A doubled "Dragon Breath" adds new air to DLL sideloading attacks

Gabor Szappanos ⁝⁝ 5/3/2023

We have spotted malicious DLL sideloading activity that builds on the classic sideloading scenario, but adds complexity and layers to its execution. Moreover, our investigation indicates that the responsible threat actor(s) fell so much in love with this adaptation of the original scenario that they used multiple variations of it, repeatedly swapping out a particular component in the process to evade detection at this step of the attack chain.

Earlier forms of the attack have been covered previously in the industry, mainly in the Sinophone CTFIoT and Zhizu blogs. The attack is based on a classic sideloading attack, consisting of a clean application, a malicious loader, and an encrypted payload, with various modifications made to these components over time. The latest campaigns add a twist in which a first-stage clean application "side"loads a *second* clean application and auto-executes it. The second clean application sideloads the malicious loader DLL. After that, the malicious loader DLL executes the final payload.

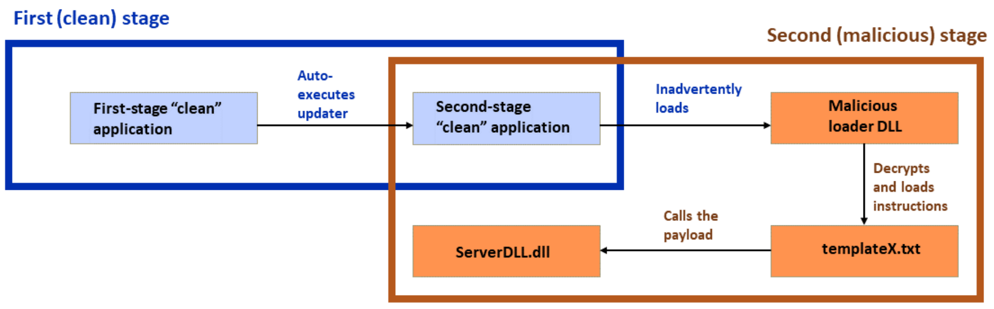


Figure 1: DLL sideloading, with recently identified extra steps; the clean applications are shown in blue boxes and within the blue outline, while the malicious steps are shown in orange boxes with red type and outlined in red. This chart will appear again in the report with the specifics of each variation highlighted

The threat actor most associated with this attack is variously called "Operation Dragon Breath," "APT-Q-27," or "Golden Eye Dog," and is believed to specialize in the online-gambling space and its participants. These actors liked this two-clean-apps scenario so much that they used multiple scenarios in which the second-stage application is replaced with other clean applications.

The original campaigns targeted Chinese-speaking Windows users engaged in online gambling, and initial infection vectors were distributed via Telegram. We have, to date, identified intended targets in the Philippines, Japan, Taiwan, Singapore, Hong Kong, and China. Sophos normally blocks sideloading attacks during the sideloading process, so the payload never executes and the users are protected.

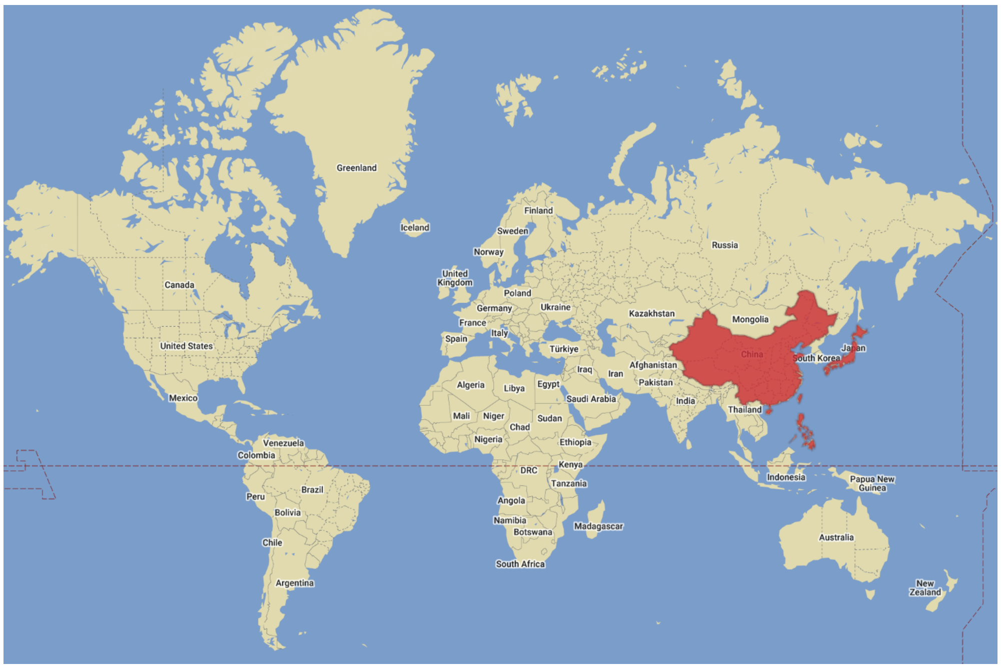
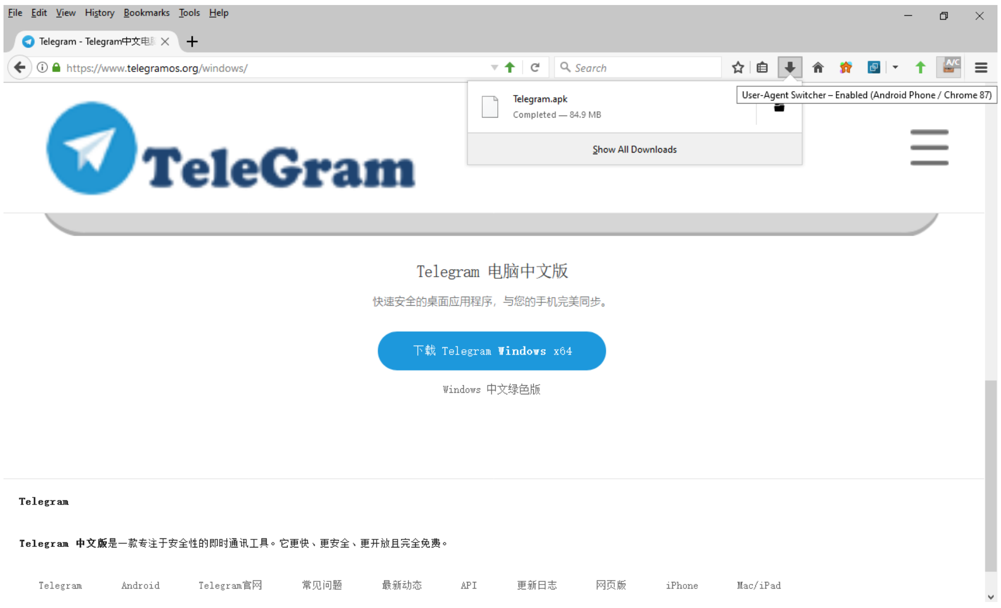


Figure 2: Where we saw Operation Double Dragon Breath

In this investigation we found several distinct variations on the double-clean-installer approach; variations mainly involved changes to precisely which program was abused in the second stage, with a few knock-on effects caused in turn by those changes. We'll describe the most commonly encountered code we found at each stage, touching on variations as we go along.

The beginning: Infection vector

Early on, our investigation led us to a Web site (telegramos[.]org) that delivers, or claims to deliver, Chinese-language versions of the Telegram application for Android, iOS, and Windows. We noted that the site — which we and other vendors flag as malicious — occasionally but not consistently ignored our OS choices when we clicked the download links, instead delivering a version based on the user-agent string to which our browser was set, as shown in the screen captures below.


File Edit View History Bookmarks Tools Help
Telegram - Telegram中文电
https://www.telegramos.org/windows/
Search
Show All Downloads
TeleGram
下载 Telegram Windows x64
Telegram
Android
Telegram官网
常见问题
最新动态
API
更新日志
网页版
iPhone
Mac/iPad

Telegram.apk
Completed — 84.9 MB

User-Agent Switcher – Enabled (Android Phone / Chrome 87)

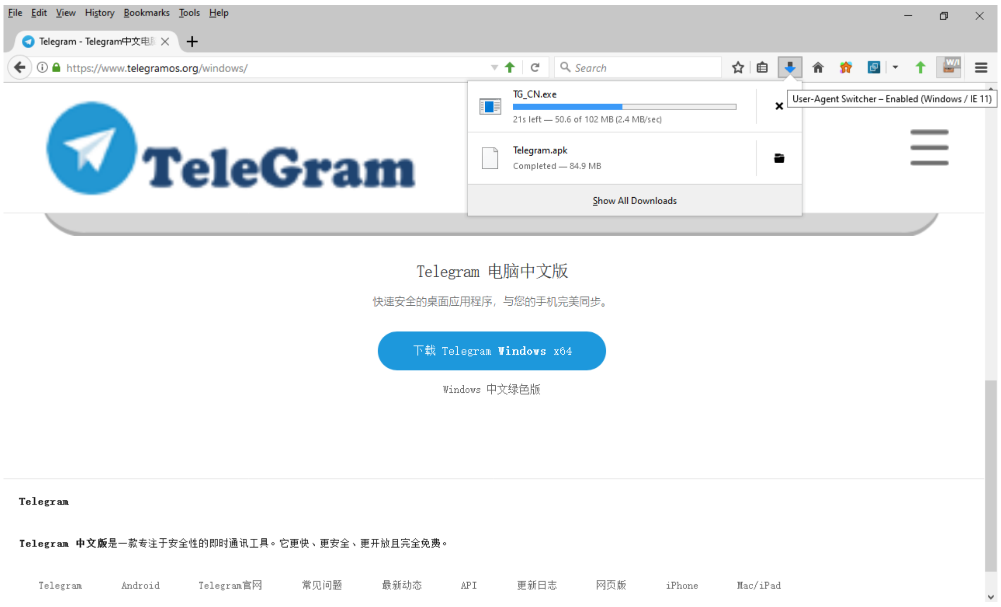
Telegram 电脑中文版

快速安全的桌面应用程序，与您的手机完美同步。

Windows 中文绿色版

Telegram 中文版是一款专注于安全性的即时通讯工具。它更快、更安全、更开放且完全免费。

Figure 3: Clicking the ‘Windows” button from the Windows download page meant nothing when our browser reported itself as Android…


File Edit View History Bookmarks Tools Help
Telegram - Telegram中文电
https://www.telegramos.org/windows/
Search
TeleGram
Show All Downloads

TG_CN.exe
21s left — 50.6 of 102 MB (2.4 MB/sec)

Telegram.apk
Completed — 84.9 MB

User-Agent Switcher – Enabled (Windows / IE 11)

Telegram 电脑中文版

快速安全的桌面应用程序，与您的手机完美同步。

下载 Telegram Windows x64

Windows 中文绿色版

Telegram

Telegram 中文版是一款专注于安全性的即时通讯工具。它更快、更安全、更开放且完全免费。

Telegram Android Telegram官网 常见问题 最新动态 API 更新日志 网页版 iPhone Mac/iPad

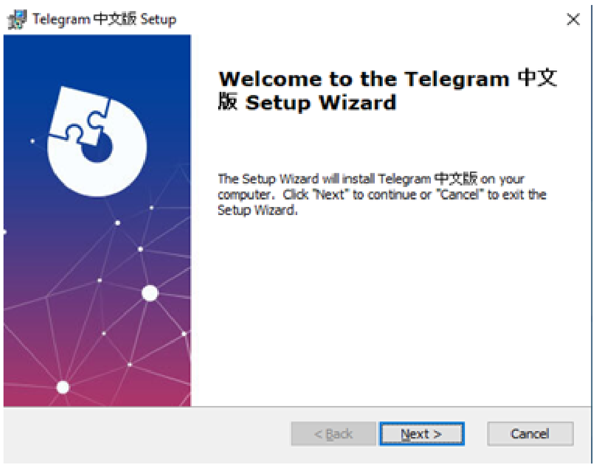
Figure 4: …so we changed our UA string to IE

This is the site from which the affected user is thought to have downloaded the package that caused the infection. How the user first encountered the site, whether through phishing or SEO poisoning or some other method, is beyond the scope of this investigation.

First-stage installer: Telegram

As mentioned above, the initial investigation of these attacks involved a malicious Telegram installer. Later in this article we’ll see variations in which other “lure” applications were used, but Telegram was by far the most common lure, and dissecting it provides a good example of how the attack works.

When the malicious Telegram installer (SHA256: 097899b3acb3599944305b064667e959c707e519aef3d98be1741bbc69d56a17) is run, it installs and executes the sideloading package.

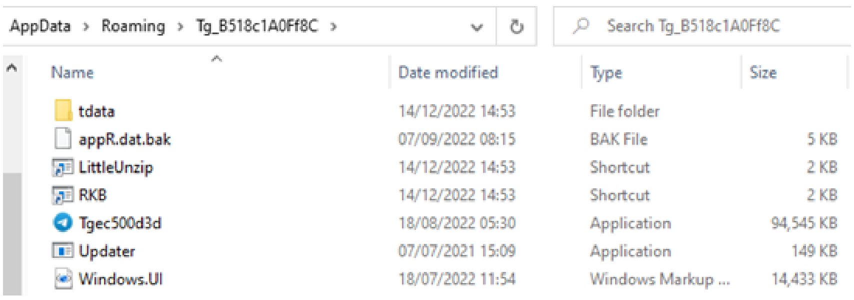


Welcome to the Telegram 中文版 Setup Wizard

The Setup Wizard will install Telegram 中文版 on your computer. Click "Next" to continue or "Cancel" to exit the Setup Wizard.

Figure 5: This setup screen is actually an evil wizard

It installs multiple components on the system, dropping them to a directory in the user data folder:


AppData › Roaming › Tg_B518c1A0Ff8C ›

Search Tg_B518c1A0Ff8C

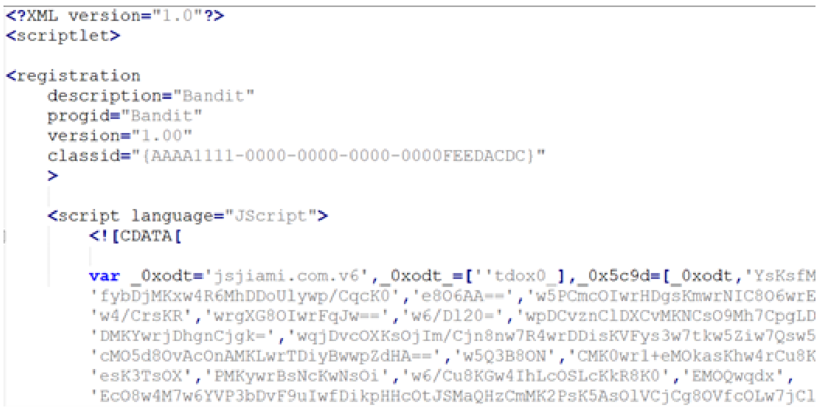
Name	Date modified	Type	Size
tdata	14/12/2022 14:53	File folder	
appR.dat.bak	07/09/2022 08:15	BAK File	5 KB
LittleUnzip	14/12/2022 14:53	Shortcut	2 KB
RKB	14/12/2022 14:53	Shortcut	2 KB
Tgec500d3d	18/08/2022 05:30	Application	94,545 KB
Updater	07/07/2021 15:09	Application	149 KB
Windows.UI	18/07/2022 11:54	Windows Markup ...	14,433 KB

Figure 6: Gifts of the evil setup wizard

It also creates a shortcut on the desktop. However, this shortcut does not execute the Telegram program, but an unusual command:

```
C:\Users\{redacted}\AppData\Roaming\Tg_B518c1A0Ff8C\appR.exe /s   /n   /u
/i:appR.dat   appR.dll
```

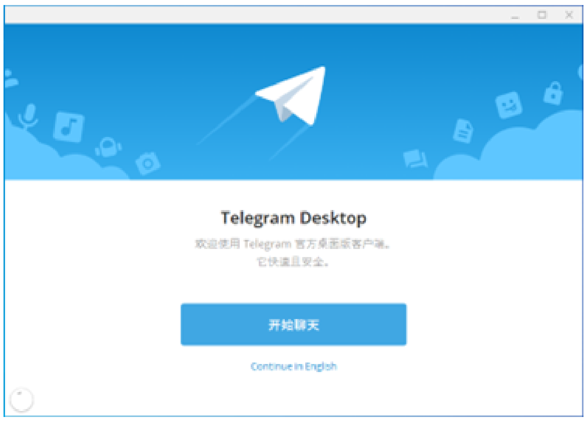
Here appR.exe is the regsvr32.exe Windows component, renamed. It will execute the appR.dll library, which is another renamed Windows component, scrobj.dll — the script execution engine. It will then execute the Javascript code stored in appR.dat:



```
<?XML version="1.0"?>
<scriptlet>

<registration
    description="Bandit"
    progid="Bandit"
    version="1.00"
    classid="{AAAA1111-0000-0000-0000-0000FEEDACDC}"
    >

    <script language="JScript">
        <![CDATA[

        var _0xodt='jsjiami.com.v6',_0xodt_=[''tdox0_],_0x5c9d=[_0xodt,'YsKsfM
        'fybDjMKxw4R6MhDDoUlywp/CqcK0','e8O6AA==','w5PCmcOIwrHDgsKmwrNIC8O6wrE
        'w4/CrsKR','wrgXG8OIwrFqJw==','w6/Dl20=','wpDCvznClDXCvMKNCsO9Mh7CpgLD
        'DMKYwrjDhgnCjgk=','wqjDvcOXKsOjIm/Cjn8nw7R4wrDDisKVFys3w7tkw5Ziw7Qsw5
        'cMO5d8OvAcOnAMKLwrTDiyBwwpZdHA==','w5Q3B8ON','CMK0wr1+eMOkasKhw4rCu8K
        'esK3TsOX','PMKywrBsNcKwNsOi','w6/Cu8KGw4IhLcOSLcKkR8K0','EMOQwqdx',
        'EcO8w4M7w6YVP3bDvF9uIwfDikpHHcOtJSMaQHzCmMK2PsK5AsOlVCjCg8OVfcOLw7jCl
```

Figure 7: Its reg description is Bandit, which is accurate

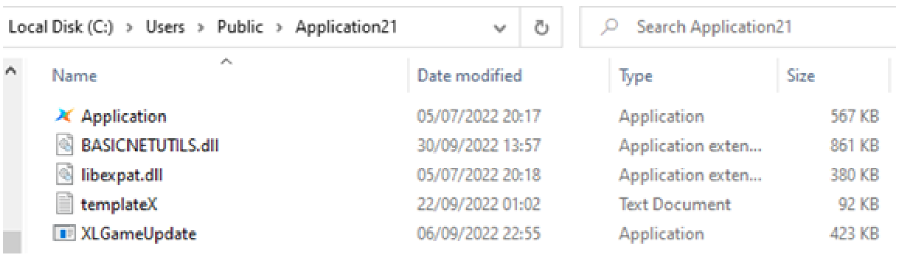
When the shortcut is executed, the JavaScript code runs. To the user, it displays the expected Telegram desktop UI, mostly in Chinese:


Telegram Desktop

欢迎使用 Telegram 官方桌面版客户端。
它快速且安全。

Figure 8: A mostly transliterated version of the Telegram desktop UI

But behind the scenes it drops various sideloading components to a directory:



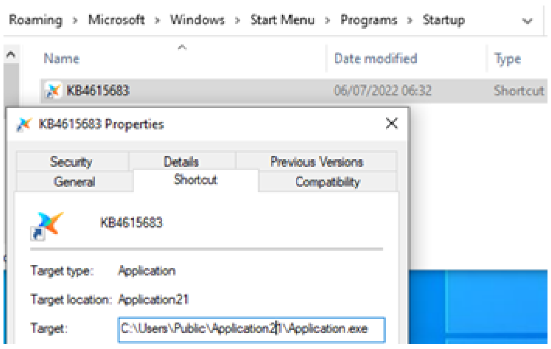
Local Disk (C:) > Users > Public > Application21

Search Application21

Name	Date modified	Type	Size
Application	05/07/2022 20:17	Application	567 KB
BASICNETUTILS.dll	30/09/2022 13:57	Application exten...	861 KB
libexpat.dll	05/07/2022 20:18	Application exten...	380 KB
templateX	22/09/2022 01:02	Text Document	92 KB
XLGameUpdate	06/09/2022 22:55	Application	423 KB

Figure 9: A directory with problematic files deposited in it

The installer also creates a shortcut file in the user's startup directory. In this way, the malware establishes persistence and allows for automatic execution after system startup.



Roaming > Microsoft > Windows > Start Menu > Programs > Startup

Name	Date modified	Type
KB4615683	06/07/2022 06:32	Shortcut

KB4615683 Properties

Security | Details | Previous Versions | General | Shortcut | Compatibility

KB4615683

Target type: Application

Target location: Application21

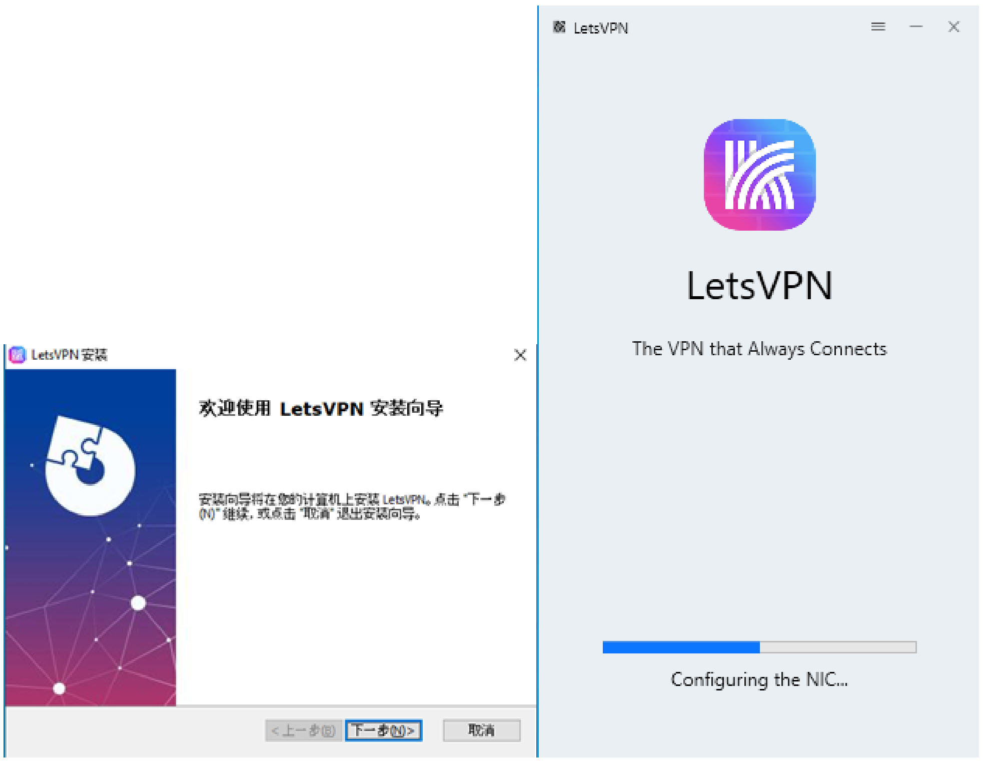
Target: C:\Users\Public\Application21\Application.exe

Figure 10: A fairly innocuous-looking shortcut is anything but; note "Application.exe," which we'll see again in the next stage of the attack

The sideloading components and the startup link are only created when the desktop Telegram link is executed. This could be an anti-analysis trick, since dynamic analysis sandboxes would not see the dropped sideloader files.

A first-stage variation: LetsVPN installer

We also found a trojanized installer for LetsVPN (SHA256: e414fc7bcd80a75d57ee4fdbb1c80a90a0993be8e8bbbe0decfc62870a2e1e86). The malicious parts of the package are the same as in the Telegram cases, but the bundled clean application is LetsVPN:



LetsVPN 安装

欢迎使用 LetsVPN 安装向导

安装向导将在您的计算机上安装 LetsVPN。点击 "下一步(N)" 继续，或点击 "取消" 退出安装向导。

< 上一步(B) | 下一步(N)> | 取消

LetsVPN

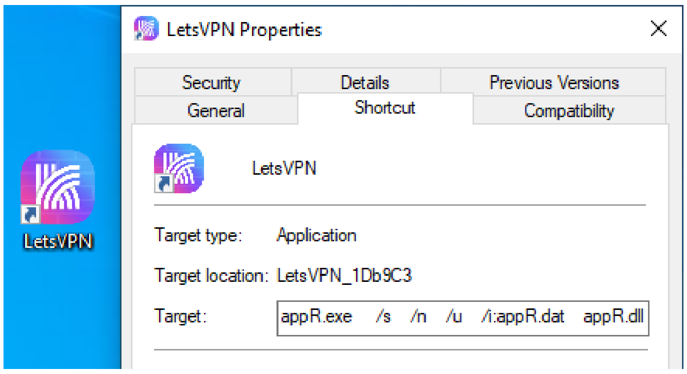
LetsVPN

The VPN that Always Connects

Configuring the NIC...

Figure 11: The LetsVPN variation we found is translated into Chinese on its initial screen, but the installation screen is in English

As the Telegram installer did, it creates a shortcut on the desktop. The program that the shortcut launches invokes the JavaScript code that does the ultimate installation of the sideloading package.


LetsVPN Properties

Security | Details | Previous Versions
General | Shortcut | Compatibility

LetsVPN

Target type: Application

Target location: LetsVPN_1Db9C3

Target: appR.exe /s /n /u /i:appR.dat appR.dll

Figure 12: The icon has changed, but the application to which it truly points remains the same

One more first-stage variation: WhatsApp installer

In one case, we did not have direct contact with the installer file, but our telemetry shows that running a file called Whatsapp.msi also leads to the installation of the malicious files we saw in the other two first-stage examples.

```
\roaming\whatsapp_ae2b02\appmain.exe :
91e4eb7517f55ac93b1da109539aa0011e9346be41704dc0da360ebad0f3f63d

\roaming\whatsapp_ae2b02\appr.dll :
e25289d44403a6f6132a470fdbe6b46eade466d08eca0ad44fca519592c54fdf

\roaming\whatsapp_ae2b02\appr.exe :
fffa7a97fba9dfb235f969ecce0e5c4a71a48a37c1bc79b77cd78f0ab72f993d

\roaming\whatsapp_ae2b02\littleunzip.exe :
81046f943d26501561612a629d8be95af254bc161011ba8a62d25c34c16d6d2a

\roaming\whatsapp_ae2b02\app-2.2232.8\whatsapp.exe :
8d92c7d7f301bc0e4965dbd9253933a4580883805119dd7c27788d04c17d595e

c:\users\public\application2\application.exe :
c936f1598721a9a92d7f31c6c13b55013b8a2a344e3df4156e5b033006336544

c:\users\public\application2\xlgameupdate.exe :
769d59d03036af86c7a9950f03ebc7b693a94d3e2f8ecd1d74cf5600ab948105

c:\users\public\application2\libexpat.dll :
31d2076066107bd04ab24ff7bbdf8271aa16dd1d04e70bd9cc492e9aa1e6c82b

c:\users\public\application2\basicnetutils.dll :
ae2e145b36ab2ed129a2d34de435b76a1f4e5a4820d9d623e7018b87f24d0648
```

Second stage: More sideloading

As mentioned, one of the most exciting things about this investigation was spotting a new variation on DLL sideloading – the use of a second "clean" application as a secondary stage in the attack. In these unusual attacks, the beginning (first-stage loader) and the end (payload) were the same; the only difference was in this second-stage sideloading.

In Figure 8 above, we pointed out "Application.exe," for which the installer left a shortcut on the desktop. In Figure 11 we see it again. It's actually the program XLGame.exe, signed by Shenzhen Thunder Networking Technologies Ltd, but renamed by the attackers to Application.exe. It has a clean dependency, libexpat.dll, which is part of the package.

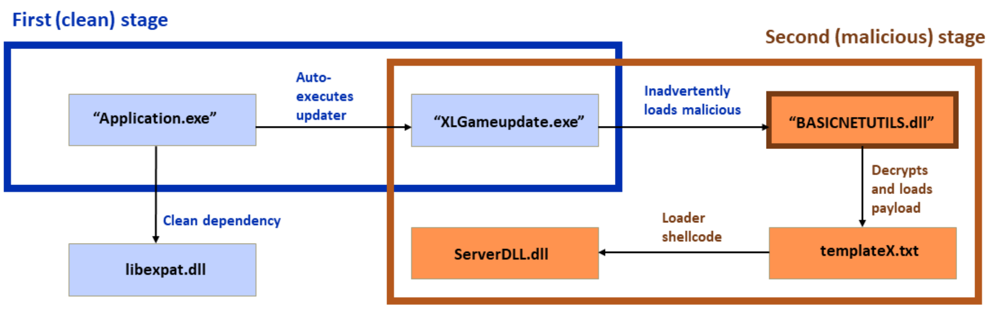
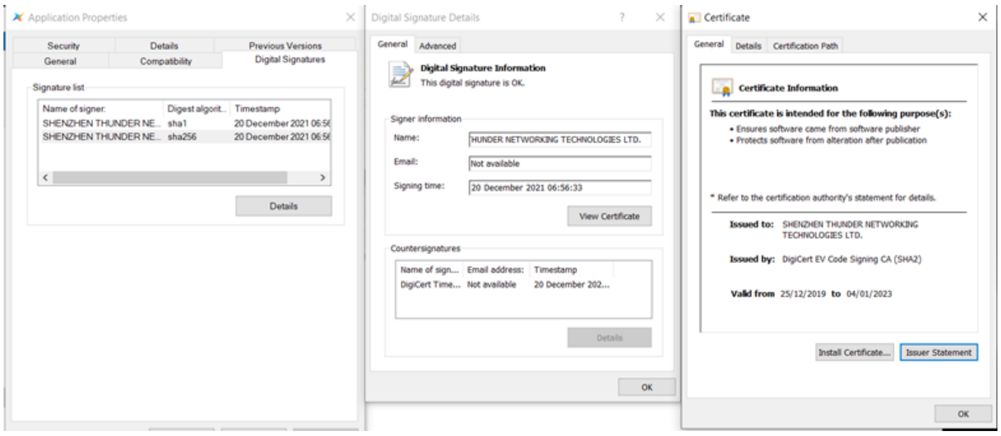


Figure 13: The attackers used a clean-but-vulnerable application (named "Application.exe" on the desktop, but really XLGame.exe) that auto-updates itself if it finds a file with a specific name. The names of malicious files are shown in the orange boxes to the right as before, and files renamed by the attacker are shown in quotation marks


Application Properties

Security | Details | Previous Versions | General | Compatibility | Digital Signatures

Signature list

Name of signer:	Digest algorit...	Timestamp
SHENZHEN THUNDER NE...	sha1	20 December 2021 06:56
SHENZHEN THUNDER NE...	sha256	20 December 2021 06:56

Details

Digital Signature Details

General | Advanced

Digital Signature Information
This digital signature is OK.

Signer information
Name: HUNDER NETWORKING TECHNOLOGIES LTD.
Email: Not available
Signing time: 20 December 2021 06:56:33

View Certificate

Countersignatures

Name of sign...	Email address:	Timestamp
DigiCert Time...	Not available	20 December 202...

Details

OK

Certificate

General | Details | Certification Path

Certificate Information

This certificate is intended for the following purpose(s):
- Ensures software came from software publisher
- Protects software from alteration after publication

* Refer to the certification authority's statement for details.

Issued to: SHENZHEN THUNDER NETWORKING TECHNOLOGIES LTD.

Issued by: DigiCert EV Code Signing CA (SHA2)

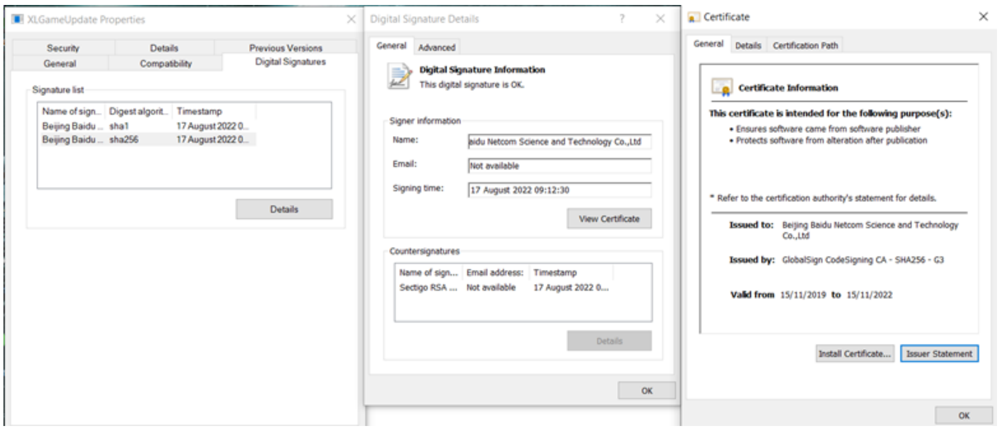
Valid from 25/12/2019 **to** 04/01/2023

Install Certificate... | Issuer Statement

OK

Figure 14: XLGame's digital signatures would seem to indicate everything is in order, despite being renamed to Application.exe

XLGame will automatically perform an automatic update if it finds a program named XLGameUpdate.exe in the same directory. The loading process makes use of this auto-update functionality, as the malicious package contains an executable with this name — but it's not the real XLGameUpdate.exe. Rather, it is a clean, signed .exe from Beijing Baidu Netcom Science and Technology Co.,Ltd.


XLGameUpdate Properties

Security | Details | Previous Versions | General | Compatibility | Digital Signatures

Signature list

Name of sign...	Digest algorit...	Timestamp
Beijing Baidu ...	sha1	17 August 2022 0...
Beijing Baidu ...	sha256	17 August 2022 0...

Details

Digital Signature Details

General | Advanced

Digital Signature Information
This digital signature is OK.

Signer information
Name: aidu Netcom Science and Technology Co.,Ltd
Email: Not available
Signing time: 17 August 2022 09:12:30

View Certificate

Countersignatures

Name of sign...	Email address:	Timestamp
Sectigo RSA ...	Not available	17 August 2022 0...

Details

OK

Certificate

General | Details | Certification Path

Certificate Information

This certificate is intended for the following purpose(s):
- Ensures software came from software publisher
- Protects software from alteration after publication

* Refer to the certification authority's statement for details.

Issued to: Beijing Baidu Netcom Science and Technology Co.,Ltd

Issued by: GlobalSign CodeSigning CA - SHA256 - G3

Valid from 15/11/2019 **to** 15/11/2022

Install Certificate... | Issuer Statement

OK

Figure 15: XLGameUpdate.exe is actually a different, unnamed application, but renamed to trick "Application.exe" (really, XLGames.exe) into running it

And now we return to the usual DLL-sideloading process. This second-stage loader has a dependency, BASICNETUTILS.dll, which the attackers have replaced with a malicious loader DLL. The malicious loader DLL finds templateX.txt in the same directory, loads the content, decrypts the payload loader shellcode, and executes it. (All these files are of course located in the same directory, as seen in Figure 7 above.)

Second stage: More sideloading (a variation)

As noted in the introduction, the attackers appear to be very fond of their double-dip DLL sideloading strategy, swapping various clean apps into the new spot in the sideloading process. Figure 16 shows a flow very similar to the previous scheme, but the clean executable is different in the second-stage loader. Consequently, the malicious loader DLL has to be renamed to reflect the dependency of the replaced clean application.

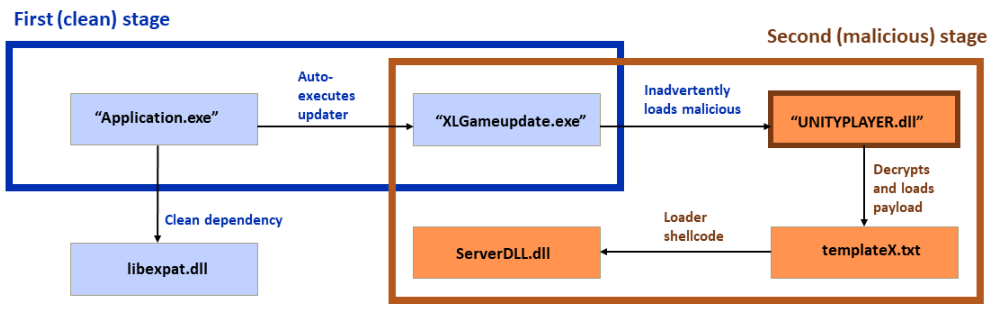
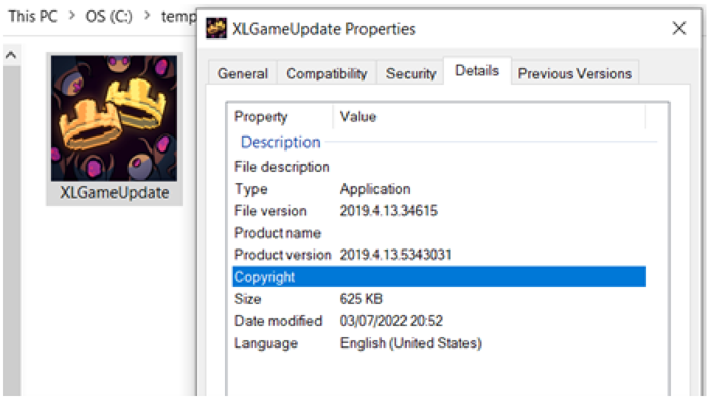


Figure 16: The attackers are running the same extra-step playbook as in Figure 13, but they've swapped in a new program in the "XLGameUpdate.exe" spot; by extension, the to-be-swapped DLL shown at upper right must change as well. Again, the names of malicious files are shown in the orange boxes to the right, and files renamed by the attacker are shown in quotation marks

As before, "Application.exe" is actually XLGames.exe. The second-stage clean loader is renamed once again to XLGameUpdate.exe, but its original (real) name is KingdomTwoCrowns.exe. It is not digitally signed, so it's not clear what the benefit might be of replacing the clean, signed loader from Baidu with this one.



Property	Value
Description	
File description	
Type	Application
File version	2019.4.13.34615
Product name	
Product version	2019.4.13.5343031
Copyright	
Size	625 KB
Date modified	03/07/2022 20:52
Language	English (United States)

Figure 17: It's still not XLGameUpdate, but this time it's actually "KingdomTwoCrowns"

It has the following PDB path:

```
C:\buildslave\unity\build\artifacts\WindowsPlayer\Win32_nondev_i_r\WindowsPlayer_Master_il2cpp_
```

This second-stage loader is used for the usual sideloading scenario; its dependency, UNITYPLAYER.dll, is replaced with a malicious loader DLL. The malicious loader finds templateX.txt in the same directory, loads the content, decrypts the payload loader shellcode, and executes it.

Thus, the second-stage clean loader is different, but the second-stage malicious loader and the payload files in this variation are essentially the same as in the variation described in the previous section (aside from being renamed). In fact, one of the encrypted payload files (3fc9405cfe9272323bd96aacfd082c16b392fea6e0f108545138026aa6f79137) was used in both scenarios. (We'll discuss the payload in the final section of this article.)

Second stage: More sideloading (one more variation)

Once again, this scenario swaps out the clean executable in the second-stage loader, this time abusing a clean, digitally signed tool once offered by HP. This is very similar to the previous scheme, but since the clean executable is once again different in the second-stage loader, the malicious loader DLL has to once again be renamed to reflect the different dependency.

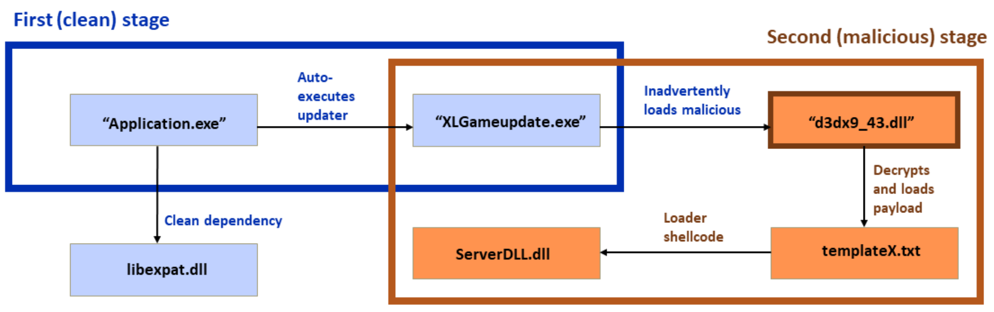
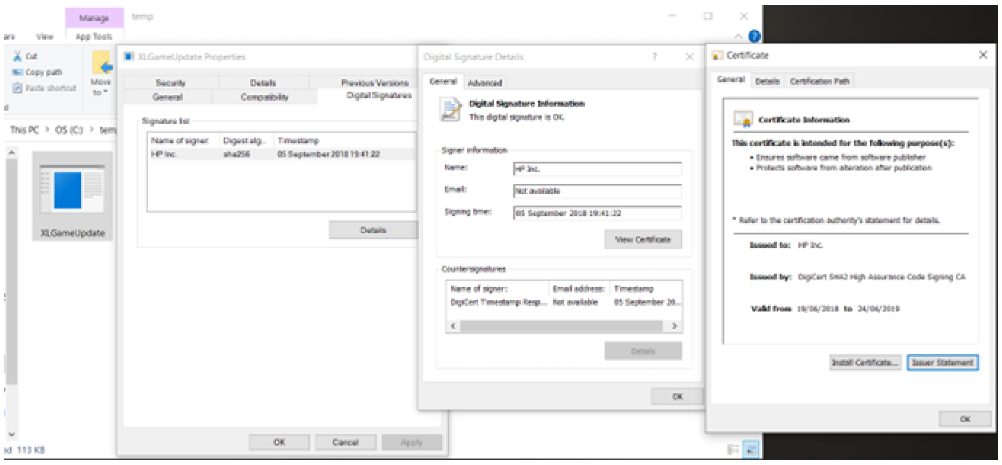


Figure 18: One more variation on the double-dip sideloading theme, with an HP tool in the XLGameUpdate spot at center-top and yet another DLL in the highlighted malicious spot at upper right. Once again the names of malicious files are shown in the orange boxes to the right, and files renamed by the attacker are shown in quotation marks

The second-stage clean loader is again renamed to XLGameUpdate.exe. Its original name is d3dim9.exe. It is digitally signed by HP Inc.


XLGameUpdate Properties

Security | Details | Previous Versions
General | Compatibility | Digital Signatures

Signature list

Name of signer:	Digest alg...	Timestamp
HP Inc.	sha256	05 September 2018 19:41:22

Digital Signature Details

Digital Signature Information
This digital signature is OK.

Signer information
Name: HP Inc.
Email: Not available
Signing time: 05 September 2018 19:41:22

Countersignatures

Name of signer:	Email address:	Timestamp
DigiCert Timestamp Resp...	Not available	05 September 20...

Certificate

Certificate Information
This certificate is intended for the following purpose(s):
• Ensures software came from software publisher
• Protects software from alteration after publication

* Refer to the certification authority's statement for details.

Issued to: HP Inc.

Issued by: DigiCert SHA2 High Assurance Code Signing CA

Valid from 19/06/2018 to 24/06/2019

Figure 19: This time, the application renamed as XLGameUpdate is really a signed, clean application from HP

This second-stage loader is used for the usual sideloading scenario. Its dependency, d3dx9_43.dll, is replaced with a malicious loader DLL. That DLL finds templateX.txt in the same directory and – once again — loads the content, decrypts the payload loader shellcode, and executes it.

Third stage: At last, the malicious DLL

The second-stage loaders had interesting variations, but all roads lead to one thing: cryptowallet theft. To that end, the payloads we saw in this investigation were fairly constant.

At the end of stage 2, the clean second-stage loader (whichever one is in use) calls a specific DLL – and get the malicious, identically named version the attackers have placed in the same directory, in the classic DLL-sideloading fashion. The malicious DLL loads the payload from the file template.txt, then decrypts it.

The payload's encryption is a simple combination of bytewise SUB and XOR:

```
int __fastcall decrypt(int a1, int a2)

{

  int result; // eax

  for ( result = 0; result < a2; ++result )

    *(_BYTE *)(result + a1) = (*(_BYTE *)(result + a1) - 122) ^ 0x19;

  return result;
```

The decrypted content is a loader shellcode, which decompresses and executes the final payload. This execution log shows this decompression of the final payload:

```
4010ae    GetProcAddress(LoadLibraryA)

4010ae    GetProcAddress(VirtualAlloc)

4010ae    GetProcAddress(VirtualFree)

4010ae    GetProcAddress(lstrcmpiA)

401153    LoadLibraryA(ntdll)

4010ae    GetProcAddress(RtlZeroMemory)

4010ae    GetProcAddress(RtlMoveMemory)

40148e    VirtualAlloc(base=0 , sz=20a00) = 600000

401635    GetProcAddress(LoadLibraryA)

401697    LoadLibraryA(ntdll)

401635    GetProcAddress(RtlDecompressBuffer)

4016bd   RtlDecompressBuffer(fmat=102,ubuf=600000, usz=20a00, cbuf=4016e3, csz=16789)
(Outsz: 20a00) = 0

4011e2    VirtualAlloc(base=0 , sz=26000) = 621000

4011f9    RtlMoveMemory(dst=621000, src=600000, sz=400)

401235    RtlMoveMemory(dst=622000, src=600400, sz=17e00)

401235    RtlMoveMemory(dst=63a000, src=618200, sz=4c00)

401235    RtlMoveMemory(dst=63f000, src=61ce00, sz=1800)

401235    RtlMoveMemory(dst=643000, src=61e600, sz=200)

401235    RtlMoveMemory(dst=644000, src=61e800, sz=2200)

4012ed    LoadLibraryA(KERNEL32.dll)
```

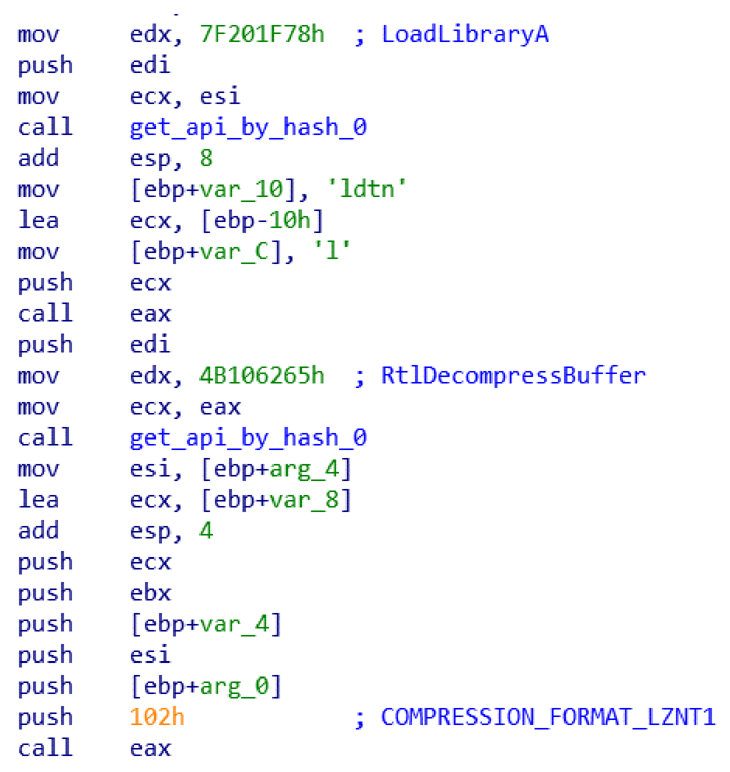

```
mov     edx, 7F201F78h  ; LoadLibraryA
push    edi
mov     ecx, esi
call    get_api_by_hash_0
add     esp, 8
mov     [ebp+var_10], 'ldtn'
lea     ecx, [ebp-10h]
mov     [ebp+var_C], 'l'
push    ecx
call    eax
push    edi
mov     edx, 4B106265h  ; RtlDecompressBuffer
mov     ecx, eax
call    get_api_by_hash_0
mov     esi, [ebp+arg_4]
lea     ecx, [ebp+var_8]
add     esp, 4
push    ecx
push    ebx
push    [ebp+var_4]
push    esi
push    [ebp+arg_0]
push    102h            ; COMPRESSION_FORMAT_LZNT1
call    eax
```

Figure 20: The decompression of the final payload

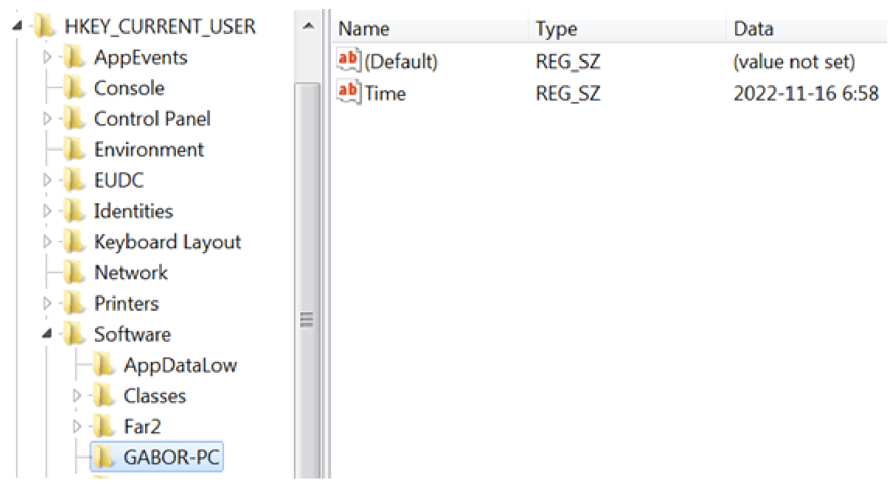
After this, the shellcode loads the final payload DLL into memory and executes it.

Fourth stage: The payload

The payload DLL contains one export, rudely named:

```
dllname: ServerDll.dll

  0   1  0x14780  0x15380 F■ck
```

This creates a flag key in the registry. The name of the key will be HKCU\SOFTWARE\%COMPUTERNAME%, if GetComputerName returns a value; otherwise *UnkNow* will be used.


```
HKEY_CURRENT_USER
  AppEvents
  Console
  Control Panel
  Environment
  EUDC
  Identities
  Keyboard Layout
  Network
  Printers
  Software
    AppDataLow
    Classes
    Far2
    GABOR-PC
```

Name	Type	Data
(Default)	REG_SZ	(value not set)
Time	REG_SZ	2022-11-16 6:58

Figure 21: The flag key picked up the name of the machine on which this exploit was dissected

Multiple values are stored under this key:

- Time: records the date and time of installation of the malware
- CopyC: updated C2 address (encoded with bytewise XOR 5 + BASE64)
- ARPD: list of names, separated with | . creates new thread for each; searches for strings isARDll, PluginMe, getDllName – may be export names

- ZU: value is used in the procedure that reads the wallet seed for the Chrome extension; likely provides destination information for exfiltration of wallet contents
- Remark: stores the hostname

The backdoor supports a set of numeric command codes:

Code	Action
0	Shutdown/Reboot/Logoff
1	
2	Set registry key “Remark”
3	Set registry key “ZU”
4	Clear event logs
5	Get status of nkbihfbeogaeaoehlefnkodbefgpgknn extension
6	Download and execute file
8	Execute command with ShellExecute, visible window
9	Execute command with ShellExecute, hidden window
112	Get clipboard content
113	Set clipboard content
125	Executes command in a hidden cmd window
126	Writes buffer to file and executes it
128	Sets registry key CopyC
35-37,101-111, 127	Checks for exports PluginMe, isARDL, getDllName, isCSDll, and perhaps more

It also contains a string related to MetaMask. MetaMask is a crypto (Ethereum) wallet available as, among other things, a Chrome extension. In the past, attackers looking to steal from cryptowallets have targeted users who have installed this extension, and that’s what appears to be happening here.

```
C:\Users\%s\AppData\Local\Google\Chrome\User

C:\Users\%s\AppData\Local\Google\Chrome\User
Data\Default\Extensions\nkbihfbeogaeaoehlefnkodbefgpgknn\
```

The C2 server name, nsjdhmdjs[.]com, has been associated with Operation Dragon Breath (aka “APT-Q-27” or “Golden Eye Dog,” as above). Some of the DLL sideloading characteristics we’ve demonstrated and also the ServerDll.dll name are likewise characteristic of this threat actor.

Fourth stage: Payload variations – a debug build version and the gh0st of a sample

We also found, on VirusTotal, a specific version of the payload (SHA256: d86f1292d83948082197f0a29fcb69fdec9feb4bf3898d7b8e693c7d5a28099c) that contained more internal information than usual. This is also an executable, unlike the usual payloads (which are DLLs).

The PDB path is the usual:

```
D:\Work\3远控\企业远程控制\Debug\ServerDll.pdb
```

In this case, however, it contains the source code of the infamous gh0st RAT. The source archive is supposed to be dropped by one of the procedures, but that code is never executed:

```
  hFile = CreateFileA(lpFileName, 0x40000000u, 1u, 0, 2u, 0, 0);

  if ( hFile == (HANDLE)-1 )

    v4 = 0;
  if ( WriteFile(hFile, &gh0st_rat_src, 0xE5B1Au, &NumberOfBytesWritten, 0) )

    v4 = 1;

  CloseHandle(hFile);

  return v4;
```

For this sample, the C2 server is 23[.]225[.]147[.]227.

We also saw on VirusTotal a similar sample (sha256: 64613eadd91a803fe103bef5349db04ddfc01b8d115ba7a24a694563123d38ad) that contained gh0st RAT source code, but no debug information and no PDB information. Both these debug versions were submitted to VirusTotal from Hong Kong, one of the regions known to be affected, so it is likely they were indeed used in attacks.

A full list of IoCs is available on our GitHub.

Conclusion

DLL sideloading, first identified in Windows products in 2010 but prevalent across multiple platforms, continues to be an effective and appealing tactic for threat actors. This double-clean-app technique employed by the Dragon Breath group, targeting a user sector (online gambling) that has traditionally been less scrutinized by security researchers, represents the continued vitality of this approach. While speculation about future uses of the technique is beyond the scope of this post, it may be useful for defenders to keep an eye out for the behavior we’ve documented here.

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