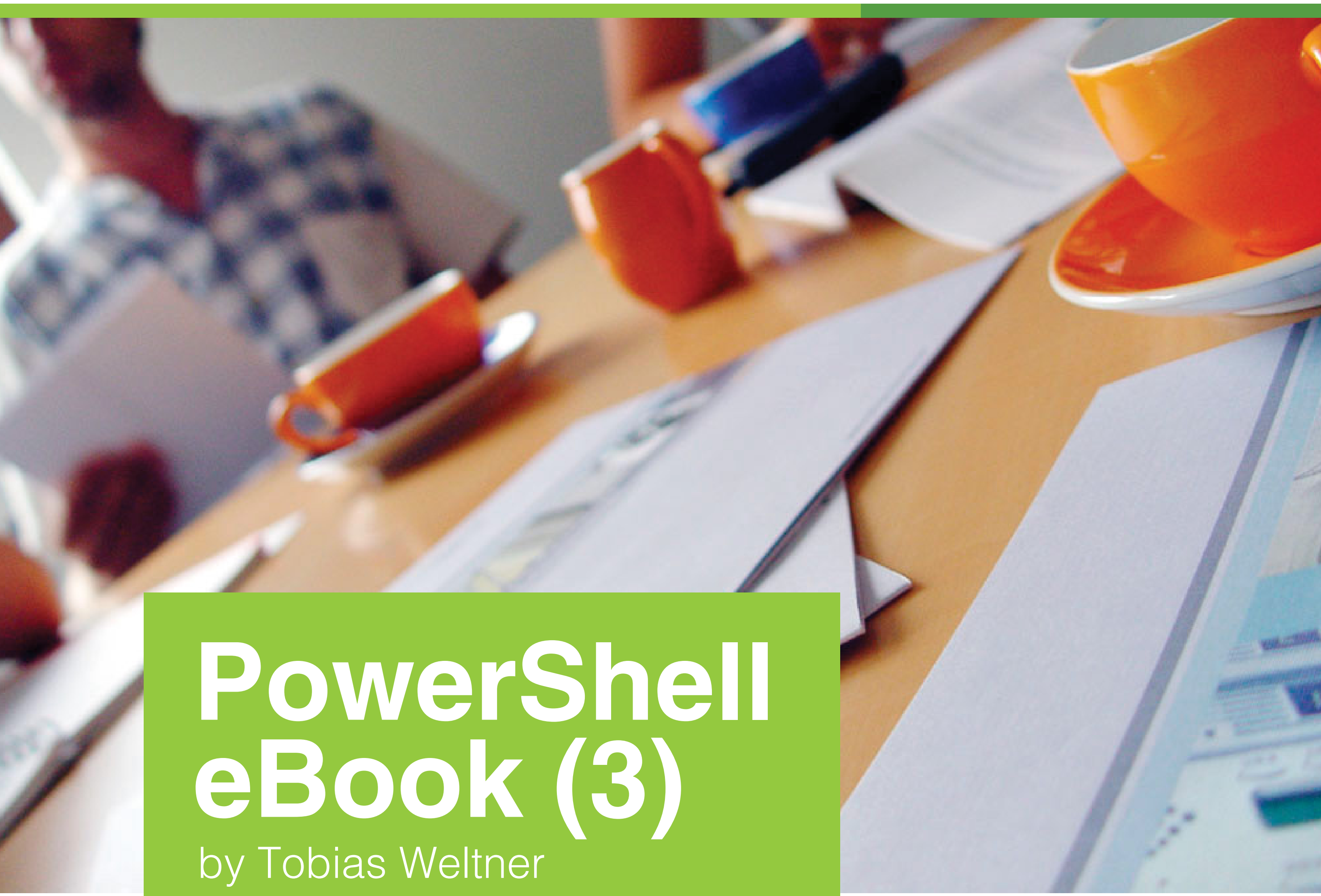

PowerShell eBook (3)

by Tobias Weltner

Index

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Chapter 15. Working with the File System

Working with files and folders is traditionally one of the most popular areas for administrators. PowerShell eases transition from classic shell commands with the help of a set of predefined "historic" aliases and functions. So, if you are comfortable with commands like "dir" or "ls" to list folder content, you can still use them. Since they are just aliases - references to PowerShell's own cmdlets - they do not necessarily work exactly the same anymore, though.
In this chapter, you'll learn how to use PowerShell cmdlets to automate the most common file system tasks.

Topics Covered:

Getting to Know Your Tools

One of the best ways to get to know your set of file system-related PowerShell cmdlets is to simply list all aliases that point to cmdlets with the keyword "item" in their noun part. That is so because PowerShell calls everything "item" that lives on a drive.

```
PS> Get-Alias -Definition *-item*
```

```
CommandType     Name              ModuleName                    Definition
-----------     ----              ----------                    ----------
Alias           cli                                             Clear-Item
Alias           clp                                             Clear-ItemProperty
Alias           copy                                            Copy-Item
Alias           cp                                              Copy-Item
Alias           cpi                                             Copy-Item
Alias           cpp                                             Copy-ItemProperty
Alias           del                                             Remove-Item
Alias           erase                                           Remove-Item
Alias           gi                                              Get-Item
Alias           gp                                              Get-ItemProperty
Alias           ii                                              Invoke-Item
Alias           mi                                              Move-Item
Alias           move                                            Move-Item
Alias           mp                                              Move-ItemProperty
Alias           mv                                              Move-Item
Alias           ni                                              New-Item
Alias           rd                                              Remove-Item
Alias           ren                                             Rename-Item
Alias           ri                                              Remove-Item
Alias           rm                                              Remove-Item
Alias           rmdir                                           Remove-Item
Alias           rni                                             Rename-Item
Alias           rnp                                             Rename-ItemProperty
Alias           rp                                              Remove-ItemProperty
Alias           si                                              Set-Item
Alias           sp                                              Set-ItemProperty
```

In addition, PowerShell provides a set of cmdlets that help dealing with path names. They all use the noun "Path", and you can use these cmdlets to construct paths, split paths into parent and child, resolve paths or check whether files or folders exist.

```
PS> Get-Command -Noun path
```

```
CommandType     Name            ModuleName                 Definition
-----------     ----            ----------                 ----------
Cmdlet          Convert-Path    Microsoft.PowerSh...       ...
Cmdlet          Join-Path       Microsoft.PowerSh...       ...
Cmdlet          Resolve-Path    Microsoft.PowerSh...       ...
Cmdlet          Split-Path      Microsoft.PowerSh...       ...
Cmdlet          Test-Path       Microsoft.PowerSh...       ...
```

Accessing Files and Directories

Use *Get-ChildItem* to list the contents of a folder. There are two historic aliases: *Dir* and *ls. Get-ChildItem* handles a number of important file system-related tasks:

- Searching the file system recursively and finding files
- Listing hidden files
- Accessing files and directory objects
- Passing files to other cmdlets, functions, or scripts

Listing Folder Contents

If you don't specify a path, *Get-ChildItem* lists the contents of the current directory. Since the current directory can vary, it is risky to use *Get-Childitem* in scripts without specifying a path. Omit a path only when you use PowerShell interactively and know where your current location actually is.

Time to put *Get-ChildItem* to work: to get a list of all PowerShell script files stored in your profile folder, try this:

```
PS> Get-ChildItem -Path $home -Filter *.ps1
```

Most likely, this will not return anything because, typically, your own files are not stored in the root of your profile folder. To find script files recursively (searching through all child folders), add the switch parameter *-Recurse:*

```
PS> Get-ChildItem -Path $home -Filter *.ps1 -Recurse
```

This may take much longer. If you still get no result, then maybe you did not create any PowerShell script file yet. Try searching for other file types. This line will get all Microsoft Word documents in your profile:

```
PS> Get-ChildItem -Path $home -Filter *.doc* -Recurse
```

When searching folders recursively, you may run into situations where you do not have access to a particular subfolder. *Get-ChildItem* then raises an exception but continues its search. To hide such error messages, add the common parameter *-Erroraction SilentlyContinue* which is present in all cmdlets, or use its short form *-ea 0:*

```
PS> Get-ChildItem -Path $home -Filter *.doc* -Recurse -ea 0
```

The *-Path* parameter accepts multiple comma-separated values, so you could search multiple drives or folders in one line. This would find all .log-files on drives C:\ and D:\ (and takes a long time because of the vast number of folders it searches):

```
PS> Get-ChildItem c:\, d:\ -Filter *.log -Recurse -ea 0
```

If you just need the names of items in one directory, use the parameter *-Name:*

```
PS> Get-ChildItem -Path $env:windir -Name
```

To list only the full path of files, use a pipeline and send the results to *Select-Object* to only select the content of the *FullName* property:

```
PS> Get-ChildItem -Path $env:windir | Select-Object -ExpandProperty FullName
```

Attention

Some characters have special meaning to PowerShell, such as square brackets or wildcards such as '*'. If you want PowerShell to ignore special characters in path names and instead take the path literally, use the *-LiteralPath* parameter instead of *-Path.*

Choosing the Right Parameters

In addition to *-Filter*, there is a parameter that seems to work very similar: *-Include*:

```
PS> Get-ChildItem $home -Include *.ps1 -Recurse
```

You'll see some dramatic speed differences, though: *-Filter* works significantly faster than *-Include.*

```
PS> (Measure-Command {Get-ChildItem $home -Filter *.ps1 -Recurse}).TotalSeconds
4,6830099
PS> (Measure-Command {Get-ChildItem $home -Include *.ps1 -Recurse}).TotalSeconds
28,1017376
```

You also see functional differences because *-Include* only works right when you also use the *-Recurse* parameter.

The reason for these differences is the way these parameters work. *-Filter* is implemented by the underlying drive provider, so it is retrieving only those files and folders that match the criteria in the first place. That's why *-Filter* is fast and efficient. To be able to use *-Filter*, though, the drive provider must support it.

-Include on the contrary is implemented by PowerShell and thus is independent of provider implementations. It works on all drives, no matter which provider is implementing that drive. The provider returns all items, and only then does *-Include* filter out the items you want. This is slower but universal. *-Filter* currently only works for file system drives. If you wanted to select items on Registry drives like HKLM:\ or HKCU:\, you must use *-Include*.

-Include has some advantages, too. It understands advanced wildcards and supports multiple search criteria:

```
# -Filter looks for all files that begin with "[A-F]" and finds none:
PS> Get-ChildItem $home -Filter [a-f]*.ps1 -Recurse
# -Include understands advanced wildcards and looks for files that begin with a-f and
end with .ps1:
PS> Get-ChildItem $home -Include [a-f]*.ps1 -Recurse
```

The counterpart to *-Include* is *-Exclude*. Use *-Exclude* if you would like to suppress certain files. Unlike *-Filter*, the *-Include* and *-Exclude* parameters accept arrays, which enable you to get a list of all image files in your profile or the windows folder:

```
Get-Childitem -Path $home, $env:windir -Recurse -Include *.bmp,*.png,*.jpg, *.gif -ea 0
```

Note

If you want to filter results returned by *Get-ChildItem* based on criteria other than file name, use *Where-Object* (Chapter 5).

For example, to find the largest files in your profile, use this code - it finds all files larger than 100MB:

```
PS> Get-ChildItem $home -Recurse | Where-Object { $_.length -gt 100MB }
```

If you want to count files or folders, pipe the result to *Measure-Object*:

```
PS> Get-ChildItem $env:windir -Recurse -Include *.bmp,*.png,*.jpg, *.gif -ea 0 | Measure-Object
 | Select-Object -ExpandProperty Count
6386
```

You can also use *Measure-Object* to count the total folder size or the size of selected files. This line will count the total size of all *.log*-files in your windows folder:

```
PS> Get-ChildItem $env:windir -Filter *.log -ea 0 | Measure-Object -Property Length -Sum |
Select-Object -ExpandProperty Sum
```

Getting File and Directory Items

Everything on a drive is called "Item", so to get the properties of an individual file or folder, use *Get-Item:*

```
PS> Get-Item $env:windir\explorer.exe | Select-Object *


PSPath            : Microsoft.PowerShell.Core\FileSystem::C:\Windows\explorer.exe
PSParentPath      : Microsoft.PowerShell.Core\FileSystem::C:\Windows
PSChildName       : explorer.exe
PSDrive           : C
PSProvider        : Microsoft.PowerShell.Core\FileSystem
PSIsContainer     : False
```

```
VersionInfo          : File                        : C:\Windows\explorer.exe
                       InternalName                : explorer
                       OriginalFilename            : EXPLORER.EXE.MUI
                       FileVersion                 : 6.1.7600.16385 (win7_rtm.090713-1255)
                       FileDescription             : Windows Explorer
                       Product                     : Microsoft® Windows® Operating System
                       ProductVersion              : 6.1.7600.16385
                       Debug                       : False
                       Patched                     : False
                       PreRelease                  : False
                       PrivateBuild                : False
                       SpecialBuild                : False
                       Language                    : English (United States)

BaseName             : explorer
Mode                 : -a---
Name                 : explorer.exe
Length               : 2871808
DirectoryName        : C:\Windows
Directory            : C:\Windows
IsReadOnly           : False
Exists               : True
FullName             : C:\Windows\explorer.exe
Extension            : .exe
CreationTime         : 27.04.2011 17:02:33
CreationTimeUtc      : 27.04.2011 15:02:33
LastAccessTime       : 27.04.2011 17:02:33
LastAccessTimeUtc    : 27.04.2011 15:02:33
LastWriteTime        : 25.02.2011 07:19:30
LastWriteTimeUtc     : 25.02.2011 06:19:30
Attributes           : Archive
```

You can even change item properties provided the file or folder is not in use, you have the proper permissions, and the property allows write access. Take a look at this piece of code:

```
"Hello" > $env:temp\testfile.txt
$file = Get-Item $env:temp\testfile.txt
$file.CreationTime
$file.CreationTime = '1812/4/11 09:22:11'
Explorer $env:temp
```

This will create a test file in your temporary folder, read its creation time and then changes the creation time to November 4, 1812. Finally, explorer opens the temporary file so you can right-click the test file and open its properties to verify the new creation time. Amazing, isn't it?

Passing Files to Cmdlets, Functions, or Scripts

Because *Get-ChildItem* returns individual file and folder objects, *Get-ChildItem* can pass these objects to other cmdlets or to your own functions and scripts. This makes *Get-ChildItem* an important selection command which you can use to recursively find all the files you may be looking for, across multiple folders or even drives.

For example, the next code snippet finds all *jpg* files in your Windows folder and copies them to a new folder:

```
PS> New-Item -Path c:\WindowsPics -ItemType Directory -ea 0
PS> Get-ChildItem $env:windir -Filter *.jpg -Recurse -ea 0 | Copy-Item -Destination
c:\WindowsPics
```

Get-ChildItem first retrieved the files and then handed them over to *Copy-Item* which copied the files to a new destination.

Tip

You can also combine the results of several separate *Get-ChildItem* commands. In the following example, two separate *Get-ChildItem* commands generate two separate file listings, which PowerShell combines into a total list and sends on for further processing in the pipeline. The example takes all the DLL files from the Windows system directory and all program installation directories, and then returns a list with the name, version, and description of DLL files:

```
PS> $list1 = @(Get-ChildItem $env:windir\system32\*.dll)
PS> $list2 = @(Get-ChildItem $env:programfiles -Recurse -Filter *.dll)
PS> $totallist = $list1 + $list2
PS> $totallist | Select-Object -ExpandProperty VersionInfo | Sort-Object -Property FileName

ProductVersion         FileVersion         FileName
--------------         -----------         --------
3,0,0,2                3,0,0,2             C:\Program Files\Bonjour\mdnsNSP.dll
2, 1, 0, 1             2, 1, 0, 1          C:\Program Files\Common Files\Microsoft Sh...
2008.1108.641...       2008.1108.641...    C:\Program Files\Common Files\Microsoft Sh...
(...)
```

Selecting Files or Folders Only

Because *Get-ChildItem* does not differentiate between files and folders, it may be important to limit the result of *Get-ChildItem* to only files or only folders. There are several ways to accomplish this. You can check the type of returned object, check the PowerShell *PSIsContainer* property, or examine the mode property:

```
# List directories only:
PS> Get-ChildItem | Where-Object { $_ -is [System.IO.DirectoryInfo] }
PS> Get-ChildItem | Where-Object { $_.PSIsContainer }
PS> Get-ChildItem | Where-Object { $_.Mode -like 'd*' }

# List files only:
PS> Get-ChildItem | Where-Object { $_ -is [System.IO.FileInfo] }
PS> Get-ChildItem | Where-Object { $_.PSIsContainer -eq $false}
PS> Get-ChildItem | Where-Object { $_.Mode -notlike 'd*' }
```

Where-Object can filter files according to other criteria as well. For example, use the following pipeline filter if you'd like to locate only files that were created after May 12, 2011:

```
PS> Get-ChildItem $env:windir | Where-Object { $_.CreationTime -gt [datetime]::Parse
("May 12, 2011") }
```

You can use relative dates if all you want to see are files that have been changed in the last two weeks:

```
PS> Get-ChildItem $env:windir | Where-Object { $_.CreationTime -gt (Get-Date).AddDays(-14) }
```

Navigating the File System

Unless you changed your prompt (see Chapter 9), the current directory is part of your input prompt. You can find out the current location by calling *Get-Location:*

```
PS> Get-Location


Path
----
Path
C:\Users\Tobias
```

If you want to navigate to another location in the file system, use *Set-Location* or the *Cd* alias:

```
# One directory higher (relative):
PS> Cd ..

# In the parent directory of the current drive (relative):
PS> Cd \

# In a specified directory (absolute):
PS> Cd c:\windows

# Take directory name from environment variable (absolute):
PS> Cd $env:windir

# Take directory name from variable (absolute):
PS> Cd $home
```

Relative and Absolute Paths

Paths can either be relative or absolute. Relative path specifications depend on the current directory, so *.\test.txt* always refers to the *test.txt* file in the current directory. Likewise, *..\test.txt* refers to the *test.txt* file in the parent directory.

Relative path specifications are useful, for example, when you want to use library scripts that are located in the same directory as your work script. Your work script will then be able to locate library scripts under relative paths—no matter what the directory is called. Absolute paths are always unique and are independent of your current directory.

Character	Meaning	Example	Result
`.`	Current directory	`ii .`	Opens the current directory in Windows Explorer
`..`	Parent directory	`Cd ..`	Changes to the parent directory
`\`	Root directory	`Cd \`	Changes to the top-most directory of a drive
`~`	Home directory	`Cd ~`	Changes to the directory that PowerShell initially creates automatically

Table 15.2: *Important special characters used for relative path specifications*

Converting Relative Paths into Absolute Paths

Whenever you use relative paths, PowerShell must convert these relative paths into absolute paths. That occurs automatically when you submit a relative path to a cmdlet. You can resolve relative paths manually, too, by using *Resolve-Path.*

```
PS> Resolve-Path .\test.txt
Path
----
C:\Users\Tobias Weltner\test.txt
```

Be careful though: *Resolve-Path* only works for files that actually exist. If there is no file in your current directory that's called *test.txt*, *Resolve-Path* errors out.

Resolve-Path can also have more than one result if the path that you specify includes wildcard characters. The following call will retrieve the names of all *ps1xml* files in the PowerShell home directory:

```
PS> Resolve-Path $pshome\*.ps1xml
Path
----
C:\Windows\System32\WindowsPowerShell\v1.0\Certificate.format.ps1xml
C:\Windows\System32\WindowsPowerShell\v1.0\DotNetTypes.format.ps1xml
C:\Windows\System32\WindowsPowerShell\v1.0\FileSystem.format.ps1xml
C:\Windows\System32\WindowsPowerShell\v1.0\Help.format.ps1xml
C:\Windows\System32\WindowsPowerShell\v1.0\PowerShellCore.format.ps1xml
C:\Windows\System32\WindowsPowerShell\v1.0\PowerShellTrace.format.ps1xml
C:\Windows\System32\WindowsPowerShell\v1.0\Registry.format.ps1xml
C:\Windows\System32\WindowsPowerShell\v1.0\types.ps1xml
```

Pushing and Popping Directory Locations

The current directory can be "pushed" onto a "stack" by using *Push-Location*. Each *Push-Location* adds a new directory to the top of the stack. Use *Pop-Location* to get it back again.

So, to perform a task that forces you to temporarily leave your current directory, first type *Push-Location* to store your current location. Then, you can complete your task and when use *Pop-Location* to return to where you were before.

Tip

Cd *$home* will always take you back to your home directory. Also, both *Push-Location* and *Pop-Location* support the -*Stack* parameter. This enables you to create as many stacks as you want, such as one for each task. *Push-Location -Stack job1* puts the current directory not on the standard stack, but on the stack called "job1"; you can use *Pop-Location -Stack job1* to restore the initial directory from this stack.

Special Directories and System Paths

There are many standard folders in Windows, for example the Windows folder itself, your user profile, or your desktop. Since the exact location of these paths can vary depending on your installation setup, it is bad practice to hard-code these paths into your scripts - hardcoded system paths may run well on your machine and break on another.

That's why it is important to understand where you can find the exact location of these folders. Some are covered by the Windows environment variables, and others can be retrieved via .NET methods.

Special directory	Description	Access
Application data	Application data locally stored on the machine	$env:localappdata
User profile	User directory	$env:userprofile
Data used in common	Directory for data used by all programs	$env:commonprogramfiles
Public directory	Common directory of all local users	$env:public
Program directory	Directory in which programs are installed	$env:programfiles
Roaming Profiles	Application data for roaming profiles	$env:appdata
Temporary files (private)	Directory for temporary files of the user	$env:tmp
Temporary files	Directory for temporary files	$env:temp
Windows directory	Directory in which Windows is installed	$env:windir

Table 15.3: *Important Windows directories that are stored in environment variables*

Environment variables cover only the most basic system paths. If you'd like to put a file directly on a user's Desktop, you'll need the path to the Desktop which is missing in the list of environment variables. The *GetFolderPath()* method of the System.Environment class of the .NET framework (Chapter 6) can help. The following code illustrates how you can put a link on the Desktop.

```
PS> [Environment]::GetFolderPath("Desktop")
C:\Users\Tobias Weltner\Desktop

# Put a link on the Desktop:
PS> $path = [Environment]::GetFolderPath("Desktop") + "\EditorStart.lnk"
PS> $comobject = New-Object -ComObject WScript.Shell
PS> $link = $comobject.CreateShortcut($path)
PS> $link.targetpath = "notepad.exe"
PS> $link.IconLocation = "notepad.exe,0"
PS> $link.Save()
```

To get a list of system folders known by GetFolderPath(), use this code snippet:

```
PS> [System.Environment+SpecialFolder] | Get-Member -Static -MemberType Property
   TypeName: System.Environment+SpecialFolder

Name                      MemberType    Definition
----                      ----------    ----------
ApplicationData           Property      static System.Environment+SpecialFolder ApplicationData
                                        {get;}
CommonApplicationData     Property      static System.Environment+SpecialFolder
                                        CommonApplicationData ...
CommonProgramFiles        Property      static System.Environment+SpecialFolder
                                        CommonProgramFiles {get;}
Cookies                   Property      static System.Environment+SpecialFolder Cookies {get;}
Desktop                   Property      static System.Environment+SpecialFolder Desktop {get;}
DesktopDirectory          Property      static System.Environment+SpecialFolder
                                        DesktopDirectory {get;}
Favorites                 Property      static System.Environment+SpecialFolder Favorites {get;}
History                   Property      static System.Environment+SpecialFolder History {get;}
InternetCache             Property      static System.Environment+SpecialFolder InternetCache
                                        {get;}
LocalApplicationData      Property      static System.Environment+SpecialFolder
                                        LocalApplicationData {...
MyComputer                Property      static System.Environment+SpecialFolder MyComputer
                                        {get;}
MyDocuments               Property      static System.Environment+SpecialFolder MyDocuments
                                        {get;}
MyMusic                   Property      static System.Environment+SpecialFolder MyMusic {get;}
MyPictures                Property      static System.Environment+SpecialFolder MyPictures
                                        {get;}
Personal                  Property      static System.Environment+SpecialFolder Personal {get;}
ProgramFiles              Property      static System.Environment+SpecialFolder ProgramFiles
                                        {get;}
Programs                  Property      static System.Environment+SpecialFolder Programs {get;}
Recent                    Property      static System.Environment+SpecialFolder Recent {get;}
SendTo                    Property      static System.Environment+SpecialFolder SendTo {get;}
StartMenu                 Property      static System.Environment+SpecialFolder StartMenu {get;}
Startup                   Property      static System.Environment+SpecialFolder Startup {get;}
System                    Property      static System.Environment+SpecialFolder System {get;}
Templates                 Property      static System.Environment+SpecialFolder Templates {get;}
```

And this would get you a list of all system folders covered plus their actual paths:

```
PS> [System.Environment+SpecialFolder] | Get-Member -Static -MemberType
Property | ForEach-Object {"{0,-25}= {1}" -f $_.name, [Environment]
::GetFolderPath($_.Name) }

ApplicationData          = C:\Users\Tobias Weltner\AppData\Roaming
CommonApplicationData    = C:\ProgramData
CommonProgramFiles       = C:\Program Files\Common Files
Cookies                  = C:\Users\Tobias Weltner\AppData\Roaming\Microsoft
                           \Windows\Cookies
Desktop                  = C:\Users\Tobias Weltner\Desktop
DesktopDirectory         = C:\Users\Tobias Weltner\Desktop
Favorites                = C:\Users\Tobias Weltner\Favorites
History                  = C:\Users\Tobias Weltner\AppData\Local\Microsoft
                           \Windows\History
InternetCache            = C:\Users\Tobias Weltner\AppData\Local\Microsoft
                           \Windows\Temporary Internet Files
LocalApplicationData     = C:\Users\Tobias Weltner\AppData\Local
MyComputer               =
MyDocuments              = C:\Users\Tobias Weltner\Documents
MyMusic                  = C:\Users\Tobias Weltner\Music
MyPictures               = C:\Users\Tobias Weltner\Pictures
Personal                 = C:\Users\Tobias Weltner\Documents
ProgramFiles             = C:\Program Files
Programs                 = C:\Users\Tobias Weltner\AppData\Roaming\Microsoft
                           \Windows\Start Menu\Programs
Recent                   = C:\Users\Tobias Weltner\AppData\Roaming\Microsoft
                           \Windows\Recent
SendTo                   = C:\Users\Tobias Weltner\AppData\Roaming\Microsoft
                           \Windows\SendTo
StartMenu                = C:\Users\Tobias Weltner\AppData\Roaming\Microsoft
                           \Windows\Start Menu
Startup                  = C:\Users\Tobias Weltner\AppData\Roaming\Microsoft
                           \Windows\Start Menu\Programs\Startup
System                   = C:\Windows\system32
Templates                = C:\Users\Tobias Weltner\AppData\Roaming\Microsoft
                           \Windows\Templates
```

You can use this to create a pretty useful function that maps drives to all important file locations. Here it is:

```
function Map-Profiles {
[System.Environment+SpecialFolder] | Get-Member -Static -MemberType Property |
ForEach-Object {
New-PSDrive -Name $_.Name -PSProvider FileSystem -Root ([Environment]::GetFolderPath($_.Name))
 -Scope
New-PSDrive -Name $_.Name -PSProvider FileSystem -Root ([Environment]::GetFolderPath($_.Name))
-Scope
Global
}
}
Map-Profiles
```

When you run this function, it adds a bunch of new drives. You can now easily take a look at your browser cookies - or even get rid of them:

```
PS> Get-ChildItem cookies:
PS> Get-ChildItem cookies: | del -WhatIf
```

You can check content of your desktop:

```
PS> Get-ChildItem desktop:
```

And if you'd like to see all the drives accessible to you, run this command:

```
PS> Get-PSDrive
```

Note that all custom drives are added only for your current PowerShell session. If you want to use them daily, make sure you add *Map-Profiles* and its call to your profile script:

```
PS> If ((Test-Path $profile) -eq $false) { New-Item $profile -ItemType File -Force }
PS> Notepad $profile
```

Constructing Paths

Path names are plain-text, so you can set them up any way you like. To put a file onto your desktop, you could add the path segments together using string operations:

```
PS> $path = [Environment]::GetFolderPath("Desktop") + "\file.txt"
PS> $path
C:\Users\Tobias Weltner\Desktop\file.txt
```

A more robust way is using *Join-Path* because it keeps track of the backslashes:

```
PS> $path = Join-Path ([Environment]::GetFolderPath("Desktop")) "test.txt"
PS> $path
C:\Users\Tobias Weltner\Desktop\test.txt
```

Or, you can use .NET framework methods:

```
PS> $path = [System.IO.Path]::Combine([Environment]::GetFolderPath("Desktop"), "test.txt")
PS> $path
C:\Users\Tobias Weltner\Desktop\test.txt
```

The *System.IO.Path* class includes a number of additionally useful methods that you can use to put together paths or extract information from paths. Just prepend *[System.IO.Path]::* to methods listed in **Table 15.4,** for example:

```
PS> [System.IO.Path]::ChangeExtension("test.txt", "ps1")
test.ps1
```

Method	Description	Example
`ChangeExtension()`	Changes the file extension	`ChangeExtension("test.txt","ps1")`
`Combine()`	Combines path strings; corresponds to *Join-Path*	`Combine("C:\test", "test.txt")`
`GetDirectoryName()`	Returns the directory; corresponds to *Split-Path -Parent*	`GetDirectoryName("c:\test\file.txt")`
`GetExtension()`	Returns the file extension	`GetExtension("c:\test\file.txt")`
`GetFileName()`	Returns the file name; corresponds to *Split-Path -Leaf*	`GetFileName("c:\test\file.txt")`
`GetFileNameWithoutExtension()`	Returns the file name without the file extension	`GetFileNameWithoutExtension("c:\test\file.txt")`
`GetFullPath()`	Returns the absolute path	`GetFullPath(".\test.txt")`
`GetInvalidFileNameChars()`	Lists all characters that are not allowed in a file name	`GetInvalidFileNameChars()`
`GetInvalidPathChars()`	Lists all characters that are not allowed in a path	`GetInvalidPathChars()`
`GetPathRoot()`	Gets the root directory; corresponds to *Split-Path -Qualifier*	`GetPathRoot("c:\test\file.txt")`
`GetRandomFileName()`	Returns a random file name	`GetRandomFileName()`
`GetTempFileName()`	Returns a temporary file name in the *Temp* directory	`GetTempFileName()`
`GetTempPath()`	Returns the path of the directory for temporary files	`GetTempPath()`
`HasExtension()`	True, if the path includes a file extension	`HasExtension("c:\test\file.txt")`
`IsPathRooted()`	True, if the path is absolute; corresponds to *Split-Path -isabsolute*	`IsPathRooted("c:\test\file.txt")`

Table 15.4: *Methods for constructing paths*

Working with Files and Directories

The cmdlets *Get-ChildItem* and Get-Item can get you file and directory items that already exist. In addition, you can create new files and directories, rename them, fill them with content, copy them, move them, and, of course, delete them.

Creating New Directories

The easiest way to create new directories is to use the *Md* function, which invokes the cmdlet *New-Item* internally and specifies as -*ItemType* parameter the *Directory* value:

```
# "md" is the predefined function and creates new directories:
PS> md Test1

    Directory: Microsoft.PowerShell.Core\FileSystem::C:\users\Tobias Weltner

Mode                 LastWriteTime                    Length          Name
----                 -------------                    ------          ----
d----            12.10.2011     17:14                                 Test1
```

```
# "New-Item" can do that, too, but takes more effort:
PS> New-Item Test2 -ItemType Directory

    Directory: Microsoft.PowerShell.Core\FileSystem::C:\users\Tobias Weltner

Mode                 LastWriteTime                    Length          Name
----                 -------------                    ------          ----
d----            12.10.2011     17:14                                 Test2
```

Tip

You can also create several sub-directories in one step as PowerShell automatically creates all the directories that don't exist yet in the specified path:

```
PS> md test\subdirectory\somethingelse
```

Three folders will be created with one line.

Creating New Files

You can use *New-Item* to also create new files. Use *-Value* if you want to specify text to put into the new file, or else you create an empty file:

```
PS> New-Item "new file.txt" -ItemType File

    Directory: Microsoft.PowerShell.Core\FileSystem::C:\users\Tobias Weltner

Mode                LastWriteTime                Length         Name
----                -------------                ------         ----
-a---            10.12.2011     17:16            0              new file.txt
```

If you add the *-Force* parameter, creating new files with *New-Item* becomes even more interesting - and a bit dangerous, too. The *-Force* parameter will overwrite any existing file, but it will also make sure that the folder the file is to be created it exists. So, *New-Item* can create several folders plus a file if you use *-Force.*

Another way to create files is to use old-fashioned redirection using the ">" and ">>" operators, *Set-Content* or *Out-File*.

```
Get-ChildItem > info1.txt
.\info1.txt
Get-ChildItem | Out-File info2.txt
.\info2.txt
Get-ChildItem | Set-Content info3.txt
.\info3.txt
Set-Content info4.txt (Get-Date)
.\info4.txt
```

As it turns out, redirection and *Out-File* work very similar: when PowerShell converts pipeline results, file contents look just like they would if you output the information in the console. *Set-Content* works differently: it does not use PowerShell's sophisticated ETS (*Extended Type System*) to convert objects into text. Instead, it converts objects into text by using their own private *ToString()* method - which provides much less information. That is because *Set-Content* is not designed to convert objects into text. Instead, this cmdlet is designed to write text to a file.

You can use all of these cmdlets to create text files. For example, *ConvertTo-HTML* produces HTML but does not write it to a file. By sending that information to *Out-File*, you can create HTML- or HTA-files and display them.

```
PS> Get-ChildItem | ConvertTo-HTML | Out-File report1.hta
PS> .\report1.hta
PS> Get-ChildItem | ConvertTo-HTML | Set-Content report2.hta
PS> .\report2.htm
```

Tip

If you want to control the "columns" (object properties) that are converted into HTML, simply use *Select-Object* (Chapter 5):

```
Get-ChildItem | Select-Object name, length, LastWriteTime | ConvertTo-HTML | Out-File report.htm
.\report.htm
```

If you rather want to export the result as a comma-separated list, use *Export-Csv* cmdlet instead of *ConvertTo-HTML | Out-File*.
Don't forget to use its *-UseCulture* parameter to automatically use the delimiter that is right for your culture.

To add content to an existing file, again you can use various methods. Either use the appending redirection operator ">>", or use *Add-Content.* You can also pipe results to *Out-File* and use *its -Append* parameter to make sure it does not overwrite existing content.

There is one thing you should keep in mind, though: do not mix these methods, stick to one. The reason is that they all use different default encodings, and when you mix encodings, the result may look very strange:

```
PS> Set-Content info.txt "First line"
PS> "Second line" >> info.txt
PS> Add-Content info.txt "Third line"
PS> Get-Content info.txt

First Line
S e c o n d  L i n e

Third line
```

All three cmdlets support the -*Encoding* parameter that you can use to manually pick an encoding. In contrast, the old redirection operators have no way of specifying encoding which is why you should avoid using them.

Reading the Contents of Text Files

Use *Get-Content* to retrieve the contents of a text-based file:

```
PS> Get-Content $env:windir\windowsupdate.log
```

There is a shortcut that uses variable notation if you know the absolute path of the file:

```
PS> ${c:\windows\windowsupdate.log}
```

However, this shortcut usually isn't very practical because it doesn't allow any variables inside curly brackets. You would have to hardcode the exact path to the file into your scripts.
Get-Content reads the contents of a file line by line and passes on every line of text through the pipeline. You can add *Select-Object* if you want to read only the first 10 lines of a very long file:

```
PS> Get-Content $env:windir\windowsupdate.log | Select-Object -First 10
```

You can also use -*Wait* with *Get-Content* to turn the cmdlet into a monitoring mode: once it read the entire file, it keeps monitoring it, and when new content is appended to the file, it is immediately processed and returned by *Get-Content*. This is somewhat similar to "tailing" a file in Unix.
Finally, you can use *Select-String* to filter information based on keywords and regular expressions. The next line gets only those lines from the *windowsupdate.log* file that contain the phrase " successfully installed ":

```
PS> Get-Content $env:windir\windowsupdate.log | Select-String "successfully installed"
```

Note that *Select-String* will change the object type to a so-called *MatchInfo* object. That's why when you forward the filtered information to a file, the result lines are cut into pieces:

```
PS> Get-Content $env:windir\windowsupdate.log -Encoding UTF8 | Select-String "successfully
installed" | Out-File $env:temp\report.txt
PS> Invoke-Item $env:temp\report.txt
```

To turn the results delivered by *Select-String* into real text, make sure you pick the property *Line* from the *MatchInfo* object which holds the text line that matched your keyword:

```
PS> Get-Content $env:windir\windowsupdate.log -Encoding UTF8 | Select-String "successfully
installed" | Select-Object -ExpandProperty Line | Out-File $env:temp\report.txt
PS> Invoke-Item $env:temp\report.txt
```

Processing Comma-Separated Lists

Use *Import-Csv* if you want to process information from comma-separated lists in PowerShell. For example, you could export an Excel spreadsheet as CSV-file and then import the data into PowerShell. When you use *Get-Content* to read a CSV-file, you'd see the plain text. A much better way is to use *Import-CSV*. It honors the delimiter and returns objects. Each column header turns into an object property.

To successfully import CSV files, make sure to use the parameter -*UseCulture* or -*Delimiter* if the list is not comma-separated. Depending on your culture, Excel may have picked a different delimiter than the comma, and -*UseCulture* automatically uses the delimiter that Excel used.

Moving and Copying Files and Directories

Move-Item and *Copy-Item* perform moving and copying operations. You may use wildcard characters with them. The following line copies all PowerShell scripts from your home directory to the Desktop:

```
PS> Copy-Item $home\*.ps1 ([Environment]::GetFolderPath("Desktop"))
```

Use *Get-Childitem* to copy recursively. Let it find the PowerShell scripts for you, and then pass the result on to *Copy-Item:* Before you run this line you should be aware that there may be hundreds of scripts, and unless you want to completely clutter your desktop, you may want to first create a folder on your desktop and then copy the files into that folder.

```
PS> Get-ChildItem -Filter *.ps1 -Recurse | Copy-Item -Destination ([Environment]::GetFolderPath
("Desktop"))}
```

Renaming Files and Directories

Use *Rename-Item* if you want to rename files or folders. Renaming files or folders can be dangerous, so do not rename system files or else Windows may stall.

```
PS> Set-Content $env:temp\testfile.txt "Hello,this,is,an,enumeration"

# file opens in notepad:
PS> Invoke-Item $env:temp\testfile.txt

# file opens in Excel now:
PS> Rename-Item $env:temp\testfile.txt testfile.csv
PS> Invoke-Item $env:temp\testfile.csv
```

Bulk Renames

Because *Rename-Item* can be used as a building block in the pipeline, it provides simple solutions to complex tasks. For example, if you wanted to remove the term "-temporary" from a folder and all its sub-directories, as well as all the included files, this instruction will suffice:

```
PS> Get-ChildItem | ForEach-Object { Rename-Item $_.Name $_.Name.Replace('-temporary', '') }
```

This line would now rename all files and folders, even if the term '"-temporary" you're looking for isn't even in the file name. So, to speed things up and avoid errors, use *Where-Object* to focus only on files that carry the keyword in its name:

```
PS> Get-ChildItem | Where-Object { $_.Name -like "*-temporary" } | ForEach-Object { Rename-Item
$_.Name $_.Name.replace('-temporary', '') }
```

Rename-Item even accepts a script block, so you could use this code as well:

```
PS> Get-ChildItem | $_.Name -like '*-temporary' } | Rename-Item { $_.Name.replace('-temporary',
 '') }
```

When you look at the different code examples, note that *ForEach-Object* is needed only when a cmdlet cannot handle the input from the upstream cmdlet directly. In these situations, use *ForEach-Object* to manually feed the incoming information to the appropriate cmdlet parameter.
Most file system-related cmdlets are designed to work together. That's why *Rename-Item* knows how to interpret the output from *Get-ChildItem*. It is "Pipeline-aware" and does not need to be wrapped in *ForEach-Object.*

Deleting Files and Directories

Use *Remove-Item* or the *Del* alias to remove files and folders. If a file is write-protected, or if a folder contains data, you'll have to confirm the operation or use the -*Force* parameter.

```
# Create an example file:
PS> $file = New-Item testfile.txt -ItemType file

# There is no write protection:
PS> $file.isReadOnly
False

# Activate write protection:
PS> $file.isReadOnly = $true
PS> $file.isReadOnly
True

# Write-protected file may be deleted only by using the -Force parameter:
PS> del testfile.txt
Remove-Item : Cannot remove item C:\Users\Tobias Weltner\testfile.txt: Not enough permission to
perform operation.
At line:1 char:4
+ del  <<<< testfile.txt
PS> del testfile.txt -Force
```

Deleting Directory Contents

Use wildcard characters if you want to delete a folder content but not the folder itself. This line, for example, will empty the *Recent* folder that keeps track of files you opened lately and - over time - can contain hundreds of lnk-files.
Because deleting files and folders is irreversible, be careful. You can always simulate the operation by using -*WhatIf* to see what happens - which is something you should do often when you work with wildcards because they may affect many more files and folders than you initially thought.

```
PS> $recents =  [Environment]::GetFolderPath('Recent')
PS> Remove-Item $recents\*.* -WhatIf
```

You can as well put this in one line, too:

```
PS> Get-Childitem ([Environment]::GetFolderPath('Recent')) | Remove-Item -WhatIf
```

This however would also delete subfolders contained in your *Recent* folder because *Get-ChildItem* lists both files and folders.
If you are convinced that your command is correct, and that it will delete the correct files, repeat the statement without -*WhatIf*. Or, you could use -*Confirm* instead to manually approve or deny each delete operation.

Deleting Directories Plus Content

PowerShell requests confirmation whenever you attempt to delete a folder that is not empty. Only the deletion of empty folders does not require confirmation:

```
# Create a test directory:
md testdirectory

    Directory: Microsoft.PowerShell.Core\FileSystem::C:\Users\Tobias Weltner\Sources\docs

Mode                LastWriteTime                 Length         Name
----                -------------                 ------         ----
d----            13.10.2011     13:31                            testdirectory

# Create a file in the directory:
PS> Set-Content .\testdirectory\testfile.txt "Hello"

# Delete directory:
PS> del testdirectory
Confirm
The item at "C:\Users\Tobias Weltner\Sources\docs\testdirectory" has children and the Recurse
parameter was not specified. If you continue, all children will be removed with the item. Are
you sure you want to continue?
[Y] Yes  [A] Yes to All  [N] No  [K] No to All  [H] Suspend  [?] Help (default is "Y"):
```

To delete folders without confirmation, add the parameter -*Recurse:*

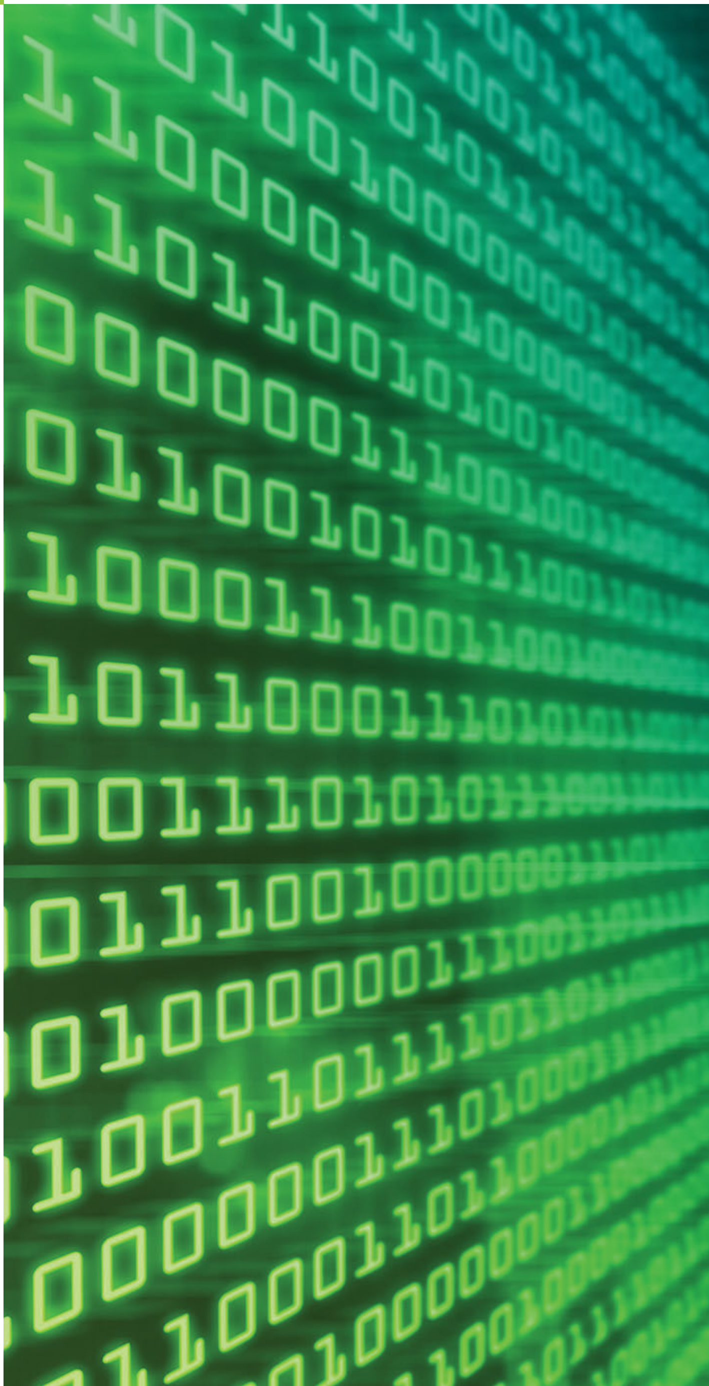
```
PS> Remove-Item testdirectory -Recurse
```

Alias	Description	Cmdlet
ac	Adds the contents of a file	Add-Content
cls, clear	Clears the console window	Clear-Host
cli	Clears file of its contents, but not the file itself	Clear-Item
copy, cp, cpi	Copies file or directory	Copy-Item
Dir, ls, gci	Lists directory contents	Get-ChildItem
type, cat, gc	Reads contents of text-based file	Get-Content
gi	Accesses specific file or directory	Get-Item
gp	Reads property of a file or directory	Get-ItemProperty
ii	Invokes file or directory using associated Windows program	Invoke-Item
-	Joins two parts of a path into one path, for example, a drive and a file name	Join-Path
mi, mv, move	Moves files and directories	Move-Item
ni	Creates new file or new directory	New-Item
ri, rm, rmdir, del, erase, rd	Deletes empty directory or file	Remove-Item
rni, ren	Renames file or directory	Rename-Item
rvpa	Resolves relative path or path including wildcard characters	Resolve-Path
sp	Sets property of file or directory	Set-ItemProperty
Cd, chdir, sl	Changes to specified directory	Set-Location
-	Extracts a specific part of a path like the parent path, drive, or file name	Split-Path
-	Returns True if the specified path exists	Test-Path

Table 15.1: *Overview of the most important file system commands*

Chapter 16. Managing Windows Registry

Thanks to PowerShells universal "Provider" concept, you can navigate the Windows Registry just as you would the file system. In this chapter, you will learn how to read and write Registry keys and Registry values.



Topics Covered:

Attention

The Registry stores many crucial Windows settings. That's why it's so cool to read and sometimes change information in the Windows Registry: you can manage a lot of configuration settings and sometimes tweak Windows in ways that are not available via the user interface.

However, if you mess things up - change the wrong values or deleting important settings - you may well permanently damage your installation. So, be very careful, and don't change anything that you do not know well.

Using Providers

To access the Windows Registry, there are no special cmdlets. Instead, PowerShell ships with a so-called provider named "Registry". A provider enables a special set of cmdlets to access data stores. You probably know these cmdlets already: they are used to manage content on drives and all have the keyword "item" in their noun part:

```
PS> Get-Command -Noun Item*

CommandType     Name                  ModuleName             Definition
-----------     ----                  ----------             ----------
Cmdlet          Clear-Item            Microsoft.PowerSh...   ...
Cmdlet          Clear-ItemProperty    Microsoft.PowerSh...   ...
Cmdlet          Copy-Item             Microsoft.PowerSh...   ...
Cmdlet          Copy-ItemProperty     Microsoft.PowerSh...   ...
Cmdlet          Get-Item              Microsoft.PowerSh...   ...
Cmdlet          Get-ItemProperty      Microsoft.PowerSh...   ...
Cmdlet          Invoke-Item           Microsoft.PowerSh...   ...
Cmdlet          Move-Item             Microsoft.PowerSh...   ...
Cmdlet          Move-ItemProperty     Microsoft.PowerSh...   ...
Cmdlet          New-Item              Microsoft.PowerSh...   ...
Cmdlet          New-ItemProperty      Microsoft.PowerSh...   ...
Cmdlet          Remove-Item           Microsoft.PowerSh...   ...
Cmdlet          Remove-ItemProperty   Microsoft.PowerSh...   ...
Cmdlet          Rename-Item           Microsoft.PowerSh...   ...
Cmdlet          Rename-ItemProperty   Microsoft.PowerSh...   ...
Cmdlet          Set-Item              Microsoft.PowerSh...   ...
Cmdlet          Set-ItemProperty      Microsoft.PowerSh...   ...
```

Many of these cmdlets have historic aliases, and when you look at those, the cmdlets probably become a lot more familiar:

```
PS> Get-Alias -Definition *-Item*

CommandType     Name           ModuleName         Definition
-----------     ----           ----------         ----------
Alias           cli                               Clear-Item
Alias          clp                                 Clear-ItemProperty
Alias          copy                                Copy-Item
Alias          cp                                  Copy-Item
Alias          cpi                                 Copy-Item
Alias          cpp                                 Copy-ItemProperty
Alias          del                                 Remove-Item
Alias          erase                               Remove-Item
Alias          gi                                  Get-Item
Alias          gp                                  Get-ItemProperty
Alias          ii                                  Invoke-Item
Alias          mi                                  Move-Item
Alias          move                                Move-Item
Alias          mp                                  Move-ItemProperty
Alias          mv                                  Move-Item
Alias          ni                                  New-Item
Alias          rd                                  Remove-Item
Alias          ren                                 Rename-Item
Alias          ri                                  Remove-Item
Alias          rm                                  Remove-Item
Alias          rmdir                               Remove-Item
Alias          rni                                 Rename-Item
Alias          rnp                                 Rename-ItemProperty
Alias          rp                                  Remove-ItemProperty
Alias          si                                  Set-Item
Alias          sp                                  Set-ItemProperty
```

Thanks to the "Registry" provider, all of these cmdlets (and their aliases) can also work with the Registry. So if you wanted to list the keys of HKEY_LOCAL_MACHINE\Software, this is how you'd do it:

```
Dir HKLM:\Software
```

Available Providers

Get-PSProvider gets a list of all available providers. Your list can easily be longer than in the following example. Many PowerShell extensions add additional providers. For example, the ActiveDirectory module that ships with Windows Server 2008 R2 (and the RSAT tools for Windows 7) adds a provider for the Active Directory. Microsoft SQL Server (starting with 2007) comes with an SQLServer provider.

```
Get-PSProvider

Name           Capabilities              Drives
----           ------------              ------
Alias          ShouldProcess             {Alias}
Environment    ShouldProcess             {Env}
FileSystem     Filter, ShouldProcess     {C, E, S, D}
Function       ShouldProcess             {Function}
Registry       ShouldProcess             {HKLM, HKCU}
```

```
Variable        ShouldProcess              {Variable}
Certificate     ShouldProcess              {cert}
```

What's interesting here is the "Drives" column, which lists the drives that are managed by a respective provider. As you see, the registry provider manages the drives *HKLM:* (for the registry root *HKEY_LOCAL_MACHINE*) and *HKCU:* (for the registry root *HKEY_CURRENT _USER*). These drives work just like traditional file system drives. Check this out:

```
Cd HKCU:
Dir
   Hive: Microsoft.PowerShell.Core\Registry::HKEY_CURRENT_USER

SKC  VC  Name                           Property
---  --- ----                           ----------
  2    0 AppEvents                      {}
  7    1 Console                        {CurrentPage}
 15    0 Control Panel                  {}
  0    2 Environment                    {TEMP, TMP}
  4    0 EUDC                           {}
  1    6 Identities                     {Identity Ordinal, Migrated7, Last ...
  3    0 Keyboard Layout                {}
  0    0 Network                        {}
  4    0 Printers                       {}
 38    1 Software                       {(default)}
  2    0 System                         {}
  0    1 SessionInformation             {ProgramCount}
  1    8 Volatile Environment           {LOGONSERVER, USERDOMAIN, USERNAME,...
```

You can navigate like in the file system and dive deeper into subfolders (which here really are registry keys).

Provider	Description	Example
Alias	Manages aliases, which enable you to address a command under another name. You'll learn more about aliases in Chapter 2.	Dir Alias: $alias:Dir
Environment	Provides access to the environment variables of the system. More in Chapter 3.	Dir env: $env:windir
Function	Lists all defined functions. Functions operate much like macros and can combine several commands under one name. Functions can also be an alternative to aliases and will be described in detail in Chapter 9.	Dir function: $function:tabexpansion
FileSystem	Provides access to drives, directories, and files.	Dir c: $(c:\autoexec.bat)
Registry	Provides access to branches of the Windows Registry.	Dir HKCU: Dir HKLM:
Variable	Manages all the variables that are defined in the PowerShell console. Variables are covered in Chapter 3.	Dir variable: $variable:pshome
Certificate	Provides access to the certificate store with all its digital certificates. These are examined in detail in Chapter 10.	Dir cert: Dir cert: -recurse

Table 16.2: *Default providers*

Creating Drives

PowerShell comes with two drives built-in that point to locations in the Windows Registry: HKLM: and HKCU:.

```
Get-PSDrive -PSProvider Registry

Name            Provider                Root                          CurrentLocation
----            --------                ------                        ---------------
HKCU            Registry                HKEY_CURRENT_USER
HKLM            Registry                HKEY_LOCAL_MACHINE
```

That's a bit strange because when you open the Registry Editor regedit.exe, you'll see that there are more than just two root hives. If you wanted to access another hive, let's say HKEY_USERS, you'd have to add a new drive like this:

```
New-PSDrive -Name HKU -PSProvider Registry -Root HKEY_USERS
Dir HKU:
```

You may not have access to all keys due to security settings, but your new drive HKU: works fine. Using *New-PSDrive*, you now can access all parts of the Windows Registry. To remove the drive, use *Remove-PSDrive* (which only works if HKU: is not the current drive in your PowerShell console):

```
Remove-PSDrive HKU
```

Tip

You can of course create additional drives that point to specific registry keys that you may need to access often.

```
New-PSDrive InstalledSoftware registry 'HKLM:\Software\Microsoft\Windows\CurrentVersion
\Uninstall'
Dir InstalledSoftware:
```

Note that PowerShell drives are only visible inside the session you defined them. Once you close PowerShell, they will automatically get removed again. To keep additional drives permanently, add the *New-PSDrive* statements to your profile script so they get automatically created once you launch PowerShell.

Using Provider Names Directly

Actually, you do not need PowerShell drives at all to access the Registry. In many scenarios, it can be much easier to work with original Registry paths. To make this work, prepend the paths with the provider names like in the example below:

```
Dir HKLM:\Software
Dir Registry::HKEY_LOCAL_MACHINE\Software
Dir Registry::HKEY_USERS
Dir Registry::HKEY_CLASSES_ROOT\.ps1
```

With this technique, you can even list all the Registry hives:

```
Dir Registry::
```

Searching for Keys

Get-ChildItem can list all subkeys of a key, and it can of course use recursion to search the entire Registry for keys with specific keywords.

The registry provider doesn't support filters, though, so you cannot use the parameter -*Filter* when you search the registry. Instead, use -*Include* and -*Exclude*. For example, if you wanted to find all Registry keys that include the word "PowerShell", you could search using:

```
PS> Get-ChildItem HKCU:, HKLM: -Recurse -Include *PowerShell* -ErrorAction SilentlyContinue |
Select-Object -ExpandProperty Name
HKEY_CURRENT_USER\Console\%SystemRoot%_System32_WindowsPowerShell_v1.0_powershell.exe
HKEY_CURRENT_USER\Software\Microsoft\ADs\Providers\LDAP\CN=Aggregate,CN=Schema,CN=Configuration,
DC=powershell,DC=local
HKEY_CURRENT_USER\Software\Microsoft\PowerShell
HKEY_CURRENT_USER\Software\Microsoft\PowerShell\1\ShellIds\Microsoft.PowerShell
```

Note that this example searches both HKCU: and HKLM:. The error action is set to SilentlyContinue because in the Registry, you will run into keys that are access-protected and would raise ugly "Access Denied" errors. All errors are suppressed that way.

Searching for Values

Since Registry values are not interpreted as separate items but rather are added to keys as so-called ItemProperties, you cannot use *Get-ChildItem* to search for Registry values. You can search for values indirectly, though. Here is some code that finds all Registry keys that have at least one value with the keyword "PowerShell":

```
PS> Get-ChildItem HKCU:, HKLM: -Recurse -ea 0 | Where-Object { $_.GetValueNames() |
Where-Object { $_ -like '*PowerShell*' } }
```

If you want to find all keys that have a value with the keyword in its data, try this:

```
PS> Get-ChildItem HKCU:, HKLM: -Recurse -ea 0 | Where-Object { $key = $_; $_.GetValueNames() |
ForEach-Object { $key.GetValue($_) } | Where-Object { $_ -like '*PowerShell*' } }
```

Reading One Registry Value

If you need to read a specific Registry value in a Registry key, use *Get-ItemProperty*. This example reads the registered owner:

```
PS> Get-ItemProperty -Path 'HKLM:\SOFTWARE\Microsoft\Windows NT\CurrentVersion' -Name
RegisteredOwner

RegisteredOwner     : Tim Telbert
```

```
PSPath           : Registry::HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT\CurrentVersion
PSParentPath     : Registry::HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows NT
PSChildName      : CurrentVersion
PSDrive          : HKLM
PSProvider       : Registry
```

Unfortunately, the Registry provider adds a number of additional properties so you don't get back the value alone. Add another *Select-Object* to really get back only the content of the value you are after:

```
PS> Get-ItemProperty -Path 'HKLM:\SOFTWARE\Microsoft\Windows NT\CurrentVersion' -Name
RegisteredOwner | Select-Object -ExpandProperty RegisteredOwner

Tim Telbert
```

Reading Multiple Registry Values

Maybe you'd like to read more than one Registry value. Registry keys can hold an unlimited number of values. The code is not much different from before. Simply replace the single Registry value name with a comma-separated list, and again use *Select-Object* to focus only on those. Since this time you are reading multiple properties, use -*Property* instead of –*ExpandProperty* parameter.

```
PS> Get-ItemProperty -Path 'HKLM:\SOFTWARE\Microsoft\Windows NT\CurrentVersion' -Name
ProductName, EditionID, CSDVersion, RegisteredOwner | Select-Object -Property ProductName,
EditionID, CSDVersion, RegisteredOwner

ProductName           EditionID       CSDVersion                    RegisteredOwner
-----------           ---------       ----------                    ---------------
Windows 7 Ultimate    Ultimate        Service Pack 1                Tim Telbert
```

Or, a little simpler:

```
PS> Get-ItemProperty -Path 'HKLM:\SOFTWARE\Microsoft\Windows NT\CurrentVersion' |
Select-Object -Property ProductName, EditionID, CSDVersion, RegisteredOwner

ProductName           EditionID       CSDVersion                    RegisteredOwner
-----------           ---------       ----------                    ---------------
Windows 7 Ultimate    Ultimate        Service Pack 1                Tim Telbert
```

Reading Multiple Keys and Values

Yet maybe you want to read values not just from one Registry key but rather a whole bunch of them. In HKLM:\Software\Microsoft\Windows\CurrentVersion\Uninstall, you find a lot of keys, one for each installed software product. If you wanted to get a list of all software installed on your machine, you could read all of these keys and display some values from them.

That again is just a minor adjustment to the previous code because Get-ItemProperty supports wildcards. Have a look:

```
PS> Get-ItemProperty -Path 'HKLM:\SOFTWARE\Microsoft\Windows\CurrentVersion\Uninstall\*' |
Select-Object -Property DisplayName, DisplayVersion, UninstallString

DisplayName                    DisplayVersion       UninstallString
-----------                    --------------       ---------------
                               0.8.2.232
Microsoft IntelliPoint 8.1     8.15.406.0           msiexec.exe /I {3ED4AD...
Microsoft Security Esse...     2.1.1116.0           C:\Program Files\Micro...
NVIDIA Drivers                 1.9                  C:\Windows\system32\nv...
WinImage                                            "C:\Program Files\WinI...
Microsoft Antimalware          3.0.8402.2           MsiExec.exe /X{05BFB06...
Windows XP Mode                1.3.7600.16422       MsiExec.exe /X{1374CC6...
Windows Home Server-Con...     6.0.3436.0           MsiExec.exe /I{21E4979...
Idera PowerShellPlus Pr...     4.0.2703.2           MsiExec.exe /I{7a71c8a...
Intel(R) PROSet/Wireles...     13.01.1000
(...)
```

Voilá, you get a list of installed software. Some of the lines are empty, though. This occurs when a key does not have the value you are looking for.

To remove empty entries, simply add *Where-Object* like this:

```
PS> Get-ItemProperty -Path 'HKLM:\SOFTWARE\Microsoft\Windows\CurrentVersion\Uninstall\*' |
Select-Object -Property DisplayName, DisplayVersion, UninstallString | Where-Object
{ $_.DisplayName -ne $null }
```

Creating Registry Keys

Since Registry keys are treated like files or folders in the file system, you can create and delete them accordingly. To create new keys, either use historic aliases like *md* or *mkdir*, or use the underlying cmdlet directly:

```
PS> New-Item HKCU:\Software\NewKey1

    Hive: Registry::HKEY_CURRENT_USER\Software

Name                                                    Property
----                                                    --------
NewKey1


PS> md HKCU:\Software\NewKey2

    Hive: Registry::HKEY_CURRENT_USER\Software

Name                                                    Property
----                                                    --------
NewKey2
```

If a key name includes blank characters, enclose the path in quotation marks. The parent key has to exist.

To create a new key with a default value, use *New-Item* and specify the value and its data type:

```
PS> New-Item HKCU:\Software\NewKey3 -Value 'Default Value Text' -Type String

    Hive: Registry::HKEY_CURRENT_USER\Software

Name                                                    Property
----                                                    --------
NewKey3                                                 (default) : Default Value Text
```

Deleting Registry Keys

To delete a key, use the historic aliases from the file system that you would use to delete a folder, or use the underlying cmdlet *Remove-Item* directly:

```
PS> Remove-Item HKCU:\Software\Test1
Del HKCU:\Software\Test2
Del HKCU:\Software\Test3
```

This process needs to be manually confirmed if the key you are about to remove contains other keys:

```
Del HKCU:\Software\KeyWithSubKeys
Confirm
```

```
The item at "HKCU:\Software\KeyWithSubKeys" has children and the Recurse parameter was not
specified. If you continue, all children will be removed with the item. Are you sure you want
to continue?
[Y] Yes  [A] Yes to All  [N] No  [L] No to All  [S] Suspend  [?] Help (default is "Y"):
```

Use the –*Recurse* parameter to delete such keys without manual confirmation:

```
Del "HKCU:\Software\First key" -Recurse
```

Creating Values

Each Registry key can have an unlimited number of values. Earlier in this chapter, you learned how to read these values. Values are called "ItemProperties", so they belong to an "Item", the Registry key.

To add new values to a Registry key, either use *New-ItemProperty* or *Set-ItemProperty*. *New-ItemProperty* cannot overwrite an existing value and returns the newly created value in its object form. *Set-ItemProperty* is more easy going. If the value does not yet exist, it will be created, else changed. *Set-ItemProperty* does not return any object.

Here are some lines of code that first create a Registry key and then add a number of values with different data types:

```
PS> New-Item HKCU:\Software\TestKey4
PS> Set-ItemProperty HKCU:\Software\TestKey4 -Name Name -Value 'Smith'
PS> Set-ItemProperty HKCU:\Software\TestKey4 -Name ID -Value 12 -Type DWORD
PS> Set-ItemProperty HKCU:\Software\TestKey4 -Name Path -Value '%WINDIR%' -Type ExpandString
PS> Set-ItemProperty HKCU:\Software\TestKey4 -Name Notes -Value 'First Note','Second Note'
-Type MultiString
PS> Set-ItemProperty HKCU:\Software\TestKey4 -Name DigitalInfo -Value 4,8,12,200,90 -Type Binary


PS> Get-ItemProperty HKCU:\Software\TestKey4

Name             : Smith
ID               : 12
Path             : C:\Windows
Notes            : {First Note, Second Note}
DigitalInfo      : {4, 8, 12, 200...}
PSPath           : Registry::HKEY_CURRENT_USER\Software\TestKey4
PSParentPath     : Registry::HKEY_CURRENT_USER\Software
PSChildName      : TestKey4
PSDrive          : HKCU
PSProvider       : Registry
```

If you wanted to set the keys' default value, use '(default)' as value name.

ItemType	Description	DataType
`String`	`A string`	`REG_SZ`
`ExpandString`	`A string with environment variables that are resolved when invoked`	`REG_EXPAND_SZ`
`Binary`	`Binary values`	`REG_BINARY`
`DWord`	`Numeric values`	`REG_DWORD`
`MultiString`	`Text of several lines`	`REG_MULTI_SZ`
`QWord`	`64-bit numeric values`	`REG_QWORD`

Table 16.4: *Permitted ItemTypes in the Registry*

Use *Remove-ItemProperty* to remove a value. This line deletes the value Name value that you created in the previous example:

```
Remove-ItemProperty HKCU:\Software\Testkey4 Name
```

Tip

Clear-ItemProperty clears the content of a value, but not the value itself.

Be sure to delete your test key once you are done playing:

```
Remove-Item HKCU:\Software\Testkey4 -Recurse
```

Securing Registry Keys

Registry keys (and its values) can be secured with Access Control Lists (ACLs) in pretty much the same way the NTFS file system manages access permissions to files and folders. Likewise, you can use *Get-Acl* to show current permissions of a key:

```
md HKCU:\Software\Testkey4
Get-Acl HKCU:\Software\Testkey

Path                         Owner                            Access
----                         -----                            ------
Microsoft.PowerShell.Core\   TobiasWeltne-PC\Tobias Weltner   TobiasWeltne-PC\Tobias Weltner
Registr...                                                    A...
```

To apply new security settings to a key, you need to know the different access rights that can be assigned to a key. Here is how you get a list of these rights:

```
PS> [System.Enum]::GetNames([System.Security.AccessControl.RegistryRights])

QueryValues
SetValue
CreateSubKey
```

```
EnumerateSubKeys
Notify
CreateLink
Delete
ReadPermissions
WriteKey
ExecuteKey
ReadKey
ChangePermissions
TakeOwnership
FullControl
```

Taking Ownership

Always make sure that you are the "owner" of the key before modifying Registry key access permissions. Only owners can recover from lock-out situations, so if you set permissions wrong, you may not be able to undo the changes unless you are the owner of the key.

This is how to take ownership of a Registry key (provided your current access permissions allow you to take ownership. You may want to run these examples in a PowerShell console with full privileges):

```
$acl = Get-Acl HKCU:\Software\Testkey
$acl.Owner
scriptinternals\TobiasWeltner
$me = [System.Security.Principal.NTAccount]"$env:userdomain\$env:username"
$acl.SetOwner($me)
```

Setting New Access Permissions

The next step is to assign new permissions to the key. Let's exclude the group "Everyone" from making changes to this key:

```
$acl = Get-Acl HKCU:\Software\Testkey
$person = [System.Security.Principal.NTAccount]"Everyone"
$access = [System.Security.AccessControl.RegistryRights]"WriteKey"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"None"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Deny"

$rule = New-Object
System.Security.AccessControl.RegistryAccessRule($person,$access,$inheritance,$propagation,
$type)

$acl.AddAccessRule($rule)
Set-Acl HKCU:\Software\Testkey $acl
```

The modifications immediately take effect.Try creating new subkeys in the Registry editor or from within PowerShell, and you'll get an error message:

```
md HKCU:\Software\Testkey\subkey
New-Item : Requested Registry access is not allowed.
At line:1 char:34
+ param([string[]]$paths); New-Item  <<<< -type directory -path $paths
```

Tip

Why does the restriction applies to you as an administrator? Aren't you supposed to have full access? No, restrictions always have priority over permissions, and because everyone is a member of the *Everyone* group, the restriction applies to you as well. This illustrates that you should be extremely careful applying restrictions. A better approach is to assign permissions only.

Removing an Access Rule

The new rule for *Everyone* was a complete waste of time after all because it applied to everyone, effectively excluding everyone from the key. So, how do you go about removing a rule? You can use *RemoveAccessRule()* to remove a particular rule, and *RemoveAccessRuleAll()* to remove all rules of the same type (permission or restriction) for the user named in the specified rule. *ModifyAccessRule()* changes an existing rule, and *PurgeAccessRules()* removes all rules for a certain user.

To remove the rule that was just inserted, proceed as follows:

```
$acl = Get-Acl HKCU:\Software\Testkey
$person = [System.Security.Principal.NTAccount]"Everyone"
$access = [System.Security.AccessControl.RegistryRights]"WriteKey"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"None"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Deny"

$rule = New-Object
System.Security.AccessControl.RegistryAccessRule($person,$access,$inheritance,$propagation,
$type)

$acl.RemoveAccessRule($rule)
Set-Acl HKCU:\Software\Testkey $acl -Force
```

However, removing your access rule may not be as straightforward because you have effectively locked yourself out. Since you no longer have modification rights to the key, you are no longer allowed to modify the keys' security settings as well.

You can overrule this only if you take ownership of the key: Open the Registry editor, navigate to the key, and by right-clicking and then selecting *Permissions* open the security dialog box and manually remove the entry for *Everyone*.

Important

You've just seen how relatively easy it is to lock yourself out. Be careful with restriction rules.

Controlling Access to Sub-Keys

In the next example, you use permission rules rather than restriction rules. The task: create a key where only administrators can make changes. Everyone else should just be allowed to read the key.

```
md HKCU:\Software\Testkey2
$acl = Get-Acl HKCU:\Software\Testkey2

# Admins may do everything:
$person = [System.Security.Principal.NTAccount]”Administrators”
$access = [System.Security.AccessControl.RegistryRights]"FullControl"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"None"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object

System.Security.AccessControl.RegistryAccessRule($person,$access,$inheritance,$propagation,
$type)
$acl.ResetAccessRule($rule)

# Everyone may only read and create subkeys:
$person = [System.Security.Principal.NTAccount]"Everyone"
$access = [System.Security.AccessControl.RegistryRights]"ReadKey"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"None"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object
System.Security.AccessControl.RegistryAccessRule($person,$access,$inheritance,$propagation,
$type)
$acl.ResetAccessRule($rule)

Set-Acl HKCU:\Software\Testkey2 $acl
```

Note that in this case the new rules were not entered by using *AddAccessRule()* but by *ResetAccessRule()*. This results in removal of all existing permissions for respective users. Still, the result isn't right because regular users could still create subkeys and write values:

```
md hkcu:\software\Testkey2\Subkey

   Hive: Microsoft.PowerShell.Core\Registry::HKEY_CURRENT_USER\software\Testkey2

SKC  VC  Name                            Property
---  --- ----                            ----------
  0    0  0 Subkey                        {}

Set-ItemProperty HKCU:\Software\Testkey2 Value1 "Here is text"
```

Revealing Inheritance

Look at the current permissions of the key to figure out why your permissions did not work the way you planned:

```
(Get-Acl HKCU:\Software\Testkey2).Access | Format-Table -Wrap

RegistryRights  AccessControl  IdentityReference   IsInherited  InheritanceFlags     Propagation
                Type                                                                 Flags
--------------  -------------  ------------------  -----------  -----------------    -----------
ReadKey         Allow          Everyone            False        None                 None
FullControl     Allow          BUILT-IN\           False        None                 None
                               Administrators
FullControl     Allow          TobiasWeltne-PC\    True         ContainerInherit,    None
                               Tobias Weltner                   ObjectInherit
FullControl     Allow          NT AUTHORITY\       True         ContainerInherit,    None
                               SYSTEM                           ObjectInherit
FullControl     Allow          BUILT-IN\           True         ContainerInherit,    None
                               Administrators                   ObjectInherit
ReadKey         Allow          NT AUTHORITY\       True         ContainerInherit,    None
                               RESTRICTED ACCESS                ObjectInherit
```

The key includes more permissions than what you assigned to it. It gets these additional permissions by inheritance from parent keys. If you want to turn off inheritance, use *SetAccessRuleProtection():*

```
$acl = Get-Acl HKCU:\Software\Testkey2
$acl.SetAccessRuleProtection($true, $false)
Set-Acl HKCU:\Software\Testkey2 $acl
```

Now, when you look at the permissions again, the key now contains only the permissions you explicitly set. It no longer inherits any permissions from parent keys:

```
(Get-Acl HKCU:\Software\Testkey2).Access | Format-Table -Wrap

RegistryRights  AccessControl  IdentityReference   IsInherited  InheritanceFlags      Propagation
                Type                                                                  Flags
--------------  -------------  ------------------  -----------  -----------------     -----------
ReadKey         Allow          Everyone            False        None                  None
FullControl     Allow          BUILT-IN\           False        None                  None
                               Administrators
```

Controlling Your Own Inheritance

Inheritance is a sword that cuts both ways. You have just turned off the inheritance of permissions from parent keys, but will your own newly set permissions be propagated to subkeys? Not by default. If you want to pass on your permissions to subdirectories, change the setting for propagation, too. Here are all steps required to secure the key:

```
del HKCU:\Software\Testkey2
md HKCU:\Software\Testkey2

$acl = Get-Acl HKCU:\Software\Testkey2
```

```
# Admins may do anything:
$person = [System.Security.Principal.NTAccount]”Administrators”
$access = [System.Security.AccessControl.RegistryRights]"FullControl"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"ObjectInherit,ContainerInherit"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object
System.Security.AccessControl.RegistryAccessRule($person,$access,$inheritance,$propagation,
$type)
$acl.ResetAccessRule($rule)


# Everyone may only read and create subkeys:
$person = [System.Security.Principal.NTAccount]"Everyone"
$access = [System.Security.AccessControl.RegistryRights]"ReadKey"
$inheritance = [System.Security.AccessControl.InheritanceFlags]"ObjectInherit,ContainerInherit"
$propagation = [System.Security.AccessControl.PropagationFlags]"None"
$type = [System.Security.AccessControl.AccessControlType]"Allow"
$rule = New-Object
System.Security.AccessControl.RegistryAccessRule($person,$access,$inheritance,$propagation,
$type)
$acl.ResetAccessRule($rule)

Set-Acl HKCU:\Software\Testkey2 $acl
```

Chapter 17. Processes, Services, and Event Logs

In your daily work as an administrator, you will probably often deal with applications (processes), services, and event logs so let's take some of the knowledge you gained from the previous chapters and play with it. The examples and topics covered in this chapter are meant to give you an idea of what you can do. By no means are they a complete list of what you can do. They will provide you with a great starting point, though.

Topics Covered:

- Working with Processes
- Managing Services
- Reading and Writing Event Logs

Working with Processes

Every application that is running is represented by a so-called "process". To view all running processes, use *Get-Process* cmdlet.

```
PS> Get-Process
```

This will list all running processes on the local machine, not just yours. So if other people are logged onto your box, their processes may also show up in that list. However, unless you have local Administrator privileges, you can only access limited properties of processes you did not launch yourself.

That's why *Get-Process* throws a number of exceptions when you try and list the executable files of all running processes. Exceptions occur either when there is no executable for a given process (namely *System* and *Idle*), or if you do not have permission to see them:

```
PS> Get-Process -FileVersionInfo
```

To hide error messages and focus only on the information you are able to retrieve, use the common parameter -*ErrorAction SilentlyContinue* which is available in every cmdlet - or its short form -*ea 0:*

```
PS> Get-Process -FileVersionInfo -ErrorAction SilentlyContinue
PS> Get-Process -FileVersionInfo -ea 0
```

Process objects returned from *Get-Process* contain a lot more information that you can see when you pipe the result to *Select-Object* and have it display all object properties:

```
PS> Get-Process | Select-Object *
```

You can then examine the object properties available, and put together your own reports by picking the properties that you need:

```
PS> Get-Process | Select-Object Name, Description, Company, MainWindowTitle

Name                  Description            Company                  MainWindowTitle
----                  -----------            -------                  ---------------
AppleMobileDevic...
conhost               Console Window Host    Microsoft Corpor...
csrss
csrss
DataCardMonitor       DataCardMonitor...     Huawei Technolog...      DataCardMonitor
Dropbox               Dropbox                Dropbox, Inc.
dwm                   Desktop Window M...    Microsoft Corpor...
(...)
```

When you do that, you'll notice that there may be blank lines. They occur when a process object has no information for the particular property you selected. For example, the property *MainWindowTitle* represents the text in the title bar of an application window. So, if a process has no application window, *MainWindowTitle* is empty.

You can use the standard pipeline cmdlets to take care of that. Use *Where-Object* to filter out processes that do not meet your requirements. For example, this line will get you only processes that do have an application window:

```
PS> Get-Process | Where-Object { $_.MainWindowTitle -ne '' } | Select-Object Description,
MainWindowTitle, Name, Company

Description             MainWindowTitle        Name                Company
-----------             ---------------        ----                -------
DataCardMonitor...      DataCardMonitor        DataCardMonitor     Huawei Technolog...
Remote Desktop C...     storage1 - Remot...    mstsc               Microsoft Corpor...
Windows PowerShell      Windows PowerShell     powershell          Microsoft Corpor...
Microsoft Office...     eBook_Chap17_V2....    WINWORD             Microsoft Corpor...
```

Tip

Note that you can also retrieve information about processes by using WMI:

```
PS> Get-WmiObject Win32_Process
```

WMI will get you even more details about running processes.

Both *Get-Process* and *Get-WmiObject* support the parameter -*ComputerName*, so you can use both to retrieve processes remotely from other machines. However, only *Get-WmiObject* also supports the parameter -*Credential* so you can authenticate. *Get-Process* always uses your current identity, and unless you are Domain Administrator or otherwise have local Administrator privileges at the target machine, you will get an *Access Denied error.*

Note that even with *Get-Process*, you can authenticate. Establish an *IPC* network connection to the target machine, and use this connection for authentication. Here is an example:

```
PS> net use \\someRemoteMachine Password /USER:domain\username
```

Here are some more examples of using pipeline cmdlets to refine the results returned by *Get-Process.* Can you decipher what these lines would do?

```
PS> Get-Process | Where-Object { $_.StartTime -gt (Get-Date).AddMinutes(-180)}
PS> @(Get-Process notepad -ea 0).Count
PS> Get-Process | Measure-Object -Average -Maximum -Minimum -Property PagedSystemMemorySize
```

Accessing Process Objects

Each *Process* object contains methods and properties. Many properties may be read as well as modified, and methods can be executed like commands. This allows you to control many fine settings of processes. For example, you can specifically raise or lower the priority of a process. The next statement lowers the priority of all Notepads:

```
PS> Get-Process notepad | ForEach-Object { $_.PriorityClass = "BelowNormal" }
```

Launching New Processes (Applications)

Launching applications from PowerShell is pretty straight-forward: simply enter the name of the program you want to run, and press ENTER:

```
PS> notepad
PS> regedit
PS> ipconfig
```

This works great, but eventually you'll run into situations where you cannot seem to launch an application. PowerShell might complain that it would not recognize the application name although you know for sure that it exists.

When this happens, you need to specify the absolute or relative path name to the application file. That can become tricky because in order to escape spaces in path names, you have to quote them, and in order to run quoted text (and not echo it back), you need to prepend it with an ampersand. The ampersand tells PowerShell to treat the text as if it was a command you entered.

So if you wanted to run Internet Explorer from its standard location, this is the line that would do the job:

```
& 'C:\Program Files\Internet Explorer\iexplore.exe'
```

When you run applications from within PowerShell, these are the rules to know:

- **Environment variable $env:path:** All folders listed in *$env:path* are special. Applications stored inside these folders can be launched by name only. You do not need to specify the complete or relative path. That's the reason why you can simply enter *notepad* and press ENTER to launch the Win dows Editor, or run commands like *ping* or *ipconfig*.
- **Escaping Spaces:** If the path name contains spaces, the entire path name needs to be quoted. Once you quote a path, though, it becomes a string (text), so when you press ENTER, PowerShell happily echoes the text back to you but won't start the application. Whenever you quote paths, you need to prepend the string with "&" so PowerShell knows that you want to launch something.
- **Synchronous and asynchronous execution:** when you run a console-based application such as *ipconfig.exe* or *netstat.exe*, it shares the console with PowerShell so its output is displayed in the PowerShell console. That's why PowerShell pauses until console-based applications finished. Window-based applications such as *notepad.exe* or *regedit.exe* use their own windows for output. Here, PowerShell continues immediately and won't wait for the application to complete.

Using Start-Process

Whenever you need to launch a new process and want more control, use *Start-Process*. This cmdlet has a number of benefits over launching applications directly. First of all, it is a bit smarter and knows where a lot of applications are stored. It can for example find *iexplore.exe* without the need for a path:

```
PS> Start-Process iexplore.exe
```

Second, *Start-Process* supports a number of parameters that allow you to control window size, synchronous or asynchronous execution or even the user context an application is using to run. For example, if you wanted PowerShell to wait for a window-based application so a script could execute applications in a strict order, use -*Wait* parameter:

```
PS> Start-Process notepad -Wait
```

You'll notice that PowerShell now waits for the Notepad to close again before it accepts new commands.

Important

Start-Process has just one limitation: it cannot return the results of console-based applications back to you. Check this out:

```
PS> $result = ipconfig
```

This will store the result of *ipconfig* in a variable. The same done with *Start-Process* yields nothing:

```
PS> $result = Start-Process ipconfig
```

That's because *Start-Process* by default runs every command synchronously, so *ipconfig* runs in its own new console window which is visible for a split-second if you look carefully. But even if you ask *Start-Process* to run the command in no new console, results are never returned:

```
PS> $result = Start-Process ipconfig -NoNewWindow
```

Instead, they are always output to the console. So if you want to read information from console-based applications, do not use *Start-Process*.

Stopping Processes

If you must kill a process immediately, use *Stop-Process* and specify either the process ID, or use the parameter -*Name* to specify the process name. This would close all instances of the Notepad:

```
PS> Stop-Process -Name Notepad
```

Stopping processes this way shouldn't be done on a regular basis: since the application is immediately terminated, it has no time to save unsaved results (which might result in data loss), and it cannot properly clean up (which might result in orphaned temporary files and inaccurate open DLL counters). Use it only if a process won't respond otherwise. Use –*WhatIf* to simulate. Use –*Confirm* when you want to have each step confirmed.

To close a process nicely, you can close its main window (which is the automation way of closing the application window by a mouse click). Here is a sample that closes all instances of notepad:

```
PS> Get-Process Notepad -ea 0 | ForEach-Object { $_.CloseMainWindow() }
```

Managing Services

Services are basically processes, too. They are just executed automatically and in the background and do not necessarily require a user logon. Services provide functionality usually not linked to any individual user.

Cmdlet	Description
Get-Service	Lists services
New-Service	Registers a service
Restart-Service	Stops a service and then restarts it. For example, to allow modifications of settings to take effect
Resume-Service	Resumes a stopped service
Set-Service	Modifies settings of a service
Start-Service	Starts a service
Stop-Service	Stops a service
Suspend-Service	Suspends a service

Table 17.1: *Cmdlets for managing services*

Examining Services

Use *Get-Service* to list all services and check their basic status.

```
PS> Get-Service
```

You can also check an individual service and find out whether it is running or not:

```
PS> Get-Service Spooler
```

Starting, Stopping, Suspending, and Resuming Services

To start, stop, temporarily suspend, or restart a service, use the corresponding cmdlets. You can also use *Get-Service* to select the services first, and then pipe them to one of the other cmdlets. Just note that you may need local administrator privileges to change service properties.

```
PS> Stop-Service Spooler
```

If a service has dependent services, it cannot be stopped unless you also specify *-Force.*

```
PS> Stop-Service Spooler -Force
```

Note that you can use WMI to find out more information about services, and also manage services on remote machines:

```
PS> Get-WmiObject Win32_Service -ComputerName Storage1 -Credential Administrator
```

Since WMI includes more information that *Get-Service,* you could filter for all services set to start automatically that are not running. By examining the service *ExitCode* property, you'd find services that did initialization tasks and finished ok (exit code is 0) or that crashed (exit code other than 0):

```
PS> Get-WmiObject Win32_Service -Filter 'StartMode="Auto" and Started=False' | Select-Object
DisplayName, ExitCode

DisplayName                                     ExitCode
-----------                                     --------
Microsoft .NET Framework NGEN v4.0.30319_X86    0
Microsoft .NET Framework NGEN v4.0.30319_X64    0
Google Update Service (gupdate)                 0
Net Driver HPZ12                                0
Pml Driver HPZ12                                0
Software Protection                             0
Windows Image Acquisition (WIA)                 0
```

Reading and Writing Event Logs

Event logs are the central place where applications as well as the operating system log all kinds of information grouped into the categories Information, Warning, and Error. PowerShell can read and write these log files. To find out which log files exist on your machine, use *Get-EventLog* with the parameter *-List:*

```
PS> Get-EventLog -List
```

To list the content of one of the listed event logs, use -LogName instead. This lists all events from the System event log:

```
PS> Get-EventLog -LogName System
```

Dumping all events is not a good idea, though, because this is just too much information. In order to filter the information and focus on what you want to know, take a look at the column headers. If you want to filter by the content of a specific column, look for a parameter that matches the column name.
This line gets you the latest 20 errors from the System event log:

```
PS> Get-EventLog -LogName System -EntryType Error -Newest 20
```

And this line gets you all error and warning entries that have the keyword "Time" in its message:

```
PS> Get-EventLog -LogName System -EntryType Error, Warning -Message *Time* | Select-Object
TimeWritten, Message
```

Writing Entries to the Event Log

To write your own entries to one of the event logs, you first need to register an event source (which acts like your "sender" address). To register an event source, you need local administrator privileges. Make sure you open PowerShell with full administrator rights and use this line to add a new event source called "PowerShellScript" to the Application log:

```
PS> New-EventLog -LogName Application -Source PowerShellScript
```

Note that an event source must be unique and may not exist already in any other event log. To remove an event source, use *Remove-EventLog* with the same parameters as above, but be extremely careful. This cmdlet can wipe out entire event logs.

Once you have registered your event source, you are ready to log things to an event log. Logging (writing) event entries no longer necessarily requires administrative privileges. Since we added the event source to the Application log, anyone can now use it to log events. You could for example use this line inside of your logon scripts to log status information:

```
PS> Write-EventLog -LogName Application -Source PowerShellScript -EntryType Information
-EventId 123 -Message 'This is my first own event log entry'
```

You can now use *Get-EventLog* to read back your entries:

```
PS> Get-EventLog -LogName Application -Source PowerShellScript

Index       Time            EntryType       Source              InstanceID      Message
-----       ----            ---------       ------              ----------      -------
163833      Nov 14 10:47    Information     PowerShellScript    123             This is...
```

Or you can open the system dialog to view your new event entry that way:

```
PS> Show-EventLog
```

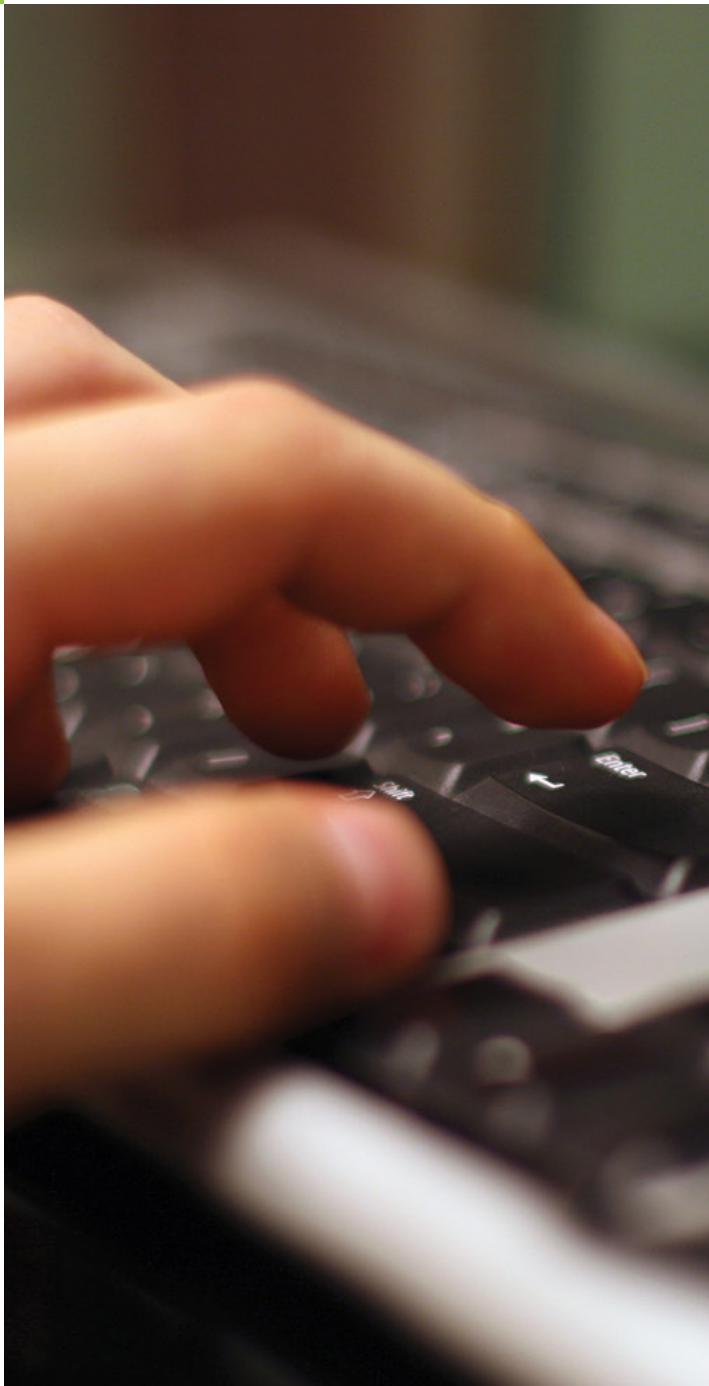
And of course you can remove your event source if this was just a test and you want to get rid of it again (but you do need administrator privileges again, just like when you created the event source):

```
PS> Remove-EventLog -Source PowerShellScript
```

Chapter 18.

WMI: Windows Management Instrumentation

Windows Management Instrumentation (WMI) is a technique available on all Windows systems starting with Windows 2000. WMI can provide you with a wealth of information about the Windows configuration and setup. It works both locally and remotely, and PowerShell makes accessing WMI a snap.



Topics Covered:

WMI Quick Start

To work with WMI you need to know just a little bit of theory. Let's check out what the terms "class" and "object" stand for.

A "class" pretty much is like the "kind of an animal". There are dogs, cats, horses, and each kind is a class. So there is always only one class of a kind.

An "object" works like an "animal", so there are zillions of real dogs, cats, and horses. So, there may be one, ten, thousands, or no objects (or "instances") of a class. Let's take the class "mammoth". There are no instances of this class these days.

WMI works the same. If you'd like to know something about a computer, you ask WMI about a class, and WMI returns the objects. When you ask for the class "Win32_BIOS", you get back exactly one instance (or object) because your computer has just one BIOS. When you ask for "Win32_Share", you get back a number of instances, one for each share. And when you ask for "Win32_TapeDrive", you get back nothing because most likely, your computer has no built-in tape drive. Tape drives thus work like mammoths in the real world. While there is a class ("kind"), there is no more instance.

Retrieving Information

How do you ask WMI for objects? It's easy! Just use the cmdlet Get-WmiObject. It accepts a class name and returns objects, just like the cmdlet name and its parameter suggest:

```
Get-WmiObject -Class Win32_BIOS

SMBIOSBIOSVersion    : RKYWSF21
Manufacturer         : Phoenix Technologies LTD
Name                 : Phoenix TrustedCore(tm) NB Release SP1 1.0
SerialNumber         : 701KIXB007922
Version              : PTLTD - 6040000
```

Exploring WMI Classes

As you can see, working with WMI does not require much knowledge. It does require though that you know the name of a WMI class that represents what you are after. Fortunately, Get-WmiObject can also work like a dictionary and look up WMI class names for you. This will get you all WMI class names that have the keyword "print" in them:

```
PS> Get-WmiObject -List Win32_*Print*

   NameSpace: ROOT\cimv2

Name                                Methods                      Properties
----                                -------                      ----------
Win32_PrinterConfiguration          {}                           {BitsPerPel, Captio...
Win32_PrinterSetting                {}                           {Element, Setting}
Win32_PrintJob                      {Pause, Resume}              {Caption, Color, Da...
Win32_Printer                       {SetPowerState, R...         {Attributes, Availa...
Win32_PrinterDriver                 {StartService, St...         {Caption, ConfigFil...
Win32_TCPIPPrinterPort              {}                           {ByteCount, Caption...
Win32_PrinterShare                  {}                           {Antecedent, Depend...
Win32_PrinterDriverDll              {}                           {Antecedent, Depend...
Win32_PrinterController             {}                           {AccessState, Antec...
```

Swallowing The Red Pill

By default, PowerShell limits the information WMI returns to you so you don't get carried away. It's pretty much like in the movie "The Matrix": you need to decide whether you want to swallow the blue pill and live in a simple world, or whether you dare to swallow the red pill and see the real world. By default, you live in the blue-pill-world with only limited information.

```
PS> Get-WmiObject -Class Win32_BIOS

SMBIOSBIOSVersion   : 02LV.MP00.20081121.hkk
Manufacturer        : Phoenix Technologies Ltd.
Name                : Phoenix SecureCore(tm) NB Version 02LV.MP00.20081121.hkk
SerialNumber        : ZAMA93HS600210
Version             : SECCSD - 6040000
```

To see the red-pill-world, pipe the results to Select-Object and ask it to show all available properties:

```
PS> Get-WmiObject -Class Win32_BIOS | Select-Object -Property *

Status                  : OK
Name                    : Phoenix SecureCore(tm) NB Version 02LV.MP00.20081121.hkk
Caption                 : Phoenix SecureCore(tm) NB Version 02LV.MP00.20081121.hkk
SMBIOSPresent           : True
__GENUS                 : 2
__CLASS                 : Win32_BIOS
__SUPERCLASS            : CIM_BIOSElement
__DYNASTY               : CIM_ManagedSystemElement
__RELPATH               : Win32_BIOS.Name="Phoenix SecureCore(tm) NB Version
                          02LV.MP00.20081121.hkk",SoftwareElementID="Phoenix
                          SecureCore(tm) NB Version 02LV.MP00.20081121.hkk",
                          SoftwareElementState=3,TargetOperatingSystem=0,
                          Version="SECCSD - 6040000"
__PROPERTY_COUNT        : 27
__DERIVATION            : {CIM_BIOSElement, CIM_SoftwareElement,
                          CIM_LogicalElement, CIM_ManagedSystemElement}
__SERVER                : DEMO5
__NAMESPACE             : root\cimv2
__PATH                  : \\DEMO5\root\cimv2:Win32_BIOS.Name="Phoenix
                          SecureCore(tm) NB Version
                          02LV.MP00.20081121.hkk",SoftwareElementID="Phoenix
                          SecureCore(tm) NB Version 02LV.MP00.20081121.hkk",
                          SoftwareElementState=3,TargetOperatingSystem=0,
                          Version="SECCSD - 6040000"
BiosCharacteristics     : {4, 7, 8, 9...}
BIOSVersion             : {SECCSD - 6040000, Phoenix SecureCore(tm) NB Version
                          02LV.MP00.20081121.hkk, Ver 1.00PARTTBL}
BuildNumber             :
CodeSet                 :
CurrentLanguage         :
Description             : Phoenix SecureCore(tm) NB Version
                          02LV.MP00.20081121.hkk
```

```
IdentificationCode       :
InstallableLanguages     :
InstallDate              :
LanguageEdition          :
ListOfLanguages          :
Manufacturer             : Phoenix Technologies Ltd.
OtherTargetOS            :
PrimaryBIOS              : True
ReleaseDate              : 20081121000000.000000+000
SerialNumber             : ZAMA93HS600210
SMBIOSBIOSVersion        : 02LV.MP00.20081121.hkk
SMBIOSMajorVersion       : 2
SMBIOSMinorVersion       : 5
SoftwareElementID        : Phoenix SecureCore(tm) NB Version 02LV.MP00.20081121.hkk
SoftwareElementState     : 3
TargetOperatingSystem    : 0
Version                  : SECCSD - 6040000
Scope                    : System.Management.ManagementScope
Path                     : \\DEMO5\root\cimv2:Win32_BIOS.Name="Phoenix
                           SecureCore(tm) NB Version
                           02LV.MP00.20081121.hkk",SoftwareElementID="Phoenix
                           SecureCore(tm) NB Version 02LV.MP00.20081121.hkk",
                           SoftwareElementState=3,TargetOperatingSystem=0,
                           Version="SECCSD - 6040000"
Options                  : System.Management.ObjectGetOptions
ClassPath                : \\DEMO5\root\cimv2:Win32_BIOS
Properties               : {BiosCharacteristics, BIOSVersion, BuildNumber, Caption...}
SystemProperties         : {__GENUS, __CLASS, __SUPERCLASS, __DYNASTY...}
Qualifiers               : {dynamic, Locale, provider, UUID}
Site                     :
Container                :
```

Once you see the real world, you can pick the properties you find interesting and then put together a custom selection. Note that PowerShell adds a couple of properties to the object which all start with "__". These properties are available on all WMI objects. __Server is especially useful because it always reports the name of the computer system the WMI object came from. Once you start retrieving WMI information remotely, you should always add __Server to the list of selected properties.

```
PS> Get-WmiObject Win32_BIOS | Select-Object __Server, Manufacturer, SerialNumber, Version

__SERVER                 Manufacturer              SerialNumber              Version
--------                 ------------              ------------              -------
DEMO5                    Phoenix Technolo...       ZAMA93HS600210            SECCSD - 6040000
```

Filtering WMI Results

Often, there are more instances of a class than you need. For example, when you query for Win32_NetworkAdapter, you get all kinds of network adapters, including virtual adapters and miniports.

PowerShell can filter WMI results client-side using Where-Object. So, to get only objects that have a MACAddress, you could use this line:

```
PS> Get-WmiObject Win32_NetworkAdapter | Where-Object { $_.MACAddress -ne $null } |
Select-Object Name, MACAddress, AdapterType

Name                              MACAddress                  AdapterType
----                              ----------                  -----------
Intel(R) 82567LM-Gigabi...        00:13:77:B9:F2:64           Ethernet 802.3
RAS Async Adapter                 20:41:53:59:4E:FF           Wide Area Network (WAN)
Intel(R) WiFi Link 5100...        00:22:FA:D9:E1:50           Ethernet 802.3
```

Client-side filtering is easy because it really just uses Where-Object to pick out those objects that fulfill a given condition. However, it is slightly inefficient as well. All WMI objects need to travel to your computer first before PowerShell can pick out the ones you want.

If you only expect a small number of objects and/or if you are retrieving objects from a local machine, there is no need to create more efficient code. If however you are using WMI remotely via network and/or have to deal with hundreds or even thousands of objects, you should instead use server-side filters.

These filters are transmitted to WMI along with your query, and WMI only returns the wanted objects in the first place. Since these filters are managed by WMI and not PowerShell, they use WMI syntax and not PowerShell syntax. Have a look:

```
PS> Get-WmiObject Win32_NetworkAdapter -Filter 'MACAddress != NULL' | Select-Object Name,
MACAddress, AdapterType

Name                              MACAddress                  AdapterType
----                              ----------                  -----------
Intel(R) 82567LM-Gigabi...        00:13:77:B9:F2:64           Ethernet 802.3
RAS Async Adapter                 20:41:53:59:4E:FF           Wide Area Network (WAN)
Intel(R) WiFi Link 5100...        00:22:FA:D9:E1:50           Ethernet 802.3
```

Simple filters like the one above are almost self-explanatory. WMI uses different operators ("!=" instead of "-ne" for inequality) and keywords ("NULL" instead of $null), but the general logic is the same.

Sometimes, however, WMI filters can be tricky. For example, to find all network cards that have an IP address assigned to them, in PowerShell (using client-side filtering) you would use:

```
PS> Get-WmiObject Win32_NetworkAdapterConfiguration | Where-Object { $_.IPAddress -ne $null }
| Select-Object Caption, IPAddress, MACAddress

Caption                          IPAddress                        MACAddress
----                             ----------                       -----------
[00000011] Intel(R) WiF...       {192.168.2.109, fe80::a...       00:22:FA:D9:E1:50
```

If you translated this to a server-side WMI filter, it fails:

```
PS> Get-WmiObject Win32_NetworkAdapterConfiguration -Filter 'IPAddress != NULL' | Select-Object
Caption, IPAddress, MACAddress
Get-WmiObject : Invalid query "select * from Win32_NetworkAdapterConfiguration where IPAddress
!= NULL"
```

The reason for this is the nature of the *IPAddress* property. When you look at the results from your client-side filtering, you'll notice that the column *IPAddress* has values in braces and displays more than one IP address. The property *IPAddress* is an array. WMI filters cannot check array contents.

So in this scenario, you would have to either stick to client-side filtering or search for another object property that is not an array and could still separate network cards with IP address from those without. There happens to be a property called *IPEnabled* that does just that:

```
PS> Get-WmiObject Win32_NetworkAdapterConfiguration -Filter 'IPEnabled = true' | Select-Object
Caption, IPAddress, MACAddress

Caption                         IPAddress                      MACAddress
-------                         ---------                      ----------
[00000011] Intel(R) WiF...      {192.168.2.109, fe80::a...     00:22:FA:D9:E1:50
```

A special WMI filter operator is "LIKE". It works almost like PowerShell's comparison operator -like. Use "%" instead of "*" for wildcards, though. So, to find all services with the keyword "net" in their name, try this:

```
PS> Get-WmiObject Win32_Service -Filter 'Name LIKE "%net%"' | Select-Object Name, DisplayName,
State

Name                            DisplayName                    State
----                            -----------                    -----
aspnet_state                    ASP.NET-Zustandsdienst         Stopped
Net Driver HPZ12                Net Driver HPZ12               Stopped
Netlogon                        Netlogon                       Running
Netman                          Network Connections            Running
NetMsmqActivator                Net.Msmq Listener Adapter      Stopped
NetPipeActivator                Net.Pipe Listener Adapter      Stopped
netprofm                        Network List Service           Running
NetTcpActivator                 Net.Tcp Listener Adapter       Stopped
NetTcpPortSharing               Net.Tcp Port Sharing Se...     Stopped
WMPNetworkSvc                   Windows Media Player Ne...     Running
```

Note

PowerShell supports the [*WmiSearcher*] type accelerator, which you can use to achieve basically the same thing you just did with the *–query* parameter:

```
$searcher = [WmiSearcher]"select caption,commandline from Win32_Process where name like 'p%'"
$searcher.Get()| Format-Table [a-z]* -Wrap
```

Direct WMI Object Access

Every WMI instance has its own unique path. This path is important if you want to access a particular instance directly. The path of a WMI object is located in the *__PATH* property. First use a "traditional" query to list this property and find out what it looks like:

```
Get-WmiObject Win32_Service | ForEach-Object { $_.__PATH }

\\JSMITH-PC\root\cimv2:Win32_Service.Name="AeLookupSvc"
```

```
\\JSMITH-PC\root\cimv2:Win32_Service.Name="AgereModemAudio"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="ALG"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="Appinfo"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="AppMgmt"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="Ati External Event Utility"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="AudioEndpointBuilder"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="Audiosrv"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="Automatic LiveUpdate - Scheduler"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="BFE"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="BITS"
\\JSMITH-PC\root\cimv2:Win32_Service.Name="Browser"
(...)
```

The path consists basically of the class name as well as one or more key properties. For services, the key property is *Name* and is the English-language name of the service. If you want to work directly with a particular service through WMI, specify its path and do a type conversion. Use either the [*wmi*] type accelerator or the underlying [*System.Management.ManagementObject*] .NET type:

```
[wmi]"Win32_Service.Name='Fax'"

ExitCode        : 1077
Name            : Fax
ProcessId       : 0
StartMode       : Manual
State           : Stopped
Status          : OK
```

In fact, you don't necessarily need to specify the name of the key property as long as you at least specify its value. This way, you'll find all the properties of a specific WMI instance right away.

```
$disk = [wmi]'Win32_LogicalDisk="C:"'
$disk.FreeSpace
10181373952
[int]($disk.FreeSpace / 1MB)
9710
$disk | Format-List [a-z]*

Status                        :
Availability                  :
DeviceID                      : C:
StatusInfo                    :
Access                        : 0
BlockSize                     :
Caption                       : C:
Compressed                    : False
ConfigManagerErrorCode        :
ConfigManagerUserConfig       :
CreationClassName             : Win32_LogicalDisk
```

```
Description                   : Local hard drive
DriveType                     : 3
ErrorCleared                  :
ErrorDescription              :
ErrorMethodology              :
FileSystem                    : NTFS
FreeSpace                     : 10181373952
InstallDate                   :
LastErrorCode                 :
MaximumComponentLength        : 255
MediaType                     : 12
Name                          : C:
NumberOfBlocks                :
PNPDeviceID                   :
PowerManagementCapabilities   :
PowerManagementSupported      :
ProviderName                  :
Purpose                       :
QuotasDisabled                :
QuotasIncomplete              :
QuotasRebuilding              :
Size                          : 100944637952
SupportsDiskQuotas            : False
SupportsFileBasedCompression  : True
SystemCreationClassName       : Win32_ComputerSystem
SystemName                    : JSMITH-PC
VolumeDirty                   :
VolumeName                    :
VolumeSerialNumber            : AC039C05
```

Changing System Configuration

WMIs primary purpose is to read information about the current system configuration but it can also be used to make changes to a system. Most WMI object properties are read-only, but some are writeable, too. In addition, a number of WMI objects contain methods that you can call to make changes.

Note that WMI objects returned by PowerShell Remoting always are read-only. They cannot be used to change the remote system. If you want to change a remote system using WMI objects, you must connect to the remote system using the -*ComputerName* parameter provided by *Get-WmiObject*.

Modifying Properties

Most of the properties that you find in WMI objects are read-only. There are few, though, that can be modified. For example, if you want to change the description of a drive, add new text to the *VolumeName* property of the drive:

```
$drive = [wmi]"Win32_LogicalDisk='C:'"
$drive.VolumeName = "My Harddrive"
$drive.Put()

Path                    : \\.\root\cimv2:Win32_LogicalDisk.DeviceID="C:"
RelativePath            : Win32_LogicalDisk.DeviceID="C:"
Server                  : .
NamespacePath           : root\cimv2
ClassName               : Win32_LogicalDisk
IsClass                 : False
IsInstance              : True
IsSingleton             : False
```

Three conditions must be met before you can modify a property:

- The property must be writeable. Most properties are read-only.
- You require the proper permissions for modifications. The drive description applies to all users of a computer so only administrators may modify them.
- You must use *Put()* to save the modification. Without *Put()*, the modification will not be written back to the system.

Invoking WMI Methods

WMI objects derived from the *Win32_Process* class have a *Terminate()* method you can use to terminate a process. Of course it is much easier to terminate a process with *Stop-Process*, so why would you use WMI? Because WMI supports remote connections. Stop-Process can only stop processes on your local machine.

This line would kill all instances of the Windows Editor "notepad.exe" on your local machine:

```
Get-WmiObject Win32_Process -Filter "name='notepad.exe'" | ForEach-Object { $_.Terminate()
.ReturnValue }
```

Add the parameter -*ComputerName* to *Get-WmiObject*, and you'd be able to kill notepads on one or more remote machines - provided you have Administrator privileges on the remote machine.

For every instance that *Terminate()* closes, it returns an object with a number of properties. Only the property *ReturnValue* is useful, though, because it tells you whether the call succeeded. That's why it is generally a good idea to add ".ReturnValue" to all calls of a WMI method. A return value of 0 generally indicates success, any other code failure. To find out what the error codes mean you would have to surf to an Internet search engine and enter the WMI class name (like "Win32_Process"). One of the first links will guide you to the Microsoft MSDN documentation page for that class. It lists all codes and clear text translations for all properties and method calls.

Tip

If you already know the process ID of a process, you can work on the process directly just as you did in the last section because the process ID is the key property of processes. For example, you could terminate the process with the ID 1234 like this:

```
([wmi]"Win32_Process='1234'").Terminate()
```

If you'd rather check your hard disk drive C:\ for errors, the proper invocation is:

```
([wmi]"Win32_LogicalDisk='C:'").Chkdsk(...
```

However, since this method requires additional arguments, the question here is what you should specify. Invoke the method without parentheses in order to get initial brief instructions:

```
([wmi]"Win32_LogicalDisk='C:'").Chkdsk

MemberType              : Method
OverloadDefinitions     : {System.Management.ManagementBaseObject Chkdsk(System.Boolean FixErrors,
                          System.BooleanVigorousIndexCheck, System.Boolean SkipFolderCycle,
                          System.Boolean ForceDismount, System.Boolean RecoverBadSectors,
                          System.Boolean OkToRunAtBootUp)}
TypeNameOfValue         : System.Management.Automation.PSMethod
Value                   : System.Management.ManagementBaseObject Chkdsk(System.Boolean FixErrors,
                          System.BooleanVigorousIndexCheck, System.Boolean SkipFolderCycle,
                          System.Boolean ForceDismount, System.Boolean RecoverBadSectors,
                          System.Boolean OkToRunAtBootUp)
Name                    : Chkdsk
IsInstance              : True
```

Get-Member will tell you which methods a WMI object supports:

```
PS> Get-WmiObject Win32_Process | Get-Member -MemberType Method
    TypeName: System.Management.ManagementObject#root\cimv2\Win32_Process

Name                 MemberType      Definition
----                 ----------      ----------
AttachDebugger       Method          System.Management.ManagementBaseObject AttachDebugger()
GetOwner             Method          System.Management.ManagementBaseObject GetOwner()
GetOwnerSid          Method          System.Management.ManagementBaseObject GetOwnerSid()
SetPriority          Method          System.Management.ManagementBaseObject SetPriority(System.
                                     Int32 Priority)
Terminate            Method          System.Management.ManagementBaseObject Terminate(System.
                                     UInt32 Reason)
```

Static Methods

There are WMI methods not just in WMI objects that you retrieved with Get-WmiObject. Some WMI classes also support methods. These methods are called "static".

If you want to renew the IP addresses of all network cards, use the *Win32_NetworkAdapterConfiguration* class and its static method *RenewDHCPLeaseAll():*

```
([wmiclass]"Win32_NetworkAdapterConfiguration").RenewDHCPLeaseAll().ReturnValue
```

You get the WMI class by using type conversion. You can either use the [*wmiclass*] type accelerator or the underlying [*System.Management.ManagementClass*].

The methods of a WMI class are also documented in detail inside WMI. For example, you get the description of the *Win32Shutdown()* method of the *Win32_OperatingSystem* class like this:

```
$class = [wmiclass]'Win32_OperatingSystem'
$class.Options.UseAmendedQualifiers = $true
(($class.methods["Win32Shutdown"]).Qualifiers["Description"]).Value
```

```
The Win32Shutdown method provides the full set of shutdown options supported by Win32 operating
systems. The method returns an integer value that can be interpretted as follows:
0 - Successful completion.
Other - For integer values other than those listed above, refer to Win32 error code
documentation.
```

If you'd like to learn more about a WMI class or a method, navigate to an Internet search page like Google and specify as keyword the WMI class name, as well as the method. It's best to limit your search to the Microsoft MSDN pages: *Win32_NetworkAdapterConfiguration RenewDHCPLeaseAll site:msdn2.microsoft.com.*

Using WMI Auto-Documentation

Nearly every WMI class has a built-in description that explains its purpose. You can view this description only if you first set a hidden option called *UseAmendedQualifiers* to *$true*. Once that's done, the WMI class will readily supply information about its function:

```
$class = [wmiclass]'Win32_LogicalDisk'
$class.psbase.Options.UseAmendedQualifiers = $true
($class.psbase.qualifiers["description"]).Value
The Win32_LogicalDisk class represents a data source that resolves to an actual local storage
device on a Win32 system. The class returns both local as well as mapped logical disks.
However, the recommended approach is to use this class for obtaining information on local
disks and to use the Win32_MappedLogicalDisk for information on mapped logical disk.
```

In a similarly way, all the properties of the class are documented. The next example retrieves the documentation for the property *VolumeDirty* and explains what its purpose is:

```
$class = [wmiclass]'Win32_LogicalDisk'
$class.psbase.Options.UseAmendedQualifiers = $true
($class.psbase.properties["VolumeDirty"]).Type
Boolean
(($class.psbase.properties["VolumeDirty"]).Qualifiers["Description"]).Value
The VolumeDirty property indicates whether the disk requires chkdsk to be run at next boot up
time. The property is applicable to only those instances of logical disk that represent a
physical disk in the machine. It is not applicable to mapped logical drives.
```

WMI Events

WMI returns not only information but can also wait for certain events. If the events occur, an action will be started. In the process, WMI can alert you when one of the following things involving a WMI instance happens:

- **__InstanceCreationEvent:** A new instance was added such as a new process was started or a new file created.
- **__InstanceModificationEvent:** The properties of an instance changed. For example, the FreeSpace property of a drive was modified.
- **__InstanceDeletionEvent:** An instance was deleted, such as a program was shut down or a file deleted.
- **__InstanceOperationEvent:** This is triggered in all three cases.

You can use these to set up an alarm signal. For example, if you want to be informed as soon as Notepad is started, type:

*Select * from __InstanceCreationEvent WITHIN 1 WHERE targetinstance ISA 'Win32_Process' AND targetinstance.name = 'notepad.exe'*

WITHIN specifies the time interval of the inspection and “WITHIN 1” means that you want to be informed no later than one second after the event occurs. The shorter you set the interval, the more effort involved, which means that WMI will require commensurately more computing power to perform your task. As long as the interval is kept at not less than one second, the computation effort will be scarcely perceptible. Here is an example:

```
$alarm = New-Object Management.EventQuery
$alarm.QueryString = "Select * from __InstanceCreationEvent WITHIN 1 WHERE targetinstance ISA
'Win32_Process' AND targetinstance.name = 'notepad.exe'"
$watch = New-Object Management.ManagementEventWatcher $alarm

"Start Notepad after issuing a wait command:"
$result = $watch.WaitForNextEvent()

"Get target instance of Notepad:"
$result.targetinstance

"Access the live instance:"
$path = $result.targetinstance.__path
$live = [wmi]$path

# Close Notepad using the live instance
$live.terminate()
```

Using WMI Remotely

WMI comes with built-in remoting so you can retrieve WMI objects not just from your local machine but also across the network. WMI uses "traditional" remoting techniques like DCOM which are also used by the Microsoft Management Consoles.

To be able to use WMI remoting, your network must support DCOM calls (thus, the firewall needs to be set up accordingly). Also, you need to have Administrator privileges on the target machine.

Accessing WMI Objects on Another Computer

Use the -*ComputerName* parameter of *Get-WmiObject* to access another computer system using WMI. Then specify the name of the computer after it:

```
Get-WmiObject -ComputerName pc023 Win32_Process
```

You can also specify a comma-separated list of a number of computers and return information from all of them. The parameter -*ComputerName* accepts an array of computer names. Anything that returns an array of computer names or IP addresses can be valid input. This line, for example, would read computer names from a file:

```
Get-WmiObject Win32_Process -ComputerName (Get-Content c:\serverlist.txt)
```

If you want to log on to the target system using another user account, use the –*Credential* parameter to specify additional log on data as in this example:

```
$credential = Get-Credential
Get-WmiObject -ComputerName pc023 -Credential $credential Win32_Process
```

In addition to the built-in remoting capabilities, you can use Get-WmiObject via PowerShell Remoting (if you have set up PowerShell Remoting correctly). Here, you send the WMI command off to the remote system:

```
Invoke-Command { Get-WmiObject Win32_BIOS } -ComputerName server12, server16
```

Note that all objects returned by PowerShell Remoting are read-only and do not contain methods anymore. If you want to change WMI properties or call WMI methods, you need to do this inside the script block you send to the remote system - so it needs to be done before PowerShell Remoting sends back objects to your own system.

WMI Background Information

WMI has a hierarchical structure much like a file system does. Up to now, all the classes that you have used have come from the WMI "directory" *root\cimv2*. Third-party vendors can create additional WMI directories, known as *Namespaces*, and put in them their own classes, which you can use to control software, like Microsoft Office or hardware like switches and other equipment.

Because the topmost directory in WMI is always named *root*, from its location you can inspect existing namespaces. Get a display first of the namespaces on this level:

```
Get-WmiObject -Namespace root __Namespace | Format-Wide Name

subscription                       DEFAULT
MicrosoftDfs                       CIMV2
Cli                                nap
SECURITY                           RSOP
Infineon                           WMI
directory                          Policy
ServiceModel                       SecurityCenter
MSAPPS12                           Microsoft
aspnet
```

As you see, the *cimv2* directory is only one of them. What other directories are shown here depends on the software and hardware that you use. For example, if you use Microsoft Office, you may find a directory called *MSAPPS12*. Take a look at the classes in it:

```
Get-WmiObject -Namespace root\msapps12 -List | Where-Object { $_.Name.StartsWith("Win32_") }

Win32_PowerPoint12Tables                   Win32_Publisher12PageNumber
Win32_Publisher12Hyperlink                 Win32_PowerPointSummary
Win32_Word12Fonts                          Win32_PowerPointActivePresentation
Win32_OutlookDefaultFileLocation           Win32_Word12Document
```

```
Win32_ExcelAddIns
Win32_ADOCoreComponents
Win32_Word12CharacterStyle
Win32_OutlookSummary
Win32_WordComAddins
Win32_OutlookComAddins
Win32_Word12Settings
Win32_OdbcDriver
Win32_Word12StartupFileLocation
Win32_FrontPagePageProperty
Win32_Language
Win32_Word12PageSetup
Win32_ServerExtension
Win32_Word12Addin
Win32_PowerPoint12PageNumber
Win32_Publisher12Fonts
Win32_OutlookAlternateStartupFile
Win32_Access12ComAddins
Win32_Word12FileConverters
Win32_Word12ParagraphStyle
Win32_Excel12StartupFolder
Win32_FrontPageWebProperty
Win32_Publisher12StartupFolder
Win32_ExcelSheet
Win32_FrontPageTheme
Win32_Word12Template
Win32_Access12AlternateStartupFileLoc
Win32_PublisherSummary
Win32_Word12Field
Win32_PowerPoint12ComAddin
Win32_PowerPoint12DefaultFileLoc
Win32_OutlookStartupFolder
Win32_Word12ActiveDocumentNotable
Win32_Word12Hyperlinks
Win32_Word12FileConverter
Win32_FrontPageActivePage
Win32_OleDbProvider
Win32_Word12SelectedTable
Win32_OdbcCoreComponent
Win32_FrontPageSummary
Win32_Word12Hyperlink
Win32_Publisher12Font
Win32_AccessDatabase
Win32_Publisher12ActiveDocument
Win32_PowerPoint12Fonts
Win32_PowerPoint12Table
Win32_Publisher12SelectedTable
Win32_Word12Styles
Win32_Word12DefaultFileLocation
Win32_PowerPoint12AlternateStartupLoc
Win32_ExcelCharts
Win32_FrontPageActiveWeb
Win32_AccessProject
Win32_ExcelActiveWorkbook
Win32_Publisher12MailMerge
Win32_FrontPageAddIns
Win32_Word12HeaderAndFooter
Win32_Publisher12ActiveDocumentNoTable
Win32_WordComAddin
Win32_JetCoreComponents
Win32_Word12Table
Win32_Word12Tables
Win32_Excel12AlternateStartupFileLoc
Win32_Access12StartupFolder
Win32_Access12ComAddin
Win32_PowerPointPresentation
Win32_Publisher12Table
Win32_WebConnectionErrorText
Win32_Publisher12Tables
Win32_PowerPoint12ComAddins
Win32_ExcelComAddins
Win32_Word12ActiveDocument
Win32_Publisher12DefaultFileLocation
Win32_Publisher12Hyperlinks
Win32_PowerPoint12Hyperlink
Win32_Publisher12Sections
Win32_Access12JetComponents
Win32_Publisher12CharacterStyle
Win32_Word12MailMerge
Win32_PowerPoint12Hyperlinks
Win32_Word12Summary
Win32_Publisher12PageSetup
Win32_PowerPoint12StartupFolder
Win32_PowerPoint12PageSetup
Win32_AccessSummary
Win32_OfficeWatsonLog
Win32_WebConnectionErrorMessage
Win32_Publisher12Styles
Win32_Word12AlternateStartupFileLocation
Win32_Word12Sections
```

```
Win32_ExcelComAddin                       Win32_Excel12DefaultFileLoc
Win32_Word12Fields                        Win32_ExcelActiveWorkbookNotable
Win32_Publisher12COMAddIn                 Win32_ExcelWorkbook
Win32_OutlookComAddin                     Win32_PowerPoint12Font
Win32_FrontPageAddIn                      Win32_ExcelChart
Win32_WebConnectionError                  Win32_Word12Font
Win32_RDOCoreComponents                   Win32_Word12PageNumber
Win32_Publisher12ParagraphStyle           Win32_Publisher12COMAddIns
Win32_Transport                           Win32_Access12DefaultFileLoc
Win32_FrontPageThemes                     Win32_ExcelSummary
Win32_ExcelAddIn                          Win32_Publisher12AlternateStartupFileLocation
Win32_PowerPoint12SelectedTable
```

Converting the WMI Date Format

WMI uses special date formats. For example, look at *Win32_OperatingSystem* objects:

```
Get-WmiObject Win32_OperatingSystem | Format-List *time*

CurrentTimeZone     : 120
LastBootUpTime      : 20111016085609.375199+120
LocalDateTime       : 20111016153922.498000+120
```

The date and time are represented a sequence of numbers: first the year, then the month, and finally the day. Following this is the time in hours, minutes, and milliseconds, and then the time zone. This is the so-called *DMTF standard,* which is hard to read. However, you can use *ToDateTime()* of the *ManagementDateTimeConverter* .NET class to decipher this cryptic format:

```
$boottime = (Get-WmiObject win32_OperatingSystem).LastBootUpTime
$boottime
20111016085609.375199+120
$realtime = [System.Management.ManagementDateTimeConverter]::ToDateTime($boottime)
$realtime
Tuesday, October 16, 2011 8:56:09 AM
```

Now you can also use standard date and time cmdlets such as *New-TimeSpan* to calculate the current system uptime:

```
New-TimeSpan $realtime (Get-Date)

Days              : 0
Hours             : 6
Minutes           : 47
Seconds           : 9
Milliseconds      : 762
Ticks             : 244297628189
TotalDays         : 0.282751884478009
TotalHours        : 6.78604522747222
TotalMinutes      : 407.162713648333
TotalSeconds      : 24429.7628189
TotalMilliseconds : 24429762.8189
```

Chapter 19. User Management

User administration in the Active Directory was a dark spot in PowerShell Version 1. Microsoft did not ship any cmdlets to manage AD user accounts or other aspects in Active Directory. That's why the 3rd party vendor Quest stepped in and published a free PowerShell Snap-In with many useful AD cmdlets. Over the years, this extension has grown to become a de-facto standard, and many

Topics Covered:

PowerShell scripts use Quest AD cmdlets. You can freely download this extension from the Quest website.
Beginning with PowerShell Version 2.0, Microsoft finally shipped their own AD management cmdlets. They are included with Server 2008 R2 and also available for download as "RSAT tools (remote server administration toolkit). The AD cmdlets are part of a module called "ActiveDirectory". This module is installed by default when you enable the Domain Controller role on a server. On a member server or client with installed RSAT tools, you have to go to control panel and enable that feature first.

This chapter is not talking about either one of these extensions. It is introducing you to the build-in low level support for ADSI methods. They are the beef that makes these two extensions work and can be called directly, as well.

Don't get me wrong: if you work a lot with the AD, it is much easier for you to get one of the mentioned AD extensions and use cmdlets for your tasks. If you (or your scripts) just need to get a user, change some attributes or determine group membership details, it can be easier to use the direct .NET framework methods shown in this chapter. They do not introduce dependencies: your script runs without the need to either install the Quest toolkit or the RSAT tools.

Connecting to a Domain

If your computer is a member of a domain, the first step in managing users is to connect to a log-on domain. You can set up a connection like this:

```
$domain = [ADSI]""
$domain
distinguishedName
-----------------
{DC=scriptinternals,DC=technet}
```

If your computer isn't a member of a domain, the connection setup will fail and generate an error message:

out-lineoutput : Exception retrieving member "ClassId2e4f51ef21dd47e99d3c952918aff9cd":
"The specified domain either does not exist or could not be contacted."

Note

If you want to manage local user accounts and groups, instead of LDAP: use the *WinNT*: moniker. But watch out: the text is case-sensitive here. For example, you can access the local administrator account like this:

```
$user = [ADSI]"WinNT://./Administrator,user"
$user | Select-Object *
```

We won't go into local user accounts in any more detail in the following examples. If you must manage local users, also look at net.exe. It provides easy to use options to manage local users and groups.

Logging On Under Other User Names

[*ADSI*] is a shortcut to the *DirectoryServices.DirectoryEntry* .NET type. That's why you could have set up the previous connection this way as well:

```
$domain = [DirectoryServices.DirectoryEntry]""
$domain
distinguishedName
-----------------
{DC=scriptinternals,DC=technet}
```

This is important to know when you want to log on under a different identity. The [*ADSI*] type accelerator always logs you on using your current identity. Only the underlying *DirectoryServices.DirectoryEntry* .NET type gives you the option of logging on with another identity. But why would anyone want to do something like that? Here are a few reasons:

- **External consultant:** You may be visiting a company as an external consultant and have brought along your own notebook computer, which isn't a member of the company domain. This prevents you from setting up a connection to the company domain. But if you have a valid user account along with its password at your disposal, you can use your notebook and this identity to access the company domain. Your notebook doesn't have to be a domain member to access the domain.
- **Several domains:** Your company has several domains and you want to manage one of them, but it isn't your log-on domain. More likely than not, you'll have to log on to the new domain with an identity known to it.

Logging onto a domain that isn't your own with another identity works like this:

```
$domain = new-object DirectoryServices.DirectoryEntry("LDAP://10.10.10.1","domain\user", `
"secret")
$domain.name
scriptinternals
$domain.distinguishedName
DC=scriptinternals,DC=technet
```

Note

Two things are important for ADSI paths: first, their names are case-sensitive. That's why the two following approaches are wrong:

```
$domain = [ADSI]"ldap://10.10.10.1" # Wrong!
$useraccount = [ADSI]"Winnt://./Administrator,user" # Wrong!
```

Second, surprisingly enough, ADSI paths use a normal slash. A backslash like the one commonly used in the file system would generate error messages:

```
$domain = [ADSI]"LDAP:\\10.10.10.1" # Wrong!
$useraccount = [ADSI]"WinNT:\\.\Administrator,user" # Wrong!
```

If you don't want to put log-on data in plain text in your code, use *Get-Credential*.

Since the password has to be given when logging on in plain text, and *Get-Credential* returns the password in encrypted form, an intermediate step is required in which it is converted into plain text:

```
$cred = Get-Credential
$pwd = [Runtime.InteropServices.Marshal]::PtrToStringAuto(
[Runtime.InteropServices.Marshal]::SecureStringToBSTR( $cred.Password ))
$domain = new-object DirectoryServices.DirectoryEntry("LDAP://10.10.10.1",$cred.UserName,
$pwd)
$domain.name
scriptinternals
```

Tip

Log-on errors are initially invisible. PowerShell reports errors only when you try to connect with a domain. This procedure is known as "binding." Calling the *$domain.Name* property won't cause any errors because when the connection fails, there isn't even any property called *Name* in the object in *$domain.*

So, how can you find out whether a connection was successful or not? Just invoke the *Bind()* method, which does the binding. *Bind()* always throws an exception and *Trap* can capture this error.

The code called by *Bind()* must be in its own scriptblock, which means it must be enclosed in brackets. If an error occurs in the block, PowerShell will cut off the block and execute the *Trap* code, where the error will be stored in a variable.

This is created using *script:* so that the rest of the script can use the variable.

Then If verifies whether an error occurred. A connection error always exists if the exception thrown by *Bind()* has the -2147352570 error code. In this event, If outputs the text of the error message and stops further instructions from running by using Break.

```
$cred = Get-Credential
$pwd = [Runtime.InteropServices.Marshal]::PtrToStringAuto(
[Runtime.InteropServices.Marshal]::SecureStringToBSTR( $cred.Password ))
$domain = new-object DirectoryServices.DirectoryEntry("LDAP://10.10.10.1",$cred.UserName, $pwd)
trap { $script:err = $_ ; continue } &{ $domain.Bind($true); $script:err = $null }
if ($err.Exception.ErrorCode -ne -2147352570)
{
  Write-Host -Fore Red $err.Exception.Message
  break
}
else
{
  Write-Host -Fore Green "Connection established."
}
Logon failure: unknown user name or bad password.
```

By the way, the error code -2147352570 means that although the connection was established, *Bind()* didn't find an object to which it could bind itself. That's OK because you didn't specify any particular object in your LDAP path when the connection was being set up.

Accessing a Container

Domains have a hierarchical structure like the file system directory structure. Containers inside the domain are either pre-defined directories or subsequently created organizational units. If you want to access a container, specify the LDAP path to the container. For example, if you want to access the pre-defined directory Users, you could access like this:

```
$ldap = "/CN=Users,DC=scriptinternals,DC=technet"
$cred = Get-Credential
$pwd = [Runtime.InteropServices.Marshal]::PtrToStringAuto(
[Runtime.InteropServices.Marshal]::SecureStringToBSTR( $cred.Password ))
$users = new-object
DirectoryServices.DirectoryEntry("LDAP://10.10.10.1$ldap",$cred.UserName, $pwd)
$users
distinguishedName
-----------------
{CN=Users,DC=scriptinternals,DC=technet}
```

The fact that you are logged on as a domain member naturally simplifies the procedure considerably because now you need neither the IP address of the domain controller nor log-on data. The LDAP name of the domain is also returned to you by the domain itself in the *distinguishedName* property. All you have to do is specify the container that you want to visit:

```
$ldap = "CN=Users"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$users = [ADSI]"LDAP://$ldap,$dn"
$users
```

While in the LDAP language pre-defined containers use names including *CN=*, specify *OU=* for organizational units. So, when you log on as a user to connect to the sales OU, which is located in the company OU, you should type:

```
$ldap = "OU=sales, OU=company"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$users = [ADSI]"LDAP://$ldap,$dn"
$users
```

Listing Container Contents

At some point, you'd like to know who or what the container contains to which you have set up a connection. The approach here is somewhat less intuitive because now you need the *PSBase* object. PowerShell wraps Active Directory objects and adds new properties and methods while removing others.

Unfortunately, PowerShell also in the process gets rid of the necessary means to get to the contents of a container. *PSBase* returns the original (raw) object just like PowerShell received it before conversion, and this object knows the *Children* property:

```
$ldap = "CN=Users"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$users = [ADSI]"LDAP://$ldap,$dn"
$users.PSBase.Children

distinguishedName
-----------------
{CN=admin,CN=Users,DC=scriptinternals,DC=technet}
{CN=Administrator,CN=Users,DC=scriptinternals,DC=technet}
{CN=All,CN=Users,DC=scriptinternals,DC=technet}
{CN=ASPNET,CN=Users,DC=scriptinternals,DC=technet}
{CN=Belle,CN=Users,DC=scriptinternals,DC=technet}
{CN=Consultation2,CN=Users,DC=scriptinternals,DC=technet}
{CN=Consultation3,CN=Users,DC=scriptinternals,DC=technet}
{CN=ceimler,CN=Users,DC=scriptinternals,DC=technet}
(...)
```

Accessing Individual Users or Groups

There are various ways to access individual users or groups. For example, you can filter the contents of a container. You can also specifically select individual items from a container or access them directly through their LDAP path. And you can search for items across directories.

Using Filters and the Pipeline

Children gets back fully structured objects that, as shown in Chapter 5, you can process further in the PowerShell pipeline. Among other things, if you want to list only users, not groups, you could query the *sAMAccountType* property and use it as a filter criterion:

```
$ldap = "CN=Users"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$users = [ADSI]"LDAP://$ldap,$dn"
$users.PSBase.Children | Where-Object { $_.sAMAccountType -eq 805306368 }
```

Another approach makes use of the class that you can always find in the *objectClass* property.

```
$users.PSBase.Children | Select-Object -first 1 |
ForEach-Object { $_.sAMAccountName + $_.objectClass }
admin
top
person
organizationalPerson
user
```

As it happens, the *objectClass* property contains an array with all the classes from which the object is derived. The listing process proceeds from the general to the specific so you can find only those elements that are derived from the *user* class:

```
$users.PSBase.Children | Where-Object { $_.objectClass -contains "user" }
distinguishedName
-----------------
{CN=admin,CN=Users,DC=scriptinternals,DC=technet}
{CN=Administrator,CN=Users,DC=scriptinternals,DC=technet}
{CN=ASPNET,CN=Users,DC=scriptinternals,DC=technet}
{CN=Belle,CN=Users,DC=scriptinternals,DC=technet}
(...)
```

Directly Accessing Elements

If you know the ADSI path to a particular object, you don't have to resort to a circuitous approach but can access it directly through the pipeline filter. You can find the path of an object in the *distinguishedName* property:

```
$users.PSBase.Children | Format-Table sAMAccountName, distinguishedName -wrap

sAMAccountName          distinguishedName
--------------          -----------------
{admin}                 {CN=admin,CN=Users,DC=scriptinternals,DC=technet}
{Administrator}         {CN=Administrator,CN=Users,DC=scriptinternals,DC=technet}
{All}                   {CN=All,CN=Users,DC=scriptinternals,DC=technet}
{ASPNET}                {CN=ASPNET,CN=Users,DC=scriptinternals,DC=technet}
{Belle}                 {CN=Belle,CN=Users,DC=scriptinternals,DC=technet}
```

```
{consultation2}          {CN=consultation2,CN=Users,DC=scriptinternals,DC=technet}
{consultation3}          {CN=consultation3,CN=Users,DC=scriptinternals,DC=technet}
(...)
```

For example, if you want to access the Guest account directly, specify its *distinguishedName*. If you're a domain member, you don't have to go to the trouble of using the *distinguishedName* of the domain:

```
$ldap = "CN=Guest,CN=Users"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$guest = [ADSI]"LDAP://$ldap,$dn"
$guest | Format-List *

objectClass              : {top, person, organizationalPerson, user}
cn                       : {Guest}
description              : {Predefined account for guest access to the computer or domain)
distinguishedName        : {CN=Guest,CN=Users,DC=scriptinternals,DC=technet}
instanceType             : {4}
whenCreated              : {12.11.2005 12:31:31 PM}
whenChanged              : {06.27.2006 09:59:59 AM}
uSNCreated               : {System.__ComObject}
memberOf                 : {CN=Guests,CN=Builtin,DC=scriptinternals,DC=technet}
uSNChanged               : {System.__ComObject}
name                     : {Guest}
objectGUID               : {240 255 168 180 1 206 85 73 179 24 192 164 100 28 221 74}
userAccountControl       : {66080}
badPwdCount              : {0}
codePage                 : {0}
countryCode              : {0}
badPasswordTime          : {System.__ComObject}
lastLogoff               : {System.__ComObject}
lastLogon                : {System.__ComObject}
logonHours               : {255 255 255 255 255 255 255 255 255 255 255 255 255 255 255 255 255
                           255 255 255 255}
pwdLastSet               : {System.__ComObject}
primaryGroupID           : {514}
objectSid                : {1 5 0 0 0 0 0 5 21 0 0 0 184 88 34 189 250 183 7 172 165 75 78 29
                           245 1 0 0}
accountExpires           : {System.__ComObject}
logonCount               : {0}
sAMAccountName           : {Guest}
sAMAccountType           : {805306368}
objectCategory           : {CN=Person,CN=Schema,CN=Configuration,DC=scriptinternals,DC=technet}
isCriticalSystemObject   : {True}
nTSecurityDescriptor     : {System.__ComObject}
```

Using the asterisk as wildcard character, *Format-List* makes all the properties of an ADSI object visible so that you can easily see which information is contained in it and under which names.

Obtaining Elements from a Container

You already know what to use to read out all the elements in a container: *PSBase.Children.* However, by using *PSBase.Find()* you can also retrieve individual elements from a container:

```
$domain = [ADSI]""
$users = $domain.psbase.Children.Find("CN=Users")
$useraccount = $users.psbase.Children.Find("CN=Administrator")
$useraccount.Description
Predefined account for managing the computer or domain.
```

Searching for Elements

You've had to know exactly where in the hierarchy of domain a particular element is stored to access it. In larger domains, it can be really difficult to relocate a particular user account or group. That's why a domain can be accessed and searched like a database.

Once you have logged on to a domain that you want to search, you need only the following few lines to find all of the user accounts that match the user name in *$UserName*. Wildcard characters are allowed:

```
$UserName = "*mini*"
$searcher = new-object DirectoryServices.DirectorySearcher([ADSI]"")
$searcher.filter = "(&(objectClass=user)(sAMAccountName= $UserName))"
$searcher.findall()
```

If you haven't logged onto the domain that you want to search, get the domain object through the log-on:

```
$domain = new-object
DirectoryServices.DirectoryEntry("LDAP://10.10.10.1","domain\user","secret")
$UserName = "*mini*"
$searcher = new-object DirectoryServices.DirectorySearcher($domain)
$searcher.filter = "(&(objectClass=user)(sAMAccountName= $UserName))"
$searcher.findall() | Format-Table -wrap
```

The results of the search are all the objects that contain the string "mini" in their names, no matter where they're located in the domain:

```
Path                                                                     Properties
----                                                                     ----------
LDAP://10.10.10.1/CN=Administrator,CN=Users,DC=scripti {samaccounttype,      whencreated...}
lastlogon, objectsid, nternals,DC=technet
```

The crucial part takes place in the search filter, which looks a bit strange in this example:

```
$searcher.filter = "(&(objectClass=user)(sAMAccountName= $UserName))"
```

The filter merely compares certain properties of elements according to certain requirements. It checks accordingly whether the term user turns up in the *objectClass* property and whether the *sAMAccountName* property matches the specified user name. Both criteria are combined by the "&" character, so they both have to be met. This would enable you to assemble a convenient search function.

Note

The search function *Get-LDAPUser* searches the current log-on domain by default. If you want to log on to another domain, note the appropriate lines in the function and specify your log-on data.

```
function Get-LDAPUser([string]$UserName, [string]$Start)
{
# Use current logon domain:
$domain = [ADSI]""
# OR: log on to another domain:
# $domain = new-object DirectoryServices.DirectoryEntry("LDAP://10.10.10.1","domain\user",
# "secret")
if ($start -ne "")
{
  $startelement = $domain.psbase.Children.Find($start)
}
else
{
  $startelement = $domain
}
$searcher = new-object DirectoryServices.DirectorySearcher($startelement)
$searcher.filter = "(&(objectClass=user)(sAMAccountName=$UserName))"
$Searcher.CacheResults = $true
$Searcher.SearchScope = "Subtree"
$Searcher.PageSize = 1000
$searcher.findall()
}
```

Get-LDAPUser can be used very flexibly and locates user accounts everywhere inside the domain. Just specify the name you're looking for or a part of it:

```
# Find all users who have an "e" in their names:
Get-LDAPUser *e*

# Find only users with "e" in their names that are in the "main office" OU or come under it.
Get-LDAPUser *e* "OU=main office,OU=company"
```

Get-LDAPUser gets the found user objects right back. You can subsequently process them in the PowerShell pipeline—just like the elements that you previously got directly from children. How does *Get-LDAPUser* manage to search only the part of the domain you want it to? The following snippet of code is the reason:

```
if ($start -ne "")
{
   $startelement = $domain.psbase.Children.Find($start)
}
else
{
  $startelement = $domain
}
```

First, we checked whether the user specified the *$start* second parameter. If yes, *Find()* is used to access the specified container in the domain container (of the topmost level) and this is defined as the starting point for the search. If *$start* is missing, the starting point is the topmost level of the domain, meaning that every location is searched.

Pro Tip

The function also specifies some options that are defined by the user:

```
$Searcher.CacheResults = $true
$Searcher.SearchScope = "Subtree"
$Searcher.PageSize = 1000
```

SearchScope determines whether all child directories should also be searched recursively beginning from the starting point, or whether the search should be limited to the start directory. PageSize specifies in which "chunk" the results of the domain are to be retrieved. If you reduce the PageSize, your script may respond more freely, but will also require more network traffic. If you request more, the respective "chunk" will still include only 1,000 data records.

You could now freely extend the example function by extending or modifying the search filter. Here are some useful examples:

Search Filter	Description
`(&(objectCategory=person)(objectClass=User))`	Find only user accounts, not computer accounts
`(sAMAccountType=805306368)`	Find only user accounts (much quicker, but harder to read)
`(&amp;(objectClass=user)(sn=Weltner)(givenName=Tobias))`	Find user accounts with a particular name
`(&(objectCategory=person)(objectClass=user)(msNPAllowDialin=TRUE))`	Find user with dial-in permission
`(&(objectCategory=person)(objectClass=user)(pwdLastSet=0))`	Find user who has to change password at next logon
`(&(objectCategory=computer)(!description=*))`	Find all computer accounts having no description
`(&(objectCategory=person)(description=*))`	Find all user accounts having no description
`(&(objectCategory=person)(objectClass=user)(whenCreated>=20050318000000.0Z))`	Find all elements created after March 18, 2005
`(&(objectCategory=person)(objectClass=user)(|(accountExpires=9223372036854775807)(accountExpires=0)))`	Find all users whose account never expires (OR condition, where only one condition must be met)
`(&(objectClass=user)(userAccountControl: 1.2.840.113556.1.4.803:=2))`	Find all disabled user accounts (bitmask logical AND)

(&(objectCategory=person)(objectClass=user)(userAccountControl:1.2.840.113556.1.4.803:=32))	Find all users whose password never expires
(&(objectClass=user)(!userAccountControl:1.2.840.113556.1.4.803:=65536))	Find all users whose password expires (logical NOT using "!")
(&(objectCategory=group)(!groupType:1.2.840.113556.1.4.803:=2147483648))	Finding all distribution groups
(&(objectCategory=Computer)(!userAccountControl:1.2.840.113556.1.4.803:=8192))	Finding all computer accounts that are not domain controllers

Table 19.1: *Examples of LDAP queries*

Accessing Elements Using GUID

Elements in a domain are subject to change. The only thing that is really constant is the so-called GUID of an account. A GUID is assigned just one single time, namely when the object is created, after which it always remains the same. You can find out the GUID of an element by accessing the account. For example, use the practical *Get-LDAPUser* function above:

```
$searchuser = Get-LDAPUser "Guest"
$useraccount = $searchuser.GetDirectoryEntry()
$useraccount.psbase.NativeGUID
f0ffa8b401ce5549b318c0a4641cdd4a
```

Because the results returned by the search include no “genuine” user objects, but only reduced *SearchResult* objects, you must first use *GetDirectoryEntry()* to get the real user object. This step is only necessary if you want to process search results. You can find the GUID of an account in *PSBase.NativeGUID*.

In the future, you can access precisely this account via its GUID. Then you won’t have to care whether the location, the name, or some other property of the user accounts changes. The GUID will always remain constant:

```
$acccount = [ADSI]"LDAP://<GUID=f0ffa8b401ce5549b318c0a4641cdd4a>"
$acccount
distinguishedName
-----------------
{CN=Guest,CN=Users,DC=scriptinternals,DC=technet}
```

Specify the GUID when you log on if you want to log on to the domain:

```
$guid = "<GUID=f0ffa8b401ce5549b318c0a4641cdd4a>"
$acccount = new-object DirectoryServices.DirectoryEntry("LDAP://10.10.10.1/$guid","domain\
user", `"secret")
distinguishedName
-----------------
{CN=Guest,CN=Users,DC=scriptinternals,DC=technet}
```

Reading and Modifying Properties

In the last section, you learned how to access individual elements inside a domain: either directly through the ADSI path, the GUID, searching through directory contents, or launching a search across domains.

The elements you get this way are full-fledged objects. You use the methods and properties of these elements to control them. Basically, everything applies that you read about in Chapter 6. In the case of ADSI, there are some additional special features:

- **Twin objects:** Every ADSI object actually exists twice: first, as an object PowerShell synthesizes and then as a raw ADSI object. You can access the underlying raw object via the *PSBase* property of the processed object. The processed object contains all Active Directory attributes, including possible schema extensions. The underlying base object contains the .NET properties and methods you need for general management. You already saw how to access these two objects when you used *Children* to list the contents of a container.
- **Phantom objects:** Search results of a cross-domain search look like original objects only at first sight. In reality, these are reduced *SearchResult* objects. You can get the real ADSI object by using the *GetDirectoryEntry()* method. You just saw how that happens in the section on GUIDs.
- **Properties:** All the changes you made to ADSI properties won't come into effect until you invoke the *SetInfo()* method.

Note

In the following examples, we will use the *Get-LDAPUser* function described above to access user accounts, but you can also get at user accounts with one of the other described approaches.

Just What Properties Are There?

There are theoretical and a practical approaches to establishing which properties any ADSI object contains.

Practical Approach: Look

The practical approach is the simplest one: if you output the object to the console, PowerShell will convert all the properties it contains into text so that you not only see the properties, but also right away which values are assigned to the properties. In the following example, the user object is the result of an ADSI search, to be precise, of the above-mentioned *Get-LDAPUser* function:

```
$useraccount = Get-LDAPUser Guest
$useraccount | Format-List *
Path       : LDAP://10.10.10.1/CN=Guest,CN=Users,DC=scriptinternals,DC=technet
Properties : {samaccounttype, lastlogon, objectsid, whencreated...}
```

The result is meager but, as you know by now, search queries only return a reduced *SearchResult* object. You get the real user object from it by calling *GetDirectoryEntry().* Then you'll get more information:

```
$useraccount = $useraccount.GetDirectoryEntry()
$useraccount | Format-List *

objectClass              : {top, person, organizationalPerson, user}
cn                       : {Guest}
description              : {Predefined account for guest access to the computer or domain)
distinguishedName        : {CN=Guest,CN=Users,DC=scriptinternals,DC=technet}
instanceType             : {4}
whenCreated              : {12.12.2005 12:31:31 PM}
whenChanged              : {06.27.2006 09:59:59 AM}
uSNCreated               : {System.__ComObject}
memberOf                 : {CN=Guests,CN=Builtin,DC=scriptinternals,DC=technet}
uSNChanged               : {System.__ComObject}
name                     : {Guest}
objectGUID               : {240 255 168 180 1 206 85 73 179 24 192 164 100 28 221 74}
userAccountControl       : {66080}
badPwdCount              : {0}
codePage                 : {0}
countryCode              : {0}
badPasswordTime          : {System.__ComObject}
lastLogoff               : {System.__ComObject}
lastLogon                : {System.__ComObject}
logonHours               : {255 255 255 255 255 255 255 255 255 255 255 255 255 255 255 255 255
                           255 255 255 255}
pwdLastSet               : {System.__ComObject}
primaryGroupID           : {514}
objectSid                : {1 5 0 0 0 0 0 5 21 0 0 0 184 88 34 189 250 183 7 172 165 75 78 29
                           245 1 0 0}
accountExpires           : {System.__ComObject}
logonCount               : {0}
sAMAccountName           : {Guest}
sAMAccountType           : {805306368}
objectCategory           : {CN=Person,CN=Schema,CN=Configuration,DC=scriptinternals,DC=technet}
isCriticalSystemObject   : {True}
nTSecurityDescriptor     : {System.__ComObject}
```

In addition, further properties are available in the underlying base object:

```
$useraccount.PSBase | Format-List *
AuthenticationType : Secure

Children                 : {}
Guid                     : {Guest}
description              : b4a8fff0-ce01-4955-b318-c0a4641cdd4a
ObjectSecurity           : System.DirectoryServices.ActiveDirectorySecurity
Name                     : CN=Guest
NativeGuid               : f0ffa8b401ce5549b318c0a4641cdd4a
```

```
NativeObject                : {}
Parent                      : System.DirectoryServices.DirectoryEntry
Password                    :
Path                        : LDAP://10.10.10.1/CN=Guest,CN=Users,DC=scriptinternals,DC=technet
Properties                  : {objectClass, cn, description, distinguishedName...}
SchemaClassName             : user
SchemaEntry                 : System.DirectoryServices.DirectoryEntry
UsePropertyCache            : True
Username                    : scriptinternals\Administrator
Options                     : System.DirectoryServices.DirectoryEntryConfiguration
Site                        :
Container                   :
```

The difference between these two objects: the object that was returned first represents the respective user. The underlying base object is responsible for the ADSI object itself and, for example, reports where it is stored inside a domain or what is its unique GUID. The *UserName* property, among others, does not state whom the user account represents (which in this case is *Guest*), but who called it (*Administrator*).

Theoretical Approach: Much More Thorough

The practical approach we just saw is quick and returns a lot of information, but it is also incomplete. PowerShell shows only those properties in the output that actually do include a value right then (even if it is an empty value). In reality, many more properties are available so the tool you need to list them is *Get-Member:*

```
$useraccount | Get-Member -memberType *Property

Name                     MemberType   Definition
----                     ----------   ----------
accountExpires           Property     System.DirectoryServices.PropertyValueCollection
                                      accountExpires {get;set;}
badPasswordTime          Property     System.DirectoryServices.PropertyValueCollection
                                      badPasswordTime {get;set;}
badPwdCount              Property     System.DirectoryServices.PropertyValueCollection
                                      badPwdCount {get;set;}
cn                       Property     System.DirectoryServices.PropertyValueCollection
                                      cn {get;set;}
codePage                 Property     System.DirectoryServices.PropertyValueCollection
                                      codePage {get;set;}
countryCode              Property     System.DirectoryServices.PropertyValueCollection
                                      countryCode {get;set;}
description              Property     System.DirectoryServices.PropertyValueCollection
                                      description {get;set;}
distinguishedName        Property     System.DirectoryServices.PropertyValueCollection
                                      distinguishedName {get;...
instanceType             Property     System.DirectoryServices.PropertyValueCollection
                                      instanceType {get;set;}
isCriticalSystemObject   Property     System.DirectoryServices.PropertyValueCollection
                                      isCriticalSystemObject ...
lastLogoff               Property     System.DirectoryServices.PropertyValueCollection
                                      lastLogoff {get;set;}
```

```
lastLogon               Property      System.DirectoryServices.PropertyValueCollection
                                      lastLogon {get;set;}
logonCount              Property      System.DirectoryServices.PropertyValueCollection
                                      logonCount {get;set;}
logonHours              Property      System.DirectoryServices.PropertyValueCollection
                                      logonHours {get;set;}
memberOf                Property      System.DirectoryServices.PropertyValueCollection
                                      memberOf {get;set;}
name                    Property      System.DirectoryServices.PropertyValueCollection
                                      name {get;set;}
nTSecurityDescriptor    Property      System.DirectoryServices.PropertyValueCollection
                                      nTSecurityDescriptor {g...
objectCategory          Property      System.DirectoryServices.PropertyValueCollection
                                      objectCategory {get;set;}
objectClass             Property      System.DirectoryServices.PropertyValueCollection
                                      objectClass {get;set;}
objectGUID              Property      System.DirectoryServices.PropertyValueCollection
                                      objectGUID {get;set;}
objectSid               Property      System.DirectoryServices.PropertyValueCollection
                                      objectSid {get;set;}
primaryGroupID          Property      System.DirectoryServices.PropertyValueCollection
                                      primaryGroupID {get;set;}
pwdLastSet              Property      System.DirectoryServices.PropertyValueCollection
                                      pwdLastSet {get;set;}
sAMAccountName          Property      System.DirectoryServices.PropertyValueCollection
                                      sAMAccountName {get;set;}
sAMAccountType          Property      System.DirectoryServices.PropertyValueCollection
                                      sAMAccountType {get;set;}
userAccountControl      Property      System.DirectoryServices.PropertyValueCollection
                                      userAccountControl {get...
uSNChanged              Property      System.DirectoryServices.PropertyValueCollection
                                      uSNChanged {get;set;}
uSNCreated              Property      System.DirectoryServices.PropertyValueCollection
                                      uSNCreated {get;set;}
whenChanged             Property      System.DirectoryServices.PropertyValueCollection
                                      whenChanged {get;set;}
whenCreated             Property      System.DirectoryServices.PropertyValueCollection
                                      whenCreated {get;set;}
```

In this list, you will also learn whether properties are only readable or if they can also be modified. Modifiable properties are designated by *{get;set;}* and read-only by *{get;}*. If you change a property, the modification won't come into effect until you subsequently call *SetInfo()*.

```
$useraccount.Description = "guest account"
$useraccount.SetInfo()
```

Moreover, *Get-Member* can supply information about the underlying *PSBase* object:

```
$useraccount.PSBase | Get-Member -MemberType *Property
TypeName: System.Management.Automation.PSMemberSet

Name                     MemberType   Definition
----                     ----------   ----------
AuthenticationType       Property     System.DirectoryServices.AuthenticationTypes
                                      AuthenticationType {get;set;}
Children                 Property     System.DirectoryServices.DirectoryEntries Children {get;}
Container                Property     System.ComponentModel.IContainer Container {get;}
Guid                     Property     System.Guid Guid {get;}
Name                     Property     System.String Name {get;}
NativeGuid               Property     System.String NativeGuid {get;}
NativeObject             Property     System.Object NativeObject {get;}
ObjectSecurity           Property     System.DirectoryServices.ActiveDirectorySecurity
                                      ObjectSecurity {get;set;}
Options                  Property     System.DirectoryServices.DirectoryEntryConfiguration
                                      Options {get;}
Parent                   Property     System.DirectoryServices.DirectoryEntry Parent {get;}
Password                 Property     System.String Password {set;}
Path                     Property     System.String Path {get;set;}
Properties               Property     System.DirectoryServices.PropertyCollection
                                      Properties {get;}
SchemaClassName          Property     System.String SchemaClassName {get;}
SchemaEntry              Property     System.DirectoryServices.DirectoryEntry
                                      SchemaEntry {get;}
Site                     Property     System.ComponentModel.ISite Site {get;set;}
UsePropertyCache         Property     System.Boolean UsePropertyCache {get;set;}
Username                 Property     System.String Username {get;set;}
```

Reading Properties

The convention is that object properties are read using a dot, just like all other objects (see Chapter 6). So, if you want to find out what is in the *Description* property of the *$useraccount* object, formulate:

```
$useraccount.Description
Predefined account for guest access
```

But there are also two other options and they look like this:

```
$useraccount.Get("Description")
$useraccount.psbase.InvokeGet("Description")
```

At first glance, both seem to work identically. However, differences become evident when you query another property: *AccountDisabled.*

```
$useraccount.AccountDisabled
$useraccount.Get("AccountDisabled")
Exception calling "Get" with 1 Argument(s):"The directory property cannot be found in the cache."
At line:1 Char:14
+ $useraccount.Get( <<<< "AccountDisabled")
$useraccount.psbase.InvokeGet("AccountDisabled")
False
```

The first variant returns no information at all, the second an error message, and only the third the right result. What happened here?

The object in *$useraccount* is an object processed by PowerShell. All attributes (directory properties) become visible in this object as properties. However, ADSI objects can contain additional properties, and among these is *AccountDisabled.*

PowerShell doesn't take these additional properties into consideration. The use of a dot categorically suppresses all errors as only *Get()* reports the problem: nothing was found for this element in the LDAP directory under the name *AccountDisabled.*

In fact, *AccountDisabled* is located in another interface of the element as only the underlying *PSBase* object, with its *InvokeGet()* method, does everything correctly and returns the contents of this property.

Tip

As long as you want to work on properties that are displayed when you use *Format-List* * to output the object to the console, you won't have any difficulty using a dot or *Get()*. For all other properties, you'll have to use *PSBase.InvokeGet().Use GetEx()* iIf you want to have the contents of a property returned as an array.

Modifying Properties

In a rudimentary case, you can modify properties like any other object: use a dot to assign a new value to the property. Don't forget afterwards to call *SetInfo()* so that the modification is saved. That's a special feature of ADSI. For example, the following line adds a standard description for all users in the user directory if there isn't already one:

```
$ldap = "CN=Users"
$domain = [ADSI]""
$dn = $domain.distinguishedName
$users = [ADSI]"LDAP://$ldap,$dn"
$users.PSBase.Children | Where-Object { $_.sAMAccountType -eq 805306368 } |
Where-Object { $_.Description.toString() -eq "" } |
ForEach-Object { $_.Description = "Standard description"; $_.SetInfo(); $_.sAMAccountName + "
was changed." }
```

In fact, there are also a total of three approaches to modifying a property. That will soon become very important as the three ways behave differently in some respects:

```
$searchuser = Get-LDAPUser Guest
$useraccount = $searchuser.GetDirectoryEntry()
```

```
# Method 1:
$useraccount.Description = "A new description"
$useraccount.SetInfo()

# Method 2:
$useraccount.Put("Description", "Another new description")
$useraccount.SetInfo()

# Method 3:
$useraccount.PSBase.InvokeSet("Description", "A third description")
$useraccount.SetInfo()
```

As long as you change the normal directory attributes of an object, all three methods will work in the same way. Difficulties arise when you modify properties that have special functions. For example among these is the *AccountDisabled* property, which determines whether an account is disabled or not. The Guest account is normally disabled:

```
$useraccount.AccountDisabled
```

The result is "nothing" because this property is—as you already know from the last section—not one of the directory attributes that PowerShell manages in this object. That's not good because something very peculiar will occur in PowerShell if you now try to set this property to another value:

```
$useraccount.AccountDisabled = $false
$useraccount.SetInfo()
Exception calling "SetInfo" with 0 Argument(s): "The specified directory service attribute or value already exists.
(Exception from HRESULT: 0x8007200A)"
At line:1 Char:18
+ $useraccount.SetInfo( <<<< )
$useraccount.AccountDisabled
False
```

PowerShell has summarily input to the object a new property called *AccountDisabled.* If you try to pass this object to the domain, it will resist: the *AccountDisabled* property added by PowerShell does not match the *AccountDisabled* domain property. This problem always occurs when you want to set a property of an ADSI object that hadn't previously been specified.

To eliminate the problem, you have to first return the object to its original state so you basically remove the property that PowerShell added behind your back. You can do that by using *GetInfo()* to reload the object from the domain. This shows that *GetInfo()* is the opposite number of *SetInfo():*

```
$useraccount.GetInfo()
```

Note

Once PowerShell has added an "illegal" property to the object, all further attempts will fail to store this object in the domain by using *SetInfo()*. You must call *GetInfo()* or create the object again:

Finally, use the third above-mentioned variant to set the property, namely not via the normal object processed by PowerShell, but via its underlying raw version:

```
$useraccount.psbase.InvokeSet("AccountDisabled", $false)
$useraccount.SetInfo()
```

Now the modification works. The lesson: the only method that can reliably and flawlessly modify properties is *InvokeSet()* from the underlying *PSBase* object.

The other two methods that modify the object processed by PowerShell will only work properly with the properties that the object does display when you output it to the console.

Deleting Properties

If you want to completely delete a property, you don't have to set its contents to 0 or empty text. If you delete a property, it will be completely removed. *PutEx()* can delete properties and also supports properties that store arrays. *PutEx()* requires three arguments. The first specifies what *PutEx()* is supposed to do and corresponds to the values listed in Table 19.2. . The second argument is the property name that is supposed to be modified. Finally, the third argument is the value that you assign to the property or want to remove from it.

Numerical Value	Meaning
1	Delete property value (property remains intact)
2	Replace property value completely
3	Add information to a property
4	Delete parts of a property

Table 19.2: *PutEx() operations*

To completely remove the Description property, use *PutEx()* with these parameters:

```
$useraccount.PutEx(1, "Description", 0)
$useraccount.SetInfo()
```

Then, the *Description* property will be gone completely when you call all the properties of the object:

```
$useraccount | Format-List *

objectClass             : {top, person, organizationalPerson, user}
cn                      : {Guest}
distinguishedName       : {CN=Guest,CN=Users,DC=scriptinternals,DC=technet}
instanceType            : {4}
whenCreated             : {12.12.2005 12:31:31}
whenChanged             : {17.10.2007 11:59:36}
uSNCreated              : {System.__ComObject}
memberOf                : {CN=Guests,CN=Builtin,DC=scriptinternals,DC=technet}
uSNChanged              : {System.__ComObject}
name                    : {Guest}
objectGUID              : {240 255 168 180 1 206 85 73 179 24 192 164 100 28 221 74}
userAccountControl      : {66080}
badPwdCount             : {0}
```

```
codePage                : {0}
countryCode             : {0}
badPasswordTime         : {System.__ComObject}
lastLogoff              : {System.__ComObject}
lastLogon               : {System.__ComObject}
logonHours              : {255 255 255 255 255 255 255 255 255 255 255 255 255 255 255 255 255
                           255 255 255 255}
pwdLastSet              : {System.__ComObject}
primaryGroupID          : {514}
objectSid               : {1 5 0 0 0 0 0 5 21 0 0 0 184 88 34 189 250 183 7 172 165 75 78 29
                           245 1 0 0}
accountExpires          : {System.__ComObject}
logonCount              : {0}
sAMAccountName          : {Guest}
sAMAccountType          : {805306368}
objectCategory          : {CN=Person,CN=Schema,CN=Configuration,DC=scriptinternals,DC=technet}
isCriticalSystemObject  : {True}
nTSecurityDescriptor    : {System.__ComObject}
```

ImportantEven Get-Member won't return to you any more indications of the *Description* property. That's a real deficiency as you have no way to recognize what other properties the ADSI object may possibly support as long as you're using PowerShell's own resources.. PowerShell always shows only properties that are defined.

However, this doesn't mean that the *Description* property is now gone forever. You can create a new one any time:

```
$useraccount.Description = "New description"
$useraccount.SetInfo()
```

Interesting, isn't it? This means you could add entirely different properties that the object didn't have before:

```
$useraccount.wwwHomePage = "http://www.powershell.com"
$useraccount.favoritefood = "Meatballs"
Cannot set the Value property for PSMemberInfo object of type
"System.Management.Automation.PSMethod".
At line:1 Char:11
+ $useraccount.L <<<< oritefood = "Meatballs"
$useraccount.SetInfo()
```

It turns out that the user account accepts the *wwwHomePage* property (and so sets the Web page of the user on user properties), while "*favoritefood*" was rejected. Only properties allowed by the schema can be set.

The Schema of Domains

The directory service comes equipped with a list of permitted data called a schema to prevent meaningless garbage from getting stored in the directory service. Some information is mandatory and has to be specified for every object of the type, others (like a home page) are optional. The internal list enables you to get to the properties that you may deposit in an ADSI object. The *SchemaClass* property will tell you which "operating manual" you need for the object:

```
$useraccount.psbase.SchemaClassName
user
```

Take a look under this name in the schema of the domain. The result is the schema object for user objects, which returns the names of all permitted properties in *SystemMayContain.*

```
$schema = $domain.PSBase.Children.find("CN=user,CN=Schema,CN=Configuration")
$schema.systemMayContain | Sort-Object

accountExpires
aCSPolicyName
adminCount
badPasswordTime
badPwdCount
businessCategory
codepage
controlAccessRights
dBCSPwd
defaultClassStore
desktopProfile
dynamicLDAPServer
groupMembershipSAM
groupPriority
groupsToIgnore
homeDirectory
homeDrive
homePhone
initials
lastLogoff
lastLogon
lastLogonTimestamp
lmPwdHistory
localeID
lockoutTime
logonCount
logonHours
logonWorkstation
mail
manager
maxStorage
mobile
msCOM-UserPartitionSetLink
msDRM-IdentityCertificate
msDS-Cached-Membership
msDS-Cached-Membership-Time-Stamp
mS-DS-CreatorSID
```

```
msDS-Site-Affinity
msDS-User-Account-Control-Computed
msIIS-FTPDir
msIIS-FTPRoot
mSMQDigests
mSMQDigestsMig
mSMQSignCertificates
mSMQSignCertificatesMig
msNPAllowDialin
msNPCallingStationID
msNPSavedCallingStationID
msRADIUSCallbackNumber
msRADIUSFramedIPAddress
msRADIUSFramedRoute
msRADIUSServiceType
msRASSavedCallbackNumber
msRASSavedFramedIPAddress
msRASSavedFramedRoute
networkAddress
ntPwdHistory
o
operatorCount
otherLoginWorkstations
pager
preferredOU
primaryGroupID
profilePath
pwdLastSet
scriptPath
servicePrincipalName
terminalServer
unicodePwd
userAccountControl
userCertificate
userParameters
userPrincipalName
userSharedFolder
userSharedFolderOther
userWorkstations
```

Setting Properties Having Several Values

PutEx() is not only the right tool for deleting properties but also for properties that have more than one value. Among these is *otherHomePhone*, the list of a user's supplementary telephone contacts. The property can store just one telephone number or several, which is how you can reset the property telephone numbers:

```
$useraccount.PutEx(2, "otherHomePhone", @("123", "456", "789"))
$useraccount.SetInfo()
```

But note that this would delete any other previously entered telephone numbers. If you want to add a new telephone number to an existing list, proceed as follows:

```
$useraccount.PutEx(3, "otherHomePhone", @("555"))
$useraccount.SetInfo()
```

A very similar method allows you to delete selected telephone numbers on the list:

```
$useraccount.PutEx(4, "otherHomePhone", @("456", "789"))
$useraccount.SetInfo()
```

Invoking Methods

All the objects that you've been working with up to now contain not only properties, but also methods. In contrast to properties, methods do not require you to call SetInfo() when you invoke a method that modifies an object. . To find out which methods an object contains, use Get-Member to make them visible (see Chapter 6):

```
$guest | Get-Member -memberType *Method
```

Surprisingly, the result is something of a disappointment because the ADSI object PowerShell delivers contains no methods. The true functionality is in the base object, which you get by using *PSBase:*

```
$guest.psbase | Get-Member -memberType *Method
TypeName: System.Management.Automation.PSMemberSet

Name                         MemberType   Definition
----                         ----------   ----------
add_Disposed                 Method       System.Void add_Disposed(EventHandler value)
Close                        Method       System.Void Close()
CommitChanges                Method       System.Void CommitChanges()
CopyTo                       Method       System.DirectoryServices.DirectoryEntry CopyTo
                                          (DirectoryEntry newPare...
CreateObjRef                 Method       System.Runtime.Remoting.ObjRef CreateObjRef
                                          (Type requestedType)
DeleteTree                   Method       System.Void DeleteTree()
Dispose                      Method       System.Void Dispose()
Equals                       Method       System.Boolean Equals(Object obj)
GetHashCode                  Method       System.Int32 GetHashCode()
GetLifetimeService           Method       System.Object GetLifetimeService()
GetType                      Method       System.Type GetType()
get_AuthenticationType       Method       System.DirectoryServices.AuthenticationTypes
                                          get_AuthenticationType()
```

```
get_Children                Method        System.DirectoryServices.DirectoryEntries
                                          get_Children()
get_Container               Method        System.ComponentModel.IContainer get_Container()
get_Guid                    Method        System.Guid get_Guid()
get_Name                    Method        System.String get_Name()
get_NativeGuid              Method        System.String get_NativeGuid()
get_ObjectSecurity          Method        System.DirectoryServices.ActiveDirectorySecurity
                                          get_ObjectSecurity()
get_Options                 Method        System.DirectoryServices.DirectoryEntryConfiguration
                                          get_Options()
get_Parent                  Method        System.DirectoryServices.DirectoryEntry get_Parent()
get_Path                    Method        System.String get_Path()
get_Properties              Method        System.DirectoryServices.PropertyCollection
                                          get_Properties()
get_SchemaClassName         Method        System.String get_SchemaClassName()
get_SchemaEntry             Method        System.DirectoryServices.DirectoryEntry
                                          get_SchemaEntry()
get_Site                    Method        System.ComponentModel.ISite get_Site()
get_UsePropertyCache        Method        System.Boolean get_UsePropertyCache()
get_Username                Method        System.String get_Username()
InitializeLifetimeService   Method        System.Object InitializeLifetimeService()
Invoke                      Method        System.Object Invoke(String methodName, Params
                                          Object[] args)
InvokeGet                   Method        System.Object InvokeGet(String propertyName)
InvokeSet                   Method        System.Void InvokeSet(String propertyName, Params
                                          Object[] args)
MoveTo                      Method        System.Void MoveTo(DirectoryEntry newParent),
                                          System.Void MoveTo(Dire...
RefreshCache                Method        System.Void RefreshCache(), System.Void RefreshCache
                                          (String[] propert...
remove_Disposed             Method        System.Void remove_Disposed(EventHandler value)
Rename                      Method        System.Void Rename(String newName)
set_AuthenticationType      Method        System.Void set_AuthenticationType(AuthenticationTypes
                                          value)
set_ObjectSecurity          Method        System.Void set_ObjectSecurity(ActiveDirectorySecurity
                                          value)
set_Password                Method        System.Void set_Password(String value)
set_Path                    Method        System.Void set_Path(String value)
set_Site                    Method        System.Void set_Site(ISite value)
set_UsePropertyCache        Method        System.Void set_UsePropertyCache(Boolean value)
set_Username                Method        System.Void set_Username(String value)
ToString                    Method        System.String ToString()
```

Changing Passwords

The password of a user account is an example of information that isn't stored in a property. That's why you can't just read out user accounts. Instead, methods ensure the immediate generation of a completely confidential hash value out of the user account and that it is deposited in a secure location. You can use the *SetPassword()* and *ChangePassword()* methods to change passwords:

```
$useraccount.SetPassword("New password")
$useraccount.ChangePassword("Old password", "New password")
```

Note

Here, too, the deficiencies of *Get-Member* become evident when it is used with ADSI objects because Get-Member suppresses both methods instead of displaying them. You just have to "know" that they exist.

SetPassword() requires administrator privileges and simply resets the password.

That can be risky because in the process you lose access to all your certificates outside a domain, including the crucial certificate for the Encrypting File System (EFS), though it's necessary when users forget their passwords. *ChangePassword* doesn't need any higher level of permission because confirmation requires giving the old password.

When you change a password, be sure that it meets the demands of the domain. Otherwise, you'll be rewarded with an error message like this one:

```
Exception calling "SetPassword" with 1 Argument(s):
"The password does not meet the password policy requirements.
Check the minimum password length, password complexity and password
history requirements. (Exception from HRESULT: 0x800708C5)"
At line:1 Char:22
+ $realuser.SetPassword( <<<< "secret")
```

Controlling Group Memberships

Methods also set group memberships. Of course, the first thing you need is the groups in which a user becomes a member. That basically works just like user accounts as you could specify the ADSI path to a group to access the group. Alternatively, you can use a universal function that helpfully picks out groups for you:

```
function Get-LDAPGroup([string]$UserName, [string]$Start)
{
# Use current logon domain:
$domain = [ADSI]""
# OR: log on to another domain:
# $domain = new-object DirectoryServices.DirectoryEntry("LDAP://10.10.10.1","domain\user",
# "secret")
if ($start -ne "")
{
  $startelement = $domain.psbase.Children.Find($start)
}
else
{
  $startelement = $domain
}
$searcher = new-object DirectoryServices.DirectorySearcher($startelement)
$searcher.filter = "(&(objectClass=group)(sAMAccountName=$UserName))"
$Searcher.CacheResults = $true
$Searcher.SearchScope = "Subtree"
$Searcher.PageSize = 1000
$searcher.findall()
}
```

In Which Groups Is a User a Member?

There are two sides to group memberships. Once you get the user account object, the *memberOf* property will return the groups in which the user is a member:

```
$guest = (Get-LDAPUser Guest).GetDirectoryEntry()
$guest.memberOf
CN=Guests,CN=Builtin,DC=scriptinternals,DC=technet
```

Which Users Are Members of a Group?

The other way of looking at it starts out from the group: members are in the Member property in group objects:

```
$admin = (Get-LDAPGroup "Domain Admins").GetDirectoryEntry()
$admin.member
CN=Tobias Weltner,CN=Users,DC=scriptinternals,DC=technet
CN=Markus2,CN=Users,DC=scriptinternals,DC=technet
CN=Belle,CN=Users,DC=scriptinternals,DC=technet
CN=Administrator,CN=Users,DC=scriptinternals,DC=technet
```

Note

Groups on their part can also be members in other groups. So, every group object has not only the *Member* property with its members, but also *MemberOf* with the groups in which this group is itself a member.

Adding Users to a Group

To add a new user to a group, you need the group object as well as (at least) the ADSI path of the user, who is supposed to become a member. To do this, use *Add():*

```
$administrators = (Get-LDAPGroup “Domain Admins”).GetDirectoryEntry()
$user = (Get-LDAPUser Cofi1).GetDirectoryEntry()
$administrators.Add($user.psbase.Path)
$administrators.SetInfo()
```

In the example, the user Cofi1 is added to the group of *Domain Admins*. It would have sufficed to specify the user's correct ADSI path to the *Add()* method. But it's easier to get the user and pass the path property of the *PSBase* object.
Aside from *Add()*, there are other ways to add users to groups:

```
$administrators.Member = $administrators.Member + $user.distinguishedName
$administrators.SetInfo()

$administrators.Member += $user.distinguishedName
$administrators.SetInfo()
```

Instead of *Add()* use the *Remove()* method to remove users from the group again..

Creating New Objects

The containers at the beginning of this chapter also know how to handle properties and methods. So, if you want to create new organizational units, groups, and users, all you have to do is to decide where these elements should be stored inside a domain. Then, use the *Create()* method of the respective container.

Creating New Organizational Units

Let's begin experimenting with new organizational units that are supposed to represent the structure of a company. Since the first organizational unit should be created on the topmost domain level, get a domain object:

```
$domain = [ADSI]""
```

Next, create a new organizational unit called “company” and under it some additional organizational units:

```
$company = $domain.Create("organizationalUnit", "OU=Idera")
$company.SetInfo()
$sales = $company.Create("organizationalUnit", "OU=Sales")
$sales.SetInfo()
$marketing = $company.Create("organizationalUnit", "OU=Marketing")
$marketing.SetInfo()
$service = $company.Create("organizationalUnit", "OU=Service")
$service.SetInfo()
```

Create New Groups

Groups can be created as easily as organizational units. You should decide again in which container the group is to be created and specify the name of the group. In addition, define with the *groupType* property the type of group that you want to create, because in contrast to organizational units there are several different types of groups:

Group	Code
`Global`	`2`
`Local`	`4`
`Universal`	`8`
`As security group`	`Add - 2147483648`

Table 19.3: *Group Types*

Security groups have their own security ID so you can assign permissions to them. Distribution groups organize only members, but have no security function. In the following example, a global security group and a global distribution group are created:

```
$group_marketing = $marketing.Create("group", "CN=Marketinglights")
$group_marketing.psbase.InvokeSet("groupType", -2147483648 + 2)
$group_marketing.SetInfo()

#
$group_newsletter = $company.Create("group", "CN=Newsletter")
$group_newsletter.psbase.InvokeSet("groupType", 2)
$group_newsletter.SetInfo()
```

Creating New Users

To create a new user, proceed analogously, and first create the new user object in a container of your choice. Then, you can fill out the required properties and set the password using *SetPassword()*. Using the *AccountDisabled* property, enable the account. The following lines create a new user account in the previously created organization unit "Sales":

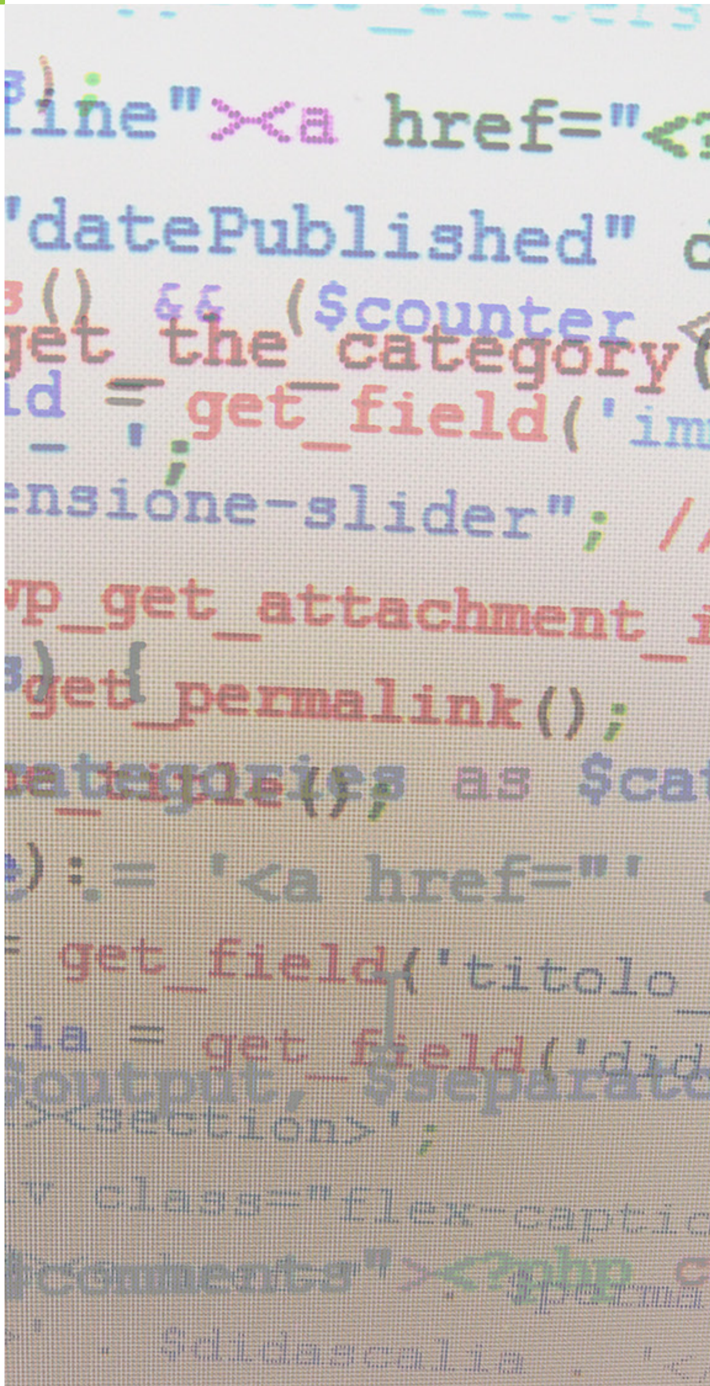
```
$user = $sales.Create("User", "CN=MyNewUser")
$user.SetInfo()
$user.Description = "My New User"
$user.SetPassword("TopSecret99")
$user.psbase.InvokeSet('AccountDisabled', $false)
$user.SetInfo()
```

Note

Instead of *Create()* use the *Delete()* method to delete objects.

Chapter 20. Loading .NET Libraries and Compiling Code

Since PowerShell is layered on the .NET Framework, you already know from Chapter 6 how you can use .NET code in PowerShell to make up for missing functions. In this chapter, we'll take up this idea once again. You'll learn about the options PowerShell has for creating command extensions on the basis of the .NET Framework. You should be able to even create your own cmdlets at the end of this chapter.



Topics Covered:

Loading .NET Libraries

Many functionalities of the .NET Framework are available right in PowerShell. For example, the following two lines suffices to set up a dialog window:

```
Add-Type -assembly Microsoft.VisualBasic
[Microsoft.VisualBasic.Interaction]::MsgBox("Do you agree?", "YesNoCancel,Question", "Question")
```

In Chapter 6, you learned in detail about how this works and what an "assembly" is. PowerShell used *Add-Type* to load a system library and was then able to use the classes from it to call a static method like *MsgBox().*

That's extremely useful when there is already a system library that offers the method you're looking for, but for some functionality even the .NET Framework doesn't have any right commands. For example, you have to rely on your own resources if you want to move text to the clipboard. The only way to get it done is to access the low-level API functions outside the .NET Framework.

Creating New .NET Libraries

As soon as you need more than just a few lines of code or access to API functions to implement the kinds of extensions you want, it makes sense to write the extension directly in .NET program code. The following example shows how a method called *CopyToClipboard()* might look in VB.NET. The VB.NET code is assigned to the *$code* variable as plain text:

```
$code = @'
Imports Microsoft.VisualBasic
Imports System
Namespace ClipboardAddon
  Public Class Utility
    Private Declare Function OpenClipboard Lib "user32" (ByVal hwnd As Integer) As Integer
    Private Declare Function EmptyClipboard Lib "user32" () As Integer
    Private Declare Function CloseClipboard Lib "user32" () As Integer
    Private Declare Function SetClipboardData Lib "user32"(ByVal wFormat As Integer, ByVal
    hMem As Integer) As Integer
    Private Declare Function GlobalAlloc Lib "kernel32" (ByVal wFlags As Integer, ByVal dwBytes
    As Integer) As Integer
    Private Declare Function GlobalLock Lib "kernel32" (ByVal hMem As Integer) As Integer
    Private Declare Function GlobalUnlock Lib "kernel32" (ByVal hMem As Integer) As Integer
    Private Declare Function lstrcpy Lib "kernel32" (ByVal lpString1 As Integer, ByVal
    lpString2 As String) As Integer

    Public Sub CopyToClipboard(ByVal text As String)
      Dim result As Boolean = False
      Dim mem As Integer = GlobalAlloc(&H42, text.Length + 1)
      Dim lockedmem As Integer = GlobalLock(mem)
      lstrcpy(lockedmem, text)
      If GlobalUnlock(mem) = 0 Then
```

```
        If OpenClipboard(0) Then
          EmptyClipboard()
          result = SetClipboardData(1, mem)
          CloseClipboard()
        End If
      End If
    End Sub
  End Class
End Namespace
'@
```

You have to first compile the code before PowerShell can execute it. Compilation is a translation of your source code into machine-readable intermediate language (IL). There are two options here.

In-Memory Compiling

To compile the source code and make it a type that you can use, feed the source code to *Add-Type* and specify the programming language the source code used:

```
$type = Add-Type -TypeDefinition $code -Language VisualBasic
```

Now, you can derive an object from your new type and call the method *CopyToClipboad()*. Done!

```
$object = New-Object ClipboardAddon.Utility
$object.CopyToClipboard("Hi Everyone!")
```

Tip

You might be wondering why in your custom type, you needed to use *New-Object* first to get an object. With *MsgBox()* in the previous example, you could call that method directly from the type.

CopyToClipboard() is created in your source code as a dynamic method, which requires you to first create an instance of the class, and that's exactly what *New-Object* does. Then the instance can call the method.

Alternatively, methods can also be *static*. For example, *MsgBox()* in the first example is a static method. To call static methods, you need neither *New-Object* nor any instances. Static methods are called directly through the class in which they are defined.

If you would rather use *CopyToClipboard()* as a static method, all you need to do is to make a slight change to your source code. Replace this line:

```
Public Sub CopyToClipboard(ByVal text As String)
```

Type this line instead:

```
Public Shared Sub CopyToClipboard(ByVal text As String)
```

Once you have compiled your source code, then you can immediately call the method like this:

```
[ClipboardAddon.Utility]::CopyToClipboard(“Hi Everyone!”)
```

DLL Compilation

With *Add-Type*, you can even compile and generate files. In the previous example, your source code was compiled in-memory on the fly. What if you wanted to protect your intellectual property somewhat and compile a DLL that your solution would then load?

Here is how you create your own DLL (make sure the folder c:\powershell exists, or else create it or change the output path in the command below):

```
PS> $code = @'
Imports Microsoft.VisualBasic
Imports System
Namespace ClipboardAddon
  Public Class Utility
    Private Declare Function OpenClipboard Lib "user32" (ByVal hwnd As Integer) As Integer
    Private Declare Function EmptyClipboard Lib "user32" () As Integer
    Private Declare Function CloseClipboard Lib "user32" () As Integer
    Private Declare Function SetClipboardData Lib "user32"(ByVal wFormat As Integer, ByVal
    hMem As Integer) As Integer
    Private Declare Function GlobalAlloc Lib "kernel32" (ByVal wFlags As Integer, ByVal
    dwBytes As Integer) As Integer
    Private Declare Function GlobalLock Lib "kernel32" (ByVal hMem As Integer) As Integer
    Private Declare Function GlobalUnlock Lib "kernel32" (ByVal hMem As Integer) As Integer
    Private Declare Function lstrcpy Lib "kernel32" (ByVal lpString1 As Integer, ByVal
    lpString2 As String) As Integer

    Public Shared Sub CopyToClipboard(ByVal text As String)
      Dim result As Boolean = False
      Dim mem As Integer = GlobalAlloc(&H42, text.Length + 1)
      Dim lockedmem As Integer = GlobalLock(mem)
      lstrcpy(lockedmem, text)
      If GlobalUnlock(mem) = 0 Then
        If OpenClipboard(0) Then
          EmptyClipboard()
          result = SetClipboardData(1, mem)
          CloseClipboard()
        End If
      End If
    End Sub
  End Class
End Namespace
'@

PS> Add-Type -TypeDefinition $code -Language VisualBasic -OutputType Library -OutputAssembly
c:\powershell\extension.dll
```

After you run these commands, you should find a file called c:\powershell\extension.dll with the compiled content of your code. If not, try this code in a new PowerShell console. Your experiments with the in-memory compilation may have interfered.

To load and use your DLL from any PowerShell session, go ahead and use this code:

```
PS> Add-Type -Path C:\powershell\extension.dll
PS> [Clipboardaddon.utility]::CopyToClipboard("Hello World!")
```

You can even compile and create console applications and windows programs that way - although that is an edge case. To create applications, you better use a specific development environment like Visual Studio.