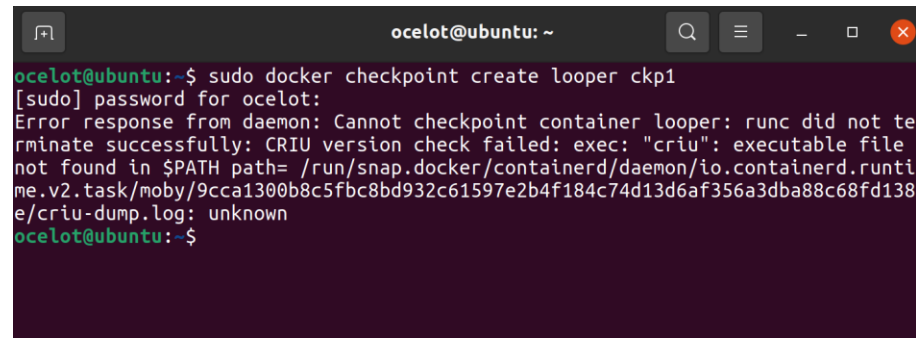


## 分布式系统作业-2 利用 criu 实现容器迁移

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### 1. 没有解决的 Bug

一开始尝试使用 docker 和 criu，就出现了以下报错：



```
ocelot@ubuntu: ~  
ocelot@ubuntu:~$ sudo docker checkpoint create loopier ckp1  
[sudo] password for ocelot:  
Error response from daemon: Cannot checkpoint container loopier: runc did not terminate successfully: CRIU version check failed: exec: "criu": executable file not found in $PATH path= /run/snap.docker/containerd/daemon/io.containerd.runtime.v2.task/moby/9cca1300b8c5fbc8bd932c61597e2b4f184c74d13d6af356a3dba88c68fd138e/criu-dump.log: unknown  
ocelot@ubuntu:~$
```

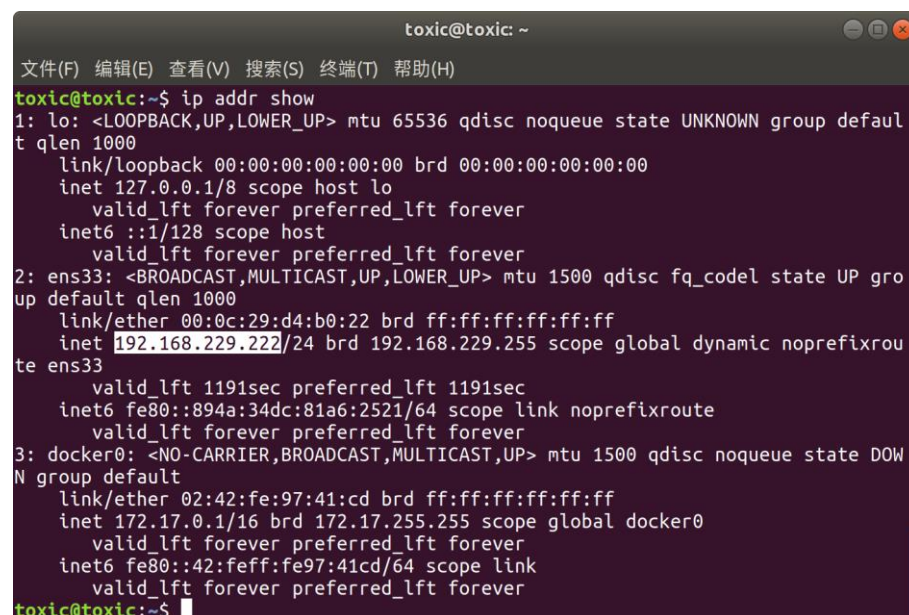
本人在老师和助教的指导下，把所有的能想到的方法都试了个遍，还是没有办法解决，主要尝试过的有：

- 重装 docker 和 criu，使用源码安装指定版本；
- 换用 Ubuntu 18.04

可能是需要在系统中安装相关依赖的原因（实在找不出来是缺了什么包），这些尝试都没有什么效果。最终的办法是借用了同学刚好不会报错的 Ubuntu 18.04 虚拟机来完成实验。

### 2. 在可以正常运行 docker 和 criu 的虚拟机下完成实验

需要准备两台虚拟机，分别用 ip addr show 找到他们的 ip 地址



```
toxic@toxic: ~  
文件(F) 编辑(E) 查看(V) 搜索(S) 终端(T) 帮助(H)  
toxic@toxic:~$ ip addr show  
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000  
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00  
    inet 127.0.0.1/8 scope host lo  
        valid_lft forever preferred_lft forever  
    inet6 ::1/128 scope host  
        valid_lft forever preferred_lft forever  
2: ens33: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel state UP group default qlen 1000  
    link/ether 00:0c:29:d4:b0:22 brd ff:ff:ff:ff:ff:ff  
    inet 192.168.229.222/24 brd 192.168.229.255 scope global dynamic noprefixroute ens33  
        valid_lft 1191sec preferred_lft 1191sec  
    inet6 fe80::894a:34dc:81a6:2521/64 scope link noprefixroute  
        valid_lft forever preferred_lft forever  
3: docker0: <NO-CARRIER,BROADCAST,MULTICAST,UP> mtu 1500 qdisc noqueue state DOWN group default  
    link/ether 02:42:fe:97:41:cd brd ff:ff:ff:ff:ff:ff  
    inet 172.17.0.1/16 brd 172.17.255.255 scope global docker0  
        valid_lft forever preferred_lft forever  
    inet6 fe80::42:feff:fe97:41cd/64 scope link  
        valid_lft forever preferred_lft forever  
toxic@toxic:~$
```

其中客户机的 ip 地址为 192.168.229.129，服务器的 ip 地址为 192.168.229.222。

然后开始实验，具体步骤大致如下：

## (1) 完成配置

### Step 1: Configure NFS on host & client server

- Downloading and Installing the Components

- On the host:

```
$ sudo apt-get update
$ sudo apt-get install nfs-kernel-server
```

- On the client:

```
$ sudo apt-get update
$ sudo apt-get install nfs-common
```

- Configuring the NFS Exports on the Host Server

```
$ sudo nano /etc/exports
# Add the below line to exports file:
/home      129.59.1.2(rw,sync,no_root_squash,no_subtree_check)
# Then restart nfs-kernel-server service
$ sudo systemctl restart nfs-kernel-server
```

- Adjusting the Firewall on the Host

```
# First, check firewall status
$ sudo ufw status
# If ufw is inactive, use the below command to enable ufw:
$ sudo ufw enable
# Make ufw allow incoming and outgoing:
$ sudo ufw default allow incoming
$ sudo ufw default allow outgoing
# Make client server can access host server
$ sudo ufw allow from 129.59.1.2 to any port nfs
# Check ufw status
$ sudo ufw status numbered
```

- Creating the Mount Points on the Client

```
$ sudo mkdir -p /nfs/home
```

- Mounting the Directory on the Client

```
sudo mount 129.59.1.1:/home /nfs/home
```

- Checking the Mounted Directory on the Client

```
$ df -h
```



过程比较简单，将 ip 地址换成自己两台虚拟机的地址即可，这里附上几张截图：

```
toxic@toxic: ~
文件(F) 编辑(E) 查看(V) 搜索(S) 终端(T) 帮助(H)
GNU nano 2.9.3 /etc/exports

# /etc/exports: the access control list for filesystems which may be exported
# to NFS clients.  See exports(5).
#
# Example for NFSv2 and NFSv3:
# /srv/homes hostname1(rw,sync,no_subtree_check) hostname2(ro,sync,no_sub$
#
# Example for NFSv4:
# /srv/nfs4 gss/krb5i(rw,sync,fsid=0,crossmnt,no_subtree_check)
# /srv/nfs4/homes gss/krb5i(rw,sync,no_subtree_check)
#
/home 192.168.229.129(rw,sync,no_root_squash,no_subtree_check)

[已读取 11 行]
^G 求助 ^O 写入 ^W 搜索 ^K 剪切文字 ^J 对齐 ^C 光标位置
^X 离开 ^R 读档 ^V 替换 ^U 还原剪切 ^T 拼写检查 ^_ 跳行
```

```
toxic@toxic: ~
文件(F) 编辑(E) 查看(V) 搜索(S) 终端(T) 帮助(H)

toxic@toxic:~$ sudo ufw delete 1
将要删除:
allow from 192.168.106.136 to any port 2049
要继续吗 (y|n)? y
规则已删除
toxic@toxic:~$ sudo ufw enable
在系统启动时启用和激活防火墙
toxic@toxic:~$ sudo ufw default allow incoming
默认的 incoming 策略更改为 "allow"
(请相应地更新你的防火墙规则)
toxic@toxic:~$ sudo ufw default allow outgoing
默认的 outgoing 策略更改为 "allow"
(请相应地更新你的防火墙规则)
toxic@toxic:~$ sudo ufw allow from 192.168.229.129 to any port nfs
规则已添加
toxic@toxic:~$ sudo ufw status numbered
状态: 激活

      至                动作        来自
--
[ 1] 2049                ALLOW IN    192.168.229.129

toxic@toxic:~$
```

## (2) 安装 docker 和 criu

这一步本人在自己的虚拟机上已经反复尝试了多次官方源和源码安装, 可惜没有留下截图, 方法比较简单, 这里不再赘述

## (3) 测试容器迁移

- Test your live migration

1. On the host

```
$ docker run -d --name loopier2 --security-opt seccomp:unconfined busybox \
/bin/sh -c 'i=0; while true; do echo $i; i=$((expr $i + 1)); sleep 1; done'

# wait a few seconds to give the container an opportunity to print a few lines, then
$ docker checkpoint create --checkpoint-dir=/home/ubuntu/Container-Checkpoints/ loopier2 check

# check your container & print log file
$ docker ps
$ docker logs loopier2
```

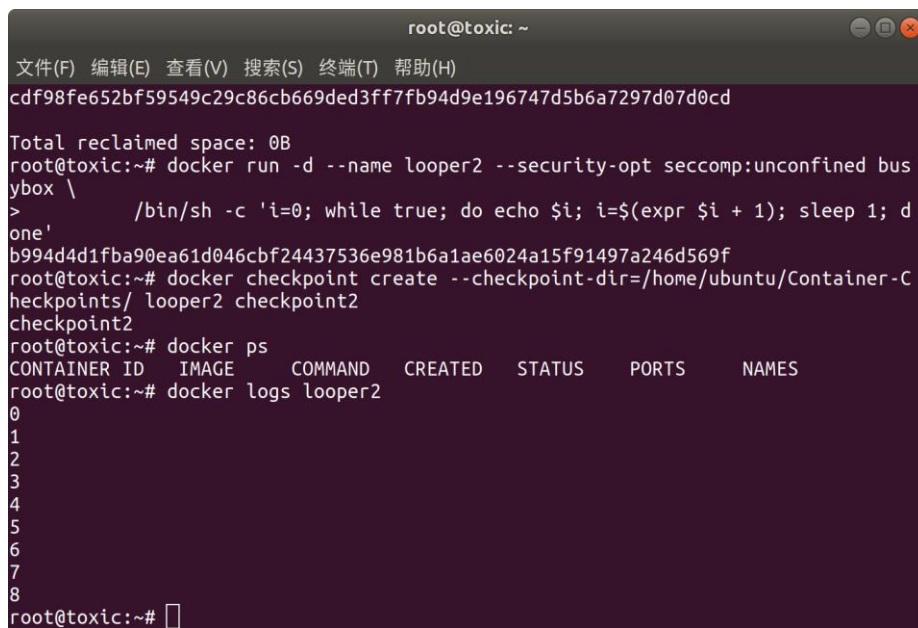
## 2. On the client

```
$ docker create --name looper-clone --security-opt seccomp:unconfined busybox \
    /bin/sh -c 'i=0; while true; do echo $i; i=$((expr $i + 1)); sleep 1; done'

$ docker start --checkpoint-dir=/nfs/home/ubuntu/Container-Checkpoints/ --checkpoint=checkpoint2

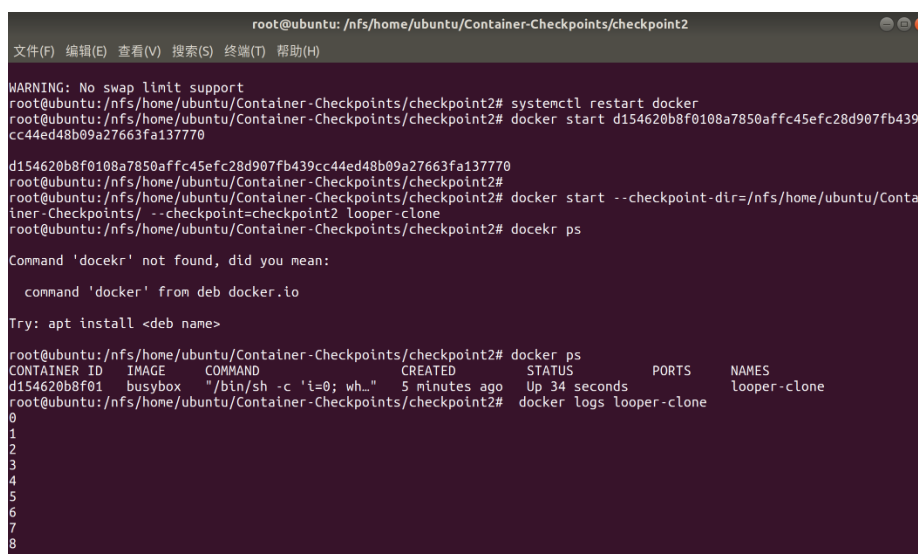
# check your container
$ docekr ps
$ docker logs looper-clone
```

这个是报错最难解决的一步，主要就是第一部分给出的报错截图。不过在同学的虚拟机上面，这一部分倒是很顺利，非常快就完成了，以下是截图：



```
root@toxic: ~
文件(F) 编辑(E) 查看(V) 搜索(S) 终端(T) 帮助(H)
cdf98fe652bf59549c29c86cb669ded3ff7fb94d9e196747d5b6a7297d07d0cd

Total reclaimed space: 0B
root@toxic:~# docker run -d --name looper2 --security-opt seccomp:unconfined busybox \
    /bin/sh -c 'i=0; while true; do echo $i; i=$((expr $i + 1)); sleep 1; done'
b994d4d1fba90ea61d046cbf24437536e981b6a1ae6024a15f91497a246d569f
root@toxic:~# docker checkpoint create --checkpoint-dir=/home/ubuntu/Container-Checkpoints/ looper2 checkpoint2
root@toxic:~# docker ps
CONTAINER ID   IMAGE     COMMAND   CREATED   STATUS    PORTS   NAMES
root@toxic:~# docker logs looper2
0
1
2
3
4
5
6
7
8
root@toxic:~#
```



```
root@ubuntu: /nfs/home/ubuntu/Container-Checkpoints/checkpoint2
文件(F) 编辑(E) 查看(V) 搜索(S) 终端(T) 帮助(H)

WARNING: No swap limit support
root@ubuntu:/nfs/home/ubuntu/Container-Checkpoints/checkpoint2# systemctl restart docker
root@ubuntu:/nfs/home/ubuntu/Container-Checkpoints/checkpoint2# docker start d154620b8f0108a7850affc45efc28d907fb439cc44ed48b09a27663fa137770
d154620b8f0108a7850affc45efc28d907fb439cc44ed48b09a27663fa137770
root@ubuntu:/nfs/home/ubuntu/Container-Checkpoints/checkpoint2#
root@ubuntu:/nfs/home/ubuntu/Container-Checkpoints/checkpoint2# docker start --checkpoint-dir=/nfs/home/ubuntu/Container-Checkpoints/ --checkpoint=checkpoint2 looper-clone
root@ubuntu:/nfs/home/ubuntu/Container-Checkpoints/checkpoint2# docekr ps

Command 'docekr' not found, did you mean:
  command 'docker' from deb docker.io

Try: apt install <deb name>

root@ubuntu:/nfs/home/ubuntu/Container-Checkpoints/checkpoint2# docker ps
CONTAINER ID   IMAGE     COMMAND   CREATED   STATUS    PORTS   NAMES
d154620b8f01   busybox   "/bin/sh -c 'i=0; wh..."  5 minutes ago  Up 34 seconds  0.0.0.0:80->80  looper-clone
root@ubuntu:/nfs/home/ubuntu/Container-Checkpoints/checkpoint2# docker logs looper-clone
0
1
2
3
4
5
6
7
8
9
```

如图所示，成功完成了容器的迁移。