

THREAT ANALYSIS REPORT: Bumblebee Loader – The High Road to Enterprise Domain Control

By Cybereason Global SOC Team

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The [Cybereason Global Security Operations Center \(GSOC\) Team](#) issues Cybereason [Threat Analysis Reports](#) to inform on impacting threats. The Threat Analysis Reports investigate these threats and provide practical recommendations for protecting against them.

In this Threat Analysis report, Cybereason GSOC team analysts have analyzed a case that involved a [Bumblebee Loader](#) infection. Following this introduction, we describe in detail the attack chain from the initial Bumblebee infection to the compromise of the entire network.

Key Findings

- **User-Driven Execution:** The majority of the infections with Bumblebee we have observed started by end-users executing [LNK files](#) which use a system binary to load the malware. Distribution of the malware is done by phishing emails with an attachment or a link to the malicious archive containing Bumblebee.
- **Intensive Reconnaissance and Data Exfiltration:** Bumblebee operators conduct intensive reconnaissance activities and redirect the output of executed commands to files for exfiltration.
- **Active Directory Compromise:** The attackers compromised Active Directory and leveraged confidential data such as users' logins and passwords for lateral movement. The time it took between initial access and Active Directory compromise was less than two days.
- **Under Active Development:** Cybereason GSOC has observed threat actors transitioning from BazarLoader, Trickbot, and IcedID to Bumblebee, which seems to be in active development and generally the loader of choice for many threat actors.
- **Critical Severity:** Attacks involving Bumblebee must be treated as critical. Based on GSOC findings, the next step for the threat actors is ransomware deployment, and this loader is known for ransomware delivery.
- **Cybereason Managed Detection and Response (MDR):** The Cybereason GSOC team has a zero-tolerance policy towards attacks involving Bumblebee and any other loader, and categorizes such attacks as critical, high-severity incidents. The [Cybereason GSOC MDR Team](#) issues a comprehensive report to customers when such an incident occurs. The report provides an in-depth overview of the incident, which helps to understand the scope of the compromise and the impact on the customer's environment. These reports also provide attribution information whenever possible, as well as recommendations for threat mitigation and isolation.
- **Detected and Prevented:** The [Cybereason Defense Platform](#) effectively detects and prevents infections from Bumblebee.

Introduction

In March 2022, a new malware loader was discovered by [Google Threat Analysis Group](#). This loader is named Bumblebee because of its unique user agent, “Bumblebee,” that is used as part of the communication with the command and control server (C2).

Cybereason GSOC observed the distribution of the loader via spear phishing emails which contain archives with ISO files as attachments or links to download the archive from external sources. The initial execution relies on the end-user execution which has to extract the archive, mount an ISO image file, and click a Windows shortcut (LNK) file.

After initial execution, the most notable post-exploitation activities performed by Bumblebee are privilege escalation, reconnaissance, and credential theft, which are detailed in this report.

Bumblebee operators use the Cobalt Strike framework throughout the attack. The threat actors use the obtained credentials to access Active Directory and make a copy of *ntds.dit* containing data for the entire Active Directory. Lastly, a domain administrator account is used to move laterally, create local user accounts, and exfiltrate data using Rclone software.

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We have previously analyzed the loader in detail, and the report is available [here](#). In this research, we chose to focus on post-exploitation actions and Tactics, Techniques, and Procedures (TTPs).

Analysis

Timeline

Following table summarizes the activities timeline from initial compromise to the data exfiltration:

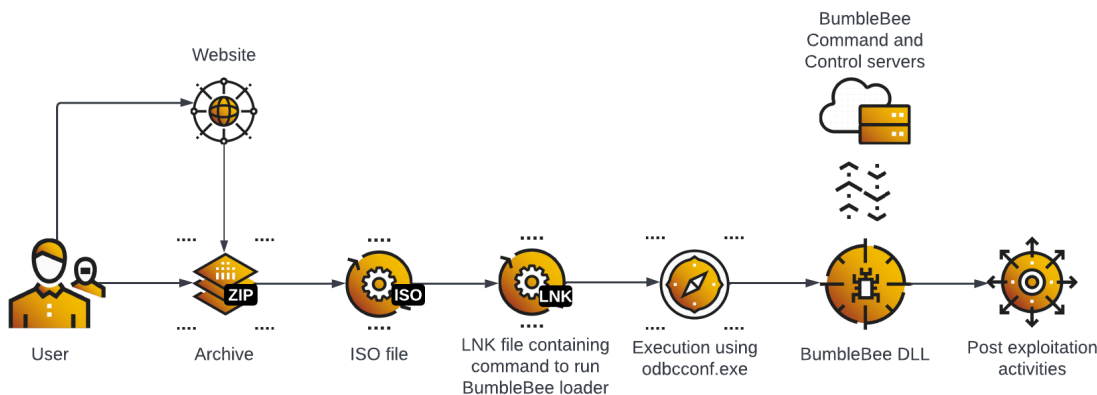
Activities	Time
Initial access	T0
Reconnaissance / nltest, net, whoami	T0 + 30 minutes
Command and Control / Loading Meterpreter agent	T0 + 4 hours
Privilege Escalation / Zerologon exploitation	T0 + 4 hours

Command and Control / Cobalt Strike beacon execution	T0 + 6 hours
Credential Theft / registry hive	T0 + 6 hours
Reconnaissance / adfind, ping, curl	T0 + 6 hours and 30 minutes
Credential Theft and Privilege Escalation / LSASS memory dump with procdump64.exe	T0 + 19 hours
Credential Theft / NTDS.dit exfiltration with Active Directory full privilege	T0 + 22 hours
Lateral Movement / Cobalt Strike socks-tunnel (RDP)	T0 + 24 hours
Data Exfiltration / Rclone	T0 + 3 days

Initial Access and Execution

Cybereason GSOC team observed the following distribution method to deliver the Bumblebee malware:

- A spear phishing email is received containing an archive or a link to an external source to download the archive.
- User extracts the archive and mounts the resulting ISO image.
- The content of the mounted ISO image is a LNK file executing the Bumblebee payload upon user interaction:



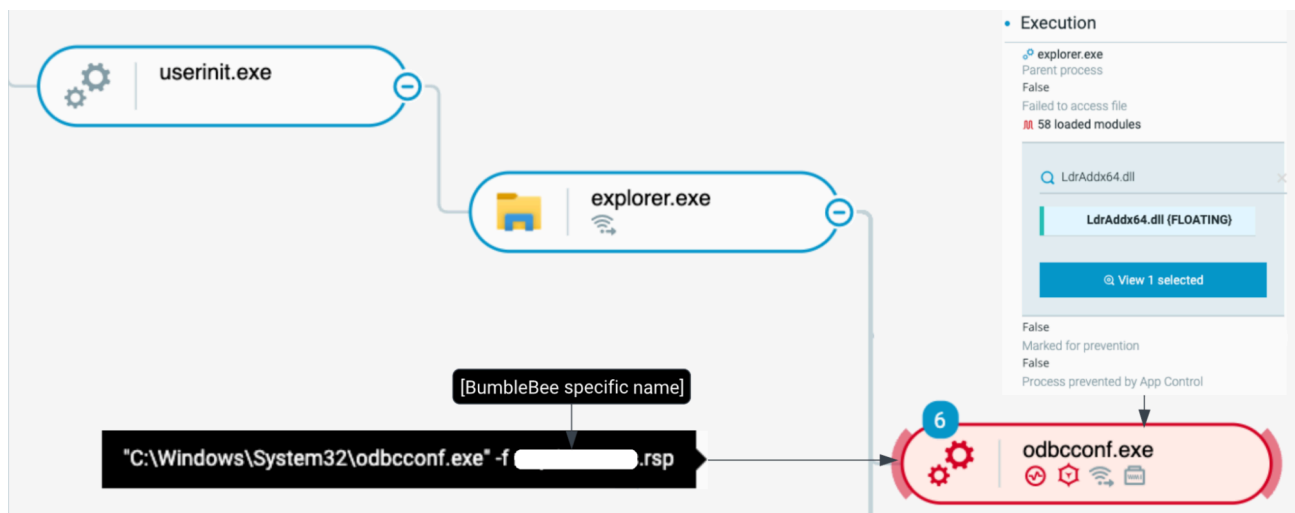
Bumblebee infection flow

Bumblebee operators host malicious websites that implement a drive-by download. To infect the system, an end-user has to first manually decompress the archive containing the ISO file, mount the file and then execute the Windows shortcut (LNK).

The LNK file has an embedded command to run Bumblebee Dynamic-link library (DLL) using [odbcconf.exe](#) [Living Off the Land Binary](#) (LOLBin) and response (.rsp) file. The file *[Bumblebee specific name].rsp* has the reference to the Bumblebee DLL:

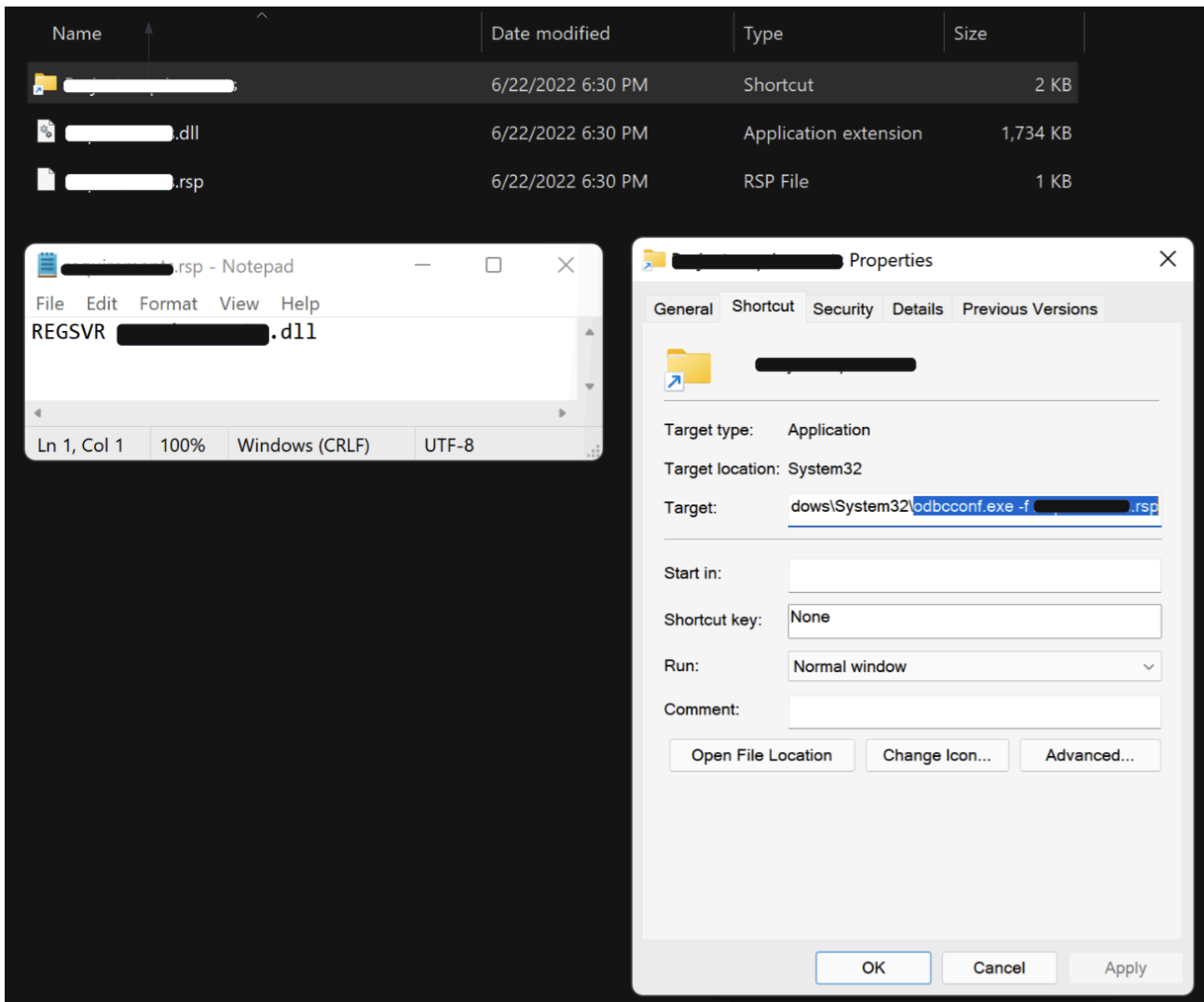


Bumblebee infection steps



An end-user interactively decompresses and executes a LNK file that Bumblebee operators distribute as seen in the Cybereason Defense Platform

`Odbcconf.exe` loads Bumblebee DLL with the [internal name](#) `LdrAddx64.dll`. The figure below illustrates the ISO image content (`DLL`, `RSP` and `LNK` files) for Bumblebee:



Content of the mounted ISO image

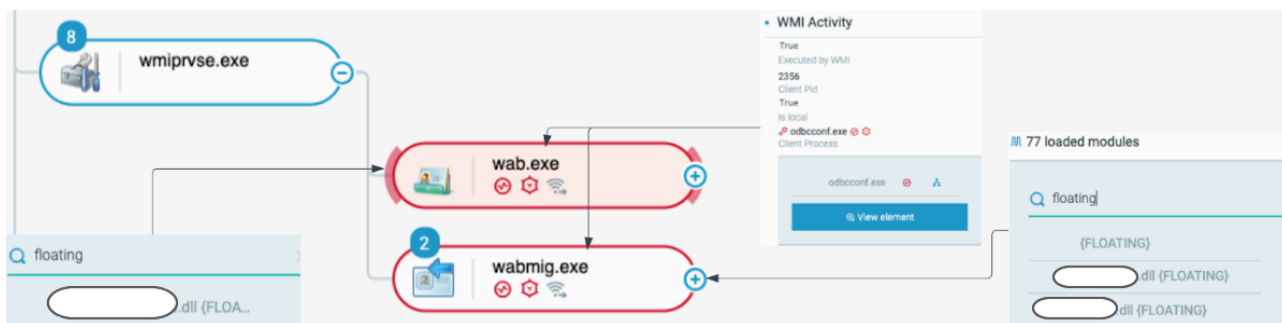
Bumblebee DLL is executed using `odbcconf.exe -f [Bumblebee specific name].rsp` in the LNK file target property. `[Bumblebee specific name].rsp` has a reference to `[Bumblebee specific name].dll` which is the Bumblebee payload

Foothold

After the initial infection, Bumblebee injects code into multiple processes in order to establish a strong foothold on infected endpoints. The process `odbcconf.exe` creates local Windows Management Instrumentation (WMI) calls to spawn new processes.

As a result, the following two processes are spawned from `wmiprvse.exe` (Windows Management Instrumentation Provider Service) :

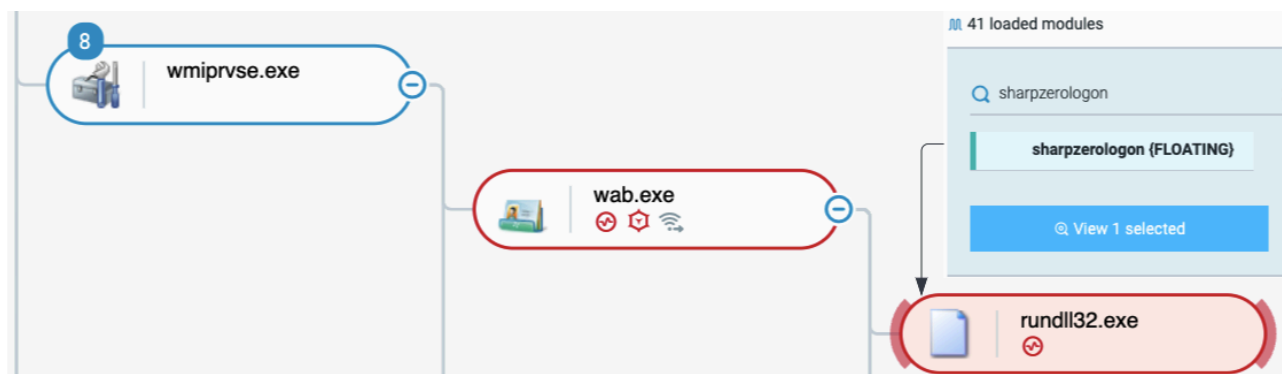
- `wabmig.exe` (Microsoft contacts import tool) with injected Meterpreter agent code (Meterpreter agent is a security product used for penetration testing and provides remote control capabilities).
- `wab.exe` (Microsoft address book application) with an injected Cobalt Strike beacon:



Bumblebee leveraging WMI to run wab.exe and wabmig.exe with injected floating code as seen in the Cybereason Defense Platform

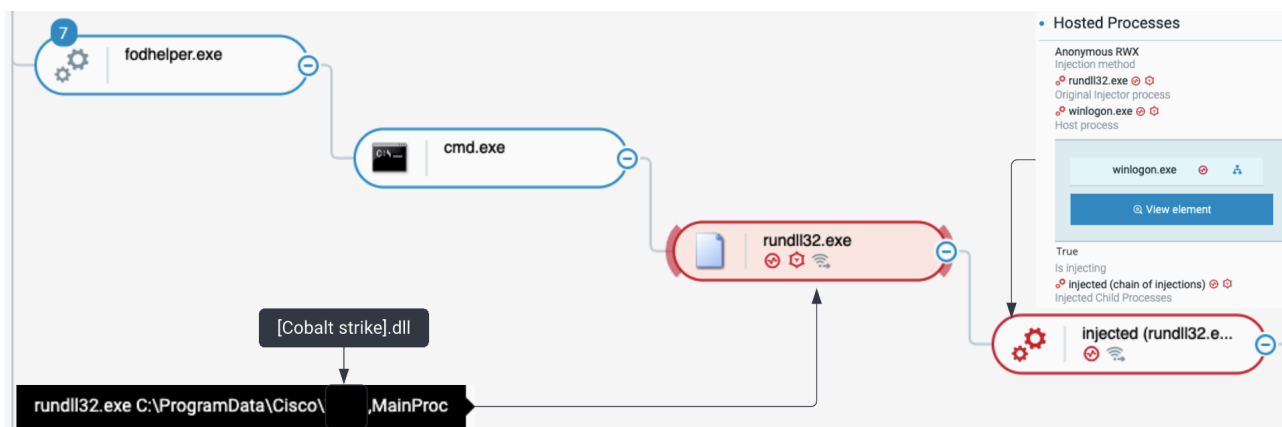
Privilege Escalation and Cobalt Strike deployment

Bumblebee performs privilege escalation by loading an [exploit for CVE-2020-1472 \(ZeroLogon\)](#) into rundll32.exe:



Exploitation of CVE-2020-1472, ZeroLogon as seen in the Cybereason Defense Platform

Bumblebee uses a User Account Control (UAC) bypass technique to deploy post exploitation tools with elevated privileges on infected machines. The method uses [fodhelper.exe](#) which is a trusted binary, meaning Windows 10 won't show a UAC window when launched into execution:



UAC bypass using fodhelper.exe and code injection into winlogon.exe as seen in the Cybereason Defense Platform

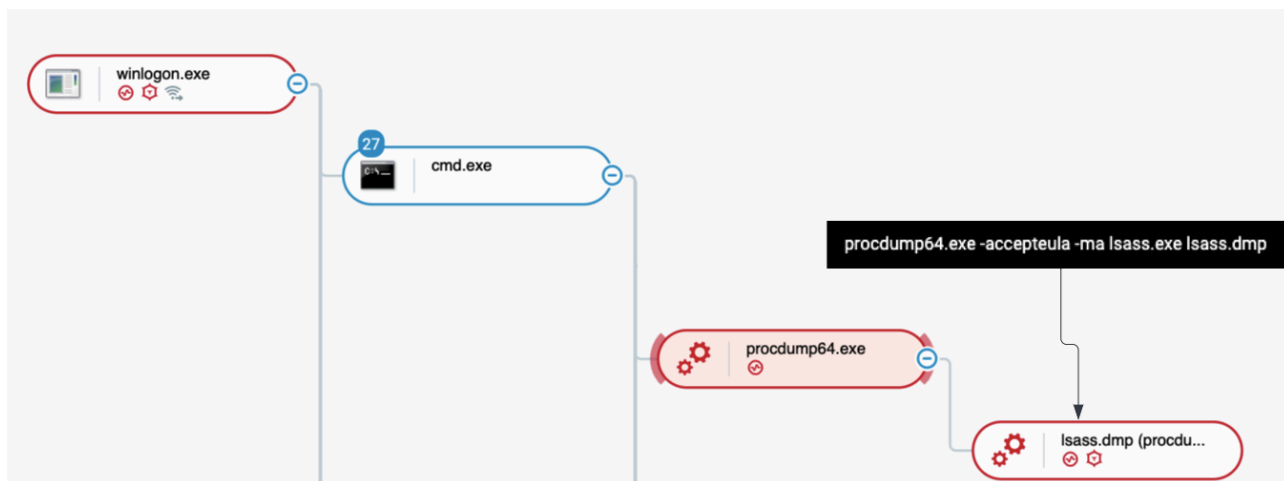
Fodhelper.exe is used to run "`cmd.exe /c rundll32.exe C:\ProgramData\Cisco\[Cobalt strike].dll`", MainProc where `[Cobalt strike].dll` is a Cobalt Strike framework beacon and MainProc is the exported function to run.

Cobalt Strike is an adversary simulation framework with the primary use case of assisting red team operations. However, Cobalt Strike is also actively used by malicious actors for conducting post-intrusion malicious activities. Cobalt Strike is a modular framework with an extensive set of features that are useful to malicious actors, such as command execution, process injection, and credential theft.

Credential Theft

After obtaining system privileges on the infected machine, Bumblebee performs credential theft using two methods detailed below.

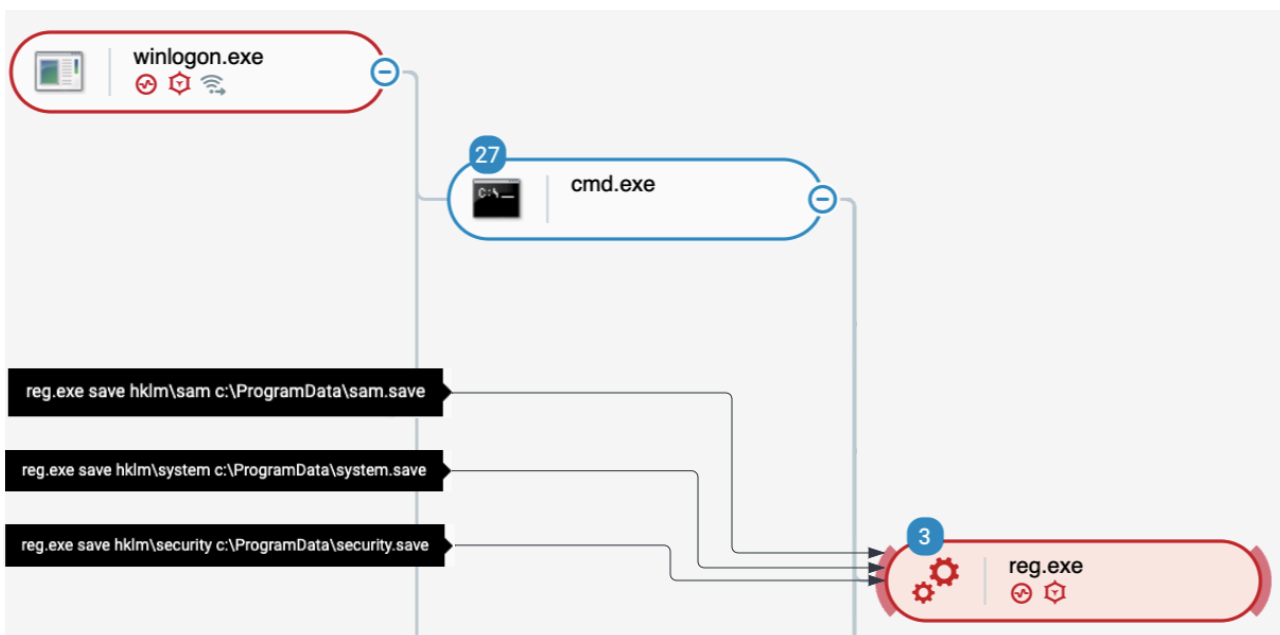
First method used is Local Security Authority Subsystem Service (LSASS) process memory dump. On Windows systems domain, local usernames and passwords are stored in the memory space of the LSASS process. Bumblebee dumps the memory of this process using `procdump64.exe` to access the sensitive information:



Bumblebee dumping lsass.exe memory as seen in the Cybereason Defense Platform

The second method of credential theft that Bumblebee operators use is registry hive extraction using `reg.exe`:

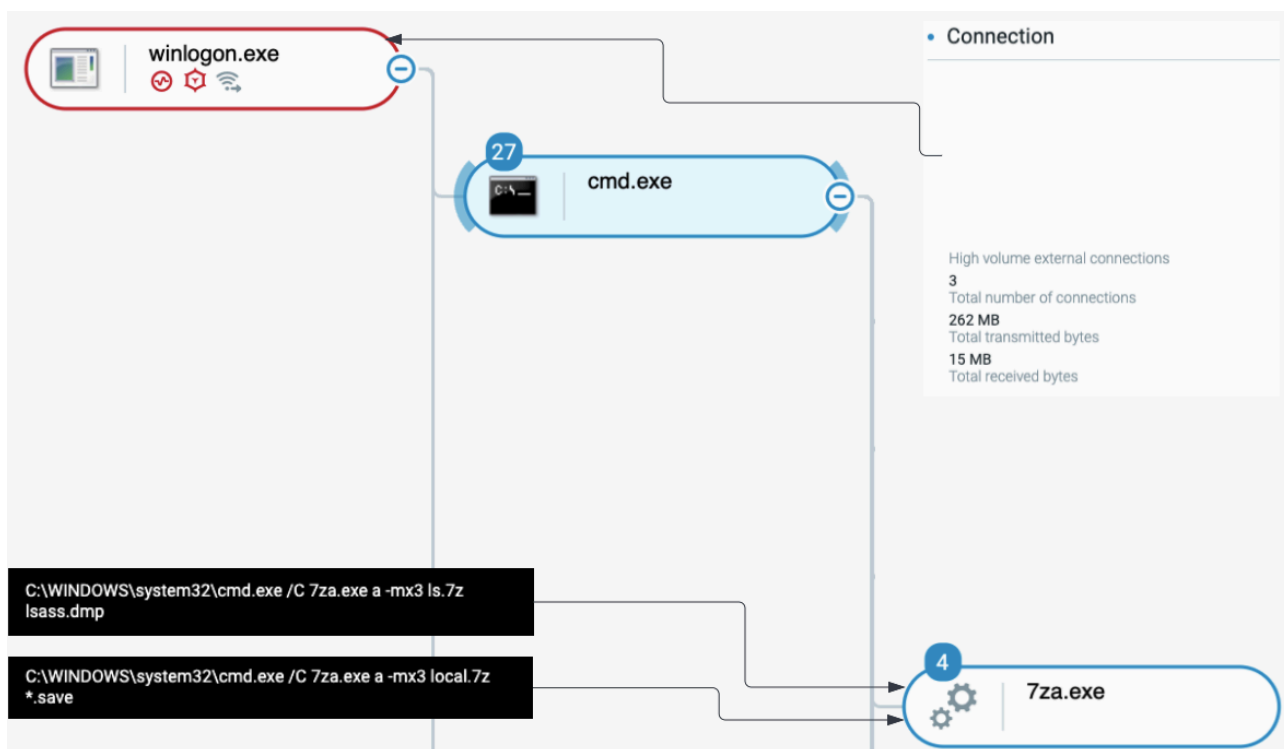
- **HKLM SAM:** The Security Account Manager (SAM) database is where Windows stores information about user accounts.
- **HKLM Security:** Local Security Authority (LSA) stores user logins and their LSA secrets.
- **HKLM System:** Contains keys that could be used to decrypt/encrypt the LSA secret and SAM database:



Bumblebee extracting registry hives as seen in the Cybereason Defense Platform

Bumblebee operators :

- Obtain registry dumps
- Compress the data
- Exfiltrate it over their network tunnel:



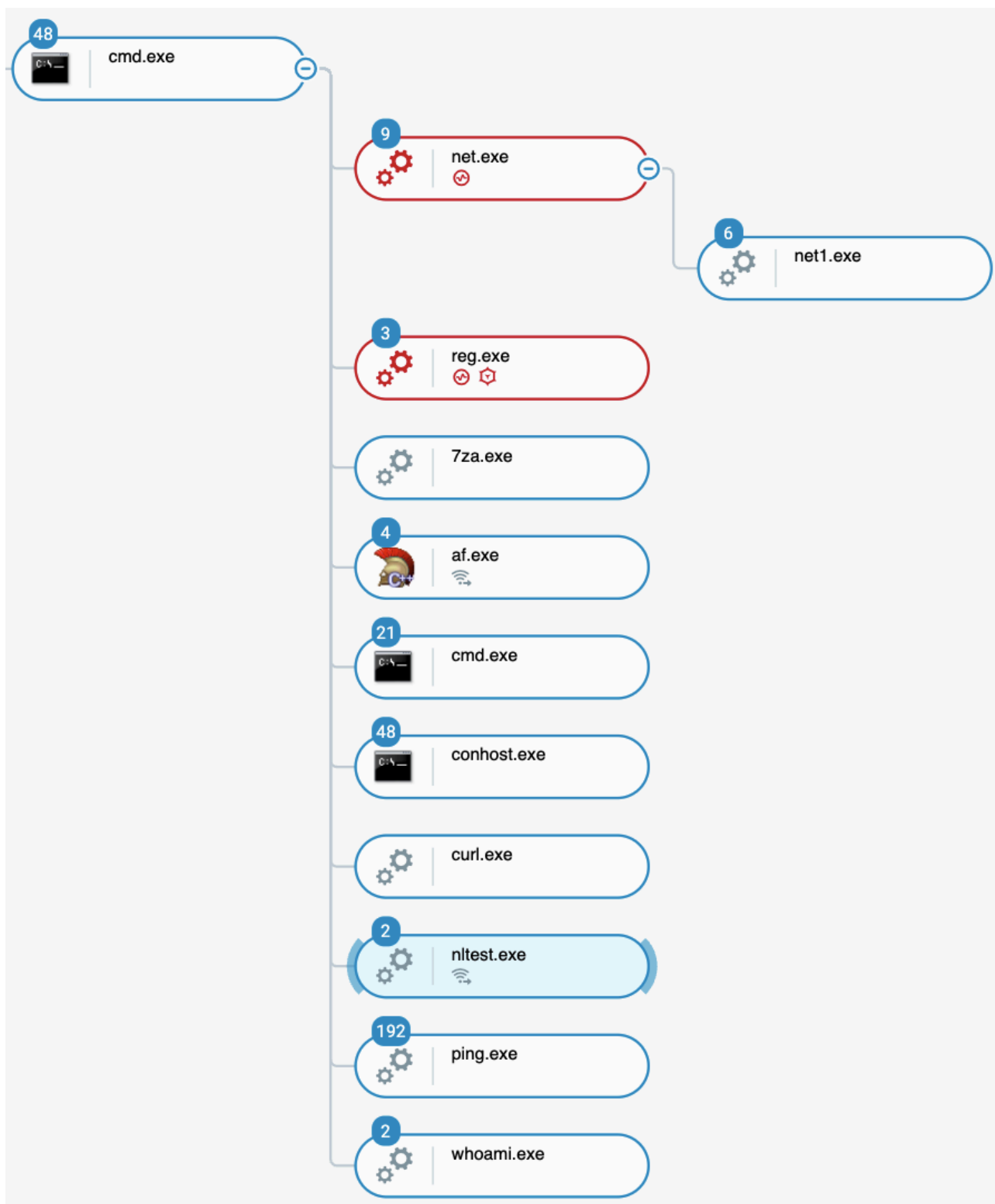
Bumblebee exfiltrating dumps containing credentials as seen in the Cybereason Defense Platform

Bumblebee operators process retrieved credentials offline, attempting to extract cleartext passwords. The time between credentials theft and the next activity is approximately 3 hours.

Reconnaissance

After the attackers gain a foothold in the organization network, they gather information in various ways. We have observed attackers using tools such as *nltest*, *ping*, *netview*, *tasklist* and *Adfind* to collect wide information related to the organization. The attackers collect information such as the domain names, users, hosts and domain controllers.

AdFind (named “af.exe”) is a publicly available tool for querying Active Directory and has been used by multiple threat actors:



Bumblebee executed multiple reconnaissance commands as seen in the Cybereason Defense Platform

During the reconnaissance phase, Bumblebee operators contacted more than 200 IP addresses and domain names within the organization. The most notable ones are Microsoft Exchange, Windows Server Update Services (WSUS) servers.

The following table summarizes the reconnaissance commands observed by Cybereason GSOC analysts:

Command	Description
<i>nltest /domain_trusts</i>	Enumerates trust relationships in a Windows Active Directory (AD) environment.
<i>nltest /dclist:</i>	Enumerates all domain controllers in the domain.
<i>af.exe -f "(objectcategory=person)" > ad_users.txt</i>	Enumerates all user objects in Active Directory and stores the output in a file.
<i>af.exe -f "objectcategory=computer" > ad_computers.txt</i>	Enumerates all computer objects in Active Directory and stores the output in a file.
<i>whoami /all</i>	Displays all information in the current access token, including the current user name, security identifiers (SID), privileges, and groups that the current user belongs to.
<i>curl ifconfig[.]me</i>	Retrieves the publicly visible IP address of the machine using an external service.
<i>ping {hostname} -n 1</i>	Enumerates live hosts.
<i>Tasklist /s {IP address}</i>	Enumerates a list of processes on a specific host.
<i>net user {username} /domain</i>	Switch forces the net user to execute on the current domain controller instead of on the local computer.
<i>net group "domain admins" /domain</i>	Enumerates users that are members of the domain admins group such that the designated Domain Controller (DC) is conducting the enumeration activity.

<pre>net view \\{IP address} /all</pre>	Enumerates all shared computers and resources on a specific system.
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Lateral Movement

Bumblebee uses a Cobalt Strike agent for lateral movement. We can see multiple connections from the process to internal addresses on Remote Desktop Protocol (RDP), on TCP port 3389:

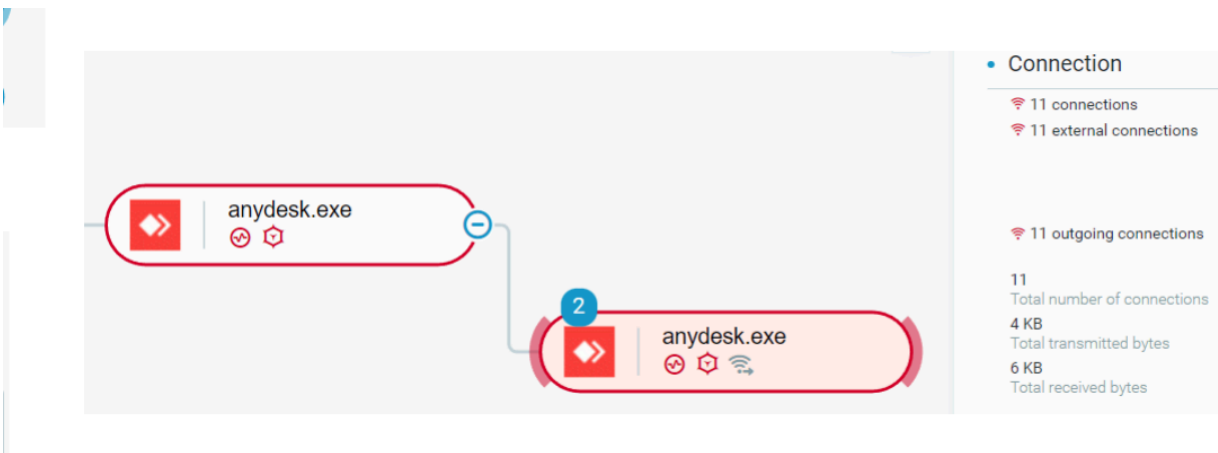
Showing 4 results

rundll32.exe C:\ProgramData\ [redacted] dll,MainProc

Element name	Direction	Server address	Server port	Owner process	Received bytes	Transmitted bytes
[redacted]:50833 > [redacted]:3389	Outgoing	[redacted]	3389	injected (chain of injections)	3 MB	3 MB
[redacted]:61550 > [redacted]:3389	Outgoing	[redacted]	3389	injected (chain of injections)	1252 KB	206 KB
[redacted]:62182 > [redacted]:3389	Outgoing	[redacted]	3389	injected (chain of injections)	1539 KB	164 KB
[redacted]:50833 > [redacted]:3389	Outgoing	[redacted]	3389	svchost.exe		

Bumblebee lateral movement from Cobalt Strike agent as seen in the Cybereason Defense Platform

Following the lateral movement, the attacker persists on the organization network using the remote management software “any desk”:



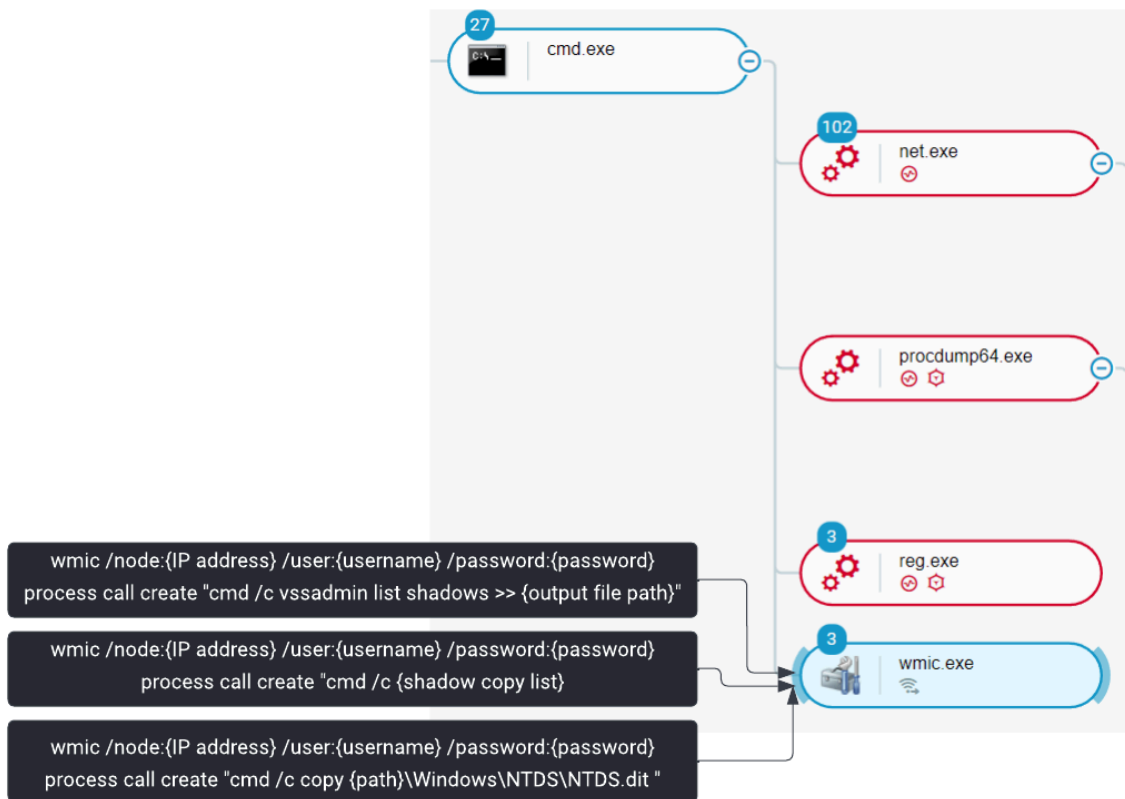
Bumblebee operators using Anydesk for lateral movement as seen in the Cybereason Defense Platform

Active Directory Compromise

After the attacker obtains a highly privileged user and its password, the attacker accesses the shadow copy. Shadow Copy is a technology included in Microsoft Windows that can create backup copies or snapshots of computer files or volumes.

Bumblebee accesses the remote Active Directory machines using Windows Management Instrumentation command-line utility (WMIC) and creates a shadow copy using `vssadmin` command. In addition, the attacker steals the `ntds.dit` file from the domain controller.

The *ntds.dit* file is a database that stores Active Directory data, including information about user objects, groups and group membership. The file also stores the password hashes for all users in the domain:



Bumblebee creates shadow copies on remote Active Directory server and exfiltrates *Ntlds.dit* as seen in the Cybereason Defense Platform

The following are the commands related to credential theft used to escalate privileges on the Active Directory:

- `wmic /node:"[Active Directory IP address]" /user:"[Compromised user name]" /password:"[Compromised user password]" process call create "cmd /c vssadmin create shadow /for=C: 2>&1"`
- `wmic /node:"[Active Directory IP address]" /user:"[Compromised user name]" /password:"[Compromised user password]" process call create "cmd /c vssadmin list shadows >> c:\log.txt"`
- `type \\[Active Directory IP address]\c$\log.txt`
- `wmic /node:"[Active Directory IP address]" /user:"[Compromised user name]" /password:"[Compromised user password]" process call create "cmd /c copy \\?\GLOBALROOT\Device\HarddiskVolumeShadowCopy635\Windows\NTDS\NTDS.dit c:\ProgramData\nt & copy \\?\GLOBALROOT\Device\HarddiskVolumeShadowCopy635\Windows\System32\config\SYSTEM c:\ProgramData\nt & copy \\?\GLOBALROOT\Device\HarddiskVolumeShadowCopy635\Windows\System32\config\SECURITY c:\ProgramData\nt"`

- `7za.exe a -mx3 nt.7z \\[Active Directory IP address]\c$\ProgramData\nt`

In order to obtain maximum privileges on the Active Directory domain, the threat actor:

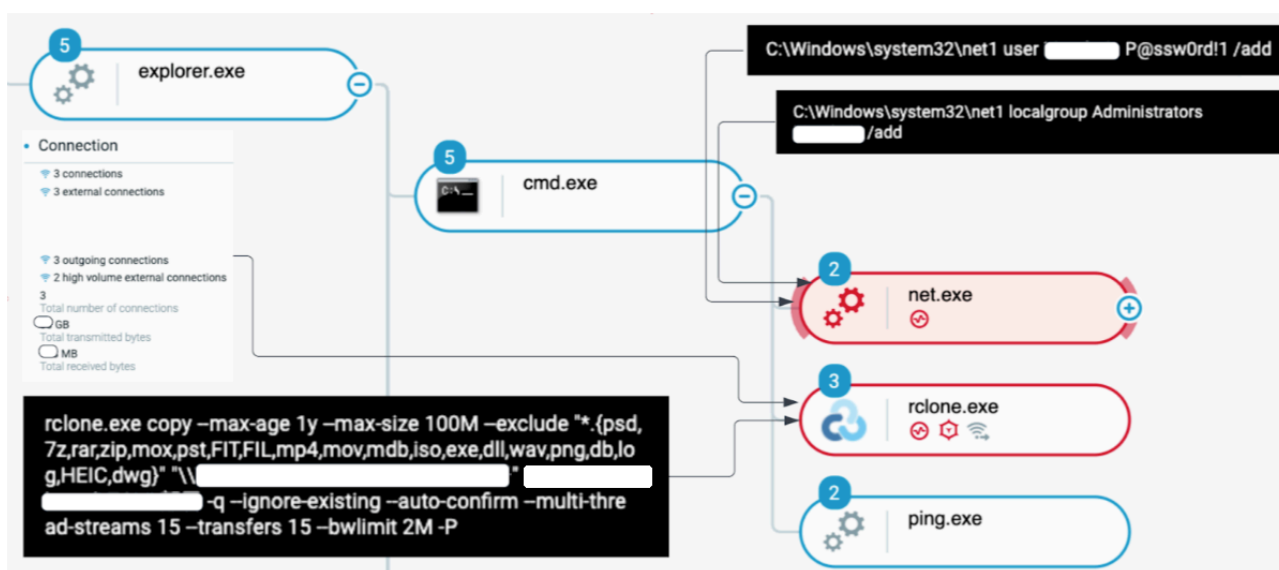
- Creates a shadow copy of the machine file's volume
- Lists all available shadow copies and stored the result in a file.
- Copies the Active Directory database (ntds.dit) as well as registry hives containing credentials and sensitive data from the shadow copy.
- Compress the output directory for exfiltration.

Account Creation and Data Exfiltration

The threat actor uses a domain administrator account obtained previously to move laterally on multiple systems. After initial connection, they create a local user and exfiltrate data using Rclone software.

User creation commands are as follows :

- `net user [Attacker created username] P@ssw0rd!1 /add`
- `net localgroup Administrators [Attacker created username] /add`



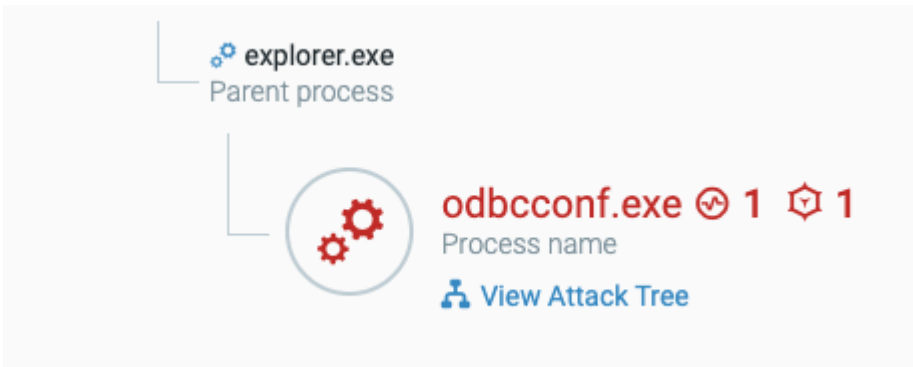
Creation of a local user and exfiltration of data using rclone.exe as seen in the Cybereason Defense Platform

The rclone.exe process transfers approximately 50 GB of data to an endpoint with an IP address over TCP port 22 (SSH), which is located in the United States.

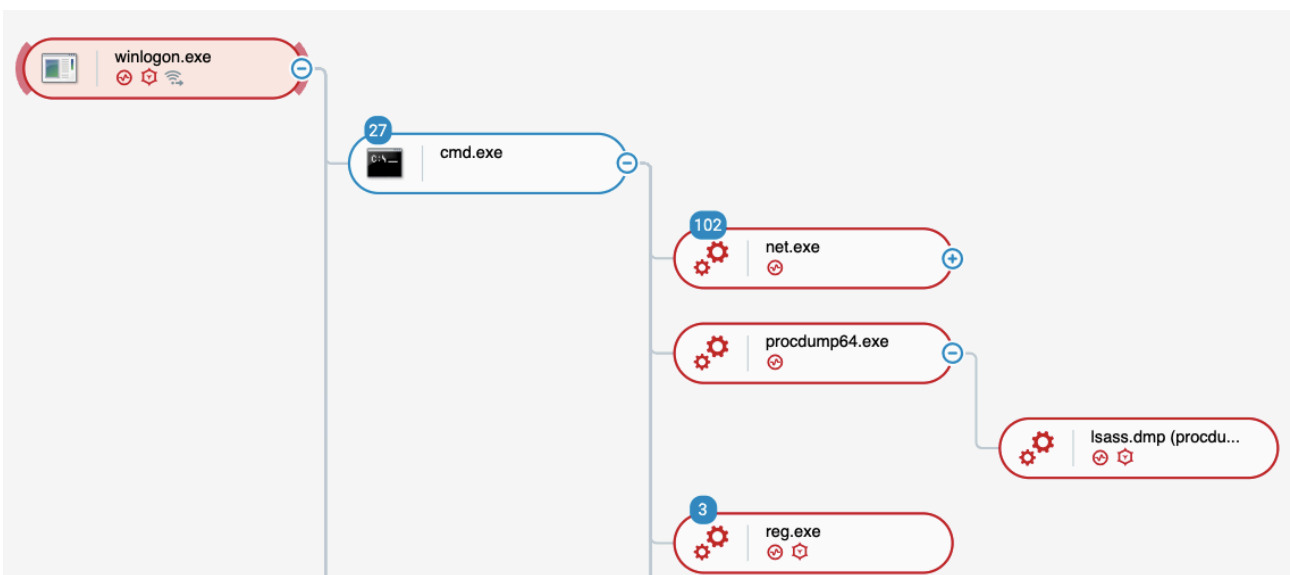
Detection and Prevention

Cybereason Defense Platform

The [Cybereason Defense Platform](#) is able to detect and prevent infections with Bumblebee and post exploitation activities, using multi-layer protection that detects and blocks malware with threat intelligence, machine learning, and Next-Gen Antivirus (NGAV) capabilities:



The Cybereason Defense Platform labels as suspicious the execution of a malicious Bumblebee DLL script using `odbcconf.exe`



The Cybereason Defense Platform detects the credential theft with both `reg.exe` and `procdump64.exe`

Evidence (5)

T1043 - Commonly Used Port : Has Absolute High Volume External

Outgoing Connection

This process has a connection that transferred high volume of data to an external address

[Search for processes with this evidence](#)

2 connections

3 rclone.exe

Connection

- 3 connections
- 3 external connections
- 3 outgoing connections
- 2 high volume external connections

3 Total number of connections

GB Total transmitted bytes

118 MB Total received bytes

The Cybereason Defense Platform detects data exfiltration activities

Affected machines

Affected users

wabmig.exe
Process has loaded a Meterpreter agent
Root cause

No Connections Incoming connections

Unknown Connection Outgoing connections

wabmig.exe
Malicious process

Infection

Timeline

Malop started

Malop detected

Outgoing communication

First execution on first machine

Resource affected

Infection

Malicious process

C&C

02:11 2022

02:13

17:17 2022

2 days

The Cybereason Defense Platform detects a Meterpreter agent

Cybereason GSOC MDR

The Cybereason GSOC recommends the following:

- Enable the Anti-Malware feature on the Cybereason NGAV and enable the [Detect and Prevent modes](#) of this feature.
- Securely handle files downloaded from the Internet and email messages that originate from external sources.
- Regularly backup files to a secured remote location and implement a data recovery plan. Regular data backups ensure that you can restore your data after a ransomware attack.
- Use secure passwords, regularly rotate passwords, and use multi-factor authentication where possible.
- Follow [Best Practices for Securing Active Directory](#) provided by Microsoft.
- To hunt for infections with Bumblebee proactively, use the Investigation screen in the Cybereason Defense Platform and the query in the Hunting Queries section to search for machines that are potentially infected with this malware. Based on the search results, take further remediation actions such as isolating the infected machines.

Cybereason is dedicated to teaming with defenders to end cyber attacks from endpoints to the enterprise to everywhere. [Schedule a demo today](#) to learn how your organization can benefit from an [operation-centric approach to security](#).

MITRE ATT&CK Mapping

Tactic	Technique or Sub-technique
TA0001 : Initial Access	T1189 : Drive-by Compromise
TA0001 : Initial Access	T1566.002 : Phishing: Spear phishing Link
TA0001 : Initial Access	T1078 : Valid Accounts
TA0002 : Execution	T1204.001 : User Execution: Malicious Link
TA0002 : Execution	T1204.002 : User Execution: Malicious File
TA0002 : Execution	T1059.003 : Command and Scripting Interpreter: Windows Command Shell
TA0002 : Execution	T1047 : Windows Management Instrumentation

TA0004 : Privilege Escalation	T1548.002 : Abuse Elevation Control Mechanism: Bypass User Account Control
TA0004 : Privilege Escalation	T1068 : Exploitation for Privilege Escalation
TA0005 : Defense Evasion	T1036.005 : Masquerading: Match Legitimate Name or Location
TA0005 : Defense Evasion	T1055 : Process Injection
TA0005 : Defense Evasion	T1218.008 : System Binary Proxy Execution: Odbcconf
TA0005 : Defense Evasion	T1218.011 : Signed Binary Proxy Execution: Rundll32
TA0005 : Defense Evasion	T1620 : Reflective Code Loading
TA0006 : Credential Access	T1003.001 : OS Credential Dumping: LSASS Memory
TA0006 : Credential Access	T1003.002 : OS Credential Dumping: Security Account Manager
TA0006 : Credential Access	T1003.003 : OS Credential Dumping: NTDS
TA0006 : Credential Access	T1003.004 : OS Credential Dumping: LSA Secrets
TA0007 : Discovery	T1018 : Remote System Discovery
TA0007 : Discovery	T1033 : System Owner/User Discovery
TA0007 : Discovery	T1057 : Process Discovery

TA0007 : Discovery	T1082 : System Information Discovery
TA0007 : Discovery	T1087 : Account Discovery
TA0009 : Collection	T1560.001 : Archive Collected Data: Archive via Utility
TA0009 : Collection	T1039 : Data from Network Shared Drive
TA0010 : Exfiltration	T1048 : Exfiltration Over Alternative Protocol

Indicators of Compromise

IOC type	IOC values
Executables	SHA-1 hash: af.exe (AdFind) - known publicly <ul style="list-style-type: none"> 4acc9ddf7f23109216ca22801ac75c8fabb97019
IP addresses	C2 server: <ul style="list-style-type: none"> 185.62.56[.]129 (known publicly, affiliated with Bumblebee)

About the Researchers



Meroujan Antonyan, Senior Security Analyst, Cybereason Global SOC

Meroujan Antonyan is a Senior Security Analyst with the Cybereason Global SOC team. Meroujan hunts for emerging threats and analyzes incidents in order to improve hunting techniques and procedures. He contributes in automation and interconnection of various cybersecurity projects to collect and leverage threat intelligence and bring value from security events. Meroujan has Digital Forensics & Incident Response experience and is interested in low level malware development, oriented towards improving security solutions capabilities.



Alon Laufer, Security Analyst, Cybereason Global SOC

Alon Laufer is a Security Analyst with the Cybereason Global SOC team. Alon analyses critical incidents. He began his career in the Israeli Air Force where he was responsible for protecting critical infrastructures. Alon is interested in malware analysis, digital forensics, and incident response.

Source: <https://www.cybereason.com/blog/threat-analysis-report-bumblebee-loader-the-high-road-to-enterprise-domain-control>