RESEARCH

Windows zero-day exploit used in targeted attacks by FruityArmor APT

By Anton Ivanov on October 20, 2016. 8:56 am

A few days ago, Microsoft published the "critical" MS16-120 security bulletin with fixes for vulnerabilities in Microsoft Windows, Microsoft Office, Skype for Business, Silverlight and Microsoft Lync.

One of the vulnerabilities – CVE-2016-3393 – was reported to Microsoft by Kaspersky Lab in September 2016.

MS16-120	Win32k Elevation of Privilege Vulnerability	CVE-2016-3270	pgboy, zhong_sf of Qihoo 360 Vulcan Team
MS16-120	Windows Graphics Component RCE Vulnerability	CVE-2016-3393	Anton Ivanov of Kaspersky Lab
MS16-120	True Type Font Parsing Elevation of Privilege Vulnerability	CVE-2016-7182	Mateusz Jurczyk of Google Project Zero
MS16-119	Microsoft Browser Information Disclosure Vulnerability	CVE-2016-3267	Wenxiang Qian of Tencent QQBrowser

Here's a bit of background on how this zero-day was discovered. A few of months ago, we deployed a new set of technologies in our products to identify and block zero-day attacks. These technologies proved their effectiveness earlier this year, when we discovered two Adobe Flash zero-day exploits – CVE-2016-1010 and CVE-2016-4171. Two Windows EoP exploits have also been found with the help of this technology. One is CVE-2016-0165. The other is CVE-2016-3393.

Like most zero-day exploits found in the wild today, CVE-2016-3393 is used by an APT group we call **FruityArmor**. FruityArmor is perhaps a bit unusual due to the fact that it leverages an attack platform that is built entirely around PowerShell. The group's primary malware implant is written in PowerShell and all commands from the operators are also sent in the form of PowerShell scripts.

In this report we describe the vulnerability that was used by this group to elevate privileges on a victim's machine. Please keep in mind that we will not be publishing all the details about this vulnerability because of the risk that other threat actors may use them in their attacks.

Attack chain description

To achieve remote code execution on a victim's machine, FruityArmor normally relies on a browser exploit. Since many modern browsers are built around sandboxes, a single exploit is generally not sufficient to allow full access to a targeted machine. Most of the recent attacks we've seen that rely on a browser exploit are combined with an EoP exploit, which allows for a reliable sandbox escape.

In the case of FruityArmor, the initial browser exploitation is always followed by an EoP exploit. This comes in the form of a module, which runs directly in memory. The main goal of this module is to unpack a specially crafted TTF font containing the CVE-2016-3393 exploit. After unpacking, the module directly loads the code exploit from memory with the help of AddFontMemResourceEx. After successfully leveraging CVE-2016-3393, a second stage payload is executed with higher privileges to execute PowerShell with a meterpreter-style script that connects to the C&C.

EOP zero-day details

The vulnerability is located in the **cjComputeGLYPHSET_MSFT_GENERAL** function from the Win32k.sys system module. This function parses the cmap table and fills internal structures. The CMAP structure looks like this:

Type	*Name*
USHORT	format
USHORT	length
USHORT	language
USHORT	segCountX2
USHORT	searchRange
USHORT	entrySelector
USHORT	rangeShift
USHORT	endCount[segCount]
USHORT	reservedPad
USHORT	startCount[segCount]
SHORT	idDelta[segCount]
USHORT	idRangeOffset[segCount]
USHORT	glyphIdArray[ ]

The most interesting parts of this structure are two arrays – endCount and startCount. The exploit contains the next cmap table with segments:

```
Length:     48
Version:    0
segCount:   28  (X2 = 56)
searchRange:    32
entrySelector:  4
rangeShift: 24
Seg   1 : St = 0000, En = 1388, D =      0, RO =     1, gId# = -28
Seg   2 : St = 1388, En = 1770, D =      0, RO =     1, gId# = -27
Seg   3 : St = 1770, En = 1B58, D =      0, RO =     1, gId# = -26
Seg   4 : St = 1B58, En = 1F40, D =      0, RO =     1, gId# = -25
Seg   5 : St = 1F40, En = 2328, D =      0, RO =     1, gId# = -24
Seg   6 : St = 2328, En = 238C, D =      0, RO =     1, gId# = -23
Seg   7 : St = 238C, En = 23F0, D =      0, RO =     1, gId# = -22
Seg   8 : St = 23F0, En = 2454, D =      0, RO =     1, gId# = -21
Seg   9 : St = 2454, En = 24B8, D =      0, RO =     1, gId# = -20
Seg  10 : St = 24B8, En = 251C, D =      0, RO =     1, gId# = -19
Seg  11 : St = 251C, En = 2580, D =      0, RO =     1, gId# = -18
Seg  12 : St = 2580, En = 25E4, D =      0, RO =     1, gId# = -17
Seg  13 : St = 25E4, En = 2648, D =      0, RO =     1, gId# = -16
Seg  14 : St = 2648, En = 2710, D =      0, RO =     1, gId# = -15
Seg  15 : St = 2710, En = 3A98, D =      0, RO =     1, gId# = -14
Seg  16 : St = 3A98, En = 4E20, D =      0, RO =     1, gId# = -13
Seg  17 : St = 4E20, En = 61A8, D =      0, RO =     1, gId# = -12
Seg  18 : St = 61A8, En = 7530, D =      0, RO =     1, gId# = -11
Seg  19 : St = 7530, En = 88B8, D =      0, RO =     1, gId# = -10
Seg  20 : St = 88B8, En = 9C40, D =      0, RO =     1, gId# = -9
Seg  21 : St = 9C40, En = AFC8, D =      0, RO =     1, gId# = -8
Seg  22 : St = AFC8, En = C350, D =      0, RO =     1, gId# = -7
Seg  23 : St = C350, En = D6D8, D =      0, RO =     1, gId# = -6
Seg  24 : St = D6D8, En = EA60, D =      0, RO =     1, gId# = -5
Seg  25 : St = EA60, En = EE48, D =      0, RO =     1, gId# = -4
Seg  26 : St = EE48, En = F230, D =      0, RO =     1, gId# = -3
Seg  27 : St = F231, En = FFFE, D =      0, RO =     1, gId# = -2
Seg  28 : St = FFFF,      = FFFF, D =      0, RO =     1, gId# = -1
```

To compute how much memory to allocate to internal structures, the function executes this code:

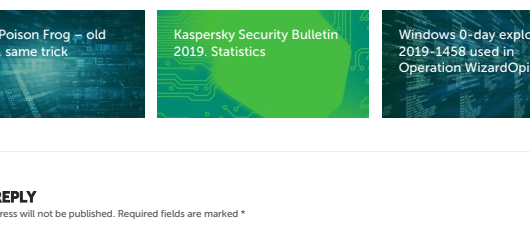
```
USHORT  cnt=0;
for (int i=0; i<cnt;i++)
       cnt += (Seg[i].end - Seg[i].start)+1
```

After computing this number, the function allocates memory for structures in the following way:

```
text:BF9EAB40 loc_BF9EAB40:                   ; CODE XREF: cjComputeGLYPHSET_MSFT_GENERAL(x,x,x,x)+75↑j
text:BF9EAB40                 movzx   eax, dx
text:BF9EAB43                 push    64667A54h       ; Tag
text:BF9EAB48                 shl     eax, 3
text:BF9EAB4B                 push    eax             ; int
text:BF9EAB4C                 push    ebx             ; char
text:BF9EAB4D                 call    EngAllocMem@12  ; EngAllocMem(x,x,x)
```

The problem is that if we compute the entire table, we will achieve an integer overflow and the **cnt** variable will contain an incorrect value.

In kernel, we see the following picture:



The code allocates memory only for 0x18 InternalStruct but then there is a loop for all the segments range (this value was extracted from the file directly):

```
v38 = EngAllocMem(v12, 8 * (unsigned __int16)v14, 'dFtI');   V14=0x18
if ( v38 )
{
  v44 = 0;
  v46 = 0;
  if ( v13 > 0 )
  {
    v18 = 0;
    v19 = v40 - (_DWORD)v39;
    for ( j = v40 - (_DWORD)v39; ; v19 = j )
    {
      LOBYTE(v20) = *(unsigned __int16 *)((char *)v39 + v19) >> 8;
      HIBYTE(v20) = *(unsigned __int16 *)((char *)v39 + v19);
      v21 = v20;
      HIBYTE(v22) = *v39;
      v34 = v20;
      LOBYTE(v22) = *v39 >> 8;
      v23 = v22;
      v33 = v22;
      if ( v22 >= v34 && v21 != -1 )
      {
        LOWORD(v24) = v21;
        v42 = v21;
        if ( v21 <= v23 )
        {
          v25 = (unsigned __int16 *)(v35 + 2 * v18);
          v41 = v21;
          do
          {
            v26 = v38 + 8 * v44;
            *(_DWORD *)v26 = 0;
```

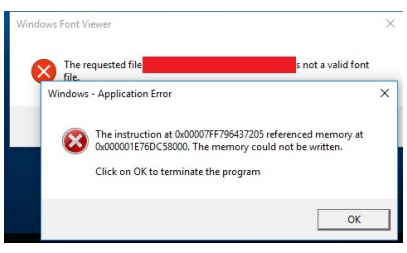
Using the cmap table, the v44 variable (index) could be controlled and, as a result, we get memory corruption. To achieve it, the attacker can do the following:

1. Make an integer overflow in **win32kIcjComputeGLYPHSET_MSFT_GENERAL**
2. Make a specific segment ranges in font file to access interesting memory.

What about Windows 10? As most of you know, the font processing in Windows 10 is performed in a special user mode process with restricted privileges. This is a very good solution but the code has the same bug in the TTF processing.

```
.text:0000000140056509                 cmp     ax, r14w
.text:000000014005650D                 jz      short loc_140056565
.text:000000014005650F                 sub     ax, cx
.text:0000000140056512                 inc     ax
.text:0000000140056514                 add     r8w, ax
.text:0000000140056517
.text:0000000140056517 loc_140056517:                          ; CODE XREF:
.text:0000000140056517                                         ; cjComputeGl
.text:0000000140056517                 inc     dx
.text:000000014005651A                 add     r8w, 2
.text:000000014005651F                 movzx   eax, dx
.text:0000000140056522                 add     r9, 2
.text:0000000140056526                 cmp     eax, ebp
.text:0000000140056528                 jl      short loc_140056509
.text:000000014005652A
.text:000000014005652A loc_14005652A:                          ; CODE XREF:
.text:000000014005652A                 movzx   edx, r8w
.text:000000014005652F                 xor     ecx, ecx        ; dwFlags
.text:0000000140056531                 shl     rdx, 3          ; dwBytes
.text:0000000140056535                 call    cs:__imp_GlobalAlloc
.text:000000014005653C                 mov     rdi, rax
```

As a result, if you load/open this font exploit in Windows 10, you will see the crash of fontdrvhost.exe:



Kaspersky Lab detects this exploit as:

- HEUR:Exploit.Win32.Generic
- PDM:Exploit.Win32.Generic

We would like to thank Microsoft for their swift response in closing this security hole.

** More information about the FruityArmor APT group is available to customers of Kaspersky Intelligence Services. Contact: intelreports@kaspersky.com*

APT MICROSOFT ZERO-DAY VULNERABILITIES

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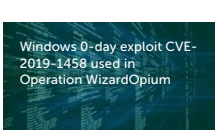

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