

# Joint Cybersecurity Advisory

TLP:CLEAR



National Cyber Security Centre  
a part of GCHQ



Bundesaamt für Sicherheit in der Informationstechnik



Bundesaamt für Verfassungsschutz



NÜKIB



National Cyber and Information Security Agency



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RÉPUBLIQUE FRANÇAISE

Liberté  
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## Russian GRU Targeting Western Logistics Entities and Technology Companies

### Executive Summary

This joint cybersecurity advisory (CSA) highlights a Russian state-sponsored cyber campaign targeting Western logistics entities and technology companies. This includes those involved in the coordination, transport, and delivery of foreign assistance to Ukraine. Since 2022, Western logistics entities and IT companies have faced an elevated risk of targeting by the Russian General Staff Main Intelligence Directorate (GRU) 85th Main Special Service Center (85<sup>th</sup> GTsSS), military unit 26165—tracked in the cybersecurity community under several names (see “[Cybersecurity Industry Tracking](#)”). The actors’ cyber espionage-oriented campaign, targeting technology companies and logistics entities, uses a mix of previously disclosed tactics, techniques, and procedures (TTPs). The authoring agencies expect similar targeting and TTP use to continue.

Executives and network defenders at logistics entities and technology companies should recognize the elevated threat of unit 26165 targeting, increase monitoring and threat hunting for known TTPs and indicators of compromise (IOCs), and posture network defenses with a presumption of targeting.

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TLP:CLEAR

This cyber espionage-oriented campaign targeting logistics entities and technology companies uses a mix of previously disclosed TTPs and is likely connected to these actors' wide scale targeting of IP cameras in Ukraine and bordering NATO nations.

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- Germany Federal Office for Information Security (BSI)<sup>2</sup>
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- United States Cybersecurity and Infrastructure Security Agency (CISA)
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## Introduction

For over two years, the Russian GRU 85<sup>th</sup> GTsSS, military unit 26165—commonly known in the cybersecurity community as APT28, Fancy Bear, Forest Blizzard, BlueDelta, and a variety of other identifiers—has conducted this campaign using a mix of known tactics, techniques, and procedures (TTPs), including reconstituted password spraying capabilities, spearphishing, and modification of Microsoft Exchange mailbox permissions.

In late February 2022, multiple Russian state-sponsored cyber actors increased the variety of cyber operations for purposes of espionage, destruction, and influence—with unit 26165 predominately involved in espionage. [1] As Russian military forces failed to meet their military objectives and Western countries provided aid to support Ukraine's territorial defense, unit 26165 expanded its targeting of logistics entities and technology companies involved in the delivery of aid. These actors have also targeted Internet-connected cameras at Ukrainian border crossings to monitor and track aid shipments.

Note: This advisory uses the MITRE ATT&CK<sup>®</sup> for Enterprise framework, version 17. See Appendix A: MITRE ATT&CK tactics and techniques for a table of the threat actors' activity mapped to MITRE ATT&CK tactics and techniques. This advisory uses the MITRE D3FEND<sup>®</sup> framework, version 1.0.

## Description of Targets

The GRU unit 26165 cyber campaign against Western logistics providers and technology companies has targeted dozens of entities, including government organizations and private/commercial entities across virtually all transportation modes: air, sea, and rail. These actors have targeted entities associated with the following verticals within NATO member states, Ukraine, and at international organizations:

- Defense Industry
- Transportation and Transportation Hubs (ports, airports, etc.)
- Maritime
- Air Traffic Management
- IT Services

In the course of the targeting lifecycle, unit 26165 actors identified and conducted follow-on targeting of additional entities in the transportation sector that had business

ties to the primary target, exploiting trust relationships to attempt to gain additional access [T1199].

The actors also conducted reconnaissance on at least one entity involved in the production of industrial control system (ICS) components for railway management, though a successful compromise was not confirmed [TA0043].

The countries with targeted entities include the following, as illustrated in Figure 1:

- Bulgaria
- Czech Republic
- France
- Germany
- Greece
- Italy
- Moldova
- Netherlands
- Poland
- Romania
- Slovakia
- Ukraine
- United States



Figure 1: Countries with Targeted Entities

## Initial Access TTPs

To gain initial access to targeted entities, unit 26165 actors used several techniques to gain initial access to targeted entities, including (but not limited to):

- Credential guessing [T1110.001] / brute force [T1110.003]
- Spearphishing for credentials [T1566]
- Spearphishing delivering malware [T1566]
- Outlook NTLM vulnerability (CVE-2023-23397)
- Roundcube vulnerabilities (CVE-2020-12641, CVE-2020-35730, CVE-2021-44026)
- Exploitation of Internet-facing infrastructure, including corporate VPNs [T1133], via public vulnerabilities and SQL injection [T1190]
- Exploitation of WinRAR vulnerability (CVE-2023-38831)

The actors abused vulnerabilities associated with a range of brands and models of small office/home office (SOHO) devices to facilitate covert cyber operations, as well as proxy malicious activity via devices with geolocation in proximity to the target [T1665]. [2]

### ***Credential Guessing/Brute Force***

Unit 26165 actors' credential guessing [T1110.001] operations in this campaign exhibit some similar characteristics to those disclosed in the previous CSA "[Russian GRU Conducting Global Brute Force Campaign to Compromise Enterprise and Cloud Environments](#)." [3] Based on victim network investigations, the current iteration of this TTP employs a similar blend of anonymization infrastructure, including the use of Tor and commercial VPNs [T1090.003]. The actors frequently rotated the IP addresses used to further hamper detection. All observed connections were made via encrypted TLS [T1573].

### ***Spearphishing***

GRU unit 26165 actors' spearphishing emails included links [T1566.002] leading to fake login pages impersonating a variety of government entities and Western cloud email providers' webpages. These webpages were typically hosted on free third-party services or compromised SOHO devices and often used legitimate documents associated with thematically similar entities as lures. The subjects of spearphishing emails were diverse and ranged from professional topics to adult themes. Phishing emails were frequently sent via compromised accounts or free webmail accounts [T1586.002, T1586.003]. The emails were typically written in the target's native language and sent to a single targeted recipient.

Some campaigns employed multi-stage redirectors [T1104] verifying IP-geolocation [T1627.001] and browser fingerprints [T1627] to protect credential harvesting infrastructure or provide multifactor authentication (MFA) [T1111] and CAPTCHA relaying capabilities [T1056]. Connecting endpoints failing the location checks were redirected to a benign URL [T1627], such as msn.com. Redirector services used include:

- Webhook[.]site
- FrgelO
- InfinityFree

- Dynu
- Mocky
- Pipedream
- Mockbin[.]org

The actors also used spearphishing to deliver malware (including HEADLACE and MASEPIE) executables [T1204.002] delivered via third-party services and redirectors [T1566.002], scripts in a mix of languages [T1059] (including BAT [T1059.003] and VBScript [T1059.005]) and links to hosted shortcuts [T1204.001].

### ***CVE Usage***

Throughout this campaign, GRU unit 26165 weaponized an Outlook NTLM vulnerability (CVE-2023-23397) to collect NTLM hashes and credentials via specially crafted Outlook calendar appointment invitations [T1187]. [4], [5] These actors also used a series of Roundcube CVEs (CVE-2020-12641, CVE-2020-35730, and CVE-2021-44026) to execute arbitrary shell commands [T1059], gain access to victim email accounts, and retrieve sensitive data from email servers [T1114].

Since at least fall 2023, the actors leveraged a WinRAR vulnerability (CVE-2023-38831) allowing for the execution of arbitrary code embedded in an archive as a means of initial access [T1659]. The actors sent emails with malicious attachments [T1566.001] or embedded hyperlinks [T1566.002] that downloaded a malicious archive prepared using this CVE.

### **Post-Compromise TTPs**

After an initial compromise using one of the above techniques, unit 26165 actors conducted contact information reconnaissance to identify additional targets in key positions [T1589.002]. The actors also conducted reconnaissance of the cybersecurity department [T1591], individuals responsible for coordinating transport [T1591.004], and other companies cooperating with the victim entity [T1591.002].

The actors used native commands and open source tools, such as Impacket and PsExec, to move laterally within the environment [TA0008]. Multiple Impacket scripts were used as .exe files, in addition to the python versions, depending on the victim environment. The actors also moved laterally within the network using Remote Desktop Protocol (RDP) [T1021.001] to access additional hosts and attempt to dump Active

Directory NTDS.dit domain databases [T1003.003] using native Active Directory Domain Services commands, such as in Figure 2: Example Active Directory Domain Services command:

```
C:\Windows\system32\ntdsutil.exe "activate instance ntds" ifm "create full C:\temp\[a-z]{3}"  
quit quit
```

*Figure 2: Example Active Directory Domain Services command*

Additionally, GRU unit 26165 actors used the tools Certipy and ADEplorer.exe to exfiltrate information from the Active Directory. The actors installed python [T1059.006] on infected machines to enable the execution of Certipy. Accessed files were archived in .zip files prior to exfiltration [T1560]. The actors attempted to exfiltrate archived data via a previously dropped OpenSSH binary [T1048].

Incident response investigations revealed that the actors would take steps to locate and exfiltrate lists of Office 365 users and set up sustained email collection. The actors used manipulation of mailbox permissions [T1098.002] to establish sustained email collection at compromised logistics entities, as detailed in a Polish Cybercommand blog. [6]

After initial authentication, unit 26165 actors would change accounts' folder permissions and enroll compromised accounts in MFA mechanisms to increase the trust-level of compromised accounts and enable sustained access [T1556.006]. The actors leveraged python scripts to retrieve plaintext passwords via Group Policy Preferences [T1552.006] using Get-GPPPassword.py and a modified ldap-dump.py to enumerate the Windows environment [T1087.002] and conduct a brute force password spray [T1110.003] via Lightweight Directory Access Protocol (LDAP). The actors would additionally delete event logs through the wevtutil utility [T1070.001].

After gaining initial access to the network, the actors pursued further access to accounts with access to sensitive information on shipments, such as train schedules and shipping manifests. These accounts contained information on aid shipments to Ukraine, including:

- sender,
- recipient,
- train/plane/ship numbers,
- point of departure,
- destination,
- container registration numbers,

- travel route, and
- cargo contents.

In at least one instance, the actors attempted to use voice phishing [T1566.004] to gain access to privileged accounts by impersonating IT staff.

## ***Malware***

Unit 26165's use of malware in this campaign ranged from gaining initial access to establishing persistence and exfiltrating data. In some cases, the attack chain resulted in multiple pieces of malware being deployed in succession. The actors used dynamic link library (DLL) search order hijacking [T1574.001] to facilitate malware execution. There were a number of known malware variants tied to this campaign against logistics sector victims, including:

- HEADLACE [7]
- MASEPIE [8]

While other malware variants, such as OCEANMAP and STEELHOOK, [8] were not directly observed targeting logistics or IT entities, their deployment against victims in other sectors in Ukraine and other Western countries suggest that they could be deployed against logistics and IT entities should the need arise.

## ***Persistence***

In addition to the abovementioned mailbox permissions abuse, unit 26165 actors also used scheduled tasks [T1053.005], run keys [T1547.001], and placed malicious shortcuts [T1547.009] in the startup folder to establish persistence.

## ***Exfiltration***

GRU unit 26165 actors used a variety of methods for data exfiltration that varied based on the victim environment, including both malware and living off the land binaries. PowerShell commands [T1059.001] were often used to prepare data for exfiltration; for example, the actors prepared zip archives [T1560.001] for upload to their own infrastructure.

The actors also used server data exchange protocols and Application Programming Interfaces (APIs) such as Exchange Web Services (EWS) and Internet Message Access Protocol (IMAP) [T1114.002] to exfiltrate data from email servers. In multiple

instances, the actors used periodic EWS queries [T1119] to collect new emails sent and received since the last data exfiltration [T1029]. The actors typically used infrastructure in close geographic proximity to the victim. Long gaps between exfiltration, the use of trusted and legitimate protocols, and the use of local infrastructure allowed for long-term collection of sensitive data to go undetected.

## Connections to Targeting of IP Cameras

In addition to targeting logistics entities, unit 26165 actors likely used access to private cameras at key locations, such as near border crossings, military installations, and rail stations, to track the movement of materials into Ukraine. The actors also used legitimate municipal services, such as traffic cams.

The actors targeted Real Time Streaming Protocol (RTSP) servers hosting IP cameras primarily located in Ukraine as early as March 2022 in a large-scale campaign, which included attempts to enumerate devices [T1592] and gain access to the cameras' feeds [T1125]. Actor-controlled servers sent RTSP DESCRIBE requests destined for RTSP servers, primarily hosting IP cameras [T1090.002]. The DESCRIBE requests were crafted to obtain access to IP cameras located on logically distinct networks from that of the routers that received the request. The requests included Base64-encoded credentials for the RTSP server, which included publicly documented default credentials and likely generic attempts to brute force access to the devices [T1110]. An example of an RTSP request is shown in Figure 3.

```
DESCRIBE rtsp://[IP ADDRESS] RTSP/1.0
CSeq: 1
Authorization: Basic <Base64-encoded credentials>
User-Agent: WebClient
Accept: application/sdp

DESCRIBE rtsp://[IP ADDRESS] RTSP/1.0
CSeq: 2
Authorization: Digest username="admin", realm="[a-f0-9]{12}", algorithm="MD5", nonce="[a-f0-9]{32}", uri="", response="[a-f0-9]{32}"
User-Agent: WebClient
Accept: application/sdp
```

*Figure 3: Example RTSP request*

Successful RTSP 200 OK responses contained a snapshot of the IP camera's image and IP camera metadata such as video codec, resolution, and other properties depending on the IP camera's configuration.

From a sample available to the authoring agencies of over 10,000 cameras targeted via this effort, the geographic distribution of victims showed a strong focus on cameras in Ukraine and border countries, as shown in Table 1:

*Table 1: Geographic distribution of targeted IP cameras*

| Country  | Percentage of Total Attempts |
|----------|------------------------------|
| Ukraine  | 81.0%                        |
| Romania  | 9.9%                         |
| Poland   | 4.0%                         |
| Hungary  | 2.8%                         |
| Slovakia | 1.7%                         |
| Others   | 0.6%                         |

## Mitigation Actions

### *General Security Mitigations*

#### Architecture and Configuration

- Employ appropriate network segmentation [D3-NI] and restrictions to limit access and utilize additional attributes (such as device information, environment, and access path) when making access decisions [D3-AMED].
  - Consider Zero Trust principles when designing systems. Base product choices on how those products can solve specific risks identified as part of the end-to-end design. [9]
- Ensure that host firewalls and network security appliances (e.g., firewalls) are configured to only allow legitimately needed data flows between devices and servers to prevent lateral movement [D3-ITF]. Alert on attempts to connect laterally between host devices or other unusual data flows.
- Use automated tools to audit access logs for security concerns and identify anomalous access requests [D3-RAPA].
- For organizations using on-premises authentication and email services, block and alert on NTLM/SMB requests to external infrastructure [D3-OTF].

- Utilize endpoint, detection, and response (EDR) and other cybersecurity solutions on all systems, prioritizing high value systems with large amounts of sensitive data such as mail servers and domain controllers [\[D3-PM\]](#) first.
  - Perform threat and attack modeling to understand how sensitive systems may be compromised within an organization's specific architecture and security controls. Use this to develop a monitoring strategy to detect compromise attempts and select appropriate products to enact this strategy.
- Collect and monitor Windows logs for certain events, especially for events that indicate that a log was cleared unexpectedly [\[D3-SFA\]](#).
- Enable optional security features in Windows to harden endpoints and mitigate initial access techniques [\[D3-AH\]](#):
  - Enable attack surface reduction rules to prevent executable content from email [\[D3-ABPI\]](#).
  - Enable attack surface reduction rules to prevent execution of files from globally writeable directories, such as Downloads or %APPDATA% [\[D3-EAL\]](#).
  - Unless users are involved in the development of scripts, limit the local execution of scripts (such as batch scripts, VBScript, JScript/JavaScript, and PowerShell [10]) to known scripts [\[D3-EI\]](#), and audit execution attempts.
  - Disable Windows Host Scripting functionality and configure PowerShell to run in Constrained mode [\[D3-ACH\]](#).
- Where feasible, implement allowlisting for applications and scripts to limit execution to only those needed for authorized activities, blocking all others by default [\[D3-EAL\]](#).
- Consider using [open source SIGMA rules](#) as a baseline for detecting and alerting on suspicious file execution or command parameters [\[D3-PSA\]](#).
- Use services that provide enhanced browsing services and safe link checking [\[D3-URA\]](#). Significant reductions in successful spearphishing attempts were noted when email providers began offering link checking and automatic file detonation to block malicious content.
- Where possible, block logins from public VPNs, including exit nodes in the same country as target systems, or, if they need to be allowed, alert on them for further

investigation. Most organizations should not need to allow incoming traffic, especially logins to systems, from VPN services [\[D3-NAM\]](#).

- Educate users to only use approved corporate systems for relevant government and military business and avoid the use of personal accounts on cloud email providers to conduct official business. Network administrators should also audit both email and web request logs to detect such activity.

Many organizations may not need to allow outgoing traffic to hosting and API mocking services, which are frequently used by GRU unit 26165. Organizations should consider alerting on or blocking the following services, with exceptions allowlisted for legitimate activity [\[D3-DNSDL\]](#).

- |                        |                           |                       |
|------------------------|---------------------------|-----------------------|
| • *.000[.]pe           | • *.free[.]nf             | • *.mybiolink[.]jio   |
| • *.1cooldns[.]com     | • *.freeddns[.]org        | • *.mysynology[.]net  |
| • *.42web[.]io         | • *.frge[.]io             | • *.mywire[.]org      |
| • *.4cloud[.]click     | • *.giize[.]com           | • *.ngrok[.]jio       |
| • *.accesscam[.]org    | • *.great-site[.]net      | • *.ooguy[.]com       |
| • *.bumbleshrimp[.]com | • *.infinityfreeapp[.]com | • *.pipedream[.]net   |
| • *.camdvr[.]org       | • *.kesug[.]com           | • *.rf[.]gd           |
| • *.casacam[.]net      | • *.loseyourip[.]com      | • *.urlbae[.]com      |
| • *.ddnsfree[.]com     | • *.lovestoblog[.]com     | • *.webhook[.]site    |
| • *.ddnsgeek[.]com     | • *.mockbin[.]jio         | • *.webhookapp[.]com  |
| • *.ddnsguru[.]com     | • *.mockbin[.]org         | • *.webredirect[.]org |
| • *.dynuddns[.]com     | • *.mocky[.]jio           | • *.wuaze[.]com       |
| • *.dynuddns[.]net     |                           |                       |

Heuristic detections for web requests to new subdomains, including of the above providers, may uncover malicious phishing activity [\[D3-DNRA\]](#). Logging the requests for each sub-domain requested by users on a network, such as in DNS or firewall logs, may enable system administrators to identify new targeting and victims.

## Identity and Access Management

Organizations should take measures to ensure strong access controls and mitigate against common credential theft techniques:

- Use MFA with strong factors, such as passkeys or PKI smartcards, and require regular re-authentication [\[D3-MFA\]](#). [11], [12] Strong authentication factors are not guessable using dictionary techniques, so they resist brute force attempts.

- Implement other mitigations for privileged accounts: including limiting the number of admin accounts, considering using hardware MFA tokens, and regularly reviewing all privileged user accounts [\[D3-JFAPA\]](#).
- Separate privileged accounts by role and alert on misuse of privileged accounts [\[D3-UAP\]](#). For example, email administrator accounts should be different from domain administrator accounts.
- Reduce reliance on passwords; instead, consider using services like single sign-on [\[D3-TBA\]](#).
  - For organizations using on-premises authentication and email services, plan to disable NTLM entirely and migrate to more robust authentication processes such as PKI certificate authentication.
- Do not store passwords in Group Policy Preferences (GPP). Remove all passwords previously included in GPP and change all passwords on the corresponding accounts [\[D3-CH\]](#). [13]
- Use account throttling or account lockout [\[D3-ANET\]](#):
  - Throttling is preferred to lockout. Throttling progressively increases time delay between successive login attempts.
  - Account lockout can leave legitimate users unable to access their accounts and requires access to an account recovery process.
  - Account lockout can provide a malicious actor with an easy way to launch a Denial of Service (DoS).
  - If using lockout, then allowing 5 to 10 attempts before lockout is recommended.
- Use a service to check for compromised passwords before using them [\[D3-SPP\]](#). For example, “Have I Been Pwned” can be used to check whether a password has been previously compromised without disclosing the potential password.
- Change all default credentials [\[D3-CRO\]](#) and disable protocols that use weak authentication (e.g., clear-text passwords or outdated and vulnerable authentication or encryption protocols) or do not support multi-factor authentication [\[D3-ACH\]](#) [\[D3-ET\]](#). Always configure access controls carefully to ensure that only well-maintained and well-authenticated accounts have access. [13]

## ***IP Camera Mitigations***

The following mitigation techniques for IP cameras can be used to defend against this type of malicious activity:

- Ensure IP cameras are currently supported. Replace devices that are out of support.
- Apply security patches and firmware updates to all IP cameras [D3-SU].
- Disable remote access to the IP camera, if unnecessary [D3-ITF].
- Ensure cameras are protected by a security appliance, if possible, such as by using a firewall to prevent communication with the camera from IP addresses not on an allowlist [D3-NAM].
- If remote access to IP camera feeds is required, ensure authentication is enabled [D3-AA] and use a VPN to connect remotely [D3-ET]. Use MFA for management accounts if supported [D3-MFA].
- Disable Universal Plug and Play (UPnP), Peer-to-Peer (P2P), and Anonymous Visit features on IP cameras and routers [D3-NI].
- Turn off other ports/services not in use (e.g., FTP, web interface, etc.) [D3-ACH].
- If supported, enable authenticated RTSP access only [D3-AA].
- Review all authentication activity for remote access to make sure it is valid and expected [D3-UBA]. Investigate any unexpected or unusual activity.
- Audit IP camera user accounts to ensure they are an accurate reflection of your organization and that they are being used as expected [D3-UAP].
- Configure, tune, and monitor logging—if available—on the IP camera.

## Indicators of Compromise (IOCs)

**Note:** Specific IOCs may no longer be actor controlled, may themselves be compromised infrastructure or email accounts, or may be shared infrastructure such as public VPN or Tor exit nodes. Care should be taken when basing triaging logs or developing detection rules on these indicators. GRU unit 26165 almost certainly uses extensive further infrastructure and TTPs not specifically listed in this report.

### *Utilities and scripts*

#### **Legitimate utilities**

Unauthorized or unusual use of the following legitimate utilities can be an indication of a potential compromise:

- ntdsutil – A legitimate Windows executable used by threat actors to export contents of Active Directory

- wevtutil – A legitimate Windows executable used by threat actors to delete event logs
- vssadmin – A legitimate Windows executable possibly used by threat actors to make a copy of the server's C: drive
- ADexplorer – A legitimate window executable to view, edit, and backup Active Directory Certificate Services
- OpenSSH – The Windows version of a legitimate open source SSH client
- schtasks – A legitimate Windows executable used to create persistence using scheduled tasks
- whoami – A legitimate Windows executable used to retrieve the name of the current user
- tasklist – A legitimate Windows executable used to retrieve the list of running processes
- hostname – A legitimate Windows executable used to retrieve the device name
- arp – A legitimate Windows executable used to retrieve the ARP table for mapping the network environment
- systeminfo – A legitimate Windows executable used to retrieve a comprehensive summary of device and operating system information
- net – A legitimate Windows executable used to retrieve detailed user information
- wmic – A legitimate Windows executable used to interact with Windows Management Instrumentation (WMI), such as to retrieve letters assigned to logical partitions on storage drives
- cacls – A legitimate Windows executable used to modify permissions on files
- icacls – A legitimate Windows executable used to modify permissions to files and handle integrity levels and ownership
- ssh – A legitimate Windows executable used to establish network shell connections
- reg – A legitimate Windows executable used to add to or modify the system registry

Note: Additional heuristics are needed for effective hunting for these and other living off the land (LOTL) binaries to avoid being overwhelmed by false positives if these legitimate management tools are used regularly. See the joint guide, [Identifying and Mitigating Living Off the Land Techniques](#), for guidance on developing a multifaceted cybersecurity strategy that enables behavior analytics, anomaly detection, and proactive hunting, which are part of a comprehensive approach to mitigating cyber threats that employ LOTL techniques.

## Malicious scripts

- Certipy – An open source python tool for enumerating and abusing Active Directory Certificate Services
- Get-GPPPassword.py – An open source python script for finding insecure passwords stored in Group Policy Preferences
- ldap-dump.py – A script for enumerating user accounts and other information in Active Directory
- Hikvision backdoor string: “YWRtaW46MTEK”

## Suspicious command lines

While the following utilities are legitimate, and using them with the command lines shown may also be legitimate, these command lines are often used during malicious activities and could be an indication of a compromise:

- edge.exe “-headless-new -disable-gpu”
- ntdsutil.exe "activate instance ntds" ifm "create full C:\temp\[a-z]{3}" quit quit
- ssh -Nf
- schtasks /create /xml

## Outlook CVE Exploitation IOCs

- md-shoeb@alfathdoor[.]com[.]sa
- jayam@wizzsolutions[.]com
- accounts@regencyservice[.]in
- m.salim@tsc-me[.]com
- vikram.anand@4ginfosource[.]com
- mdelafuente@ukwwfze[.]com
- sarah@cosmicgold469[.]co[.]za
- franch1.lanka@bplanka[.]com
- commerical@vanadrink[.]com
- maint@goldenloaduae[.]com
- karina@bhpcapital[.]com
- tv@coastalareabank[.]com
- ashoke.kumar@hbclife[.]in
- 213[.]32[.]252[.]221
- 124[.]168[.]91[.]178
- 194[.]126[.]178[.]8
- 159[.]196[.]128[.]120

### Commonly Used Webmail Providers

- portugalmail[.]pt
- mail-online[.]dk
- email[.]cz
- seznam[.]cz

### Malicious Archive Filenames Involving CVE-2023-38831

- calc.war.zip
- news\_week\_6.zip
- Roadmap.zip
- SEDE-PV-2023-10-09-1\_EN.zip
- war.zip
- Zeyilname.zip

### Brute Forcing IP Addresses

Disclaimer: These IP addresses date June 2024 through August 2024. The authoring agencies recommend organizations investigate or vet these IP addresses prior to taking action, such as blocking.

| June 2024            | July 2024           | August 2024          |                      |                       |
|----------------------|---------------------|----------------------|----------------------|-----------------------|
| 192[.]162[.]174[.]94 | 207[.]244[.]71[.]84 | 31[.]135[.]199[.]145 | 79[.]184[.]25[.]198  | 91[.]149[.]253[.]204  |
| 103[.]97[.]203[.]29  | 162[.]210[.]194[.]2 | 31[.]42[.]4[.]138    | 79[.]185[.]5[.]142   | 91[.]149[.]254[.]75   |
| 209[.]14[.]71[.]127  |                     | 46[.]112[.]70[.]252  | 83[.]10[.]46[.]174   | 91[.]149[.]255[.]122  |
| 109[.]95[.]151[.]207 |                     | 46[.]248[.]185[.]236 | 83[.]168[.]66[.]145  | 91[.]149[.]255[.]19   |
|                      |                     | 64[.]176[.]67[.]117  | 83[.]168[.]78[.]27   | 91[.]149[.]255[.]195  |
|                      |                     | 64[.]176[.]69[.]196  | 83[.]168[.]78[.]31   | 91[.]221[.]88[.]76    |
|                      |                     | 64[.]176[.]70[.]18   | 83[.]168[.]78[.]55   | 93[.]105[.]185[.]139  |
|                      |                     | 64[.]176[.]70[.]238  | 83[.]23[.]130[.]49   | 95[.]215[.]76[.]209   |
|                      |                     | 64[.]176[.]71[.]201  | 83[.]29[.]138[.]115  | 138[.]199[.]59[.]43   |
|                      |                     | 70[.]34[.]242[.]220  | 89[.]64[.]70[.]69    | 147[.]135[.]209[.]245 |
|                      |                     | 70[.]34[.]243[.]226  | 90[.]156[.]4[.]204   | 178[.]235[.]191[.]182 |
|                      |                     | 70[.]34[.]244[.]100  | 91[.]149[.]202[.]215 | 178[.]37[.]97[.]243   |
|                      |                     | 70[.]34[.]245[.]215  | 91[.]149[.]203[.]73  | 185[.]234[.]235[.]69  |
|                      |                     | 70[.]34[.]252[.]168  | 91[.]149[.]219[.]158 | 192[.]162[.]174[.]67  |
|                      |                     | 70[.]34[.]252[.]186  | 91[.]149[.]219[.]23  | 194[.]187[.]180[.]20  |
|                      |                     | 70[.]34[.]252[.]222  | 91[.]149[.]223[.]130 | 212[.]127[.]78[.]170  |
|                      |                     | 70[.]34[.]253[.]113  | 91[.]149[.]253[.]118 | 213[.]134[.]184[.]167 |
|                      |                     | 70[.]34[.]253[.]247  | 91[.]149[.]253[.]198 |                       |
|                      |                     | 70[.]34[.]254[.]245  | 91[.]149[.]253[.]20  |                       |

## Detections

### *Customized NTLM listener*

```
rule APT28_NTLM_LISTENER {
  meta:
    description = "Detects NTLM listeners including APT28's custom one"

  strings:
    $command_1 = "start-process powershell.exe -WindowStyle hidden"
    $command_2 = "New-Object System.Net.HttpListener"
    $command_3 = "Prefixes.Add('http://localhost:8080/')"
    $command_4 = "-match 'Authorization'"
    $command_5 = "GetValues('Authorization')"
    $command_6 = "Request.RemoteEndPoint.Address.IPAddressToString"
    $command_7 = "@(0x4e,0x54,0x4c,0x4d,
0x53,0x53,0x50,0x00,0x02,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x28,0x00,0x00,0x01,0x82,0x00
,0x00,0x11,0x22,0x33,0x44,0x55,0x66,0x77,0x88,0x00,0x00,0x00,0x00,0x00,0x00,0x00,0x00)"
    $command_8 = ".AllKeys"

    $variable_1 = "$NTLMAuthentication" nocase
    $variable_2 = "$NTLMType2" nocase
    $variable_3 = "$listener" nocase
    $variable_4 = "$hostip" nocase
    $variable_5 = "$request" nocase
    $variable_6 = "$ntlmt2" nocase
    $variable_7 = "$NTLMType2Response" nocase
    $variable_8 = "$buffer" nocase

  condition:
    5 of ($command_*)
    or
    all of ($variable_*)
}
```

## ***HEADLACE shortcut***

```
rule APT28_HEADLACE_SHORTCUT {
    meta:
        description = "Detects the HEADLACE backdoor shortcut dropper. Rule is meant for
threat hunting."

    strings:
        $type = "[InternetShortcut]" ascii nocase
        $url = "file://"
        $edge = "msedge.exe"
        $icon = "IconFile"

    condition:
        all of them
}
```

## ***HEADLACE credential dialogbox phishing***

```
rule APT28_HEADLACE_CREDENTIALDIALOG {
    meta:
        description = "Detects scripts used by APT28 to lure user into entering
credentials"

    strings:
        $command_1 = "while($true)"
        $command_2 = "Get-Credential $(whoami)"
        $command_3 = "Add-Content"
        $command_4 = ".UserName"
        $command_5 = ".GetNetworkCredential().Password"
        $command_6 = "GetNetworkCredential().Password.Length -ne 0"

    condition:
        5 of them
}
```

## HEADLACE core script

```
rule APT28_HEADLACE_CORE {
  meta:
    description = "Detects HEADLACE core batch scripts"

  strings:
    $chcp = "chcp 65001" ascii
    $headless = "start \"\" msedge --headless=new --disable-gpu" ascii

    $command_1 = "taskkill /im msedge.exe /f" ascii
    $command_2 = "whoami>\"%programdata%" ascii
    $command_3 = "timeout" ascii
    $command_4 = "copy \"%programdata%\" \"\" ascii

    $non_generic_del_1 = "del /q /f \"%programdata%" ascii
    $non_generic_del_3 = "del /q /f \"%userprofile%\\Downloads\" \"\" ascii

    $generic_del = "del /q /f" ascii

  condition:
    (
      $chcp
      and
      $headless
    )
    and
    (
      1 of ($non_generic_del_*)
      or
      ($generic_del)
      or
      3 of ($command_*)
    )
}
```

## MASEPIE

```
rule APT28_MASEPIE {
  meta:
    description = "Detects MASEPIE python script"

  strings:
    $masepie_unique_1 = "os.popen('whoami').read()"
    $masepie_unique_2 = "elif message == 'check'"
    $masepie_unique_3 = "elif message == 'send_file':"
    $masepie_unique_4 = "elif message == 'get_file'"
    $masepie_unique_5 = "enc_mes('ok'"
    $masepie_unique_6 = "Bad command!".encode('ascii'"
    $masepie_unique_7 = "{user}{SEPARATOR}{k}"
    $masepie_unique_8 = "raise Exception(\"Reconnect"

  condition:
    3 of ($masepie_unique_*)
}
```

## STEELHOOK

```
rule APT28_STEELHOOK {
  meta:
    description = "Detects APT28's STEELHOOK powershell script"

  strings:
    $s_1 = "$($env:LOCALAPPDATA\\Google\\Chrome\\User Data\\Local State)"
    $s_2 = "$($env:LOCALAPPDATA\\Google\\Chrome\\User Data\\Default\\Login
Data)"

    $s_3 = "$($env:LOCALAPPDATA\\Microsoft\\Edge\\User Data\\Local State)"
    $s_4 = "$($env:LOCALAPPDATA\\Microsoft\\Edge\\User
Data\\Default\\Login Data)"

    $s_5 = "os_crypt.encrypted_key"
    $s_6 = "System.Security.Cryptography.DataProtectionScope"
    $s_7 = "[system.security.cryptography.protectdata]::Unprotect"
    $s_8 = "Invoke-RestMethod"

  condition:
    all of them
}
```

## PSEXEC

```
rule GENERIC_PSEXEC {
  meta:
    description = "Detects SysInternals PSEXEC executable"

  strings:
    $sysinternals_1 = "SYSINTERNALS SOFTWARE LICENCE TERMS"
    $sysinternals_2 = "/accepteula"
    $sysinternals_3 = "Software\\Sysinternals"

    $network_1 = "\\\\%s\\IPC$"
    $network_2 = "\\\\%s\\ADMIN$\\%s"
    $network_3 = "\\Device\\LanmanRedirector\\%s\\ipc$"

    $psexec_1 = "PSEXESVC"
    $psexec_2 = "PSEXEC-{}-"
    $psexec_3 = "Copying %s to %s..."
    $psexec_4 = "gPSINFSVC"

  condition:
    (
      ( uint16( 0x0 ) ==0x5a4d )
      and
      ( uint16( uint32( 0x3c ) ) == 0x4550 )
    )
    and
      filesize < 1024KB
    and
      (
        ( any of ($sysinternals_*) and any of ($psexec_*) )
        or
        ( 2 of ($network_*) and 2 of ($psexec_*) )
      )
  }
}
```

## Cybersecurity Industry Tracking

The cybersecurity industry provides overlapping cyber threat intelligence, IOCs, and mitigation recommendations related to GRU unit 26165 cyber actors. While not all encompassing, the following are the most notable threat group names related under [MITRE ATT&CK G0007](#) and commonly used within the cybersecurity community:

- APT28 [14]
- Fancy Bear [14]
- Forest Blizzard [14]
- Blue Delta [15]

Note: Cybersecurity companies have different methods of tracking and attributing cyber actors, and this may not be a 1:1 correlation to the U.S. government's understanding for all activity related to these groupings.

## Further Reference

To search for the presence of malicious email messages targeting CVE-2023-23397, network defenders may consider using the script published by Microsoft:

<https://aka.ms/CVE-2023-23397ScriptDoc>.

For the Impacket TTP, network defenders may consider using the following publicly available Impacket YARA detection rule:

[https://github.com/Neo23x0/signature-base/blob/master/yara/gen\\_impacket\\_tools.yar](https://github.com/Neo23x0/signature-base/blob/master/yara/gen_impacket_tools.yar)

## Version History

May 2025: Initial publication (Ver. 1.0)

April 2026: Correction on two domains, \*.accesscam[.]org and \*.giize[.]com (Ver. 1.1)

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## Disclaimer of endorsement

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## Purpose

This document was developed in furtherance of the authoring agencies' cybersecurity missions, including their responsibilities to identify and disseminate threats and to develop and issue cybersecurity specifications and mitigations. This information may be shared broadly to reach all appropriate stakeholders.

## Contact

### United States organizations

- **National Security Agency (NSA)**  
Cybersecurity Report Feedback: [CybersecurityReports@nsa.gov](mailto:CybersecurityReports@nsa.gov)  
Defense Industrial Base Inquiries and Cybersecurity Services: [DIB\\_Defense@cyber.nsa.gov](mailto:DIB_Defense@cyber.nsa.gov)  
Media Inquiries / Press Desk: NSA Media Relations: 443-634-0721, [MediaRelations@nsa.gov](mailto:MediaRelations@nsa.gov)
- **Cybersecurity and Infrastructure Security Agency (CISA) and Federal Bureau of Investigation (FBI)**  
U.S. organizations are encouraged to reporting suspicious or criminal activity related to information in this advisory to CISA via the agency's [Incident Reporting System](#), its 24/7 Operations Center ([report@cisa.gov](mailto:report@cisa.gov) or 888-282-0870), or your [local FBI field office](#). When available, please include the following information regarding the incident: date, time, and location of the incident; type of activity; number of people affected; type of equipment user for the activity; the name of the submitting company or organization; and a designated point of contact.
- **Department of Defense Cyber Crime Center (DC3)**  
Defense Industrial Base Inquiries and Cybersecurity Services: [DC3.DCISE@us.af.mil](mailto:DC3.DCISE@us.af.mil)  
Media Inquiries / Press Desk: [DC3.Information@us.af.mil](mailto:DC3.Information@us.af.mil)

### United Kingdom organizations

- Report significant cyber security incidents to [ncsc.gov.uk/report-an-incident](https://ncsc.gov.uk/report-an-incident) (monitored 24/7)

### Germany organizations

- Bundesnachrichtendienst (BND): Media Relations / Press Desk: +49 30 20 45 36 30, [pressestelle@bnd.bund.de](mailto:pressestelle@bnd.bund.de)
- BfV Prevention/Economic Protection Unit: +49 30 18792-3322, [wirtschaftsschutz@bfv.bund.de](mailto:wirtschaftsschutz@bfv.bund.de)
- BSI Service-Center: +49 800 274 1000, [service-center@bsi.bund.de](mailto:service-center@bsi.bund.de)

### Czech Republic organizations

- Security Information Service (BIS): [cyber.threats@bis.cz](mailto:cyber.threats@bis.cz)
- National Cyber and Information Security Agency (NÚKIB): [cert.incident@nukib.gov.cz](mailto:cert.incident@nukib.gov.cz)

### Poland organizations

- Poland Military Counterintelligence Service (SKW): [cyber.int@skw.gov.pl](mailto:cyber.int@skw.gov.pl)

### Australian organizations

- Visit [cyber.gov.au](https://cyber.gov.au) or call 1300 292 371 (1300 CYBER 1) to report cybersecurity incidents and access alerts and advisories.

### Canadian organizations

- Report incidents by emailing CCCS at [contact@cyber.gc.ca](mailto:contact@cyber.gc.ca).

### Estonia organizations

- Estonian Foreign Intelligence Service (EFIS): [info@valisluureamet.ee](mailto:info@valisluureamet.ee)
- Estonian National Cyber Security Centre (NCSC-EE): [ria@ria.ee](mailto:ria@ria.ee)

### French organizations

- French organizations are encouraged to report suspicious activity or incident related to information found in this advisory by contacting ANSSI/CERT-FR by email at [cert-fr@ssi.gouv.fr](mailto:cert-fr@ssi.gouv.fr) or by phone at: 3218 or +33 9 70 83 32 18.

## Appendix A: MITRE ATT&CK tactics and techniques

See Table 2 through Table 14 for all the threat actor tactics and techniques referenced in this advisory.

**Table 2: Reconnaissance**

| Tactic/Technique Title                                | ID                        | Use  |
|---|---------------------------|--|
| Reconnaissance  | <a href="#">TA0043</a>    | Conducted reconnaissance on at least one entity involved in the production of ICS components for railway management. |
| Gather Victim Identity Information: Email Addresses   | <a href="#">T1589.002</a> | Conducted contact information reconnaissance to identify additional targets in key positions.                        |
| Gather Victim Org Information                         | <a href="#">T1591</a>     | Conducted reconnaissance of the cybersecurity department.  |
| Gather Victim Org Information: Identify Roles         | <a href="#">T1591.004</a> | Conducted reconnaissance of individuals responsible for coordinating transport.                                      |
| Gather Victim Org Information: Business Relationships | <a href="#">T1591.002</a> | Conducted reconnaissance of other companies cooperating with the victim entity.                                      |
| Gather Victim Host Information                        | <a href="#">T1592</a>     | Attempted to enumerate Real Time Streaming Protocol (RTSP) servers hosting IP cameras.                               |

**Table 3: Resource development**

| Tactic/Technique Title              | ID                        | Use  |
|-------------------------------------|---------------------------|--|
| Compromise Accounts: Email Accounts | <a href="#">T1586.002</a> | Sent phishing emails using compromised accounts. |
| Compromise Accounts: Cloud Accounts | <a href="#">T1586.003</a> | Sent phishing emails using compromised accounts. |

**Table 4: Initial Access**

| Tactic/Technique Title             | ID                        | Use  |
|------------------------------------|---------------------------|--|
| Trusted Relationship               | <a href="#">T1199</a>     | Conducted follow-on targeting of additional entities in the transportation sector that had business ties to the primary target, exploiting trust relationships to attempt to gain additional access. |
| Phishing                           | <a href="#">T1566</a>     | Used spearphishing for credentials and delivering malware to gain initial access to targeted entities.   |
| Phishing: Spearphishing Attachment | <a href="#">T1566.001</a> | Sent emails with malicious attachments.  |
| Phishing: Spearphishing Link       | <a href="#">T1566.002</a> | Used spearphishing with included links to fake login pages. Sent emails with embedded hyperlinks that downloaded a malicious archive.  |
| Phishing: Spearphishing Voice      | <a href="#">T1566.004</a> | Attempted to use voice phishing to gain access to privileged accounts by impersonating IT staff.   |
| External Remote Services           | <a href="#">T1133</a>     | Exploited Internet-facing infrastructure, including corporate VPNs, to gain initial access to targeted entities.   |

| Tactic/Technique Title            | ID                    | Use   |
|-----------------------------------|-----------------------|---|
| Exploit Public-Facing Application | <a href="#">T1190</a> | Exploited public vulnerabilities and SQL injection to gain initial access to targeted entities.       |
| Content Injection                 | <a href="#">T1659</a> | Leveraged a WinRAR vulnerability allowing for the execution of arbitrary code embedded in an archive. |

**Table 5: Execution**

| Tactic/Technique Title                                   | ID                        | Use   |
|--|---------------------------|---|
| User Execution: Malicious Link                           | <a href="#">T1204.001</a> | Used malicious links to hosted shortcuts in spearphishing.                |
| User Execution: Malicious File                           | <a href="#">T1204.002</a> | Delivered malware executables via spearphishing.                          |
| Scheduled Task/Job: Scheduled Task                       | <a href="#">T1053.005</a> | Used scheduled tasks to establish persistence.                            |
| Command and Scripting Interpreter                        | <a href="#">T1059</a>     | Delivered scripts in spearphishing. Executed arbitrary shell commands.    |
| Command and Scripting Interpreter: PowerShell            | <a href="#">T1059.001</a> | PowerShell commands were often used to prepare data for exfiltration.     |
| Command and Scripting Interpreter: Windows Command Shell | <a href="#">T1059.003</a> | Used BAT script in spearphishing.   |
| Command and Scripting Interpreter: Visual Basic          | <a href="#">T1059.005</a> | Used VBScript in spearphishing.   |
| Command and Scripting Interpreter: Python                | <a href="#">T1059.006</a> | Installed python on infected machines to enable the execution of Certipy. |

**Table 6: Persistence**

| Tactic/Technique Title  | ID                        | Use  |
|---|---------------------------|--|
| Account Manipulation: Additional Email Delegate Permissions           | <a href="#">T1098.002</a> | Used manipulation of mailbox permissions to establish sustained email collection.  |
| Modify Authentication Process: Multi-Factor Authentication            | <a href="#">T1556.006</a> | Enrolled compromised accounts in MFA mechanisms to increase the trust-level of compromised accounts and enable sustained access. |
| Hijack Execution Flow: DLL Search Order Hijacking                     | <a href="#">T1574.001</a> | Used DLL search order hijacking to facilitate malware execution.   |
| Boot or Logon Autostart Execution: Registry Run Keys / Startup Folder | <a href="#">T1547.001</a> | Used run keys to establish persistence.  |
| Boot or Logon Autostart Execution: Shortcut Modification              | <a href="#">T1547.009</a> | Placed malicious shortcuts in the startup folder to establish persistence.   |

**Table 7: Defense Evasion**

| Tactic/Technique Title                      | ID                        | Use  |
|---|---------------------------|--|
| Indicator Removal: Clear Windows Event Logs | <a href="#">T1070.001</a> | Deleted event logs through the wevtutil utility. |

Table 8: Credential access

| Tactic/Technique Title                          | ID                        | Use   |
|---|---------------------------|---|
| Brute Force                                     | <a href="#">T1110</a>     | Sent requests with Base64-encoded credentials for the RTSP server, which included publicly documented default credentials, and likely were generic attempts to brute force access to the devices. |
| Brute Force: Password Guessing                  | <a href="#">T1110.001</a> | Used credential guessing to gain initial access to targeted entities.   |
| Brute Force: Password Spraying                  | <a href="#">T1110.003</a> | Used brute force to gain initial access to targeted entities. Conducted a brute force password spray via LDAP.  |
| Multi-Factor Authentication Interception        | <a href="#">T1111</a>     | Used multi-stage redirectors to provide MFA relaying capabilities in some campaigns.  |
| Input Capture                                   | <a href="#">T1056</a>     | Used multi-stage redirectors to provide CAPTCHA relaying capabilities in some campaigns.  |
| Forced Authentication                           | <a href="#">T1187</a>     | Used an Outlook NTLM vulnerability to collect NTLM hashes and credentials via specially crafted Outlook calendar appointment invitations.   |
| OS Credential Dumping: NTDS                     | <a href="#">T1003.003</a> | Attempted to dump Active Directory NTDS.dit domain databases.   |
| Unsecured Credentials: Group Policy Preferences | <a href="#">T1552.006</a> | Retrieved plaintext passwords via Group Policy Preferences using Get-GPPPassword.py.  |

Table 9: Discovery

| Tactic/Technique Title            | ID                        | Use  |
|-----------------------------------|---------------------------|--|
| Account Discovery: Domain Account | <a href="#">T1087.002</a> | Used a modified ldap-dump.py to enumerate the Windows environment. |

Table 10: Command and Control

| Tactic/Technique Title | ID                        | Use  |
|------------------------|---------------------------|--|
| Hide Infrastructure    | <a href="#">T1665</a>     | Abused SOHO devices to facilitate covert cyber operations, as well as proxy malicious activity, via devices with geolocation in proximity to the target. |
| Proxy: External Proxy  | <a href="#">T1090.002</a> | Actor-controlled servers sent RTSP DESCRIBE requests destined for RTSP servers.  |
| Proxy: Multi-hop Proxy | <a href="#">T1090.003</a> | Used Tor and commercial VPNs as part of their anonymization infrastructure   |
| Encrypted Channel      | <a href="#">T1573</a>     | Connected to victim infrastructure using encrypted TLS.  |
| Multi-Stage Channels   | <a href="#">T1104</a>     | Used multi-stage redirectors for campaigns.  |

Table 11: Defense evasion (mobile framework)

| Tactic/Technique Title           | ID                        | Use  |
|----------------------------------|---------------------------|--|
| Execution Guardrails             | <a href="#">T1627</a>     | Used multi-stage redirectors to verify browser fingerprints in some campaigns. |
| Execution Guardrails: Geofencing | <a href="#">T1627.001</a> | Used multi-stage redirectors to verify IP-geolocation in some campaigns.       |

Table 12: Lateral movement

| Tactic/Technique Title                   | ID                        | Use  |
|--|---------------------------|--|
| Lateral Movement                         | <a href="#">TA0008</a>    | Used native commands and open source tools, such as Impacket and PsExec, to move laterally within the environment. |
| Remote Services: Remote Desktop Protocol | <a href="#">T1021.001</a> | Moved laterally within the network using RDP.  |

Table 13: Collection

| Tactic/Technique Title                      | ID                        | Use  |
|---|---------------------------|--|
| Email Collection                            | <a href="#">T1114</a>     | Retrieved sensitive data from email servers.   |
| Email Collection: Remote Email Collection   | <a href="#">T1114.002</a> | Used server data exchange protocols and APIs such as Exchange Web Services (EWS) and IMAP to exfiltrate data from email servers. |
| Automated Collection                        | <a href="#">T1119</a>     | Used periodic EWS queries to collect new emails.   |
| Video Capture                               | <a href="#">T1125</a>     | Attempted to gain access to the cameras' feeds.  |
| Archive Collected Data                      | <a href="#">T1560</a>     | Accessed files were archived in .zip files prior to exfiltration.  |
| Archive Collected Data: Archive via Utility | <a href="#">T1560.001</a> | Prepared zip archives for upload to the actors' infrastructure.  |

Table 14: Exfiltration

| Tactic/Technique Title                 | ID                    | Use   |
|--|-----------------------|---|
| Exfiltration Over Alternative Protocol | <a href="#">T1048</a> | Attempted to exfiltrate archived data via a previously dropped OpenSSH binary.                      |
| Scheduled Transfer                     | <a href="#">T1029</a> | Used periodic EWS queries to collect new emails sent and received since the last data exfiltration. |

## Appendix B: CVEs exploited

Table 15: Exploited CVE information

| CVE                            | Vendor/Product    | Details   |
|--------------------------------|-------------------|---|
| <a href="#">CVE-2023-38831</a> | RARLAB WinRAR     | Allows execution of arbitrary code when a user attempts to view a benign file within a ZIP archive.   |
| <a href="#">CVE-2023-23397</a> | Microsoft Outlook | External actors could send specially crafted emails that cause a connection from the victim to an untrusted location of the actor's control, leaking the Net-NTLMv2 hash of the victim that the actor could then relay to another service to authenticate as the victim.            |
| <a href="#">CVE-2021-44026</a> | Roundcube Webmail | Roundcube before 1.3.17 and 1.4.x before 1.4.12 is prone to a potential SQL injection via search or search params.  |
| <a href="#">CVE-2020-35730</a> | Roundcube Webmail | An XSS issue was discovered in Roundcube Webmail before 1.2.13, 1.3.x before 1.3.16 and 1.4.x before 1.4.10, where a plaintext email message with JavaScript in a link reference element is mishandled by <code>linkref_addindex</code> in <code>rcube_string_replacer.php</code> . |
| <a href="#">CVE-2020-12641</a> | Roundcube Webmail | Roundcube Webmail before 1.4.4 allows arbitrary code execution via shell metacharacters in a configuration setting for <code>im_convert_path</code> or <code>im_identify_path</code> in <code>rcube_image.php</code> .  |

## Appendix C: MITRE D3FEND Countermeasures

Table 16: MITRE D3FEND countermeasures

| Countermeasure Title                | ID                      | Details  |
|-------------------------------------|-------------------------|--|
| Network Isolation                   | <a href="#">D3-NI</a>   | Employ appropriate network segmentation. Disable Universal Plug and Play (UPnP), Peer-to-Peer (P2P), and Anonymous Visit features on IP cameras and routers.   |
| Access Mediation                    | <a href="#">D3-AMED</a> | Limit access and utilize additional attributes (such as device information, environment, and access path) when making access decisions. Configure access controls carefully to ensure that only well-maintained and well-authenticated accounts have access.   |
| Inbound Traffic Filtering           | <a href="#">D3-ITF</a>  | Implement host firewall rules to block connections from other devices on the network, other than from authorized management devices and servers, to prevent lateral movement.  |
| Resource Access Pattern Analysis    | <a href="#">D3-RAPA</a> | Use automated tools to audit access logs for security concerns and identify anomalous access requests.   |
| Outbound Traffic Filtering          | <a href="#">D3-OTF</a>  | Block NTLM/SMB requests to external infrastructure.  |
| Platform Monitoring                 | <a href="#">D3-PM</a>   | Install EDR/logging/cybersecurity solutions onto high value systems with large amounts of sensitive data such as mail servers and domain controllers.  |
| System File Analysis                | <a href="#">D3-SFA</a>  | Collect and monitor Windows logs for certain events, especially for events that indicate that a log was cleared unexpectedly.  |
| Application Hardening               | <a href="#">D3-AH</a>   | Enable optional security features in Windows to harden endpoints and mitigate initial access techniques.   |
| Application-based Process Isolation | <a href="#">D3-ABPI</a> | Enable attack surface reduction rules to prevent executable content from email.  |
| Executable Allowlisting             | <a href="#">D3-EAL</a>  | Enable attack surface reduction rules to prevent execution of files from globally writable directories, such as Downloads or %APPDATA%.  |
| Execution Isolation                 | <a href="#">D3-EI</a>   | Unless users are involved in the development of scripts, limit the execution of scripts (such as batch, JavaScript, and PowerShell) to known scripts.  |
| Application Configuration Hardening | <a href="#">D3-ACH</a>  | Disable Windows Host Scripting functionality and configure PowerShell to run in Constrained mode. Disable protocols that use weak authentication (e.g., clear-text passwords, or outdated and vulnerable authentication or encryption protocols) or do not support multi-factor authentication. Turn off other ports/services not in use (e.g., FTP, web interface, etc.). |
| Process Spawn Analysis              | <a href="#">D3-PSA</a>  | Use open source SIGMA rules as a baseline for detecting and alerting on suspicious file execution or command parameters.   |
| URL Reputation Analysis             | <a href="#">D3-URA</a>  | Use services that provide enhanced browsing services and safe link checking.   |

|                                      |                          |   |
|--------------------------------------|--------------------------|---|
| Network Access Mediation             | <a href="#">D3-NAM</a>   | Do not allow incoming traffic, especially logins to systems, from public VPN services. Where possible, logins from public VPNs, including exit nodes in the same country as target systems, should be blocked or, if allowed, alerted on for further investigation. Ensure cameras and other Internet of Things devices are protected by a security appliance, if possible. |
| DNS Denylisting                      | <a href="#">D3-DNSDL</a> | Do not allow outgoing traffic to hosting and API mocking services frequently used by malicious actors.  |
| Domain Name Reputation Analysis      | <a href="#">D3-DNRA</a>  | Heuristic detections for web requests to new subdomains may uncover malicious phishing activity. Logging the requests for each sub-domain requested by users on a network, such as in DNS or firewall logs, may enable system administrators to identify new targeting and victims.   |
| Multi-factor Authentication          | <a href="#">D3-MFA</a>   | Use MFA with strong factors and require regular re-authentication, especially for management accounts.  |
| Job Function Access Pattern Analysis | <a href="#">D3-JFAPA</a> | Implement other mitigations for privileged accounts: including limiting the number of admin accounts, considering using hardware MFA tokens, and regularly reviewing all privileged user accounts.  |
| User Account Permissions             | <a href="#">D3-UAP</a>   | Separate privileged accounts by role and alert on misuse of privileged accounts. Audit user accounts on all devices to ensure they are an accurate reflection of your organization and that they are being used as expected.  |
| Token-based Authentication           | <a href="#">D3-TBA</a>   | Reduce reliance on passwords; instead, consider using services like single sign-on.   |
| Credential Hardening                 | <a href="#">D3-CH</a>    | Do not store passwords in Group Policy Preferences (GPP). Remove all passwords previously included in GPP and change all passwords on the corresponding accounts.   |
| Authentication Event Thresholding    | <a href="#">D3-ANET</a>  | Use account throttling or account lockout. Throttling progressively increases time delay between successive login attempts. If using account lockout, allow between 5 to 10 attempts before lockout.  |
| Strong Password Policy               | <a href="#">D3-SPP</a>   | Use a service to check for compromised passwords before using them.   |
| Credential Rotation                  | <a href="#">D3-CRO</a>   | Change all default credentials.   |
| Encrypted Tunnels                    | <a href="#">D3-ET</a>    | Disable protocols that use weak authentication (e.g., clear-text passwords, or outdated and vulnerable authentication or encryption protocols). Use a VPN for remote connections to devices.  |
| Software Update                      | <a href="#">D3-SU</a>    | Apply security patches and firmware updates to all devices. Ensure devices are currently supported. Replace devices that are end-of-life.   |
| Agent Authentication                 | <a href="#">D3-AA</a>    | Ensure authentication is enabled for remote access to devices. If supported on IP cameras, enable authenticated RTSP access only.   |

|                        |                        |   |
|------------------------|------------------------|---|
| User Behavior Analysis | <a href="#">D3-UBA</a> | Review all authentication activity for remote access to make sure it is valid and expected. Investigate any unexpected or unusual activity. |
|------------------------|------------------------|---|