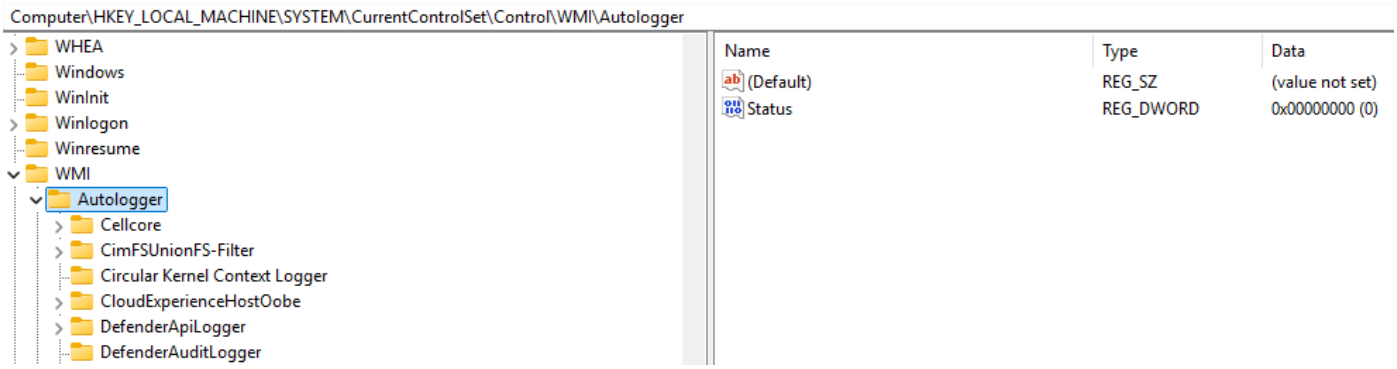
Check Your Privilege: The Curious Case of ETW's SecurityTrace Flag

[Ø] originhq.com/blog/securitytrace-etw-ppl

Connor McGarr January 19, 2026



Next Generation
Endpoint Security

Introduction

Recently, while investigating new feature development for our Origin (by Prelude) Runtime Memory Protection research preview product, we were forced to dig into the inner-workings of Event Tracing for Windows (ETW). In the course of leveraging our internal ETW tooling, which executes at a signing and protection level of Antimalware Protected Process Light (PPL), we noticed that it was possible to issue a "stop trace" code to a target ETW session that had an undocumented "security trace" flag enabled - which will be the topic of this blog post - without (seemingly) the necessary privileges required. This undocumented flag appears to ensure that only processes running at Antimalware-PPL can interact with or modify any ETW trace session with this flag enabled. In practice, it seems most applicable to AutoLogger ETW trace sessions (as we will see later). Yet we were able to stop the trace session with only administrative privileges, without any special signing or elevated protection level. If you're familiar with Windows internals you will know that - even if not *officially* acknowledged - resources created or managed by a protected process generally should not be modifiable by less-privileged entities, including administrative processes. Given that this flag appears to delegate trace-session management exclusively to Antimalware-PPL processes, our interest was piqued.

As we set out to determine how any of this was possible in the first place, this led us to identifying both how to configure and manage this undocumented "security trace" ETW flag without needing Antimalware-PPL. However, and much more practical and impactful, **this allowed us to identify a new method to consume events from ETW providers which require Antimalware-PPL, like Microsoft-Windows-Threat-Intelligence, without running as**

Antimalware-PPL *and* without relying on a kernel driver - or any of the usual "patch-the-kernel" gymnastics researchers have historically relied on. Alongside this post, we are also releasing a public proof of concept that encapsulates this research: ThreatIntelligenceConsumer.

ETW Session Management

Although the functionality for creating and managing ETW sessions is exposed in user-mode on Windows, the kernel is still responsible for the *true* management of resources related to trace sessions. One of the primary structures used by the kernel to manage a specific ETW session is through the `WMI_LOGGER_CONTEXT` structure.

```
lkd> dt nt!_WMI_LOGGER_CONTEXT
   +0x000 LoggerId         : Uint4B
   +0x004 BufferSize       : Uint4B
   +0x008 MaximumEventSize : Uint4B
   +0x00c LoggerMode       : Uint4B
   +0x010 AcceptNewEvents  : Int4B
   +0x018 GetCpuClock      : Uint8B
   +0x020 LoggerThread     : Ptr64 _ETHREAD
   +0x028 LoggerStatus     : Int4B
   +0x02c FailureReason    : Uint4B
   +0x030 BufferQueue      : _ETW_BUFFER_QUEUE
   +0x040 OverflowQueue    : _ETW_BUFFER_QUEUE
   +0x050 GlobalList       : _LIST_ENTRY
   +0x060 DebugIdTrackingList : _LIST_ENTRY
   +0x070 DecodeControlList : Ptr64 _ETW_DECODE_CONTROL_ENTRY
   +0x078 DecodeControlCount : Uint4B
   +0x080 BatchedBufferList : Ptr64 _WMI_BUFFER_HEADER
   +0x080 CurrentBuffer    : _EX_FAST_REF
   +0x088 LoggerName       : _UNICODE_STRING
   +0x098 LogFileName      : _UNICODE_STRING
   +0x0a8 LogFilePattern   : _UNICODE_STRING
   +0x0b8 NewLogFileName   : _UNICODE_STRING
<--- Truncated --->
```

This structure, which is quite large, manages a lot of the data and metadata needed for the session including the name of the logger, the state of ETW buffers being written to, Last Branch Record (LBR) and Intel Processor Trace (IPT) ETW enablement status if applicable, flags, and other items of interest. For the purposes of this blog post, we will examine the various flags which are present.

```
+0x330 Flags            : Uint4B
+0x330 Persistent       : Pos 0, 1 Bit
+0x330 AutoLogger       : Pos 1, 1 Bit
+0x330 FsReady          : Pos 2, 1 Bit
+0x330 RealTime         : Pos 3, 1 Bit
+0x330 Wow              : Pos 4, 1 Bit
+0x330 KernelTrace      : Pos 5, 1 Bit
+0x330 NoMoreEnable     : Pos 6, 1 Bit
+0x330 StackTracing     : Pos 7, 1 Bit
+0x330 ErrorLogged      : Pos 8, 1 Bit
+0x330 RealtimeLoggerContextFreed : Pos 9, 1 Bit
+0x330 PebsTracing      : Pos 10, 1 Bit
+0x330 PmcCounters      : Pos 11, 1 Bit
+0x330 PageAlignBuffers : Pos 12, 1 Bit
+0x330 StackLookasideListAllocated : Pos 13, 1 Bit
+0x330 SecurityTrace    : Pos 14, 1 Bit
+0x330 LastBranchTracing : Pos 15, 1 Bit
+0x330 SystemLoggerIndex : Pos 16, 8 Bits
+0x330 StackCaching     : Pos 24, 1 Bit
+0x330 ProviderTracking : Pos 25, 1 Bit
+0x330 ProcessorTrace   : Pos 26, 1 Bit
+0x330 QpcDeltaTracking : Pos 27, 1 Bit
+0x330 MarkerBufferSaved : Pos 28, 1 Bit
+0x330 LargeMdlPages    : Pos 29, 1 Bit
+0x330 ExcludeKernelStack : Pos 30, 1 Bit
```

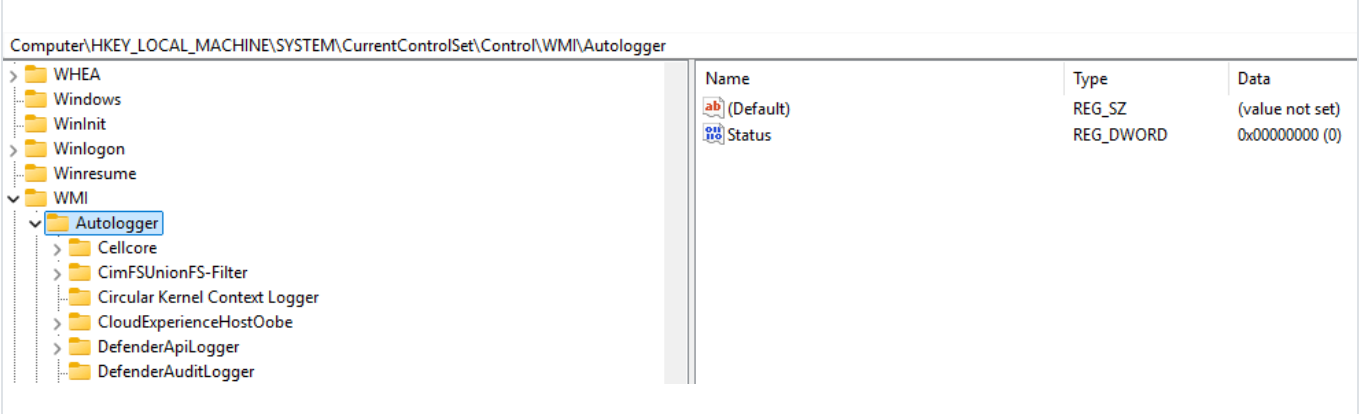
Although the mask of flags is technically represented by `WMI_LOGGER_CONTEXT.Flags`, the symbols contain a convenient breakdown of the various values which are available. As we can see, `SecurityTrace` is a flag which is present and will be the subject of this blog post. By itself, however, this flag does not indicate what it is used for, other than the fact that it denotes the trace is somehow related to security.

To get a sense as to what this flag may be used for, we first enumerated all of the trace sessions which contained this flag. Note that the list of active loggers cannot exceed 0x50 (80), as this currently is the maximum number of supported loggers on a system. WinDbg, which we use for our research, is a very powerful tool for ETW analysis.

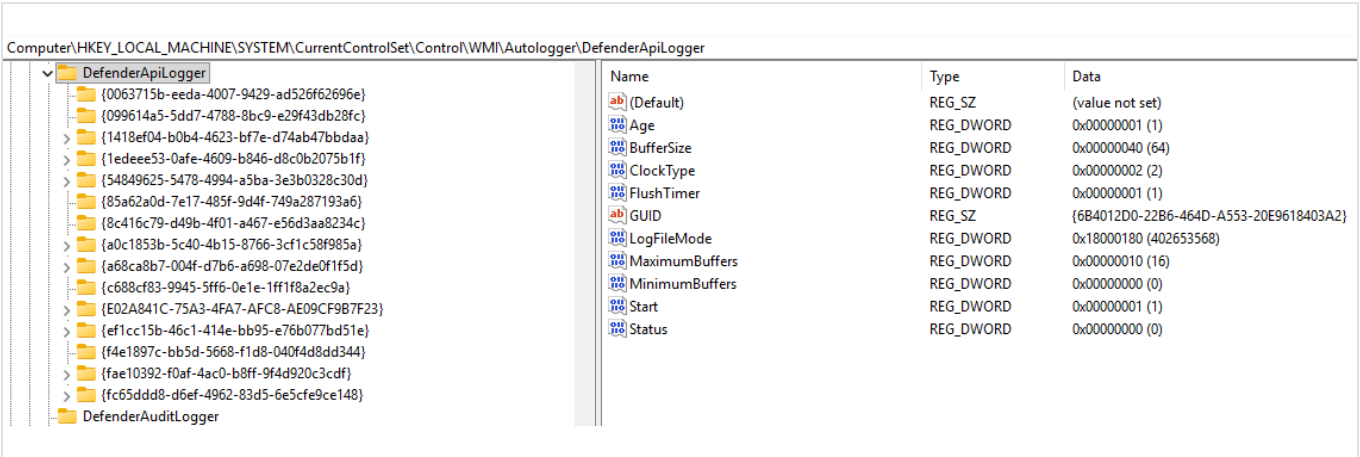
```
lkd> dx ((nt!_WMI_LOGGER_CONTEXT*(*)[0x50])
(((nt!_ESERVERSILO_GLOBALS*)&nt!PspHostSiloGlobals)->EtwSiloState->EtwpLoggerContext))-
>Where(l => l != 1).Where(l => l->SecurityTrace == 1).Select(i => i->LoggerName)
((nt!_WMI_LOGGER_CONTEXT*(*)[0x50])(((nt!_ESERVERSILO_GLOBALS*)&nt!PspHostSiloGlobals)-
>EtwSiloState->EtwpLoggerContext))->Where(l => l != 1).Where(l => l->SecurityTrace ==
1).Select(i => i->LoggerName)
    [5]              : "DefenderApiLogger" [Type: _UNICODE_STRING]
    [6]              : "DefenderAuditLogger" [Type: _UNICODE_STRING]
```

There are only two trace sessions with this feature enabled - DefenderApiLogger and DefenderAuditLogger. These trace sessions are associated with Microsoft Defender. If one attempts to analyze the relevant binaries, you will not find the creation of these ETW sessions

present (via `StartTrace`). This is because these sessions are registered as AutoLogger ETW sessions. For the unfamiliar, AutoLogger sessions are used in order for some loggers to consume events fairly early (all things considered) in the boot process and are not created by a particular process, but instead are created by the kernel directly (unlike most "normal" sessions - which are created by a particular process invoking `StartTrace`). These sessions are configured through the Registry via `HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\WMI\Autologger`.



By examining one of the AutoLogger sessions associated with Microsoft Defender we can glean further insight, potentially, into the `SecurityTrace` feature.



The DefenderApiLogger key itself contains AutoLogger-compliant configuration settings (not all of the ETW trace session configuration settings are available to AutoLoggers). As we can see in the above image, there are no configuration options related to "Flags" or any other moniker which would indicate configuration of various features such as `SecurityTrace`, etc. Moreover, if we put AutoLogger sessions aside and look at the `EVENT_TRACE_PROPERTIES` structure, which is used by callers of `StartTrace` to create a new ETW session programmatically, there *still* are no options to configure an item such as a "security trace" feature or a `SecurityTrace` flag.

In the case of DefenderApiLogger, all that is present are a list of AutoLogger-compliant ETW settings, along with a list of GUIDs for the various ETW providers which the DefenderApiLogger trace session wishes to consume from. For example, the Microsoft-Windows-Services ETW provider is represented by the first GUID present in the subkey, `0063715B-EEDA-4007-9429-AD526F62696E`. Each of these keys contains additional settings, such as the configuration of how a particular provider should emit events or how the logger should consume them - including an additional subkey named "Filters" (if present) which denotes various ETW filters (event ID filtering, etc.).

Still, however, there is nothing particularly identifiable about any of these configuration settings that would indicate the configuration of `SecurityTrace`. Given that the `WMI_LOGGER_CONTEXT` structure is a kernel-only structure, we further sought to understand how the ETW runtime in kernel-mode manages the undocumented `SecurityTrace` feature.

SecurityTrace Logger Flag

We've mentioned the `SecurityTrace` flag - but what does it actually *do*? One of the clearest ways to answer this is to look where this flag is evaluated (or set). The primary place where `SecurityTrace` is evaluated is in the Windows kernel, specifically the `EtwpQueryTrace`. As the name suggests, this function handles queries against a target ETW session. In practice, when you use a built-in tool like `logman` to retrieve details about an ETW trace session, the request ultimately funnels down to `EtwpQueryTrace` in order to be serviced.

```
NTSTATUS __fastcall EtwpQueryTrace(_ETW_SILODRIVERSTATE *SiloState, _WMI_LOGGER_INFORMATION *WmiLoggerInformation)
{
  NTSTATUS status; // eax MAPDST
  struct _KTHREAD *CurrentThread; // rax
  _WMI_LOGGER_CONTEXT *targetLoggerContext; // [rsp+40h] [rbp+18h] MAPDST BYREF

  targetLoggerContext = 0;
  status = EtwpValidateLoggerInfo(WmiLoggerInformation);
  if ( status >= 0 )
  {
    CurrentThread = KeGetCurrentThread();
    --CurrentThread->KernelApcDisable;
    status = EtwpAcquireLoggerContext(SiloState, &targetLoggerContext);
    if ( status >= 0 )
    {
      status = EtwpCheckLoggerControlAccess(1u, targetLoggerContext);
      if ( status >= 0 )
      {
        //
        // 0x4000 = SecurityTrace
        //
        if ( (targetLoggerContext->Flags.Flags & 0x4000) == 0
          //
          // Is the process performing the query PPL? If not, access denied.
          //
          || (status = EtwCheckSecurityLoggerAccess(
                         KeGetCurrentThread()->ApcState.Process,
                         KeGetCurrentThread()->PreviousMode),
              status >= 0) )
        {
          EtwpGetLoggerInfoFromContext(WmiLoggerInformation, targetLoggerContext);
        }
      }
      KeReleaseMutex(&targetLoggerContext->LoggerMutex, 0);
      ExReleaseRundownProtectionCacheAwareEx(
        targetLoggerContext->SiloState->EtwpLoggerRundown[targetLoggerContext->LoggerId],
        1u);
    }
    KeLeaveCriticalRegion();
  }
  return status;
}
```

Before talking about how `SecurityTrace` is evaluated in this function it is worth talking about how queries *actually* work - as this information will become prevalent in the latter portion of this blog.

ETW session query functionality resides around the `WMI_LOGGER_INFORMATION` structure. This undocumented structure is what is actually used by the low-level user-mode caller, `NtTraceControl` (via `ControlTrace`) for most ETW operations, such as starting or querying a trace. This structure is what is sent to the kernel - not the higher-level (and documented) `EVENT_TRACE_PROPERTIES` structure present in the Windows SDK. Although the Windows Research Kernel (WRK) has a definition of this structure, it has seen quite a few updates since the WRK was last updated. Luckily, the structure is present in `combase.dll` (as an aside, COM is notoiously hard to debug, so Microsoft actually ships private symbols for `combase.dll`. Given COM intersects with much of the OS, it can be a gold mine for information like this).

```
0:000> dt combase!_WMI_LOGGER_INFORMATION
   +0x000 Wnode            : _WNODE_HEADER
   +0x030 BufferSize       : Uint4B
   +0x034 MinimumBuffers   : Uint4B
   +0x038 MaximumBuffers   : Uint4B
   +0x03c MaximumFileSize  : Uint4B
   +0x040 LogFileMode      : Uint4B
   +0x044 FlushTimer       : Uint4B
   +0x048 EnableFlags      : Uint4B
   +0x04c AgeLimit         : Int4B
   +0x04c FlushThreshold   : Int4B
   +0x050 Wow              : Pos 0, 1 Bit
   +0x050 QpcDeltaTracking : Pos 1, 1 Bit
   +0x050 LargeMdlPages    : Pos 2, 1 Bit
   +0x050 ExcludeKernelStack : Pos 3, 1 Bit
   +0x050 V2Options        : Uint8B
   +0x058 LogFileHandle    : Ptr64 Void
   +0x058 LogFileHandle64  : Uint8B
   +0x060 NumberOfBuffers  : Uint4B
   +0x060 InstanceCount    : Uint4B
   +0x064 FreeBuffers      : Uint4B
   +0x064 InstanceId       : Uint4B
   +0x068 EventsLost       : Uint4B
   +0x068 NumberOfProcessors : Uint4B
   +0x06c BuffersWritten   : Uint4B
   +0x070 LogBuffersLost   : Uint4B
   +0x070 Flags            : Uint4B
   +0x074 RealTimeBuffersLost : Uint4B
   +0x078 LoggerThreadId   : Ptr64 Void
   +0x078 LoggerThreadId64 : Uint8B
   +0x080 LogFileName      : _UNICODE_STRING
   +0x080 LogFileName64    : _STRING64
   +0x090 LoggerName       : _UNICODE_STRING
   +0x090 LoggerName64     : _STRING64
   +0x0a0 RealTimeConsumerCount : Uint4B
   +0x0a4 SequenceNumber   : Uint4B
   +0x0a8 LoggerExtension  : Ptr64 Voidf
   +0x0a8 LoggerExtension64 : Uint8B
```

`WMI_LOGGER_INFORMATION` acts as a *translation* layer to extract information from, or store information into, the target trace session's `WMI_LOGGER_CONTEXT` from the original `EVENT_TRACE_PROPERTIES` structure associated with the target operation (such as `StartTrace` or `ControlTrace`).

`Sechost.dll`, the user-mode component which receives the high-level query request from user-mode, translates the `EVENT_TRACE_PROPERTIES` structure into the appropriate `WMI_LOGGER_INFORMATION` structure - which then is sent to kernel-mode and is populated by the target `WMI_LOGGER_CONTEXT` structure. This is then translated back into the expected `EVENT_TRACE_PROPERTIES` structure provided by the caller of `ControlTrace` query operation.

This translation is achieved in `Sechost.dll` via `EtwpCopyPropertiesToInfo` (`EVENT_TRACE_PROPERTIES` -> `WMI_LOGGER_INFORMATION`) and `EtwpCopyInfoToProperties` (`WMI_LOGGER_INFORMATION` -> `EVENT_TRACE_PROPERTIES`).

```
void __fastcall EtwpCopyPropertiesToInfo(
        struct _EVENT_TRACE_PROPERTIES_V2 *EventTraceProperties,
        _WMI_LOGGER_INFORMATION *LoggerInformation)
{
  ULONG BufferSize; // eax
  bool useVersionedProperties; // zf
  unsigned __int64 *v2Options; // rax
  ULONG64 versionedOptions; // rdx

  BufferSize = LoggerInformation->Wnode.BufferSize;
  *&LoggerInformation->Wnode.BufferSize = *&EventTraceProperties->Wnode.BufferSize;
  *&LoggerInformation->Wnode.CountLost = *&EventTraceProperties->Wnode.CountLost;
  *LoggerInformation->Wnode.Guid.Data4 = *EventTraceProperties->Wnode.Guid.Data4;
  useVersionedProperties = (LoggerInformation->Wnode.Flags & 0x800000) == 0;
  LoggerInformation->Wnode.BufferSize = BufferSize;
  LoggerInformation->BufferSize = EventTraceProperties->BufferSize;
  LoggerInformation->MinimumBuffers = EventTraceProperties->MinimumBuffers;
  LoggerInformation->MaximumBuffers = EventTraceProperties->MaximumBuffers;
  LoggerInformation->MaximumFileSize = EventTraceProperties->MaximumFileSize;
  LoggerInformation->LogFileMode = EventTraceProperties->LogFileMode;
  LoggerInformation->FlushTimer = EventTraceProperties->FlushTimer;
  LoggerInformation->EnableFlags = EventTraceProperties->EnableFlags;
  LoggerInformation->AgeLimit = EventTraceProperties->AgeLimit;
  LoggerInformation->NumberOfBuffers = EventTraceProperties->NumberOfBuffers;
  LoggerInformation->FreeBuffers = EventTraceProperties->FreeBuffers;
  LoggerInformation->EventsLost = EventTraceProperties->EventsLost;
  LoggerInformation->BuffersWritten = EventTraceProperties->BuffersWritten;
  LoggerInformation->LogBuffersLost = EventTraceProperties->LogBuffersLost;
  LoggerInformation->RealTimeBuffersLost = EventTraceProperties->RealTimeBuffersLost;
  LoggerInformation->LoggerThreadId64 = EventTraceProperties->LoggerThreadId;
  v2Options = &LoggerInformation->V2Options;
  if ( useVersionedProperties )
    versionedOptions = 0;
  else
    versionedOptions = EventTraceProperties->V2Options;
  *v2Options = versionedOptions;
}
```

What does this have to do with an ETW "security trace"? The actual functionality of a query operation, as we saw previously in `EtwpQueryTrace`, is gated by the presence of the target trace session's `WMI_LOGGER_CONTEXT.Flags.SecurityTrace` bit. In order for the target session's `WMI_LOGGER_INFORMATION` structure to be populated from the `WMI_LOGGER_CONTEXT` structure (in other words, in order for a trace query operation to take place), the caller process (i.e., the process which is performing the query, such as `logman.exe` or any other caller of `ControlTrace`) must contain *at least* Antimalware-PPL signing level/privilege.

```
status = EtwpCheckLoggerControlAccess(1u, targetLoggerContext);
if ( status >= 0 )
{
  //
  // 0x4000 = SecurityTrace
  //
  if ( (targetLoggerContext->Flags.Flags & 0x4000) == 0
    //
    // Is the process performing the query PPL? If not, access denied.
    //
    || (status = EtwCheckSecurityLoggerAccess(
                   KeGetCurrentThread()->ApcState.Process,
                   KeGetCurrentThread()->PreviousMode),
        status >= 0) )
  {
    EtwpGetLoggerInfoFromContext(WmiLoggerInformation, targetLoggerContext);
  }
```

This means it is not even possible to query these ETW sessions from a process which has, for example, `SYSTEM` privileges.

```
Microsoft Windows [Version 10.0.26100.6584]
(c) Microsoft Corporation. All rights reserved.

C:\Windows\System32>whoami
nt authority\system

C:\Windows\System32>logman query "DefenderApiLogger" -ets

Error:
Access is denied.
Try running this command as an administrator.
```

However, the `SecurityTrace` feature is more useful than *just* filtering the ability to query a session from user-mode directly via `ControlTrace` with the `EVENT_TRACE_CONTROL_QUERY` control code (although it is one of, if not *the* fundemental operation it is used for). The `SecurityTrace` flag is also checked in other security-relevant code paths. **Curiously, however, the check is not present when the "stop ETW trace session" code path (`EtwpStopLogger` in `Sechost.dll`, `EtwpStopTrace` in NT) is exercised**.

In the kernel, the presence of the `SecurityTrace` bit is checked in `EtwpStopLoggerInstance` (which is called by `EtwpStopTrace`). However, the check is *not* "security-related" (i.e., validating the calling process is running at Antimalware-PPL) and simply is to, if the target trace session had the Microsoft-Windows-Security-Auditing provider enabled, update global information about this provider - which has special handling in the kernel. This is because, as we will see later, one of the ways in which the `SecurityTrace` feature can be enabled is to consume from the Microsoft-Windows-Security-Auditing ETW provider in a very specific manner.

```
etwSiloState->EtwpSecurityProviderGuidEntry.Lock.Value = 0;
etwSiloState->EtwpSecurityProviderGuidEntry.SiloState = etwSiloState;
etwSiloState->EtwpSecurityProviderGuidEntry.Guid = SecurityProviderGuid;
```

Given no explicit Antimalware-PPL check occurs (and that a stop operation also does not result in a query, which would implicitly perform the Antimalware-PPL check) between the issuing of the stop code and the trace session being stopped, if the name of the target session with `SecurityTrace` enabled is known it is still possible for a process with only administrative privileges (`SYSTEM` in the case of the Defender session due to additional security descriptors) privileges to stop an ETW trace session with the `SecurityTrace` flag present (even though querying such a session would require the querying process to possess Antimalware-PPL). Though, as just mentioned, additional measures such as security descriptors can further tighten the permissions needed to perform such an action on a trace session.

```
eventProperties->Wnode.Guid = k_DefenderApiLoggerGuid;
eventProperties->LoggerNameOffset = sizeof(EVENT_TRACE_PROPERTIES);

error = ControlTraceW(0,
                      L"DefenderApiLogger",
                      eventProperties,
                      EVENT_TRACE_CONTROL_STOP);
if (error != ERROR_SUCCESS)
{
    goto Exit;
}

wprintf(L"[+] Successfully stopped DefenderApiLogger trace session.\n");
```

```
Microsoft Windows [Version 10.0.26100.6584]
(c) Microsoft Corporation. All rights reserved.

C:\Windows\System32>whoami
nt authority\system

C:\Windows\System32>logman query "DefenderApiLogger" -ets

Error:
Access is denied.
Try running this command as an administrator.

C:\Windows\System32>C:\Users\ANON\Desktop\StopSecurityTraceEtw.exe
[+] Successfully stopped DefenderApiLogger trace session.

C:\Windows\System32>logman query "DefenderApiLogger" -ets

Error:
Data Collector Set was not found.
```

Lastly, `SecurityTrace` and Antimalware-PPL checks almost always occur in tandem with the `EtwCheckSecurityLoggerAccess` kernel function. This is the actual function which performs the check for if the requesting/querying process has the necessary privilege (Antimalware-PPL) the operation. This function is also responsible for ensuring that only Antimalware-PPL processes can enable Microsoft-Windows-Threat-Intelligence related telemetry on desired processes. Not all Microsoft-Windows-Threat-Intelligence events are generated by "default" even with the appropriate keywords enabled. For example, processes must be *opted-in* to emitting specific events, such as reading/writing to/from memory. Processes do not emit these events by default.

```
NTSTATUS __fastcall EtwCheckSecurityLoggerAccess(_EPROCESS *QueryingProcess, char PreviousMode)
{
  if ( PreviousMode )
    return RtlTestProtectedAccess(QueryingProcess->Protection.Level, 0x31u) == STATUS_SUCCESS ? STATUS_ACCESS_DENIED : 0;
  else
    return STATUS_SUCCESS;
}
```

To summarize: the point, in our view, of the `SecurityTrace` flag seems to be to prevent non-Antimalware-PPL processes from accessing ETW data specific to sessions (more specifically, as we will see, AutoLogger trace sessions) with this bit set. This brings up the obvious question: how can one enable this feature in the first place? Additionally, could there be any implications for sessions which have the `SecurityTrace` feature enabled?

SecurityTrace - AutoLogger Sessions

In our analysis we identified three ways to enable the `SecurityTrace` feature. The first two methods happen indirectly through the specific configuration of an AutoLogger trace session.

AutoLogger sessions go through a special code path in the kernel in order to have all of the requested providers enabled (this will be important for later in the blog post). AutoLoggers trace sessions have their target providers enabled via `EtwpEnableAutoLoggerProvider` (instead of `EtwEnableTrace` directly). This function begins by extracting all of the provider subkeys in the target AutoLogger Registry key entry, iterating by provider GUID. If any of the target providers are either Microsoft-Windows-Kernel-Audit-Api-Calls or Microsoft-Windows-Threat-Intelligence, the target trace's `WMI_LOGGER_CONTEXT` structure is updated to contain the `SecurityTrace` flag.

```
//
// Did the AutoLogger have Kernel-Audit-API-Calls or
// Threat-Intelligence in the enabled providers?
//
if ( !memcmp(&targetGuid, &s_ProviderAuditApiCalls, 0x10u) || !memcmp(&targetGuid, &s_ProviderThreatInt, 0x10u) )
{
  if ( TargetSiloState != EtwpHostSiloState )
    goto Exit;
  if ( loggerId < TargetSiloState->MaxLoggers )
  {
    loggerContext = TargetSiloState->EtwpLoggerContext[loggerId];
    if ( (loggerContext & 1) == 0 )
    {
      if ( loggerContext->LogFileName.Buffer )
        goto Exit;
      //
      // SecurityTrace
      //
      _InterlockedOr(&loggerContext->Flags, 0x4000u);
    }
  }
}
```

The key here to remember is that the sessions are not started in context of any particular process - meaning there is no Antimalware-PPL check to be done at this point because the requesting "process" is the `System` process - in other words, the kernel itself. Traditionally, an ETW trace session cannot enable Microsoft-Windows-Threat-Intelligence because of the fact that when `EnableTraceEx2` is called, the caller process has its identity verified - and if it is not an Antimalware-PPL process, an access denied error is propogated back to the caller.

The difference for AutoLoggers resides in the fact that there is no check to be done on a caller of `EnableTraceEx2` because provider enablement for AutoLoggers it not tied to a particular process identity, as it does not involve a process calling `EnableTraceEx2`. The kernel itself is responsible for enabling all of the requested providers (which are listed, as previously shown, in the Registry for each AutoLogger). This is why the presence of the `SecurityTrace` flag is important, as it's purpose is to protect AutoLogger sessions which have enabled privileged providers, like Microsoft-Windows-Threat-Intelligence, from being consumed by non-

Antimalware-PPL processes. Although nothing can be done to check the identity of a process enabling a particular provider for an AutoLogger trace session at the time of enablement (as there is no process context to check), the OS can at least delegate this check to later, when a process attempts to then *consume* from this session. This is exactly where `SecurityTrace` comes into play.

The second way an AutoLogger can enable this capability is by setting an undocumented, but valid, AutoLogger Registry configuration value. The value in this case is `EnableSecurityProvider`. This is achieved in `EtwpStartAutoLogger` in the kernel (note that `SecTraceUnion` is *user-defined* and is not the name of the union which is actually used in the `WMI_LOGGER_INFORMATION` structure we have previously mentioned. `Flags` in this case is a 1-to-1 mapping of `Flags` in the target session's `WMI_LOGGER_CONTEXT`, as we will see later).

```
if ( autoLoggerEnabledSecurityProvider )
{
  logFileMode = loggerInfo->LogFileMode;
  if ( (logFileMode & 0x80u) == 0 || (logFileMode & 0x100) == 0 || loggerInfo->DUMMYUNIONNAME9.LogFileName.Buffer )
  {
    status = STATUS_ACCESS_DENIED;
    goto Exit;
  }
  //
  // Sets both QpcDeltaTracking and SecurityTrace
  //
  loggerInfo->SecTraceUnion.Flags |= 0x8004000u;
}
```

As a point of contention, when the `EnableSecurityProvider` AutoLogger key is set a few additional implicit actions occur. Any AutoLogger which has this key set will *automatically* be opted-in to consuming the Microsoft-Windows-Security-Auditing ETW provider and the target logger ID is added to the list of known loggers consuming from this provider, via the `ETW_SILODRIVERSTATE` structure managed `PspHostSiloGlobals` in the kernel. This is because the `EtwpSecurityProviderGuidEntry` is always set to the Microsoft-Windows-Security-Auditing provider in `EtwpPreInitializeSiloState`.

```
//
// SecurityTrace
//
if ( (LoggerContext->Flags.Flags & 0x4000) != 0 )
{
  for ( i = 0; i < 8; ++i )
  {
    siloState = (siloState + 2 * i);
    if ( siloState->EtwpSecurityLoggers[0] == LoggerContext->LoggerId )
    {
      currentThread = KeGetCurrentThread();
      --currentThread->KernelApcDisable;
      unknown = KeAbPreAcquire(&siloState->EtwpSecurityProviderGuidEntry.Lock, 0, 0);
      if ( _interlockedbittestandset64(&siloState->EtwpSecurityProviderGuidEntry.Lock, 0) )
        ExfAcquirePushLockExclusiveEx(
          &siloState->EtwpSecurityProviderGuidEntry.Lock,
          unknown,
          &siloState->EtwpSecurityProviderGuidEntry.Lock);
      if ( unknown )
      {
        if ( (KiAbpGlobalState & 1) != 0 )
          AutoBoost::KiAbpPostAcquire(unknown);
        else
          *(unknown + 10) = 1;
      }
      siloState->EtwpSecurityProviderEnableMask &= ~(1 << i);
      index = i;
      *&siloState->EtwpSecurityProviderGuidEntry.EnableInfo[index].IsEnabled = 0;
      *&siloState->EtwpSecurityProviderGuidEntry.EnableInfo[index].MatchAnyKeyword = 0;
      siloState->EtwpSecurityLoggers[0] = 0;
      siloState->EtwpSecurityProviderGuidEntry.LockOwner = 0;
      _m_prefetchw(&siloState->EtwpSecurityProviderGuidEntry.Lock);
      lockValue = siloState->EtwpSecurityProviderGuidEntry.Lock.Value;
      val = lockValue - 16;
      if ( (lockValue & 0xFFFFFFFFFFFFFFF0uLL) <= 0x10 )
        val = 0;
      if ( (lockValue & 2) != 0
        || (Value = siloState->EtwpSecurityProviderGuidEntry.Lock.Value,
            Value != _InterlockedCompareExchange64(&siloState->EtwpSecurityProviderGuidEntry.Lock, val, lockValue)) )
      {
        ExfReleasePushLock(&siloState->EtwpSecurityProviderGuidEntry.Lock, val);
      }
      KeAbPostRelease(&siloState->EtwpSecurityProviderGuidEntry.Lock);
      KeLeaveCriticalRegion();
      break;
    }
  }
}
```

Additionally, the first logger ID in the `EtwpSecurityLoggers` array is hardcoded, in `EtwpPreInitializeSiloState`, to the logger ID of 3 - which is always reserved for the EventLog-Security trace session. And, as mentioned, any AutoLogger which specifies the `EnableSecurityProvider` Registry value will be added to this list - as well as have the `SecurityTrace` bit enabled.

```
etwSiloState->MaxLoggers = maxLoggers;
loggerRundown = ExAllocatePool2(0x48u);
etwSiloState->EtwpLoggerRundown = loggerRundown;
if ( loggerRundown )
{
  loggerId = 0;
  etwSiloState->EtwpLoggerContext = (loggerRundown + maxLoggers);
  while ( loggerId < etwSiloState->MaxLoggers )
  {
    etwSiloState->EtwpLoggerContext[loggerId] = 1;
    loggerRundown = etwSiloState->EtwpLoggerRundown;
    loggerRundown[loggerId] = ExAllocateCacheAwareRundownProtection(NonPagedPoolNx, 'cwtE');
    if ( !etwSiloState->EtwpLoggerRundown[loggerId] )
      goto Exit;
    ++loggerId;
  }
  KeInitializeMutex(&etwSiloState->EtwpStartTraceMutex, 0);
  hashTable = etwSiloState->EtwpGuidHashTable;
  etwSiloState->EtwpSecurityLoggers[0] = 3;
```

In addition there is a "non-AutoLogger" method to enable the `SecurityTrace` flag without running at Antimalware-PPL (and also, for that matter, dynamically/programmatically without the help of the AutoLogger Registry keys). Additionally, we will outline how it is possible to also consume from such traces without Antimalware-PPL.

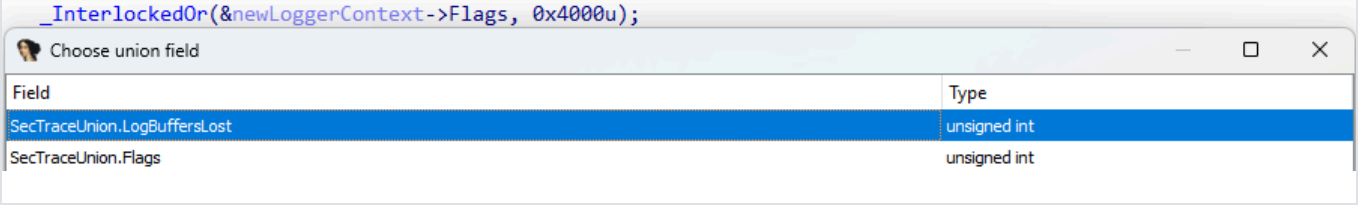
WMI_LOGGER_INFORMATION

As previously mentioned there is a level of abstraction, in user-mode, between the documented `EVENT_TRACE_PROPERTIES` structure and the kernel-mode `WMI_LOGGER_CONTEXT` structure - and that is the `WMI_LOGGER_INFORMATION` structure. Taking a look at this structure, there is some interesting behavior present. Specifically, `Flags` and `LogBuffersLost`:

```
0:000> dt combase!_WMI_LOGGER_INFORMATION
    <--- Truncated --->
   +0x070 LogBuffersLost   : Uint4B
   +0x070 Flags            : Uint4B
   <--- Truncated --->
```

As seen above, both of these members are located at the same place in memory (offset 0x70). This infers these two members are actually part of a *union* (represented by our `SecTraceUnion` union earlier), and only one of the values can be valid at a time. `LogBuffersLost`, which is present in the documented `EVENT_TRACE_PROPERTIES` structure is unioned with another member which is not present in the documented structure: `Flags`. This `Flags` member, as we mentioned earlier, is directly imported from the intermediary `WMI_LOGGER_INFORMATION` structure, provided by user-mode, into the `Flags` member of the `WMI_LOGGER_CONTEXT` structure in kernel mode.

```
if ( (newLoggerContext->LoggerMode & 0x100) != 0 )
  _InterlockedOr(&newLoggerContext->Flags, 8u);
else
  _InterlockedAnd(&newLoggerContext->Flags, 0xFFFFFFF7);
if ( (LoggerInformation->SecTraceUnion.Flags & 2) != 0 )
  _InterlockedOr(&newLoggerContext->Flags, 2u);
if ( (LoggerInformation->SecTraceUnion.Flags & 0x80000000) != 0 )
  _InterlockedOr(&newLoggerContext->Flags, 0x80000000);
if ( (LoggerInformation->SecTraceUnion.Flags & 1) != 0 )
  _InterlockedOr(&newLoggerContext->Flags, 1u);
if ( (LoggerInformation->SecTraceUnion.LogBuffersLost & 0x4000) != 0 )
  _InterlockedOr(&newLoggerContext->Flags, 0x4000u);
```



In our case, however, because `LogBuffersLost` is present in the `EVENT_TRACE_PROPERTIES` structure passed to `StartTrace`, and because this is unioned with `Flags`, if `LogBuffersLost` is set to `0x4000` in the call to `StartTrace` (the mask associated with the `SecurityTrace` bit being set in `WMI_LOGGER_CONTEXT.Flags`) this value is directly imported into the target `WMI_LOGGER_CONTEXT` structure! This is because, again, `EtwpCopyPropertiesIntoInfo` (`EVENT_TRACE_PROPERTIES` -> `WMI_LOGGER_INFORMATION`) in `Sechost.dll` performs a direct copy of the unioned data.

```
void __fastcall EtwpCopyPropertiesToInfo(
        struct _EVENT_TRACE_PROPERTIES_V2 *EventTraceProperties,
        _WMI_LOGGER_INFORMATION *LoggerInformation)
{
  ULONG BufferSize; // eax
  bool useVersionedProperties; // zf
  unsigned __int64 *v2Options; // rax
  ULONG64 versionedOptions; // rdx

  BufferSize = LoggerInformation->Wnode.BufferSize;
  *&LoggerInformation->Wnode.BufferSize = *&EventTraceProperties->Wnode.BufferSize;
  *&LoggerInformation->Wnode.CountLost = *&EventTraceProperties->Wnode.CountLost;
  *LoggerInformation->Wnode.Guid.Data4 = *EventTraceProperties->Wnode.Guid.Data4;
  useVersionedProperties = (LoggerInformation->Wnode.Flags & 0x800000) == 0;
  LoggerInformation->Wnode.BufferSize = BufferSize;
  LoggerInformation->BufferSize = EventTraceProperties->BufferSize;
  LoggerInformation->MinimumBuffers = EventTraceProperties->MinimumBuffers;
  LoggerInformation->MaximumBuffers = EventTraceProperties->MaximumBuffers;
  LoggerInformation->MaximumFileSize = EventTraceProperties->MaximumFileSize;
  LoggerInformation->LogFileMode = EventTraceProperties->LogFileMode;
  LoggerInformation->FlushTimer = EventTraceProperties->FlushTimer;
  LoggerInformation->EnableFlags = EventTraceProperties->EnableFlags;
  LoggerInformation->AgeLimit = EventTraceProperties->AgeLimit;
  LoggerInformation->NumberOfBuffers = EventTraceProperties->NumberOfBuffers;
  LoggerInformation->FreeBuffers = EventTraceProperties->FreeBuffers;
  LoggerInformation->EventsLost = EventTraceProperties->EventsLost;
  LoggerInformation->BuffersWritten = EventTraceProperties->BuffersWritten;
  LoggerInformation->LogBuffersLost = EventTraceProperties->LogBuffersLost;
  LoggerInformation->RealTimeBuffersLost = EventTraceProperties->RealTimeBuffersLost;
  LoggerInformation->LoggerThreadId64 = EventTraceProperties->LoggerThreadId;
  v2Options = &LoggerInformation->V2Options;
  if ( useVersionedProperties )
    versionedOptions = 0;
  else
    versionedOptions = EventTraceProperties->V2Options;
  *v2Options = versionedOptions;
}
```

Choose union field

Field	Type
LogBuffersLost	unsigned int
Flags	unsigned int

This allows one programmatically to enable `SecurityTrace` without running at Antimalware-PPL, or without needing to even use an `AutoLogger` trace session that enables any providers which do require Antimalware-PPL in order to consume from the trace. Additionally, one must set this flag on the call to `StartTrace` (it is not possible to call `ControlTrace` with an updated `EVENT_TRACE_PROPERTIES` containing a new value for `LogBuffersLost`. This value is ignored in update scenarios by the kernel via `EVENT_TRACE_CONTROL_UPDATE`).

```
//
// <snip>
//
traceProperties->LogBuffersLost = 0x4000;  // Treated as "Flags" if 0x4000 is set in
nt!EtwpStartLogger.

error = StartTraceW(TraceHandle,
                    TraceName,
                    traceProperties);
if (error != ERROR_SUCCESS)
{
    wprintf(L"[-] Error in StartTraceW! (Error: 0x%lx)\n", error);
    goto Exit;
}
```

After the call to `StartTrace`, with `LogBuffersLost` set to `0x4000`, the `SecurityTrace` bit is set in the target trace's `WMI_LOGGER_CONTEXT`.

```
3: kd> dx ((nt!_WMI_LOGGER_CONTEXT*(*)[0x50])
(((nt!_ESERVERSILO_GLOBALS*)&nt!PspHostSiloGlobals)->EtwSiloState->EtwpLoggerContext))-
>Where(l => l != 1).Where(l => l->SecurityTrace == 1).Select(i => i->LoggerName)
((nt!_WMI_LOGGER_CONTEXT*(*)[0x50])(((nt!_ESERVERSILO_GLOBALS*)&nt!PspHostSiloGlobals)-
>EtwSiloState->EtwpLoggerContext))->Where(l => l != 1).Where(l => l->SecurityTrace ==
1).Select(i => i->LoggerName)
    [5]              : "DefenderApiLogger" [Type: _UNICODE_STRING]
    [6]              : "DefenderAuditLogger" [Type: _UNICODE_STRING]
    [41]             : "MyTrace" [Type: _UNICODE_STRING]
```

So, as we can see, we *can* still create a trace which prevents any process without Antimalware-PPL from querying the session! This is especially useful for software which wants to create an ETW session that is protected from being discovered by other processes (as no AutoLogger key is needed to do this).

The issue though is that, in its current state, this is completely useless because we still run into an issue when it comes time to actually consume ETW events from this trace session. As we have seen thus far - in almost every scenario where `SecurityTrace` is enabled, the assumption is the target process consuming from the trace will be running at Antimalware-PPL (even though we know it is possible for a process which is *not* running at Antimalware-PPL to enable this feature).

In order to consume events (using the documented APIs) we need two calls: `OpenTrace` and `ProcessTrace`. `OpenTrace` and `ProcessTrace`, for real-time ETW consumers, contain a call to the private function `EtwpQueryRealTimeTraceProperties` in `Sechost.dll`.

```
ULONG __fastcall EtwpQueryRealTimeTraceProperties(
        LPCWSTR InstanceName,
        PEVENT_TRACE_PROPERTIES Properties,
        unsigned int *NumberOfProcessors,
        unsigned int *HistoricalContext)
{
  ULONG error; // eax
  ULONG64 historicalContext; // rbx
  ULONG numberOfProcessors; // ecx
  _DWORD outBuffer[6]; // [rsp+30h] [rbp-18h] BYREF
  ULONG returnLength; // [rsp+58h] [rbp+10h] BYREF

  outBuffer[0] = 0;
  returnLength = 0;
  memset_0(&Properties->Wnode.ProviderId, 0, 0x1074u);
  Properties->Wnode.BufferSize = 0x1078;
  error = ControlTraceW(0, InstanceName, Properties, EVENT_TRACE_CONTROL_QUERY);
  if ( !error )
  {
    if ( (Properties->LogFileMode & 0x100) != 0 )
    {
      historicalContext = Properties->Wnode.HistoricalContext;
      if ( TraceQueryInformation(historicalContext, TraceStreamCount, outBuffer, 4u, &returnLength) || returnLength != 4 )
      {
        if ( (Properties->LogFileMode & 0x10000000) != 0 )
          numberOfProcessors = 1;
        else
          numberOfProcessors = NtCurrentPeb()->NumberOfProcessors;
      }
      else
      {
        numberOfProcessors = outBuffer[0];
      }
      if ( HistoricalContext )
        *HistoricalContext = historicalContext;
      if ( NumberOfProcessors )
        *NumberOfProcessors = numberOfProcessors;
      return 0;
    }
    else
    {
      return ERROR_WMI_INSTANCE_NOT_FOUND;
    }
  }
  return error;
}
```

This function occurs inline with `OpenTrace` and `ProcessTrace`. The fundamental problem here is that calling both of these functions will implicitly call `ControlTrace` with the `EVENT_TRACE_CONTROL_QUERY` code - which results in a query operation to the kernel. As already mentioned, given that `SecurityTrace` must be set at the time of the call to `StartTrace` and cannot be updated, the `SecurityTrace` bit will already be set at the time of the call to `EtwpQueryRealTimeTraceProperties`. Since query operations result in a check of the `SecurityTrace` bit (and given our process which is making the calls to `OpenTrace` and `ProcessTrace` is *not* running as Antimalware-PPL) the operation will fail with `ERROR_ACCESS_DENIED`. Going back to what we mentioned earlier, this is why it is not possible to consume events from a trace session that has `SecurityTrace` enabled without Antimalware-PPL. However, given that this check is occurring in user-mode, there is more than what meets the eye!

Consuming from a SecurityTrace Session Without Antimalware-PPL

The fundamental reason why consuming fails is due to the query operation. However, given that the check is delegated to user-mode instead of happening *inline* in the kernel itself as part of a call to `NtTraceControl` for consuming events, and given that we fully-control the process which is invoking `OpenTrace` and `ProcessTrace` - we can bypass this check and consume from any trace session which has `SecurityTrace` enabled. There are two primary options to choose from:

1. Use only native APIs from `ntdll.dll` (primarily `NtTraceControl`) to consume from the trace session. Since `OpenTrace` and `ProcessTrace` are high-level APIs, directly calling the native APIs will result in a bypassing of the query operation
2. Install a hook on `EtwpQueryRealTimeTraceProperties` (or `ControlTrace` itself) to detour all query operations to our own variant. This can be achieved using a supported library like Microsoft Detours, or by installing your own hook.

Due to time constraints we opted for the latter option, which resulted in using our own simple function hook (not using Detours or any other library). Given we opted for a function hook, we needed to compensate for a few things. The first being returning to the caller of `EtwpQueryRealTimeTraceProperties` all of the information it expects. This includes:

1. The number of processors on the system
2. The `HistoricalContext` (which is referred to as the "trace handle", but really is just the logger ID preserved in the `ETW_REALTIME_CONSUMER` structure - or additionally the position of the session's `WMI_LOGGER_CONTEXT` structure in the `EtwpLoggerContext` array found in `PspHostSiloGlobals->EtwSiloState` in the kernel)
3. The "final" `EVENT_TRACE_PROPERTIES` to return to the caller (which needs to be 0x1078 bytes in size)
4. An `ERROR_SUCCESS` (`0`) return code

However, this is if we choose to install a hook on `EtwpQueryRealTimeTraceProperties`. Given that this is a *private* function - as indicated by the `Etwp` prefix - this function is not exported and it will be a more involved process in order to keep a working POC portable/updated. A more portable method for a POC would be to install a hook on `ControlTrace` for only query operations. `ControlTrace` is exported and its address can always be known. Because of this all that is required is returning both a a "success" error code and the output tracing properties. Note that the call to `TraceQueryInformation`, which is one of the ways the number of processors is retrieved, does not result in an *actual* call to `EtwpQueryTrace` in the kernel.

Going back to `EtwpQueryRealTimeTraceProperties`, the query operation is presumably an artifact of getting a "known good copy" of the target trace properties from the kernel - and additionally so that a check of the `SecurityTrace` bit can occur. Trial-and-error revealed that simply just providing the `EVENT_TRACE_PROPERTIES` returned from the original call to `StartTrace`

was sufficient and the queried properties are not necessary. So, for our purposes, all that is needed is to detour calls to `ControlTrace` for query operations to our own hook and then return to the caller the tracing properties we already have populated from the call to `StartTrace`! The `ControlTrace` hook simply identifies if the target operation is a query and, if it is, returns the target trace properties to `EtwpQueryRealTimeTraceProperties` (which then fills out the `HistoricalContext` and number of processors as a result of natural execution).

Disassembly | Hooks.asm | SecurityTrace.cpp

```
.CODE

extern k_TraceProperties:QWORD
extern g_OriginalControlTraceW:QWORD

; RCX: TraceId
; RDX: InstanceName
; R8: Properties
; R9: ControlCode
MyControlTraceW PROC
    ; If the target operation is anything other than a query,
    ; jump to the real ControlTraceW function.
    int 3
    cmp r9, 0 ; EVENT_TRACE_CONTROL_QUERY
    je hooked_control_tracew
    jmp real_control_tracew

hooked_control_tracew:
    ; RDI, RSI, and RCX are going to be used here.
    ; Preserve them. Also the flags.
    pushfq
    push rdi
    push rsi
    push rcx

    ; R8 is a structure on the stack. Therefore
    ; we need to memcpy instead of just assigning
    ; the value.
    mov rdi, r8
    mov rsi, k_TraceProperties
    xor rax, rax
    mov eax, 20Fh                    ; Counter: 0x1078 / 8 = 0x20F (527 qwords)

    ; memcpy implementation.
memcpy_loop:
    mov rcx, qword ptr [rsi]        ; Read 8 bytes from source
    mov qword ptr [rdi], rcx        ; Write 8 bytes to destination
    add rsi, 8                      ; Advance source
    add rdi, 8                      ; Advance destination
    dec eax                         ; Decrement counter
    jnz memcpy_loop

    ; Restore non-volatile registers. And flags.
    pop rcx
    pop rsi
    pop rdi
    popfq

    ; bail
    jmp exit_label

exit_label:
    ; ERROR_SUCCESS
    xor rax, rax
    ret

```

```
; Forward to standalone trampoline that properly executes
; the original ControlTraceW with all parameters intact.
real_control_tracew:
    ; Simply jump to the trampoline function in allocated memory.
    ; All parameters (RCX, RDX, R8, R9) are still intact.
    ; The trampoline will execute the original bytes and return properly.
    int 3
    jmp qword ptr [g_OriginalControlTraceW]
MyControlTraceW ENDP

END
```

The above code simply returns the necessary information the caller of `EtwpQueryRealTimeTraceProperties` needs without the actual query operation (which would fail, as mentioned, due to the consuming process not running at Antimalware-PPL). By simply inserting this thunk we can now successfully consume ETW events from a trace session which has the `SecurityTrace` bit set without Antimalware-PPL! We can also use this exact same method to consume protected ETW providers, like Microsoft-Windows-Threat-Intelligence, without Antimalware-PPL!

Consuming From Microsoft-Windows-Threat-Intelligence Without Antimalware-PPL

As mentioned earlier, the whole point of the `SecurityTrace` bit is to protect ETW trace sessions that wish to consume from privileged ETW providers, like Microsoft-Windows-Threat-Intelligence - specifically in AutoLogger scenarios. The reason for this is pretty straightforward - the code paths to enable an ETW provider in a target trace session, in the kernel, differ based on if the trace session is an AutoLogger session or not. If the trace session is not an AutoLogger trace session it is impossible to consume from the Microsoft-Windows-Threat-Intelligence provider without being an Antimalware-PPL. This is due to a check which occurs in `EtwpCheckNotificationAccess` in kernel-mode (recall when the AutoLogger enablement happens there is no "process context" for which `EnableTraceEx2` can be invoked, since the kernel is responsible for standing up all AutoLogger sessions).

```
NTSTATUS __fastcall EtwpCheckNotificationAccess(_GUID *TargetGuid, _GUID *TraceSessionGuid)
{
  NTSTATUS status; // eax MAPDST
  __int64 isNotProtectedProvider; // rax

  status = EtwpCheckGuidAccess(TargetGuid, 0x80u);
  if ( status >= STATUS_SUCCESS )
  {
    status = EtwpCheckGuidAccess(TraceSessionGuid, 0x80u);
    if ( status >= STATUS_SUCCESS )
    {
      isNotProtectedProvider = *&TargetGuid->Data1 - *&s_ProviderThreatInt.Data1;
      if ( *&TargetGuid->Data1 == *&s_ProviderThreatInt.Data1 )
        isNotProtectedProvider = *TargetGuid->Data4 - *s_ProviderThreatInt.Data4;
      if ( !isNotProtectedProvider )
        //
        // Does the consuming process have PPL?
        //
        return EtwCheckSecurityLoggerAccess(KeGetCurrentThread()->ApcState.Process, KeGetCurrentThread()->PreviousMode);
    }
  }
  return status;
}
```

The issue here is that with an AutoLogger ETW trace session the actual check is different. If the Microsoft-Windows-Threat-Intelligence provider is to be consumed by an AutoLogger, only the `SecurityTrace` flag is checked - there is no call to `EtwpCheckNotificationAccess`, as there is no process context to validate against. This is because the kernel itself is responsible for instantiating all AutoLogger sessions, not a particular process. We saw this earlier in the blog with how an AutoLogger has the `SecurityTrace` bit set in the first place. Given this, we can instrument the following:

1. Create an entry in the AutoLogger Registry key to consume from Microsoft-Windows-Threat-Intelligence. This will enable Microsoft-Windows-Threat-Intelligence in the trace session. Note that the trace has not yet been consumed by a target process, meaning no Antimalware-PPL check happens because it is not applicable at this state as the kernel is creating all of these sessions - not a particular process
2. Patch `ControlTrace` in user-mode, which allows consumption from a trace that has the `SecurityTrace` bit set. We just need to provide the target `EVENT_TRACE_PROPERTIES` structure
3. Call `OpenTrace` and `ProcessTrace` as normal. This results in everything needed to consume from the session *without* the query operation we previously showed.

The only challenge in the above implementation is `EVENT_TRACE_PROPERTIES`. In our original proof-of-concept, we took solace in the fact that we had a fully-populated `EVENT_TRACE_PROPERTIES` structure after the original call to `StartTrace`. Given that we are trying to consume from an already-existing AutoLogger session, we can no longer call `StartTrace` because the session already exists. This means we need to manually populate our own `EVENT_TRACE_PROPERTIES` structure to return to the caller of `EtwpQueryRealTimeTraceProperties` in `Sechost.dll`. Recall that we cannot directly query for

these properties without Antimalware-PPL, since `SecurityTrace` is set. Trial-and-error revealed that the following fields in the `EVENT_TRACE_PROPERTIES` structure are needed for the call to succeed (and the entirety of the `OpenTrace` and `ProcessTrace` operations in general):

1. All relevant `WNODE_HEADER` fields (`Guid`, etc.). *Especially* `HistoricalContext`
2. `BufferSize` (a valid value - I have chosen `0x40`)
3. `LogFileMode` (`EVENT_TRACE_REAL_TIME_MODE`)
4. `FlushTimer`
5. `MinimumBuffers`
6. `LoggerNameOffset`

All of the aforementioned fields are trivial to fill out (they just need to be reconciled with the target AutoLogger trace session settings in the Registry) except for `HistoricalContext`. `HistoricalContext`, however, is deterministic. This because it is simply, as mentioned, the ID of the logger. Given that we are consuming from an AutoLogger trace session, the only "relevant" IDs will be those present in the AutoLogger Registry key at the time an ID is assigned to our trace session. Additionally, the AutoLoggers are enabled in alphabetical order (with a few exceptions that are easily compensated for).

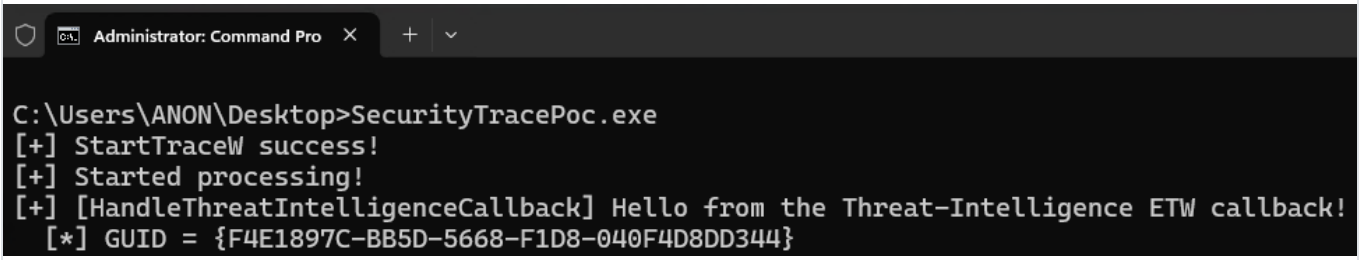
Through testing, it seems the first logger ID used is always 2 (for the "traditional" kernel logger session), and we also know from earlier that ID 3 is always reserved for the EventLog-Security trace - meaning the first possible ID is 4. Compensating for all of this, one can easily infer what the projected `HistoricalContext` will be for the target session by brute-forcing all values from 4 - 80 (the maximum ID) with a query operation. AutoLoggers will always reserve the "lower" IDs (starting at 4, 5, 6, etc.) and, thus, iterating over values 4 - 80 until a query to a value that returns `ERROR_ACCESS_DENIED` is found is a good indicator that the target trace session is likely a `SecurityTrace` target (although this is not *always* the case as there can be other reasons why a query can fail that is not related to `SecurityTrace`). What we are releasing is a POC and, thus, other implementations to reconcile the trace ID are left as an exercise to the reader, as the trace IDs themselves are simply just numeric values and AutoLoggers themselves are enabled in alphabetical order. In the POC we have released, we simply create a trace session name which starts with 0. This all but guarantees, for POC purposes, that this session will be the first ID (4) in the registered trace session, since it will come first alphabetically in most cases.

Finally, with the relevant checks passed, it is then possible to consume from the Microsoft-Windows-Threat-Intelligence ETW provider without Antimalware-PPL or any sort of kernel-mode memory patching or driver loading.

```
void
HandleThreatIntelligenceCallback (
    _In_ PEVENT_RECORD EventRecord
    )
{
    wprintf(L"[+] [HandleThreatIntelligenceCallback] Hello from the Threat-Intelligence
ETW callback!\n");

    //
    // Print the GUID
    //
    wprintf(L"  [*] GUID = {%08lX-%04hX-%04hX-%02hhX%02hhX-
%02hhX%02hhX%02hhX%02hhX%02hhX%02hhX}\n",
            EventRecord->EventHeader.ProviderId.Data1,
            EventRecord->EventHeader.ProviderId.Data2,
            EventRecord->EventHeader.ProviderId.Data3,
            EventRecord->EventHeader.ProviderId.Data4[0],
            EventRecord->EventHeader.ProviderId.Data4[1],
            EventRecord->EventHeader.ProviderId.Data4[2],
            EventRecord->EventHeader.ProviderId.Data4[3],
            EventRecord->EventHeader.ProviderId.Data4[4],
            EventRecord->EventHeader.ProviderId.Data4[5],
            EventRecord->EventHeader.ProviderId.Data4[6],
            EventRecord->EventHeader.ProviderId.Data4[7]);

    return;
}
```



We can see the GUID here is that of the Microsoft-Windows-Threat-Intelligence GUID (`F4E1897C-BB5D-5668-F1D8-040F4D8DD344`). Additionally, if we enumerate the list of consumers attached to this trace session (via the linked-list in `WMI_LOGGER_CONTEXT`) for a list of `ETW_REALTIME_CONSUMER` structures - we can see the only process which is consuming from this trace session, which has enabled the Microsoft-Windows-Threat-Intelligence provider, does not have Antimalware-PPL, and is our proof-of-concept process!

```
3: kd> dx ((nt!_WMI_LOGGER_CONTEXT*(*)[0x50])
(((nt!_ESERVERSILO_GLOBALS*)&nt!PspHostSiloGlobals)->EtwSiloState->EtwpLoggerContext))-
>Where(l => l != 1).Where(l => l->SecurityTrace == 1).Select(i => new { Name = i-
>LoggerName, Consumers = Debugger.Utility.Collections.FromListEntry(i->Consumers,
"nt!_ETW_REALTIME_CONSUMER", "Links")})[0n4].Consumers[0]
((nt!_WMI_LOGGER_CONTEXT*(*)[0x50])(((nt!_ESERVERSILO_GLOBALS*)&nt!PspHostSiloGlobals)-
>EtwSiloState->EtwpLoggerContext))->Where(l => l != 1).Where(l => l->SecurityTrace ==
1).Select(i => new { Name = i->LoggerName, Consumers =
Debugger.Utility.Collections.FromListEntry(i->Consumers, "nt!_ETW_REALTIME_CONSUMER",
"Links")})[0n4].Consumers[0]                 [Type: _ETW_REALTIME_CONSUMER]
    [+0x000] Links            [Type: _LIST_ENTRY]
    [+0x010] ProcessHandle    : 0xffffffff800037b0 [Type: void *]
    [+0x018] ProcessObject    : 0xffffa58900524080 [Type: _EPROCESS *]
    [+0x020] NextNotDelivered : 0x0 [Type: void *]
    [+0x028] RealtimeConnectContext : 0x0 [Type: void *]
    [+0x030] DisconnectEvent  : 0xffffa5890188e2e0 [Type: _KEVENT *]
    [+0x038] DataAvailableEvent : 0xffffa5890188e760 [Type: _KEVENT *]
    [+0x040] UserBufferCount  : 0x202d0255450 : Unable to read memory at Address
0x202d0255450 [Type: unsigned long *]
    [+0x048] UserBufferListHead : 0x202d0255448 [Type: _SINGLE_LIST_ENTRY *]
    [+0x050] BuffersLost      : 0x0 [Type: unsigned long]
    [+0x054] EmptyBuffersCount : 0x0 [Type: unsigned long]
    [+0x058] LoggerId         : 0x4 [Type: unsigned short]
    [+0x05a] Flags            : 0x0 [Type: unsigned char]
    [+0x05a ( 0: 0)] ShutDownRequested : 0x0 [Type: unsigned char]
    [+0x05a ( 1: 1)] NewBuffersLost   : 0x0 [Type: unsigned char]
    [+0x05a ( 2: 2)] Disconnected     : 0x0 [Type: unsigned char]
    [+0x05a ( 3: 3)] Notified         : 0x0 [Type: unsigned char]
    [+0x05a ( 4: 4)] Wow              : 0x0 [Type: unsigned char]
    [+0x060] ReservedBufferSpaceBitMap [Type: _RTL_BITMAP]
    [+0x070] ReservedBufferSpace : 0x202d0360000 : Unable to read memory at Address
0x202d0360000 [Type: unsigned char *]
    [+0x078] ReservedBufferSpaceSize : 0x80000 [Type: unsigned long]
    [+0x07c] UserPagesAllocated : 0x0 [Type: unsigned long]
    [+0x080] UserPagesReused  : 0x3d [Type: unsigned long]
    [+0x088] EventsLostCount  : 0x202d0255368 : Unable to read memory at Address
0x202d0255368 [Type: unsigned long *]
    [+0x090] BuffersLostCount : 0x202d025536c : Unable to read memory at Address
0x202d025536c [Type: unsigned long *]
    [+0x098] SiloState        : 0xffffa588f8631000 [Type: _ETW_SILODRIVERSTATE *]

3: kd> dx ((nt!_EPROCESS*)0xffffa58900524080)->Protection
((nt!_EPROCESS*)0xffffa58900524080)->Protection                [Type: _PS_PROTECTION]
    [+0x000] Level            : 0x0 [Type: unsigned char]
    [+0x000 ( 2: 0)] Type             : 0x0 [Type: unsigned char]
    [+0x000 ( 3: 3)] Audit            : 0x0 [Type: unsigned char]
    [+0x000 ( 7: 4)] Signer           : 0x0 [Type: unsigned char]
```

As a point of contention for the reader, it is worth noting that this POC is not capable of enabling sources of telemetry which are disabled by default on processes. For example, one still needs Antimalware-PPL in order to call `NtSetInformationProcess` to enable impersonation events -

which have to be explicitly enabled through this privileged system call that this POC is incapable of making. The method outlined here is capable of consuming the following telemetry by default (telemetry that is emitted without a separate privileged system call being made to enable it on a per-process basis):

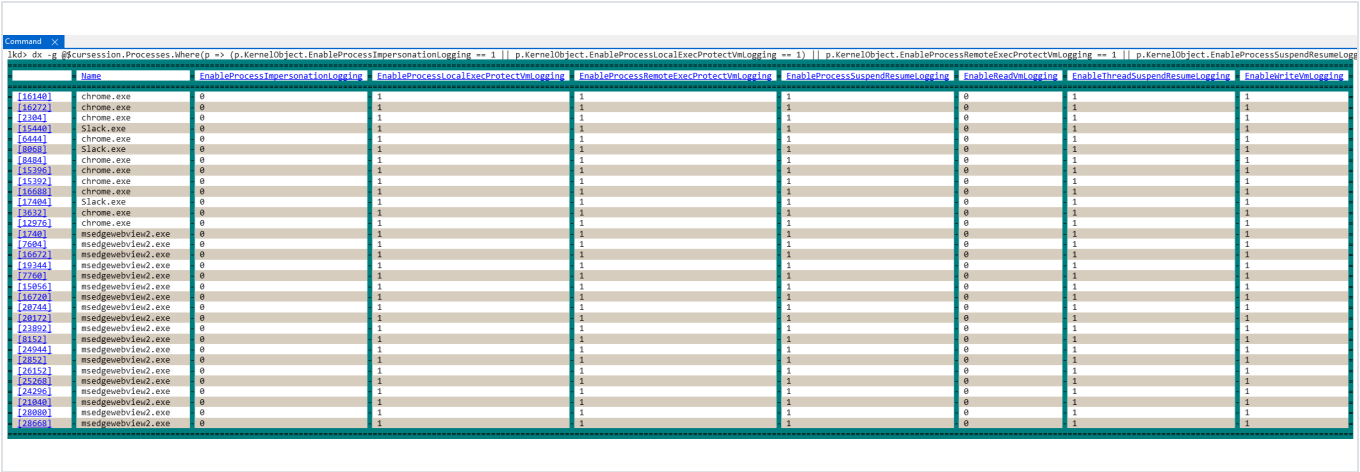
1. Executable memory allocation events (user-mode and kernel-mode callers)
2. Executable memory mapping events (user-mode and kernel-mode callers)
3. Remote APC events (user-mode)
4. Thread context update events (SetThreadContext)
5. Kernel-mode device and driver load and unload events
6. System call events. At the time this blog post was written, this includes only NtSystemDebugControl and NtQuerySystemInformation system calls

However, it is also worth pointing out that on the latest Insider Preview version of Windows (Canary channel), there are several processes which have already been opted-in to the "optional" telemetry (including memory protection, process/thread suspension, and other events). This means that using the methodology outlined in this blog post will result in receiving such events "for free". This is a result of Microsoft Defender invoking the functionality, since it is a process running at Antimalware-PPL, for enabling the other "optional" telemetry bits.

```
Command
2: kd> dx @$curprocess.Name
@$curprocess.Name : MsMpEng.exe
    Length           : 0xb
2: kd> r rdx
rdx=0000000000000060
2: kd> k
 # Child-SP          RetAddr               Call Site
00 fffff586`8bea7a98 fffff804`a46b8c55     nt!NtSetInformationProcess
01 fffff586`8bea7aa0 00007ffd`38241e84     nt!KiSystemServiceCopyEnd+0x25
02 00000092`54cfdbb8 00007ffd`1efc3dfa     ntdll!NtSetInformationProcess+0x14
03 00000092`54cfdbc0 00000000`00000000     mpengine!_rsignal+0x20dbba
```

A list of all processes which have opted-in to the optional Threat-Intelligence telemetry can be seen below:

```
dx -g @$cursession.Processes.Where(p =>
(p.KernelObject.EnableProcessImpersonationLogging == 1 ||
p.KernelObject.EnableProcessLocalExecProtectVmLogging == 1) ||
p.KernelObject.EnableProcessRemoteExecProtectVmLogging == 1 ||
p.KernelObject.EnableProcessSuspendResumeLogging == 1 ||
p.KernelObject.EnableReadVmLogging == 1 ||
p.KernelObject.EnableThreadSuspendResumeLogging == 1 ||
p.KernelObject.EnableWriteVmLogging == 1).Select(p => new { Name = p->Name,
EnableProcessImpersonationLogging = p.KernelObject.EnableProcessImpersonationLogging,
EnableProcessLocalExecProtectVmLogging =
p.KernelObject.EnableProcessLocalExecProtectVmLogging,
EnableProcessRemoteExecProtectVmLogging =
p.KernelObject.EnableProcessRemoteExecProtectVmLogging,
EnableProcessSuspendResumeLogging = p.KernelObject.EnableProcessSuspendResumeLogging,
EnableReadVmLogging  = p.KernelObject.EnableReadVmLogging,
EnableThreadSuspendResumeLogging = p.KernelObject.EnableThreadSuspendResumeLogging,
EnableWriteVmLogging = p.KernelObject.EnableWriteVmLogging }),d
```



	Name	EnableProcessImpersonationLogging	EnableProcessLocalExecProtectVmLogging	EnableProcessRemoteExecProtectVmLogging	EnableProcessSuspendResumeLogging	EnableReadVmLogging	EnableThreadSuspendResumeLogging	EnableWriteVmLogging
[16140]	chrome.exe	0	1	1	1	0	1	1
[16272]	chrome.exe	0	1	1	1	0	1	1
[2304]	chrome.exe	0	1	1	1	0	1	1
[15440]	Slack.exe	0	1	1	1	0	1	1
[6444]	chrome.exe	0	1	1	1	0	1	1
[8068]	Slack.exe	0	1	1	1	0	1	1
[8484]	chrome.exe	0	1	1	1	0	1	1
[15396]	chrome.exe	0	1	1	1	0	1	1
[15392]	chrome.exe	0	1	1	1	0	1	1
[16688]	chrome.exe	0	1	1	1	0	1	1
[17404]	Slack.exe	0	1	1	1	0	1	1
[30372]	chrome.exe	0	1	1	1	0	1	1
[12976]	chrome.exe	0	1	1	1	0	1	1
[1740]	msedgewebview2.exe	0	1	1	1	0	1	1
[7604]	msedgewebview2.exe	0	1	1	1	0	1	1
[16672]	msedgewebview2.exe	0	1	1	1	0	1	1
[19344]	msedgewebview2.exe	0	1	1	1	0	1	1
[7760]	msedgewebview2.exe	0	1	1	1	0	1	1
[15056]	msedgewebview2.exe	0	1	1	1	0	1	1
[16720]	msedgewebview2.exe	0	1	1	1	0	1	1
[20744]	msedgewebview2.exe	0	1	1	1	0	1	1
[20172]	msedgewebview2.exe	0	1	1	1	0	1	1
[23892]	msedgewebview2.exe	0	1	1	1	0	1	1
[8452]	msedgewebview2.exe	0	1	1	1	0	1	1
[24944]	msedgewebview2.exe	0	1	1	1	0	1	1
[2852]	msedgewebview2.exe	0	1	1	1	0	1	1
[26152]	msedgewebview2.exe	0	1	1	1	0	1	1
[25268]	msedgewebview2.exe	0	1	1	1	0	1	1
[24296]	msedgewebview2.exe	0	1	1	1	0	1	1
[21040]	msedgewebview2.exe	0	1	1	1	0	1	1
[28080]	msedgewebview2.exe	0	1	1	1	0	1	1
[28668]	msedgewebview2.exe	0	1	1	1	0	1	1

Conclusion

We have coordinated with Microsoft the findings in this blog post and MSRC has concluded no vulnerability exists due to the administrative <-> PPL boundary which is not enforceable. The `SecurityTrace` is a pretty obscure and undocumented flag that we found interesting as a result of research we were conducting within the Origin (By Prelude) company - in order to better protect our customers. This blog post would also be incomplete without any recommendation - which would be to move such a check for `SecurityTrace` traces to the kernel and not delegate it to user-mode. Thank you for reading and we hope you enjoyed this blog post!