

Raytheon Blackbird Technologies

HeapDestroy - DLL Rootkit PoC Report

**For
SIRIUS Task Order PIQUE**

**Submitted to:
U.S. Government**

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1.0 (U) Analysis Summary

(U) ZxShell contained an interesting technique that might allow for hiding malicious DLLs and self deletion. Due to the description of this technique, additional research was performed to determine the viability of a Proof of Concept (PoC). In particular, the API call and DLL load procedure were investigated.

(U) Ultimately, we believe the overarching technique is valid; however, the description appears to contain multiple flaws that need to be mitigated during PoC development.

2.0 (U) Detailed Analysis

(U) For reference purposes, the text below describes the original process to implement the technique.

(U) The ZxShell's ShellMain() performs an interesting rootkit implementation. The ZxShell ShellMain function is a stub that relocates the main DLL to another buffer and spawns a new thread and performs an interesting hook of the HeapDestroy() API in order to hide the ZxShell.DLL. It replaces the first three bytes of HeapDestroy() with the RET 4 (opcode) and calls FreeLibrary() to free its own buffer. The allocated heaps will not be freed. It re-copies the DLL from the new buffer to the original one using memcpy(). It then spawns the main thread that starts at the original location of the ShellMainThread procedure, and terminates. At this point, the ZxShell library is no longer linked in the module list of the host process and any tool that tries to open the host process will never see the ZxShell.DLL.

(U) The primary concern with this technique is the purpose of the HeapDestroy() hook and is detailed below.

2.1 (U) API Hook

(U) Hooking HeapDestroy(), while possible, does not seem useful when trying to prevent DLL memory allocation and freeing. Typically, when a DLL is loaded, it inherits the parent process's heap and does not create its own.

(U) Further research into exactly how a DLL is loaded into memory showed that the above is, in fact, true. In actuality, when a DLL is loaded, the file is memory mapped into the virtual address space of the process. When one of the regions in the mapped file is accessed, a page fault occurs and the data is paged in by the OS's page fault handler (which resides in the kernel). Because of this procedure, it is impossible for us to hook anything to prevent unmapping the memory from usermode.

2.2 (U) Mitigation

(U) Because there is no manner easily available to prevent the memory from [potentially] being freed when unloaded, we believe a workaround was necessary to properly handle the situation. Instead of preventing the memory from being freed, the full loaded image is copied to a newly allocated block of memory. After freeing the library, the exact virtual address that the library was mapped to is allocated using VirtualAlloc() and the backed up image is copied in. In

this way, we are able to leverage the OS-handled relocations but effectively disappear from process lists. Additionally, because the library has been freed at this point, the library can self delete itself, but continue execution.

3.0 (U) Recommendations

(U) We recommend developing a PoC that incorporates the fixes detailed above. With these fixes, we believe that the PoC will demonstrate the ability to use the Operating System loader for slient loading and will also enable file self-deletion.