

Cardinal RAT Sins Again, Targets Israeli Fin-Tech Firms

By Tom Lancaster, Josh Grunzweig

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In 2017, Unit 42 reported on and analyzed a low-volume malware family called [Cardinal RAT](#). This malware family had remained undetected for over two years and was delivered via a unique downloader named Carp Downloader. Since that publication, we have continued to monitor this threat, resulting in the discovery of a series of attacks using an updated version of Cardinal RAT. A series of modifications have been made to the RAT, many of which are used to evade detection and hinder analysis.

We witnessed attacks targeting the financial technology (FinTech) sector, primarily focused on organizations based in Israel. While researching these attacks, we discovered a possible relationship between Cardinal RAT and another malware family named EVILNUM. EVILNUM is a JavaScript-based malware family that is used in attacks against similar organizations.

Cardinal RAT Employs BMP Trick

Since the original discovery of Cardinal RAT, the attackers have made some minor updates that are worth discussing, particularly regarding obfuscation techniques. For the sake of this analysis we'll look at the most recent version of Cardinal RAT:

SHA256	b742162197744a8caeb09f954213a3172ed699f8375f69c40b57b8c219c5e37c
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The last time [we wrote about Cardinal RAT in 2017](#), we looked at version 1.4 of the malware family. We identify this latest sample as version 1.7.2 based on information within the payload. Unlike previously discussed samples, this latest instance of Cardinal RAT employs various obfuscation techniques to hinder analysis of the underlying code. The first layer of obfuscation comes in the form of steganography; the initial sample is compiled with .NET and contains an embedded bitmap (BMP) file.

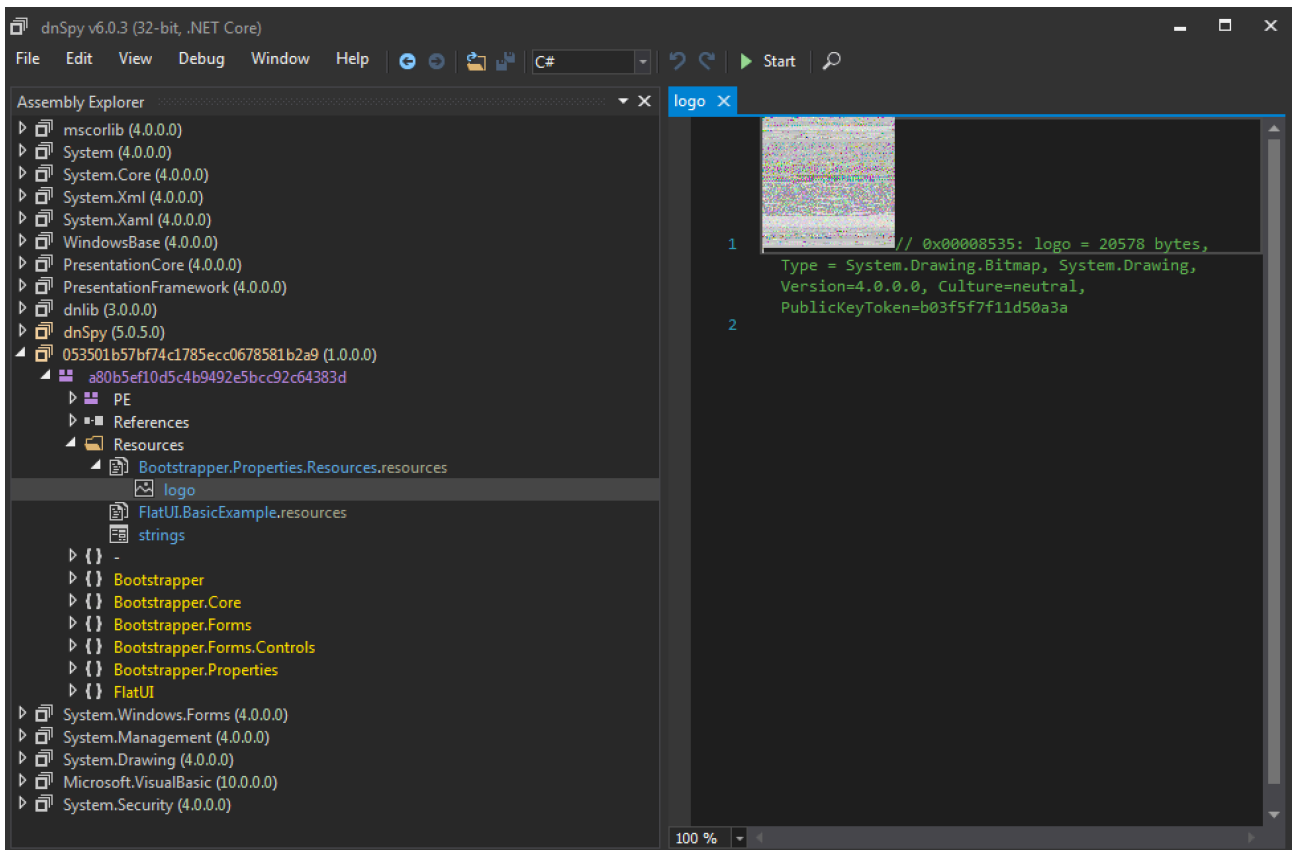


Figure 1. Embedded BMP file contained within .NET loader

Upon execution, the malware will read this file, parse out pixel data from the image, and decrypt the result using a single-byte XOR key. We have provided a Python script to automate this process in the Appendix of the blog post. The result is a DLL also compiled with .NET, with the following hash:

SHA256	01e007b8304eb0cbb2be11ddb86298dc85c084fb5459eda319a69ef50799f88
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After this file has been loaded in memory, the initial loader will load and execute the 'corerun' function, initiating the second stage of the malware. The DLL begins by performing a sleep using the built-in Windows [choice](#) utility:

```
cmd.exe /c choice /C Y /N /D Y /T 20
```

The command prompts the user for a choice with a 20 second timeout, at which point the process will exit. Since the window is hidden, and there is no utility for this choice, the malware simply uses this as an alternative sleep command.

The second stage DLL reads in the 'strings' embedded resource from the first stage executable. Part of this resource is decrypted to provide configuration information to the dropper. This configuration information will instruct whether or not the malware enters its installation routine. In the installation routine, it begins by writing a unique GUID identifier to %TEMP%\[random].ini. Afterwards, it creates the following directory:

```
%APPDATA%\Microsoft\Windows\IEConfig
```

It then writes an embedded executable with the hash below to %TEMP%\[random].exe. This file has an internal filename of RunExecutive.exe and simply copies the contents of argument #2 to the file path specified in argument #1.

SHA256	2167d393ec89ec0c6e2d7557a7ad22aa1953dd8082f599bee14977c25a128cce
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The malware creates an LNK file in the victim's startup folder with a randomly generated filename using a GUID (Example: {fcb29182-b3cc-47e2-a95c-b22c6d87dda1}.lnk). The LNK file executes the following command:

```
C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe -windowstyle hidden  
"%APPDATA%\Microsoft\Windows\IEConfig\[random]\sqlreader.exe"
```

Finally, the malware will execute the previously written RunExecutive executable with arguments to copy the original executable to the previously referenced sqlreader.exe file path.

The remaining segment of the embedded resource is decrypted using a 16-byte XOR key, resulting in a .NET executable. This executable is injected into one of the following two legitimate executables or processes on the system:

- RegSvcs.exe
- RegAsm.exe

In previous versions of this malware family, there were a larger number of legitimate processes Cardinal RAT would inject into. The final payload has the following hash:

SHA256	04de4b51c881e65236c9efdbfbc0099e6b48fd1723a6e51bf480b52104dd2ba2
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Underneath all this obfuscation, this Cardinal RAT payload does not have any significant changes compared to the previously discussed version in terms of its operation or capabilities. One of the most significant changes lies in the obfuscation used by the malware; all of the functions, methods, and variables have been renamed to MD5 hashes.

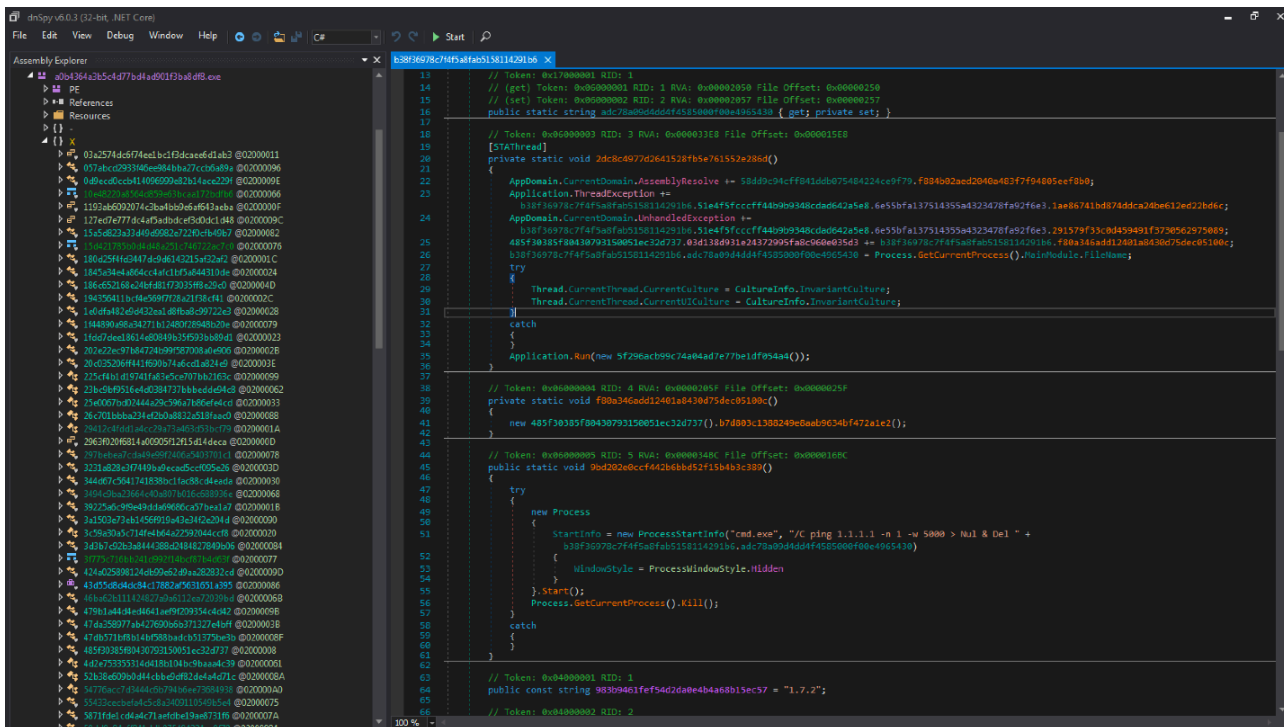


Figure 2. Obfuscation present in Cardinal RAT payload

In addition to the obfuscation routines in use, there have been a few minor changes within the malware itself. First, the embedded configuration has a few changes both in the order of the embedded values, as well as what values are present. Additionally, the way this configuration is encoded has changed slightly, as several values that were previously base 64 encoded in version 1.4 are no longer base64-encoded.

- \$ python parseConfig.py GreyCardinalConfig
- Mutex: {509ce3ef-e03e-467e-be19-710782f13c28}
- Campaign Identifier: \xf1\xaf\x02i.\xa4\xe0'
- C2 Server: affiliatecollective[.]club
- C2 Port: 443
- Hash Value: 0304674e9876530dfbea5a9b4fec7b98
- Additional C2 Servers: 0
- GUID: \xd6\x04hr\x9a\xedLN\xae\xe8\xd0\x87\x80\x19\x15z'
- Buffer Size: 81920
- Max Buffer Size: 40960000
- Sleep Timer between Requests: 2000
- Unused Integer: 60000

Unused Integer: 0

Perform Keylogging: 0

Disable Sleep on Victim: 0

Network communication and actions available to the remote operator remain consistent between versions. The script provided in our previous report continues to work as expected against the network traffic generated by this malware family. The following actions continue to be present within the malware:

- Collect victim information
- Update settings
- Act as a reverse proxy
- Execute command
- Uninstall itself
- Recover passwords
- Download and Execute new files
- Keylogging
- Capture screenshots
- Update Cardinal RAT
- Clean cookies from browsers

Enter EVILNUM

When looking at files submitted by the same customer in a similar timeframe to the Cardinal RAT samples, we saw that the customer had also submitted a malware family we'd been tracking as EVILNUM. From our viewpoint this is another family that seems to be used solely in attacks against finance related organisations.

When we cross-referenced submissions to online sandboxes, we found an additional case to ours, where another organization had submitted both EVILNUM and Cardinal RAT on the same day; both of which are rare malware families with limited distribution.

We opted to use the name EVILNUM, since in some versions of the malware the C2 is calculated by reading the page, parsing a numerical value, dividing it by [666](#) and then converting the resulting decimal to an IP address. There are at least two versions of this malware, one written in JavaScript, and another written in .NET.

SHA256	Type
bee6c5a506d6fb2cc129443c74b7676fbb9a79b53b92b2cac4c7fb8209592714	.NET
97c97ad2baef37eea023549131c192f441aa7976747166cd31095e7dad17948c	JS

Despite the differences in programming language used, the samples are similar, and we believe the .NET edition is likely a rewrite of the .JS version.

EVILNUM has been [covered in the public domain previously](#) (albeit with no name assigned to the malware family) and has been [noticed by multiple analysts on Twitter](#). It’s a first-stage malware family which gives an attacker data about the infected host before they decide to install other utilities on the machine.

EVILNUM’s supported commands vary from version to version and include but are not limited to:

- Setting up persistence
- Run an arbitrary command using “cmd /c”
- Download of additional files
- Ability to take screenshots

Since the operation of the malware is well covered already in the pwncode article, we’ll simply illustrate a few of the differences and similarities between the older and newer versions of the malware in the table below:

	May 2018 version	January 2019 version
Version #	1.3	2.1
C2s used	Public Forums/Git, find number, divide by 666, num2ip	Public Forums/Git, find number, divide by 8, num2ip
Functionality to steal local cookies	n	y
Use of Lock file	y	y
Adds to Startup as LNK?	y	y
Add to startup method?	via cmd line	By importing a reg file
Function naming	this_function	ThisFunction
Ability to take screenshots	n	y

Table 1. Highlights of the similarities (in green) and differences (in red) between EVILNUM versions

The malware appears to have been given a general rewrite, (as indicated by the authors’ version number) with many functions being rewritten from scratch.

Despite this, the core functionality of the malware is mostly the same, and some of the concepts used in the malware family (such as the lock file) remain the same. It’s likely that the malware only serves as a first stage and the attackers deploy further tools to target networks of interest.

Targeting

Since April 2017, we have observed Cardinal RAT in attacks against two customers, both customers were FinTech companies who write software relating to forex and cryptocurrency trading, and both companies were based in Israel. Looking at submissions to VirusTotal, there are 13 Carp Downloader documents. Note that we are only

looking at submissions for “entry” type files, not subsequent dropped files. When looking at the first submitters for these documents in Figure 1, we see they are predominantly uploaded from Israel.

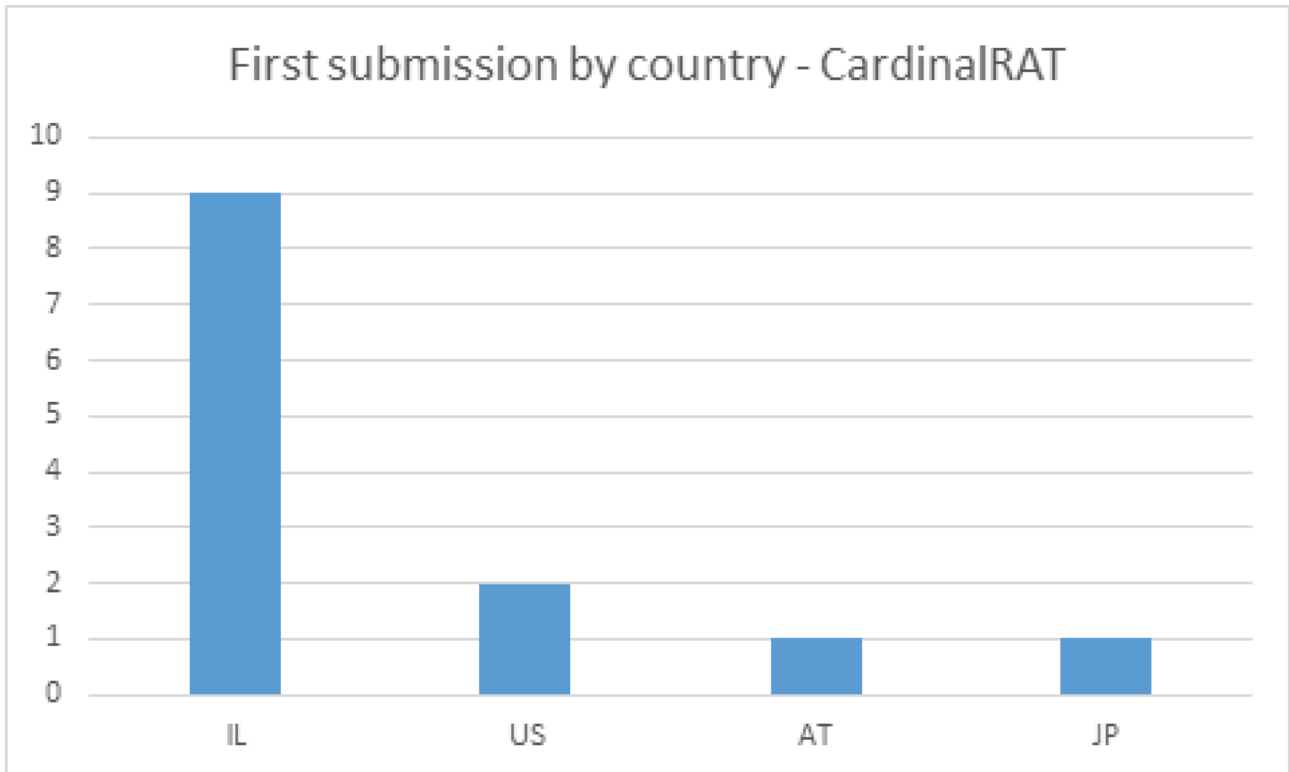


Figure 3. Distribution by country for Carp Downloader submissions to VirusTotal

In the case of EVILNUM, we have only seen one instance at a customer (the same one we referred to earlier in this article). When it comes to investigations from public sandboxes though, the distribution of the initial files used in infections is most commonly via LNK files. The geographical distribution of first submitters for EVILNUM is quite different, as shown in Figure 4.

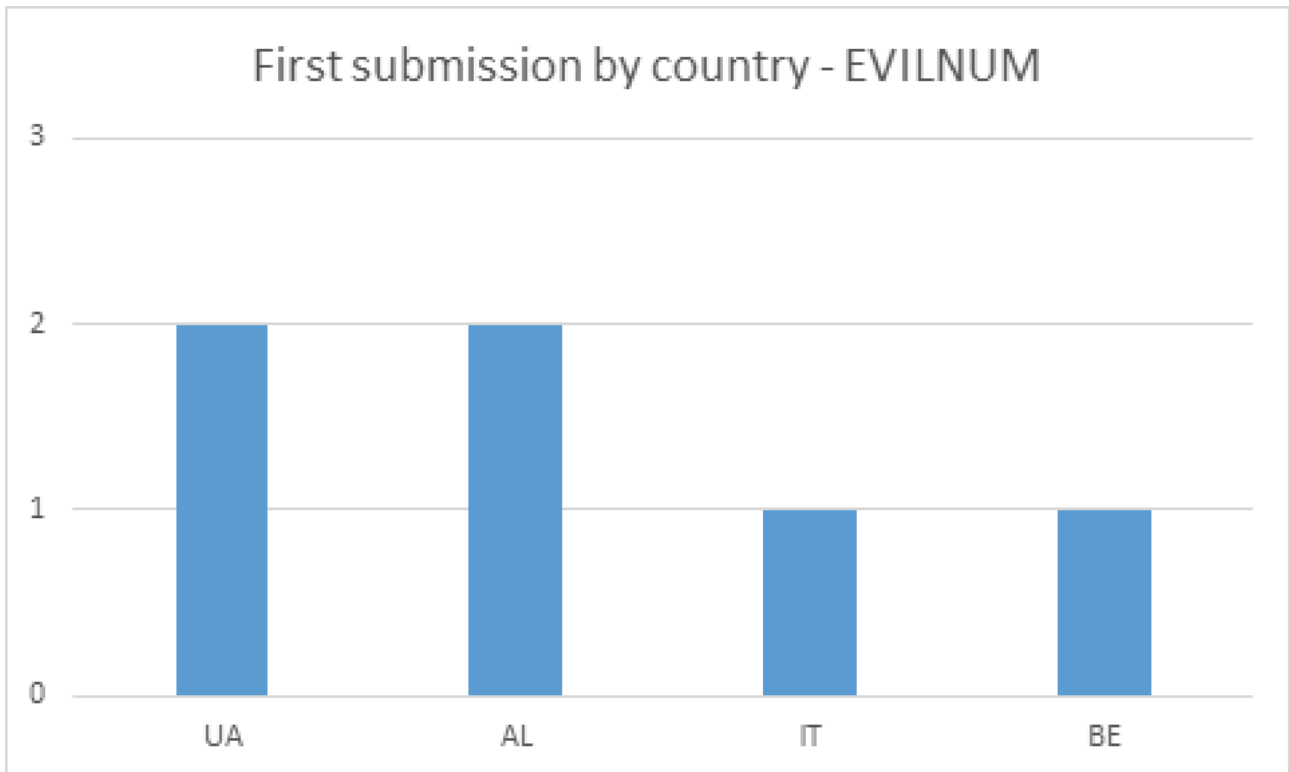


Figure 4. Distribution by country for EVILNUM submissions to VirusTotal

Conclusion

Cardinal RAT and EVILNUM are both used in limited distribution attacks against FinTech companies. In one case, both families were observed at the same target in a short space of time, whilst droppers for both families share similarly themed lure documents.

We suggest that these families are used in targeted attacks against FinTech companies because:

- Our telemetry shows these families are only used against companies in this sector.
- The lure documents used consistently related to lists of names/numbers of individuals involved in trading forex/crypto currency, a niche theme to use if targeting individuals outside of this sector.

We believe it's possible that both families are used by the same attackers because:

- We know of two cases where a company was targeted or appears to have been targeted by both malware families in short succession.
- Both families have been distributed using malicious documents containing lists of names/numbers of individuals involved in trading forex/crypto currency.
- The differences in geographical distribution can be easily explained as a difference in visibility.

However, there are a number of arguments against the two families being related:

- In terms of the geographic spread of where these families are seen, the targeting for each family seems to be quite different.

- The delivery methods for each family do not share any similarities.
- The infrastructure associated with each malware family is distinctive and different with no cross-over in terms of hosting providers or other attributes being observed.

Even if the two families are not linked, they both have similar targeting interests, and so FinTech organisations should ensure they are protected against the malware used. Whilst we haven't been able to gain an insight into what the attackers do once successfully on a target network, it's likely (based on the targets) they use their access to facilitate financial gain.

Organizations with effective spam filtering, proper system administration, and up-to-date Windows hosts have a much lower risk of infection. Generic defenses against these threats include:

- Do not allow inbound e-mails with LNK file as attachments, or, do not allow inbound e-mails with attached ZIP files containing a single LNK file inside them.
- Do not allow inbound e-mails from external sources where the documents contain macros, or, if you do, [ensure proper policy](#) is configured.
- [Enforce parent-child process policies](#) to restrict use of scripting languages by malware.

Palo Alto Networks customers are further protected from this threat by:

- EVILNUM variants are blocked by our IPS, see threat IDs 18781 and 18782.
- Wildfire and Traps detect all files referenced as malware.

[AutoFocus](#) users can track this activity using the [CardinalRAT](#), [CarpDownloader](#) and [EVILNUM](#) tags.

Appendix

Script to decrypt BMP from Cardinal RAT dropper

```
from PIL import Image

import sys

from struct import *

im = Image.open(sys.argv[1])

pix = im.load()

width, height = im.size

fileSize = unpack("I", (pack("bbbb", pix[0,0][0],pix[0,0][1],pix[0,0][2],pix[1,0][0])))

key = 187

out = ""

for ind, h in enumerate(range(height)):
```

```
if ind == 0:

    j = 2

    for w in range(width-2):

        pixel = pix[j, ind]

        out += chr(pixel[0] ^ key)

        out += chr(pixel[1] ^ key)

        out += chr(pixel[2] ^ key)

        j += 1

    else:

        for k in range(width):

            pixel = pix[k, ind]

            out += chr(pixel[0] ^ key)

            out += chr(pixel[1] ^ key)

            out += chr(pixel[2] ^ key)

        finished = out[0:fileSize]

        print("Writing output to 'dumped.exe_'.")

        fh = open("dumped.exe_", 'wb')

        fh.write(finished)

        fh.close()
```

Indicators of Compromise

Cardinal RAT samples

b742162197744a8caeb09f954213a3172ed699f8375f69c40b57b8c219c5e37c
06151c14153e983ae7ab793c7cd0e5ac3faf8e200894955b02e1191429eff29a
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f027735c3db77e67cf7bada8862d8bb0d85a2caacbb4b2825e4acdfa863a14c9
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985d893426373d4e71386d731e5bc44c1c2ac93e0920dddeb4380929af43dfcb
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6272ed2a9b69509ac16162158729762d30f9ca06146a1828ae17afedd5c243ef
440504899b7af6f352cfaad6cdef1642c66927ecce0cf2f7e65d563a78be1b29

Carp Downloader samples (binaries and documents)

9a2491d803407b8696d6b797f8b90d728a8db3583bf4c2977cbeef8be0eb7249

7220e659d59491db50661c54762b49bf6976acbeb723b5d59abde48301c86228
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0438becfd66d728778f47d734d2f0bc4d1462d945cf4b6dde9fbf627eb0bb02d
84e705341a48c8c6552a7d3dd97b7cd968d2a9bc281a70c287df70813f5dca52
ae1a6c4f917772100e3a5dc1fab7de4a277876a6e626da114baf8179b13b0031
e49e61da52430011f1a22084a601cc08005865fe9a76abf503a4a9d2e11a5450
192b204dbc702d3762c953544975b61db8347a7739c6d8884bb4594bd816bf91
571b58ba655463705f45d2541f0fde049c83389a69552f98e41ece734a59f8d4
10f53502922bf837900935892fb1da28fc712848471bf4afcd08440d3bd037f
8bea55d2e35a2281ed71a59f1feb4c1cf6af1c053a94781c033a94d8e4c853e5

057965e8b6638f0264d89872e80366b23255f1a0a30fd4efb7884c71b4104235

EVILNUM samples

97c97ad2baef37eea023549131c192f441aa7976747166cd31095e7dad17948c

bee6c5a506d6fb2cc129443c74b7676fbb9a79b53b92b2cac4c7fb8209592714

7f0c5e2850d10d4bf129e0d290010bedff44a0f506d92de79ef6d69fd78487e3

508e25a0e729824f06f4960b635600acf3cab87ebb87854d1989ff0ba2f03e78

997de4372efd576cdb55188a06e4699660a29c37e285e23cdd8a1a9585e6e789

e5e172cd93e97480a9982f821c8f1bdf9756803a3fb8a1a7a39e262cda192cb6

8db0118d4bbc10efd0fd6733d987ddeee7afc6c3ebe4ee1157ae9243aba362d9

Cardinal RAT Infrastructure (samples observed from mid 2017 onwards only)

s.dropinbox[.]host

secure.dropinbox[.]pw

s.spotmacro[.]online

secure.spotoption[.]pw

190.10.8[.]238

affiliatecollective[.]club

EVILNUM Infrastructure

hxxps://raw.githubusercontent.com/venomisherow/wearevenom/master/README.md

hxxps://raw.githubusercontent.com/idontwantcofee/ihavepoop/master/README.md

hxxps://raw.githubusercontent.com/yoshimaster8/whatcha/master/readme

hxxps://raw.githubusercontent.com/grobagala/pizza/master/readme

hxxps://gitlab[.]com/githubuser/testing/commits/master

hxxps://raw.githubusercontent.com/sarutubi/LuckyLuke/master/README.md

hxxps://raw.githubusercontent.com/hititdolly/justcallmeangel/master/README.md

hxxps://www.codeplex[.]com/site/users/view/saidjaosdjo

hxxps://raw.githubusercontent.com/iuasbduias/auhidshas/master/README.md

hxxps://www.digitalpoint[.]com/members/bitbox123.922831/

139.28.37[.]0

127.194.87[.]192 # likely attacker testing

127.194.73[.]243 # likely attacker testing

wikipeldia[.]org

185.247.211[.]198

185.20.187[.]14

193.22.96[.]98

193.22.98[.]182

193.22.99[.]168

Source: <https://unit42.paloaltonetworks.com/cardinal-rat-sins-again-targets-israeli-fin-tech-firms/>