COMP6845 Report 1

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Term 2, 2024

Contents

1 Introduction

1.1 Background

1.1.1 Jim's Forensics (JF) have been engaged by Penelope Legal (PL) in relation to proceedings with Caelus Engineering (CE).

1.1.2 On the 14^{th} of September, 2021, PL instructed JF by letter containing a series of instructions on which we were to proceed.

1.2 My instructions

1.2.1 As a result of the above engagement, on the 14^{th} of September, 2021, PL advised me to prepare a report addressing the following issues:

(a) **Question 1** - Does the data on the laptop provide any indications regarding the reason for its destruction and disposal? If so, what?

(b) **Question 2** - Is there any indication of an attempt to "cover tracks", such as deleting or obscuring data?

(c) **Question 3** - Is there any indication of hidden data, *i.e.*, encryption? If so, are you able to make the data usable?

(d) **Question 4** - Any other matters that are relevant to the use or misuse of the laptop?

(e) **Question 5** - Has the additional information changed opinions on the events which occurred?

(f) **Question 6** - Your recommendation regarding any further enquiries and examinations that needed to be conducted.

1.3 Provided materials

1.3.1 We are provided the following materials from which we are to base our investigations on:

(a) a raw image of the hard disk of Alyx Hamilton's laptop,

(b) a photo of the collection site, and

(c) profiles of the staff at Caelus Engineering.

1.4 Qualifications

1.4.1 I am a second year computer science student at the University of New South Wales, currently enrolled in the COMP6845 course, otherwise known as *Extended Digital Forensics*.

1.5 Information relied upon

1.5.1 I have relied upon the following information in the preparation of my report:

(a) a letter containing instructions addressed to JF dated 14^{th} of September, 2021,

(b) a second letter containing further instructions addressed to JF,

(c) an image of the storage of the laptop used by Alyx Hamilton,

(d) a dump of the memory of the laptop used by Alyx Hamilton,

(e) copies of the logs of the email correspondence of Alyx Hamilton and Michael Harris,

(f) a copy of the network traffic capture data from Alyx Hamilton's laptop, as well as a log of the TLS keys necessary to decrypt the data,

(g) a screenshot of the CCTV overlooking the entry gates at Caelus Engineering,

(h) a copy of the logs of the entry and exit of personnel from the gates at Caelus Engineering,

(i) a photo of the collection site, and

(j) profiles of the staff at Caelus Engineering.

1.6 Disclaimer

1.6.1 I have made all inquiries which I believe are desirable and appropriate for the purposes of this report. There are no matters of significance which I regard as relevant to my opinions which have been withheld.

1.6.2 This report has been prepared solely for the use of PL. In accordance with the usual practice of JF, I expressly disclaim all responsibility to any other person or entity (other than the Court) for any reliance on the content of this report. This report should not be copied or distributed to any other person or entity, other than in connection with the above matter.

1.7 Assumptions

1.7.1 In preparing this report, I have made the following assumptions:

(a) the information described in the background section above is accurate, and

(b) the computers identified by CE, and subsequently imaged, were used by Alyx Hamilton.

1.8 Structure of this report

1.8.1 The remaining sections of this report addresses the following:

(a) In Section 2, I set out information with respect to Question 1 above;

(b) In Section 3, I set out information with respect to Question 2 above;

(c) In Section 4, I set out information with respect to Question 3 above;

(d) In Section 5, I set out information with respect to Question 4 above;

(e) In Section 6, I set out information with respect to Question 5 above;

(f) In Section 7, I set out information with respect to Question 6 above;

1.8.2 For convenience, I note that I have organised my findings in the same order as the questions outlined in my letter of instruction. I have also included questions, in some instances paraphrased, from the letter of instruction before presenting my corresponding findings. Additionally, I have referred to the appropriate section number as contained in the letter of instruction in my responses.

1.9 Code of conduct

1.9.1 I understand that my report is required for the purpose of proceedings in the Supreme Court of New South Wales. Accordingly, I confirm that I have read and agree to be bound by the Expert Witness Code of Conduct (Schedule 7) of the Uniform Civil Procedure Rules 2005 (NSW).

2 Question 1: Reason for destruction

2.1 Procurement and extraction of evidence

2.2 Extraction of evidence

2.2.1 This section describes the method with which the evidence laid out in the rest of this report is procured.

2.2.2 A disk image is a digital replica of the contents of a physical drive, including any unallocated space.

2.2.3 I note that there are no additional cryptographic hashes provided with the disk image, nor is the disk image formatted in a forensically admissible format (such as E01).

2.2.4 I extracted the information presented from this point onwards from the provided disk image using the Autopsy forensics toolkit.

2.3 Email

2.3.1 I note the existence of an email from `alyx.hamilton@caelusengineering.com.au` sent to the address `johndavis5891@gmail.com` at 2020-09-04 16:27:18 AEST with the subject: *"It's done"*. Some notable details include:

(a) The body of the email contains only the following line: *"The files are copying over as we speak. What should I do now? Where do I meet you?"*.

(b) The email is found on the `\\Root - Mailbox\IPM_SUBTREE\[Gmail]\Bin`.

(c) This email is the only correspondence found between Alyx Hamilton and `johndavis5891@gmail.com`.

(d) This email is the last email found on the disk image of Alyx Hamilton's laptop

2.4 Accessing Google Drive

2.4.1 Some of the most web history on the device displays the rapid access of various pages in the Google Suite. These are briefly listed in Table 1

2.5 Attached USB drives

2.5.1 Table 2 details the make, model, and ID of two external USB drives that are recorded to have been connected to this device, as well as the time they were attached.

Table 1: Google Drive URLs accessed

Date accessed	Title	URL
2020-09-04 14:31:21 AEST	PROJECTS 19:20 - Google Drive	https://drive.google.com/drive/folders/1S7ETsR
2020-09-04 14:27:57 AEST	Shared Drive - Google Drive	https://drive.google.com/drive/folders/1sinCWR
2020-09-04 14:27:55 AEST	Shared with me - Google Drive	https://drive.google.com/drive/shared-with-me

Table 2: List of attached external USB drives

No.	Device make	Device model	Device ID	Date/Time
1	SanDisk Corp.	Cruzer Blade	4C530300831216101192	2020-09-04 10:11:55 AEST
2	SanDisk Corp.	Product: 55A5	4C530000050910115114	2020-09-04 15:50:09 AEST

2.6 Discussion

The email found on 2.2.1 appears to be suspicious from multiple aspects. The most noticeable among which is its cryptic language. Furthermore, the recipient is not an address within Caelus Engineering, nor is it one which otherwise appears in other emails in Alyx Hamilton's mailbox. Lastly, the email is found in the `Bin` directory, which indicates attempts at hiding it.

The web activity discussed in 2.3.1 were also found to be within temporal proximity of the email discussed above. They directly precede the web history entry belonging to said email. The site accessed, belonging to "Google Drive" and "Google Docs", are benign, but may be used as a method of exfiltrating data.

Likewise, the external USB devices that are noted to have been connected to the device in 2.4.1 are occurences that are otherwise benign, but may be used as a method of exfiltrating data.

3 Question 2: Covering tracks

3.1 Deleted email

3.1.1 The email discussed previously in 2.2.1 was found on the folder `\\Root - Mailbox\IPM_SUBTREE\[Gmail]\Bin`, which indicates an attempt at deleting the email.

3.2 Deleted project archives

3.2.1 ZIP archives containing what appears to be project files appear to have been deleted and are found in the 'Recycle Bin', as can be seen in Figure 4 in the appendix.

4 Question 3: Encryption

4.1 Introduction

4.1.1 The NIST[1] defines "encrypt" as to "cryptographically transform data to produce cipher text".

(a) The NIST[2] further defines "cryptography" as "the discipline that embodies the principles, means, and methods for the transformation of data in order to hide their semantic content, prevent their unauthorized use, or prevent their undetected modification".

(b) The NIST[3] further defines "cipher text" as "data in its encrypted form".

4.1.2 Encryption can therefore be defined as the transformation of data in order to ensure its secrecy and integrity.

[1]NIST, "encrypt," in Glossary | CSRC. [Online]. Available: https://csrc.nist.gov/glossary/term/encrypt. [Accessed: 22-Jul-2024].

[2]NIST, "cryptography," in Glossary | CSRC. [Online]. Available: https://csrc.nist.gov/glossary/term/cryptography. [Accessed: 22-Jul-2024]

[3]NIST, "cipher text," in Glossary | CSRC. [Online]. Available: https://csrc.nist.gov/glossary/term/cipher_text. [Accessed: 22-Jul-2024]

4.1.3 Encryption is a virtually ubiquitous feature of modern computing technology, as its nature of providing secrecy has a wealth of uses, whether benign (such as protecting one's financial information when performing a transaction online) or malicious (such as obscuring evidence of illegal activities).

4.2 Network encryption

4.2.1 A pcap, or *packet capture* file, is a file which stores network packet data. Such a file is typically procured by capturing the packets which passes through a device (note that this does not necessarily mean that every packet captured involves said device). Such a file logs all network communication that said device "hears".

(a) A "packet" is a small segment of a larger message, which are sent through computer networks, and are recombined by the recipient to obtain the whole message.[4]

4.2.2 JF is provided the pcap file procured from Alyx Hamilton's laptop by CE.

4.2.3 A cryptographic hash (using the MD5 algorithm) is provided alongside the pcap file. The calculated hash of the pcap file appears to match the provided hash, as can be seen in Figure 5. Assuming that the integrity of the file containing the provided hash is maintained, this means that the pcap file has not been tampered with throughout the span of time between the calculation of the provided hash and the time of verification.

4.2.4 Secure Sockets Layer (SSL), as well as its successor, Transport Layer Security (TLS), are protocols for encrypting, securing, and authenticating communications that take place on the internet.[5] It is used to ensure the secrecy and authenticity of communication over the internet.

4.2.5 Because the pcap file contains packets encrypted using SSL, a log of the SSL keys necessary to decrypt them is also provided to JF by CE. A cryptographic hash of the log is also provided, and the calculated hash of the log file appears to match that of the provided hash, as can be seen in Figure 6. Similar to the pcap file, this means that the pcap file has not been tampered with throughout the span of time between the calculation of the provided hash and the time of verification, assuming that the integrity of the file containing the provided hash is maintained.

4.2.6 Wireshark is a network traffic analyser.[6] It is a tool that can be used to capture packets from the host device's network interface, creating a pcap file, and analysing pcap files.

(a) The pcap file can be accessed in Wireshark by clicking `File > Open` on the top menu bar, and then selecting the file from the resulting file explorer dialog.

(b) After opening the pcap file, the SSL key log can be imported by selecting `Edit > Preferences` on the top menu bar, selecting `Protocols > TLS` on the preferences menu, and then clicking the the `Browse` button underneath `(Pre)-Master-Secret log filename` and selecting the SSL key log file, as can be seen in Figure 7.

4.2.7 Quick UDP Internet Connections (QUIC) is an encrypted-by-default transport protocol originally developed by Google[7] that is supported by the Google Chrome web browser, beginning small-scale deployments of the original implementation, gQUIC in 2013, and eventually default-enabling its successor, IETF QUIC in 2021 with Chrome 93.[8]

4.2.8 I note that the version of Google Chrome running on Alyx Hamilton's laptop is 84. This can be found by extracting the list of DLLs from Google Chrome processes found on the memory dump using Volatility, as can be seen in Figure 8. Two points of observation can be drawn from this:

(a) It does not appear to be possible to decrypt the QUIC packets sent to and from Google Chrome in the provided pcap file, because the export of QUIC secrets is only available on version 89 onwards of Google Chrome.[9]

[4] Cloudflare, "What is a Packet?" Cloudflare. Available: https://web.archive.org/web/20240622023826/https://www.cloudflare.com/learning/netw layer/what-is-a-packet/. [Accessed: 22-Jul-2024].

[5] Cloudflare, "How does SSL work?" Cloudflare. [Online]. Available: https://www.cloudflare.com/learning/ssl/how-does-ssl-work/. [Accessed: 22-Jul-2024].

[6] Wireshark Foundation, "Wireshark," GitLab. [Online]. Available: https://gitlab.com/wireshark/wireshark. [Accessed: 22-Jul-2024].

[7] A. Ghedini, "The Road to QUIC," Cloudflare Blog. [Online]. Available: https://blog.cloudflare.com/the-road-to-quic. [Accessed: 22-Jul-2024].

[8] Chromium Project, "QUIC, a multiplexed transport over UDP," Chromium. [Online]. Available: https://www.chromium.org/quic/. [Accessed: 22-Jul-2024].

[9] Wireshark Foundation, "The TLS/QUIC sessions can't be decrypted," GitLab. [Online]. Available: https://gitlab.com/wireshark/wireshark/-/issues/17111. [Accessed: 22-Jul-2024].

(b) It appears that the use of QUIC is manually enabled on the Google Chrome browser running on Alyx Hamilton's laptop, as the protocol is only enabled by default from version 93 onwards of Google Chrome.

5 Appendix

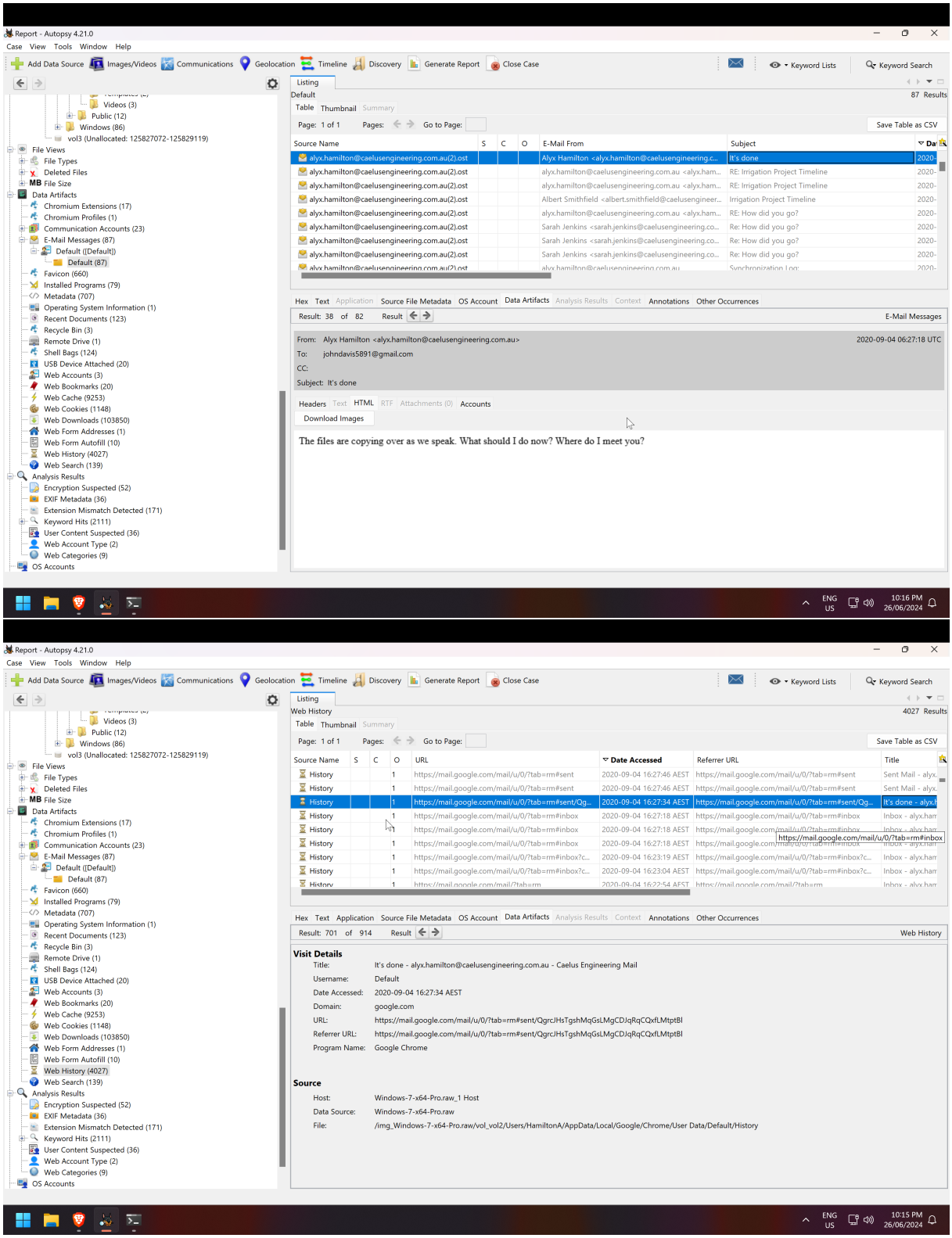


Figure 1: Cryptic email

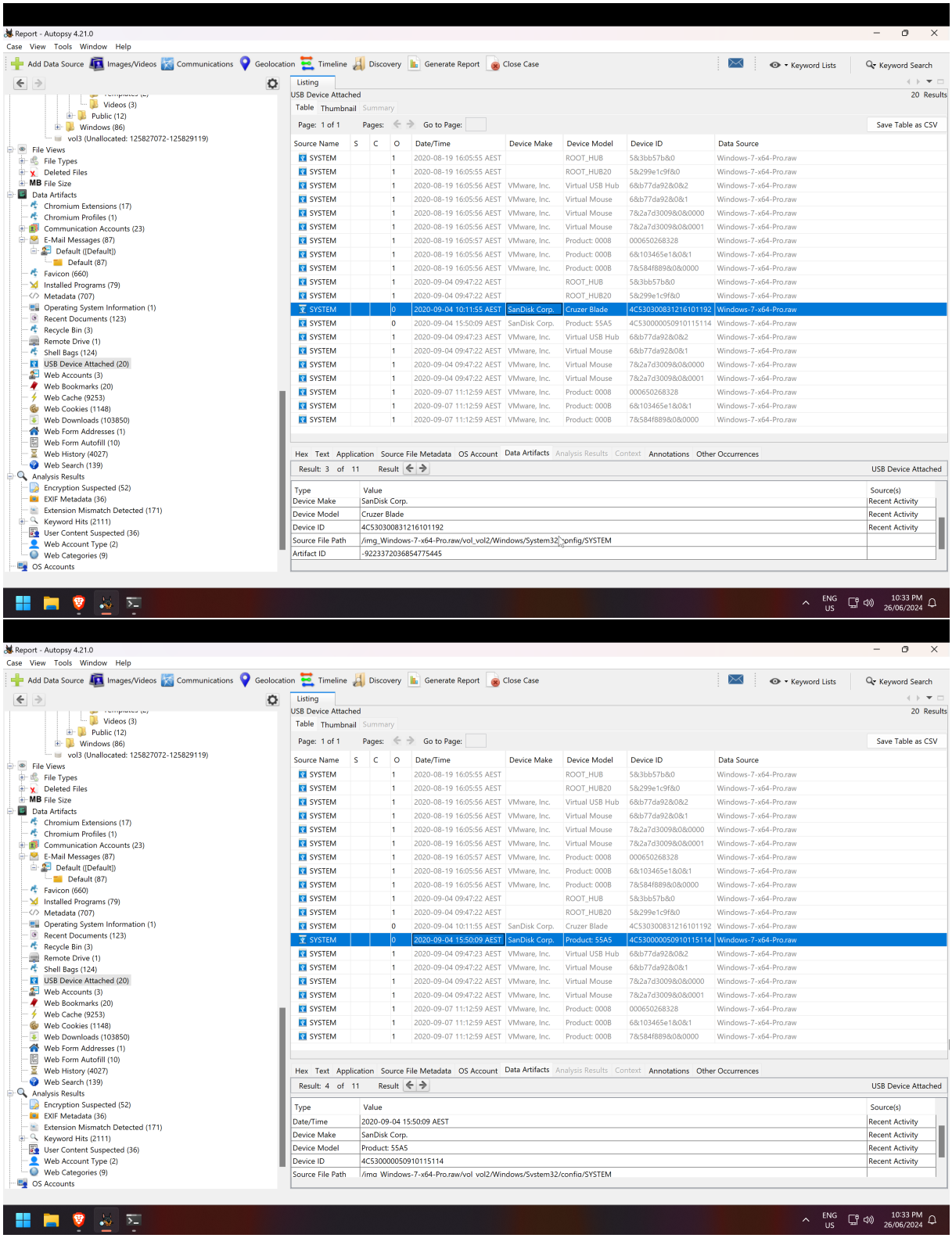
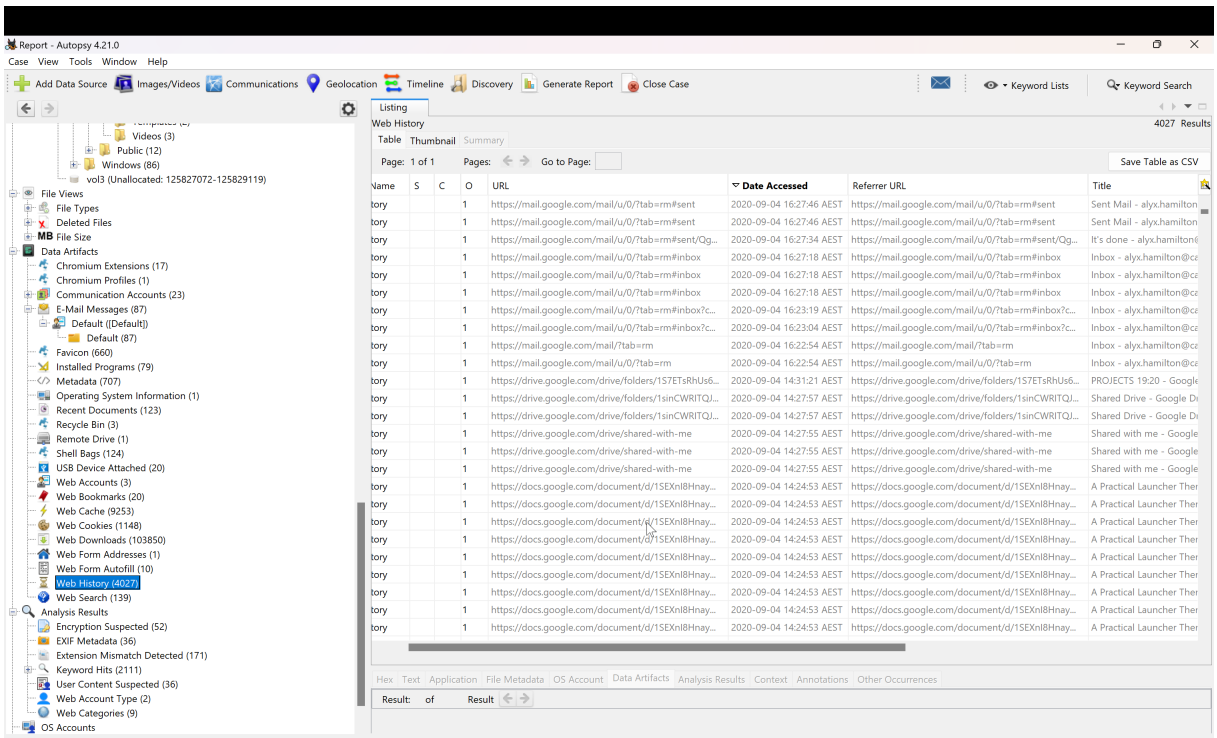


Figure 2: Attached USB drives


Report - Autopsy 4.21.0
Case View Tools Window Help
Add Data Source Images/Videos Communications Geolocation Timeline Discovery Generate Report Close Case
Keyword Lists Keyword Search
Listing
Web History
4027 Results
Table Thumbnail Summary
Page: 1 of 1 Pages: Go to Page:
Save Table as CSV
Name S C O URL Date Accessed Referrer URL Title
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Result: of Result
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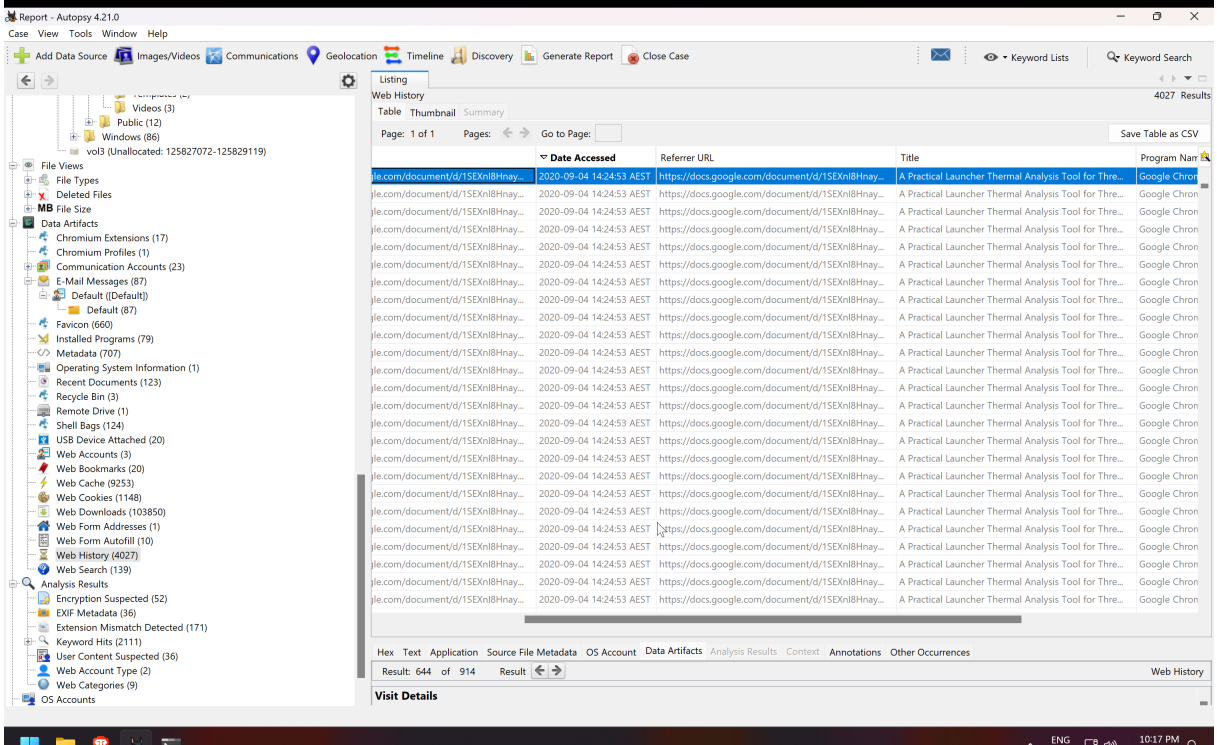
Report - Autopsy 4.21.0
Case View Tools Window Help
Add Data Source Images/Videos Communications Geolocation Timeline Discovery Generate Report Close Case
Keyword Lists Keyword Search
Listing
Web History
4027 Results
Table Thumbnail Summary
Page: 1 of 1 Pages: Go to Page:
Save Table as CSV
Date Accessed Referrer URL Title Program Name
Hex Text Application Source File Metadata OS Account Data Artifacts Analysis Results Context Annotations Other Occurrences
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Web History
Visit Details
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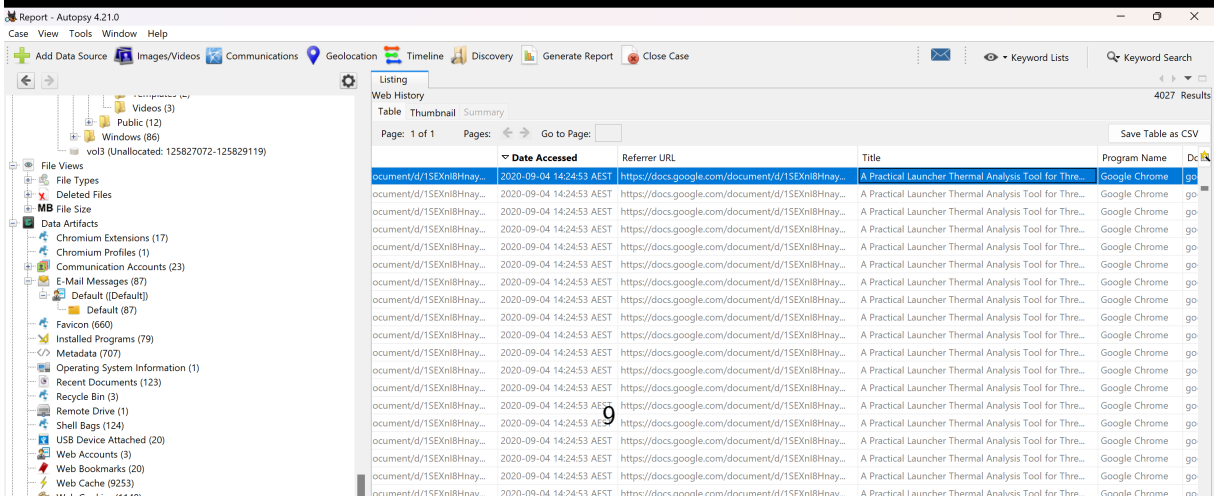
Report - Autopsy 4.21.0
Case View Tools Window Help
Add Data Source Images/Videos Communications Geolocation Timeline Discovery Generate Report Close Case
Keyword Lists Keyword Search
Listing
Web History
4027 Results
Table Thumbnail Summary
Page: 1 of 1 Pages: Go to Page:
Save Table as CSV
Date Accessed Referrer URL Title Program Name

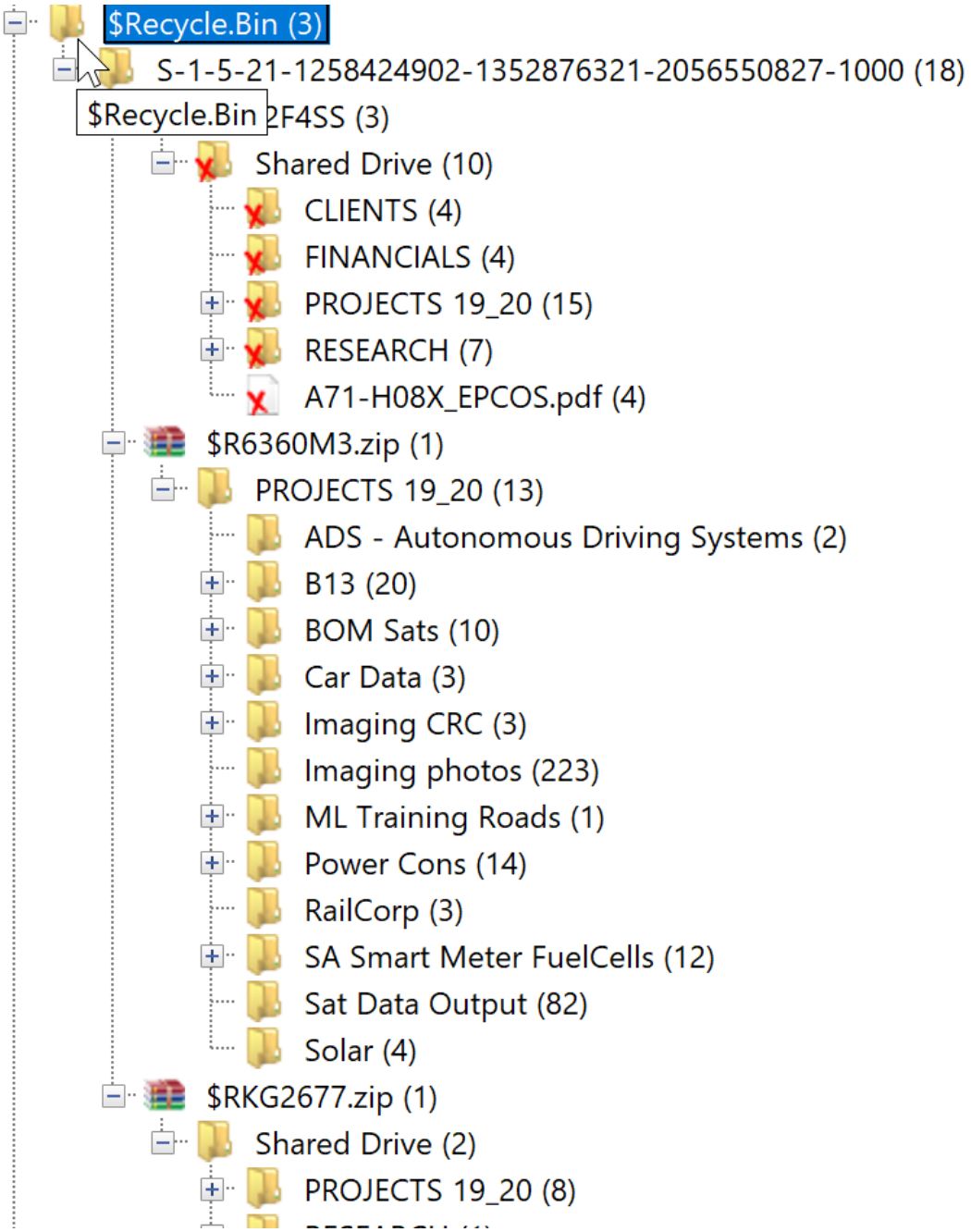

Figure 4: Recycling bin

```
bash-5.2$ cat files.hash | rg hamiltona_network_log.pcapng
45330b81a6a3c0b7cc5dfd4428e1e737  hamiltona_network_log.pcapng
bash-5.2$ md5sum hamiltona_network_log.pcapng
45330b81a6a3c0b7cc5dfd4428e1e737  hamiltona_network_log.pcapng
bash-5.2$ if diff <(md5sum hamiltona_network_log.pcapng) <(rg 'hamiltona_network_log.pcapng' files.hash); then echo "hash matches"; else echo "hash does not match"; fi
hash matches
```

Figure 5: Cryptographic hash verification of the packet capture file

```
bash-5.2$ cat files.hash | rg ssl-keys.log
6ab3c33164a2eeffbb3c1b850e80213d  ssl-keys.log
bash-5.2$ md5sum ssl-keys.log
6ab3c33164a2eeffbb3c1b850e80213d  ssl-keys.log
bash-5.2$ if diff <(md5sum ssl-keys.log) <(rg 'ssl-keys.log' files.hash); then echo "hash matches"; else echo "hash does not match"; fi
hash matches
```

Figure 6: Cryptographic hash verification of the SSL key log file

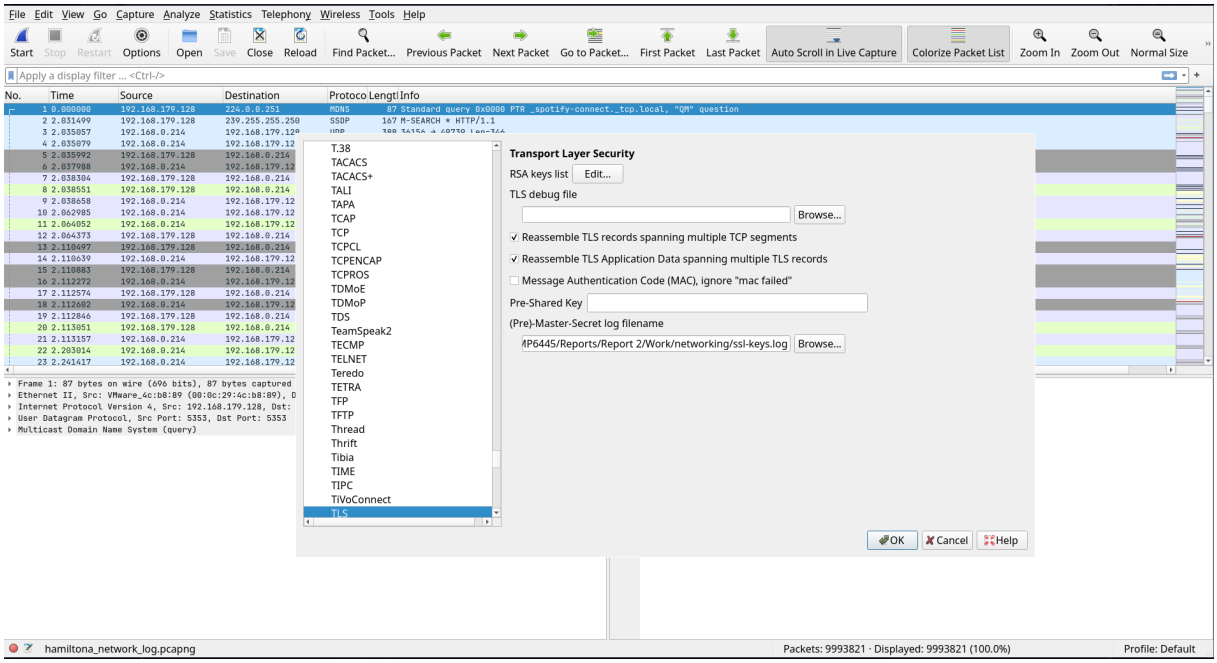

Figure 7: Importing the SSL key log to Wireshark

```
Work/drop2/memory
● [podman] ❱ vol.py -f Windows-7-x64-Pro-Snapshot7.vmem windows.pslist 2> /dev/null | rg chrome | awk '{print$1}' > pids

Work/drop2/memory
● [podman] ❱ while IFS= read -r pid; do
    vol.py -f Windows-7-x64-Pro-Snapshot7.vmem windows.dlllist.DllList --pid $pid 2> /dev/null >> dlllist
done < "pids"

Work/drop2/memory took 4s
● [podman] ❱ rg -i 'chrome.dll' dlllist
28:1084 chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 04:17:25.000000     Disabled
170:1428        chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 04:17:26.000000     Disabled
243:3684        chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 04:17:26.000000     Disabled
307:964 chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 04:17:30.000000     Disabled
355:2764        chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 04:17:37.000000     Disabled
403:1508        chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 06:22:54.000000     Disabled
451:3056        chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 06:22:59.000000     Disabled
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652:1428        chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 04:17:26.000000     Disabled
725:3684        chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 04:17:26.000000     Disabled
789:964 chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 04:17:30.000000     Disabled
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933:3056        chrome.exe      0x7fee4d20000   0x821c000       chrome.dll      C:\Program Files (x86)\Google\Chrome\Application\84.0.4147.135\chrome.dll       2020-09-04 06:22:59.000000     Disabled
```

Figure 8: Finding the version of Google Chrome used from the memory dump