

Raytheon

Blackbird Technologies

SIRIUS Pique Proof-of-Concept Delivery
Direct Kernel Object Manipulation (DKOM)
Interim PoC Report and Current Source Code

For

SIRIUS Task Order PIQUE

Submitted to:
U.S. Government

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1.0 (U) Executive Summary

(U) Direct Kernel Object Manipulation (DKOM) is a rootkit technique for hiding processes, drivers, and files from the system task manager and event scheduler. Process hiding via DKOM is accomplished by modifying the doubly linked list of active threads and processes so that forward and backward pointers (FLINK and BLINK) of items adjacent to the process so that they “point around” the process to be hidden. The task manager and event scheduler use EPROCESS, which relies on enumeration of the FLINKs and BLINKs to identify running processes, and if the FLINKs and BLINKs are modified processes become “hidden” from the task manager and event scheduler in **Figure 2**.

(U) As discussed at recent TEMS, we decided to produce a DKOM Proof-of-Concept (PoC) for Windows 8.1 64-bit. The reason for writing a DKOM PoC for Windows 8.1 is to provide a PoC that has a longer ‘shelf-life’ than one written against Windows Vista or Windows 7 going forward. We had originally investigated using user-mode API calls to ZwSystemDebugControl() to implement the PoC, but determined through research that it’s not practical for Windows 8.1. We have therefore focused our attention to writing a device driver and user application to call the driver as briefed at recent TEMs.

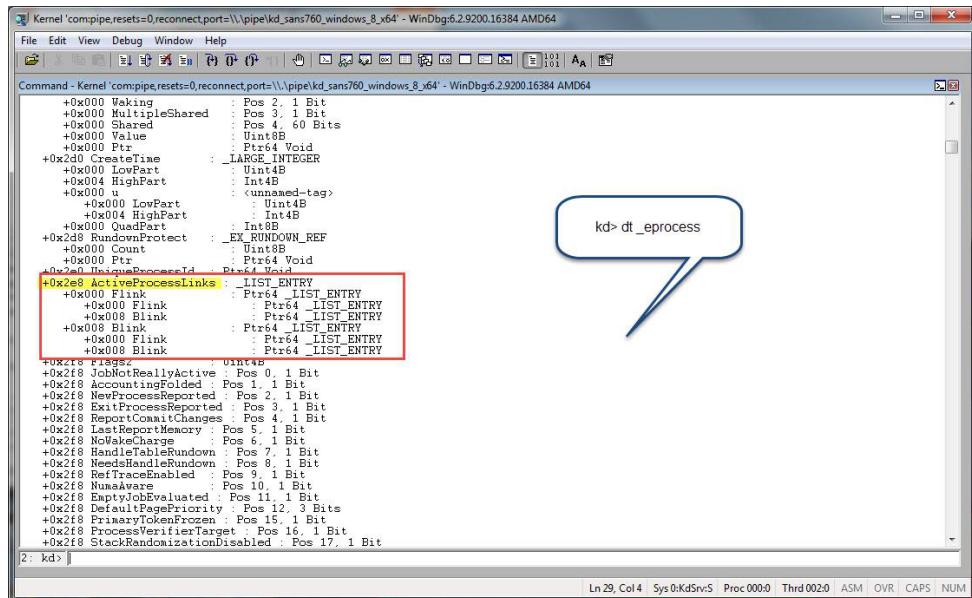
(U) It was our hope and intention to have this PoC ready for delivery on December 23rd and indications as late as Monday December 22nd were that we would be able to meet that deadline, but we ran into some issues during testing. The issues we encountered during testing are described later. All other PoCs and Analysis Reports were delivered as scheduled on December 23rd. We anticipate this PoC to be completed shortly after the holidays.

(U) We have the device driver and user application designed and coded. Both are compiling and the device driver is installing properly on the target Windows 8.1 64-bit machine. However, when the user application is executed, the target BSODs. It appears the issue is related to kernel memory and we are in the process of investigating. We suspect the device driver is accessing the wrong memory address in kernel space. We are very close to having the PoC functioning properly and will have this difficult and complex PoC working in January.

2.0 (U) Description of the PoC Technique

(U) To implement this PoC we first need to locate the ‘ActiveProcessList’, which is in the EPROCESS structure and contains the FLINK and BLINK we need to adjust in order to hide the process of our choosing. In Windows 8.1 64-bit, the ‘ActiveProcessList’ happens to be at offset 0x2e8 as seen in **Figure 1**. We’ve hardcoded the offset into our driver code for the purposes of this PoC, but in a production capability we would check for the target Operating System and plug the correct offset into the code at runtime.

(U) Once we’ve gotten access to the FLINK and BLINK we will modify them to point “around” the process we want to hide, thereby making them “invisible” to the system task manager and system management tools that rely on the information provided by the processes FLINK and BLINK information. This high-level description of the PoC technique is depicted in **Figure 2**.



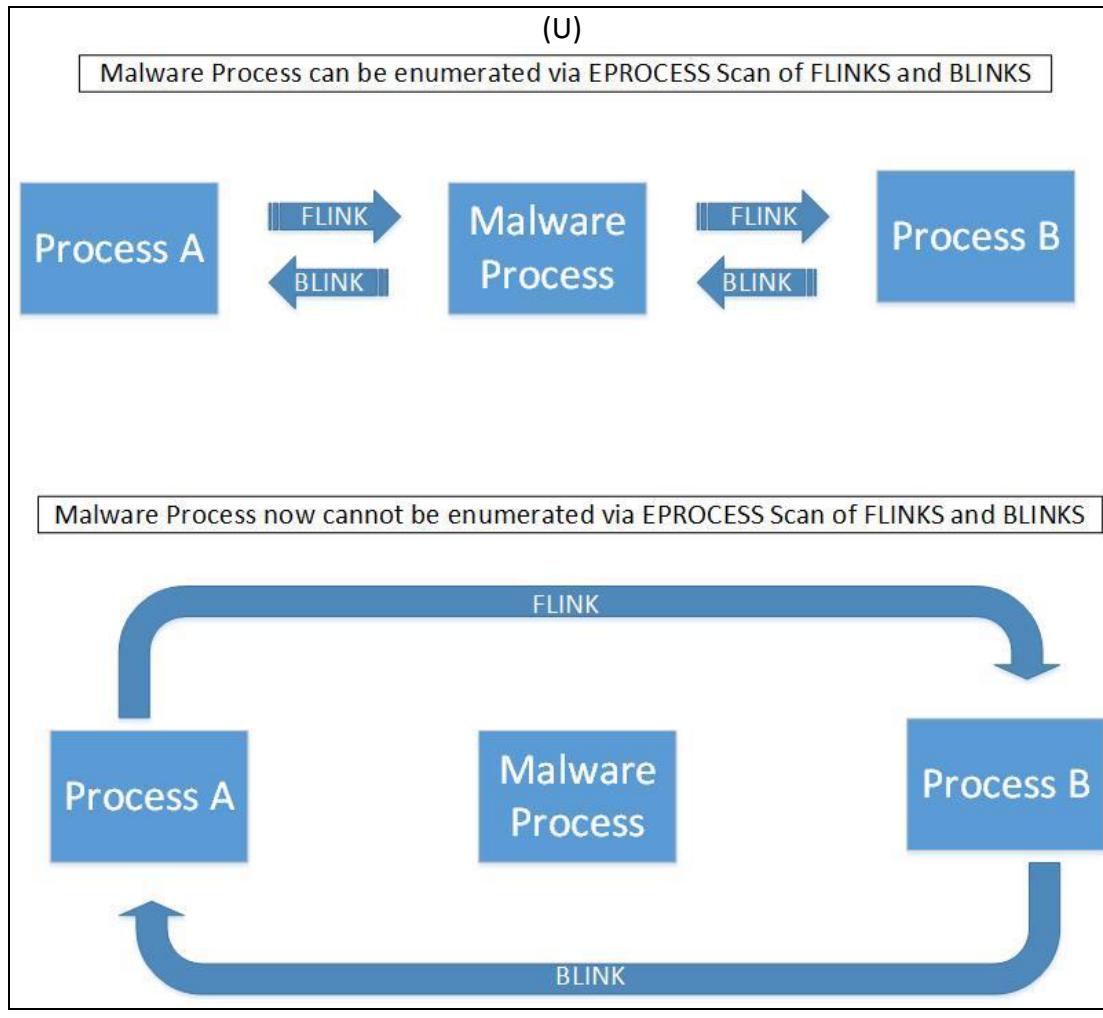
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File Edit View Debug Window Help
File Edit View Debug Window Help
Command - Kernel\compipe.reset=0,reconnect.port=\\pipe\kd_sans760_windows_8_x64 - WinDbg 6.2.9200.16384 AMD64
+0x0000 Walking : Pos 2. 1 Bit
+0x0000 Multiplexed : Pos 3. 1 Bit
+0x0000 Shared : Pos 4. 50 Bits
+0x0000 Value : Int32B
+0x0000 Ptr : Ptr64 Void
+0x2d0 CreateTime : _LARGE_INTEGER
+0x0000 LowPart : UInt4B
+0x0000 HighPart : Int4B
+0x0000 : unnamed-tag
+0x0000 LowPart : UInt4B
+0x0004 HighPart : Int4B
+0x2d0 QuadPart : Int64
+0x2d0 RevisionProtect : _EXCEPTION_POINTING_REF
+0x0000 Count : UInt32
+0x0000 Ptr : Ptr64 Void
+0x2e0 UserId : Ptr64 Void
+0x2e0 UserProcessId : Ptr64 Void
+0x2e8 ActiveProcessLinks : _LIST_ENTRY
+0x2e80 : Ptr64 _LIST_ENTRY
+0x2e80 Flink : Ptr64 _LIST_ENTRY
+0x2e80 Blink : Ptr64 _LIST_ENTRY
+0x0000 Blink : Ptr64 _LIST_ENTRY
+0x0000 Flink : Ptr64 _LIST_ENTRY
+0x0000 Blink : Ptr64 _LIST_ENTRY
+0x2f0 : unnamed-tag
+0x2f0 JobNotReallyActive : Pos 0. 1 Bit
+0x2f0 AccountingFolded : Pos 1. 1 Bit
+0x2f0 NewProcessReported : Pos 2. 1 Bit
+0x2f0 NewThreadReported : Pos 3. 1 Bit
+0x2f0 ReportConcurred : Pos 4. 1 Bit
+0x2f0 LastReportMemory : Pos 5. 1 Bit
+0x2f0 NcWakeCharge : Pos 6. 1 Bit
+0x2f0 HandleTableRundown : Pos 7. 1 Bit
+0x2f0 HandleTableRundown : Pos 8. 1 Bit
+0x2f0 RefTraceEnabled : Pos 9. 1 Bit
+0x2f0 NumaAware : Pos 10. 1 Bit
+0x2f0 EmptyJobEvaluated : Pos 11. 1 Bit
+0x2f0 DefaultPagePriority : Pos 12. 3 Bits
+0x2f0 PrimaryTokenFrom : Pos 15. 3 Bits
+0x2f0 ProcessVerifierTarget : Pos 16. 1 Bit
+0x2f0 StackRandomizationDisabled : Pos 17. 1 Bit
2: kd> 

```

Ln 29, Col 4 Sys 0:KdSrvS Proc 000:0 Thrd 002:0 ASM OVR CAPS NUM

Figure 1. ActiveProcessList in EPROCESS at Offset 0x2e8



3.0 (U) Current Status

(U) We've reverse engineered the Windows 8.1 64-bit data structures and have determined the EPROCESS offsets for the elements of that structure we need to modify the target FLINKs and BLINKs in order to hide the processes of interest.

(U) We've designed and coded both the DKOM device driver and the user application that interacts with the device driver to hide the processes. Both projects are compiling correctly and the device driver is loading properly on the Windows 8.1 64-bit target.

(U) The DKOM device driver and the user application have been written in C language and compiled with Microsoft's Visual Studio 2013. We used Microsoft's WDK 8.1. We use Visual Studio 2013's integrated driver testing facilities to connect to a remote (VMWare image) Windows 8.1 64-bit target.

(U) Although both the device driver and the user application are compiling properly and the device driver installs properly on the target, when the user application is executed we get a hard bugcheck, which results in BSOD. We are in the process of tracking down the bugcheck and expect to have the PoC working in January.

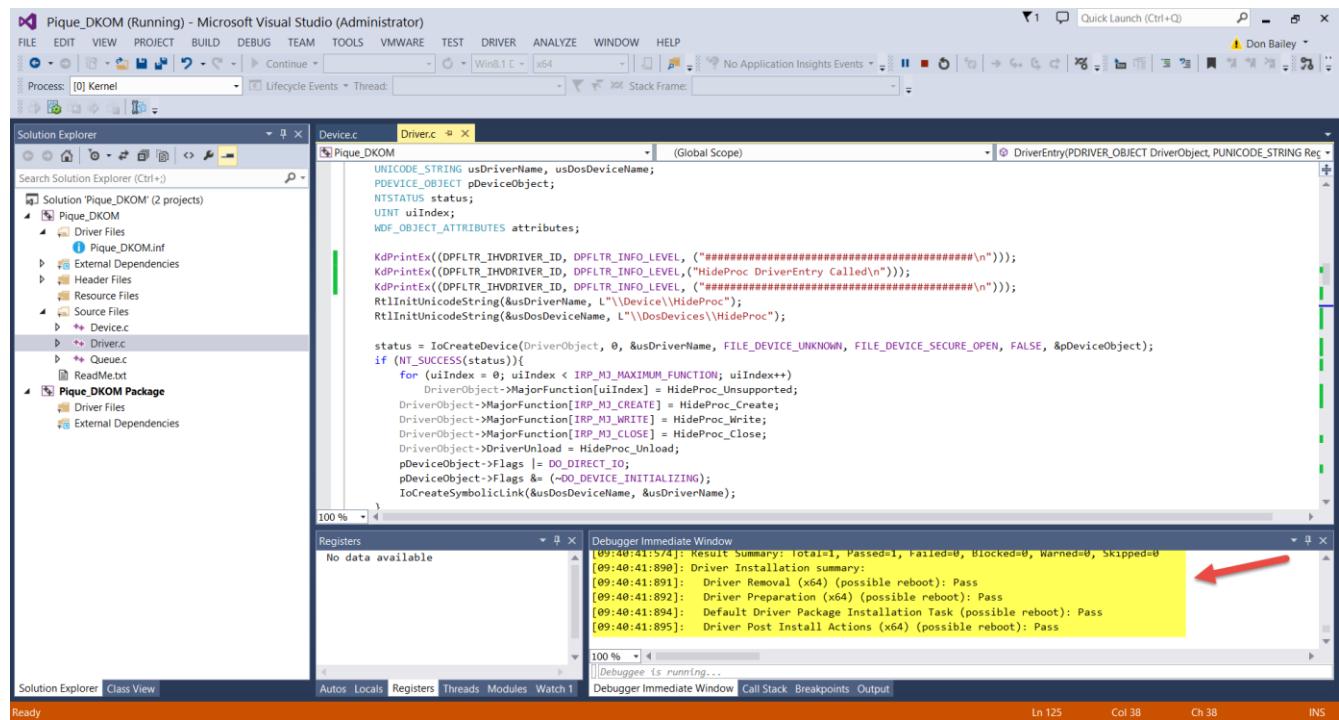


Figure 3. DKOM Device Driver Compiles and Loads on Target Correctly

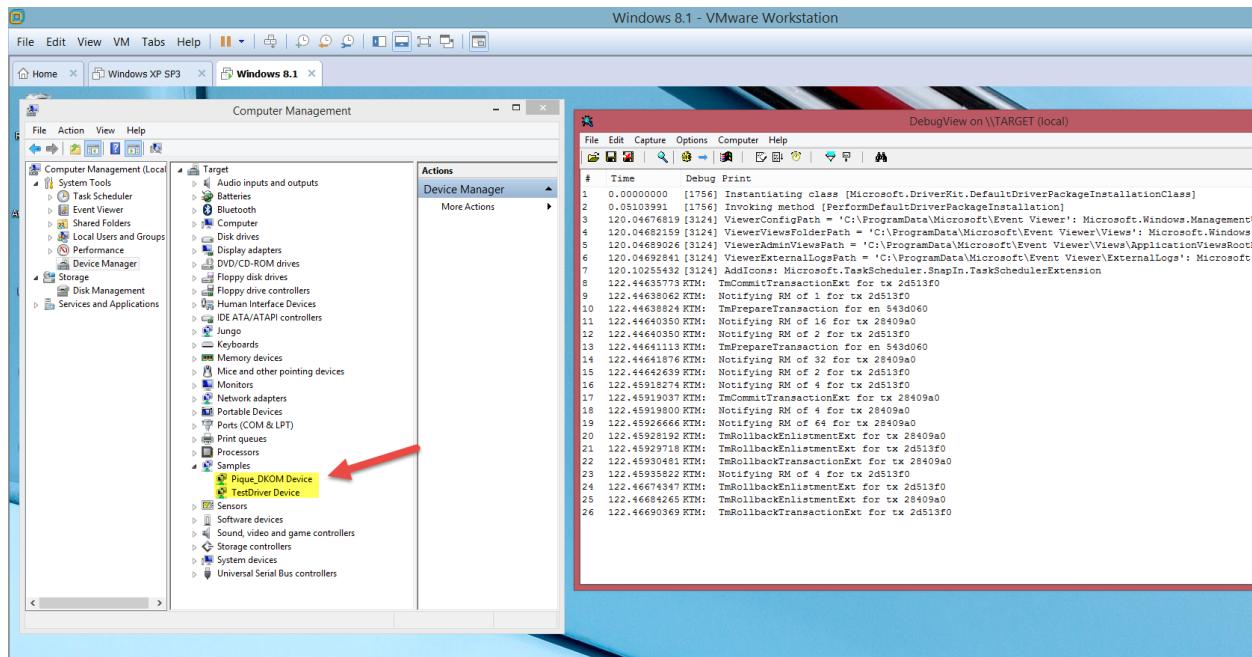


Figure 4. DKOM Device Driver Loads on Remote Target

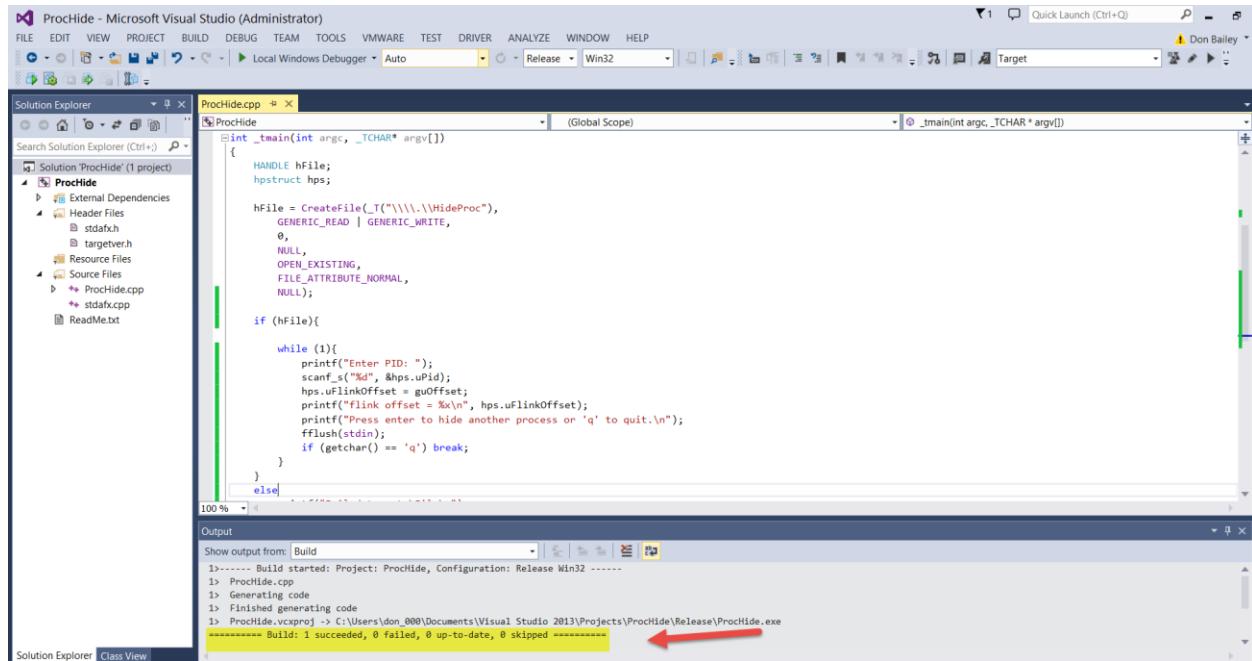


Figure 5. User Application Compiles Correctly

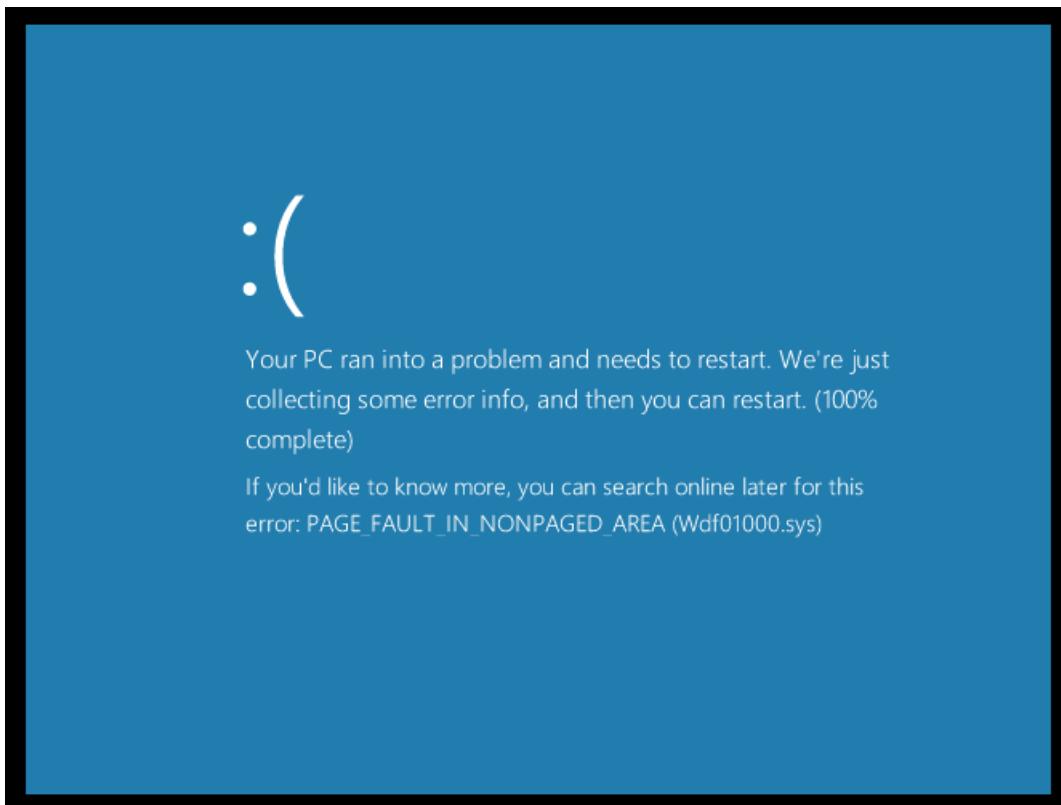


Figure 6. Execution of User Application on Target BSODs

4.0 (U) Next Steps

(U) We will debug the target kernel during our PoC code execution to get insight into the nature of the BSOD. We will review the user application and driver code to find any improper memory address usage or IRP-based communications errors between the user application and device driver. We will draw on additional debug/reverse engineering resources within Blackbird to track down the issue(s) with the BSOD down and resolve them.

(U) We believe we are very close to having this PoC completed.

5.0 (U) Delivery

(U) Per guidance received at the TEM on December 15, after describing the some of the development challenges, this report and the separately attached Microsoft Visual Studio 2013 Solution files with the associated compiler settings and configurations constitutes a PoC delivery for December.

(U) We expect to have the final working PoC completed and delivered in January after the holidays.