TrickBot's new API-Hammering explained

joesecurity.org/blog/498839998833561473

As usual, at Joe Security, we keep a close eye on evasive malware. Some days ago we detected an interesting sample, MD5: b32d28ebab62e99cd2d46aca8b2ffb81. It turned out to be a new TrickBot sample using API hammering to bypass analysis. In this blog post, we will outline the evasion and explain how it works.

The full analysis report of the TrickBot variant is available here.

Two Stage API Hammering

Right after the entry point, the sample tries to load taskmgr.exe as a DLL:

This is likely a trick to bypass emulators that do not check if a given DLL exists if LoadLibraryEx is called. Next, it performs a massive *printf* loop - the first stage. Since before the loop *FreeConsole* has been called all *printf* calls do basically nothing:

```
0x00401af5          _v8572 = _v8576;
0x00401b03          while(1) {
0x00401b03              _a12 = _a12 - 1;
0x00401b0b              _t124 = (_t81 + 1) % 0x215f;
0x00401b0d              _push("blue");
0x00401b17              _t103 = _t131 + _t124 - 0x2168;
0x00401b1e              _t84 =  *_t103;
0x00401b20              _v8557 = _t84;
0x00401b2f              _v8568 = _t124;
0x00401b37              _t126 = ((_t84 & 0x000000ff) + _v8564) % 0x215f;
0x00401b39              _t88 = _t131 + _t126 - 0x2168;
0x00401b42               *_t103 =  *_t88;
0x00401b4a              _v8564 = _t126;
0x00401b50               *_t88 = _v8557; // executed
0x00401b52              printf("The color: %s\n"); // executed
0x00401b54              _push(0x3039);
0x00401b5e              printf("First number: %d\n"); // executed
0x00401b60              _push(0x19);
0x00401b67              printf("Second number: %04d\n"); // executed
0x00401b69              _push(0x4d2);
0x00401b73              printf("Third number: %i\n"); // executed
0x00401b7b              _t133 = _t132 + 0x18;
0x00401b7e               *_t133 =  *0x403f00;
0x00401b86              printf("Float number: %3.2f\n"); // executed
0x00401b88              _push(0xff);
0x00401b92              printf("Hexadecimal: %x\n"); // executed
0x00401b94              _push(0xff);
0x00401b9e              printf("Octal: %o\n"); // executed
0x00401ba0              _push(0x96);
0x00401baa              printf("Unsigned value: %u\n"); // executed
0x00401bac              _push(0xa);
0x00401bb3              printf("Just print the percentage sign %%\n"); // executed
0x00401bc1              asm("cdq");
0x00401bc4              _t115 = (( *_t103 & 0x000000ff) + (_v8557 & 0x000000ff)) % 0x215f;
0x00401bc6              _t101 = _v8572;
0x00401bcc              _t132 = _t133 + 0x2c;
0x00401bd6               *_t101 =  *_t101 ^  *(_t131 + (( *_t103 & 0x000000ff) + (_v8557 & 0x000000ff)) % 0x215f - 0x2168);
0x00401bdd              _v8572 =  &(_t101[0]);
0x00401be3              if(_a12 == 0) {
0x00000000                  break;
0x00000000              }
```

File Written

File Path	Offset	Length	Value	Ascii	Completion	Count	Source Address	Symbol
unknown	unknown	17	54 68 65 20 63 6f 6c 6f 72 3a 20 62 6c 75 65 0d 0a	The color: blue..	invalid handle	12	77C22FBA	RtlUserThreadStart
unknown	unknown	21	46 69 72 73 74 20 6e 75 6d 62 65 72 3a 20 31 32 33 34 35 0d 0a	First number: 12345..	invalid handle	11	77C22FBA	RtlUserThreadStart
unknown	unknown	21	53 65 63 6f 6e 64 20 6e 75 6d 62 65 72 3a 20 30 30 32 35 0d 0a	Second number: 0025..	invalid handle	11	77C22FBA	RtlUserThreadStart
unknown	unknown	20	54 68 69 72 64 20 6e 75 6d 62 65 72 3a 20 31 32 33 34 0d 0a	Third number: 1234..	invalid handle	11	77C22FBA	RtlUserThreadStart
unknown	unknown	20	46 6c 6f 61 74 20 6e 75 6d 62 65 72 3a 20 33 2e 31 34 0d 0a	Float number: 3.14..	invalid handle	11	77C22FBA	RtlUserThreadStart
unknown	unknown	17	48 65 78 61 64 65 63 69 6d 61 6c 3a 20 66 66 0d 0a	Hexadecimal: ff..	invalid handle	11	77C22FBA	RtlUserThreadStart
unknown	unknown	12	4f 63 74 61 6c 3a 20 33 37 37 0d 0a	Octal: 377..	invalid handle	11	77C22FBA	RtlUserThreadStart
unknown	unknown	21	55 6e 73 69 67 6e 65 64 20 76 61 6c 75 65 3a 20 31 35 30 0d 0a	Unsigned value: 150..	invalid handle	11	77C22FBA	RtlUserThreadStart
unknown	unknown	34	4a 75 73 74 20 70 72 69 6e 74 20 74 68 65 20 70 65 72 63 65 6e 74 61 67 65 20 73 69 67 6e 20 25 0d 0a	Just print the percentage sign %..	invalid handle	11	77C22FBA	RtlUserThreadStart

This code has been directly copied from the documentation of printf:

Formatting other Types

Until now we only used integers and floats, but there are more types you can use. Take a look at the following example:

```
#include<stdio.h>

main()
{
        printf("The color: %s\n", "blue");
        printf("First number: %d\n", 12345);
        printf("Second number: %04d\n", 25);
        printf("Third number: %i\n", 1234);
        printf("Float number: %3.2f\n", 3.14159);
        printf("Hexadecimal: %x\n", 255);
        printf("Octal: %o\n", 255);
        printf("Unsigned value: %u\n", 150);
        printf("Just print the percentage sign %%\n", 10);
}
```

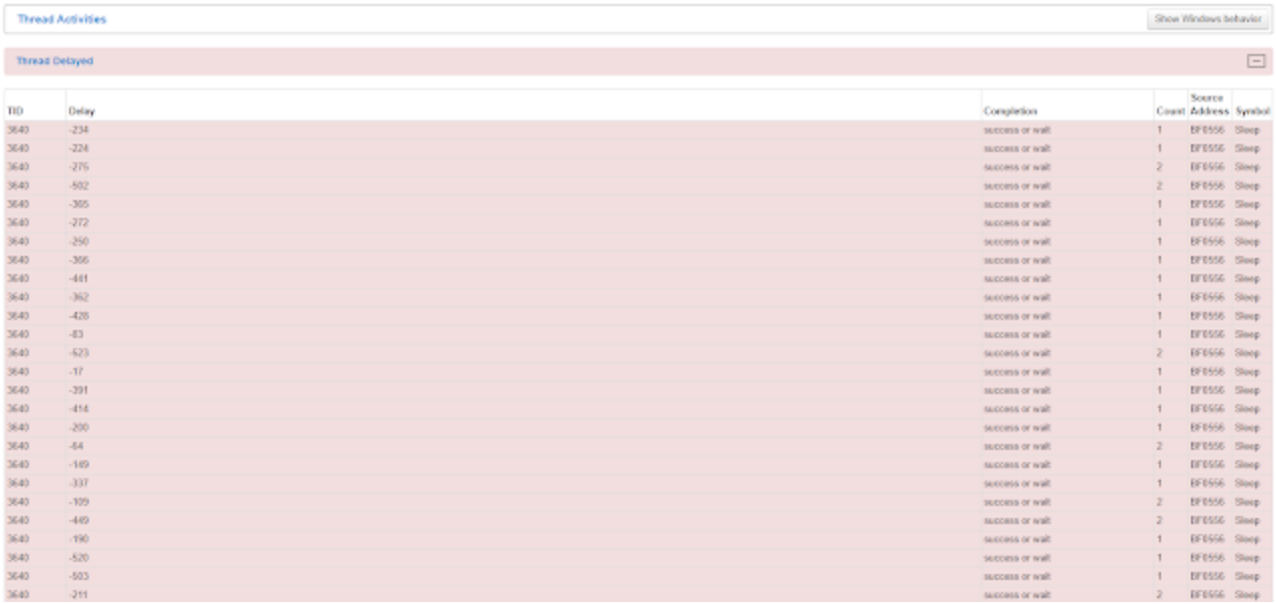
So what is the purpose of those numerous *printf* loops? Well, sandboxes are designed to log all behavior including the 1.8M calls. As a result, the massive amount of calls delay the execution process and overload the sandbox with junk data. As a result, the final payload is never called.

This behavior is called **API Hammering**. API Hammering is not a new technique, we have already seen it several years ago e.g. in the Nymaim Loader. Joe Sandbox detects the API hammering successfully and rates it as malicious:

Malware Analysis System Evasion:

High number of junk calls founds (likely related to sandbox DOS / API hammering)	
Source: Global behavior	Junk call stats: NtWriteFile 1841508

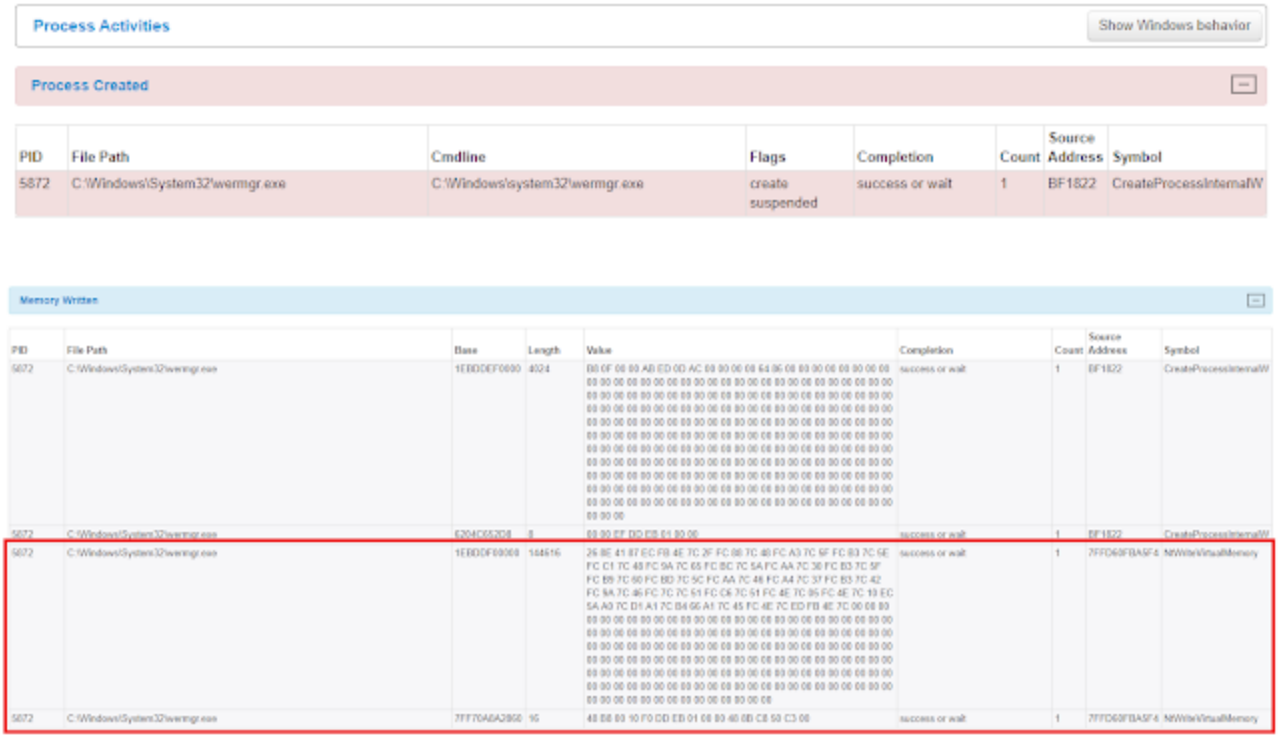
Right after the *printf* flood, the sample performs another loop to delay execution by creating and writing to a temporary file - the second stage. In between it performs random sleeps:



Again, the purpose is to overload the sandbox and delay the execution. This time however the all calls are valid.

WERMGR

Finally, when this loop is passed, the sample starts and injects TrickBot (by using directly Nt* APIs) into legit wermgr.exe - the process responsible for Windows error handling and reporting:



It's noticeable that a 32bit sample is able to inject successfully into 64bit *wermgr.exe* on a Windows 64bit.

In *wermgr.exe* TrickBot fully unpacks itself:

This enables Joe Sandbox to successfully detect TrickBot and extract full configurations:

E-Banking Fraud:

Yara detected Trickbot	
Source: Yara match	File source: Process Memory Space: wermgr.exe PID: 5764, type: MEMORY

Threatname: Trickbot


```
{
  "gtag": "ono45",
  "C2 list": [
    "110.232.76.39:449",
    "134.119.191.11:443",
    "107.175.72.141:443",
    "36.91.45.10:449",
    "185.90.61.9:443",
    "5.1.81.68:443",
    "185.99.2.65:443",
    "185.99.2.66:443",
    "45.6.16.68:449",
    "110.50.84.5:449",
    "181.112.157.42:449",
    "181.129.104.139:449",
    "200.107.35.154:449",
    "182.253.113.67:449",
    "85.204.116.216:443",
    "95.171.16.42:443",
    "103.111.83.246:449",
    "194.5.250.121:443",
    "181.129.134.18:449",
    "134.119.191.21:443",
    "190.136.178.52:449",
    "110.93.15.98:449",
    "91.235.129.20:443",
    "80.210.32.67:449",
    "36.89.182.225:449",
    "185.14.31.104:443",
    "192.3.247.123:443",
    "36.66.218.117:449",
    "122.50.6.122:449",
    "103.12.161.194:449",
    "121.100.19.18:449",
    "85.204.116.100:443",
    "131.161.253.190:449",
    "36.92.19.205:449",
    "78.108.216.47:443",
    "36.89.243.241:449",
    "51.81.112.144:443"
  ],
  "modules": [
    "pwgrab",
```


Conclusion

In contrast to many other evasions, API Hammering is one of the more interesting techniques since it directly exploits the design of a sandbox. No matter what technology your favorite sandbox uses, it has to handle API Hammering correctly.

You are interested to get a list of other evasive malware analyses? Check out these other blogs:

- New Sandbox Evasions spot in VBS samples
- Analyzing Azorult's Anti-Analysis Tricks with Joe Sandbox Hypervisor
- Fighting Country Aware Microsoft Office Macro Droppers with VBA Instrumentation
- Malicious Documents: The Evolution of country-aware VBA Macros

or this extensive list of evasive samples.

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