running  Appinfo             Application Information               PLUTO
Stopped  AppMgmt             Application Management                PLUTO
Stopped  AppReadiness        App Readiness                         PLUTO
Stopped  AppVClient          Microsoft App-V Client                PLUTO
Stopped  AppXSvc             AppX Deployment Service (AppXSVC)     PLUTO
Stopped  AssignedAccessM...  AssignedAccessManager Service         PLUTO
Running  AudioEndpointBu...  Windows Audio Endpoint Builder        PLUTO
Running  Audiosrv            Windows Audio                         PLUTO
Stopped  AxInstSV            ActiveX Installer (AxInstSV)          PLUTO
Stopped  BcastDVRUserSer...  GameDVR and Broadcast User Service_... PLUTO
Stopped  BDESVC              BitLocker Drive Encryption Service    PLUTO
```

Example C: Acquire Remote IP Configuration from PLUTO

```
import subprocess
ipConfig = subprocess.check_output("PowerShell -Executionpolicy byPass
                 -Command Invoke-Command -ComputerName PLUTO
-Credential PLUTO\Remote-Admin -ScriptBlock { Get-NetIP
Configuration -All}")

print ipConfig.decode()
```



```
>>> ipConfig = subprocess.check_output("PowerShell -Executionpolicy byPass -Command Invoke-Command -ComputerName PLUTO -Credent:
>>> print ipConfig.decode()


PSComputerName         : PLUTO
RunspaceId             : f68fdf8c-7738-4dd8-b202-9113ad8f59a6
ComputerName           : PLUTO
InterfaceAlias         : Ethernet
InterfaceIndex         : 9
InterfaceDescription : Intel(R) PRO/1000 MT Desktop Adapter
CompartmentId          : 1
NetAdapter             : MSFT_NetAdapter (CreationClassName = "MSFT_NetAdapter", DeviceID =
                         "{9604506C-3293-40A8-8C15-D0249B141841}", SystemCreationClassName = "CIM_NetworkPort",
                         SystemName = "PLUTO")
NetCompartment         : MSFT_NetCompartment (InstanceID = ";55;")
NetIPv6Interface       : MSFT_NetIPInterface (Name = "C55??55;", CreationClassName = "", SystemCreationClassName = "",
                         SystemName = "")
NetIPv4Interface       : MSFT_NetIPInterface (Name = "C55?55;", CreationClassName = "", SystemCreationClassName = "",
                         SystemName = "")
NetProfile             : MSFT_NetConnectionProfile (InstanceID = "{9604506C-3293-40A8-8C15-D0249B141841}")
AllIPAddresses         : {MSFT_NetIPAddress (Name = ";C?8;@B8B@8??55C55;55;", CreationClassName = "",
                         SystemCreationClassName = "", SystemName = ""), MSFT_NetIPAddress (Name =
                         "poB:DD?m?oD?p:BD?;C:Dn?@?/C55C55;55;", CreationClassName = "", SystemCreationClassName = "",
                         SystemName = "")}
IPv6Address            : {}
IPv6TemporaryAddress : {}
IPv6LinkLocalAddress : {MSFT_NetIPAddress (Name = "poB:DD?m?oD?p:BD?;C:Dn?@?/C55C55;55;", CreationClassName = "",
                         SystemCreationClassName = "", SystemName = "")}
```

Chapter 5: Multiple Target Computer DNSCache Acquisition

Examining the scripts given in Chapter 6 provides the needed methods necessary to complete and advance this challenge. I challenge you to complete this one entirely on your own.

Index

C. Hosmer, *PowerShell and Python Together*, https://doi.org/10.1007/978-1-4842-4504-0