PowerShell for Forensics

by Washington Almeida

Organizations today handle more sensitive personal data than ever before. As the amount of sensitive personal data increases, the more they are susceptible to security incidents and breaches. One of the biggest challenges in Incident Response nowadays is in the incident detection phase. There are several tools available to help Forensics specialists on working into detection phase. Some of them are open-source and some of them are commercial tools. However, the Windows OS environment has a built-in tool that can support the forensic activities in live response: PowerShell.

PowerShell is an object-oriented automation engine and scripting language with an interactive command-line shell developed by Microsoft to help IT professionals in configuring systems and automating administrative tasks. Quite similar to the Perl language that has been introduced in Linux, Microsoft designed PowerShell to automate system tasks, such as batch processing, and to create systems management tools for commonly implemented processes in the MS Windows environment.

PowerShell language was developed by a Microsoft technical partner named Jeffrey Snover. While working on system administration tasks on Windows, Snover felt Windows lacked the power and flexibility to automate tasks, which was already available in the Unix environment. Thus, Snover developed the idea to create a standardized platform that used the .NET framework through objects and automation tasks.

Microsoft produced a new command-line interface along with a shell called Monad which the first beta was released on June 2005. In April 2006, Microsoft renamed Monad to Windows PowerShell and made it a core part of the Windows operating system environment. Microsoft released PowerShell 1.0 in the end of 2006 for Windows XP SP2, Windows Vista and Windows Server 2003 SP1. With Windows Server 2008, Microsoft offered PowerShell as an optional component. PowerShell 2.0 was released with Windows 7 and Windows Server 2008 R2. PowerShell 3.0 was released in 2012 as part of Windows 8/ Server 2012. It completed the core language features and started to ship the ISE Editor. PowerShell 4.0 was released in 2013 as part of Windows 8.1/Server 2012R2. It added DSC (Desired State Configuration). PowerShell 5.0 was released in 2015 as part of Windows 10. This version is a major milestone with various new features and language extensions. Finally, PowerShell 5.1 was released in 2016 as part of Windows 10 Anniversary Update and Server 2016.

PowerShell commands or Cmdlets are based on .NET Framework objects, which mean that the objects carry multiple aspects or properties of the command. These Cmdlets let you access the file system and other Windows operating system data stores, such as the registry. PowerShell also provides access to Windows Management Instrumentation (WMI), which means that all the WMI commands that incident responders and information security professionals are familiar with can be run using PowerShell. Complete documentation about PowerShell can be found in the Microsoft URI at *https://docs.microsoft.com/en-us/powershell*.

PowerShell updates:

PowerShell updates are free and come as ".msu" packages, so they can be distributed just like any other Windows update. If you run an outdated version of PowerShell, you're not just missing features, it's also a potential security risk.

Understanding PowerShell help:

Later we will go into the details of PowerShell environment, but before you get started using PowerShell, you need to understand the syntax of its parameters, such as -ComputerName and -Class. Thus, for a better understanding of how PowerShell works, you can investigate the master cmdlet Get-

WmiObject (and all others) calling the help of it by Get-Help. To do this you can call the help for the cmdlet Get-WmiObject as follows:

```
C:\Users\Wash>powershell

Windows PowerShell

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PS C:\Users\Wash> Get-Help Get-WmiObject
```
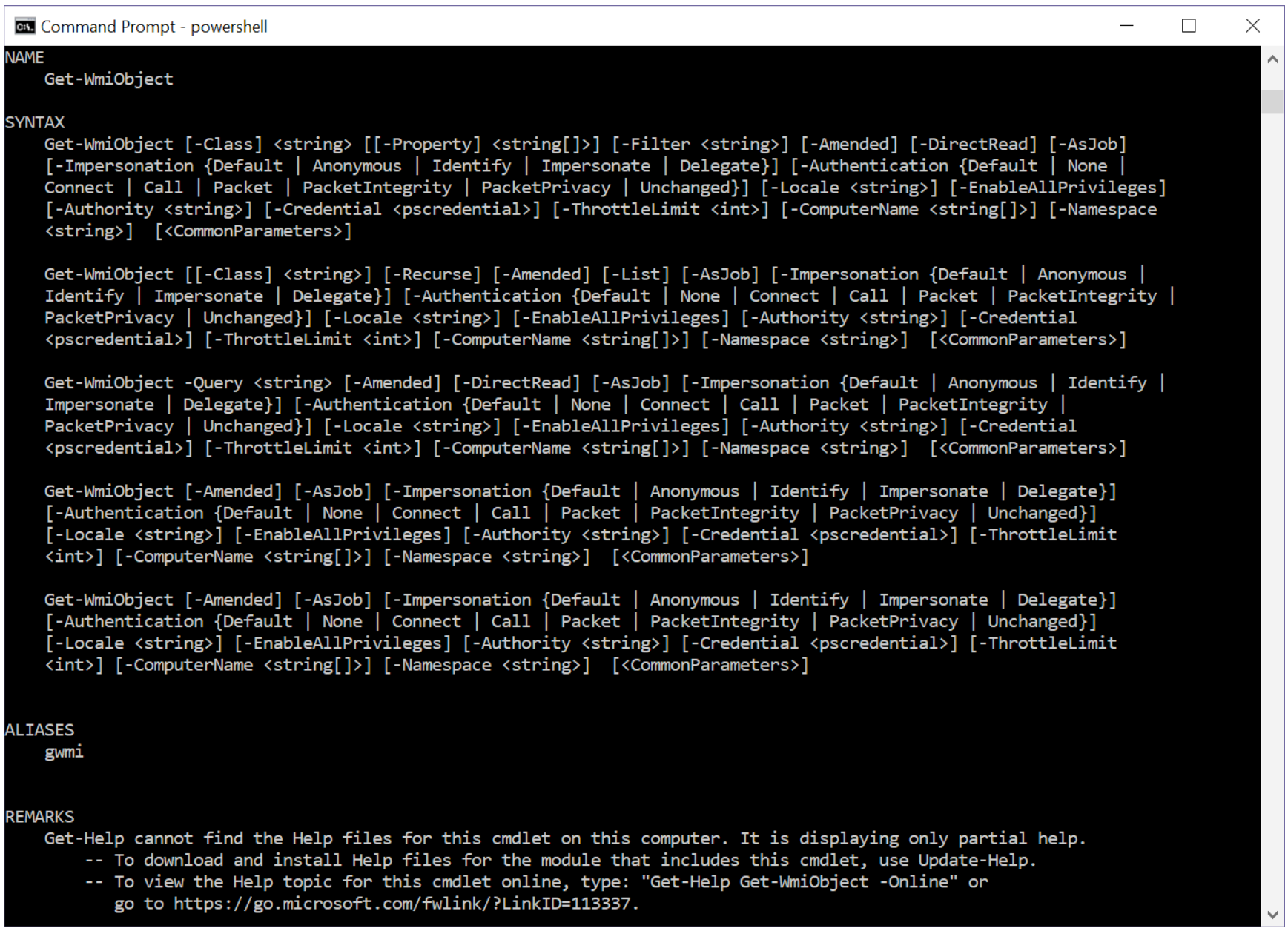
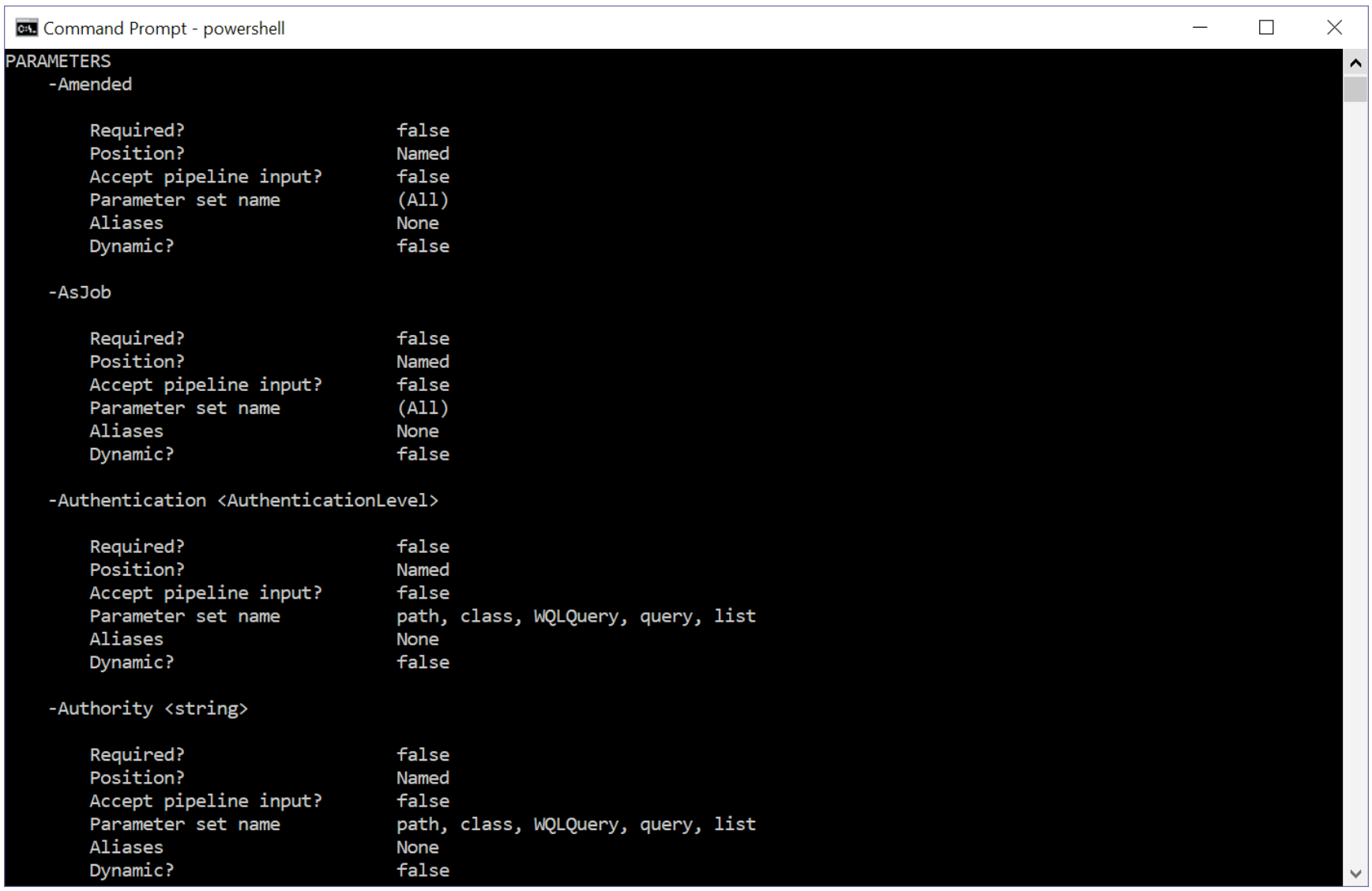



As a result, the eForensics reader can have information about almost all possible combinations to get information of objects using Get-WmiObject. The reader also can see the ALIASES gwmi, which means you can use the alias gwmi instead of Get-WmiObject for PowerShell operations. You may prefer to have a complete help information of the cmdlet Get-WmiObject. In such case, use the following:

PS C:\Users\Wash> Get-Help Get-WmiObject -full



Beyond the information you receive with the command **Get-Help Get-WmiObject** you realize that adding the clause "**-full**" you can have the information about all parameters, which is partially shown in the screenshot taken above.

Essential PowerShell Configuration:

Initially, PowerShell works in a limited mode and only accepts interactive commands. To fully leverage its capabilities, a small set of settings control what you can do and what you cannot do. Before you start working with PowerShell on a new computer, you should review these settings (and adjust them if necessary).

PowerShell is locked down by default but you can decide which areas you want to open. Basically, you need to worry about two items: scripting and remote access.

Initially, PowerShell can only execute interactive commands, but no scripts. Scripts work like batch files that can contain many commands that run in an ordered sequence.

Even if you don't plan to run scripts yourself, you should consider enabling scripts right away. Many of the commands are script-based, and when you don't allow PowerShell to run scripts, you may run into a lot of limitations. Let me explain how to enable this feature.

```
PS C:\Users\Wash> Get-ExecutionPolicy

Restricted

PS C:\Users\Wash> Get-ExecutionPolicy -list

Scope                ExecutionPolicy

-----                ---------------

MachinePolicy        Undefined

UserPolicy           Undefined

Process              Undefined

CurrentUser          Undefined

LocalMachine         Undefined
```

Get-ExecutionPolicy reports the effective setting. When you add the parameter -List, you discover that there are five settings. PowerShell evaluates them from top to bottom, and if all are Undefined, script execution is disabled ("Restricted"). This configuration is the default for the brand-new computers.

MachinePolicy: this parameter is controlled via Group Policy. This one should always be "Undefined". If you see anything else, contact the Active Directory Administrator of the company. Execution policy works like a seat belt for you, not like a security boundary for your company. Users should always be able to change this setting.

UserPolicy: Same as MachinePolicy but just per user.

Process: Applies to the currently running instance of PowerShell only, and does not affect other instances. This parameter is not often used.

CurrentUser: This is your setting. It applies only to you and no one else.

LocalMachine: If the Active Directory Administrator of your company accidentally set this setting in one of the top two scopes, then point them to this setting: it works like a general preference for all users, yet users can still change it in one of the scopes above. That's where centrally managed settings should be set. Remember, you need Admin privileges to make changes on this.

So, to enable scripts, change the setting for CurrentUser. PowerShell cmdlets typically come in pairs, so the verb "Get" reads, and the verb "Set" changes, like shown below:

```
PS C:\Users\Wash> Set-ExecutionPolicy -Scope CurrentUser -
ExecutionPolicy RemoteSigned -Force


PS C:\> Get-ExecutionPolicy

RemoteSigned


PS C:\> Get-ExecutionPolicy -List

Scope                ExecutionPolicy

-----                ---------------

MachinePolicy        Undefined

UserPolicy           Undefined

Process              Undefined

CurrentUser          RemoteSigned

LocalMachine         Undefined
```

When you enter these commands, depending on which host you use, you get different levels of help. In the PowerShell console, you can press TAB to get auto completion suggestions. Also, you can press TAB multiple times for more choices, and press SHIFT+TAB to go back. If you are in the ISE Editor, you don't have to really do anything since Intellisense opens automatically, and you just need to pick from the choices described below.

RemoteSigned: You can execute scripts that are stored on your computer, or on any other computer that is part of your domain. You cannot execute scripts that you downloaded from the Internet, received via Email, or that are stored on computers outside your domain – unless they carry a valid digital signature (which scripts typically seldom do).

Unrestricted: You can execute any script. If it falls under any of the "potentially hostile" categories listed above, a dialog pops up and asks whether you are sane.

Bypass: You can execute any script. Period. No questions asked.

Restricted: You cannot execute any script.

Undefined: Resets the scope. PowerShell continues to evaluate the child scopes. If they are all "Undefined", then PowerShell defaults to "Restricted"

AllSigned: Every single script needs to carry a valid digital signature. Remember, this affects not just scripts you launch. Often, applications run PowerShell scripts in the background. This setting is useful only for very locked down systems like teller machines.

All settings persist until you decide to change them again, excepting for the scope "Process".

For Remote Access on PowerShell you need to have local Administrator privileges on the remote system you want to access and work with PowerShell. Sometimes this feature is useful while working on forensics activities, but it must be previously configured. For the purpose of this article, this subject will not be covered. However, if the eForensics reader comes to face the need to enable this feature, consult Microsoft PowerShell Documentation.

Live response:

Live response is an area that deals with collecting information from a live machine in order to identify if an incident has occurred.

Such information includes artifacts such as process information, connection information, files opened by processes (i.e. ransomware), and any artifact to establish the fact that an incident has occurred.

As the goal of live response is to identify incidents as quickly as possible, the Forensics specialists must know what artifacts they should collect, which vary from case to case.

About the environment:

To take a first dip in the PowerShell environment I invite the eForensics reader to join us and use PowerShell to identify my machine and the environment.

Firstly, we open a command line interface and launch the following simple command powershell as shown below.

```
Microsoft Windows [Version 10.0.15063]

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C:\Users\Wash>powershell

Windows PowerShell

Copyright (C) 2016 Microsoft Corporation. All rights reserved.

PS C:\Users\Wash>
```

When launching PowerShell command line the prompt is changed with the characters PS in the beginning of the prompt, which means you are now working under the PowerShell environment.

So, instead of telling the eForensics reader about my computer environment, let us use PowerShell to get some information regarding my machine. The command I will be using is “Get-WmiObject -Class Win32_ComputerSystem”.

```
PS C:\Users\Wash> Get-WmiObject -Class Win32_ComputerSystem

Domain              : WORKGROUP

Manufacturer        : Alienware

Model               : Alienware 13 R3

Name                : DESKTOP-7HH470E

PrimaryOwnerName    :

TotalPhysicalMemory     : 17046671360
```

I am working on an Alienware machine 13 inches equipped with 16Gb of RAM memory, identified by TotalPhysicalMemory.

Now let us understand this basic PS command.

Get-WmiObject – Lists details of a WMI class.

-Class – instruct PS to a type of class that must be informed.

Win32_ComputerSystem – Is the WMI class of which I want to collect information.

As you work with PowerShell, you realize that it is relatively simple to use. You just need to know the arguments you should use to get the results you want to collect. How about the BIOS? How can I identify the BIOS of my system using PowerShell? We just need to change the class followed by the correct parameters as shown below.

```
PS C:\Users\Wash> Get-WmiObject -Class Win32_BIOS -ComputerName .

SMBIOSBIOSVersion       : 1.1.6

Manufacturer            : Alienware

Name                    : 1.1.6

SerialNumber            : 388Z7H2

Version                 : ALWARE - 1072009
```

The eForensics reader must realize the **Get-WmiObject** is one of the most important cmdlets for general system management tasks and it is relatively easy to perceive since all critical subsystem settings are exposed through WMI into Windows environment.

What is the wallpaper that I am using in my desktop? Can PowerShell tell me about it? Yes.

```
PS C:\Users\Wash> Get-WmiObject -Class Win32_Desktop -ComputerName . | Select-Object -Property Wallpaper

Wallpaper

---------

C:\Users\Wash\Pictures\rainbow_alienware_red_by_darkangelkrys-d4xmzna.jpg
```

And how about the processor that equips my notebook?

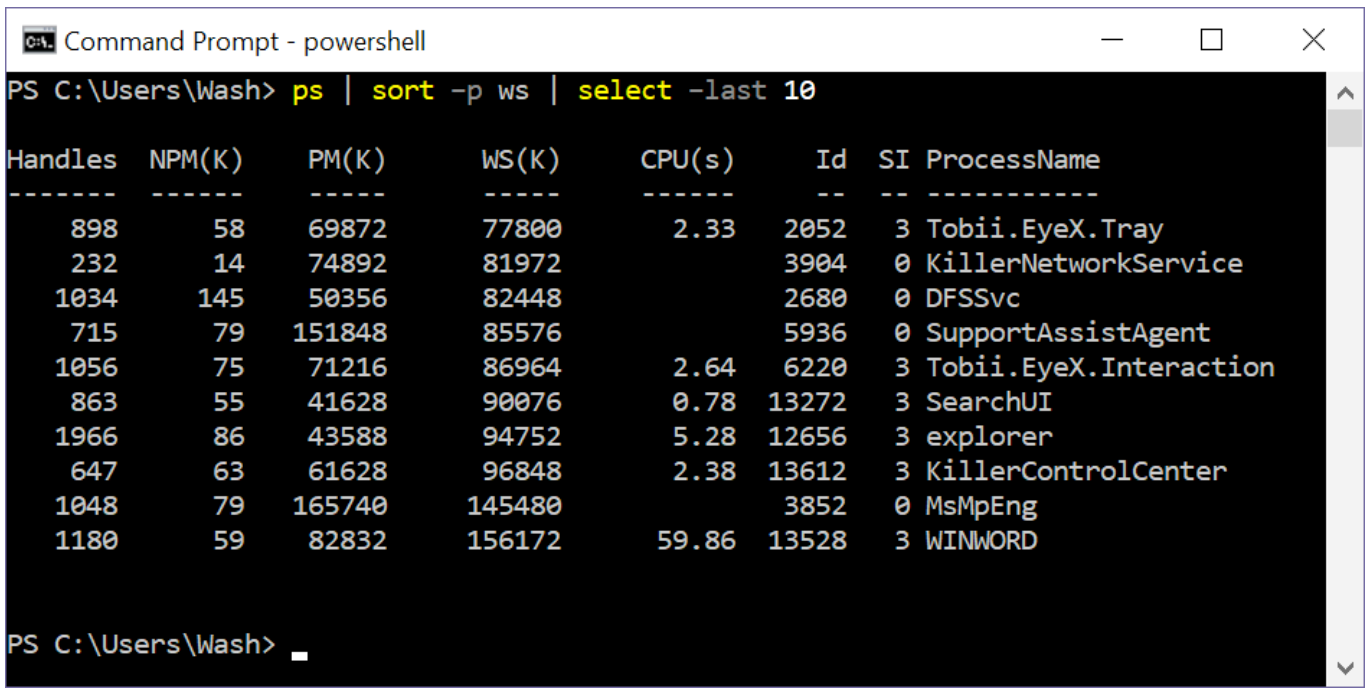
```
PS C:\Users\Wash> Get-WmiObject -Class Win32_Processor -ComputerName . | Select-Object -Property Name


Name
----
Intel(R) Core(TM) i7-7700HQ CPU @ 2.80GHz
```

Can PowerShell collect the information regarding the number of the logical processors in the Intel(R) Core(TM) i7-7700HQ CPU @ 2.80GHz?

```
PS C:\Users\Wash> Get-WmiObject -Class Win32_Processor -ComputerName . | Select-Object -Property NumberOfLogicalProcessors


NumberOfLogicalProcessors
-------------------------
8
```

How about the top ten processes using the most memory?

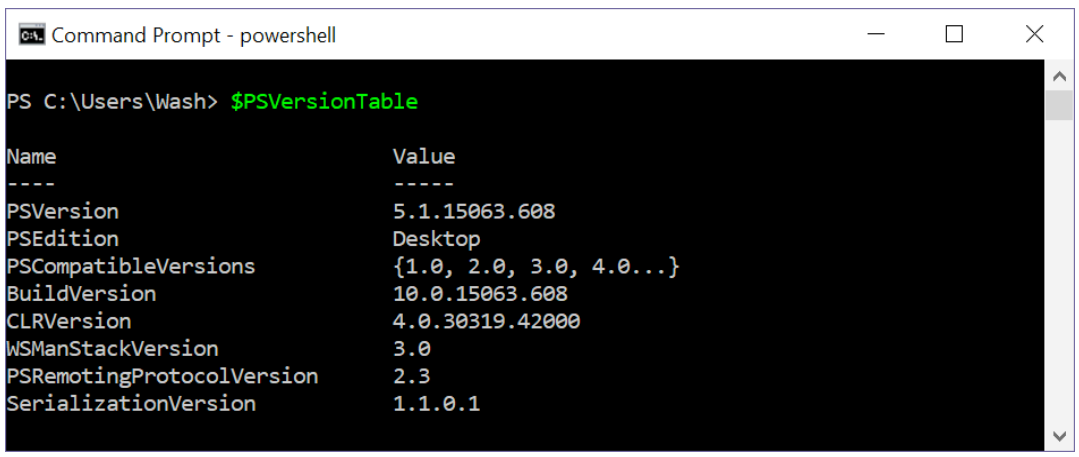
```
PS C:\Users\Wash> ps | sort -p ws | select -last 10
```



The examples above demonstrate how to collect specific information by using Get-WmiObject against an arbitrary computer. Notice that I specified the ComputerName parameter with the dot value (.), which represents the local computer. The eForensics reader may already realize that the PowerShell language is a very powerful tool that is available to forensic specialists in Windows environment system.

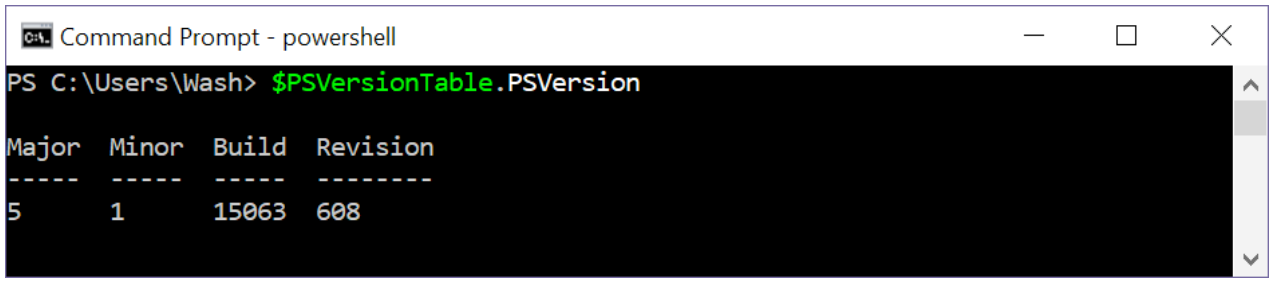
Also, depending on which version of PowerShell you are using, some commands may not be supported. So, it's always a good practice to check which version of PowerShell your system is using. To do so, just type $PSVersionTable under PS command line prompt as below.

```
PS C:\Users\Wash> $PSVersionTable
```



Alternatively, you can collect only a specific item of the table above. Let us suppose we want just to collect the PSVersion information of the table. If you know how the information and tables are built-in into PowerShell, then it makes the task easier.

```
PS C:\Users\Wash> $PSVersionTable.PSVersion
```



As the eForensics reader can see, the variable $PSVersionTable lists the versions of PowerShell ("PSVersion") and all its related components. We can just use a dot (".") to drill deeper into the specific information we want to collect. Now let us go ahead and see how we can use PowerShell for forensics purposes.

Working with PowerShell for forensics:

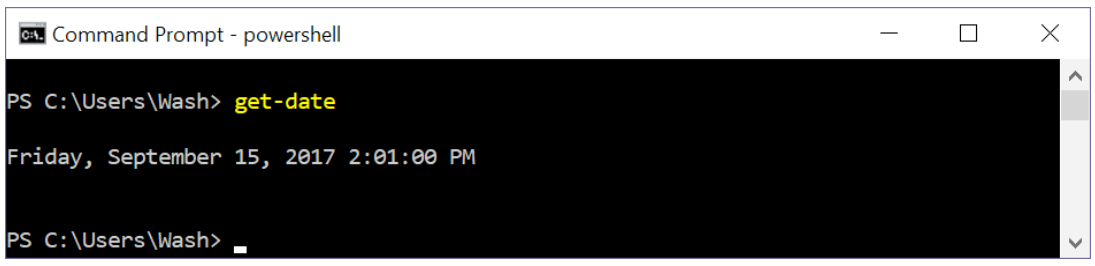
Writing about PowerShell can easily take us to several books separated by topics, which makes this article a real challenge in targeting PowerShell features for forensic activities.

So, let us suppose you face a breach in your systems. Thus, you want to retrieve as much information as possible to help you build a timeline of the intrusion, and hopefully figure out how the attackers gained access to your system and what parts of it they had access to. For this matter, PowerShell can prove to be very useful. Windows has integrated it in its newest operating systems, and steadily become Microsoft's preferred method for managing their core products. For example, the latest versions of Exchange, SharePoint, and even Windows Server 2012 can be managed almost entirely via PowerShell. As a matter of fact, many of the Microsoft GUI management tools provides for these applications are simply performing PowerShell operations in the background.

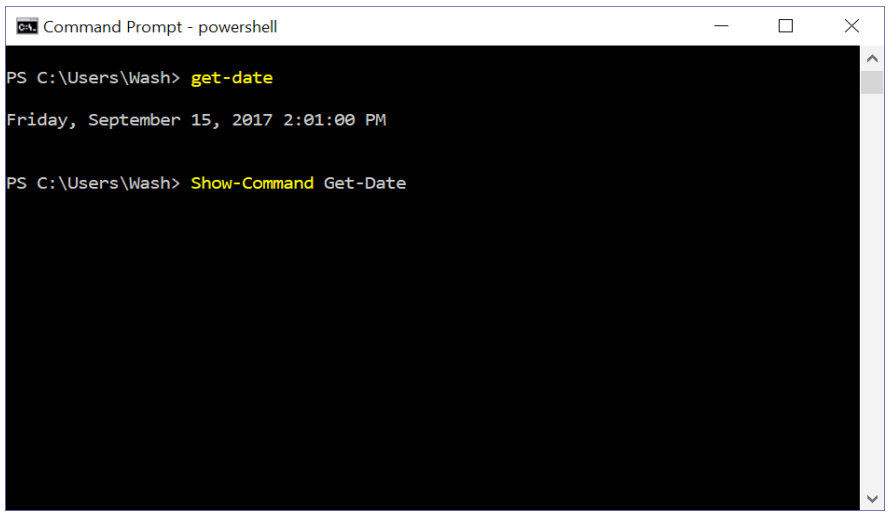
PowerShell provides a complete set of related cmdlets. We will explore some of them. The list of cmdlets that a forensics specialist can explore is very long. Also, some outputs will be omitted since they are very long.

Getting the date:

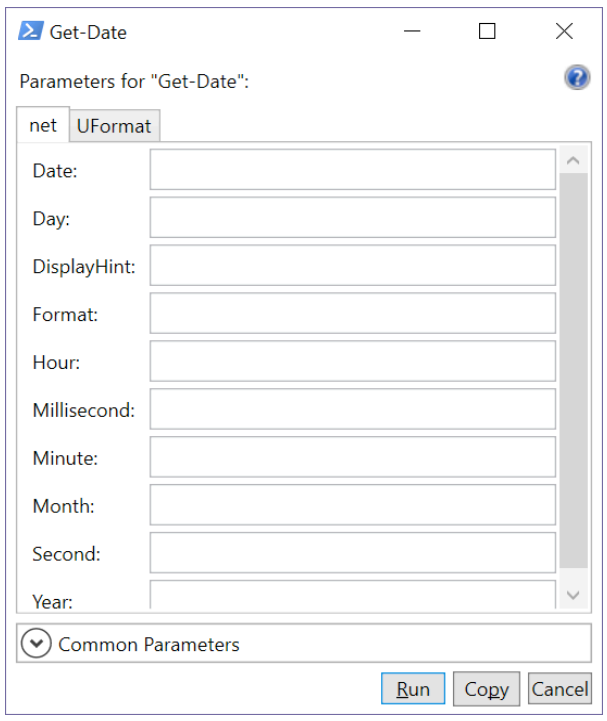
```
PS C:\Users\Wash> Get-Date
```



Other PowerShell features: When in doubt about completing the parameters of a certain cmdlet, you can load the command panel even in command line mode. The command panel is a graphical window very similar to the PowerShell ISE command panel and allows you to view the optional parameters and mandatory cmdlets. For instance, let us do this Show-Command cmdlet.

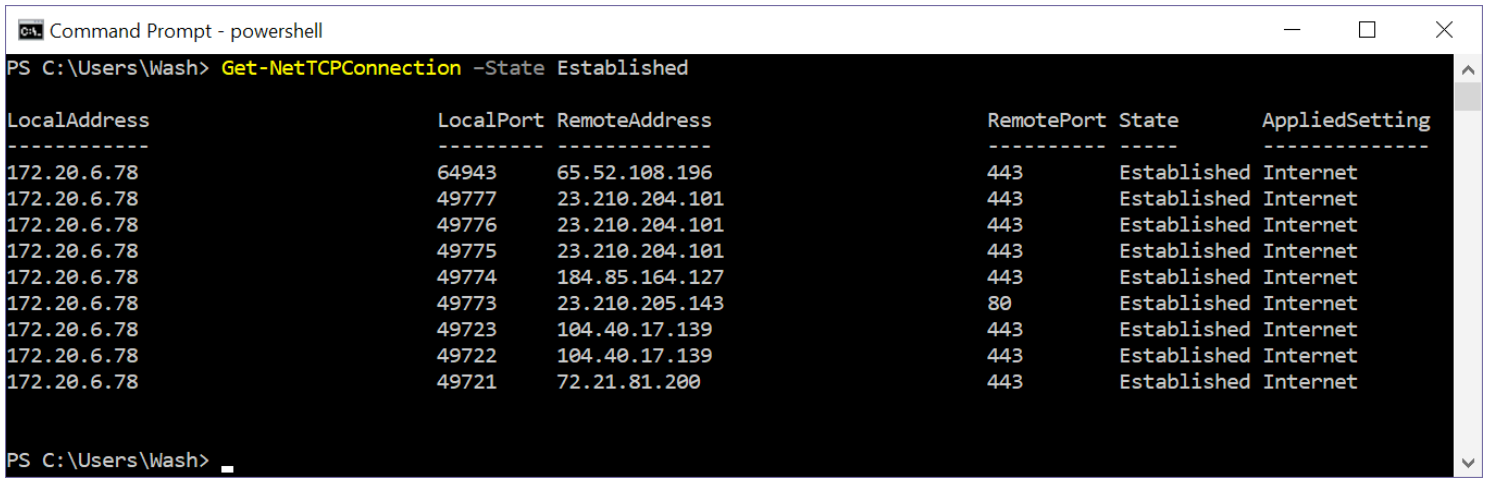


And Windows will open the cmdlet Get-Date in a GUI showing all possible parameters that can be used.



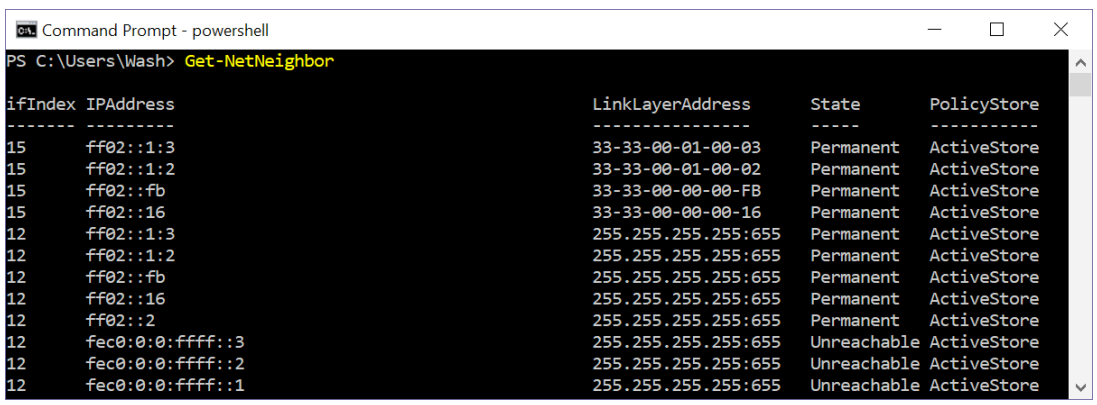
Collecting Network Information:

```
PS C:\ Users\Wash> Get-NetTCPConnection –State Established
```



```
PS C:\> Get-NetNeighbor
```

The Get- NetNeighbor cmdlet gets the neighbor cache entries. The output expected will be something like what follows:



Controlling the display (output) of information.

Information that you can collect through Windows PowerShell can be formatted to make it easier to see information. Using the pipe (|) we can pass the output of the command to several options. The pipe is an operator. Each command after the pipe receives an object from the previous command, performs some operation on the object, and then passes on to the next command in the pipeline. Some examples are shown below:

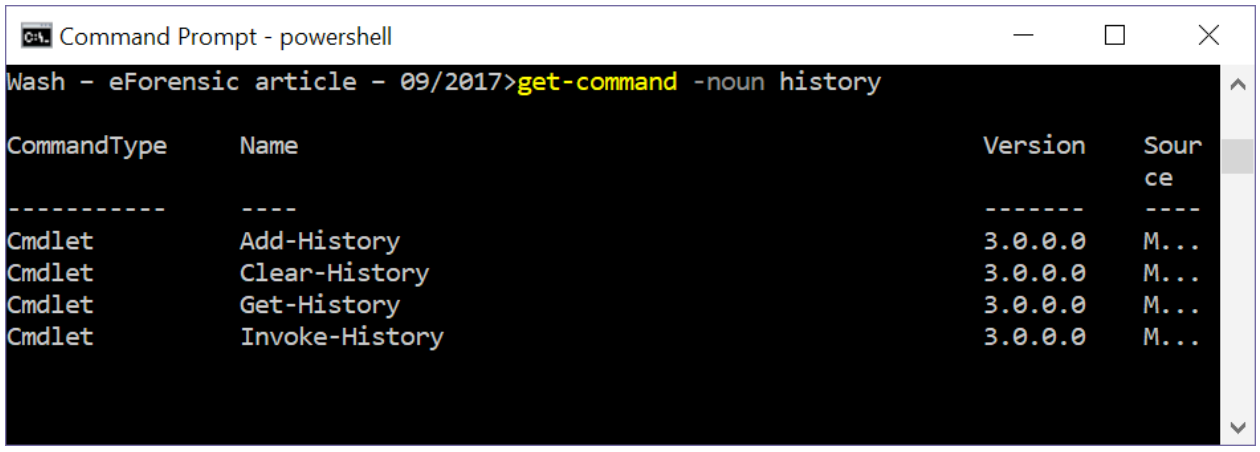
```
Get-Process | more

Get-Process | Format-List

Get-Process | Format-List | more

Get-Process | ConvertTo-HTML | Out-File "Processes.html"

Get-Process | Export-CSV "Processes.csv"
```

We will explore this feature later.

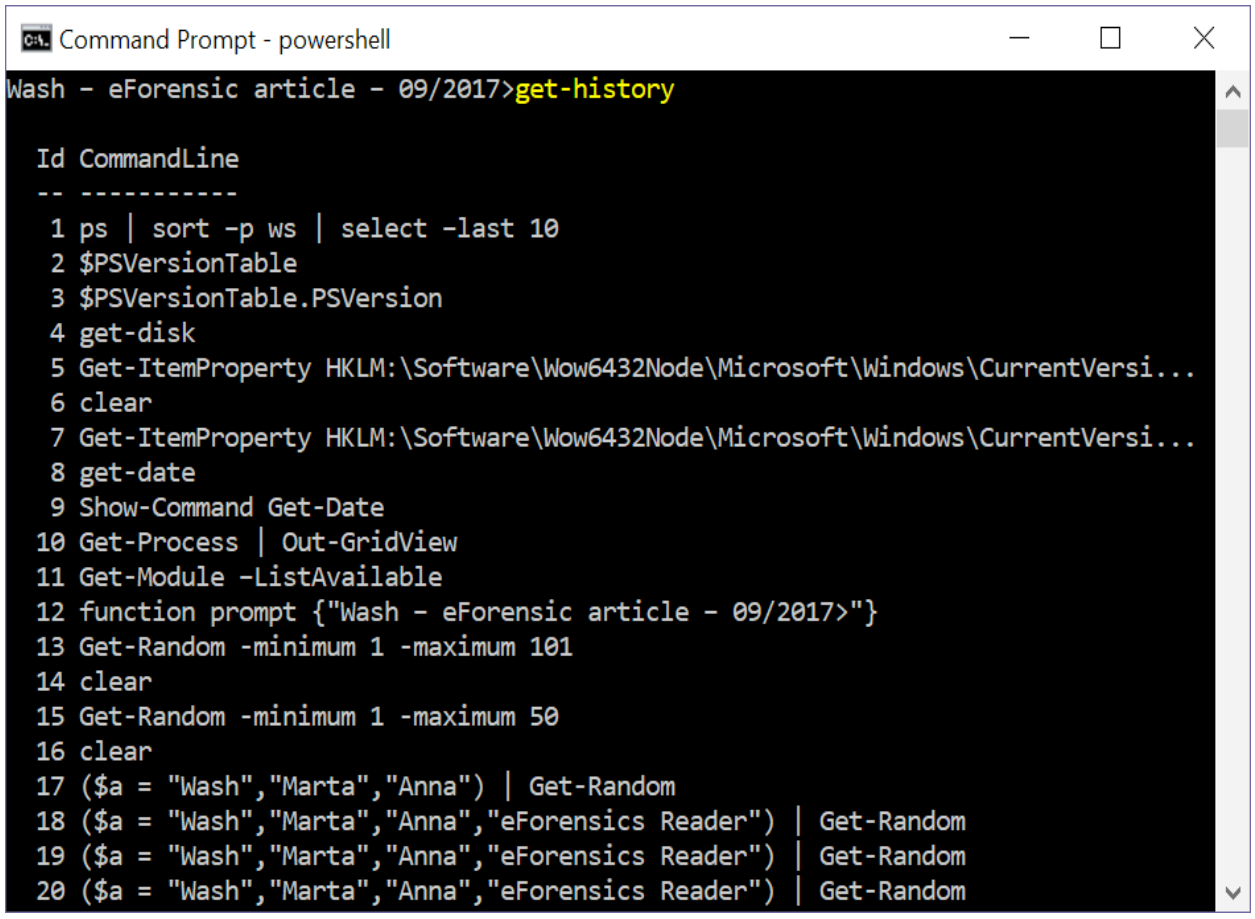
Collecting information about what was typed in sessions:

PowerShell automatically maintains a history of each session. We can save session history in XML or CSV format. By default, the history files are saved in the directory where the commands are executed, in this case c: \ users \ administrator, but the file can be saved anywhere.

We have four Windows PowerShell cmdlets that allow us to work with **Get-History**.



Using Get-History, the Forensics Expert can see what was typed in the console.

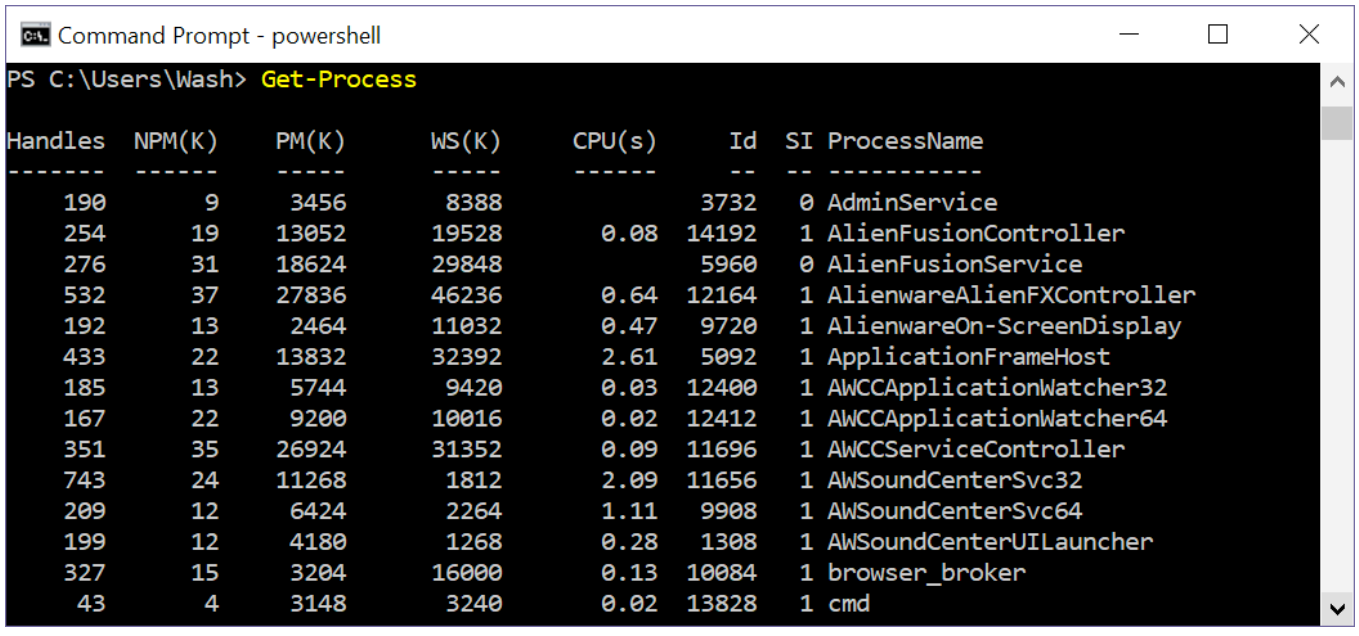


Collecting System Information:

```
PS C:\Users\Wash> Get-Process
```

The Get-Process cmdlet gets the processes on a local or remote computer. By default, Get-Process 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 Get-Process to get file version information for the program that runs in the process and to get the modules that the process loaded.

The output expected will be something like what follows:



Windows Event Logs can be collected by cmdlet Get-EventLog. If used without a parameter, the forensics specialist will be invited to supply the name of the Log he/she wants to collect. I suggest the eForensics reader launch Get-EventLog with the parameter "-list" in order to see all Logs available to be collected.

Some existing cmdlets create incredible outputs, such as out cmdlets. To list the "out" cmdlets: Get-command out-

Out-Default - Send the output to the standard formatter and the default output cmdlet.

Out-File - Outputs a file.

Out-GridView - Output the output to an interactive table in a separate window.

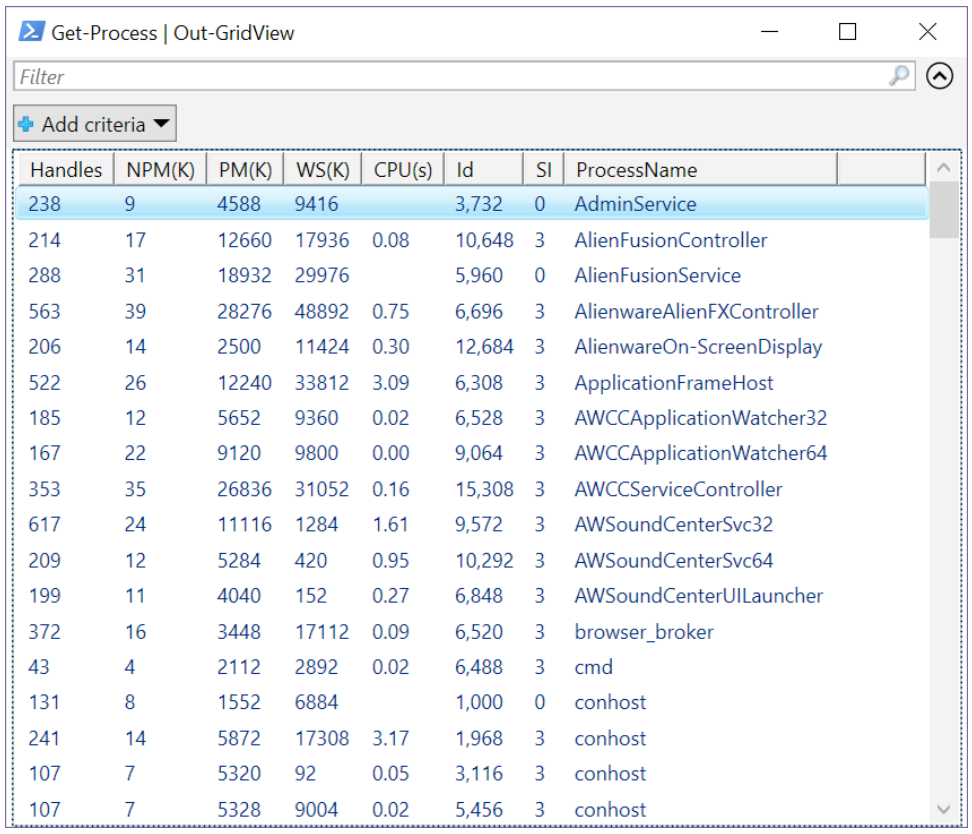
Out-Host - Sends the output to the command line.

Out-Null - Erases output instead of sending it to the console.

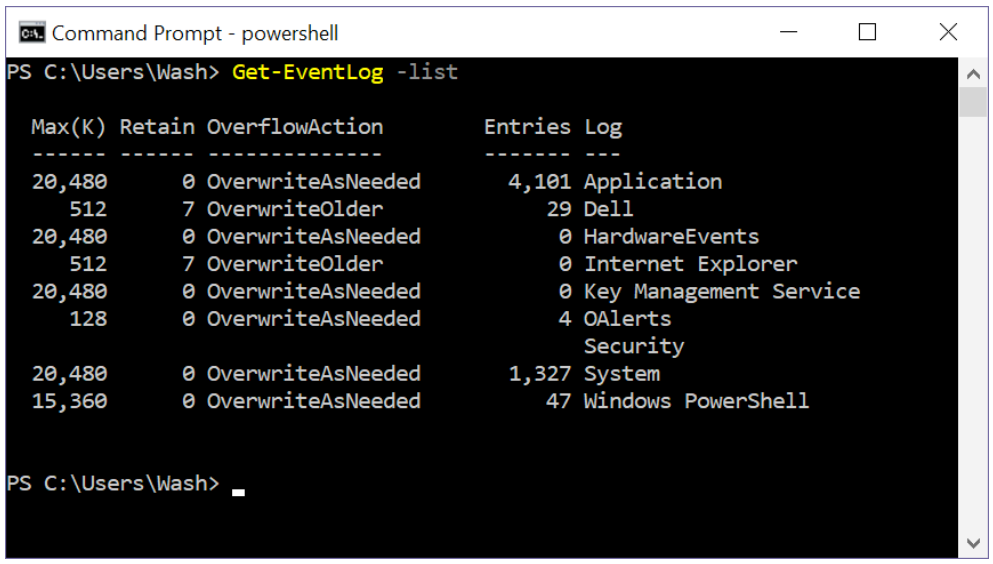
Out-Printer - Outputs to a printer.

Out-String - Sends out a string of strings.

Get-Process | Out-GridView brings the following output:

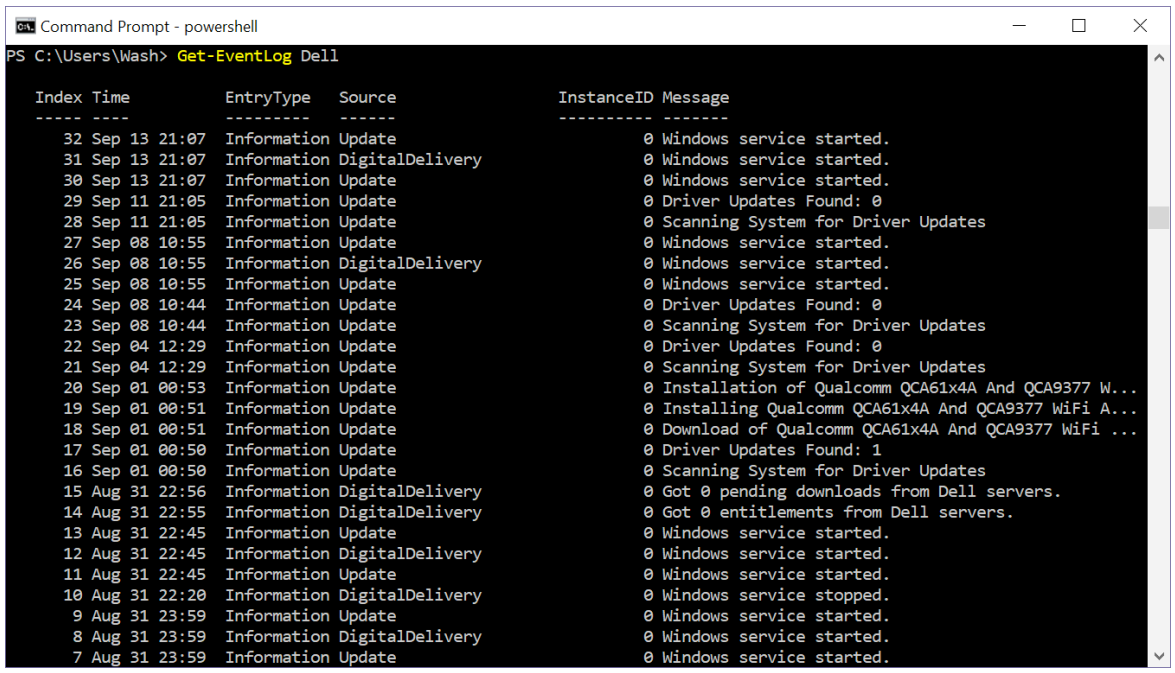


PS C:\Users\Wash> Get-EventLog -list

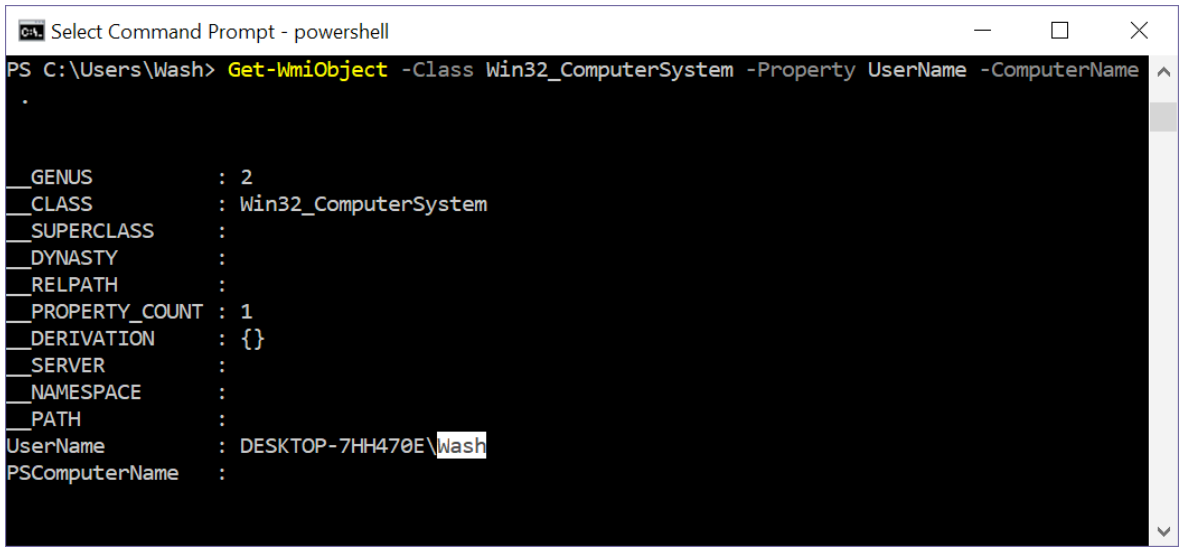


Now let us suppose we want to collect the Logs regarding the Dell log entries.

PS C:\Users\Wash> Get-EventLog Dell

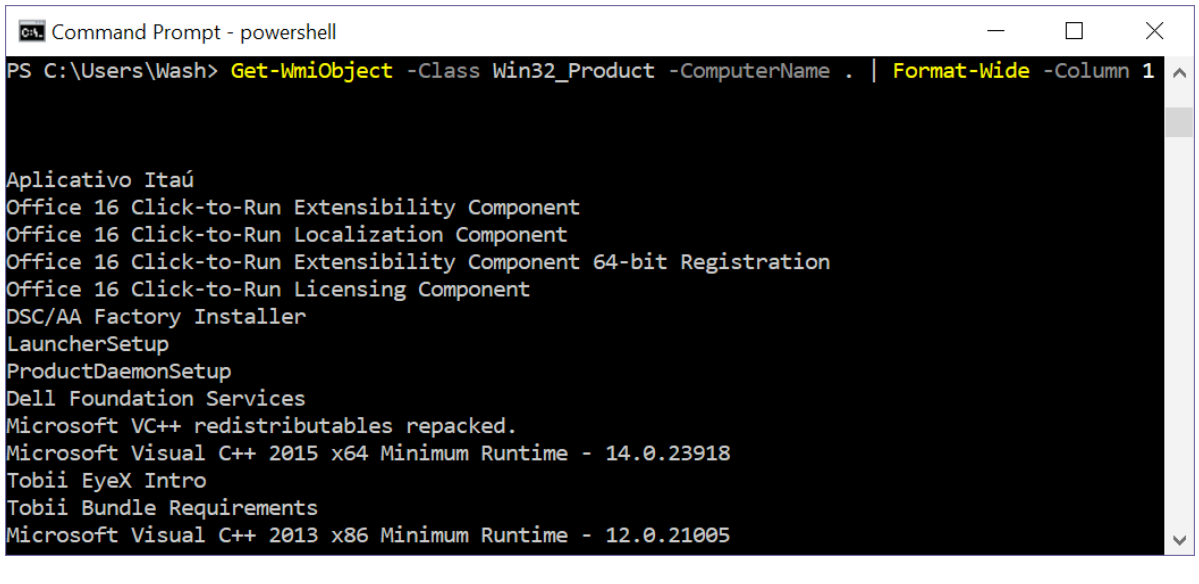


Getting the username of the person currently logged on to a computer:



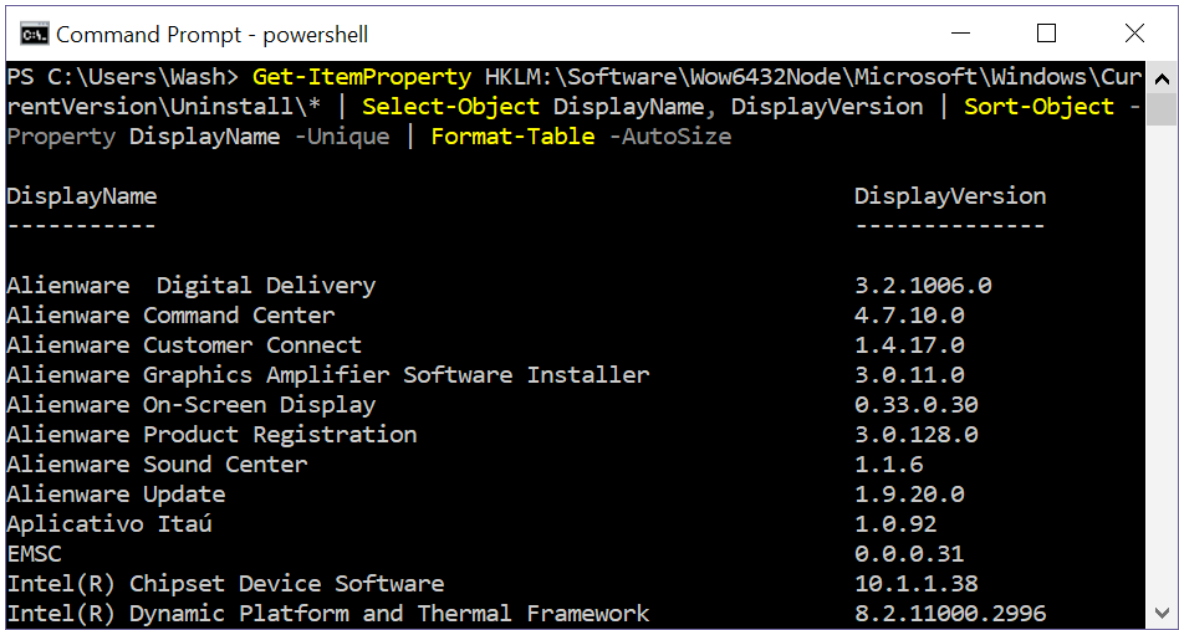
Finding the names of installed applications on the current computer:

```
Get-WmiObject -Class Win32_Product -ComputerName . | Format-Wide -Column 1
```

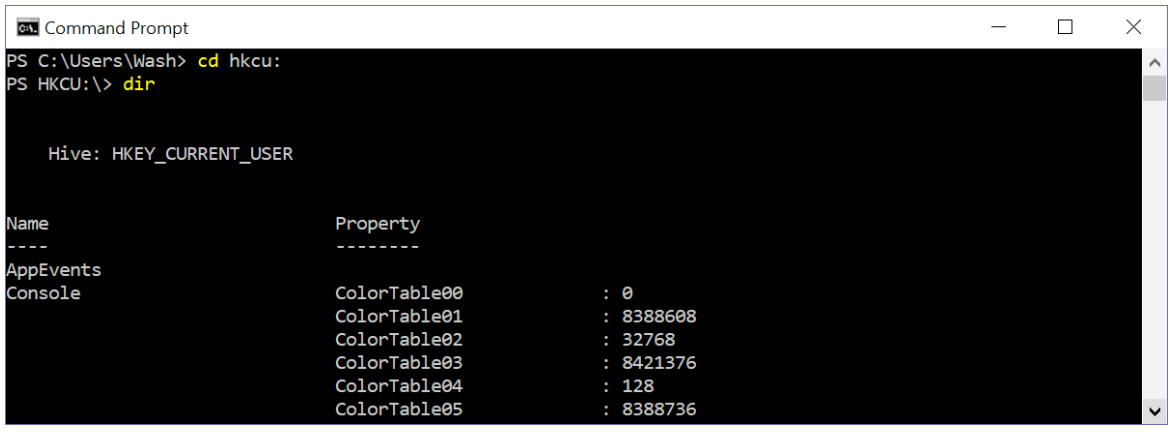


Finding the names of installed applications on the current computer and its versions:

```
Get-ItemProperty HKLM:\Software\Wow6432Node\Microsoft\Windows\CurrentVersion
\Uninstall\* | Select-Object DisplayName, DisplayVersion | Sort-Object -Property
DisplayName -Unique | Format-Table -AutoSize
```

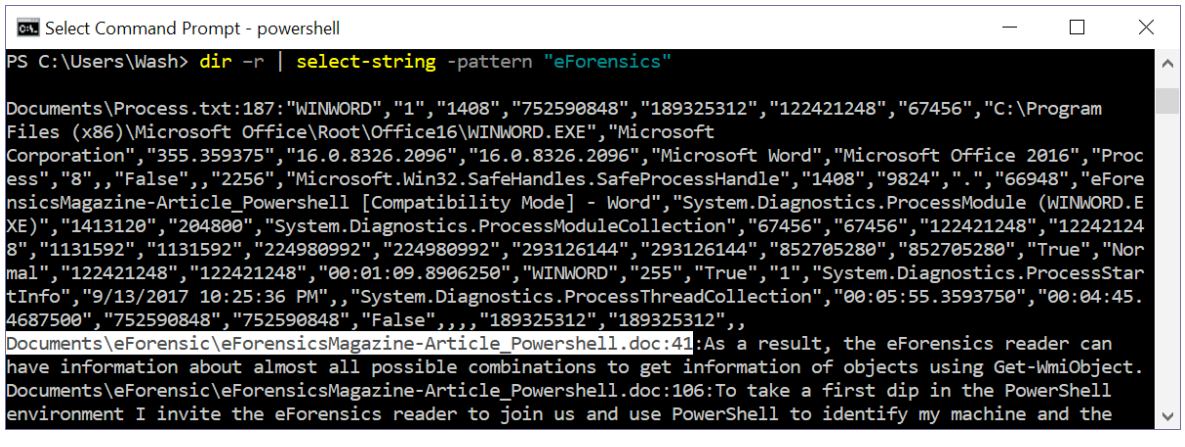


We can navigate into Windows Registry the same way we navigate into the file system:



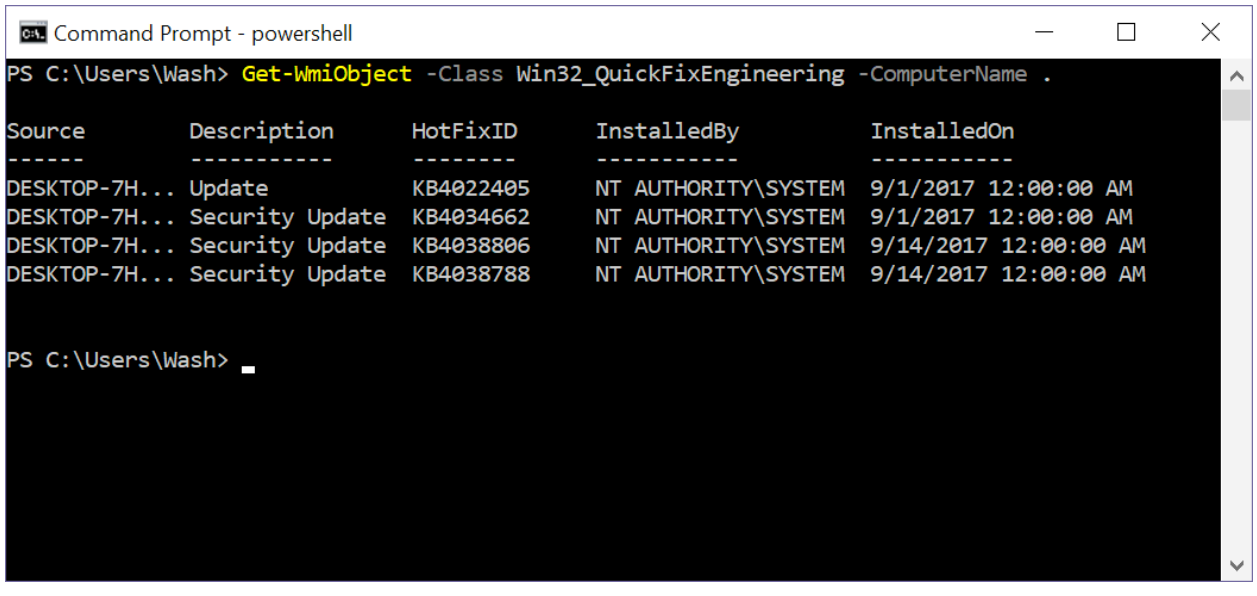
The Forensics Expert can also search recursively for a certain string within files:

```
PS C:\Users\Wash> dir -r | select-string -pattern "eForensics"
```



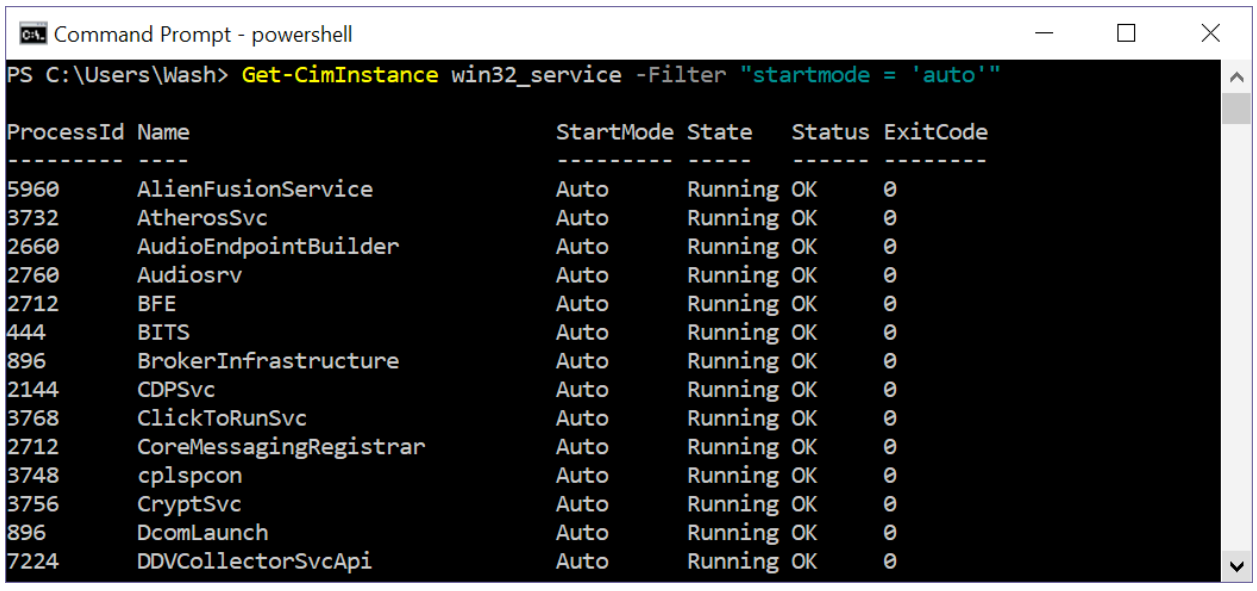
Listing installed hotfixes -- QFEs, or Windows Update files:

```
Get-WmiObject -Class Win32_QuickFixEngineering -ComputerName
```



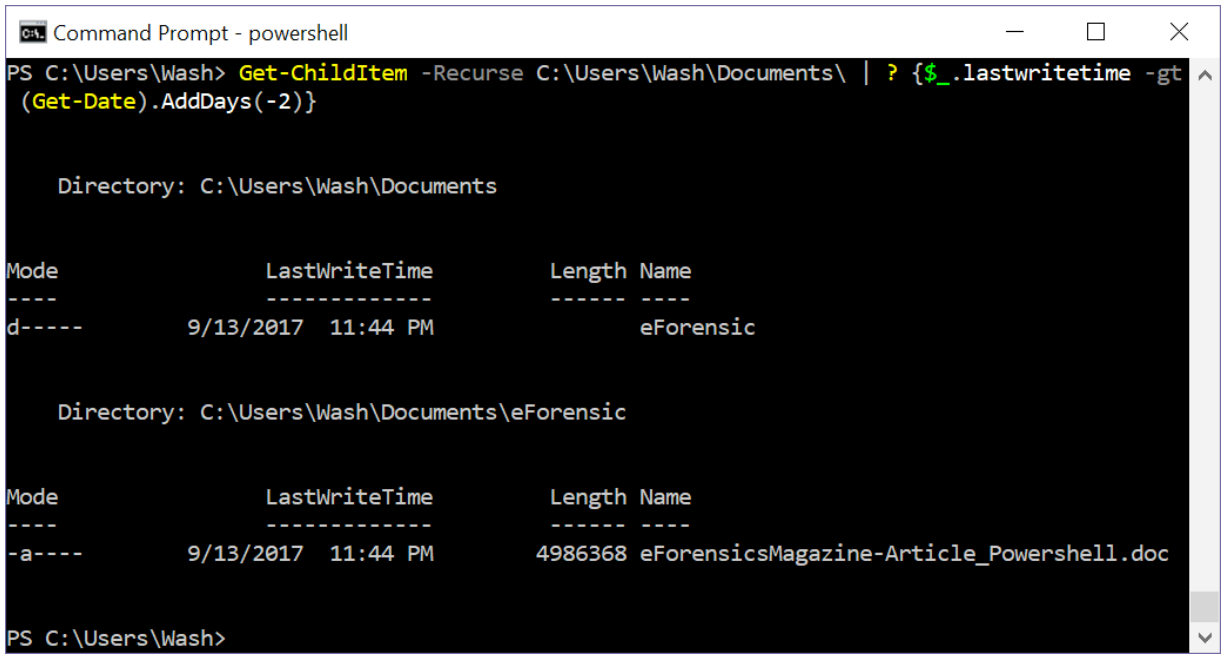
Start-Up Processes:

Another useful thing to remember when carrying out a forensic investigation is to check for strange start-up processes. This can be easily done with the "Get-CIMInstance" and its ability to access CIM instances of a class from a CIM server.



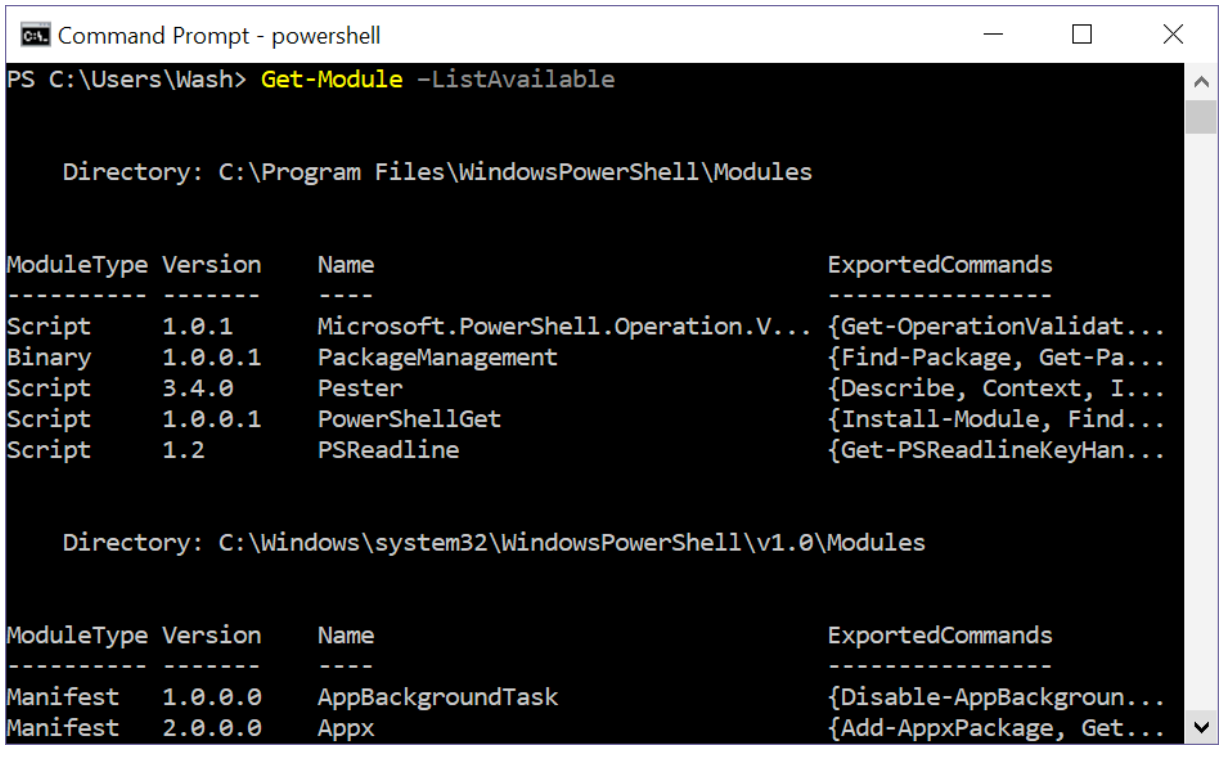
Recently Modified Files:

Using the "Get-ChildItem" we can retrieve the items and child items in one or more specified locations. By doing so recursively and then applying a filter to the modified date of the file it is possible to get a list of files modified within a certain period; for the following example we will use within the last 2 days:



To list the modules on your server or workstation run the cmdlets:

`Get-Module -ListAvailable`



And you will see that there are several interesting modules and some of them we will use throughout this material.

Remote Machines:

PowerShell has a very interesting and relatively new management platform called WinRM. From a PowerShell standpoint, WinRM provides the platform that allows for running PowerShell commands directly on remote machines. WinRM is included by default on Vista and higher, and can be installed on

XP and Server 2003 R2. However, the WinRM service is not running by default on workstation platforms (Vista/7/8), though it is started automatically on Server 2008 and 2012. For more information please refer to the official documentation informed in the beginning of this article.

The cmdlet Invoke-Command runs the commands on remote computers and displays the result on your console. This is extremely useful in environments with multiple servers or computers and you want to run commands remotely. However, as explained before, for security reasons the Forensics Expert may not find this feature enabled on the customer's environment.

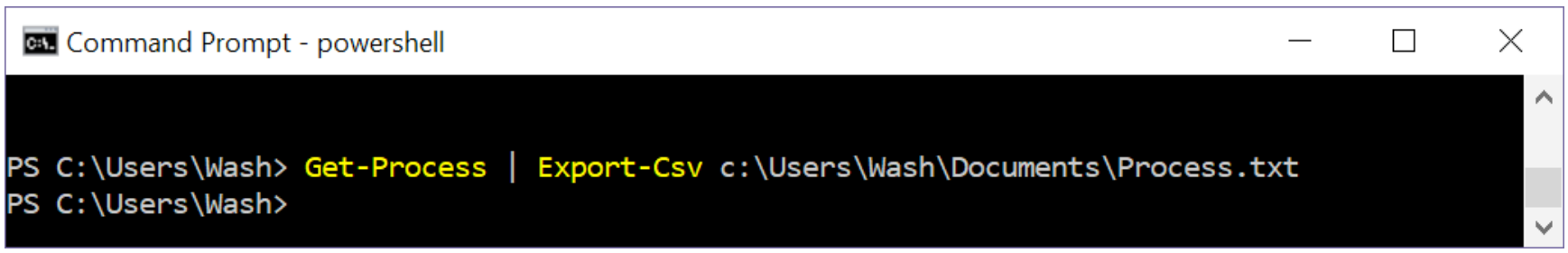
An example in my office would be the following:

```
Invoke-Command -ComputerName Wash-Station-1 -ScriptBlock {Get-WmiObject Win32_Bios
```

The result would be the BIOS information of the computer named Wash-Station-1.

Saving collected Data as a Comma-Separated Values File:

Another point to mention is that PowerShell provides multiple cmdlets to export the output of its commands and store them in a convenient way. Some examples of these cmdlets are:



This command uses Get-Process to grab information about all the processes running on the computer, then uses Export-Csv to write that data to a file named Process.txt that will be written in the folder c:\Users\Wash\Documents.

The resulting text file is shown below.

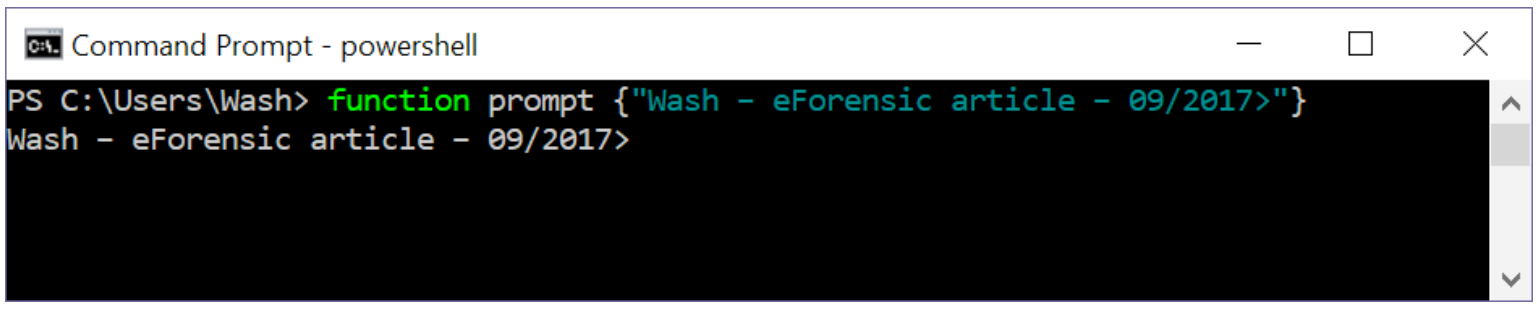
By default, data is saved in ASCII format. What if you'd prefer to save the data in Unicode format (or maybe UTF7 or UTF8)? Just add the -encoding parameter followed by the desired format like "Unicode".

Changing the PowerShell Prompt:

The Forensics Expert may want to change the PowerShell prompt while analyzing the machine. This is not complex and can be done with the following embedded function as shown below:

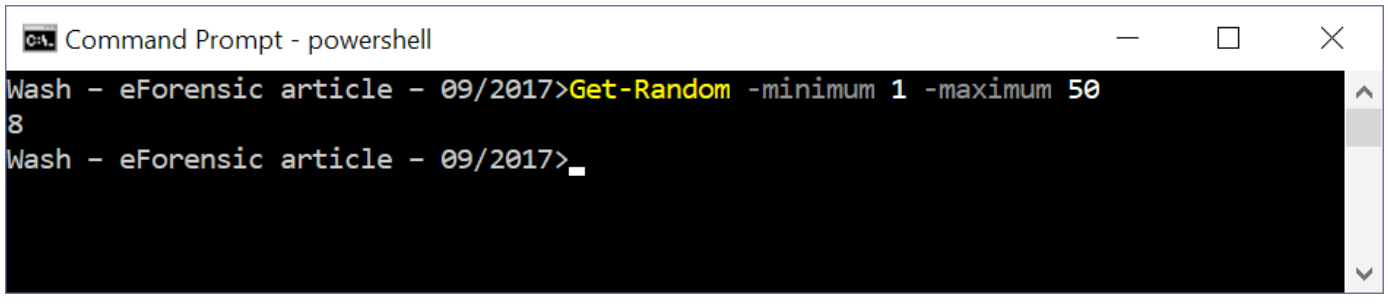
```
function prompt {"Wash - eForensic article - 09/2017>"}
```

The result is the prompt changing just after launching the function.

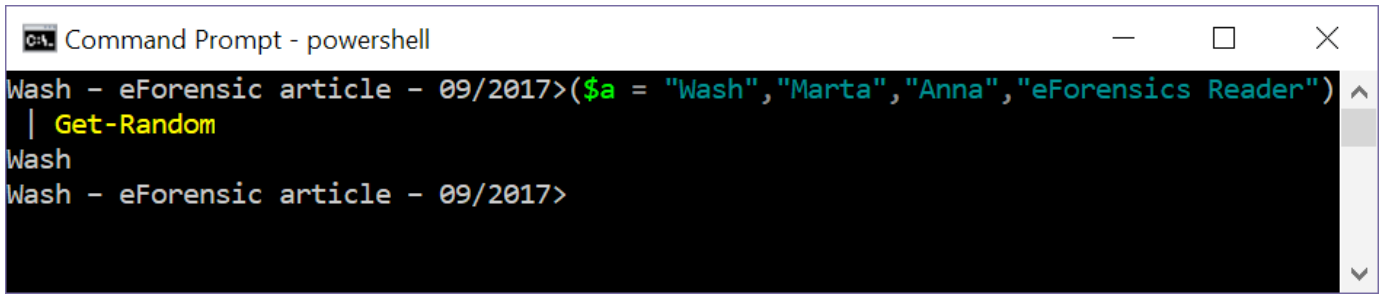


Other PowerShell features:

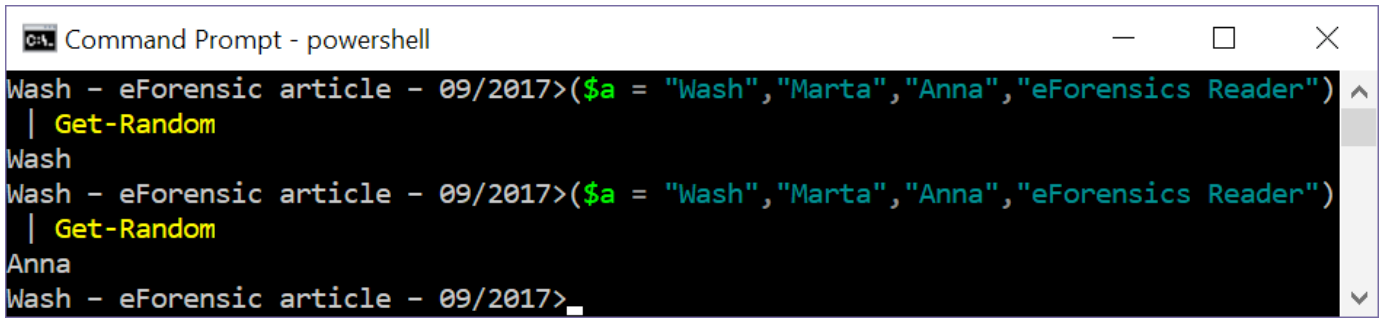
PowerShell can also make random sweeps through the System.Random Object. As an example, let us draw a number from 1 to 50.



Let us now draw a name between Wash, Marta, Anna and eForensic Reader.



Wash was drawn. Let us repeat.



Now Anna was drawn. Another interesting feature is that you can use a text file and draw content. The following command would make it.

```
Get-Content C:\Users\Wash\Scripts\Wash-list.txt | Get-Random
```

PowerShell ISE:

You can choose to load the PowerShell Integrated Scripting Environment (ISE), a PowerShell programming environment that makes it easy to develop scripts because you can execute commands, write, test, and debug scripts in a Windows-based graphical user interface.

PowerShell and Cyber Security:

Any scripting language can be used to spread malicious code and PowerShell is not an exception. Because of this, Windows PowerShell by default does not allow the scripts to be run. It is controlled by what is called an execution policy, as explained earlier.

I strongly recommend that you enable PowerShell scripts to run if, and only if, you have full understanding of the security implications that may affect your environment as well as running its features on remote access. Do not do this if you do not quite understand how to operate with PowerShell for scripting and the potential impacts by running via remote access.

Summary:

The information you want to collect with PowerShell in a forensic investigation may vary from case to case, however, we know that PowerShell can bring any and all information from the investigated environment using the appropriate query. Remember we always must have a plan. So plan the activity before starting into it.

PowerShell comes with a large number of in-built commands to satisfy the live response need. Developers can also utilize the PowerShell APIs to create additional Cmdlets if required.

Since PowerShell is based on .NET Framework, it also enables PowerShell commands access to large collection of .NET classes. The .NET classes already provide access to various Windows system resources.

Another major advantage of using PowerShell for live response is its ability to completely automate, which is always beneficial as it becomes more efficient and scalable.

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Washington Almeida is an electronic engineer specializing in digital forensics and cyber security with more than 25 years of experience working for large companies in cases involving intellectual property infringement, computer network intrusion, social networking monitoring, among others. Cyber security professional also works with sophisticated systems invasion testing, helping companies to improve the security of their assets. In the assistance of the Justice, he is licensed by the "Tribunal de Justica de São Paulo" and "Tribunal Regional do Trabalho da 2ª Região" to work as digital forensic expert appointed by the judge.

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