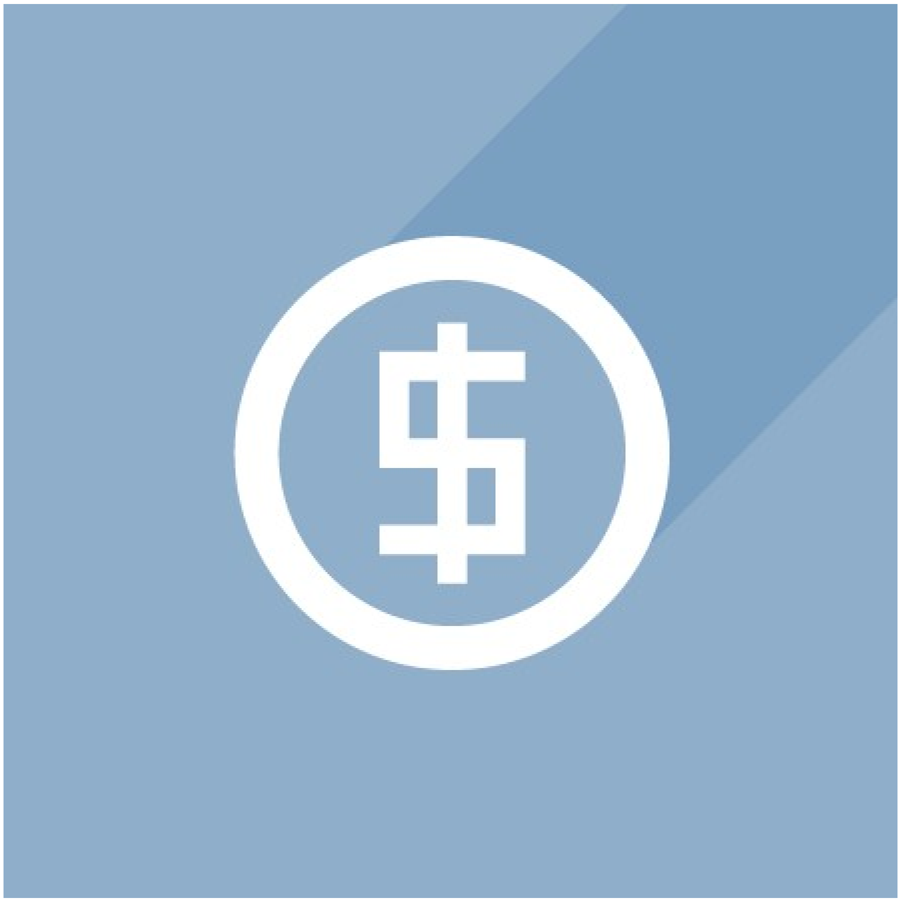
Dyre Banking Trojan Exploits CVE-2015-0057

fireeye.com/blog/threat-research/2015/07/dyre_banking_trojan.html

New variants of the Dyre Banking Trojan are exploiting a patched vulnerability in Microsoft Windows (**CVE-2015-0057)**. We first observed these new variants on June 17th -- more than 4 months after Microsoft released the patch (MS15-010).

CVE-2015-0057 is a Use-After-Free vulnerability that exists in the win32k.sys component of the Windows Kernel which can be exploited to perform local privilege escalation. The vulnerability was reported to Microsoft by Udi Yavo, and, after the patch was released, Udi authored a short blog describing a few details of the vulnerability. However, it is important to note that the exploit code for **CVE-2015-0057** has not yet been made public.



In addition to this, these new variants of Dyre also include an exploit for **CVE-2013-3660** as a fallback in case the system is patched for CVE-2015-0057.

Initial Validation

Initally, the malware first checks its privilege level. If it already has administrator rights, it decrypts the embedded resource **FILE1** using a single byte XOR decryption. The decrypted binary is then written to the file system and executed.

If the malware does not have administrator rights, it proceeds to perform the following sequence:

1. If the NT version is 5.x (Windows XP/Windows 2000/Windows 2003), it scans the following registry paths for the pattern "3036220":

   SOFTWARE\Microsoft\Updates\Windows XP\SP0

   SOFTWARE\Microsoft\Updates\Windows XP\SP10

   SOFTWARE\Microsoft\Updates\Windows XP\SP3

   SOFTWARE\Microsoft\Updates\Windows XP\SP4

This pattern is used to detect if the Microsoft Update (KB3036220 or MS-15-010) is installed and thus CVE-2015-0057 is patched. In this case, Dyre checks if CVE-2013-3660 is patched as well by scanning the registry for the pattern: "KB2850851" which corresponds to the security update for CVE-2013-3660. It looks for this pattern in the same registry paths as mentioned above. If it is not patched, then the exploit code corresponding to CVE-2013-3660 is used for escalation of privileges.

2. If the NT version is 6.0 or 6.1 (Windows Vista/Windows 7/Windows Server 2008), then it proceeds to scan the following path in the registry for the pattern "3036220":

SOFTWARE\Microsoft\Windows\CurrentVersion\Component Based Servicing\Packages.

Now, let us discuss in depth how this binary exploits the vulnerability from CVE-2015-0057.

Exploitation of CVE-2015-0057

The main vulnerability is in the function: win32k!xxxEnableWndSBArrows which is used to manage the Window scroll bars. The vulnerable code in xxxEnableWndSBArrows modifies the cEntries field of a previously allocated tagPROPLIST structure which is used by the exploit to modify other critical data structures.

Below are the steps used by Dyre to exploit the use-after-free vulnerability present in win32k!xxxEnableWndSBArrows:

1. Allocate large numbers of contiguous kernel memory by calling the routine win32k!CreateProp (to create tagPROPLIST structure of a particular size).

2. Free some tagPROPLIST structures selectively, to create memory holes for the vulnerable structure to fall into.

3. Allocate SBINFO structure by calling the routine win32k!_InitPwSB. tagPROPLIST size can be controlled from user mode.

An attacker would set the size of allocated tagPROPLIST to the size of SBINFO. After calling _InitPwSB, an SBINFO structure will fall into one of the holes in memory created in step 2.

4. Within the function, win32k!xxxEnableWndSBArrows, the routine xxxDrawScrollBar initiates a user mode callback.

a) In the process of the user mode callback (USER32!__ClientLoadLibrary), the attacker destroys the window, which frees a block of memory.

b) Before returning to xxxEnableWndSBArrows (in kernel mode), the attacker will invoke win32k!NtUserSetProp (in user mode). This action will occupy the kernel memory previously freed with a new tagPROPLIST structure, replacing the previously allocated SBINFO structure.

5. When the user mode callback returns to the kernel, the routine win32k!xxxEnableWndSBArrows will cause a modification (OR Instruction) of the tagPROPLIST.cEntries field. This will increase the size of the tagPROPLIST.aprop array. The main vulnerability is present here which is used by the exploit in the next steps.

Figure 1 shows the modification of cEntries field of tagPROPLIST structure in win32k!xxxEnableWndSBArrows:

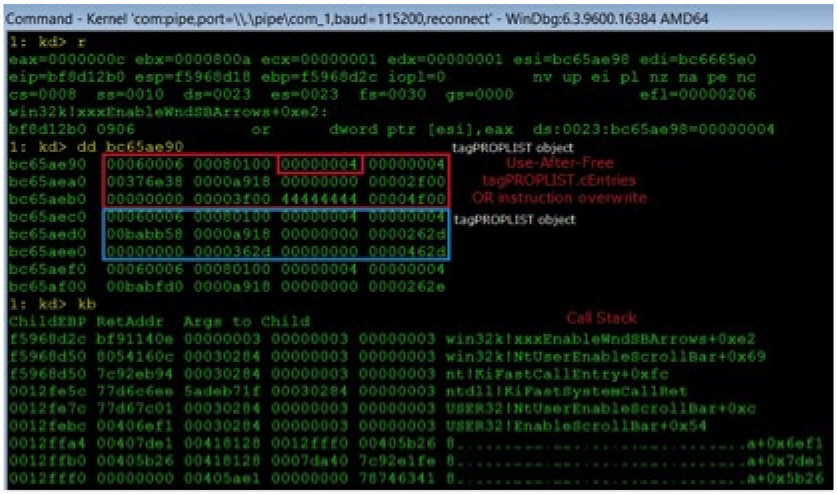


Figure 1: Modification of tagPROPLIST.cEntries field

6. Using this corrupted tagPROPLIST object, an attacker is able to achieve arbitrary relative memory writes. This primitive enables the exploit to overwrite a value within a critical GDI object.

7. Lastly, the attacker calls a function in win32k.sys which uses the above corrupted GDI object and this results in arbitrary memory write of absolute addresses.

8. The attacker is then able to modify a kernel function pointer to point to his shellcode buffer in user mode, leading to escalation of privileges.

Figure 2 summarizes the use-after-free memory overwrite and the sequence of arbitrary memory writes:

Figure 2: Sequence of Arbitrary Memory Writes

The technique used to redirect control flow to user mode shellcode and escalate the privileges is as follows:

1. HalDispatchTable+0x4 will be overwritten by the exploit as mentioned in step 7 above.

Figure 3 shows the exact point when HalDispatchTable+0x4 is overwritten with the address of user mode shellcode.

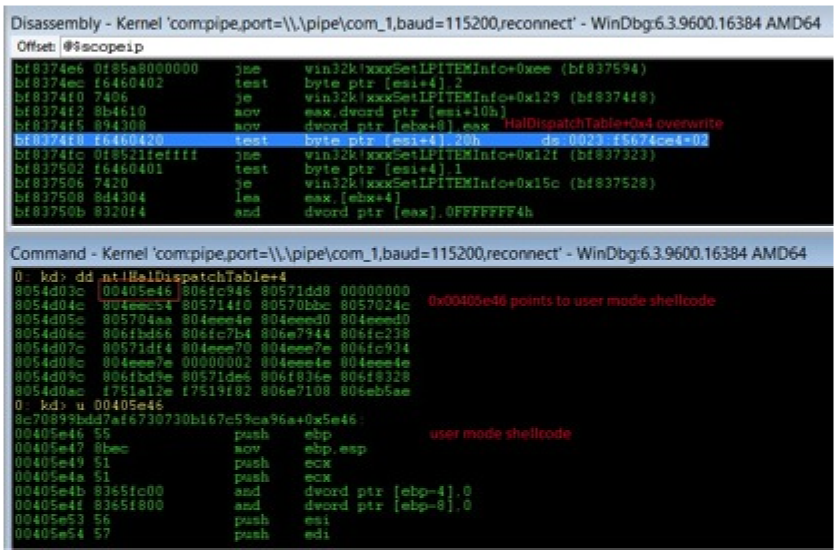


Figure 3: HalDispatchTable+0x4 Overwrite and User Mode Shellcode

2. From user mode, it calls the API, ZwQueryIntervalProfile. In kernel mode, this transfers control to HalDispatchTable+x04. Since the value at this location is overwritten with user mode shellcode, the control is transferred to privilege escalation shellcode.

This shellcode uses the standard method of copying the token field of the EPROCESS structure of the SYSTEM process and storing it in the EPROCESS structure of the target process. The following steps describe this technique:

1. Call PsLookupProcessByProcessId to get the pointer to EPROCESS structures of both victim process and SYSTEM process.

2. Call PsReferencePrimaryToken to get the token of both the processes.

3. Iterate over the EPROCESS structure of victim process to find the offset where token is stored.

4. Store the SYSTEM process token at that offset to escalate its privileges.

Similar shellcode was used in this binary for exploiting CVE-2013-3660 (used only if security update for CVE-2015-0057 is installed) however, we observed the following differences which indicate that these exploits were most likely written by 2 different authors or re-used from elsewhere.

CVE-2015-0057:

It fetches the EPROCESS structure of SYSTEM process using PsLookUpProcessByProcessId.

It uses an iteration counter of 0x200 to scan the EPROCESS structure for offset of token.

CVE-2013-3660:

It fetches the EPROCESS structure of SYSTEM process using PsInitialSystemProcess.

It uses an iteration counter of 0x300 to scan the EPROCESS structure for offset of token.

Kernel Mode Protections

It is important to note that this exploit does not bypass SMEP since it performs a user mode callback from kernel mode as described above. So, Windows 8.1 is not impacted by it.

For users of Win NT 5.x, Win NT 6.0 and Win NT 6.1, they are advised to install the update KB3036220 since this exploit is in the wild now.

Indicators of this Exploit Technique in User Mode

Below are some of the indicators of this exploit in user mode:

1. A Long sequence of calls to SetPropA/RemovePropA APIs.

2. Creation of an array of Windows in a loop and setting the Property list of each Window using SetPropA.

3. Destroying few windows from the above created array to create holes.

4. Calling EnableScrollBar with the parameters as shown below:

EnableScrollBar(hWnd, SB_BOTH, ESB_DISABLE_BOTH);

5. Calling ZwQueryIntervalProfile to perform the actual privilege escalation.

Conclusion

The inclusion of this most recent privilege escalation exploit in the code of Dyre indicates the sophistication of the malware authors of banking trojans.