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English Version only

May 2023

Exposing RDStealer
Deep Dive into a Targeted Cyber-Attack Against East-Asia Infrastructure

Contents

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Overview

Modern cyber-crime rings are becoming increasingly attracted to the use of legitimate components to achieve their goals. Execution of malicious components via DLL hijacking and persisting on affected systems by abusing legitimate scheduled tasks and services are just a few examples of their agility and focus. State-affiliated actors such as the notorious The APT29 group have successfully used this approach in the past by switching a binary responsible for updating Adobe Reader with a malicious component to abuse the corresponding scheduled task used for running the binary, and ultimately, to achieve persistence. Another strategy that aims to make the attackers keep a low profile is the use of locations that are less likely to be suspected to accommodate malware, and which are more likely to be excepted from security solution scrutiny.

We identified these behaviors in a recent incident investigated by Bitdefender researchers, where a presumably custom malware tracked by Bitdefender as **Logutil** backdoor was deployed. The operation was active for more than a year with the end goal of compromising credentials and data exfiltration.

Our investigation revealed that the operation started at least since early 2022. During this time, the attackers attempted to load their tools through multiple means, the **Logutil** being their main tool of choice. **AsyncRat** was also used at the earlier stages of infection.

Based on used infrastructure, it was established that **CobaltStrike** is another tool from the attackers' arsenal.

The target of this operation was a company activating in the **Technology/IT Services** industry in East Asia.

Key findings

- → DLL search order Hijacking involving the "**Microsoft WMI Provider Subsystem" DCOM** and **%SYSTEM32%\wbem\ncobjapi.dll** loader
- → Use of locations that are less likely to be suspected to contain malware and that are more likely to be excepted from scanning by the security solutions
- → Use of tools capable of collecting credential material from various applications such as MobaXterm, mRemoteNG, KeePass, Chrome passwords and history, and many others
- → Attempts of exfiltrating mysql data by accessing the server process memory and attempts of dumping LSASS memory
- → Capabilities to infect other systems in case a RDP session was established to the already infected system by placing malicious components to the \\tsclient\c\ subfolders if tsclient share was enabled

Technical Details

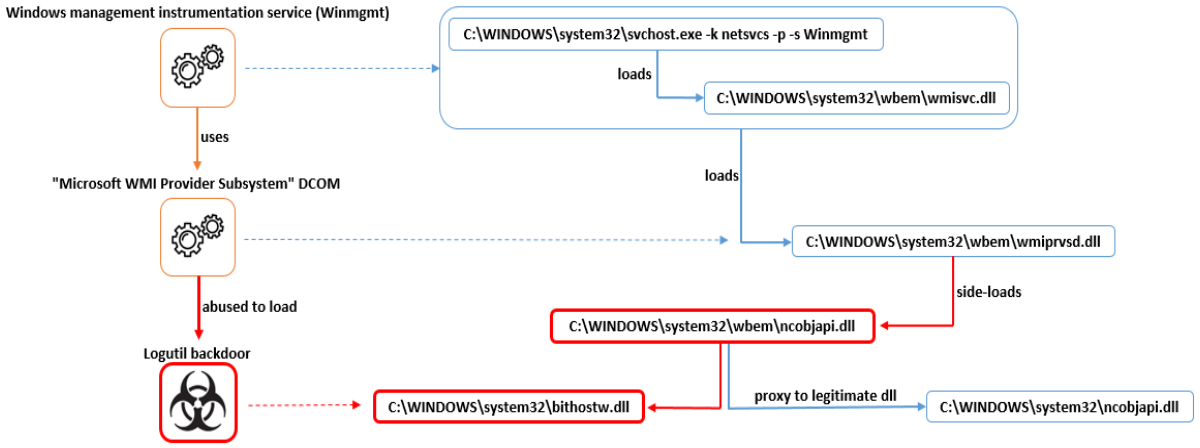
The primary purpose of the attack is credentials theft and data exfiltration as concluded after analyzing the gathered artefacts. In pursuit of staying unnoticed, the attackers used the following locations for hiding their tools:

- → c:\windows\system32\
- → c:\windows\system32\wbem\
- → c:\windows\security\database\
- → %PROGRAM_FILES%\f-secure\psb\diagnostics
- → %PROGRAM_FILES_x86%\dell\commandupdate\
- → %PROGRAM_FILES%\dell\md storage software\md configuration utility\

The locations within **%PROGRAM_FILES%** and **%PROGRAM_FILES_x86%** most likely help attackers blend the malware into legitimate software.

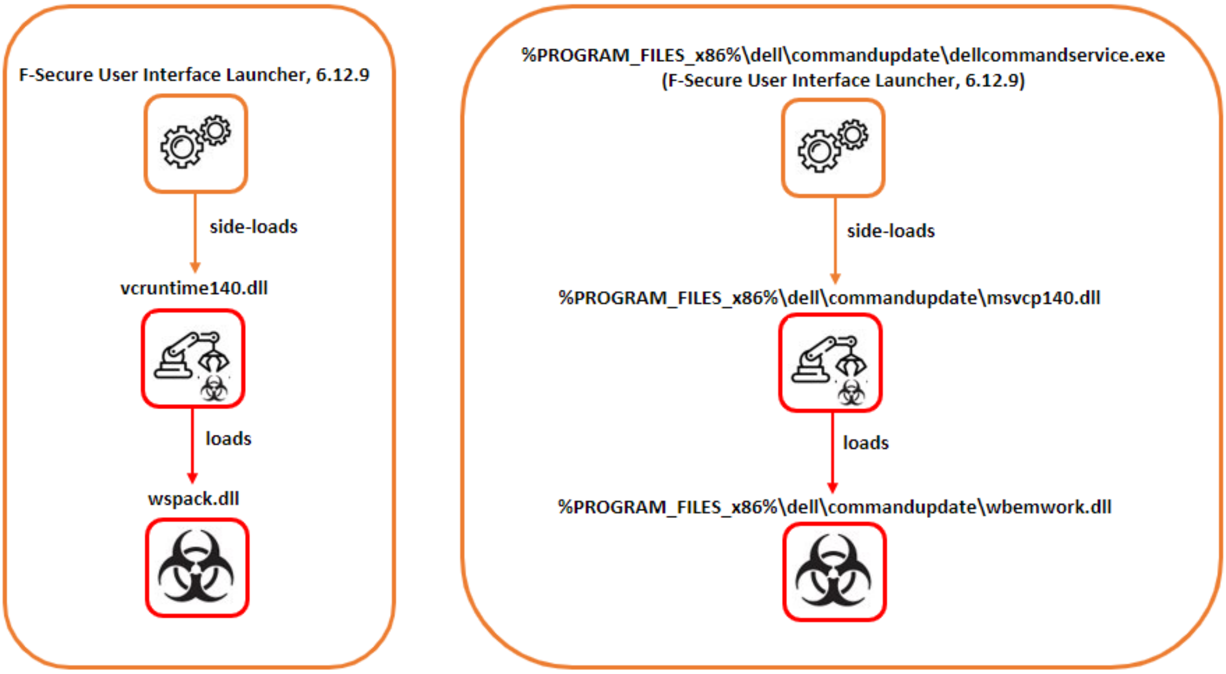
Another location where malware was found is **c:\windows\security\database**, which corresponds to the location for windows security files, a location probably chosen to evade detection. Microsoft recommends excepting some files within that location from scanning, so the attackers' choice of dropping the malware there might be motivated by the fact that there might be security solutions that would ignore all files within that location from scanning, including malware.

The collected evidence shows that the service **Winmgmt** was indirectly abused to ensure persistence for **Logutil** backdoor. This was possible because of DLL Hijacking with the help of the malicious loader located at **%SYSTEM32%\wbem\ncobjapi.dll**. The analysis of the **Winmgmt** behavior shows that it uses the **"Microsoft WMI Provider Subsystem" DCOM** that is implemented in **c:\windows\system32\wbem\wmiprvsd.dll**. The **wmiprvsd.dll** DLL depends on **ncobjapi.dll** DLL which resides in **c:\windows\system32**, but because of the DLL search order algorithm, the **%SYSTEM32%\wbem** is inspected first, and so, the malicious loader will be loaded. The malicious loader will ensure that it correctly mimics the legitimate **ncobjapi.dll** functionality by proxy-ing the calls to exported functions to corresponding ones of the legitimate DLL.



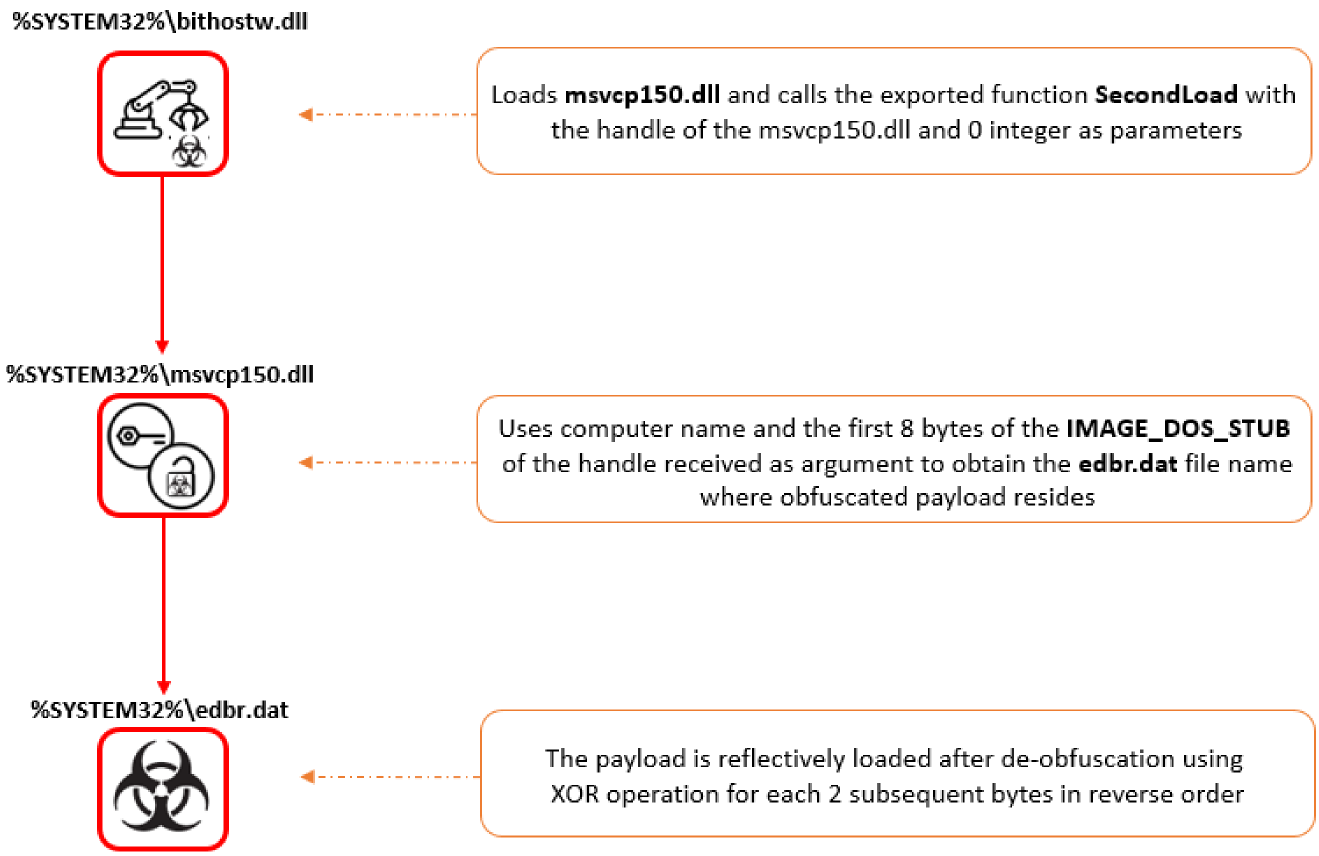
The use of **%SYSTEM32%\wbem\ncobjapi.dll** for sideloading is not new, as other known threats such as operators of **RadRat** and **Lazarus** group have used the same technique for loading the malicious DLL. However, the technique used by the current threat actors stands out for the way DLL sideloading takes placehappens: the final payload is not **ncobjapi.dll**, but other DLL files located either in **c:\windows\system32** or in **c:\windows\system32\wbem\,** such as the **bithostw.dll** as shown in the previous image.

The attackers expended significant effort to defenses, as suggested by the extensive use of side-loading the **F-Secure User Interface Launcher**, version **6.12.9 in particular**:



F-Secure has been informed of the binary abuse to perform side-loading of malicious DLLs used in the attack. F-Secure acknowledged that, as the binary was used independently, outside of the normal software functionality, no further action is required. The F-Secure product installed on a system is not vulnerable to the DLL side-loading abuse.

Another interesting detail that emerged after the analysis of one of the samples of **bithostw.dll** was the use of Execution Guardrails (T1480) for defense evasion, which involved the use of the infected computer's name to derive the file name where the obfuscated and UPX-packed **Logutil backdoor** resides:



Evidence suggests that the legitimate **rdpclip.exe** from one of the affected machines was also used to side-load the **Logutil** malicious DLL with the help of the scheduled task **“Microsoft\Windows\NetTrace\GatherInfo”**. The use of that task name can be categorized as an attempt to mimic the legitimate scheduled task **“Microsoft\Windows\NetTrace\GatherNetworkInfo”**.

It is worth mentioning that almost all files related to the incident have corresponding digital signatures with the same serial number - the purpose of that being evading detection:

```
Verified:   Signed
Catalog:    <path to file>
Signers:
   ARGOS LABS
Status:          A required certificate is not within its validity period when
verifying against the current system clock or the timestamp in the signed file.
Valid Usage:     Code Signing
Serial Number:   00 F7 B7 5C 60 5B 00 83 95 73
8A AC 06 AB E3 B4 70
Thumbprint: AD8F0BEA52A943CF63A0E6F2AEC0EE25127E6E76
Algorithm:  1.2.840.113549.1.1.11
Valid from: 3:00 AM 2019-07-16
Valid to:   2:59 AM 2021-07-20
   Sectigo RSA Code Signing CA
Status:          Valid
Valid Usage:     Code Signing, Timestamp Signing
Serial Number:   1D A2 48 30 6F 9B 26 18 D0 82
E0 96 7D 33 D3 6A
Thumbprint: 94C95DA1E850BD85209A4A2AF3E1FB1604F9BB66
Algorithm:  1.2.840.113549.1.1.12
Valid from: 3:00 AM 2018-11-02
Valid to:   2:59 AM 2031-01-01
   Sectigo
Status:          Valid
Valid Usage:     Client Auth, Code Signing,
EFS, Email Protection, IPSEC Tunnel,
IPSEC User, Server Auth, Timestamp Signing
Serial Number:   01 FD 6D 30 FC A3 CA 51 A8 1B
BC 64 0E 35 03 2D
Thumbprint: 2B8F1B57330DBBA2D07A6C51F70EE90DDAB9AD8E
Algorithm:  1.2.840.113549.1.1.12
Valid from: 3:00 AM 2010-02-01
Valid to:   2:59 AM 2038-01-19
Signing date:    12:07 PM 2021-06-30
```

More details of the capabilities of the tools can be found in the following sections.

File collector

Located at "%**PROGRAM_FILES%\dell\md storage software\md configuration utility\modular disk service daemon.exe**", the identified sample presents traces of a tool specialized in data gathering. Implemented in Go, the sample has metadata that easily allows us to infer its capabilities, as shown in the table listing the used packages below:

package name	description
`cli`	Implements the capture of the clipboard content by using windows API such as **OpenClipboard** and **GetClipboardData**;
`key`	Implements keystroke capture alongside with window name;
`main`	Acts as the orchestrator and uses the package **modules** to perform persistence setup and start the routine for data collection if certain conditions are met;
`modules`	Implements different functions used for collecting and staging the data for further exfiltration;

package name	description
utils	Implements encryption and decryption functions, file attribute manipulation, and log function

The modules information extracted from one of the binaries looks like this:

```
Package modules: modules
File: clip.go
    ClipInfo Lines: 7 to 17 (10)
File: dirs.go
    ZipDir Lines: 15 to 74 (59)
    ZipDirfunc1 Lines: 37 to 85 (48)
    LogDir Lines: 74 to 151 (77)
    LogDirfunc1 Lines: 85 to 154 (69)
    DiskEnum Lines: 151 to 199 (48)
    DiskEnumfunc1 Lines: 154 to 181 (27)
    needEnumDisks Lines: 199 to 217 (18)
File: startup.go
    init Lines: 12 to 12 (0)
    getAllUserStartupDir Lines: 25 to 31 (6)
    writeInfoGather Lines: 31 to 76 (45)
    WriteUsrStartup Lines: 76 to 106 (30)
File: wbem.go
    WorkWithWbem Lines: 21 to 57 (36)
```

```
Package utils: utils
File: de.go
    De Lines: 9 to 21 (12)
    RandInt Lines: 21 to 23 (2)
File: file.go
    init0 Lines: 26 to 40 (14)
    createFileGenericRead Lines: 40 to 51 (11)
    Touch Lines: 51 to 94 (43)
    IsFileExist Lines: 94 to 104 (10)
    PathExists Lines: 104 to 115 (11)
    CopyFile Lines: 115 to 126 (11)
File: log.go
    init Lines: 15 to 15 (0)
    EncryptGCM Lines: 19 to 152 (133)
    DecryptGCM Lines: 75 to 152 (77)
    GenerateNonce Lines: 134 to 169 (35)
    WriteFileLog Lines: 169 to 185 (16)
File: net.go
    GetLocalIP Lines: 8 to 34 (26)
```

```
Package cli: cli
File: cli_windows.go
    init Lines: 21 to 31 (10)
    readAll Lines: 34 to 58 (24)

Package key: key
File: key.go
    StartLogger Lines: 10 to 24 (14)
    getForegroundWindow Lines: 24 to 34 (10)
    getWindowText Lines: 34 to 47 (13)
    windowLogger Lines: 47 to 70 (23)
    keyLogger Lines: 70 to 395 (325)
File: vars.go
    init Lines: 90 to 94 (4)
```

```
Package main: command-line-arguments
File: main.go
    writePersist Lines: 21 to 39 (18)
    diskMounted Lines: 39 to 57 (18)
    work Lines: 57 to 62 (5)
    startClip Lines: 62 to 88 (26)
    notifyMaster Lines: 88 to 111 (23)
    workMonitor Lines: 111 to 147 (36)
    main Lines: 147 to 149 (2)
```

First thing that happens after the main function starts executing is the creation of two go routines for clipboard data capture and for keystroke capture, that would periodically push the gathered data into the log file **c:\users\public\log.log**, in form of base64 encoded AES-GCM encrypted strings that have the format "**<domain>\<username> clp: <captured data>**" and "**<domain>\<username> k: <window text><new line><captured keystrokes>**" respectively, one per line.

The same AES-GCM encryption algorithm was used for storing into the binary the strings representing file extensions, locations where to look for information and locations where to drop tools.

Next, in an infinite loop, the function **diskMounted** will be called to check the availability of the **tsclient** and one of drives **C**, **D**, **E**, **F**, **G** and **H**. The availability of one of those shared drives will trigger the execution of these three functions – **main.notifyMaster**, **main.writePersist** and **modules.DiskEnum**.

→ The **main.notifyMaster** function makes and http GET request to **https://<a local ip address>:7443/pdr.php?name=<hostname>&ip=<host local ip address>,** to notify the attackers that a client is connected to the infected system and probably to be prepared for manual exfiltration of the collected data. The use of a local IP address as the server address indicates that there is another component that acts like a proxy or a server, but this component was not identified.

→ The **main.writePersist** function, as the name suggests, is responsible for persistence setup, but it will ensure the persistence of malicious components on the client that initiated the RDP connection to the infected machine, after these components are successfully copied to the **\\tsclient\c** at specific locations. Two functions will be called to do the job:

Function name	Description
modules.WriteUsrStartup	Obtains the list of users from **\\tsclient\c\users\;** For each user home directory, it copies the following files from the infected system to the RDP client share: → C:\Users\Public\Downloads\t1lnk.dat -> \\tsclient\c\users\<user>\AppData\Roaming\Microsoft\Windows\Start Menu\Programs\Startup\t1lnk.dat.lnk → C:\Users\Public\Downloads\msengine.exe -> \\tsclient\c\Users\Public\Documents\msengine.exe → C:\Users\Public\Downloads\Event.dll -> \\tsclient\c\Users\Public\Documents\Event.dll → C:\Users\Public\Downloads\event.sdb -> \\tsclient\c\Users\Public\Documents\event.sdb No such files were found on the affected machines, but a sideloading triad is apparently intended to be used and the t1lnk.dat.lnk should trigger the execution at startup;
modules.WorkWithWbem	Copies from the infected computer to the RDP share the following files: → C:\Users\Public\Documents\n.dat -> \\tsclient\c\windows\system32\wbem\NCObjAPI.dll → C:\Users\Public\Documents\w.dat -> \\tsclient\c\windows\system32\wbem\WBEMWork.dll If the file copy succeeds, the file attributes of the newly copied files are set to the ones of the wmiprvse.exe files from the **\\tsclient\c** share. Based on the analyzed artefact, ncobjapi.dll and wbemwork.dll are the loader and the **Logutil** backdoor used for further propagation into the victim's network;

→ The **modules.DiskEnum** function starts looking for valuable information in many locations on the \\tsclient\c\ share and it creates an archive with each folder of interest from the tsclient C drive such as:

Location	ID
`\\tsclient\c\users\<user>\appdata\roaming\mremoteng`	mre
`\\tsclient\c\users\<user>\appdata\roaming\keepass`	keyp
`\\tsclient\c\users\<user>\appdata\local\\Google\Chrome\User Data\Default\History`	chro

In case the malware finds the folders of interest within any of the user home directories from the **tsclient** share, a ZIP archive containing the respective folder's content is created and will be saved as "**C:\Users\Public\Documents\<ID><timestamp>.dat**" on the initial infected system where the ID is the one indicated in the second column of the previous table.

While inspecting users' home directories, the folders "**appdata\roaming**", "**appdata\local**", **Desktop**, **Documents** and **Downloads** are searched for files with specific extensions and file names. Once found, it triggers the collection of the subfolder containing the file:

Extension or file name	ID	Details
`.kdb, .kdbx`	kdb	Keepass password database
`confCons.xml`	mre	Config file belonging to **mremoteng** application
`.rdg`	rdg	Remote Desktop Connection Manager Configuration files
`id_rsa`	idrsa	Ssh private keys
`.xsh`	xsh	netsarang Xshell session information
`.tlp, .bscp`	tlp	Bitvise SSH Client
`.mxtsessions`	mxts	MobaXterm session information

The archives will be saved at **C:\Users\Public\Documents**, having the same file name format **<ID><timestamp>.dat**.

After inspecting each home directory on the **tsclient** share, the function proceeds with listing the "**\\tsclient\c\Program Files (x86)**" and "**\\tsclient\c\Program Files**" in search of the same previously described extensions and file names.

Then the tool proceeds to look for the same information within the following location - **\\tsclient\d**, **\\tsclient\e**, **\\tsclient\f**, **\\tsclient\g** and **\\tsclient\h**, but with a slightly different approach as a list of strings is used toskip the listing of subfolders that contain one of the strings from the following list:

```
windows,datareporting,libreoffice,node_modules,all user,default user,user data,.
rust,download,
desktop,document,assembly,.git,microsoft,winsxs,en-us,mui,.net,dotnet, visual,cache,
recycle,systemapp,driverstore,catroot,package, prefetch,installer,font,cursors
```

Moreover, a mechanism exists that limits the listing to once a week, for the shared drives starting with D. The file attributes of a file located at "**users\public\Videos\vcache.dat**" are used to determine the difference from the time of the last modification to the current moment, and this difference is used to determine if a week has passed since the last scan. If the file does not exist or the file attributes indicate that a listing should be performed, then the file is created and the word "**peek**" is written into it, completing this way the file collection process.

As a remark here, the algorithm limiting the listing once a week seems to not work properly as the "**users\public\Videos\vcache.dat**" string, without a drive letter or a share location, is an invalid file location. It is most likely that the attackers intended to create that file on the **\\tsclient\c**, as it makes more sense in case there are multiple RDP clients connecting to the infected system.

Logutil backdoor

Written in Go, the **Logutil** backdoor implements the usual capabilities that are needed to maintain the foothold in the victim's network - capabilities such as file download/upload and command execution.

All collected samples of this tool have common executable attributes. For example, all of them export the Log function and have the export name of either logutil32.dll or logutil64.dll, depending on the architecture.

The go metadata from the samples offer a good understanding of how the **Logutil** works, and further details are provided below:

```
Package main: c
File: client.go
    (*Client)getClientID Lines: 52 to 91 (39)
    (*Client)getRunningState Lines: 91 to 106 (15)
    (*Client)postRunningState Lines: 106 to 111 (5)
    (*Client)initTrans Lines: 111 to 147 (36)
    (*Client)getRemoteText Lines: 147 to 175 (28)
    (*Client)postBack Lines: 175 to 203 (28)
    (*Client)touch Lines: 203 to 220 (17)
    (*Client)process Lines: 220 to 276 (56)
File: cmd_windows.go
    init Lines: 21 to 286 (265)
    initGUID Lines: 31 to 71 (40)
    (*Client)execCmdWork Lines: 71 to 108 (37)
    (*Client)execCmd Lines: 108 to 207 (99)
    (*Client)load Lines: 207 to 274 (67)
    decrypt Lines: 274 to 290 (16)
    wrap·1 Lines: 286 to 286 (0)
    (*Client)d2 Lines: 290 to 374 (84)
    (*Client).d2func1 Lines: 294 to 298 (4)
File: file.go
    (*Client)postbackFile Lines: 16 to 25 (9)
    (*Client)execFileUp Lines: 25 to 70 (45)
    (*Client)execFileDown Lines: 70 to 129 (59)
    (*Client)execLs Lines: 129 to 169 (40)
    (*Client).execLsfunc1 Lines: 132 to 163 (31)
File: filetime_windows.go
    init0 Lines: 22 to 36 (14)
    createFileGenericRead Lines: 36 to 159 (123)
    Touch Lines: 159 to 199 (40)

File: icmp.go
    Ping Lines: 26 to 83 (57)
File: main.go
    workLoop Lines: 12 to 32 (20)
    Log Lines: 32 to 41 (9)
    init2 Lines: 41 to 79 (38)
    main Lines: 79 to 79 (0)
File: memload_windows.go
    Memcpy Lines: 139 to 159 (20)
    VirtualAlloc Lines: 159 to 210 (51)
    GetNTHdrArch Lines: 210 to 228 (18)
    GetImageBase Lines: 228 to 257 (29)
    SetImageBase Lines: 257 to 273 (16)
    GetDirectoryEntry Lines: 273 to 318 (45)
    gApplyRelocations Lines: 318 to 340 (22)
    gProcessRelocBlock Lines: 340 to 375 (35)
    ProcessRelocationTable Lines: 375 to 436 (61)
    FinalizeSection Lines: 436 to 488 (52)
    SectionsRawToVirtual Lines: 488 to 552 (64)
    ParseImportTable Lines: 552 to 632 (80)
    Init Lines: 632 to 663 (31)
    MLoad Lines: 663 to 710 (47)
File: work.go
    exitHandle Lines: 18 to 22 (4)
    init1 Lines: 22 to 28 (6)
    GetWorkPath Lines: 28 to 42 (14)
    workNetwork Lines: 42 to 116 (74)
```

The **main.Log** function that represents the logical entry point of the Logutil, proceeds with the decryption of the config string that is stored as a base64 encoded string. The result of the decoding is then decrypted using a XOR-byte operation using the first byte of the decoded buffer as the key and is applied for the entire buffer. The result of the decryption is a string containing multiple parameters separated by "#":

```
3509200054#https://#dns-a.ntp-update[.]com:53#info#exit#/sys/class/
net/#idle#sleep#ls#shell#fu#fd#/bin/bash#/bin/sh#/bin/zsh#/update#/
info#${COMSPEC}#${SystemRoot}#TEMP#winsxs.dat#quic
```

Although many of these parameters are self-explanatory, such as the http schema, the C2 address and command identifier that will be described shortly, we'll bring a few features into the spotlight, as they might be more counter-intuitive:

→ The last parameter, corresponding to the **quic** value in the previous config indicates that a proxy should be used and the protocol of the proxy; In the previous example, the proxy over QUIC protocol will be used, meaning that the C2 in this case is the address of the proxy server;

→ The parameters "/bin/bash", "/bin/sh" and "/bin/zsh" are not referred anywhere in the identified samples, but might indicate the type of the Linux shell to be used for execution, meaning that the Logutil backdoor is probably a multi-platform tool;

The strings obtained from the config are used to initialize the Client structure that will be further passed to other functions to perform their task:

```
type main.Client struct {
host      string
url       string
proxy     string
ID        string
_id       string
startT    time.Time
ips       string
lock      sync.RWMutex
shellCmd  *exec.Cmd
stdinPipe io.WriteCloser
http      *http.Client
}
```

Communication with the C2 server is done by making subsequent http GET and POST requests where JSON messages described by the following structure are exchanged:

```
type proto.Info struct {
Cm string `json:"c"`
P1 string `json:"p"`
}
```

Another structure is used by the file upload/download operation to perform chunk upload/download where for each chunk a **zlib** compression is applied followed by base64 encoding:

```
type proto.FileUp struct {
Path    string `json:"path"`
Offset  int64  `json:"offset"`
Size    int64  `json:"size"`
IsError bool   `json:"iserr"`
Data    string `json:"data"`
}
```

The first message sent to the C2 is the return value of **getRunningState** containing the amount of time the backdoor is running and information from the **main.Client** structure. The resulting string is base64 encoded and is sent to the C2 as part of the JSON representation of the **proto.Info** structure in the body of the POST request to the **https://<host:port>/update**. The same information will be sent periodically, but the ICMP protocol will be used instead.

The commands from the C2 are obtained by making http GET request to **https://<host:port>/info** from which a **proto.Info** structure will be obtained, where the *Cm* field will be interpreted as the command identifier and the *P1* will be the argument for that command. In some cases, multiple requests will be made. The output of the commands is sent to the C2 using POST requests to **https://<host:port>/update**.

All supported commands are the following:

command	parameter	details
set	<key>=<val>	The name of the variable and its value are received; The os.Setenv function is used to assign the given value to the indicated variable;
load	<Dll path> or <base64 representation of a dll to be loaded into the memoty>	The given DLL will be reflectively loaded into the memory;
c	<command>	Executes command with output capture, create a shell object or interact with previously created shell
s	<command>	Executes command without output capture, create a shell object or interact with previously created shell

command	parameter	details
t	<filepath1>,<filepath2>	Touch operation that sets the file attributes of the first file to the second one
d1	<hex encoded data>	Calls CryptUnprotectData on the received data, and send the result back
fu		Uploads the file in chunks on the victim
fd		Downloads the file in chunks from the victim
idle		Sleeps for an increasing amount of time; The sleep time starts with 6 seconds and increases each time by a random integer value of between 0 and 4;
sleep	<int>	Sleeps for indicated amount of seconds
ls	<path>	Performs a recursive listing of the folder
info		Sends information about the implant, such as the amount of time it is running and the assigned id
exit		Exit

Infrastructure

The C2 information obtained from the config strings of identified samples gives us insight into the attackers' preferences for choosing the infrastructure provider:

Domain	Resolved IP (resolved on 2023.04.04)
a-ad-tml[.]ntp-update[.]com	34.96.222[.]22
rps-a[.]ntp-update[.]com	34.96.222[.]22
a-rps[.]ntp-update[.]com a-rps[.]ntp-update[.]com:123	35.220.144[.]179
dns-a[.]ntp-update[.]com:53	35.220.144[.]179
a-tb[.]ntp-update[.]com	35.220.202[.]191
alast[.]sun-java[.]com:443	35.220.144[.]179
alast[.]ntp-update[.]com:48918	35.220.144[.]179
dell-a[.]ntp-update[.]com dell-a[.]ntp-update[.]com:123	35.220.144[.]179

It's worth mentioning that some of the subdomains reflect particularities of the environment where the implant is deployed (e.g the location where the backdoor is being dropped, as in the case of the domain **dell-a[.]ntp-update[.]com** and the **%PROGRAM_FILES%\dell** location of the backdoor).

Besides the C2 addresses from the Logutil configs, one more domain is used by attackers, which was obtained from two AsyncRat samples – one standalone executable located at **%PROGRAM_FILES%\f-secure\psb\diagnostics\fs_ui.exe** (md5:**dec5b1c097b8d547666f76b55c5d0fdc**) and another in the form of a donut shellcode executed using sideloading and the legitimate executable **c:\\program files (x86)\\f-secure\\psb\\diagnostics\\fs_ui.exe**. These samples seem to be artefacts from the earliest moments of infection and both samples communicate with the C2 **a-sp-rps.0g6666[.]com:1900** that at the moment of writing resolves to the already-known IP address **34.96.222[.]22.**

After inspecting passive DNS information for the known IP addresses, yet another domain name used by attackers came to light - **windows.javaupdate-cdn[.]com**, that resolves to the **35.220.144[.]179** address. The domain **javaupdate-cdn[.]com** has at least other two subdomains - **adobe.javaupdate-cdn[.]com** and **flash.javaupdate-cdn[.]com** that resolves to **34.96.235[.]162** and **35.220.190[.]145** respectively. The **flash.javaupdate-cdn[.]com** domain, based on VT data, is related to two samples – **6cf0007b0d487f899fbd05ffc3401211** and **3294710063ee0dc7d6dfffc4de337b68**, that are a **CobaltStrike** Beacon implant and a loader for **AsyncRat**, which suggests that the attackers used these tools in the past.

With continued digging into the passive DNS information, more domain names that seem related to the attackers' operations were identified - domains that enforce the hypothesis that the attackers target multiple platforms and OS and the LogUtil is a multi-platform backdoor, as suggested by the following subset of domains (the full list of domains can be found in the IOC section):

linux.ntp-update.com
windows.0g6666.com
esxi-lty.ntp-update.com

ubuntu-ndi.ntp-update.com

Three unknown domain names, obtained from pDNS data, also seem related to the attackers' operations – a fact assessed with medium confidence as these domains resolved to the same group of IP addresses in 2020, at the time when the IP addresses were already used as C2 by attackers:

```
h1[.]xpjpz400[.]com
cg[.]xpjpz400[.]com
letsencrypt[.]msupdatesync[.]com
```

Based on the same pDns data, it was established that the subdomains of the already known malicious domains are used by attackers at least from 2020-03-29.

Logutil uses TLS to communicate with the C2, and here is the information about the TLS certificates:

Cert fingerprint	Cert dns	Obs.
7d5ea2769d07326c4f7418ff422bc30c0f6d7135	cugaa.com	It was noticed to be used starting with 2023.03.30 as a replacement for the cert corresponding to op888kai.com;
3dc9116e3bce0f5e8afbcc69928ee473b0ff0eb4	op888kai.com	It was extensively used during the operation;
82abe94672dc3498be7ea57c2de19affdb9e98f5		Self-signed

Based on certificate fingerprints, it was possible to discover a few more IP addresses that, with high confidence, belong to the attackers' infrastructure:

```
35.220.183[.]209
35.208.179[.]162
34.92.13[.]119
```

An interesting fact emerged from the analysis of the geolocation of all these IP addresses and the ASN information– all belong to GCP and all of them are located in Hong Kong except for **35.208.179[.]162,** which is in the US.

IOCs

Files

md5	file path
e89cb63e1352a1c9f86e03e4c744b5cd	%SYSTEM32%\wbem\ncobjapi.dll
f51e88b159b5661f0b83c3947f3e0b24	%SYSTEM32%\wbem\ncobjapi.dll
61ac19b0f812b10e7690109430cba4a5	vcruntime140.dll
d80827879b2e15b18a9c0feaf5a3c859	%PROGRAM_FILES%\dell\md storage software\md configuration utility\modular disk service daemon.exe
1d6b37bd2dfc9d6b4a811f90f6f48dce	%SYSTEM32%\wbem\lzsrv64.dll %SYSTEM32%\mcpbroker.dll
2af313bdd3c54d95303c14786a3ad58d	%SYSTEM32%\wbem\efsmgr32.dll
d5cdeba19d1a31b5be424a82210e3417	%SYSTEM32%\wbem\secure64.dll
de9233ed6689f84286fe0b7da8bc89e9	%SYSTEM32%\splsys64.dll %SYSTEM32%\mcpbroker.dll
e7121980263c08d2a759df827f97ecae	
78a7df158236edd372946347a156e5bc	%SYSTEM32%\bithostw.dll %SYSTEM32%\bithosts.dll %SYSTEM32%\efsmgr32.dll
2b1130775c44be96990b2916ba071f40	%SYSTEM32%\efsmgr32.dll
211ffebfbf679b713148c6dad94ec1df	%SYSTEM32%\lzsrv64.dll
3b8424499183af6f886f722d85353abf	%SYSTEM32%\splsys64.dll
	%SYSTEM32%\efsmgr32.dll

md5	file path
5a5e02256c0a8b65b2db8a0f88887744	wspack.dll %SYSTEM32%\bithostw.dll %SYSTEM32%\wbem\bithosts.dll %WINDOWS%\temp__deleted.dat
1325ad15712a875ff61de3bbb0eccebd	
dec5b1c097b8d547666f76b55c5d0fdc	%PROGRAM_FILES%\f-secure\psb\diagnostics\fs_ui.exe
b7538226437cea21297b94f37d2c2813	%PROGRAM_FILES%\f-secure\psb\diagnostics\fs_ui.exe
6cf0007b0d487f899fbd05ffc3401211	
3294710063ee0dc7d6dfffc4de337b68	
003d6351a2a2a2835f2b64a999963ec1	%PROGRAM_FILES_x86%\dell\commandupdate\wbemwork.dll
e89cb63e1352a1c9f86e03e4c744b5cd	%WINDOWS%\temp__to_be_deleted.dat
20ef20fd88dc7a5e90908f1667c08d11	%SYSTEM32%\bithostw.dll %SYSTEM32%\winrpc32.dll
f18eb7a820f75e51b619b14967c83bb2	%PROGRAM_FILES_x86%\dell\commandupdate\wbemwork2.dll
b7538226437cea21297b94f37d2c2813	%PROGRAM_FILES_x86%\dell\commandupdate\dellcommandservice.exe
43b238bf6829e6f1056749bebdc01dbe	%SYSTEM32%\msvcp150.dll
a83cdb7efbe7bbc4dafa1c11578e6372	%SYSTEM32%\edbr.dat
f14a812c6c377e52fb98f8d4c1ed0abd	
2a421eec6784f1675585e9b428c1b68c	%PROGRAM_FILES_x86%\dell\commandupdate\dellcommandupdate.exe
5c613c1f1f426d7b4630673966a125ba	%PROGRAM_FILES_x86%\dell\commandupdate\msvcp140.dll
ea4cee8027df495c0da7b22e5a9d8457	%WINDOWS%\temp\winsxs.dll
32efbf302aaa2845d3a2b76a50840dc2	%SYSTEM32%\msvcp150.dll
47a02b5f59bbc62b7f4be0f4ce7574cd	%WINDOWS%\security\database\msvcp150.dll
13f5490acf5f5fab2f43f71999563bb9	%WINDOWS%\security\database\msprotect.dll
9fc12edb2e5f193ed4ae365a57c47ffb	%WINDOWS%\security\database\edbt.dat

Domains

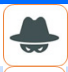
a-ad-tml[.]ntp-update[.]com
rps-a[.]ntp-update[.]com
a-rps[.]ntp-update[.]com
dns-a[.]ntp-update[.]com
a-tb[.]ntp-update[.]com
alast[.]sun-java[.]com
alast[.]ntp-update[.]com
dell-a[.]ntp-update[.]com
a-sp-rps[.]0g6666[.]com
og8888[.]0g6666[.]com
windows[.]javaupdate-cdn[.]com
adobe[.]javaupdate-cdn[.]com
flash[.]javaupdate-cdn[.]com
linux[.]0g6666[.]com
ad[.]ntp-update[.]com
linux[.]ntp-update[.]com
windows[.]0g6666[.]com
www[.]0g6666[.]com
wt[.]ntp-update[.]com
aliyun[.]ntp-update[.]com

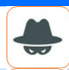
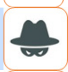
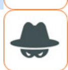
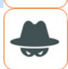
```
cloud[.]ntp-update[.]com
fe[.]ntp-update[.]com
wtech[.]ntp-update[.]com
imp[.]ntp-update[.]com
ogplus[.]ntp-update[.]com
organization[.]0g6666[.]com
global[.]ntp-update[.]com
kaiy[.]0g6666[.]com
kaiy[.]ntp-update[.]com
ky[.]0g6666[.]com
oriental[.]ntp-update[.]com
guard[.]ntp-update[.]com
oglive[.]ntp-update[.]com
guard[.]0g6666[.]com
plus[.]ntp-update[.]com
oglty[.]0g6666[.]com
oglty[.]ntp-update[.]com
oglty-ml[.]ntp-update[.]com
esxi-lty[.]ntp-update[.]com
ml-lty[.]ntp-update[.]com
telegram[.]ntp-update[.]com
easyh[.]ntp-update[.]com
weblog[.]ntp-update[.]com
weblog-ml[.]ntp-update[.]com
o-fsh[.]ntp-update[.]com
idn-tb[.]ntp-update[.]com
tb-ndi2[.]ntp-update[.]com
ml-ndi[.]ntp-update[.]com
vct[.]0g6666[.]com
windows-i-tb[.]ntp-update[.]com
ubuntu-ndi[.]ntp-update[.]com
windows-qc-tb-i[.]ntp-update[.]com
windows-tb-i[.]ntp-update[.]com
a-fms[.]ntp-update[.]com
plus[.]0g6666[.]com
aprotect[.]sun-java[.]com
```

IP addresses

```
34.96.222[.]22
35.220.144[.]179
35.220.202[.]191
34.96.235[.]162
35.220.190[.]145
35.220.183[.]209
35.208.179[.]162
34.92.13[.]119
```

TTPS

TOOL	REPRESENTATION
Logutil backdoor	
Collection TOOL	
OPERATIONAL ACTIVITY	

Tactic	Technique	Tools
Execution	Command and Scripting Interpreter: Windows Command Shell (T1059.003)	 
	Scheduled Task/Job: Scheduled Task (T1053.005)	
	Native API (T1106)	 
	Windows Management Instrumentation (T1047)	
Persistence	Boot or Logon Autostart Execution: Registry Run Keys / Startup Folder (T1547.001)	
	Create or Modify System Process: Windows Service (T1543.003)	
	Scheduled Task/Job: Scheduled Task (T1053.005)	
	Hijack Execution Flow: DLL Search Order Hijacking (T1574.001)	
Defense evasion	Execution Guardrails (T1480)	
	Hijack Execution Flow: DLL Search Order Hijacking (T1574.001)	
	Hijack Execution Flow: DLL Side-Loading (T1574.002)	
	Masquerading: Invalid Code Signature (T1036.001)	 
	Masquerading: Masquerade Task or Service (T1036.004)	
	Masquerading: Match Legitimate Name or Location (T1036.005)	 
	Obfuscated Files or Information: Software Packing (T1027.002)	
	Reflective Code Loading (T1620)	
	Deobfuscate/Decode Files or Information (T1140)	 
	Indicator Removal: File Deletion (T1070.004)	 
	Indicator Removal: Timestomp (T1070.006)	 
Credential Access	OS Credential Dumping: LSASS Memory (T1003.001)	
	Input Capture: Keylogging (T1056.001)	
	Credentials from Password Stores: Credentials from Web Browsers (T1555.003)	 

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