Klingon RAT Holding on for Dear Life

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With more malware written in Golang than ever before, the threat from Go-based Remote Access Trojans (RATs) has never been higher. Not only has the number of Go malware increased but also the sophistication of these threats. This is a technical analysis of an advanced RAT written in Go that we are calling **Klingon RAT**. The RAT is well-featured and resilient due to its multiple methods of persistence and privilege escalation. It was determined that the RAT is being used by cybercriminals for financial gain. It is important to stay on top of this threat as it will degrade Antivirus security through killing targeted processes and hiding communications through encrypted channels.

Technical Analysis

When searching our various hunting platforms for malware one particular sample caught our eye. This Go sample, active since at least 2019, was flagged as malicious but mostly unique code by our platform. It is not common to find RATs with very few code reuse. Threat actors reuse code all the time to expedite malware development. Since it is rare to see a RAT with such a large amount of code written from scratch, we dug deeper down the gopher hole. This RAT is full of tactics to combat Antiviruses, maintain persistence and escalate privileges. It communicates encrypted with its Command and Control (C2) server using TLS and can receive commands allowing the attacker to fully control the infected machine.

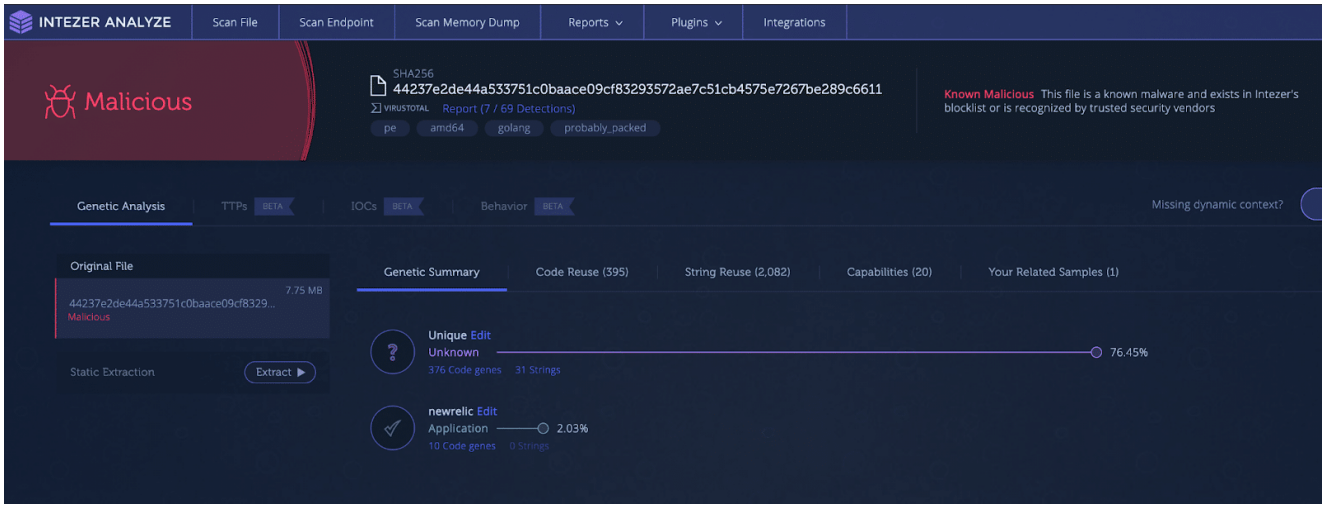


Figure 1: Old analysis with unique code

Initialization

The malware starts by creating an object whose purpose is to store information about the victim machine, controller setup and paths to dropped utilities. It will then run a WMI command (wmic process get Caption,ParentProcessId,ProcessId) to get all running processes. The returned value is parsed and stored in a slice. The malware will check this process list and match it against a list of targeted Antivirus processes. The taskkill command is used to kill matching processes and child processes. The targeted processes are linked here. To start gathering the information on the victim machine, it will get the OS version using the ver command, then grab the username. A GET request is made to https://api.ipify.org to get the public IP address. Finally in this function, it will fetch the machine ID from the registry key

HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Cryptography\ as shown in Figure 2. This ID will later be sent in a beacon to the Command and Control (C2) server.

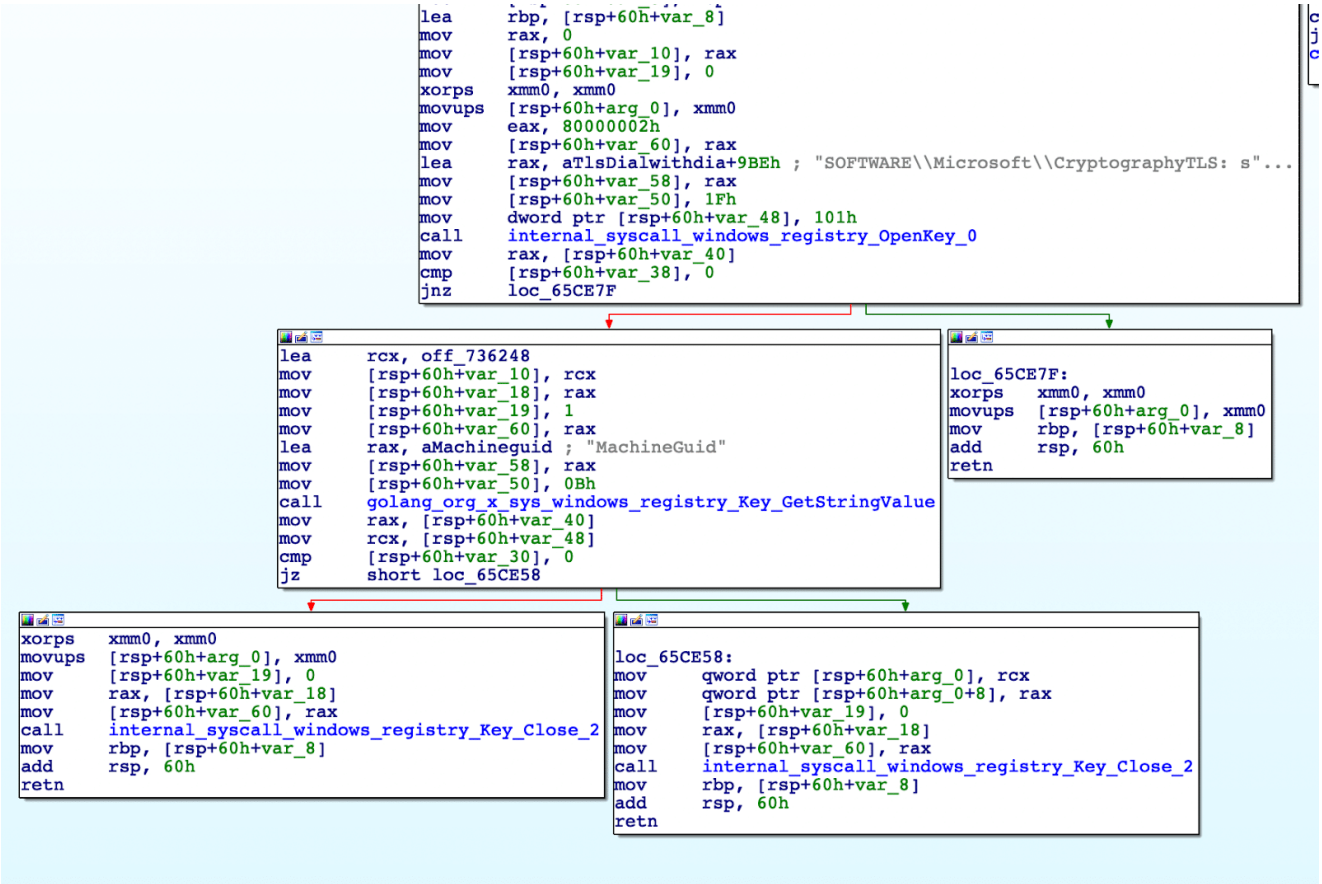


Figure 2: Function that fetches the key

Dependency Deployment

The malware will decompress and drop three Gzip embedded files into the %temp% directory. The dropped files are utilities for the threat actor to use once a C2 channel has been established. The files dropped are Foxmail, PAExec and LSASS, shown below.

```
|    0x00685435      833dc4c33500.   cmp dword [0x009
:> pxr @ 0x983360
0x00983360 0x000000000088b1f    ........ 559903
0x00983368 0xd5147c7dbdecff00   ....}|..
0x00983370 0x605924eecd7c30d9   .0|..$Y`
0x00983378 0xa0d04a2a34481661   a.H4*J..
0x00983380 0xdc04c4a2b23b8062   b.;.....
0x00983388 0x4366217175808668   h..uq!fC
0x00983390 0x42a5bb74d5b424c4   .$..t..B
0x00983398 0x357674204b680661   a.hK tv5
0x009833a0 0xea1fbbdab62ae393   ..*.....
0x009833a8 0xb6b7debed8fb05a3   ........
0x009833b0 0x3e69b0dd2d68ad37   7.h-..i>
0x009833b8 0xa8a0d50a3512f910   ...5....
0x009833c0 0x9881b26241a8dd67   g..Ab... @ str.gAb
0x009833c8 0x7a09376673aefef3   ...sf7.z
```

Figure 3: Head of embedded Foxmail.exe file, Gzip compressed

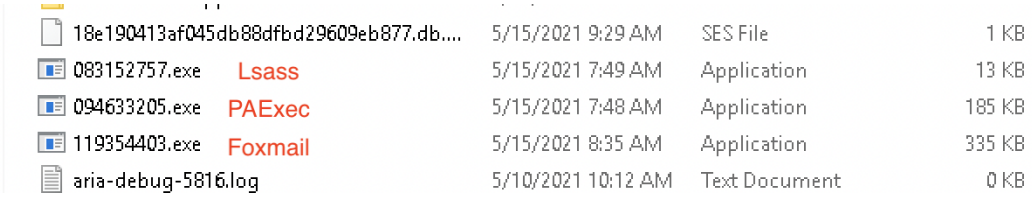


Figure 4: Dropped dependencies Next, the malware will check to see if it is installed at “C:\Users\IEUser\AppData\Local\Windows Update\updater10.exe.” If not installed, the malware will be relocated to the path.

Persistence

Persistence can be set up in multiple ways, some of which require admin privileges. Privilege escalation will be covered in a later section.

Registry Run Key: Current User

The following registry entry is created:

- **Key:** Computer\HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Run
- **Name:** Windows Updater
- **Value:** “C:\Users\\AppData\Local\Windows Update\updater10.exe” -1 -0

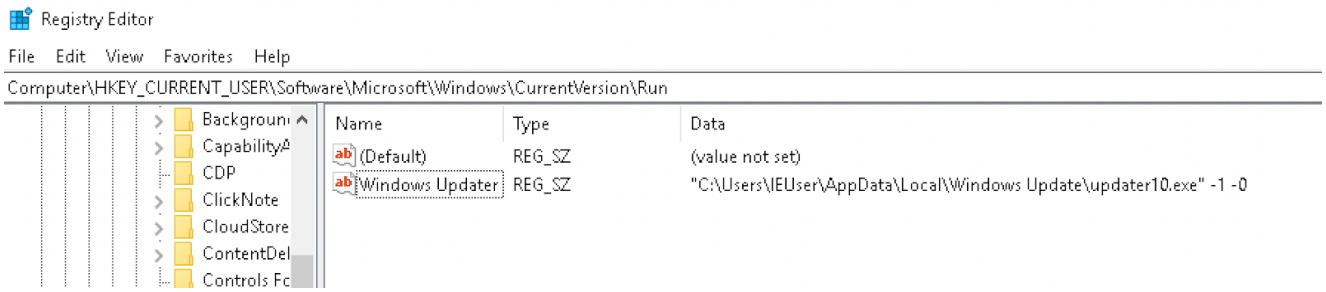


Figure 5: Registry Run Key

Registry Run Key: Local Machine

A similar entry as the above is created at:
Computer\HKEY_LOCAL_MACHINE\Software\Microsoft\Windows\CurrentVersion\Run

Image File Execution Options Injection

Image File Execution Options are configured by the Windows registry with the intention of being used for debugging. This can be leveraged for persistence as any executable can be used as a “debugger.” The malware ensures the following keys exist:
HKEY_LOCAL_MACHINE Software\Microsoft\Windows NT\CurrentVersion\Accessibility
HKEY_CURRENT_USER Software\Microsoft\Windows NT\CurrentVersion\Image File Execution Options\magnify.exe The Image File Execution Options key has the following entries set:

Name	Data
Configuration	mangnifierpane
Debugger	“C:\Users\IEUser\AppData\Local\Windows Update\updater10.exe” -1 -0

This causes the binary for Microsoft Screen Magnifier (magnify.exe) accessibility tool to be backdoored and execute the malware.

WMI Event Subscription

In this option the malware utilizes “WMIC” to create an event subscription for persistence. Three commands are executed to create events in the “\rootsubscription” namespace that will start the payload within 60 seconds of Windows booting up. The commands executed are:
wmic /namespace:’\\root\subscription’ PATH __EventFilter CREATE Name=’GuacBypassFilter’, EventNameSpace=’root\cimv2′, QueryLanguage=’WQL’, Query=’SELECT * FROM __InstanceModificationEvent WITHIN 60 WHERE TargetInstance ISA ‘Win32_PerfFormattedData_PerfOS_System” wmic /namespace:’\\root\subscription’ PATH CommandLineEventConsumer CREATE Name=’GuacBypassConsumer’, ExecutablePath=’”C:\Users\IEUser\AppData\Local\Windows Update\updater10.exe” -1 -0′, CommandLineTemplate=’”C:UsersIEUserAppDataLocalWindows Updateupdater10.exe” -1 -0′

wmic /namespace:'\\root\subscription' PATH __FilterToConsumerBinding CREATE Filter='__EventFilter.Name='GuacBypassFilter'', Consumer='CommandLineEventConsumer.Name='GuacBypassConsomer'')

Winlogon Helper DLL

The malware can modify the "Winlogon" key in order to run itself during Windows logon. The path of the executable is appended to the "Userinit" entry.

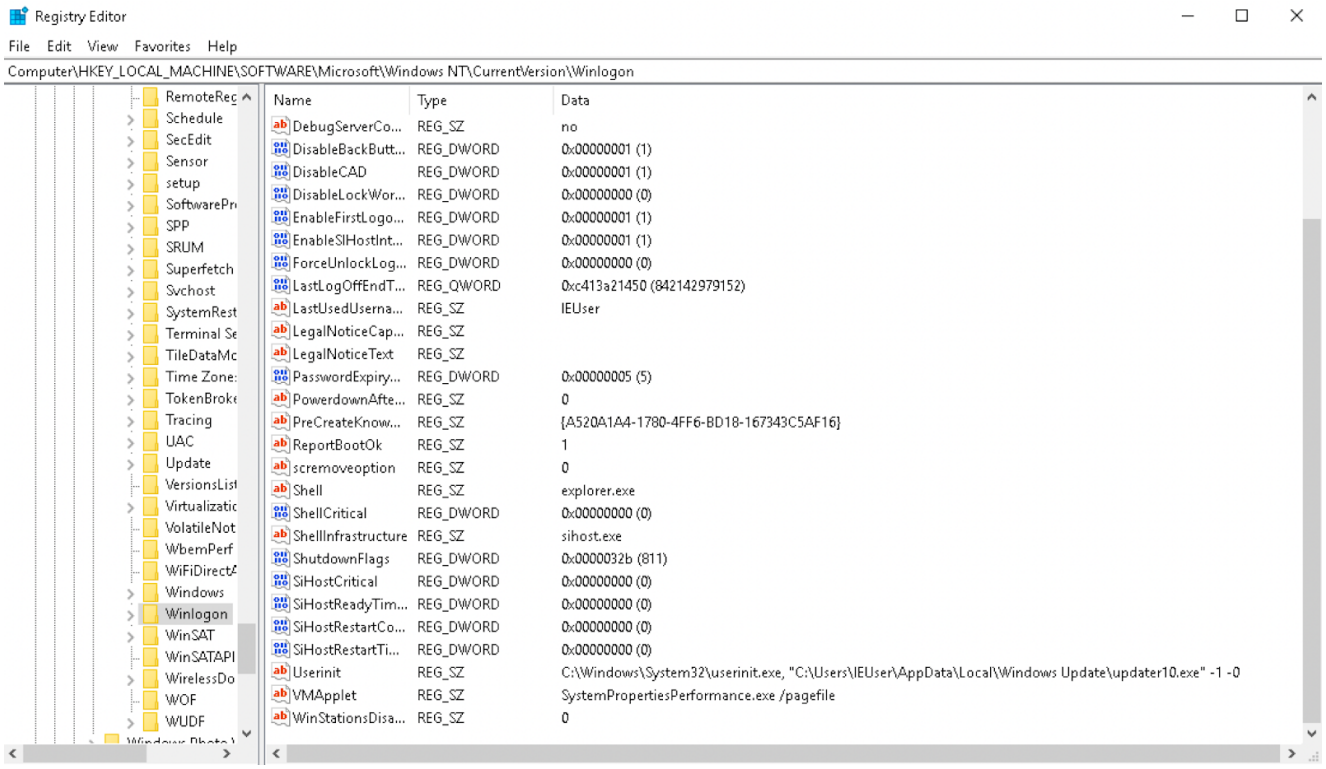


Figure 6: Winlogon registry modified

Scheduled Task

The malware can create a scheduled task called "OneDriveUpdate" to maintain persistence. The task is configured from an XML file, "elevator.xml" dropped to APPDATA, to trigger upon logon.

```
<?xml version="1.0" encoding="UTF-16"?>
<Task version="1.2" xmlns="http://schemas.microsoft.com/windows/2004/02/mit/task">
  <RegistrationInfo>
    <Date>2018-06-09T15:45:11.0109885</Date>
    <Author>00000000000000000000</Author>
    <URI>\Microsoft\Windows\OneDriveUpdate</URI>
  </RegistrationInfo>
  <Triggers>
    <LogonTrigger>
      <Enabled>true</Enabled>
    </LogonTrigger>
  </Triggers>
  <Principals>
    <Principal id="Author">
      <UserId>S-1-5-18</UserId>
      <RunLevel>HighestAvailable</RunLevel>
    </Principal>
  </Principals>
  <Settings>
    <MultipleInstancesPolicy>IgnoreNew</MultipleInstancesPolicy>
    <DisallowStartIfOnBatteries>false</DisallowStartIfOnBatteries>
    <StopIfGoingOnBatteries>false</StopIfGoingOnBatteries>
    <AllowHardTerminate>false</AllowHardTerminate>
    <StartWhenAvailable>true</StartWhenAvailable>
    <RunOnlyIfNetworkAvailable>false</RunOnlyIfNetworkAvailable>
    <IdleSettings>
      <StopOnIdleEnd>true</StopOnIdleEnd>
      <RestartOnIdle>false</RestartOnIdle>
    </IdleSettings>
    <AllowStartOnDemand>true</AllowStartOnDemand>
    <Enabled>true</Enabled>
    <Hidden>false</Hidden>
    <RunOnlyIfIdle>false</RunOnlyIfIdle>
    <WakeToRun>false</WakeToRun>
    <ExecutionTimeLimit>PT0S</ExecutionTimeLimit>
    <Priority>7</Priority>
    <RestartOnFailure>
      <Interval>PT2H</Interval>
      <Count>999</Count>
    </RestartOnFailure>
  </Settings>
  <Actions Context="Author">
    <Exec>
      <Command>"C:\Users\IEUser\AppData\Local\Windows Update\updater10.exe" -1 -0</Command>
    </Exec>
  </Actions>
</Task>
```

Figure 7: Task configuration file

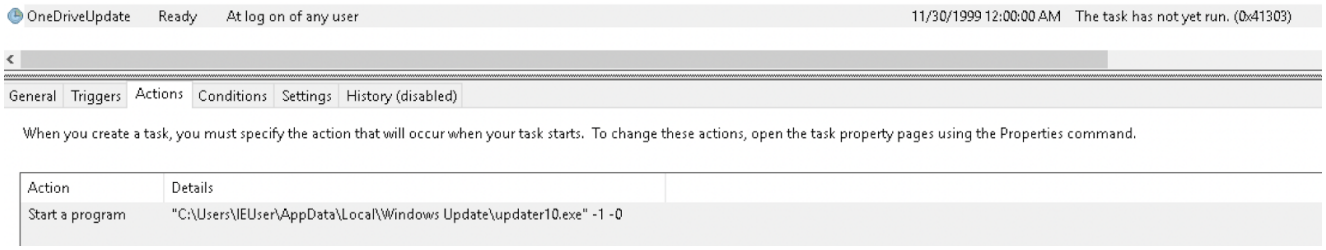


Figure 8: Action of triggering the task The file “elevator.xml” is then removed from the disk.

Privilege Escalation

There are multiple avenues that the malware can take for privilege escalation. It will first test to see if it already has admin privileges and if it is a Windows server. To check if the process has admin privileges, it will attempt to open “\\\\.\\PHYSICALDRIVE0;” if unsuccessful, the malware will attempt to open “\\\\.\\SCSI0.” If successful for either of these, it will return “True” from the function. If “False,” the program will check to see if it is a Windows server by running the command “systeminfo,” and parsing for the string “Microsoft Windows Server,” as shown in Figure 9.

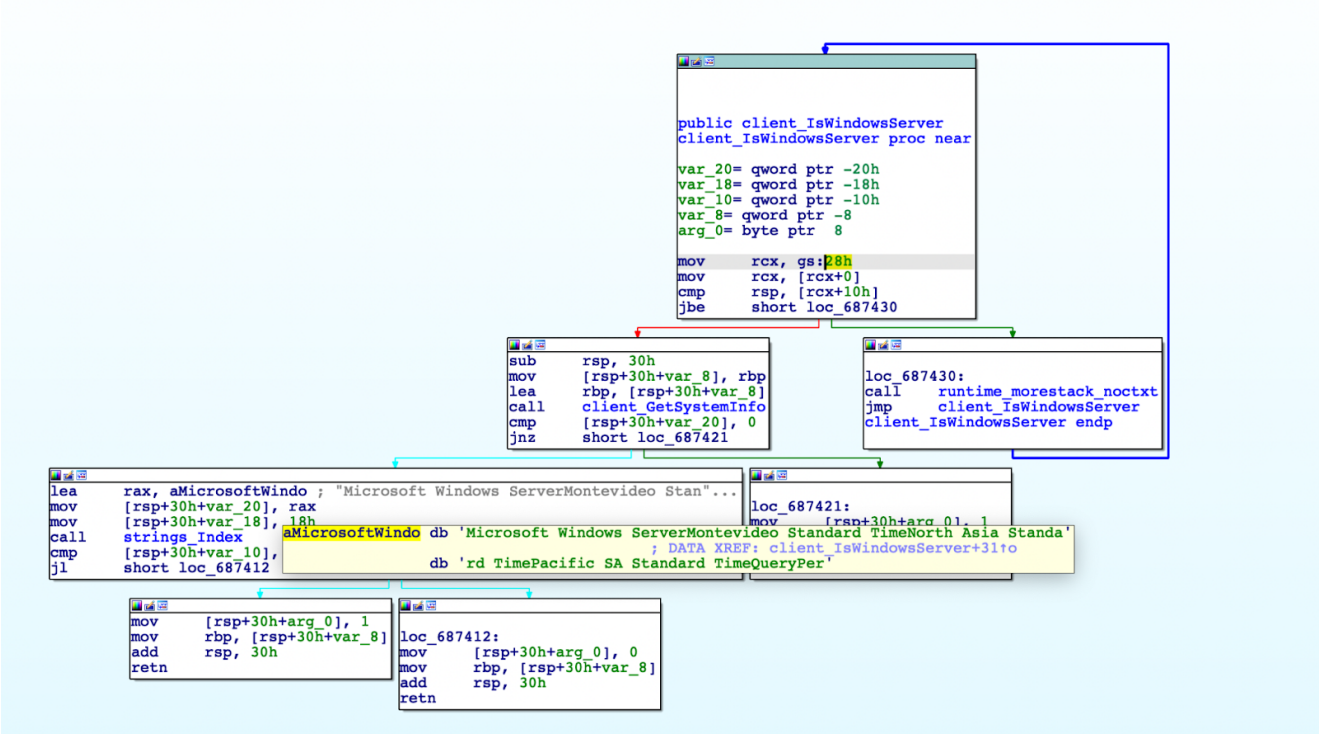


Figure 9: Check for Windows Server The malware has four options for privilege escalation, one of which is not implemented properly:

UAC Bypass: Computer Defaults

This exploit starts by opening the following registry key: HKEY_CURRENT_USER (0x80000001) Software\Classes\ms-settings\shell\open\command The default entry is set to the path of the malware, and an entry “DelegateExecute” has an empty string value added. Next, the program “computerdefaults.exe” is executed to complete the exploit.

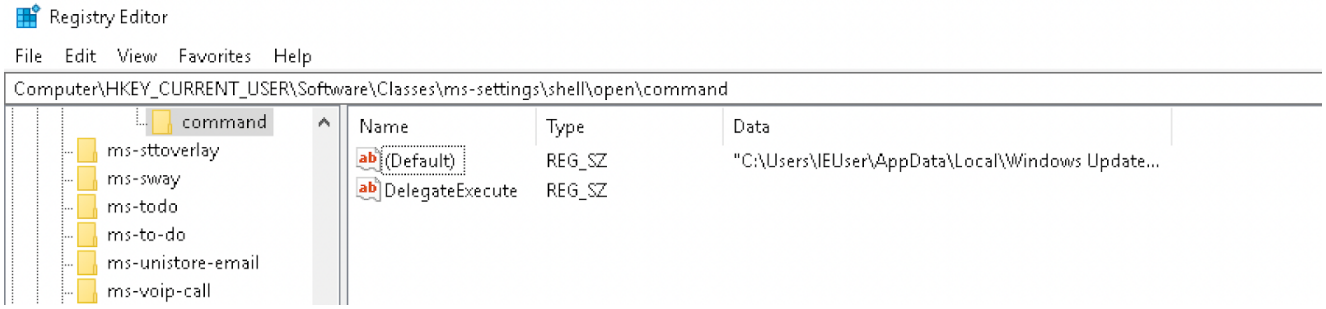


Figure 10: Registry set for exploit The key is deleted after exploitation.

UAC Bypass: Fodhelper

This exploit is similar to the Computer Defaults UAC bypass but this time it leverages the program “Features on Demand Helper” (Fodhelper.exe), a binary with the “autoelevate” setting set to true. The same registry entries are used.

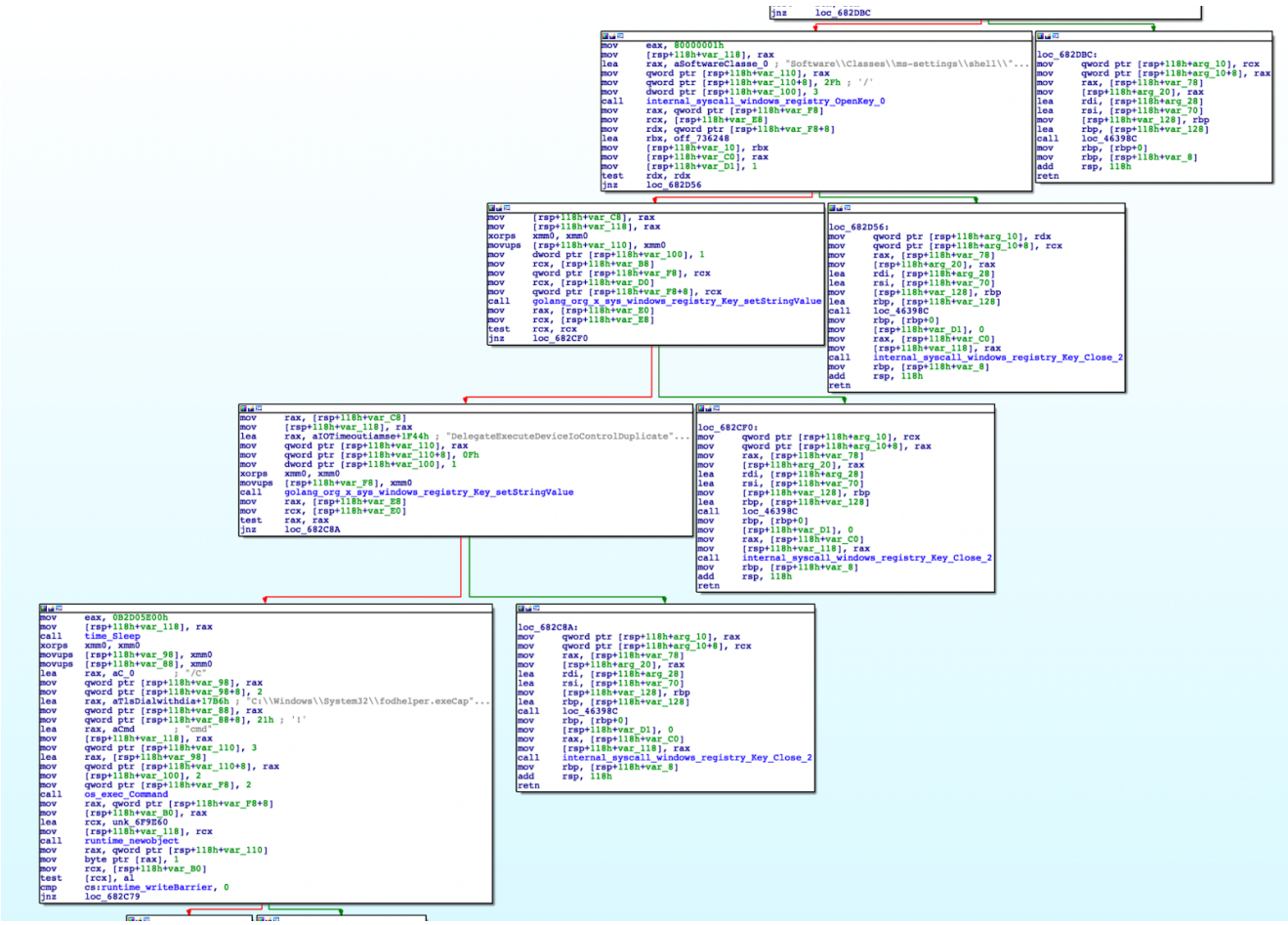


Figure 11: UAC bypass with Fodhelper.exe

UAC Bypass: Disk Cleanup

This UAC bypass works by leveraging the scheduled task named “SilentCleanup.” This task runs with the highest privileges but is configured to have the ability to be executed by unprivileged users.

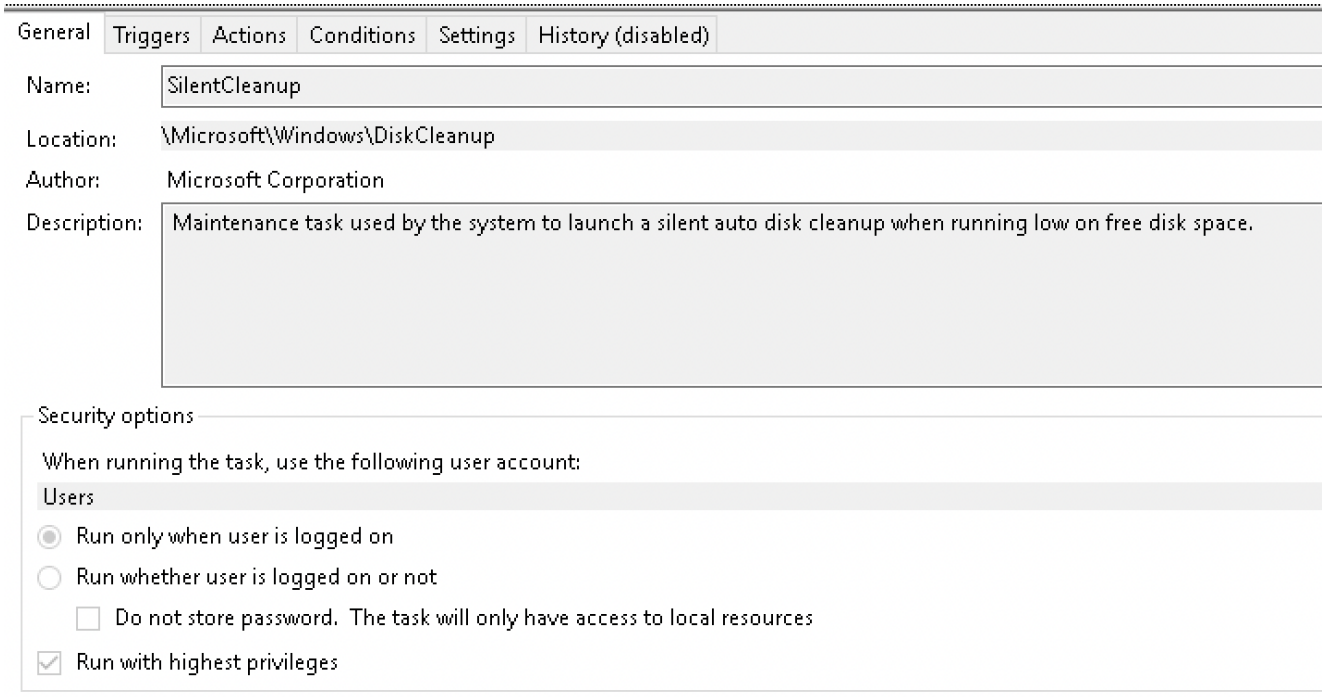


Figure 12: Config for SilentCleanup The malware attempts to leverage the environment variable "%windir%" to execute itself with higher privileges. The scheduled task runs an action "%windir%\system32\cleanmgr.exe," therefore the malware tries to set the "windir" variable to the path of the malware.

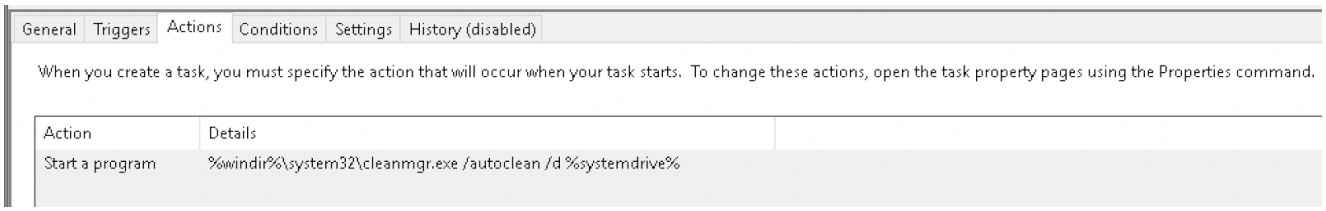


Figure 13: Action of the scheduled task (SilentCleanup)

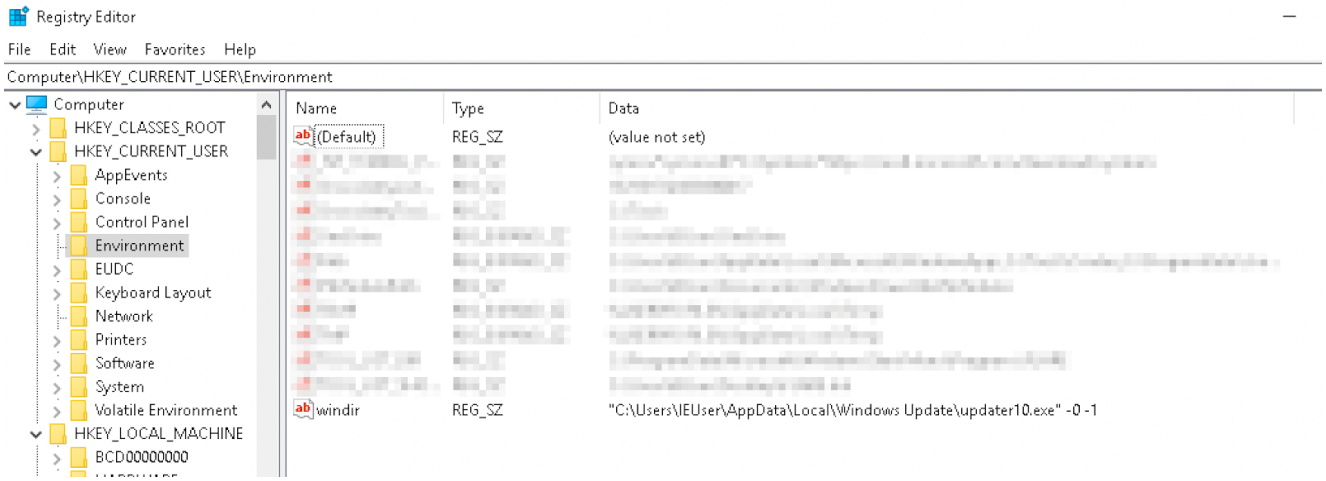


Figure 14: "windir" variable set in the registry After setting the registry, the malware runs the scheduled task.

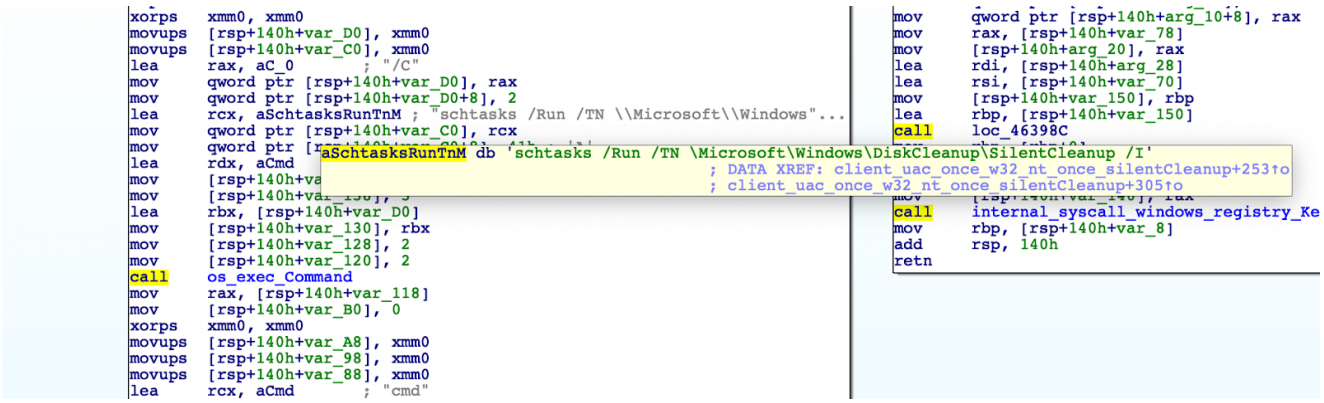


Figure 15: Execution of the scheduled task The resulting process:

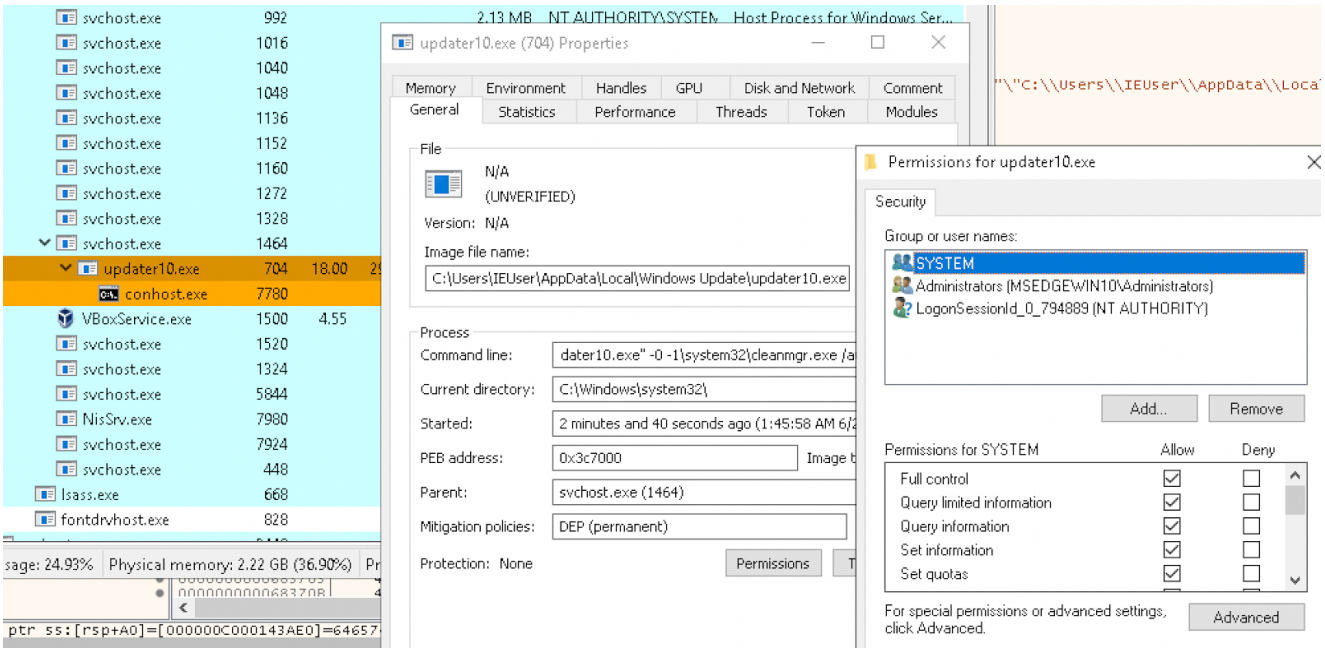


Figure 16: The elevated process

UAC Bypass: Event Viewer

Based on the strings in this path, it appears that the malware intended to leverage the "Event Viewer" UAC bypass. But this does not appear to be properly implemented in the program.

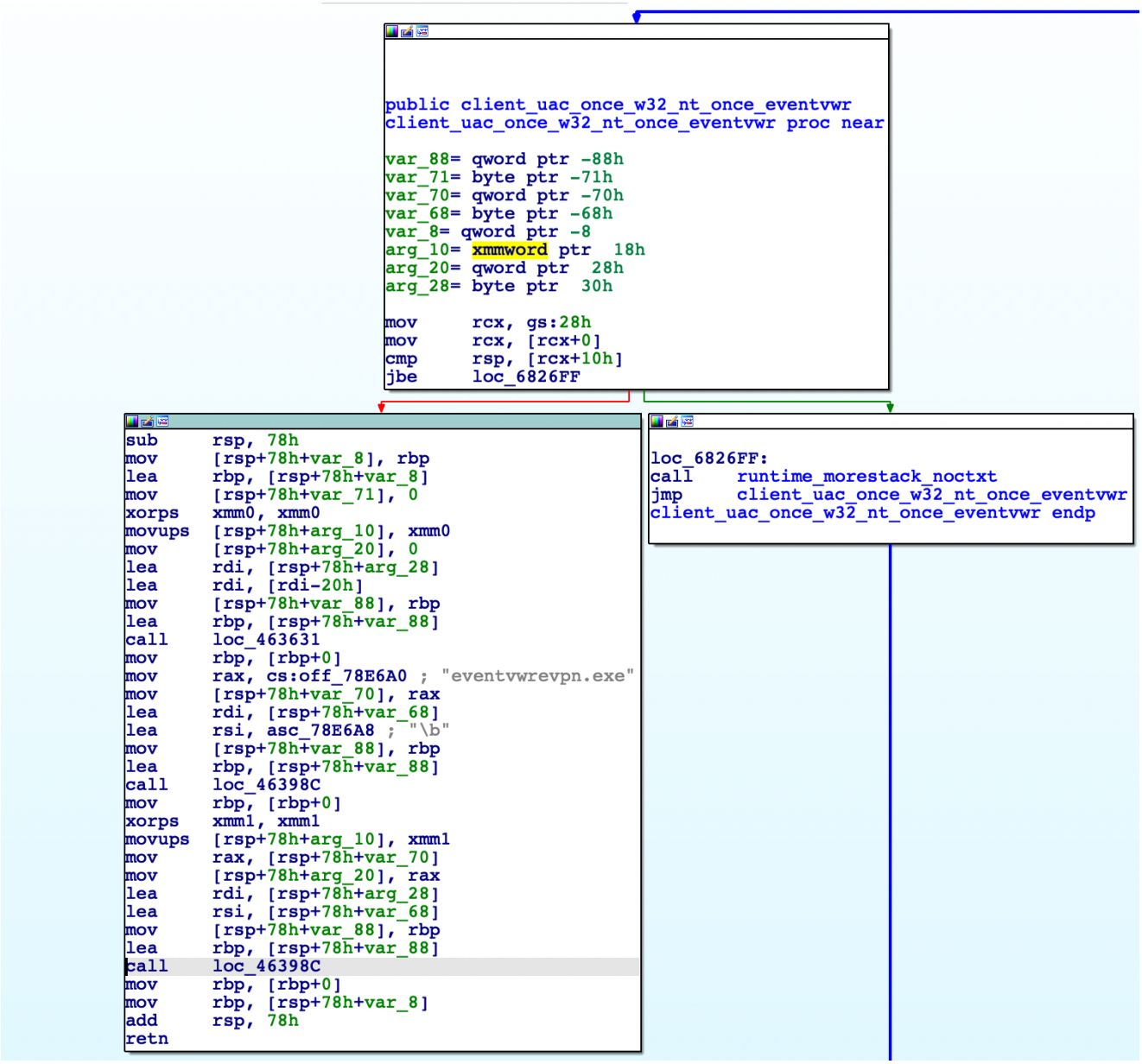


Figure 17: References to “eventvwr” in a function called by “MakeAdmin” parent

Command and Control

Before Command and Control (C2) is established the malware initiates a controller struct: type control.Controller struct{ bot model.Bot socksSessions []control.SocksProxy shellSessions []control.Shell connection net.Conn keepAlive net.Conn }

First, a x509 keypair is decoded from Base64 and loaded by the function tls.x509KeyPair.

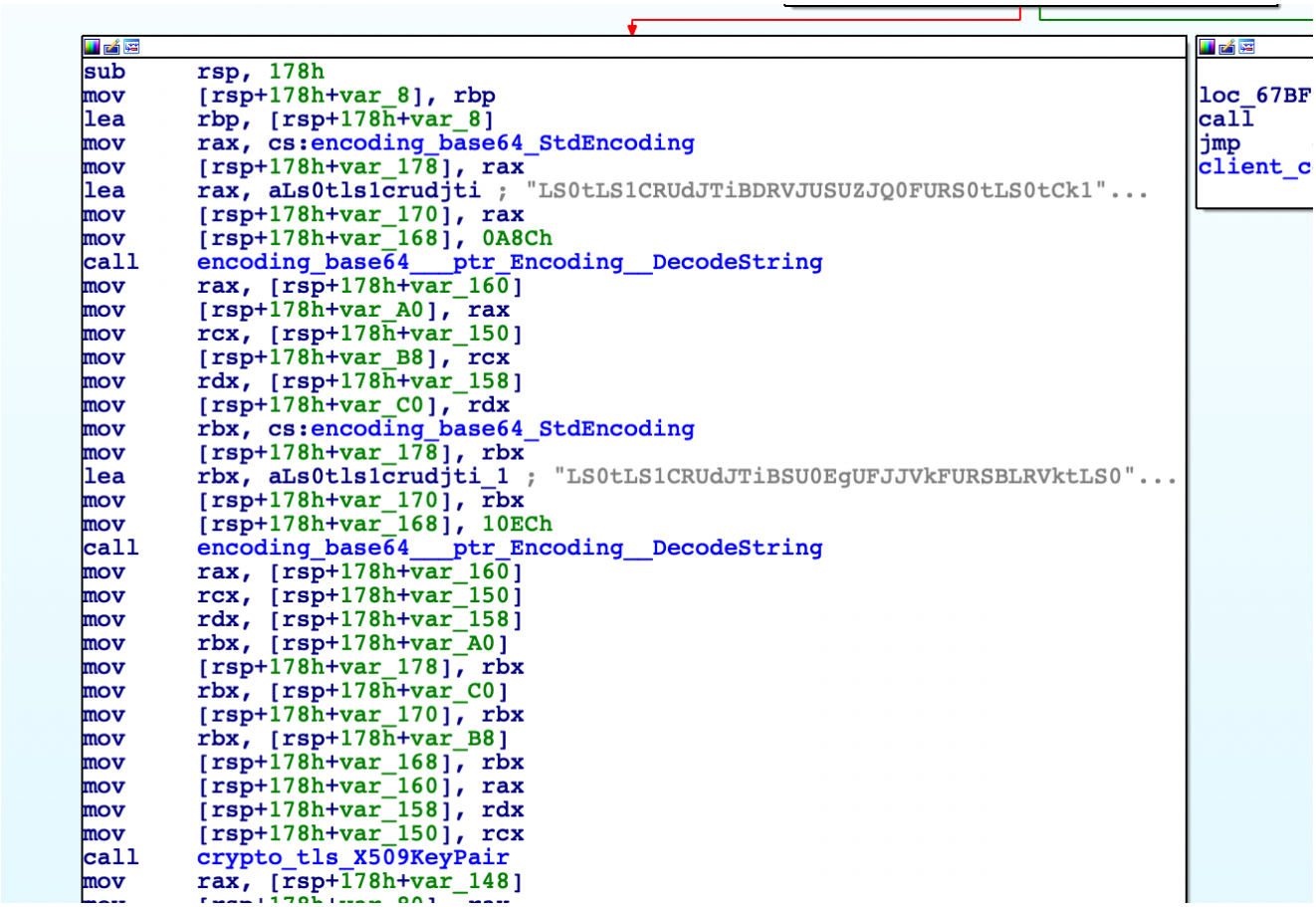


Figure 18: Loading x509 key pair The decoded keypair is linked here and here. Strings from this certificate can be matched to strings in the Issuer DN of a similar certificate with subject "UrbanCulture, Inc." A further PEM certificate is decoded and appended to the cert pool. A TLS handshake is performed with the C2 server 185.188.183[.]144 on the port 1141 and then creates a Goroutine called "Controller.WaitCommands." The malware is able to:

- Start a SOCKS proxy ('proxy')
- Start a reverse shell ('shell')
- Start an RDP server ('rdp')
- Start a binary ('binary')
- Update binary ('update')
- Run PowerShell command ('cmd')

The malware will initiate further Goroutines to collect information from the system. If running as administrator, it will run the Lsass binary previously dropped into the temp folder.

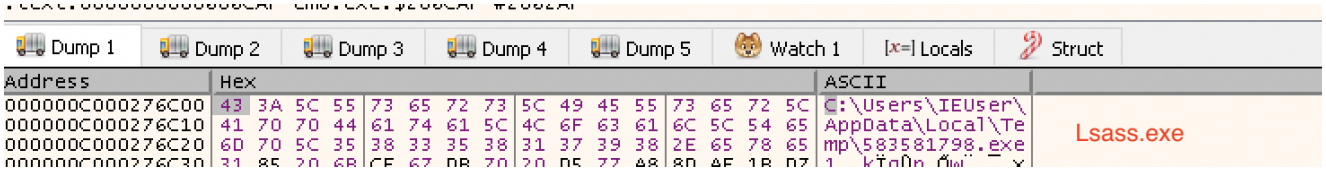


Figure 19: Path of the Lsass binary to be executed The results are stored in a file called "Andrew.dmp" inside the temp folder. This information is sent to the C2 server through a HTTP POST request.

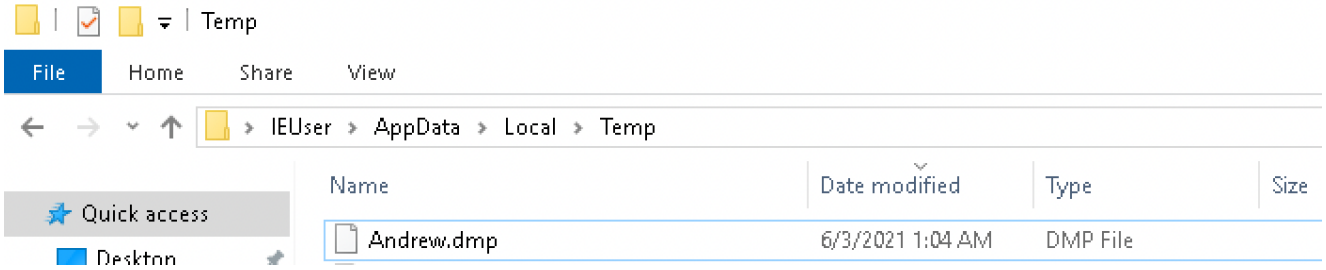


Figure 20: Location of dump file Another routine will take a fingerprint of the machine, concatenating the results into a string, and send this off in a HTTP POST request. It runs the following commands in this order:

1. systeminfo
2. ipconfig
3. net view /all
4. net view /all domain
5. net users /domain
6. nltest /domain_trusts
7. nltest /domain_trusts /all_trusts

Finally, the malware will periodically get information about the local network and adapters.

Detect and Respond to Klingon RAT

Detect if your Windows machine or server has been compromised by Klingon RAT or any variant that reuses code using the Intezer Analyze Live Endpoint Scanner available via the enterprise edition. Running the scanner will classify all binary code residing in your machine's memory.

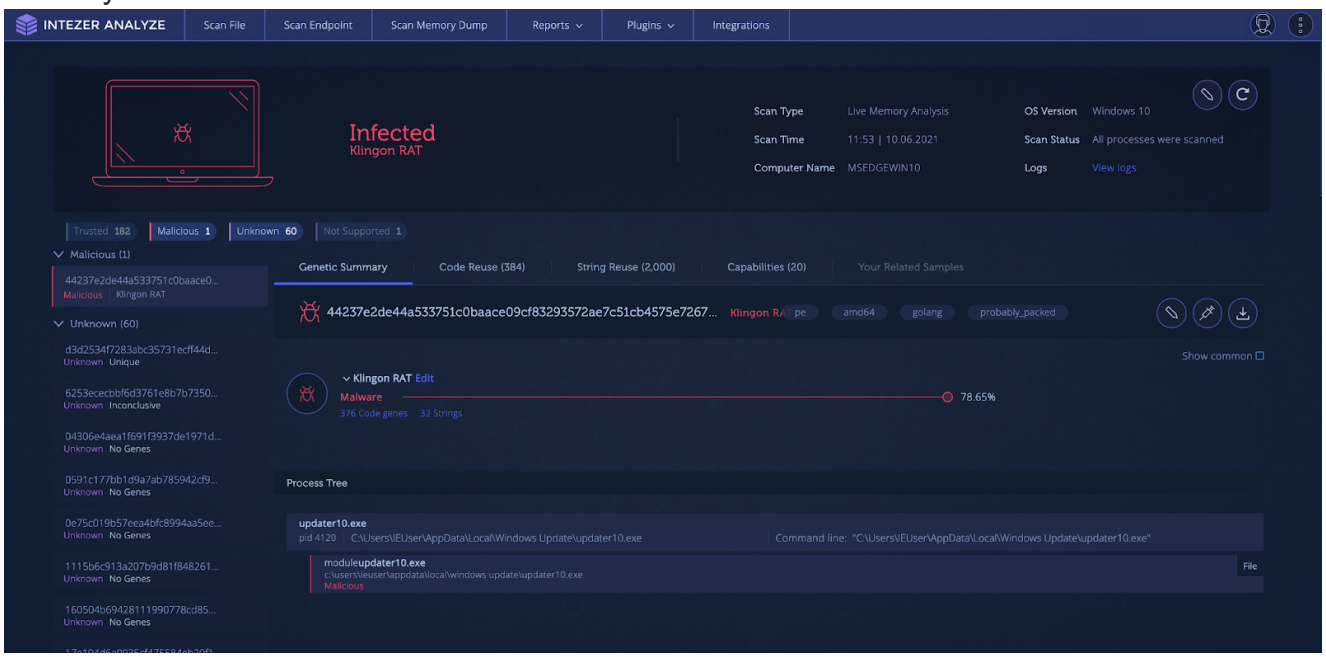


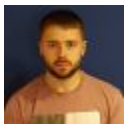
Figure 21: Endpoint scan of an infected system

Indicators of Compromise

MD5	C2
8d44ccac6b5512a416339984ad664d79	185.188.183[.]144
14471a353788bb6cdb6071d0e0a83004	94.177.123[.]134
327090cbddf94fc901662f0e863ba0cb	88.214.27[.]40
39d550fd902ca4c1461961d01ad1aeb6	51.83.216[.]211

MITRE ATT&CK

Tactic	ID	Name
Execution	T1059.001	PowerShell
	T1059.003	Windows Command Shell
	T1047	Windows Management Instrumentation
Persistence	T1547.001	Registry Run Keys / Startup Folder
	T1547.004	Winlogon Helper DLL
	T1546.003	Windows Management Instrumentation Event Subscription
	T1546.012	Image File Execution Options Injection
	T1053.005	Scheduled Task
Privilege Escalation	T1548.002	Bypass User Account Control
Defense Evasion	T1562.001	Disable or Modify Tools
	T1070.004	File Deletion
Credential Access	T1003.001	LSASS Memory
Discovery	T1082	System Information Discovery
	T1016	System Network Configuration Discovery
	T1018	Remote System Discovery
Command and Control	T1571	Non-Standard Port
	T1071.001	Web Protocols



Ryan Robinson

Ryan is a security researcher analyzing malware and scripts. Formerly, he was a researcher on Anomali's Threat Research Team.