PowerShell for Admins

An introduction to PowerShell from a sysadmin's perspective

2019-04

Housekeeping

- April 9 – 11 | 8:30 – 17:30
- Seminarraum 0-05

- Break: Whenever you need one ;-)
- Lunch: 12:30

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  - 2007 - 2013: Support > Systems Administrator, Italy
  - 2013 - 2015: Senior Consultant (Unified Communications), Germany
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- Get in touch

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Agenda

- What's PowerShell & some history
- Basics
- Building Tools
- Remoting
- Error Handling
- Providers

What would you like to learn?
What have you done with PS?
What are you working on?

So what is PowerShell?

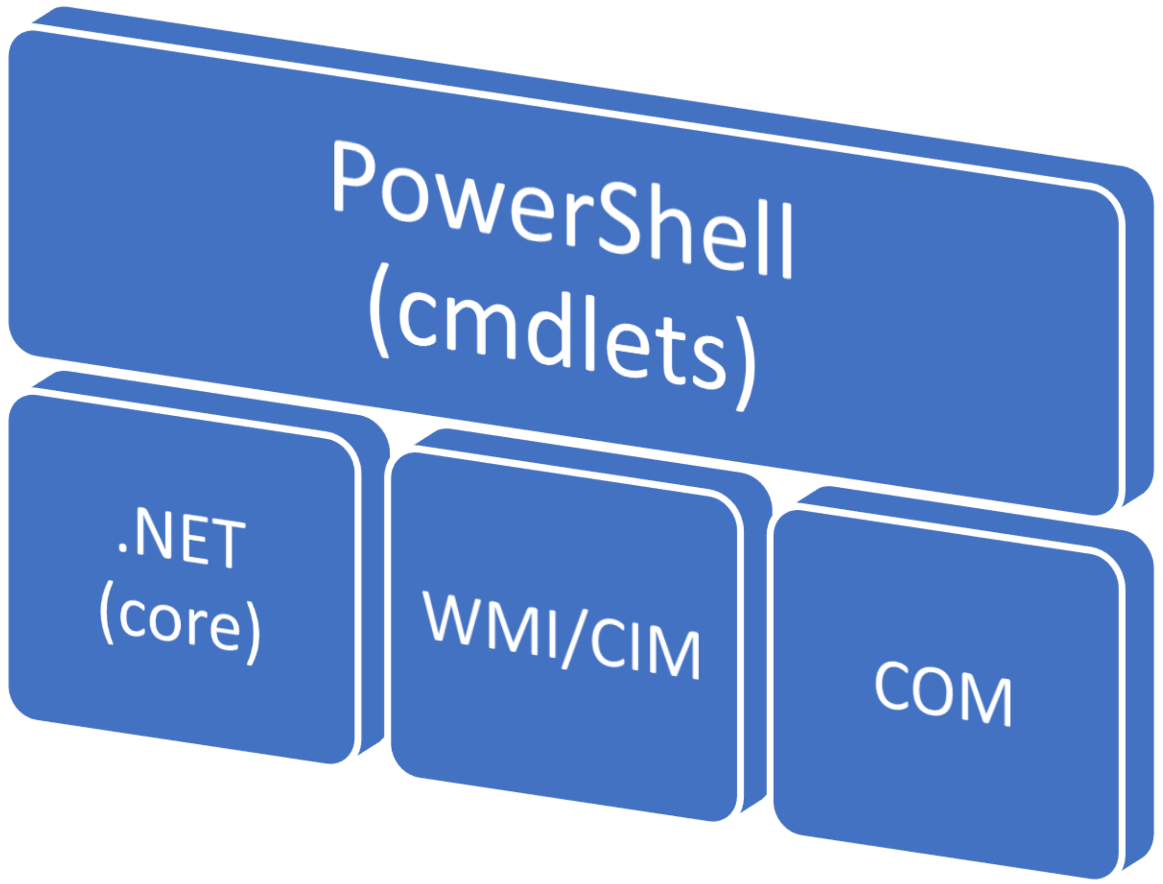
Definition

- Windows PowerShell is an interactive object-oriented command environment with scripting language features that utilizes small programs called **cmdlets** to simplify *configuration*, *administration*, and *management* of heterogeneous environments in both standalone and networked typologies by utilizing standards-based remoting protocols.

Source: https://blogs.technet.microsoft.com/heyscriptingguy/2015/01/02/what-is-powershell/

Definition (cont’d)

- .NET Framework Application
  - Security Model
- WMI/CIM Classes
- COM-Objects
- Interactive
- Scripting
- …



The Monad Manifesto

- The original whitepaper by Jeffrey Snover (2002)
  - Problem: GUIs are not really suitable for automation; APIs are not easily consumable by Admins
  - Proposed Solution: A vital middle way, suitable for Admins (and Developers)

- Annotated version of the whitepaper: https://devopscollective.gitbooks.io/the-monad-manifesto-annotated/content/
- V1 shipped with Windows Vista/Server 2008

Versions

- 2.0 Windows 7 / Server 2008R2
  - Remoting
  - Moudules
- 3.0 Windows 8 / Server 2012
  - Jobs
  - Module Auto Loading
- 4.0 Windows 8.1 / Server 2012R2
  - DSC
- 5.1 Windows 10 [1709]
  - OneGet (PackageManagement)

- 6.x.x Open Sourced; based on .NET Core
  - Nano Server
  - Linux, macOS
  - Cloud Shell
- ...

$PSVersionTable

$IsLinux

Basics

Interactive vs. Script

- The easiest way to get started
- Suitable for one-off tasks
- Few commands chained together

- Can easily be turned into a tool and re-used or shared!
  - Just save as *.ps1
  - Turn it into a function and create a module
  - Execution Policy (Get-, Set-)

Basic features

- 1 + 2
- (3GB + 4MB) / 1MB
- 1..9 ; 9..1
- () are evaluated first
- Escape Character: ` (backtick)
- Single vs. Double Quotes
  - ‘a string’ is ”a string” but...
  - „It‘s $((Get-Date).TimeOfDay)“
- Aliases (to avoid): %, ?, dir, cat, curl...

History

- Command History is stored and can be reused
- $MaximumHistoryCount
  - Controls how many entries are stored

Get-History

Invoke-History –Id xx

Transcript

- Easy documentation ;-)
- Start-Transcript
  - Looks for $Global:Transcript
  - Path parameter
  - Documents folder
- Stop-Transcript

New-Variable –Scope Global –Name Transcript –Value documentation.txt

Cmdlets & Parameters

- Verbs
  - Well-known, approved
  - Get-Verb
- Nouns
  - Singular, specific, descriptive
  - Pascal Case (Get-ChildItem)
- Use Get-Command to discover cmdlets by verb, noun, module…

- Parameters
  - Input
  - Singular, standard (Name, not ItemName)
  - Validation

Autocomplete with “tab”

Common Parameters

- Built-in parameters for all cmdlets
- Cannot be used in custom functions
- General
  - Debug, ErrorAction, ErrorVariable, OutBuffer, OutVariable, WarningAction, WarningVariable, Verbose
- Risk Mitigation
  - WhatIf, Confirm
- Transaction
  - UseTransaction

Help & Discovery

Updateable Help?

- PowerShell is a part of Windows and can only be updated by “Service Packs” (pre Win10)…
- The PowerShell Team required a faster method to ship help files

- Run: Update-Help –UICulture en-us

- Put it into your $Profile

```
Start-Job –Name UpdateHelp `
–Command {Update-Help -UICulture en-us}
```

Asking for Help

- help Get-Process
  - One page at a time
- Get-Help Get-Process –ShowWindow
  - Opens a window with searchbox
- Get-Help Get-Process –Parameter Name
  - Show help for a specific parameter
- Get-Help Get-Process –Online
  - Show online version of the help content (if available)

Help Files

- Get-Help about_Arrays
  - Shows help file for Arrays
- Get-Help –Category HelpFile
  - Shows all Help Files (about_*)

Discovering commands

- Google? Stack Overflow? GitHub? ;-)
  - Do “x” with PowerShell

- Get-Module –ListAvailable
- Get-Command –Module PackageManagement
- Get-Command –Parameter CimSession
- ISE
- Show-Command -Name New-Item
  - This will not work in Core PowerShell

Try it for yourself

- Get familiar with the Shell, start a transcript, update help
- Show-Command

SSID: Datacenter-on-the-Road
cisco1234

server10x 172.25.81.10x
Administrator/Password0!

Variables

Variables

- Stored in the variable: drive
- Store values that can be used, typically command outputs
- Assigned with “=“ character

```
$a = 1
$b = ”a”,”b”,”c”
$procs = Get-Process
```

- Other assignment operators

```
+=, -=, *=, /=, %=, ++, --
```

Get-Help about_Variables

Variables (cont’d)

- Arrays
  - Collections

  $array = @(1,2,3)

- Index using number: $array[1]
- Add items using += which creates a new array

Get-Help about_Arrays

Variables (cont’d)

- Hash Tables (dictionary)
  - Key=Value pairs

```
$info = @{
  ComputerName = "localhost"
  Memory = 1GB
  MaxCpuSpeed = 2000
}
```

- Index using the key: $ht.ComputerName
- Add/Remove using the respective Method: $ht.Remove(“Memory”)

Get-Help about_Hash_Tables

Automatic Variables

- $?
  - Execution status of last operation
  - True if succeeded; False if failed
- $True and $False
  - True and False ;-)
- $_ or $PSItem
  - Contains the current object in the pipeline
- $PSVersionTable, $PSEdition
- $PSCmdlet, $PSBoundParameters...

```
Get-Help about_Automatic_Variables
```

Preference Variables

- Can be used to customize the behavior of PowerShell
- $ConfirmPreference
  - High impact cmdlets (Remove*) should have a Confirm parameter
- $WarningPreference
  - Default is to display warning and continue execution
- $WhatIfPreference
  - Default is $false; set to $true to use WhatIf by default
- $ErrorActionPreference
  - Default is to display error and continue execution for non terminating errors

Get-Help about_Preference_Variables

Objects & Data Types

Objects and the Pipeline

- PowerShell cmdlets return *Objects*
- Objects have *Members*
- Members include *Properties* and *Methods*

- Objects returned by a cmdlet can be used as input for another cmdlet
  - Get-Process | Where-Object Name –like “WiFi*”
  - In this case, Get-Process returns all processes and Where-Object is used to filter for a specific Name.
  - Remember: Name is a *Property*, use Get-Member to list available members

Get-Help about_Objects

Objects (cont’d)

- Get-Command –Noun Object
  - Select-; Where-; Measure-; Sort-; Group-…
- Can be created easily from a hash table

```
$info = @{
  ComputerName = "localhost"
  Memory = 1GB
  MaxCpuSpeed = 2000
}
New-Object -TypeName psobject -Property $info
```

Objects (cont’d)

- Import-* / Export-*
- Out-*
- ConvertTo-* / ConvertFrom-*

- Format-*

- Extract nested properties using

```
|Select-Object ComputerName, @{Name="DriveLetter";
Expression={$_.Volumes.DriveLetter}}
```

Data Types

- Data type is determined by .NET
- Generally loosely typed

```
$a = 1
$b = “2”
$a + $b = ?
$b + $a = ?
[int]$b + $a = ?
```

- Use Get-Member or .GetType()

```
$a.GetType()
“2” | Get-Member
```

- Operators

```
-is, -isNot, -as
```

Compare

```
”1” –ne ”2”
1 -is [int]
(1..2) –is [Array]
“PowerShell“ –match „P.*“; $Matches
```

- Note: „=“ is an assignment operator and is not used for comparison

```
$a = 1  # Set the content of $a to 1
$a –eq 1  # Compare the content of $a with 1
```

Get-Help about_Comparison_Operators

Try it for yourself

- Create a script that gets information about the local computer and output an object to the pipeline

```
$info = @{
  ComputerName = "localhost"
  Memory = 1GB
  MaxCpuSpeed = 2000
  ...
}
New-Object -TypeName psobject -Property $info
```

$Profile

Profile

- A script that gets loaded every time PowerShell starts
- **$PSHOME\profile.ps1**
  This profile applies to all users and all shells.

- **$PSHOME\Microsoft.PowerShell_profile.ps1**
  This profile applies to all users, but only to the Microsoft.PowerShell shell.

- **$HOME\Documents\WindowsPowerShell\profile.ps1**
  This profile applies only to the current user, but affects all shells.

- **$HOME\Documents\WindowsPowerShell\Microsoft.PowerShell_profile.ps1**
  This profile applies only to the current user and the Microsoft.PowerShell shell.

Profiles Linux/macOS

- **$PSHOME/profile.ps1**
  This profile applies to all users and all shells.
- **$PSHOME/Microsoft.PowerShell_profile.ps1**
  This profile applies to all users, but only to the Microsoft.PowerShell shell.
- **$HOME/.config/powershell/profile.ps1**
  This profile applies only to the current user, but affects all shells.
- **$HOME/.config/powershell/Microsoft.PowerShell_profile.ps1**
  This profile applies only to the current user and the Microsoft.PowerShell shell.

Profile example

- Default values for parameters can be set using a preference variable

```
$PSDefaultParameterValues=@{"<CmdletName>:<ParameterName>"="<DefaultValue>"}
```

```
$PSDefaultParameterValues = @{"Send-MailMessage:SmtpServer"=”mail01"}
$PSDefaultParameterValues = @{"*:Verbose"=$true}
```

```
$PSDefaultParameterValues.Add(”*:Verbose”,$true)
```

Try it for yourself

- Create a profile and customize your session
- Check out $Profile and try Test-Path and New-Item

https://code.visualstudio.com/

Building Tools

function Verb-Noun {…

- Specific, do one thing and do it right
- Validate Inputs
- Do something
- Output Objects to the pipeline

…}

[CmdletBinding()]

- Enables Common Parameters
- Confirm Preference
- Should Process
- #Requires statements

Get-Help about_Requires

param()

- Input validation
  - [ValidateNotNull()]
  - [ValidateSet(1,2,3)]

- Accept pipeline input
  - [Parameter(Mandatory=$true,Position=1)]
  - [Parameter(ValueFromPipeline=$true)]

Write-Information

- Write information to information stream
- Should be used as alternative to Write-Host

- Write-Information “message”

- Redirect with 6>
  - Test-Debug 6> information.log

Get-Help about_Redirection

Write-Verbose

- Write information to verbose stream if Verbose parameter is used
- Useful for power users or troubleshooting

- Write-Verbose –Message

- Redirect with 4>
  - New-Item –Name test1 –Verbose 4> Verbose.log

Write-Debug

- Pauses execution and writes debug output to the console if Debug parameter is used
- Useful for troubleshooting, step-by-step execution

- Write-Debug –Message

- Redirect with 5>
    - New-Item –Name test1 –Debug 5> Debug.log

Controlling Flow

If, ElseIf, Else

- Evaluates a condition and executes code if condition is met

```
If ($x –eq 1) {
    # executes if $x is 1
} elseif ($x –eq 2) {
    # executes if $x is 2 (but not 1)
} else {
    # executes if $x is any other value
}
```

Get-Help about_If

Switch

- Handle multiple if statements

```
switch (4, 2) {
    1 {”One." }
    2 {”Two." }
    3 {”Three." }
    4 {”Four.”; Break }
    2 {”Two again."}
    Default {“default output”}
}
```

- All statements are evaluated unless there is a ; Break
- Default triggers when no other condition matches

Get-Help about_Switch

ForEach

- Loops through a collection of objects

```
ForEach ($i in 1..9) {
    $i
}

1..9 | ForEach-Object {
    $PSItem
}
```

Get-Help about_ForEach

While (<condition>) {<command>}

- Execute statement while condition is $true

```
while($true) {
    “this will loop until stopped with ctrl-c”
}


$i = 0
while($i –lt 9) {
    $i++
    “`$i is $i”
}
```

Get-Help about_While

For (<init>;<cond>;<rep>) {<command>}

- Execute statement while condition is $true
- Typically used to iterate through arrays; prefer ForEach

```
$var = 1..9
for ($i = 0; $i -lt $var.count; $i++) {
    ”`$i is $($var[$i])”
}

$var.ForEach{“`$i is $PSItem”}
```

Get-Help about_For

Error Handling

Try and Catch

- A terminating error inside a try {} block can be handled gracefully by whatever is defined in the catch {} block

```
Try {
    SomethingThatCouldBreak
}
Catch {
    “handle gracefully and continue execution”
}
```

Get-Help about_Try_Catch_Finally

Finally

- Always executes (even when exit, ctrl-c)
- Can be used to cleanup resources

- $Error contains error messages (latest is [0])
- Don’t override $ErrorActionPreference globally
  - If really necessary it can be done using the -ErrorAction parameter

Throw

- Generates a terminating error
- If used in catch block (without further parameters) echoes the exception

```
throw “That did not work!”
throw $PSItem
```

Remoting

Remoting

- Run commands on one or more remote computers and get output in local session

- ComputerName Parameter

```
Get-EventLog –ComputerName s01,s02
```

- Interactive with Enter-PSSession

```
Enter-PSSession s01
S01\PS>…
```

Remoting (cont’d)

- One-to-many

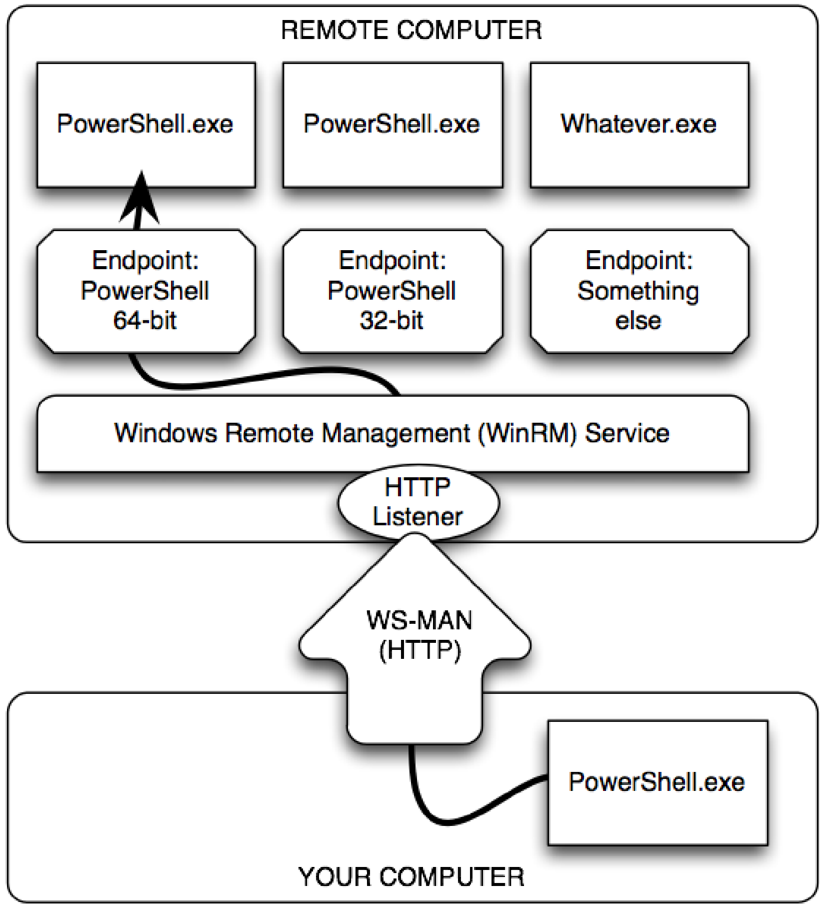
```
Invoke-Command –ComputerName s01,s02 –ScriptBlock { # do something }
```

- Sessions for persistence

```
$s = New-PSSession –ComputerName s01
Invoke-Command –Session $s –ScriptBlock { # do something}
```

Remoting (cont'd)

- Commands are sent to remote machine
- Remote machine executes command
- Output is serialized to XML and sent back
- Local session deserializes XML and displays information
  - No methods are available locally



Remoting security

- Requires membership of “Administrators” group on the target machine
- Session configuration (endpoint) can be used to configure the session parameters
- Uses encryption and delegation (credentials are never sent to remote machine)
- Mutual authentication is required by default (domain)
- https (certificate based authentication) can be used for non-domain or cross-domain scenarios

PSSession vs. CimSession

- Both use encryption over tcp/5985

```
$pss = New-PSSession –ComputerName server101
$cim = New-CimSession –ComputerName server101
```

```
Invoke-Command –Session $pss –ScriptBlock {Get-Disk}
Get-Disk –CimSession $cim | Set-Disk...
```

SSH Transport

- Uses SSH for transport and authentication
- Requires one line in /etc/ssh/sshd_config

```
Subsystem powershell /usr/bin/pwsh -sshs -NoLogo -NoProfile
```

```
$ssh = New-PSSession –HostName server201 –UserName admin
```

Import Session

- A dynamic module is created
- Remote commands are made available in local session

```
$s = New-PSSession –ComputerName server101
Import-PSSession $s –CommandName Get-Process
Import-PSSession $s –Prefix s101
```

Yes. This “just works” over SSH.

Session Configuration

- Create Endpoints for remoting sessions
- Limit available cmdlets, restrict/elevate permissions…

New-PSSessionConfigurationFile

Register- PSSessionConfiguration

New-PSSession –ComputerName server101 –ConfigurationName Endpoint1

Try it for yourself

- Create remote sessions
- Gather information from various servers
- Import a remote session

Modules

Modules

- A set of PowerShell functionalities grouped together as a unit (folder)
- Enables modularization ;-)
  - Reuse and abstraction of code
  - Publish functions
  - Define scope for functions/variables
- The Module Manifest (*.psd1) contains a hash table and defines
  - The contents and attributes of the module
  - The prerequisites
  - How the components are processed

Modules (cont’d)

- Script Module
  - Consists of one or more plaintext (*.psm1) files
  - Written in PowerShell
- Binary Module
  - .NET framework assembly (*.dll)
  - Written e.g. in C#
- Dynamic Module
  - Not saved to a file
  - Created by script or remoting
  - Intended to be short-lived/non-persistent

Modules (cont’d)

- Get-Module
  - List imported modules
  - -ListAvailable lists available modules
- Import-Module
  - Import a module, i.e. make it available in the current session
  - Remember auto-loading (>3.0)
- $PSModuleAutoLoadingPreference
  - Control module auto-loading behaviour
- $env:PSModulePath
  - A list of directories containing PowerShell Modules

Modules PowerShell 5.1

- User modules
  $HOME\Documents\WindowsPowerShell\Modules

- Shared modules will be read from
  $env:ProgramFiles\WindowsPowerShell\Modules

- Default modules will be read from
  $PSHOME\Modules

$env:PSModulePath –split “;”

Modules PowerShell 6.x

- User modules
  $HOME\Documents\PowerShell\Modules

- Shared modules will be read from
  $env:ProgramFiles\PowerShell\Modules

- Default modules will be read from
  C:\Windows\system32\WindowsPowerShell\v1.0\Modules

$env:PSModulePath –split “;”

Modules Linux/macOS

- User modules
  $HOME/.local/share/powershell/Modules

- Shared modules will be read from
  /usr/local/share/powershell/Modules

- Default modules will be read from
  $PSHOME/Modules

```
$env:PSModulePath –split ":"
```

Providers

Providers and Drives

- Provide access to data/components that would not otherwise be easily accessible
- Data is shown as a file system drive

- Get-PSProvider lists available providers
- Try:

```
Get-ChildItem Cert:
cd hklm: ; dir
cd hkcu: ; dir
```

Providers (cont’d)

- Default, built-in providers
- Can be expanded by Modules or 3rd parties
    - Active Directory
    - VMware

```
Get-ChildItem Cert:\LocalMachine\My
```

```
Get-ItemProperty 'HKLM:\SOFTWARE\Microsoft\Windows
NT\CurrentVersion' -Name CurrentVersion
```

Providers with SHiPS

- Simple Hierarchy with PowerShell (https://github.com/PowerShell/ShiPS)
- Create new providers based on classes
- Examples can be installed from PSGallery:
    - CimPSDrive
    - AzurePSDrive

Background Jobs

Background Jobs

- Long-running tasks can be sent to the background to make the command prompt available for use
- Start-Job –ScriptBlock { Get-Process }
  - Starts a background job in current session
- Get-Job
  - Gets background jobs that were started in current session
- Receive-Job
  - Returns data only once, make sure to store in variable or export

Misc

Scope

- Items are created in a scope to limit where they can be accessed and changed
- Child scope does not inherit but can access items

```
function Test-Scope {
    $test = 1 ; $test
    function Test-ChildScope {
        $test2 = 2; $test; $test2
    }
    Test-ChildScope
}
```

Scheduling .ps1 files

- Simply pointing to the .ps1 file in Task Manager does not work ☹
- We have to start powershell.exe with parameters
- powershell.exe -NonInteractive -NoProfile -Command "& {C:\LogStats\GetTransactionLogStats.ps1 -Gather -WorkingDirectory C:\LogStats}"

Resources

- PowerShell Home: https://docs.microsoft.com/en-us/powershell/

- Free eBooks: https://www.gitbook.com/@devopscollective
- https://www.powershellgallery.com
- https://powershell.org

- Documents and snippets: https://github.com/tomtorggler/PoSh4Admins