MAGNET VIRTUAL SUMMIT 2023
CAPTURE THE FLAG (CTF)
WINDOWS 11

ABOUT THIS CTF CHALLENGE

This challenge was created by Magnet Forensics as part of their 2023 Virtual Summit.

Information about the next summit is available at:

- https://magnetvirtualsummit.com/
- https://magnetvirtualsummit.com/capture-the-flag/

FORENSIC IMAGE SOURCE

Download: PC-MUS-001.E01 (49.0 GB)

OTHER ONLINE SOLUTIONS

The following solutions can be found on the web:

- https://forensafe.com/blogs/challenges/mvs_windows11_ctf.html
- https://www.stark4n6.com/2023/03/magnet-virtual-summit-2023-ctf-windows.html
- https://www.forgottennook.com/blog/magnet-windows11-2023

CTF QUESTIONS ONLY

The following questions were provided:

1	Gmail? Outlook? Yeah, right.. ***What non-standard email service has the user used previously?***	5
2	Two different versions, twice the emulation power! Makes sense to me! ***The user installed and ran a mobile device emulation program on their system. Which 2 versions of this software did the user install? (Format: SoftwareName V1/V2)?***	5
3	LITEning fast write speeds! ***The user's system is equipped with a 256GB NVMe SSD. What is the make and model of this drive?***	5
4	Really...? Plaintext...? ***The user frequently accesses a Chrome Remote Desktop virtual machine. What password is used to log into this VM?***	10
5	Why was 6 afraid of 7? Because 7 can unarchive virtual drives! ***Within the past 2 years, a popular unarchiving program gained the ability to unarchive VHDX virtual disk images. What version of the program was this upgrade implemented?***	10
6	We're not in Kansas anymore... ***The user has established an RDP connection to one destination more than any other. What is the Geolocation of this destination? (Format: City, ST)?***	25

7	Make sure to keep some tabs on that SysAdmin from Southern California ***The user visited the Mastodon page of one user more than any others on the platform. What is the full legal name of the user Michael visited?***	25
8	We have a History of attracting some sizeable donors with our projects ***Michael used PowerShell to clone a particular GitHub utility. What is the account name of one of this repo's most prominent sponsors?***	25
9	Scratch that Itch.io ***The user viewed a YouTube video by the creator BenBonk surrounding video game developers. Within this video, how many developers were involved with the project?***	25
10	The breakfast bell is ringing ***The user has been doing some research lately on fast food items. What is, according to some experts, the unhealthiest food item of the bunch?***	50
11	Oh Deer...I think we're lost ***Michael lives just a mile south of a beautiful body of water. What is the name of this body of water?***	50
12	Gotta Git going fast with some Accelerated emulation! ***In order to emulate an Android device, the user required some specialized management tools. What Android port is used by default with these services?***	50
13	PCA Program Clang Assistant? ***The user has installed Android Studio with a specialized plugin dedicating to diagnosing and fixing some programming errors. When this plugin runs, what exit code is used upon completion?***	100

PREPARING THE CASE IN FORENSIC EXPLORER

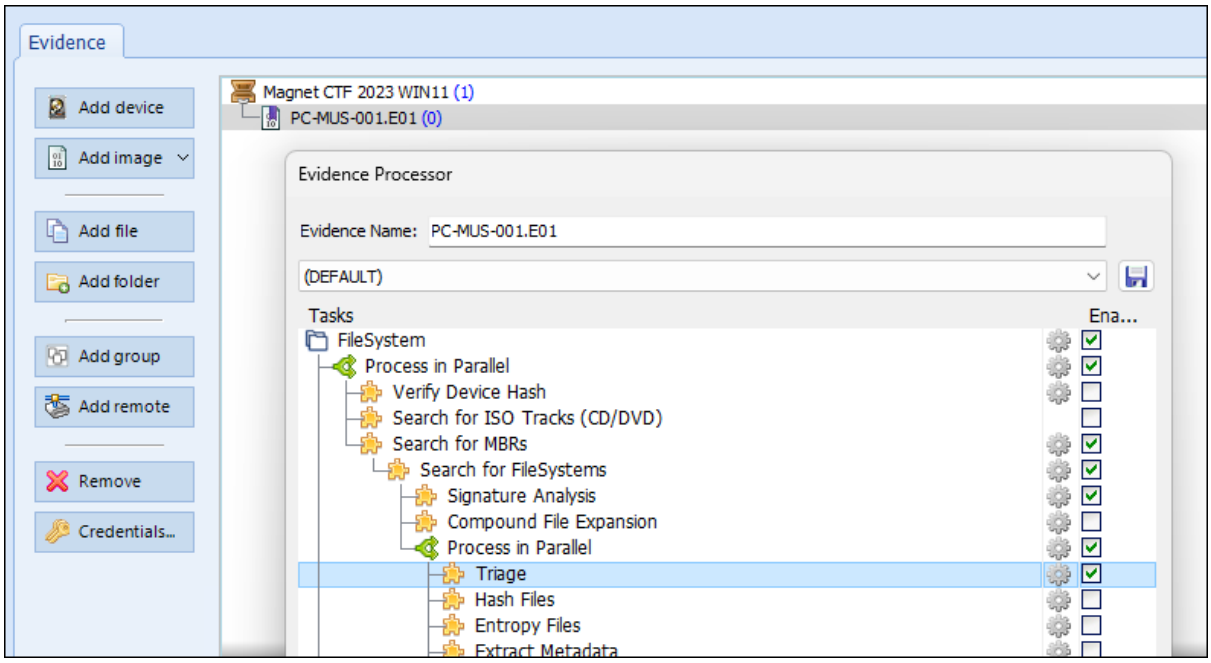
The following initial Forensic Explorer processing steps are recommended. These steps should take no longer than 15 minutes to complete.

ADD EVIDENCE: PC-MUS-001.E01

In the Forensic Explorer **Evidence module**:

1. Select the **New Case**.
2. Enter **investigator details** (if required) and a **case name**.
3. Click **Add Image**.
4. Add the evidence file **PC-MUS-001.E01**.
5. In the **Evidence Processor** window, add **Triage** to processing options. [Optional].

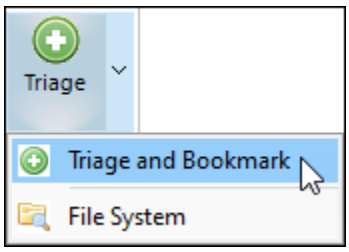
Figure 1: New Case > Add Image > Evidence Processor



TRIAGE

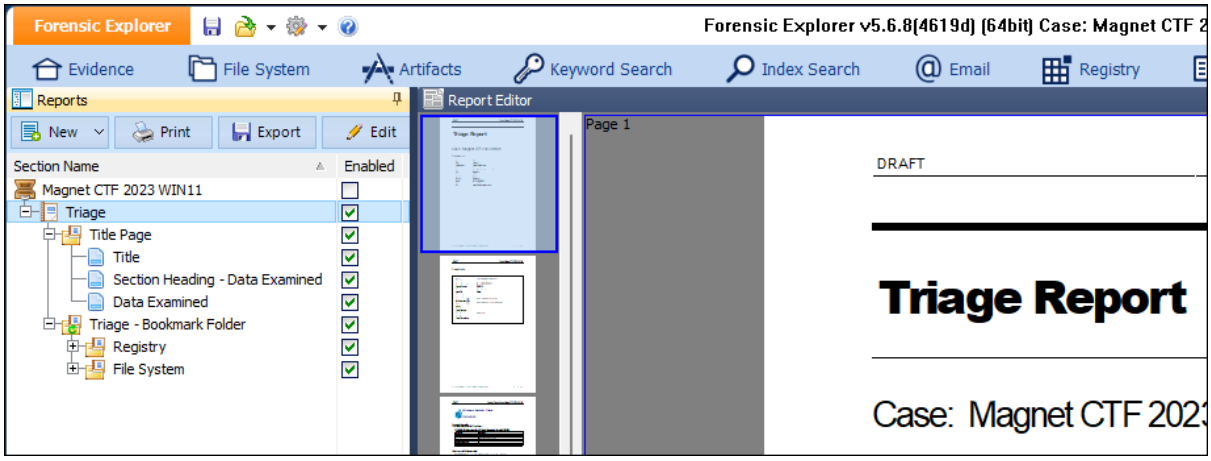
In Forensic Explorer, Triage is a fast process that extract and bookmark common artifacts and display this information in the **Reports** module as a **Triage Report.** If Triage was not run from the **Evidence Processor** it can be run at a later time from the **File System module > Triage button**.

Figure 2: Launch Triage from File System module



The Triage Report can often contain answers to CTF questions.

Figure 3: Triage Module > Triage Report

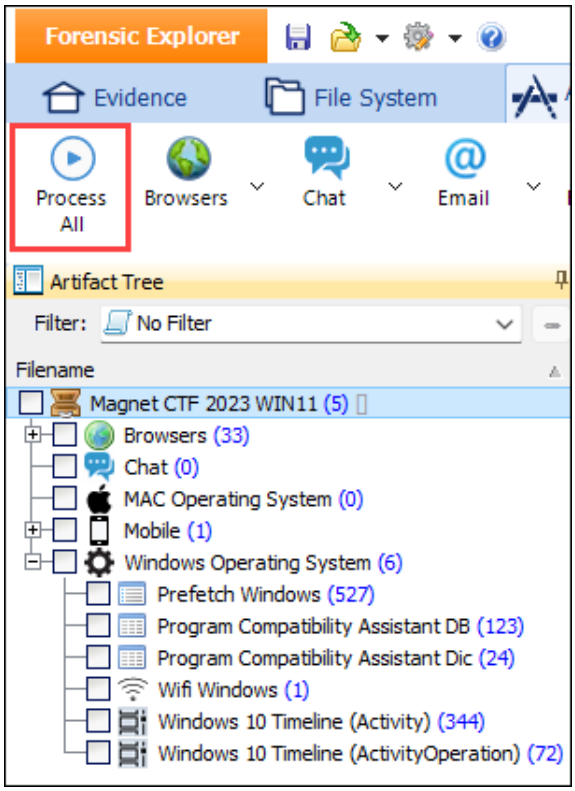


ARTIFACTS > PROCESS ALL

The Forensic Explorer **Artifacts module** extracts common forensic artifacts from files, including SQLite, Plist, and XML. To populate artifacts:

1. Click the **Artifacts module > Process All** button.

Figure 4: Artifacts > Process All

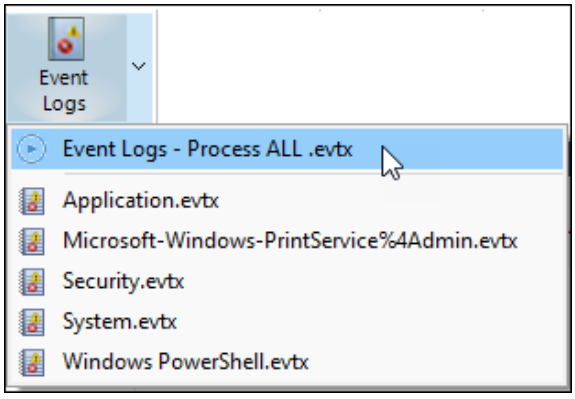


ARTIFACTS > EVENT LOGS

It is evident that Question 6 will require analysis of Windows Event Logs (.evtx). To populate Event Logs in the Artifacts module:

1. Click the **Artifacts module** > **Event Logs – Process All .evtx** button.

Figure 5: Windows Event Logs



REGISTRY

In the File System module:

1. Apply the Folder Filter: **Registry (All) - SAM, SECURITY, SOFTWARE, SYSTEM, NTUSER.DAT, USERCLASS.DAT.**
2. In the **File List**, click **Ctrl A** to highlight all of the filtered registry files.
3. Right-click and **Send to module > Registry**.

Figure 6: Send registry files to the Registry module

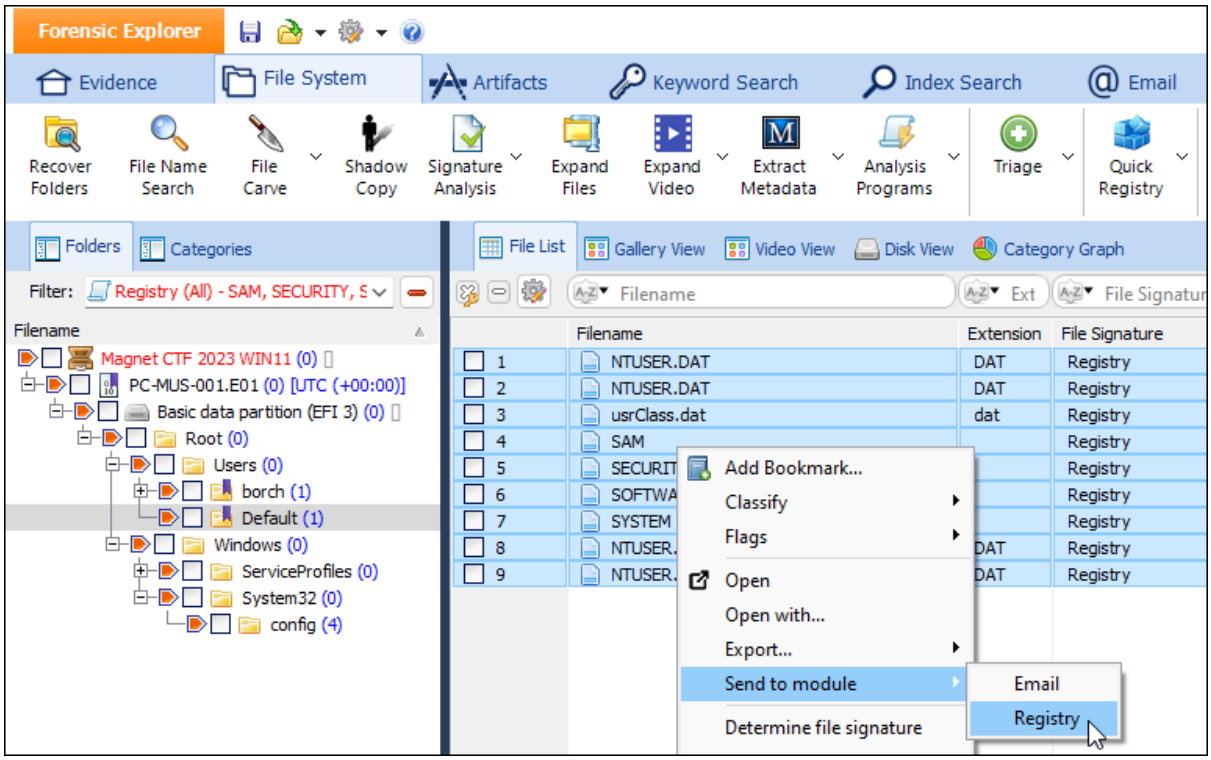
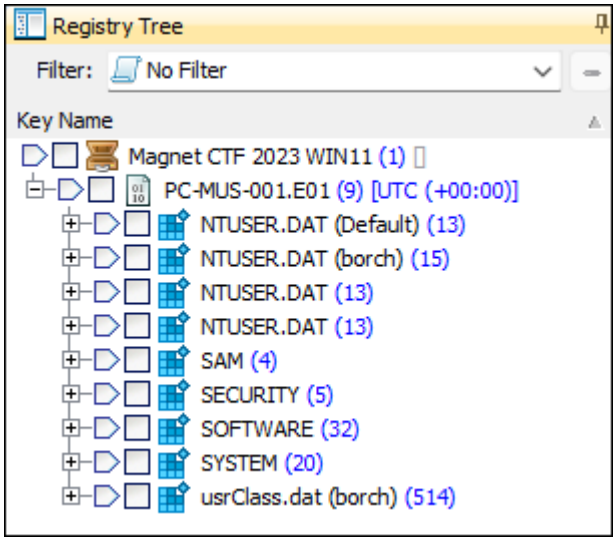


Figure 7: Registry module > Populated Registry Tree



LIVE BOOT

Forensic Explorer Live Boot enables an investigator to virtualize a forensic evidence file and operate the target computer in a virtual environment. Live Boot uses a combination of Forensic Explorer, Mount Image Pro (provided with a Forensic Explorer license) and virtualization software (VirtualBox, or VMWare). Live Boot can provide insights into user activity that may not readily identifiable using standard forensic software methods.

Note that the target system uses a **UEFI** boot process. See the Forensic Explorer manual for setup instructions and information to bypass the Win11 user password using **PCUnlocker**.

Figure 8: PC-MUS-001.E01 login screen

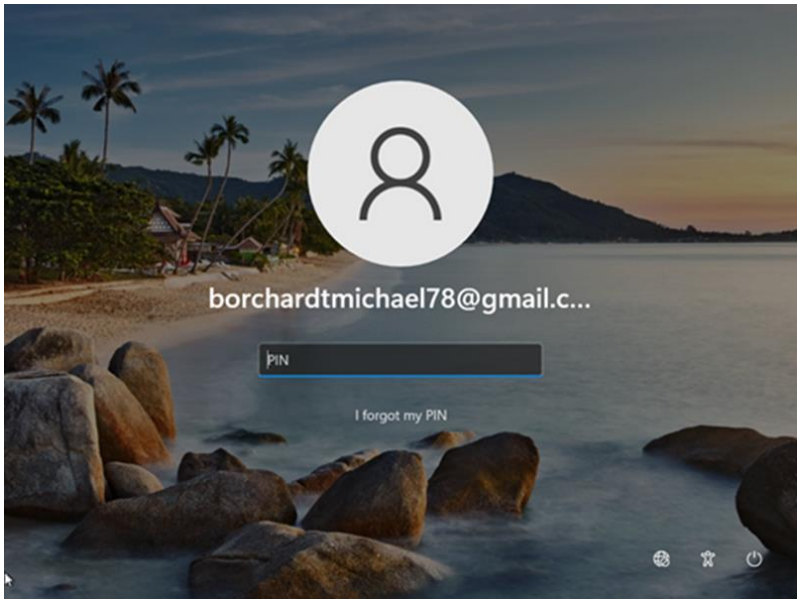
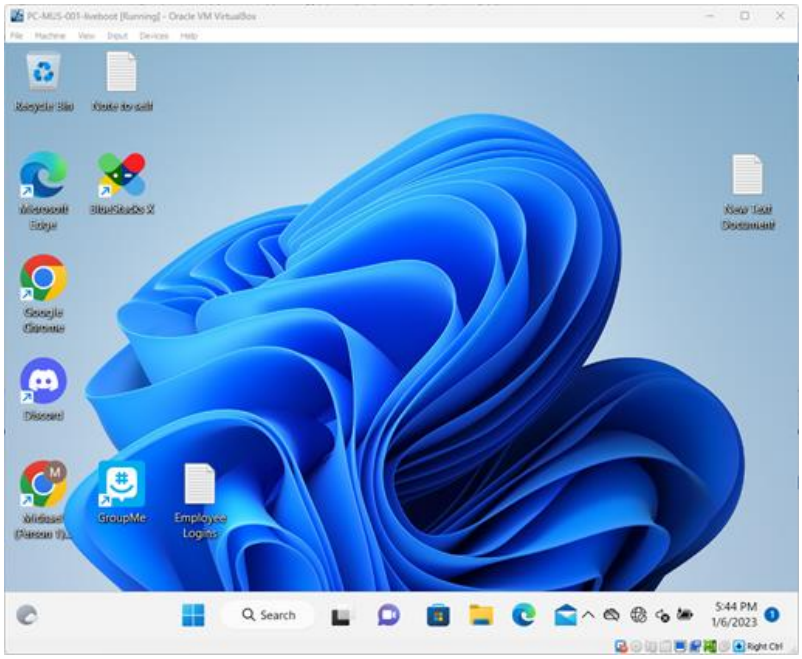


Figure 9: PC-MUS-001.E01 virtualized desktop



QUESTION 1 - GMAIL? OUTLOOK? YEAH, RIGHT.. (5 POINTS)

What non-standard email service has the user used previously?

Q1. ANSWER

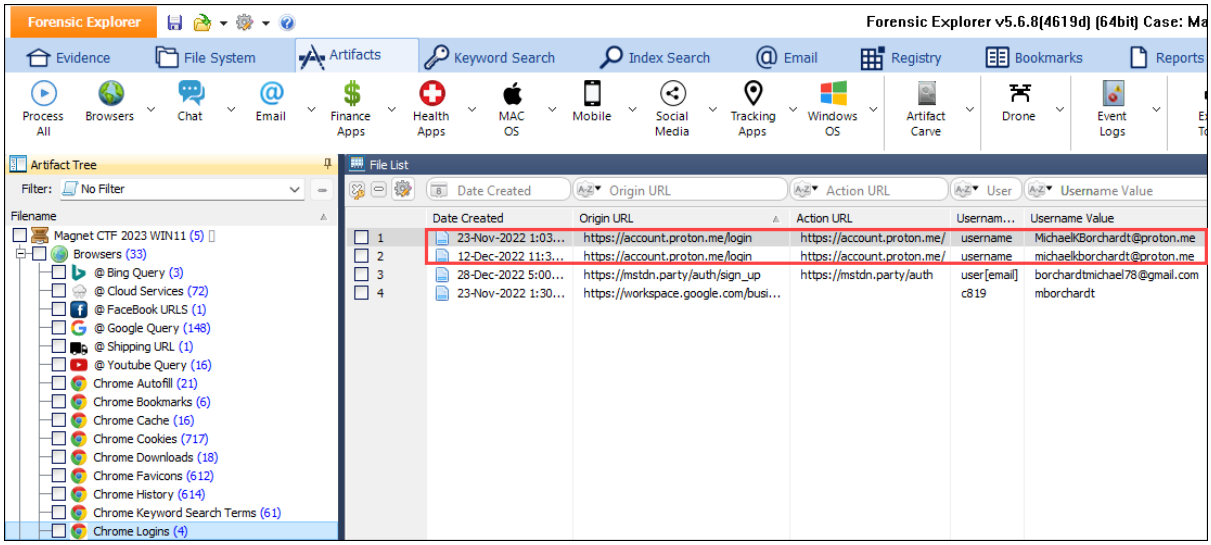
Proton.

Q1. FORENSIC EXPLORER METHODOLOGY

This question suggests that a lesser know email program is in use. Artifacts web history is a useful place to start to check for web-based activity.

Chrome Logins identifies that the user has visited the login screen for Proton mail, https://account.proton.me/login.

Figure 10: Artifacts > Browsers > Chrome Logins



QUESTION 2 - TWO DIFFERENT VERSIONS, TWICE THE EMULATION POWER! MAKES SENSE TO ME!

The user installed and ran a mobile device emulation program on their system. Which 2 versions of this software did the user install? (Format: SoftwareName V1/V2)?

Q2. ANSWER

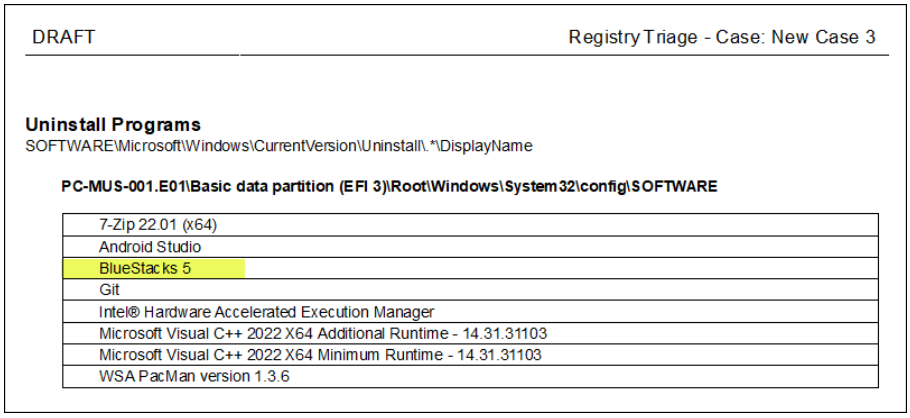
BlueStacks 5 - 5.10.10.1014

BlueStacks X - 0.19.21.1002

Q. FORENSIC EXPLORER METHODOLOGY

Information about installed applications is contained in the Forensic Explorer Triage report. This identifies from registry information the mobile device emulation program called **BlueStacks 5**.

Figure 11: Reports > Triage Report



DRAFT — Registry Triage - Case: New Case 3

Uninstall Programs
SOFTWARE\Microsoft\Windows\CurrentVersion\Uninstall\.*\DisplayName

PC-MUS-001.E01\Basic data partition (EFI 3)\Root\Windows\System32\config\SOFTWARE

7-Zip 22.01 (x64)
Android Studio
BlueStacks 5
Git
Intel® Hardware Accelerated Execution Manager
Microsoft Visual C++ 2022 X64 Additional Runtime - 14.31.31103
Microsoft Visual C++ 2022 X64 Minimum Runtime - 14.31.31103
WSA PacMan version 1.3.6

Switching to the Forensic Explorer Registry module, there are two places when information about installed applications can be extracted.

1. NT User Hive > Uninstall Programs
2. Software Hive > Uninstall Programs (metadata)

Figure 12: Registry > NTUser Hive > Uninstall Programs

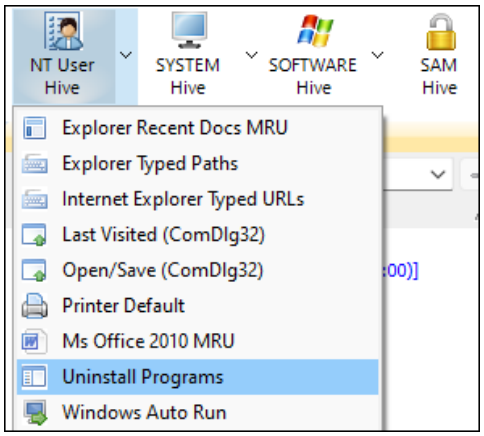


Figure 13: Output from Registry > NT User Hive > Uninstall Programs

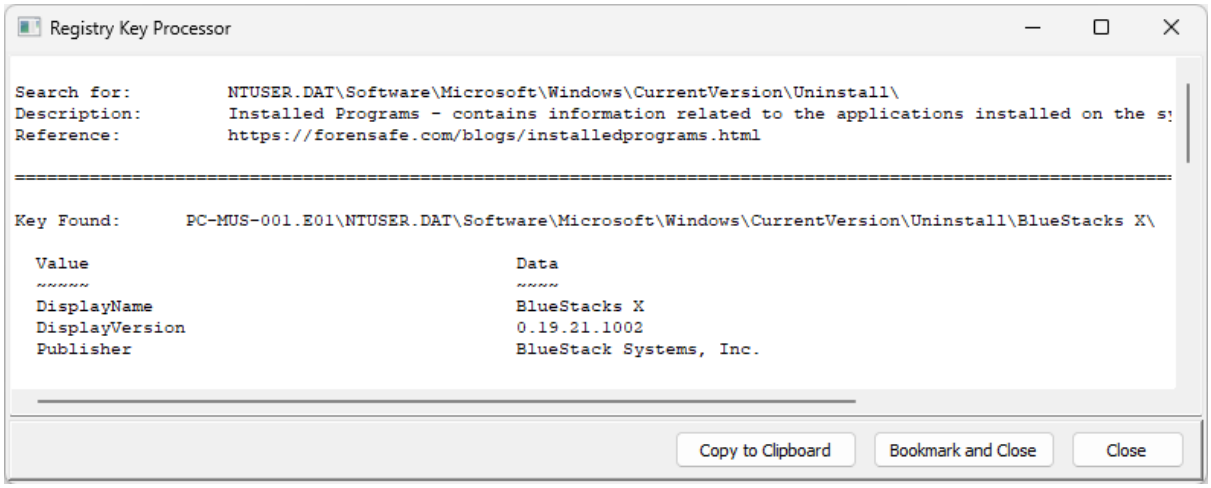
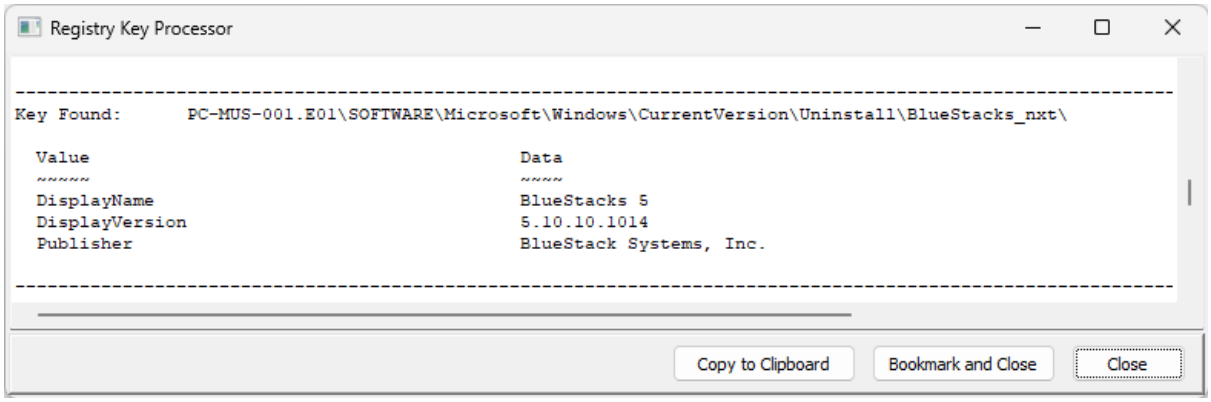
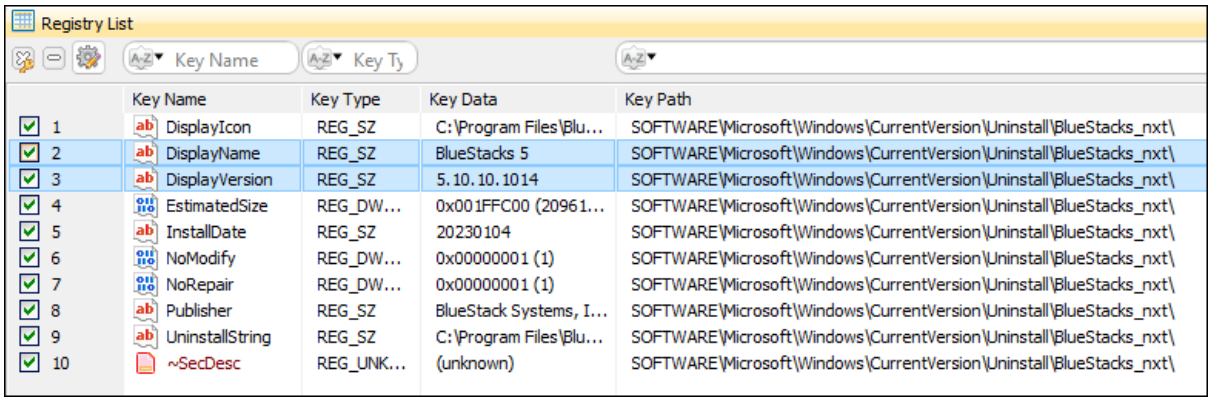


Figure 14: Output from Registry > SOFTWARE Hive > Uninstall Programs (metadata)



Once registry key names have been identified, it is possible to branch plate the entire Registry module and then use filtering techniques to read individual keys and their contents.

Figure 15: Registry > DisplayName > BlueStacks 5



QUESTION 3 - LITENING FAST WRITE SPEEDS! (5 POINTS)

The user's system is equipped with a 256GB NVMe SSD. What is the make and model of this drive?

Q3. ANSWER

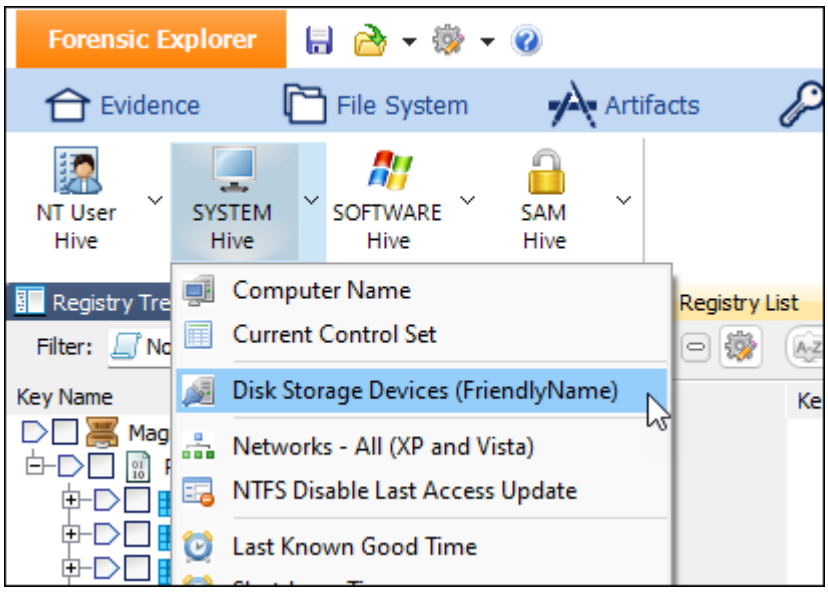
LITEON CA1-8D256-HP

Q3. FORENSIC EXPLORER METHODOLOGY

Disk storage information is held in the Windows registry, SYSTEM hive. For fast access select:

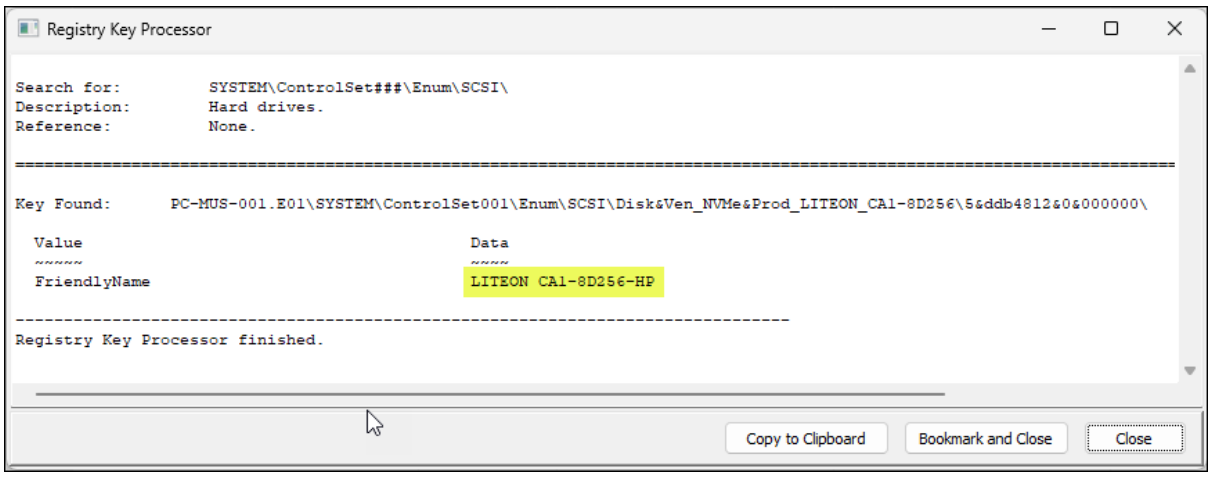
1. SYSTEM HIVE > Disk Storage Devices (Friendly Name).

Figure 16: Registry Module > System Hive > Disk Storage Devices (FriendlyName)



With the following output:

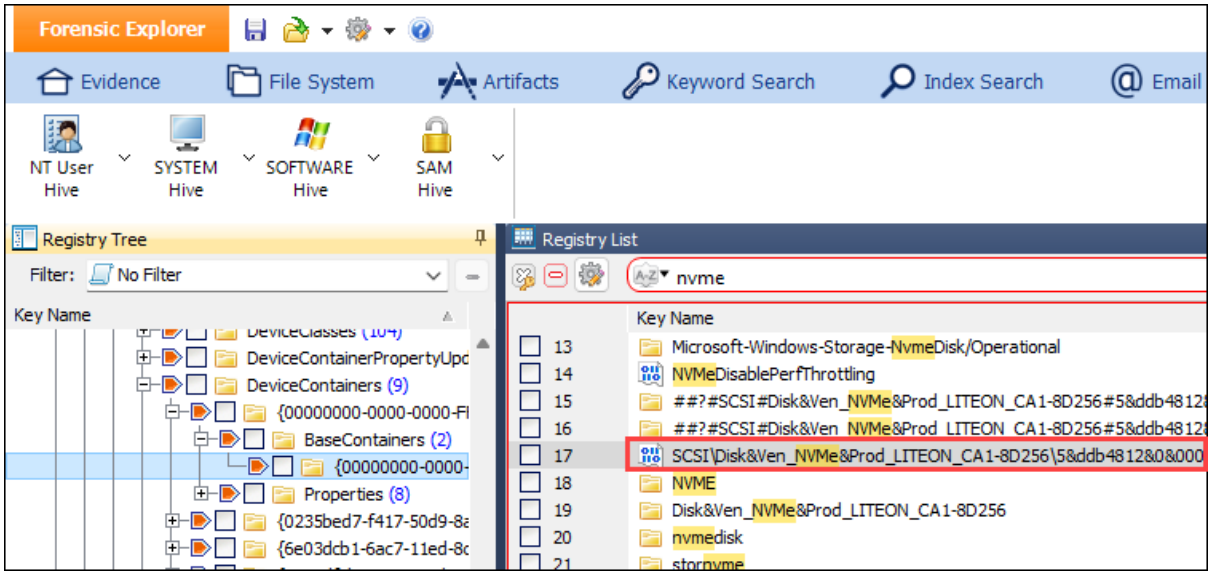
Figure 17: Registry Module > System Hive > Disk Storage Devices (FriendlyName) > Output



An alternative method is to:

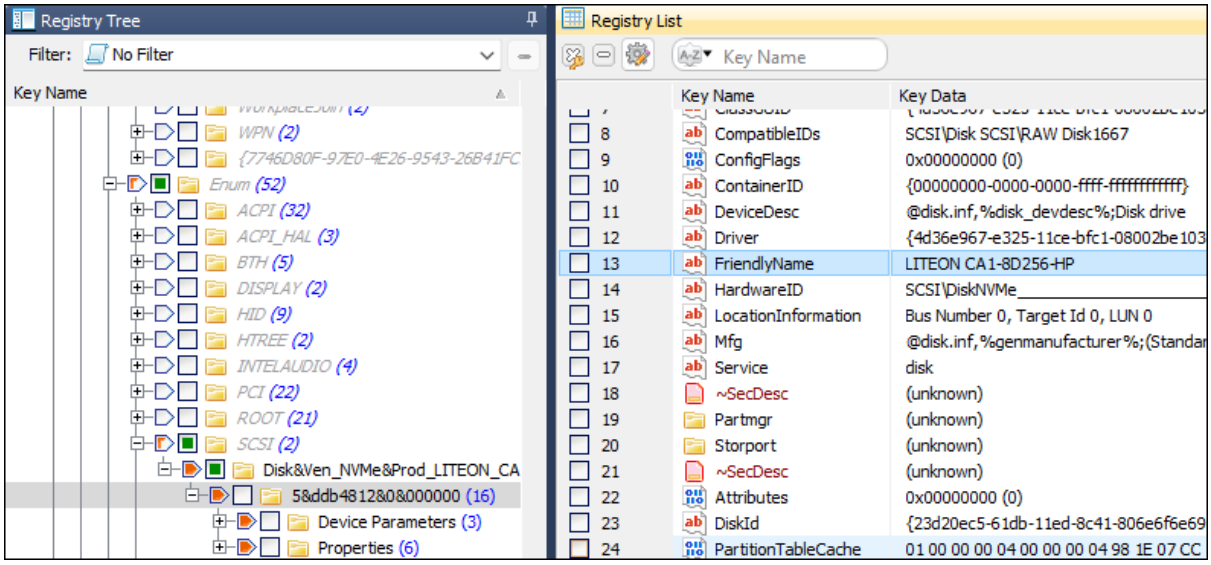
1. In the Registry module, branch plate the entire case so that all registry items are shown in the Registry List.
2. Use **nvme** (or other keywords) in the **Key Name** column filter.

Figure 18: Registry Module > Column Filter



Once the parent folder for the relevant registry key has been identified, it can be isolated with the Branch Plate and individual keys examined.

Figure 19: Registry Module > Branch Plate of SCSI folder



QUESTION 4 - REALLY...? PLAINTEXT...? (10 POINTS)

The user frequently accesses a Chrome Remote Desktop virtual machine. What password is used to log into this VM?

Q4. ANSWER

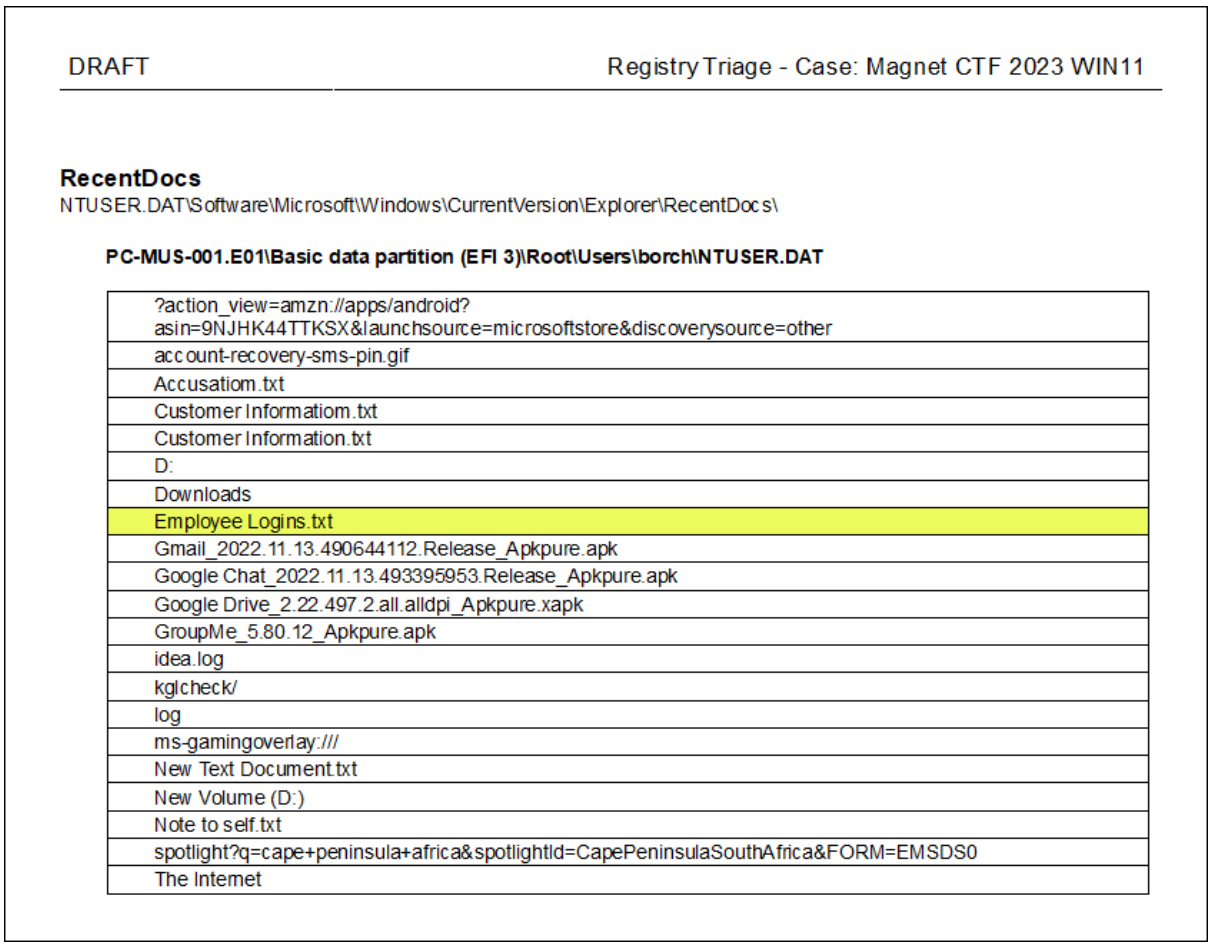
,a]JEU0yG^+]2O]

Q4. FORENSIC EXPLORER METHODOLOGY

Passwords are sometimes kept by users in non-secure formats like .txt files.

Most recently used documents is a fast way to establish recent activities of the user. **RecentDocs** information in the Report module > Triage Report lists one such file called **Employee Logins.txt**.

Figure 20: Reports > Triage Report > RecentDocs



DRAFT Registry Triage - Case: Magnet CTF 2023 WIN11

RecentDocs

NTUSER.DAT\Software\Microsoft\Windows\CurrentVersion\Explorer\RecentDocs\

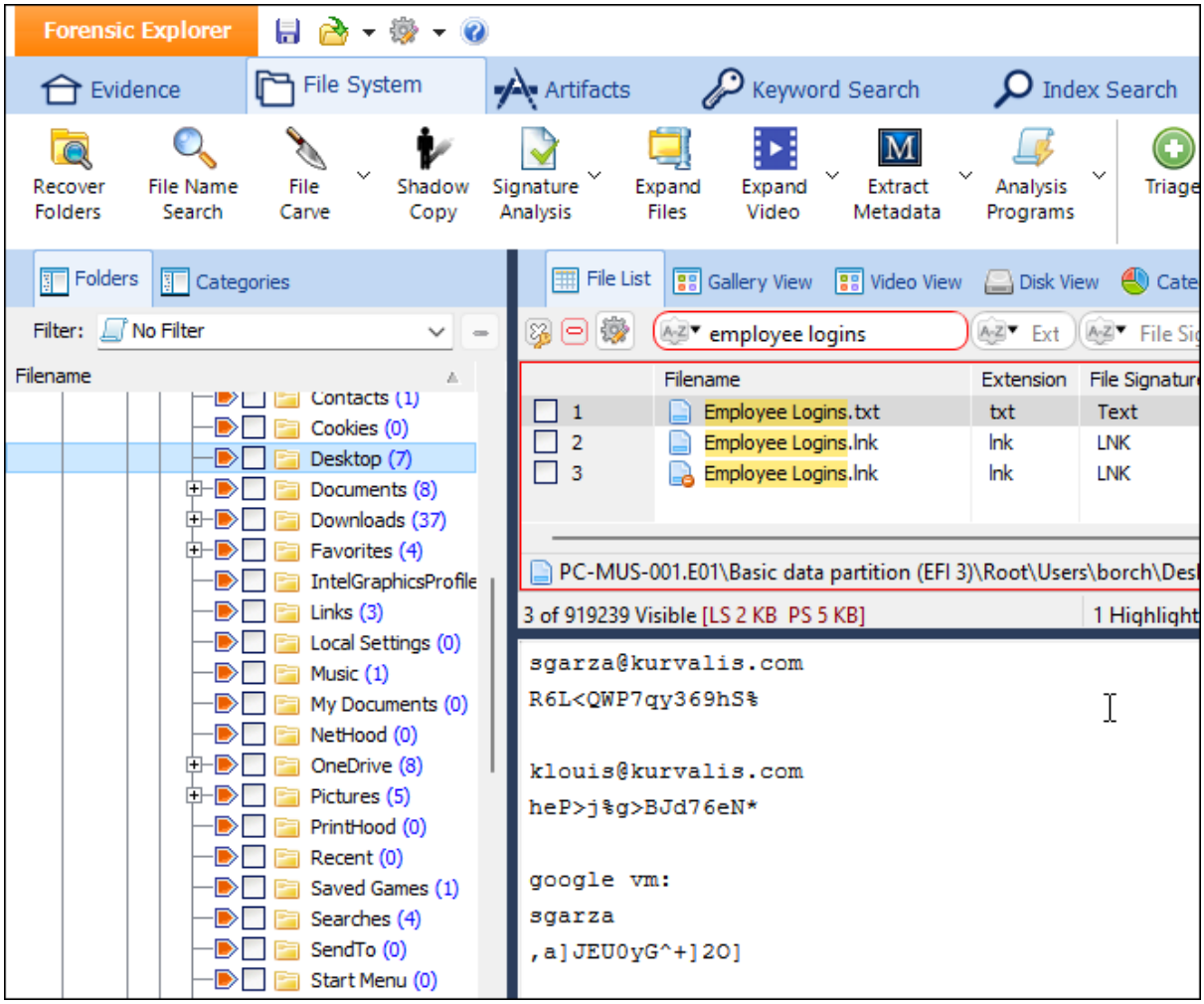
PC-MUS-001.E01\Basic data partition (EFI 3)\Root\Users\borch\NTUSER.DAT

?action_view=amzn://apps/android?asin=9NJHK44TTKSX&launchsource=microsoftstore&discoverysource=other
account-recovery-sms-pin.gif
Accusation.txt
Customer Informatiom.txt
Customer Information.txt
D:
Downloads
Employee Logins.txt
Gmail_2022.11.13.490644112.Release_Apkpure.apk
Google Chat_2022.11.13.493395953.Release_Apkpure.apk
Google Drive_2.22.497.2.all.alldpi_Apkpure.xapk
GroupMe_5.80.12_Apkpure.apk
idea.log
kglcheck/
log
ms-gamingoverlay:///
New Text Document.txt
New Volume (D:)
Note to self.txt
spotlight?q=cape+peninsula+africa&spotlightId=CapePeninsulaSouthAfrica&FORM=EMSDS0
The Internet

To locate this file in the Forensic Explorer File System module:

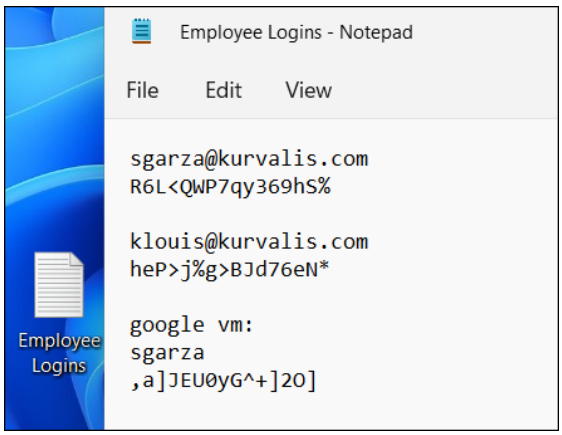
1. Branch Plate the entire case.
2. Use the **Filename** column filter tool to filter for **employee logins**.\
3. Use the **Display View** tab to show the contents of the file.

Figure 21: File System module > Filename column filter > employee logins



The presence of **Employee Logins.txt** was also identified on the desktop of the computer during the Live Boot process described in Preparing the Case in Forensic Explorer.

Figure 22: Live Boot Virtualization > Desktop > Employee Logins



QUESTION 5 - WHY WAS 6 AFRAID OF 7? BECAUSE 7 CAN UNARCHIVE VIRTUAL DRIVES! (10 POINTS)

Within the past 2 years, a popular unarchiving program gained the ability to unarchive VHDX virtual disk images. What version of the program was this upgrade implemented?

Q5. ANSWER

7-Zip - 21.07

Q5. FORENSIC EXPLORER METHODOLOGY

This question can be answered without use of the forensic image. A Perplexity AI query identified 7-Zip as the likely answer, which was confirm using the 7-Zip version history on their website.

Figure 23: Perplexity AI

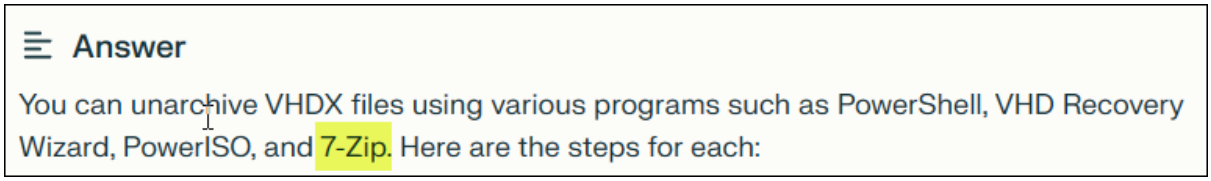


Figure 24: Perplexity AI

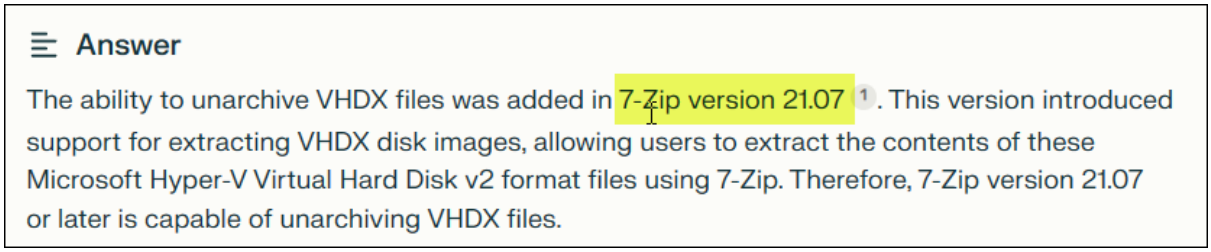
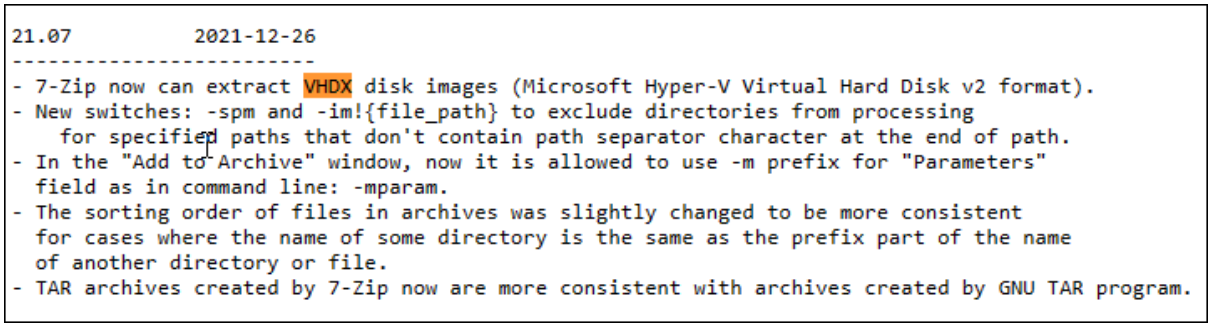


Figure 25: https://7-zip.org

Figure 26: https://7-zip.org/history.txt



```
21.07          2021-12-26
--------------------------
- 7-Zip now can extract VHDX disk images (Microsoft Hyper-V Virtual Hard Disk v2 format).
- New switches: -spm and -im!{file_path} to exclude directories from processing
    for specified paths that don't contain path separator character at the end of path.
- In the "Add to Archive" window, now it is allowed to use -m prefix for "Parameters"
  field as in command line: -mparam.
- The sorting order of files in archives was slightly changed to be more consistent
  for cases where the name of some directory is the same as the prefix part of the name
  of another directory or file.
- TAR archives created by 7-Zip now are more consistent with archives created by GNU TAR program.
```

QUESTION 6 - WE'RE NOT IN KANSAS ANYMORE... (25 POINTS)

The user has established an RDP connection to one destination more than any other. What is the Geolocation of this destination? (Format: City, ST)?

Q6. ANSWER

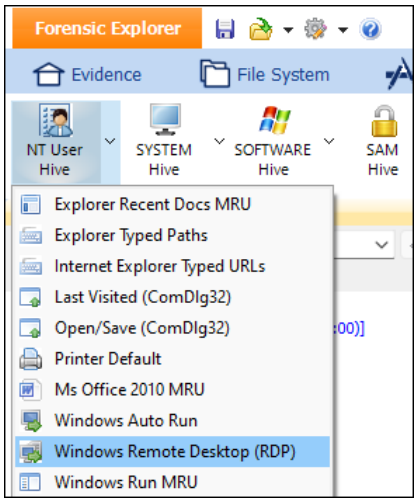
34.162.97.100 – Columbus, Ohio.

Q6. FORENSIC EXPLORER METHODOLOGY

Windows Remote Desktop (RDP) information is located in the Windows Registry.

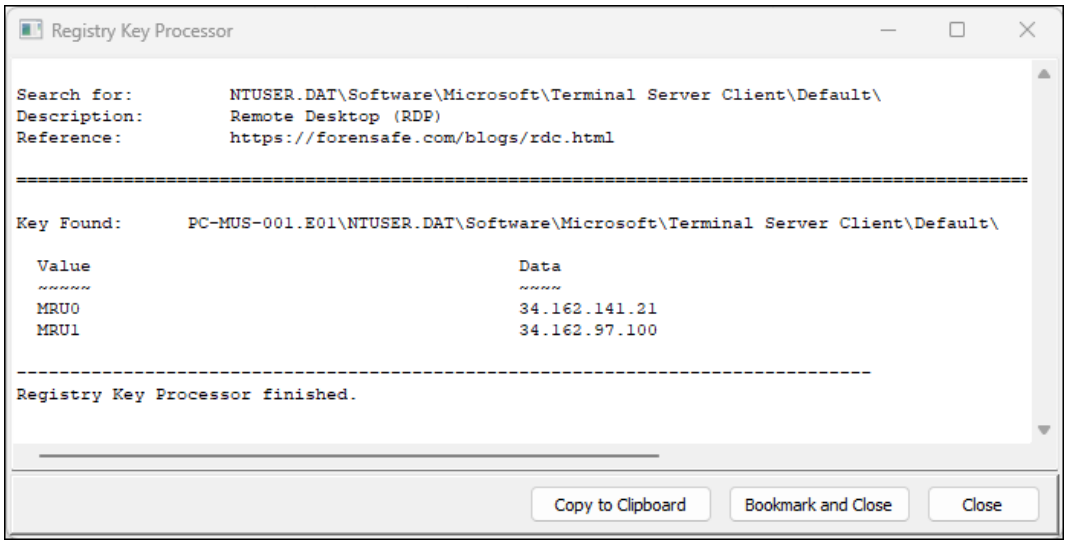
1. Select Registry > NT User Hive > Windows Remote Desktop (RDP).

Figure 27: Registry > NT User Hive > Windows Remote Desktop (RDP)



The following relevant I.P. addresses are identified.

Figure 28: Registry > NT User Hive > Windows Remote Desktop (RDP) output



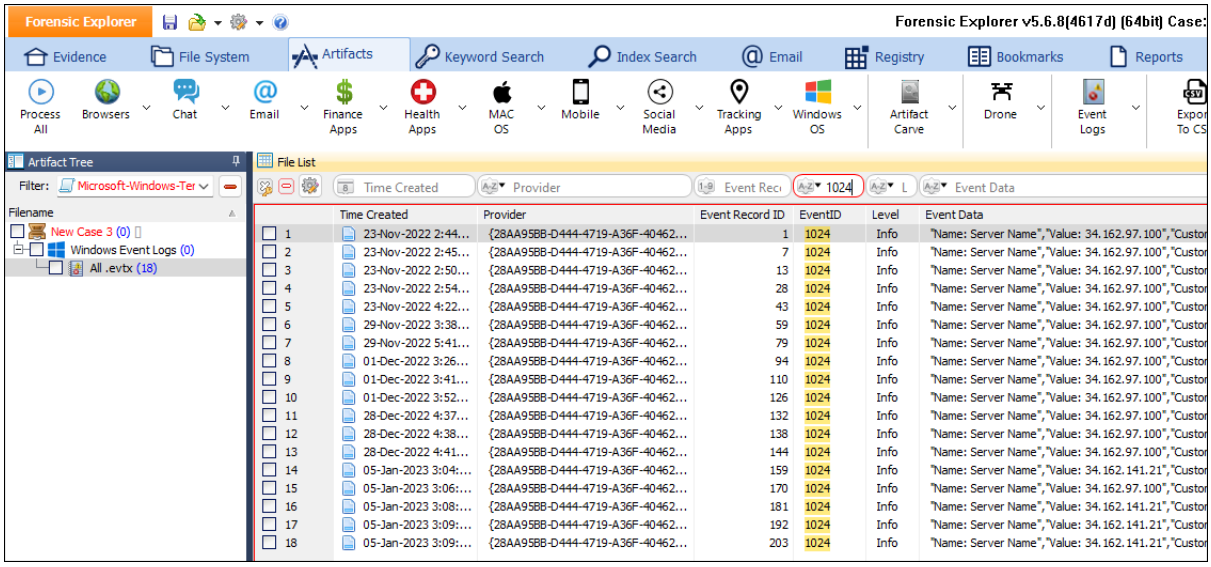
More detailed RDP information can be located in Windows Event Logs. The Windows event with ID 1024 is related to RDP (Remote Desktop Protocol) connections. It is generated when a user initiates an RDP connection using the RDP client MSTSC.exe in Windows by pressing 'connect'.

To filter RDP Event logs:

1. Switch to the **Artifacts module**.
2. In the **Artifact Tree**, select the drop-down filter **Microsoft-Windows-TerminalServices-RDPClient%4Operational.evtx.**
3. Or use **1024** in the **EventID** column filter.

The output shows the most frequent connection is to I.P. address 34.162.97.100.

Figure 29: Artifacts > Windows Event Logs > Folders and/or Column Filter > RDP Event ID 1024



Online I.P. address tracing tools can be used to determine the geographic location of the I.P. address.

Figure 30: Online IP Address tracking

QUESTION 7 - MAKE SURE TO KEEP SOME TABS ON THAT SYSADMIN FROM SOUTHERN CALIFORNIA (25 POINTS)

The user visited the Mastodon page of one user more than any others on the platform. What is the full legal name of the user Michael visited?

Q7. ANSWER

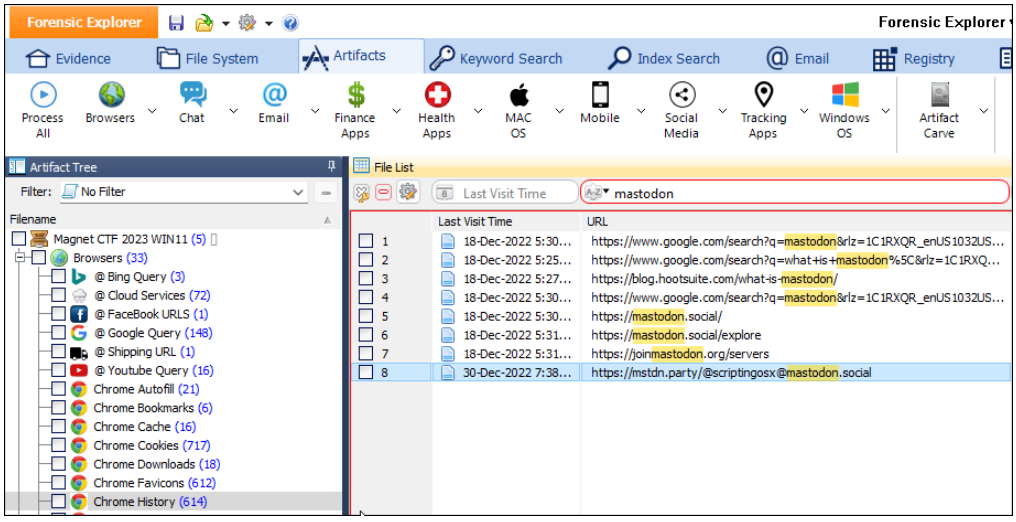
Armin Briegel

Q7. FORENSIC EXPLORER METHODOLOGY

This answer is found in the Artifacts module browsing history.

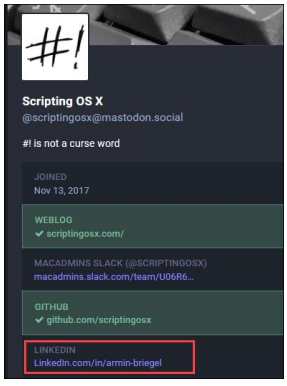
1. In the **Artifacts** module, select **Chrome History**.
2. In the **URL** column filter, search for **mastodon**.

Figure 31: Artifacts > Browsers > Chrome History



Right-click, **copy cell**, and paste the URL into a browser (https://mstdn.party/@scriptingosx@mastodon.social) reveals a LinkedIn profile on the page for Armin Briegel.

Figure 32: LinkedIn Profile - Armin Briegel



QUESTION 8 - WE HAVE A HISTORY OF ATTRACTING SOME SIZEABLE DONORS WITH OUR PROJECTS (25 POINTS)

Michael used PowerShell to clone a particular GitHub utility. What is the account name of one of this repo's most prominent sponsors?

Q8. ANSWER

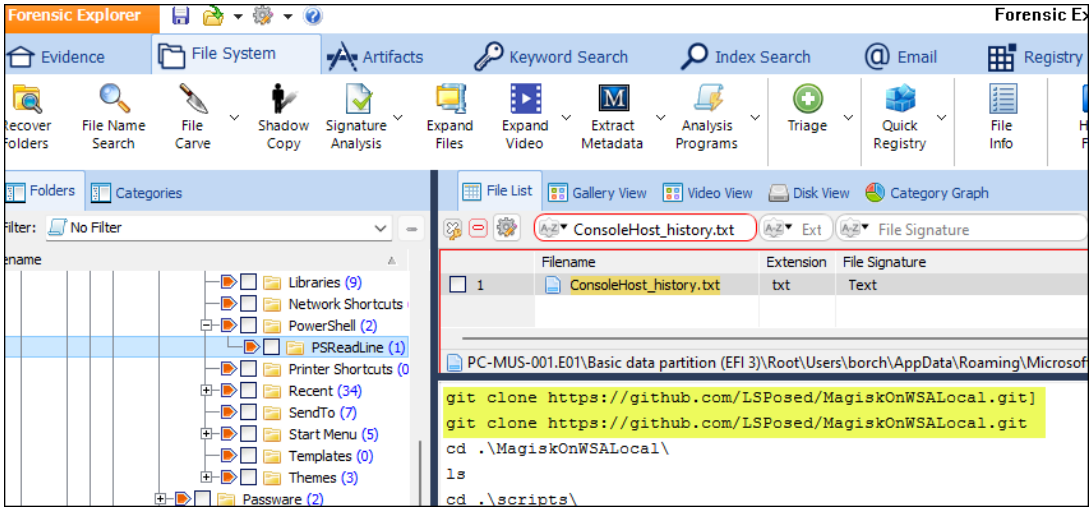
yujincheng08

Q8. FORENSIC EXPLORER METHODOLOGY

ConsoleHost_history.txt is a know artifact for PowerShell logs. Without this information, this file could also have been identified by running a Keyword Search or Index Search for **github** or similar keywords.

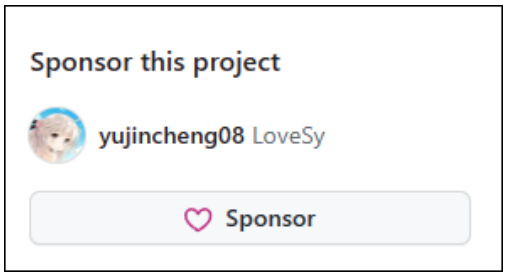
To locate **ConsoleHost_history.txt**:

1. In the **File System** module, branch place the entire case.
2. In the **Filename** column, apply the column filter **ConsoleHost_history.txt**.
3. Use the Display, Hex, or Text views to examine the file content.



Visiting the URL https://github.com/LSPosed/MagiskOnWSALocal.git identifies the sponsor of the page to be yujincheng08.

Figure 33: Page sponsor - https://github.com/LSPosed/MagiskOnWSALocal



QUESTION 9 - SCRATCH THAT ITCH.IO (25 POINTS)

The user viewed a YouTube video by the creator BenBonk surrounding video game developers. Within this video, how many developers were involved with the project?

Q9. ANSWER

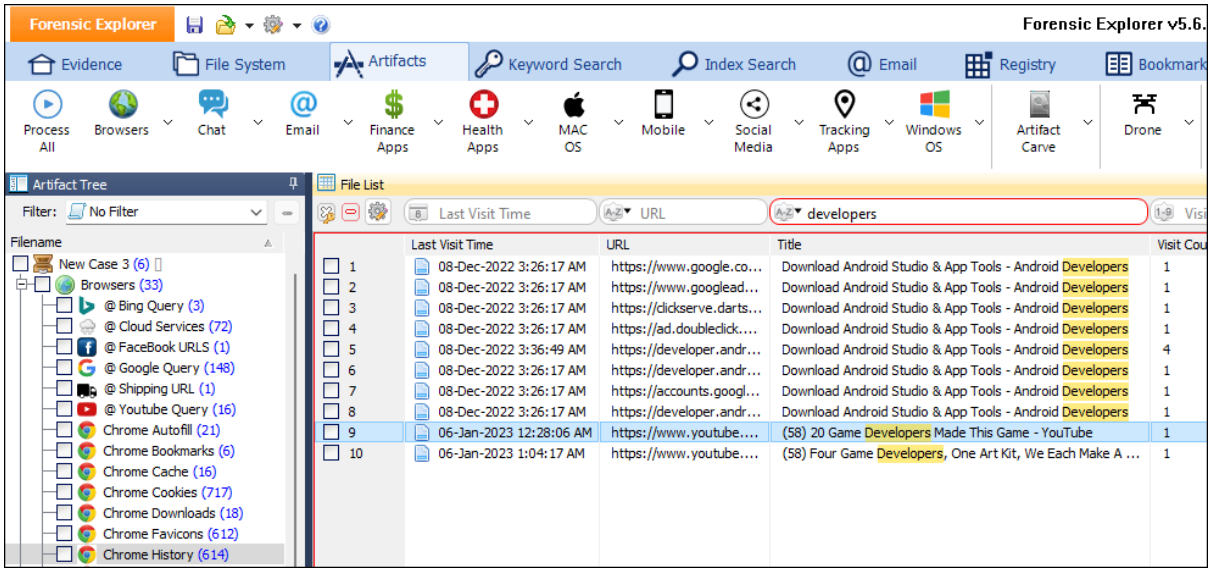
20.

Q9. FORENSIC EXPLORER METHODOLOGY

This answer is found in the Artifacts module browsing history.

1. In the **Artifacts** module, select **Chrome History**.
2. In the **Title** column filter, search for **developers**.

Figure 34: Artifacts > Browsers > Chrome History



Right-click, copy cell, and paste the URL into a browser (https://www.youtube.com/watch?v=EUDQoGL-Hnk) reveals the text **20 Game Developers Made This Game.**

Figure 35: URL - https://www.youtube.com/watch?v=EUDQoGL-Hnk

QUESTION 10 - THE BREAKFAST BELL IS RINGING (50 POINTS)

The user has been doing some research lately on fast food items. What is, according to some experts, the unhealthiest food item of the bunch?

Q10. ANSWER

breakfast crunchwrap sausage supreme

Q4. FORENSIC EXPLORER METHODOLOGY

From the wording of this question, 'user research' suggests web browsing, and 'breakfast bell' suggests Taco Bell. This answer is found in the Artifacts module browsing history.

1. In the **Artifacts** module, select **Chrome History**.
2. In the **Title** column filter, search for **bell**.

Figure 36: Artifacts > Browsers > Chrome History

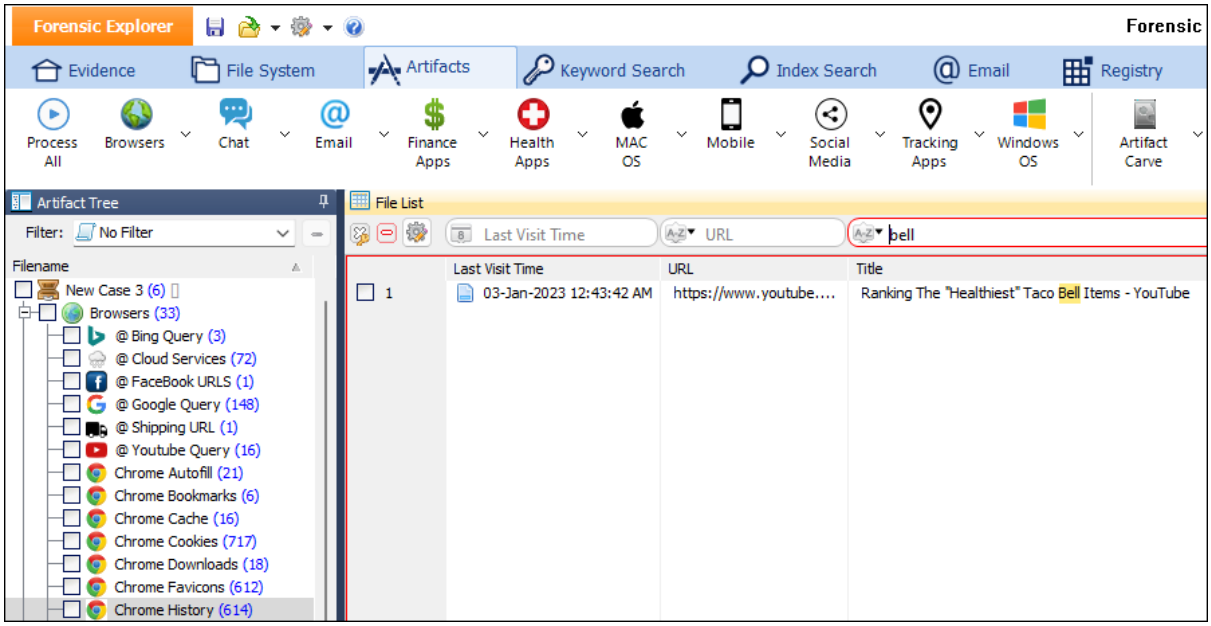


Figure 37: Ranking The "Healthiest" Taco Bell Items – YouTube (https://www.youtube.com/watch?v=u0V2kYuNOTc)

QUESTION 11 - OH DEER...I THINK WE'RE LOST (50 POINTS)

Michael lives just a mile south of a beautiful body of water. What is the name of this body of water?

Q11. ANSWER

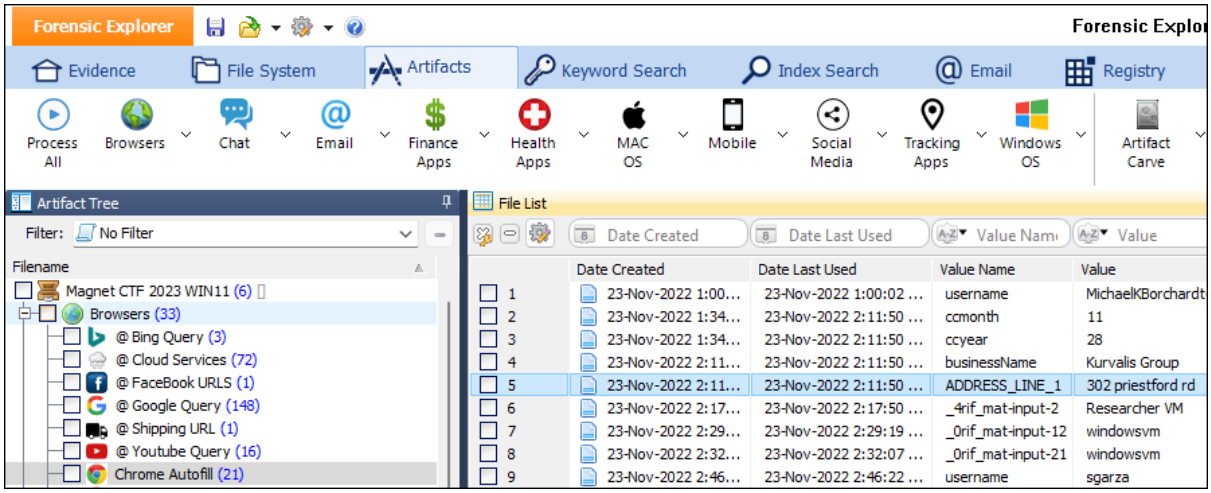
Deer Creek.

Q11. FORENSIC EXPLORER METHODOLOGY

A reliable artifact to find user home address information is the browser autofill, where uses auto complete web forms. To view autofill information:

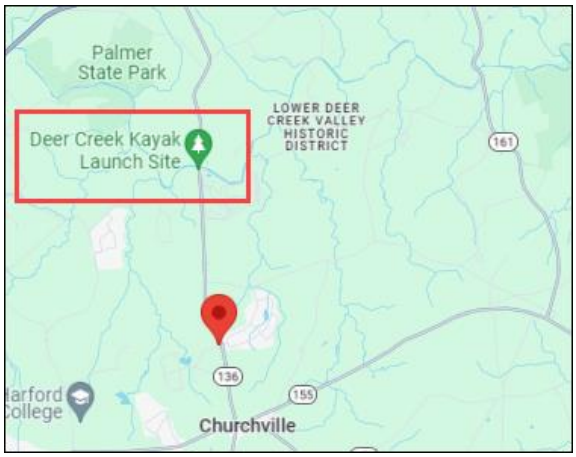
1. In the **Artifacts** module, select **Chrome Autofill**.
2. **ADDRESS_Line_1** of **302 preistford rd** is located.

Figure 38: Artifacts > Browsers > Chrome Autofill



Google Maps shows that the first body of water north of **302 preistford rd** is **Deer Creek**.

Figure 39: Google Maps - 302 preistford rd



QUESTION 12 - GOTTA GIT GOING FAST WITH SOME ACCELRATED EMULATION! (50 POINTS)

In order to emulate an Android device, the user required some specialized management tools. What Android port is used by default with these services?

Q12. ANSWER

58526

Q12. FORENSIC EXPLORER METHODOLOGY

The question suggests that there is emulation software has been installed on the PC. Similar to Question2, we can examine the software installed using the Report module triage report, and the source data in the Registry module. The candidate is **WSA PacMan version 1.3.6**:

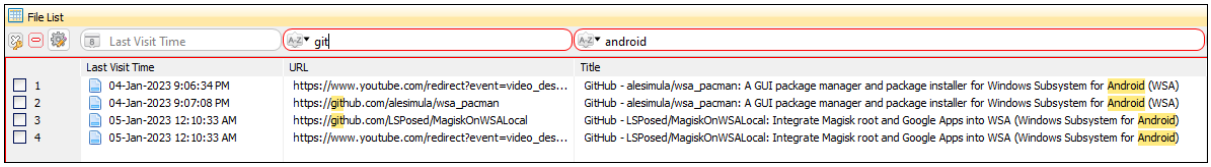
Figure 40: Registry > Uninstall Programs

PC-MUS-001.E01\Basic data partition (EFI 3)\Root\Windows\System32\config\SOFTWARE

7-Zip 22.01 (x64)
Android Studio
BlueStacks 5
Git
Intel® Hardware Accelerated Execution Manager
Microsoft Visual C++ 2022 X64 Additional Runtime - 14.31.31103
Microsoft Visual C++ 2022 X64 Minimum Runtime - 14.31.31103
WSA PacMan version 1.3.6

A check of browsing history in Artifacts > Chrome History and using a column filter for **git** and **android** give as match for **https://github.com/alesimula/wsa_pacman**.

Figure 41: Artifacts > Browsers > Chrome History



Right-click and copy the URL to a browser confirms the following information on the Git page:

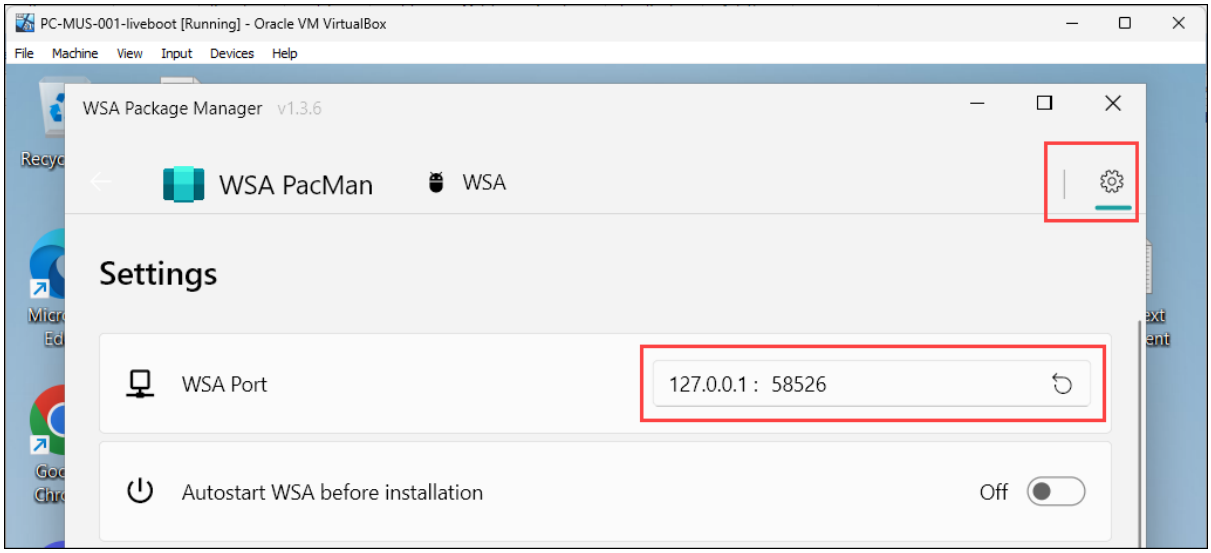
Figure 42: https://github.com/alesimula/wsa_pacman

About

A GUI package manager and package installer for Windows Subsystem for Android (WSA)

In Live Boot virtualization, WSA PacMan is launched and the WSA Port is identified in the Settings window:

Figure 43: Live Boot virtualization - WSA PacMan



QUESTION 13 - PCA - PROGRAM CLANG ASSISTANT? (100 POINTS)

The user has installed Android Studio with a specialized plugin dedicating to diagnosing and fixing some programming errors. When this plugin runs, what exit code is used upon completion?

Q13. ANSWER

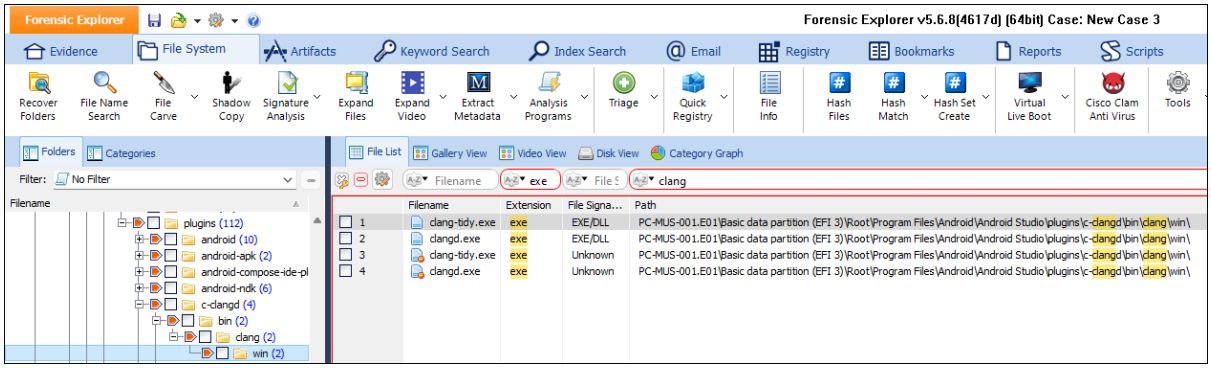
0xc0000135

Q13. FORENSIC EXPLORER METHODOLOGY

The keyword **clang** provided the most unique entry point to search for files related to this question.

The entire case was branch plated, and then **exe** files were filtered with **clang** in the file path. This identified the potential candidate **clang-tidy.exe**.

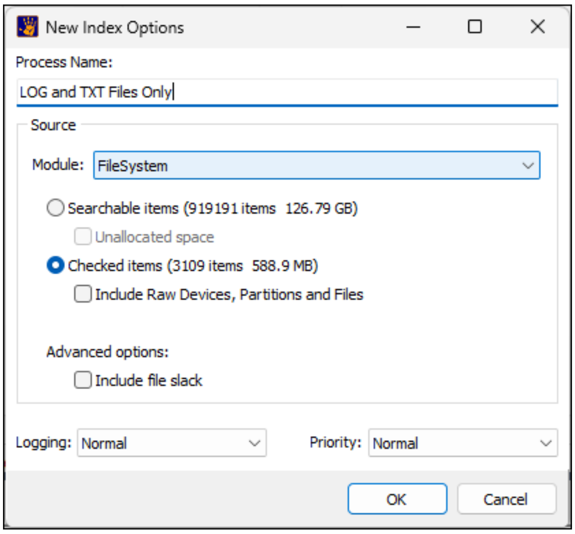
Figure 44: File System column filter for .exe files with 'clang' in the path



With the knowledge that application exit codes are usually written to associated **.log** or **.txt**, an **Index Search** was created for just those file types:

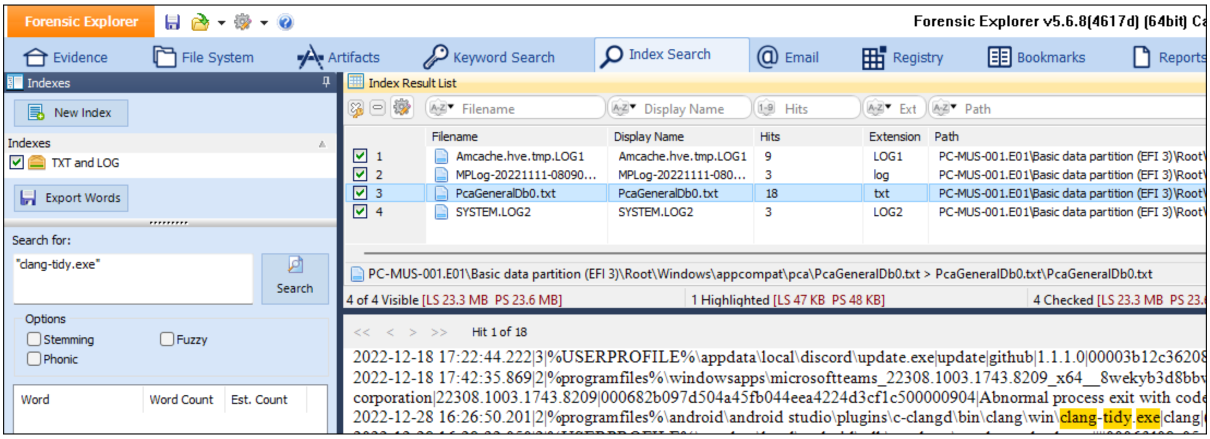
1. In the File System module **branch plate** the **entire case**.
2. Right-click in the **File System module Folder Tree** and **Clear All Checks**.
3. In the Extension column, change the column filter type to **Regex** and filter for **log|txt** (log or txt files). 3109 files are located.
4. Click **Ctrl A** in the **File List** view to highlight all 3019 files.
5. Press **Space Bar** to place a checkmark in all 3019 items.
6. In the **Index Search** module, create a **New Index**.
7. Index only the **checked items**.

Figure 45: Index Search module > New Index > LOG and TXT only > Checked Items



Once indexed, a search for **"clang-tidy.exe"** identified a log file called **PcaGeneralDb0.txt**.

Figure 46: Index Search results



This log file reveals the exit code to be: 0xc0000135.

Figure 47: PcaGeneralDb0.txt

```
\clang-tidy.exe|clang|(|14.0.0 (llvm 14.0.0git)|000623406514916fe8a730bb66e71c60028500000904|Abnormal process exit with code 0xc0000135
\clang-tidy.exe|clang|(|14.0.0 (llvm 14.0.0git)|00003dc162e21f8e083201c5f6999a10e97d0000ffff|Abnormal process exit with code 0xc0000135
\clang-tidy.exe|clang|(|14.0.0 (llvm 14.0.0git)|00003dc162e21f8e083201c5f6999a10e97d0000ffff|Abnormal process exit with code 0xc0000135
\clang-tidy.exe|clang|(|14.0.0 (llvm 14.0.0git)|00003dc162e21f8e083201c5f6999a10e97d0000ffff|Abnormal process exit with code 0xc0000135
\clang-tidy.exe|clang|(|14.0.0 (llvm 14.0.0git)|00003dc162e21f8e083201c5f6999a10e97d0000ffff|Abnormal process exit with code 0xc0000135
\clang-tidy.exe|clang|(|14.0.0 (llvm 14.0.0git)|00003dc162e21f8e083201c5f6999a10e97d0000ffff|Abnormal process exit with code 0xc0000135
```