

第 00 章作业 - Linux 知识补充 - Socket 编程

- TCP 阻塞方式 - 基本知识

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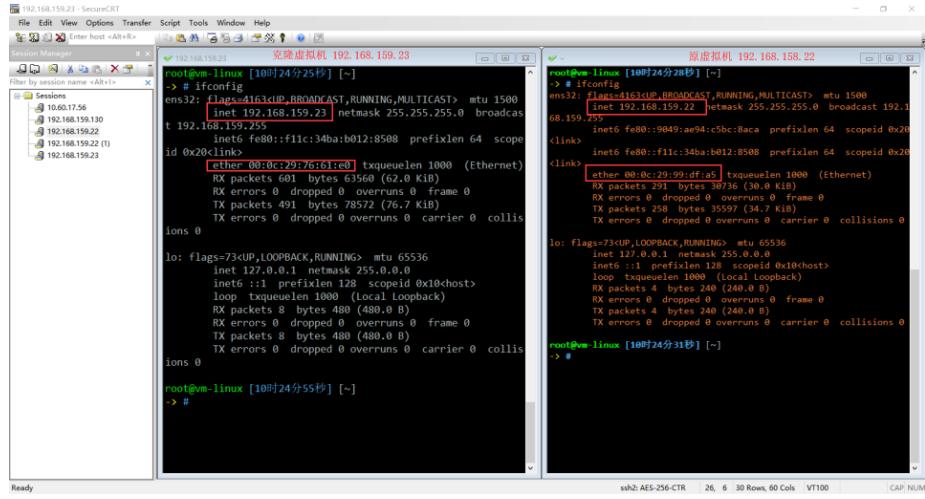
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1 补充知识

1. 新的虚拟机如何设置网卡并使生效

克隆后,修改新虚拟机的 ifcfg-ens33,将“192.168.159.22”改为“192.168.159.23”
Mac 地址好像自动就不一样.



```
root@192.168.159.23 ~]# ifconfig
ens3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
      inet 192.168.159.23 netmask 255.255.255.0 broadcast 192.168.159.255
        inet6 fe80::fe3c:34ba:b012:8508 prefixlen 64 scopeid 0x20<br/>
          ether 00:0c:29:76:61:e0 txqueuelen 1000  (Ethernet)
            RX packets 601 bytes 63560 (62.0 Kib)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 491 bytes 78572 (76.7 Kib)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
      inet 127.0.0.1 netmask 255.0.0.0
        inet6 ::1 prefixlen 128 scopeid 0x10<host>
          loop txqueuelen 1000  (Local Loopback)
            RX packets 8 bytes 480 (480.0 B)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 8 bytes 480 (480.0 B)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
root@192.168.159.23 ~]# > &

root@192.168.159.22 ~]# ifconfig
ens3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
      inet 192.168.159.22 netmask 255.255.255.0 broadcast 192.168.159.255
        inet6 fe80::9e49:aef4:c5bc:8aca prefixlen 64 scopeid 0x20<br/>
          link
            inet6 fe80::fe3c:34ba:b012:8508 prefixlen 64 scopeid 0x20<br/>
              ether 00:0c:29:79:dfe:5 txqueuelen 1000  (Ethernet)
                RX packets 291 bytes 30736 (30.0 Kib)
                RX errors 0 dropped 0 overruns 0 frame 0
                TX packets 258 bytes 35597 (34.7 Kib)
                TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
      inet 127.0.0.1 netmask 255.0.0.0
        inet6 ::1 prefixlen 128 scopeid 0x10<host>
          loop txqueuelen 1000  (Local Loopback)
            RX packets 4 bytes 240 (240.0 B)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 4 bytes 240 (240.0 B)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
root@192.168.159.22 ~]# > &
```

2. 一个网卡设置多地址

方法是建立 ifcfg-ens33:x 文件, 其中 x 属于 0-255

vim

```

file Edit View Options Transfer Script Tools Window Help
Session Manager
File by session name <All+>
10:48:17.56
  192.168.159.130
  192.168.159.22
  192.168.159.22 (1)
  192.168.159.23
1 TYPE=Ethernet
2 PROXY_METHOD=none
3 BROWSER_ONLY=no
4 BOOTPROTO=static
5 DEFROUTE=yes
6 IPV4_FAILURE_FATAL=yes
7 IPV6INIT=yes
8 IPV6_AUTOCONF=yes
9 IPV6_DEFROUTE=yes
10 IPV6_FAILURE_FATAL=no
11 IPV6_ADDR_GEN_MODE=stable-privacy
12 NAME=enx3210
13 UUID=13dce403-8e25-4250-b18a-01c5d62471bd
14 DEVICE=enx3210
15 ONBOOT=yes
16 IPADDR=192.168.158.23
17 NETMASK=255.255.255.0
18 PREFIX=24
19 IPV6_PRIVACY=no
20 ZONE=public
~
```

iifcfg-ens32:0* 20L, 369C 16,21 全部

Ready

twrk-scripts

```

file Edit View Options Transfer Script Tools Window Help
Session Manager
File by session name <All+>
10:48:17.56
  192.168.159.130
  192.168.159.22
  192.168.159.22 (1)
  192.168.159.23
root@ewm-linux [10时40分09秒] [/etc/sysconfig/network-scripts]
-> # systemctl restart network
root@ewm-linux [10时41分09秒] [/etc/sysconfig/network-scripts]
-> # ifconfig
ens32: flags=416<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.159.22 netmask 255.255.255.0 broadcast 192.168.159.255
        inet6 fe80::f094:9e94%ens32: scopeid 0x20<link>
    ether 00:0c:29:99:df:a5 txqueuelen 1000 (Ethernet)
        RX packets 40375 (393.9 KiB)
        RX errors 0 dropped 0 overruns 0 frame 0
        TX packets 2550 bytes 498668 (477.2 KiB)
        TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ens32:0: flags=416<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.158.23 netmask 255.255.255.0 broadcast 192.168.158.255
        ether 00:0c:29:99:df:a5 txqueuelen 1000 (Ethernet)

lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
    inet 127.0.0.1 netmask 255.0.0.0
        inet6 ::1/128 scopeid 0x10<host>
            loop txqueuelen 1000 (local loopback)
            RX packets 12 bytes 720 (720.0 B)
            RX errors 0 dropped 0 overruns 0 frame 0
            TX packets 12 bytes 720 (720.0 B)
            TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

root@ewm-linux [10时41分11秒] [/etc/sysconfig/network-scripts]
-> #
```

Ready

192.168.159.23 - SecureCRT

```

file Edit View Options Transfer Script Tools Window Help
Session Manager
File by session name <All+>
10:48:17.56
  192.168.159.130
  192.168.159.22
  192.168.159.22 (1)
  192.168.159.23
root@ewm-linux [10时42分05秒] [~]
-> # ping 192.168.159.22
PING 192.168.159.22 (192.168.159.22) 56(84) bytes of data.
64 bytes from 192.168.159.22: icmp_seq=1 ttl=64 time=0.548 ms
64 bytes from 192.168.159.22: icmp_seq=2 ttl=64 time=0.890 ms
64 bytes from 192.168.159.22: icmp_seq=3 ttl=64 time=0.347 ms
64 bytes from 192.168.159.22: icmp_seq=4 ttl=64 time=0.593 ms
64 bytes from 192.168.159.22: icmp_seq=5 ttl=64 time=1.49 ms
```

root@ewm-linux [10时42分05秒] [/etc/sysconfig/network-scripts]

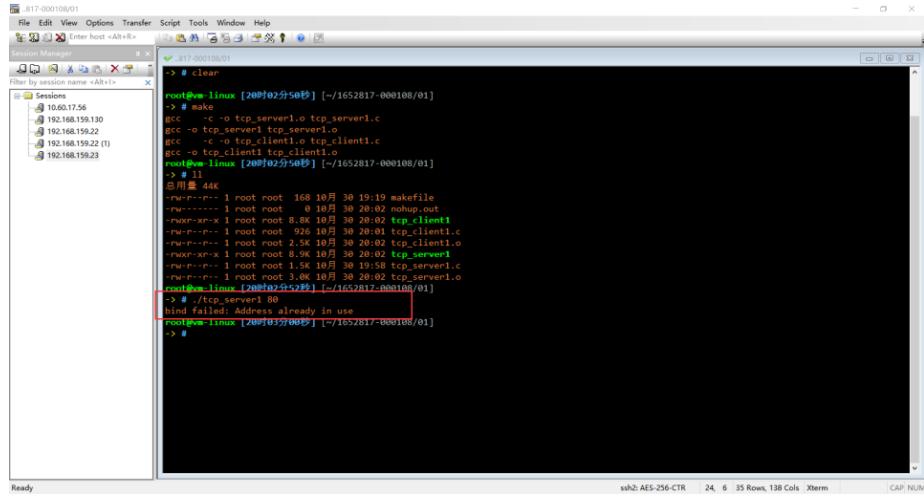
```

-> # ping 192.168.159.23
PING 192.168.159.23 (192.168.159.23) 56(84) bytes of data.
64 bytes from 192.168.159.23: icmp_seq=1 ttl=64 time=0.801 ms
64 bytes from 192.168.159.23: icmp_seq=2 ttl=64 time=0.809 ms
64 bytes from 192.168.159.23: icmp_seq=3 ttl=64 time=0.91 ms
64 bytes from 192.168.159.23: icmp_seq=4 ttl=64 time=0.925 ms
64 bytes from 192.168.159.23: icmp_seq=5 ttl=64 time=0.819 ms
64 bytes from 192.168.159.23: icmp_seq=6 ttl=64 time=0.936 ms
64 bytes from 192.168.159.23: icmp_seq=7 ttl=64 time=0.889 ms
64 bytes from 192.168.159.23: icmp_seq=8 ttl=64 time=0.880 ms
64 bytes from 192.168.159.23: icmp_seq=9 ttl=64 time=0.954 ms
64 bytes from 192.168.159.23: icmp_seq=10 ttl=64 time=0.932 ms
64 bytes from 192.168.159.23: icmp_seq=11 ttl=64 time=0.334 ms
64 bytes from 192.168.159.23: icmp_seq=12 ttl=64 time=0.852 ms
64 bytes from 192.168.159.23: icmp_seq=13 ttl=64 time=0.676 ms
```

Ready

2 01 子目录

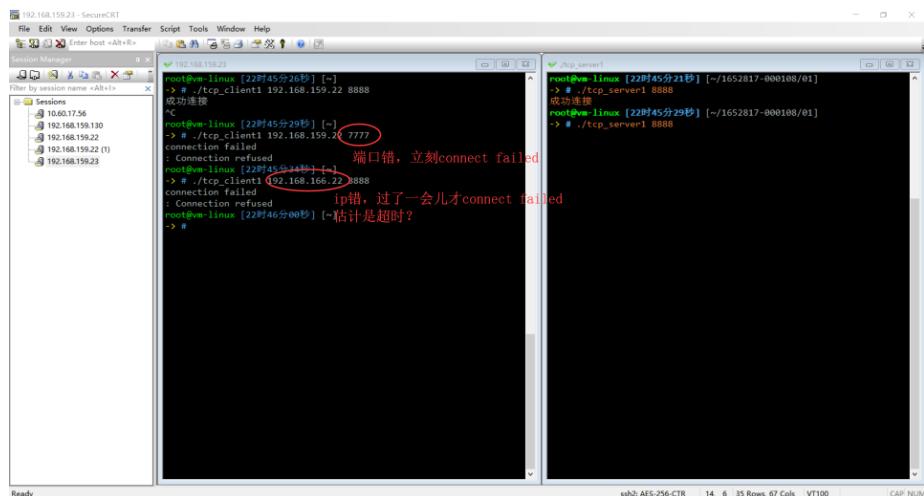
1. 如果服务端绑定的端口号已被使用，那么无法进入 LISTEN 状态，在 bind 函数报错。



```
root@wsl:~[20时02分50秒] [~/1652817-000108/01]
-> # make
gcc -c -o tcp_server1.o tcp_server1.c
gcc -c -o tcp_server1.o tcp_server1.o
gcc -c -o tcp_client1.o tcp_client1.c
gcc -c -o tcp_client1.o tcp_client1.c
root@wsl:~[20时02分50秒] [~/1652817-000108/01]
-> # 11
总用量 44K
-rw-r--r-- 1 root root 168 10月 30 19:19 makefile
-rw-r--r-- 1 root root 409 10月 30 20:02 makefile
-rwxr-xr-x 1 root root 8.8K 10月 30 20:02 tcp_client1
-rwxr-xr-x 1 root root 926 10月 30 20:01 tcp_client1.o
-rwxr-xr-x 1 root root 2.5K 10月 30 20:02 tcp_client1.c
-rwxr-xr-x 1 root root 8.9K 10月 30 20:02 tcp_server1
-rwxr-xr-x 1 root root 1.3K 10月 30 19:58 tcp_server1.c
-rwxr-xr-x 1 root root 1.0K 10月 30 19:58 tcp_server1.o
root@wsl:~[20时02分50秒] [~/1652817-000108/01]
-> # ./tcp_server1 80
bind failed: Address already in use
root@wsl:~[20时02分50秒] [~/1652817-000108/01]
-> #
```

2. 如果 client 连接时 ip 地址不正确，会在 connect 时报错；port 不正确，也在 connect 这里错误。

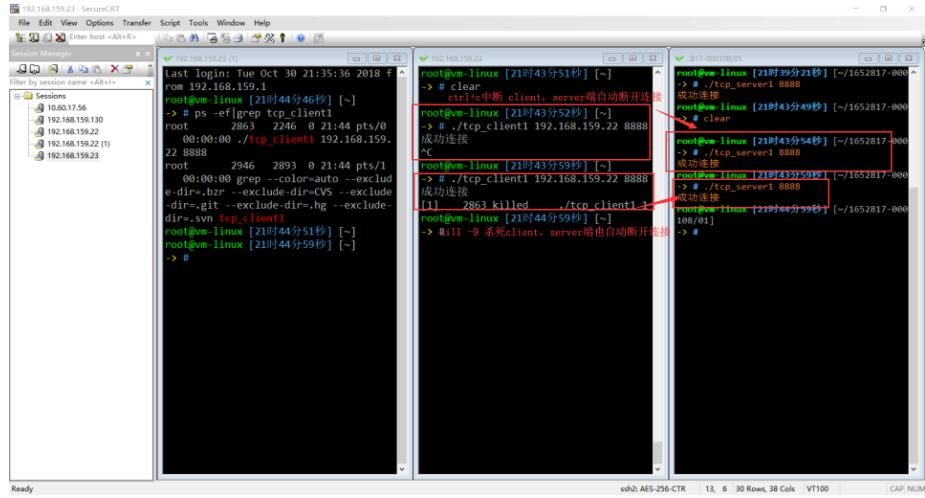
3. 连接成功



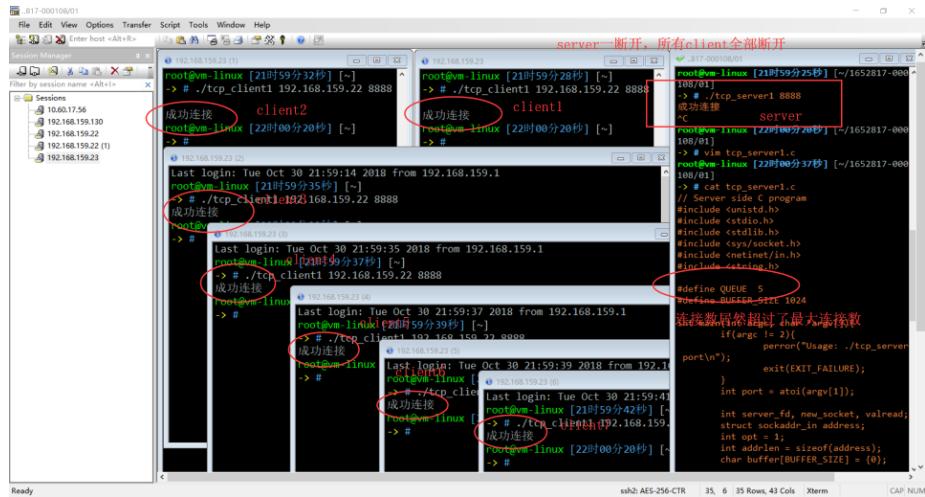
```
root@wsl:~[22时45分26秒] [~]
-> # ./tcp_client1 192.168.159.22 8888
成功连接
`C
root@wsl:~[22时45分29秒] [~]
-> # ./tcp_client1 192.168.159.22 7777
connection failed : Connection refused
端口错，立刻connect failed
root@wsl:~[22时45分34秒] [~]
-> # ./tcp_client1 192.168.159.22 8888
connection failed : Connection refused
ip错，过了一会儿才connect failed
root@wsl:~[22时46分00秒] [~]
-> #
```

```
root@wsl:~[22时45分21秒] [~]
-> # ./tcp_server1 8888
成功连接
root@wsl:~[22时45分29秒] [~]
-> # ./tcp_server1 8888
root@wsl:~[22时46分00秒] [~]
```

4. 用 `ctrl+c` 或者 `kill -9` 使 client 退出后, server 端都能察觉到, 并且断开连接.



5. 如果在新的会话中再启动一个 `tcp_client1` 连接 `server`. 好像无论多少个都可以连. 而且数量能超过 `listen` 设定的最大等待数. 当 `server` 断开的时候, 所有 `client` 全部断开.



6. 如果用了 REUSEADDR，重新启动是能成功的。

如果没用 REUSEADDR，重新启动会失败，但好像过了一会儿又好了。

The screenshot shows two terminal windows side-by-side. Both windows have a title bar with 'File Edit View Options Transfer Script Tools Window Help' and a status bar at the bottom.

Left Terminal:

```
root@ws:linux [22时29分10秒] [~/1652817-000108/01]
-> # ./tcp_server1 8888
`-
```

Right Terminal:

```
root@ws:linux [22时29分11秒] [~/1652817-000108/01]
-> # ./tcp_server1 8888
`-
```

Both terminals show the command `./tcp_server1 8888` being run. The right terminal's output shows a bind failure error: `bind failed: Address already in use`.

A red arrow points from the error message in the right terminal to the text "过了一会儿又能用了" (Available again after some time) located below the right terminal window.

REUSEADDR 的作用是即使进程崩溃或被杀死，也允许重用端口。

7. 能 ping 通，因为两台虚拟机网段相同。

CentOS 7 64 位 - VMware Workstation

文件(F) 编辑(E) 查看(V) 虚拟机(M) 选项卡(T) 帮助(H)

库 在此处键入内容进行搜索

我的计算机

- CentOS 7 64 位
- Red Hat Enterprise Linux 7 64 位
- CentOS 7 64 位 的克隆
- 共享的虚拟机

```

[root@vm-linux ~]# ifconfig
ens32: flags=4163UP,BROADCAST,RUNNING,MULTICAST mtu 1500
        inet 192.168.168.22 brd 192.168.168.255 broadcast 192.168.168.255
              netmask 255.255.255.0
              ether 00:0c:29:99:d1:a5 txqueuelen 1000 (Ethernet)
              RX packets 119874 bytes 34388993 (33.3 MB)
              RX errors 0 dropped 0 overruns 0 frame 0
              TX packets 92196 bytes 21734625 (29.7 MB)
              TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ens32:8: flags=4163UP,BROADCAST,RUNNING,MULTICAST mtu 1500
        inet 192.168.168.22 netmask 255.255.255.0 broadcast 192.168.168.255
              ether 00:0c:29:99:d1:a5 txqueuelen 1000 (Ethernet)

lo: flags=73UP,LOOPBACK,RUNNING mtu 65536
        inet 127.0.0.1 netmask 255.0.0.0
              inet6 ::1 prefixlen 128 scopeid 0x10<host>
                  loop txqueuelen 1000 (Local Loopback)
                  RX packets 242 bytes 21272 (20.7 KIB)
                  RX errors 0 dropped 0 overruns 0 frame 0
                  TX packets 242 bytes 21272 (20.7 KIB)
                  TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

[root@vm-linux ~]# ping 192.168.159.23
PING 192.168.159.23 (192.168.159.23) 56(84) bytes of data.
44 bytes from 192.168.159.23: icmp_seq=1 ttl=64 time=0.000 ms
44 bytes from 192.168.159.23: icmp_seq=2 ttl=64 time=0.007 ms
44 bytes from 192.168.159.23: icmp_seq=3 ttl=64 time=0.565 ms
44 bytes from 192.168.159.23: icmp_seq=4 ttl=64 time=0.000 ms
...
-- 192.168.159.23 ping statistics --
4 packets transmitted, 4 received, 0% packet loss, time 309ms
rtt min/avg/max/mdev = 0.456/0.682/0.808/0.124 ms
[root@vm-linux ~]#

```

要将输入定向到该虚拟机，请在虚拟机内部单击或按 Ctrl+G。

CentOS 7 64 位 的克隆 - VMware Workstation

文件(F) 编辑(E) 查看(V) 虚拟机(M) 选项卡(T) 帮助(H)

库 在此处键入内容进行搜索

我的计算机

- CentOS 7 64 位
- Red Hat Enterprise Linux 7 64 位
- CentOS 7 64 位 的克隆
- 共享的虚拟机

```

[root@vm-linux ~]# ifconfig
ens32: flags=4163UP,BROADCAST,RUNNING,MULTICAST mtu 1500
        inet 192.168.168.22 brd 192.168.168.255 broadcast 192.168.168.255
              netmask 255.255.255.0
              ether 00:0c:29:76:61:e8 txqueuelen 1000 (Ethernet)
              RX packets 62376 bytes 19344533 (18.1 MB)
              RX errors 0 dropped 0 overruns 0 frame 0
              TX packets 74100 bytes 44652669 (42.0 MB)
              TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

ens32:1: flags=4163UP,BROADCAST,RUNNING,MULTICAST mtu 1500
        inet 192.168.168.23 netmask 255.255.255.0 broadcast 192.168.168.255
              ether 00:0c:29:76:61:e8 txqueuelen 1000 (Ethernet)

lo: flags=73UP,LOOPBACK,RUNNING mtu 65536
        inet 127.0.0.1 netmask 255.0.0.0
              inet6 ::1 prefixlen 128 scopeid 0x10<host>
                  loop txqueuelen 1000 (Local Loopback)
                  RX packets 224 bytes 13440 (13.1 KIB)
                  RX errors 0 dropped 0 overruns 0 frame 0
                  TX packets 224 bytes 13440 (13.1 KIB)
                  TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

[root@vm-linux ~]# ping 192.168.159.22
PING 192.168.159.22 (192.168.159.22) 56(84) bytes of data.
44 bytes from 192.168.159.22: icmp_seq=1 ttl=64 time=0.231 ms
44 bytes from 192.168.159.22: icmp_seq=2 ttl=64 time=0.560 ms
44 bytes from 192.168.159.22: icmp_seq=3 ttl=64 time=0.325 ms
44 bytes from 192.168.159.22: icmp_seq=4 ttl=64 time=0.483 ms
...
-- 192.168.159.22 ping statistics --
4 packets transmitted, 4 received, 0% packet loss, time 309ms
rtt min/avg/max/mdev = 0.231/0.381/0.560/0.125 ms
[root@vm-linux ~]#

```

要将输入定向到该虚拟机，请在虚拟机内部单击或按 Ctrl+G。

```
Windows PowerShell
连接特定的 DNS 后缀 . . . . . : fe80::2c79:3fd7:decd:e7fe%23
本地链接 IPv6 地址 . . . . . : 192.168.137.1
IPv4 地址 . . . . . : 255.255.255.0
子网掩码 . . . . . : 255.255.255.0
默认网关 . . . . . : 192.168.137.1

以太网适配器 VMware Network Adapter VMnet8:
连接特定的 DNS 后缀 . . . . . : fe80::f16a:44e:a843:ef89%18
本地链接 IPv6 地址 . . . . . : 192.168.150.1
IPv4 地址 . . . . . : 255.255.255.0
子网掩码 . . . . . : 255.255.255.0
默认网关 . . . . . : 192.168.150.1

无线局域网适配器 WLAN:
连接特定的 DNS 后缀 . . . . . : fe80::91cf:8395:19dc:7cab%24
本地链接 IPv6 地址 . . . . . : 192.168.1.101
IPv4 地址 . . . . . : 255.255.255.0
子网掩码 . . . . . : 192.168.1.1
默认网关 . . . . . : 192.168.1.1

以太网适配器 蓝牙网络连接:
媒体状态 . . . . . : 媒体已断开连接
连接特定的 DNS 后缀 . . . . . : fe80::2c79:3fd7:decd:e7fe%23

PS C:\Users\admin>
```

但此时的VMnet8 ip和虚拟机不在同一网段

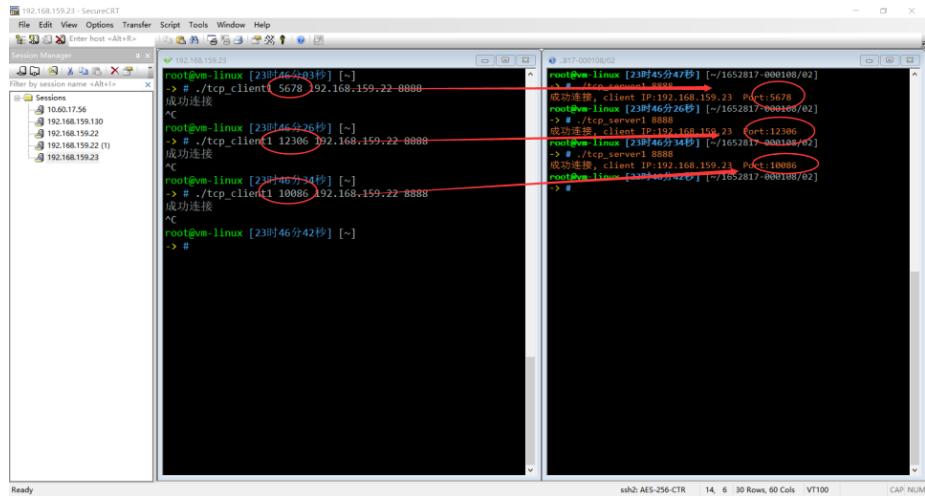
3 02 子目录

1. 的确是自动分配的

```
root@vm-linux [23时28分33秒] [~]
-> # ./tcp_client1 192.168.159.22 8888
成功连接
rroot@vm-linux [23时28分36秒] [~]
-> # ./tcp_client1 192.168.159.22 8888
成功连接
^C
rroot@vm-linux [23时28分39秒] [~]
-> #
rroot@vm-linux [23时28分41秒] [~]
-> # ./tcp_client1 192.168.159.22 8888
成功连接
^C
rroot@vm-linux [23时28分44秒] [~]
-> #
```

```
root@vm-linux [23时28分29秒] [~/1652817-000108/02]
-> # ./tcp_server1 8888
(等待连接) client IP:192.168.159.33 Port:48032
(C
root@vm-linux [23时28分30秒] [~/1652817-000108/02]
-> # ./tcp_server1 8888
(等待连接) client IP:192.168.159.23 Port:48034
root@vm-linux [23时28分31秒] [~/1652817-000108/02]
-> # ./tcp_server1 8888
(等待连接) client IP:192.168.159.23 Port:48036
root@vm-linux [23时28分44秒] [~/1652817-000108/02]
-> #
```

2. 固定端口号



```
root@vm-linux [23时46分01秒] [-] > ./tcp_client 5678 192.168.159.22 8888  
成功连接  
^C  
root@vm-linux [23时46分26秒] [-] > # ./tcp_client1 12306 192.168.159.22 8888  
成功连接  
^C  
root@vm-linux [23时46分41秒] [-] > # ./tcp_client1 10086 192.168.159.22 8888  
成功连接  
^C  
root@vm-linux [23时46分42秒] [-] > #  
  
root@vm-linux [23时46分47秒] [-] > ./tcp_server 8888  
成功连接, client IP:192.168.159.23 Port:5678  
root@vm-linux [23时46分48秒] [-] > # ./tcp_server 8888  
成功连接, client IP:192.168.159.23 Port:12306  
root@vm-linux [23时46分54秒] [-] > # ./tcp_server 8888  
成功连接, client IP:192.168.159.23 Port:10086  
root@vm-linux [23时46分55秒] [-]
```

4 03 子目录

1. 打印 IP 地址，绑定 IP 地址

The screenshot shows two terminal windows. The left window displays the output of the command `ifconfig` on a Linux system with multiple interfaces (ens32, ens32:0, lo). The right window shows the output of `netstat -an` and `lsof -i` commands, which list a listening TCP socket on port 50166 with local address 192.168.160.22 and remote address 192.168.159.23. A red arrow points from the text "自动用了192.168.160.23这个地址而不是192.168.159.23" (Automatically used 192.168.160.23 instead of 192.168.159.23) in the left window to the IP address in the netstat output. Another red arrow points from the text "打印的所有IP地址" (Print all IP addresses) in the left window to the IP address in the lsof output.

```
root@vee-linux [10时24分47秒] [-]
> # ifconfig
ens32: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 192.168.159.23 brd 255.255.255.0 broadcast 192.168.159.255
inet6 fe80::fe04:9e94%ens32 brd ff02::1 linklayer
        inet6 fe80::flic:34ba:b012:8508 brd ff02::1 linklayer
        linklayer
        ether 00:0c:29:76:61:e0 txqueuelen 1000 (Ethernet)
        RX packets 1255 bytes 141237 (137.9 KiB)
        RX errors 0 dropped 0 overruns 0 frame 0
        TX packets 8 bytes 480 (480.0 B)
        TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
ens32:1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 192.168.160.23 brd 255.255.255.0 broadcast 192.168.160.255
inet6 fe80::flic:34ba:b012:8508 brd ff02::1 linklayer
        linklayer
        ether 00:0c:29:76:61:e0 txqueuelen 1000 (Ethernet)
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 brd 127.0.0.1 netmask 255.255.255.0
        loop txqueuelen 1000 (Local Loopback)
        RX packets 8 bytes 480 (480.0 B)
        RX errors 0 dropped 0 overruns 0 frame 0
        TX packets 8 bytes 480 (480.0 B)
        TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
root@vee-linux [10时24分48秒] [-]
-> # ./tcp_server1 192.168.160.22 8888
成功连接
打印的所有IP地址
```

```
root@vee-linux [10时24分34秒] [-/1652817-000108/03]
> # ifconfig
ens32: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 192.168.159.22 brd 255.255.255.0 broadcast 192.168.159.255
inet6 fe80::flic:34ba:b012:8508 brd ff02::1 linklayer
        linklayer
        ether 00:0c:29:99:df:a5 txqueuelen 1000 (Ethernet)
        RX packets 3322 bytes 377809 (368.9 KiB)
        RX errors 0 dropped 0 overruns 0 frame 0
        TX packets 2376 bytes 463816 (452.9 KiB)
        TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
ens32:0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
inet 192.168.160.22 brd 255.255.255.0 broadcast 192.168.160.255
inet6 fe80::flic:34ba:b012:8508 brd ff02::1 linklayer
        linklayer
        ether 00:0c:29:99:df:a5 txqueuelen 1000 (Ethernet)
lo: flags=73<UP,LOOPBACK,RUNNING> mtu 65536
inet 127.0.0.1 brd 127.0.0.1 netmask 255.255.255.0
        loop txqueuelen 1000 (Local Loopback)
        RX packets 8 bytes 480 (480.0 B)
        RX errors 0 dropped 0 overruns 0 frame 0
        TX packets 8 bytes 480 (480.0 B)
        TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0
root@vee-linux [10时24分48秒] [-/1652817-000108/03]
-> # ./tcp_client1 192.168.160.22 8888
成功连接, client IP:192.168.160.23 Port:50166
IP:192.168.160.22
IP:192.168.159.22
IP:127.0.0.1
成功连接, client IP:192.168.160.23 Port:50166
IP:192.168.160.22
IP:192.168.159.22
IP:127.0.0.1
```

2. 如果连接未绑定的 IP 地址，那么会连接被拒绝

The screenshot shows two terminal windows. The left window displays the output of the command `ifconfig` on a Linux system with multiple interfaces (ens32, ens32:0, lo). The right window shows the output of `netstat -an` and `lsof -i` commands, which list a listening TCP socket on port 50166 with local address 192.168.160.22 and remote address 192.168.159.23. A red circle highlights the text "连接被拒绝" (Connection refused) in the left window's output. Another red circle highlights the IP address in the netstat output.

```
root@vee-linux [10时24分48秒] [-]
-> # ./tcp_server1 192.168.160.22 8888
成功连接
连接被拒绝
root@vee-linux [10时28分13秒] [-]
-> # ./tcp_client1 192.168.159.22 8888
connection failed
: Connection refused
root@vee-linux [10时28分28秒] [-]
-> #
```

```
root@vee-linux [10时24分48秒] [-/1652817-000108/03]
-> # ./tcp_server1 192.168.160.22 8888
成功连接
IP:192.168.160.22
IP:192.168.159.22
IP:127.0.0.1
成功连接, client IP:192.168.160.23 Port:50166
IP:192.168.160.22
IP:192.168.159.22
IP:127.0.0.1
root@vee-linux [10时26分13秒] [-/1652817-000108/03]
-> # ./tcp_client1 192.168.160.22 8888
connection failed
: Connection refused
root@vee-linux [10时28分28秒] [-]
```

5 04 子目录

1. 测试 1: read/write

1.1 client 一次发送超过 20bytes 读取内容一致

The screenshot shows two terminal windows side-by-side. The left window is titled 'Session Manager' and lists several session entries. The right window is a terminal session with the following content:

```
root@vm_ubuntu: [11时17分49秒] [-]
-> # ./tcp_client4-1-1 192.168.159.22 8888
成功连接
准备发送33bytes
已发送33bytes
root@vm_ubuntu: [11时17分50秒] [-]
-> #
root@vm_ubuntu: [11时17分50秒] [-/1052817/000108/04]
-> # cat tcp_client4 1 23 | grep str
#include <string.h>
struct sockaddr_in address, serv_addr;
if(connect(sock, (struct sockaddr *)&serv_addr, sizeof(serv_
_addr)) <= 0)
{
    const char* str = "zhongyuchenzhongyuchen:zhongyuchen";
    strcpy(buffer, str);
    printf("准备发送%dbytes\n", strlen(str));
    int write_len = write(sock, buffer, strlen(str));
}
root@vm_ubuntu: [11时18分38秒] [-/1052817/000108/04]
-> #
```

A red circle highlights the output '准备发送33bytes' in the first terminal. Another red circle highlights the output '准备发送%dbytes\n' in the second terminal.

1.2 client 断续发送 20bytes 读取内容一致

The screenshot shows two terminal windows from SecureCRT. The left window is titled '192.168.159.23 - SecureCRT' and shows a client session. The right window is titled '817-000108/04' and shows a server session. Both windows have a red circle around them.

Client Session (Left):

```
root@192.168.159.23: ~]# ./tcp_client4-1-2 192.168.159.22 8888
-> # 
--> 0
正在连接
准备发送2bytes
已发送2bytes
sleep
准备发送2bytes
已发送2bytes
sleep
准备发送2bytes
已发送2bytes
sleep
准备发送2bytes
root@192.168.159.23: ~]# > #
```

Server Session (Right):

```
root@192.168.159.22: ~]# ./tcp_server4-1 192.168.159.22 8888
-> # 
成功连接, client IP:192.168.159.23 Port:53956
已读取2bytes
读取的内容是: zh
root@192.168.159.22: ~]# > #
```

A red arrow points from the text '但是client成功发送了两次' to the client session window. Another red arrow points from the text '可见server端只读了client第一次发送的2bytes数据' to the server session window.

2. 测试 2: recv/send

flag 位均为 0，结果和 read/write 一致

```

root@wsl:~[14时23分02秒] [~]
> # ls
tcp_client4-1: 192.168.159.22 8888
tcp_client4-2: 192.168.159.22 8888
成功连接
准备发送3bytes
已发送3bytes
已发送3bytes
成功连接
准备发送2bytes
已发送2bytes
sleep
准备发送2bytes
root@wsl:~[14时23分49秒] [~]
> a

root@wsl:~[14时23分10秒] [~/1652817-000108/04]
> # ./tcp_server4-2 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53646
读取20bytes
读取的内容是:zhongyuchenzhongyuch
root@wsl:~[14时23分10秒] [~/1652817-000108/04]
> # ./tcp_server4-2 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53648
读取20bytes
读取的内容是:zh
root@wsl:~[14时23分47秒] [~/1652817-000108/04]
> #

```

server 的 flag 位设为 MSG_WAITALL，可以读满 20 字节

```

root@wsl:~[14时23分49秒] [~]
> # ./tcp_client4-2 192.168.159.22 8888
成功连接
准备发送2bytes
已发送2bytes
sleep
root@wsl:~[14时28分29秒] [~]
> #

root@wsl:~[14时23分10秒] [~/1652817-000108/04]
> # ./tcp_server4-2 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53646
读取20bytes
读取的内容是:zhongyuchenzhenguch
root@wsl:~[14时23分10秒] [~/1652817-000108/04]
> # ./tcp_server4-2 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53648
读取20bytes
读取的内容是:zh
root@wsl:~[14时23分47秒] [~/1652817-000108/04]
> # vim ./tcp_server4-2.c
root@wsl:~[14时26分22秒] [~/1652817-000108/04]
> # make
root@wsl:~[14时26分22秒] [~/1652817-000108/04]
> # ./tcp_server4-2 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53650
读取20bytes
读取的内容是:zhongyuchenzhenguch
root@wsl:~[14时28分20秒] [~/1652817-000108/04]
> #

```

flag位设置为MSG_WAITALL

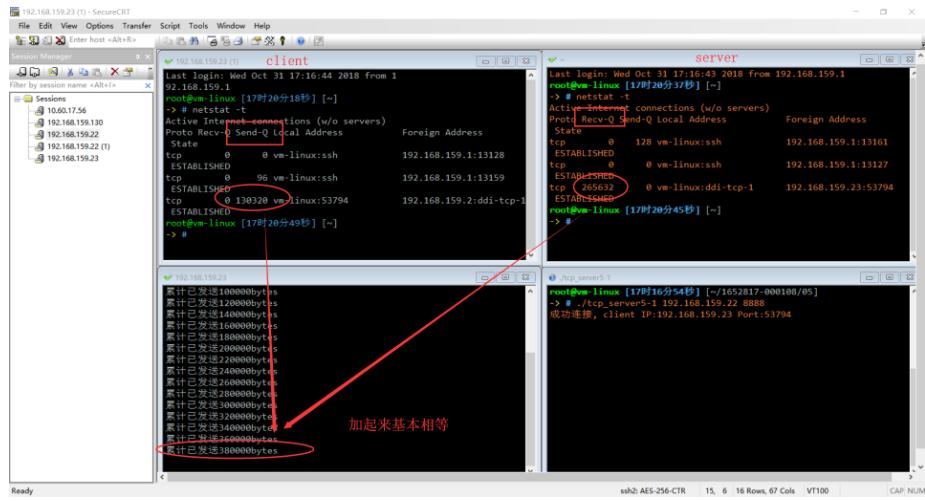
3. read/recv 和 write/send 使用区别

recv/send 与 read/write 之间唯一的区别就是前者可以指定实际操作的某些选项。后者是“通用”的文件描述符函数，而 recv/send 是更加专门细化的。比如，可以设置一个 flag 忽略 SIGPIPE。如果 flag 设置为 0，那么两者一样。

6 05 子目录

1. 测试 1

发送到 380000bytes 就阻塞了。



打开 netstat -t 查看 client 和 server 的信息，
其中

- Recv-Q: 如果是 Established 状态，数值表示连接到这个 socket 的程序尚未拷贝的字节数
- Send-Q: 如果是 Established 状态，数值表示没有被远程主机所接受的字节数。

注意到，Recv-Q 和 Send-Q 之和和发送的 bytes 数值基本相等。(如果关闭了 server，client 还会继续打印一条输出，显示发送了 395951bytes)

下面三张图显示了中间过程：

Three screenshots of a terminal session on host 192.168.159.23 showing the transfer of a file from port 53802 to port 8888.

Screenshot 1:

```
Every 2.0s: netstat -t   Wed Oct 31 17:33:04 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 vm-linux:ssh              192.168.159.1:13128 ESTABLISHED
tcp        0      0 vm-linux:ssh              192.168.159.1:13159 ESTABLISHED
tcp        0      0 vm-linux:53802             192.168.159.2:ddi-tcp-1 ESTABLISHED
tcp        0      0 vm-linux:ssh               192.168.159.1:13127 ESTABLISHED

Every 2.0s: netstat -t   Wed Oct 31 17:33:05 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 vm-linux:ssh              192.168.159.1:13161 ESTABLISHED
tcp        1400000  0 vm-linux:ddi-tcp-1     192.168.159.23:53802 ESTABLISHED
tcp        0      0 vm-linux:ssh               192.168.159.1:13127 ESTABLISHED

root@vm: ~]# ./tcp_client -s 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53802

累计已发送640000bytes
累计已发送660000bytes
累计已发送680000bytes
累计已发送700000bytes
累计已发送720000bytes
累计已发送740000bytes
累计已发送760000bytes
累计已发送780000bytes
累计已发送800000bytes
累计已发送820000bytes
累计已发送840000bytes
累计已发送860000bytes
累计已发送880000bytes
累计已发送900000bytes
累计已发送920000bytes
累计已发送940000bytes
累计已发送960000bytes
累计已发送980000bytes
累计已发送1000000bytes
累计已发送1020000bytes
累计已发送1040000bytes
累计已发送1060000bytes
累计已发送1080000bytes
累计已发送1100000bytes
累计已发送1120000bytes
累计已发送1140000bytes
累计已发送1160000bytes
累计已发送1180000bytes
累计已发送1200000bytes
累计已发送1220000bytes
累计已发送1240000bytes
累计已发送1260000bytes
累计已发送1280000bytes
累计已发送1300000bytes
累计已发送1320000bytes
累计已发送1340000bytes
累计已发送1360000bytes
累计已发送1380000bytes
累计已发送1400000bytes
```

Screenshot 2:

```
Every 2.0s: netstat -t   Wed Oct 31 17:33:12 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 vm-linux:ssh              192.168.159.1:13128 ESTABLISHED
tcp        0      0 vm-linux:ssh              192.168.159.1:13159 ESTABLISHED
tcp        14240   0 vm-linux:53802             192.168.159.2:ddi-tcp-1 ESTABLISHED
tcp        0      0 vm-linux:ssh               192.168.159.1:13127 ESTABLISHED

Every 2.0s: netstat -t   Wed Oct 31 17:33:13 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 vm-linux:ssh              192.168.159.1:13161 ESTABLISHED
tcp        265760  0 vm-linux:ddi-tcp-1     192.168.159.23:53802 ESTABLISHED
tcp        0      0 vm-linux:ssh               192.168.159.1:13127 ESTABLISHED

root@vm: ~]# ./tcp_server -s 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53802

累计已发送640000bytes
累计已发送660000bytes
累计已发送680000bytes
累计已发送700000bytes
累计已发送720000bytes
累计已发送740000bytes
累计已发送760000bytes
累计已发送780000bytes
累计已发送800000bytes
累计已发送820000bytes
累计已发送840000bytes
累计已发送860000bytes
累计已发送880000bytes
累计已发送900000bytes
累计已发送920000bytes
累计已发送940000bytes
累计已发送960000bytes
累计已发送980000bytes
累计已发送1000000bytes
累计已发送1020000bytes
累计已发送1040000bytes
累计已发送1060000bytes
累计已发送1080000bytes
累计已发送1100000bytes
累计已发送1120000bytes
累计已发送1140000bytes
累计已发送1160000bytes
累计已发送1180000bytes
累计已发送1200000bytes
累计已发送1220000bytes
累计已发送1240000bytes
累计已发送1260000bytes
累计已发送1280000bytes
累计已发送1300000bytes
累计已发送1320000bytes
累计已发送1340000bytes
累计已发送1360000bytes
累计已发送1380000bytes
累计已发送1400000bytes
```

Screenshot 3:

```
Every 2.0s: netstat -t   Wed Oct 31 17:33:22 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 vm-linux:ssh              192.168.159.1:13128 ESTABLISHED
tcp        0      0 vm-linux:ssh              192.168.159.1:13159 ESTABLISHED
tcp        0 130320  vm-linux:53802            192.168.159.2:ddi-tcp-1 ESTABLISHED
tcp        0      0 vm-linux:ssh               192.168.159.1:13127 ESTABLISHED

Every 2.0s: netstat -t   Wed Oct 31 17:33:21 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 vm-linux:ssh              192.168.159.1:13161 ESTABLISHED
tcp        0      0 vm-linux:ddi-tcp-1     192.168.159.23:53802 ESTABLISHED
tcp        0      0 vm-linux:ssh               192.168.159.1:13127 ESTABLISHED

root@vm: ~]# ./tcp_server -s 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53802

累计已发送640000bytes
累计已发送660000bytes
累计已发送680000bytes
累计已发送700000bytes
累计已发送720000bytes
累计已发送740000bytes
累计已发送760000bytes
累计已发送780000bytes
累计已发送800000bytes
累计已发送820000bytes
累计已发送840000bytes
累计已发送860000bytes
累计已发送880000bytes
累计已发送900000bytes
累计已发送920000bytes
累计已发送940000bytes
累计已发送960000bytes
累计已发送980000bytes
累计已发送1000000bytes
累计已发送1020000bytes
累计已发送1040000bytes
累计已发送1060000bytes
累计已发送1080000bytes
累计已发送1100000bytes
累计已发送1120000bytes
累计已发送1140000bytes
累计已发送1160000bytes
累计已发送1180000bytes
累计已发送1200000bytes
累计已发送1220000bytes
累计已发送1240000bytes
累计已发送1260000bytes
累计已发送1280000bytes
累计已发送1300000bytes
累计已发送1320000bytes
累计已发送1340000bytes
累计已发送1360000bytes
累计已发送1380000bytes
累计已发送1400000bytes
```

Three screenshots of a terminal session showing the execution of a TCP server and monitoring network traffic.

Screenshot 1:

```

./tcp_server5-1
File Edit View Options Transfer Script Tools Window Help
Session Manager
Filter by session name -All+>
192.168.159.23 (1)
Every 1.0s: netstat -t   Wed Oct 31 17:56:06 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      0      0 vm-linux:53818          192.168.159.2:ddi-tcp-1
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13128
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13159
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13127
ESTABLISHED

```

Screenshot 2:

```

Every 1.0s: netstat -t   Wed Oct 31 17:56:07 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      253776    0 vm-linux:ddi-tcp-1  192.168.159.23:53818
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13161
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13127
ESTABLISHED

```

Screenshot 3:

```

root@vm-linux [17时55分18秒] (~/1652817-000108/05)
> # ./tcp_server5-1 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53818

累计已读取100000bytes
累计已读取120000bytes
累计已读取140000bytes
累计已读取160000bytes
累计已读取180000bytes
累计已读取200000bytes
累计已读取220000bytes
累计已读取240000bytes
累计已读取260000bytes
累计已读取280000bytes
累计已读取300000bytes
累计已读取320000bytes
累计已读取340000bytes
累计已读取360000bytes
累计已读取380000bytes

```

Screenshot 4:

```

Every 1.0s: netstat -t   Wed Oct 31 17:56:11 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      57496    0 vm-linux:53818          192.168.159.2:ddi-tcp-1
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13128
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13159
ESTABLISHED

```

Screenshot 5:

```

Every 1.0s: netstat -t   Wed Oct 31 17:56:12 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      263016    0 vm-linux:ddi-tcp-1  192.168.159.23:53818
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13161
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13127
ESTABLISHED

```

Screenshot 6:

```

root@vm-linux [17时55分18秒] (~/1652817-000108/05)
> # ./tcp_server5-1 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53818

累计已读取110000bytes
累计已读取120000bytes

```

Screenshot 7:

```

Every 1.0s: netstat -t   Wed Oct 31 17:56:16 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      93712    0 vm-linux:53818          192.168.159.2:ddi-tcp-1
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13128
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13159
ESTABLISHED

```

Screenshot 8:

```

Every 1.0s: netstat -t   Wed Oct 31 17:56:15 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      259840    0 vm-linux:ddi-tcp-1  192.168.159.23:53818
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13161
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13127
ESTABLISHED

```

Screenshot 9:

```

root@vm-linux [17时55分18秒] (~/1652817-000108/05)
> # ./tcp_server5-1 192.168.159.22 8888
成功连接, client IP:192.168.159.23 Port:53818

累计已读取100000bytes
累计已读取200000bytes
累计已读取300000bytes
累计已读取400000bytes
累计已读取500000bytes
累计已读取600000bytes
累计已读取700000bytes
累计已读取800000bytes
累计已读取900000bytes
累计已读取1000000bytes
累计已读取1100000bytes

```

如果 server 端开始 read, 变化过程如上三张图所示. server 大致从读了 80000 个 bytes 开始, client 开始显示继续发送. 这个过程中, 先是 recv-Q 开始降低, 然后马上 send-Q 降低. 当 send-Q 降低到一定程度时, client 结束阻塞, 继续发送. 这说明了如果接收的缓冲区有空, 那么发送的缓冲区将立即发送到接收缓冲区; 如果发送的缓冲区有足够的空位, 那么 client 将继续发送. 这就是生产者-消费者模型.

2. 测试 2 交换 client server

结果和测试 1 一样. 差不都也是发送 380000 开始阻塞. 读取 80000 个 bytes 后, server 开始继续发送.

The screenshot shows two terminal windows in SecureCRT. Both windows are connected to the host 192.168.159.23. The top window shows the output of the command 'netstat -t' at two different times: 18:07:39 and 18:07:40. The bottom window shows the output of 'tcpdump -n' at two different times: 18:07:39 and 18:07:40. The bottom window also displays the client's log messages indicating the progress of data transmission.

```
192.168.159.23 - SecureCRT
File Edit View Options Transfer Script Tools Window Help
Session Manager
Filter by session name <All>
Session Manager
192.168.159.23
192.168.159.130
192.168.159.22
192.168.159.23 (1)
192.168.159.23
Every 1.0s: netstat -t      Wed Oct 31 18:07:39 2012
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp    0      0      vm-linux:53826        192.168.159.2:ddi-tcp-1
ESTABLISHED
tcp    0      0      vm-linux:ssh         192.168.159.1:13161
ESTABLISHED
tcp    0      0      vm-linux:ssh         192.168.159.1:13127
ESTABLISHED
tcp    0      0      vm-linux:ddi-tcp-1   192.168.159.23:53826
ESTABLISHED
tcp    0      0      vm-linux:41462       192.168.159.23:ssh
TIME_WAIT
Every 1.0s: netstat -t      Wed Oct 31 18:07:40 2012
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp    0      0      vm-linux:ssh         192.168.159.1:13161
ESTABLISHED
tcp    0      0      vm-linux:ssh         192.168.159.1:13127
ESTABLISHED
tcp    0      0      vm-linux:ddi-tcp-1   192.168.159.23:53826
ESTABLISHED
tcp    0      0      vm-linux:41462       192.168.159.23:ssh
TIME_WAIT
192.168.159.23
root@vm-linux [18时07分24秒] [-]
> # ./tcp_client5-2 192.168.159.22 8888
成功连接
累计已发送20000bytes
累计已发送40000bytes
累计已发送60000bytes
累计已发送80000bytes
累计已发送100000bytes
累计已发送120000bytes
累计已发送140000bytes
累计已发送160000bytes
累计已发送180000bytes
累计已发送200000bytes
累计已发送220000bytes
累计已发送240000bytes
累计已发送260000bytes
累计已发送280000bytes
192.168.159.23 - SecureCRT
File Edit View Options Transfer Script Tools Window Help
Session Manager
Filter by session name <All>
Session Manager
192.168.159.23
192.168.159.130
192.168.159.22
192.168.159.23 (1)
192.168.159.23
Every 1.0s: netstat -t      Wed Oct 31 18:07:40 2012
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp    0      0      vm-linux:53826        192.168.159.2:ddi-tcp-1
ESTABLISHED
tcp    0      0      vm-linux:ssh         192.168.159.1:13161
ESTABLISHED
tcp    0      0      vm-linux:ssh         192.168.159.1:13127
ESTABLISHED
tcp    0      0      vm-linux:ddi-tcp-1   192.168.159.23:53826
ESTABLISHED
tcp    0      0      vm-linux:41462       192.168.159.23:ssh
TIME_WAIT
Every 1.0s: netstat -t      Wed Oct 31 18:07:41 2012
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp    0      0      vm-linux:ssh         192.168.159.1:13161
ESTABLISHED
tcp    0      0      vm-linux:ssh         192.168.159.1:13127
ESTABLISHED
tcp    0      0      vm-linux:ddi-tcp-1   192.168.159.23:53826
ESTABLISHED
tcp    0      0      vm-linux:41462       192.168.159.23:ssh
TIME_WAIT
192.168.159.23
root@vm-linux [18时07分24秒] [-]
> # ./tcp_client5-2 192.168.159.22 8888
成功连接
累计已发送20000bytes
累计已发送40000bytes
累计已发送60000bytes
累计已发送80000bytes
累计已发送100000bytes
累计已发送120000bytes
累计已发送140000bytes
累计已发送160000bytes
累计已发送180000bytes
累计已发送200000bytes
累计已发送220000bytes
累计已发送240000bytes
累计已发送260000bytes
累计已发送280000bytes

```

Three screenshots of a SecureCRT session on host 192.168.159.23 showing network traffic analysis and file transfer.

Screenshot 1:

- Session Manager:** Shows sessions 10.6.0.156, 192.168.159.130, 192.168.159.22, and 192.168.159.23.
- Terminal 1:** netstat -t output showing connections to 192.168.159.22:8888.
- Terminal 2:** netstat -t output showing connections to 192.168.159.23:53826.
- Terminal 3:** nc -l -p 8888 command followed by ./tcp_clients -2 192.168.159.22 8888. A red circle highlights the connection to 192.168.159.22:8888.
- Terminal 4:** watch command showing cumulative byte counts sent to 192.168.159.22:8888. A red circle highlights the final byte count of 3800000 bytes.

Screenshot 2:

- Session Manager:** Shows sessions 10.6.0.156, 192.168.159.130, 192.168.159.22, and 192.168.159.23.
- Terminal 1:** netstat -t output showing connections to 192.168.159.22:8888.
- Terminal 2:** netstat -t output showing connections to 192.168.159.23:53826.
- Terminal 3:** nc -l -p 8888 command followed by ./tcp_clients -2 192.168.159.22 8888. A red circle highlights the connection to 192.168.159.22:8888.
- Terminal 4:** watch command showing cumulative byte counts sent to 192.168.159.22:8888. A red circle highlights the final byte count of 3800000 bytes.

Screenshot 3:

- Session Manager:** Shows sessions 10.6.0.156, 192.168.159.130, 192.168.159.22, and 192.168.159.23.
- Terminal 1:** netstat -t output showing connections to 192.168.159.22:8888.
- Terminal 2:** netstat -t output showing connections to 192.168.159.23:53826.
- Terminal 3:** nc -l -p 8888 command followed by ./tcp_clients -2 192.168.159.22 8888. A red circle highlights the connection to 192.168.159.22:8888.
- Terminal 4:** watch command showing cumulative byte counts sent to 192.168.159.22:8888. A red circle highlights the final byte count of 3800000 bytes.

The screenshot shows the SecureCRT application interface with three main panes:

- Session Manager:** Shows five sessions: 10.60.17.56, 192.168.159.130, 192.168.159.22, 192.168.159.22 (T), and 192.168.159.23.
- Session 1 (192.168.159.23):** Displays the output of the command "netstat -t".
- Session 2 (192.168.159.23):** Displays the output of the command "netstat -t".
- Terminal Window:** Labeled ".php_server5-2", showing a log of file transfers between two hosts.

```

Every 1.0s: netstat -t                               Wed Oct 31 18:08:18 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp   259448      0 vm-linux:50826        192.168.159.2:ddi-tcp-1
tcp     0         0 vm-linux:ssh          192.168.159.1:3128
tcp     0         0 vm-linux:ssh          192.168.159.1:3128
tcp     0         0 vm-linux:ssh          192.168.159.1:3159
tcp     0         0 vm-linux:ssh          ESTABLISHED

Every 1.0s: netstat -t                               Wed Oct 31 18:08:19 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp     0         0 vm-linux:ssh          192.168.159.1:13161
tcp     0         0 vm-linux:ssh          192.168.159.1:13127
tcp     0       94688 vm-linux:ddi-tcp-1    192.168.159.23:53826
tcp     0         0 vm-linux:ssh          ESTABLISHED

成功连接
累计已接收10000bytes
累计已接收20000bytes
累计已接收30000bytes
累计已接收40000bytes
累计已接收50000bytes
累计已接收60000bytes
累计已接收70000bytes
累计已接收80000bytes
累计已接收90000bytes
累计已接收100000bytes
累计已接收110000bytes
累计已接收120000bytes
累计已接收130000bytes
累计已发送460000bytes

```

3. 测试 3 改变缓冲区大小

使用 setsockopt 函数.

```

vim - vim
File Edit View Options Transfer Script Tools Window Help
File Edit View Options Transfer Script Tools Window Help
Session Manager
Sessions
10.60.17.56
192.168.159.130
192.168.159.22
192.168.159.22 (1)
192.168.159.23

16 int main(int argc, char *argv[]){
17     if(argc != 3){
18         perror("Usage: ./tcp_server ip port\n");
19         exit(EXIT_FAILURE);
20     }
21     int port = atoi(argv[2]);
22
23     int server_fd, new_socket, valread;
24     struct sockaddr_in address;
25     int opt = 1;
26     socklen_t addrlen = sizeof(address);
27     char buffer[BUFFER_SIZE] = {0};
28
29     // Create socket file descriptor
30     if ((server_fd = socket(AF_INET, SOCK_STREAM, 0)) < 0) {
31         perror("socket failed");
32         exit(EXIT_FAILURE);
33     }
34
35     // Forcefully attaching socket to the given port
36     if (setsockopt(server_fd, SOL_SOCKET, SO_REUSEADDR , &opt, sizeof(opt)) < 0) {
37         perror("Setsockopt failed");
38         exit(EXIT_FAILURE);
39     }
40     int recv_buf = 64*1024;
41     if(setsockopt(server_fd, SOL_SOCKET, SO_RCVBUF, (const char*)&recv_buf, sizeof(int)) < 0){
42         perror("Setsockopt buffer size failed");
43         exit(EXIT_FAILURE);
44     }
45
46     address.sin_family = AF_INET;
47     address.sin_addr.s_addr = inet_addr(argv[1]);
48     address.sin_port = htons(port);
49
50     // Forcefully attaching socket to the given port
51     if (bind(server_fd, (struct sockaddr *)&address, sizeof(address)) < 0) {
52         perror("Bind failed");
53     }
54     listen(server_fd, 3);
55     if ((new_socket = accept(server_fd, (struct sockaddr *)&address, &addrlen)) < 0) {
56         perror("accept failed");
57     }
58
59     valread = read(new_socket, buffer, recv_buf);
60     if(valread < 0) {
61         perror("Reading failed");
62     }
63     else {
64         write(new_socket, buffer, valread);
65     }
66
67     close(new_socket);
68     close(server_fd);
69
70     return 0;
71 }

```

Ready

```

vim - vim
File Edit View Options Transfer Script Tools Window Help
File Edit View Options Transfer Script Tools Window Help
Session Manager
Sessions
10.60.17.56
192.168.159.130
192.168.159.22
192.168.159.22 (1)
192.168.159.23

1 // Client side C program
2 #include <stdio.h>
3 #include <sys/types.h>
4 #include <sys/socket.h>
5 #include <sys/types.h>
6 #include <sys/socket.h>
7 #include <netinet/in.h>
8 #include <string.h>
9
10 #define BUFFER_SIZE 21000
11
12 int main(int argc, char *argv[]){
13     if(argc != 3) {
14         perror("Usage: ./tcp_client ip port\n");
15         exit(EXIT_FAILURE);
16     }
17     int port = atoi(argv[2]);
18
19     struct sockaddr_in address, serv_addr;
20     int sock = 0, valread;
21     char buffer[BUFFER_SIZE] = {0};
22
23     if( (sock = socket(AF_INET, SOCK_STREAM, 0)) < 0) {
24         perror("Socket failed\n");
25         exit(EXIT_FAILURE);
26     }
27
28     int send_buf = 64*1024;
29     if(setsockopt(sock, SOL_SOCKET, SO_SNDBUF, (const char*)&send_buf, sizeof(int)) < 0){
30         perror("Setsockopt failed");
31         exit(EXIT_FAILURE);
32     }
33
34     memset(&serv_addr, 0, sizeof(serv_addr));
35     serv_addr.sin_family = AF_INET;
36     serv_addr.sin_port = htons(port);
37     serv_addr.sin_addr.s_addr = inet_addr(argv[1]);
38
39     connect(sock, (struct sockaddr *)&serv_addr, sizeof(serv_addr));
40
41     valread = read(sock, buffer, send_buf);
42     if(valread < 0) {
43         perror("Reading failed");
44     }
45     else {
46         write(sock, buffer, valread);
47     }
48
49     close(sock);
50
51     return 0;
52 }

```

Ready

Three screenshots of a SecureCRT session on host 192.168.159.23 showing network traffic analysis and client-server communication.

Screenshot 1:

- Session Manager: Shows sessions 10.80.17.56, 192.168.159.130, 192.168.159.22, and 192.168.159.23.
- Terminal 1 (Top Left): netstat -t output at 18:36:38 on Oct 31, 2018. Shows connections to 192.168.159.22:8888.
- Terminal 2 (Top Right): netstat -t output at 18:36:38 on Oct 31, 2018. Shows connections from 192.168.159.23:53850 to 192.168.159.1:13128.
- Terminal 3 (Bottom Left): /tcp_client5-3 output. Shows connection statistics up to 80000 bytes.
- Terminal 4 (Bottom Right): /tcp_server5-3 output. Shows connection statistics up to 80000 bytes.

Screenshot 2:

- Session Manager: Shows sessions 10.80.17.56, 192.168.159.130, 192.168.159.22, and 192.168.159.23.
- Terminal 1 (Top Left): netstat -t output at 18:34:51 on Oct 31, 2018. Shows connections to 192.168.159.22:8888.
- Terminal 2 (Top Right): netstat -t output at 18:34:50 on Oct 31, 2018. Shows connections from 192.168.159.23:53844 to 192.168.159.1:13128.
- Terminal 3 (Bottom Left): /tcp_client5-3 output. Shows connection statistics up to 100000 bytes.
- Terminal 4 (Bottom Right): /tcp_server5-3 output. Shows connection statistics up to 100000 bytes.

Screenshot 3:

- Session Manager: Shows sessions 10.80.17.56, 192.168.159.130, 192.168.159.22, and 192.168.159.23.
- Terminal 1 (Top Left): netstat -t output at 18:36:49 on Oct 31, 2018. Shows connections to 192.168.159.22:8888.
- Terminal 2 (Top Right): netstat -t output at 18:36:48 on Oct 31, 2018. Shows connections from 192.168.159.23:53850 to 192.168.159.1:13128.
- Terminal 3 (Bottom Left): /tcp_client5-3 output. Shows connection statistics up to 720000 bytes.
- Terminal 4 (Bottom Right): /tcp_server5-3 output. Shows connection statistics up to 720000 bytes.

Three screenshots of a terminal session showing network traffic between two hosts.

Screenshot 1:

- Terminal 1 (tcp_server5-3):
 - Output of netstat -t: Shows active connections to 192.168.159.22 (port 8888) and 192.168.159.23 (port 53850).
 - Output of netstat -i: Shows interface statistics for vm-linux:ssh and vm-linux:ddi-tcp-1.
 - Output of ./tcp_client5-3 192.168.159.22 8888: Shows a successful connection attempt and data exchange (bytes sent/received).
- Terminal 2 (tcp_server5-3):
 - Output of netstat -t: Shows active connections from 192.168.159.22 (port 8888) and 192.168.159.23 (port 53850).
 - Output of netstat -i: Shows interface statistics for vm-linux:ssh and vm-linux:ddi-tcp-1.
 - Output of ./tcp_client5-3 192.168.159.22 8888: Shows a successful connection attempt and data exchange (bytes sent/received).

Screenshot 2:

- Terminal 1 (tcp_server5-3):
 - Output of netstat -t: Shows active connections to 192.168.159.22 (port 8888) and 192.168.159.23 (port 53850).
 - Output of netstat -i: Shows interface statistics for vm-linux:ssh and vm-linux:ddi-tcp-1.
 - Output of ./tcp_client5-3 192.168.159.22 8888: Shows a successful connection attempt and data exchange (bytes sent/received).
- Terminal 2 (tcp_server5-3):
 - Output of netstat -t: Shows active connections from 192.168.159.22 (port 8888) and 192.168.159.23 (port 53850).
 - Output of netstat -i: Shows interface statistics for vm-linux:ssh and vm-linux:ddi-tcp-1.
 - Output of ./tcp_client5-3 192.168.159.22 8888: Shows a successful connection attempt and data exchange (bytes sent/received).

Screenshot 3:

- Terminal 1 (tcp_server5-3):
 - Output of netstat -t: Shows active connections to 192.168.159.22 (port 8888) and 192.168.159.23 (port 53850).
 - Output of netstat -i: Shows interface statistics for vm-linux:ssh and vm-linux:ddi-tcp-1.
 - Output of ./tcp_client5-3 192.168.159.22 8888: Shows a successful connection attempt and data exchange (bytes sent/received).
- Terminal 2 (tcp_server5-3):
 - Output of netstat -t: Shows active connections from 192.168.159.22 (port 8888) and 192.168.159.23 (port 53850).
 - Output of netstat -i: Shows interface statistics for vm-linux:ssh and vm-linux:ddi-tcp-1.
 - Output of ./tcp_client5-3 192.168.159.22 8888: Shows a successful connection attempt and data exchange (bytes sent/received).

7 06 子目录

1. 测试 1

都先 read，结果双方都阻塞了。符合预期。

```
Last login: Wed Oct 31 20:08:25 2018 from 192.168.159.1
root@vm-linux [20时10分46秒] [-]
> # netstat -t
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 vm-linux:ssh              192.168.159.2:ddi-tcp-1 ESTABLISHED
tcp        0      0 vm-linux:ssh              192.168.159.1:14941 ESTABLISHED
tcp        0      96 vm-linux:ssh             192.168.159.1:14947 ESTABLISHED
root@vm-linux [20时11分03秒] [-]
-> #
```

```
Last login: Wed Oct 31 18:31:19 2018 from 1
92.168.159.3
root@vm-linux [20时10分46秒] [-]
> # netstat -t
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 vm-linux:ssh              192.168.159.1:13127 ESTABLISHED
tcp        0      128 vm-linux:ssh             192.168.159.1:14946 ESTABLISHED
tcp        0      0 vm-linux:ddi-tcp-1       192.168.159.23:53880 ESTABLISHED
root@vm-linux [20时11分00秒] [-]
-> #
```

```
root@vm-linux [20时00分58秒] [-]
> # ./tcp_client 6-1 192.168.159.22 8888 1000 1000
成功连接

root@vm-server-1 [20时00分55秒] [-]
> # ./tcp_server 6-1 8888 1000 1000
成功连接, client IP:192.168.159.23 Port:53880
```

都阻塞了，这种情况类似于死锁

2. 测试 2

都是先写，会在一开始产生一点点缓存

1000/1000，读写正常

```
Every 1.0s: netstat -t                               Wed Oct 31 20:57:58 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp        0      0 vm-linux:ssh              192.168.159.2:ddi-res ESTABLISHED
tcp        0      0 vm-linux:ssh              192.168.159.1:ibm-res ESTABLISHED
tcp        0      0 vm-linux:ssh              192.168.159.1:sophia-lm ESTABLISHED
tcp      1000      0 vm-linux:53910          192.168.159.2:ddi-tcp-1 ESTABLISHED
ESTABLISHED
```

```
watch
Every 1.0s: netstat -t                               Wed Oct 31 20:57:58 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address         State
tcp      1000      0 vm-linux:ddi-tcp-1       192.168.159.23:53910 ESTABLISHED
tcp        0      0 vm-linux:ssh              192.168.159.1:13127 ESTABLISHED
tcp        0      0 vm-linux:ssh              192.168.159.1:netlabs-1m ESTABLISHED
```

```
192.168.159.21
累计已发送5000bytes
累计已读取5000bytes
累计已发送6000bytes
累计已读取6000bytes
累计已发送16000bytes
累计已读取16000bytes
累计已发送7000bytes
累计已读取7000bytes
累计已发送8000bytes
累计已读取8000bytes
累计已发送9000bytes
累计已读取9000bytes
累计已发送10000bytes
累计已读取10000bytes
累计已发送11000bytes
累计已读取11000bytes
累计已发送12000bytes
```

```
192.168.159.21
累计已发送5000bytes
累计已读取5000bytes
累计已发送6000bytes
累计已读取6000bytes
累计已发送16000bytes
累计已读取16000bytes
累计已发送7000bytes
累计已读取7000bytes
累计已发送8000bytes
累计已读取8000bytes
累计已发送9000bytes
累计已读取9000bytes
累计已发送10000bytes
累计已读取10000bytes
累计已发送11000bytes
累计已读取11000bytes
累计已发送12000bytes
```

1000/500 500/1000, client 是发送比读取多一倍, server 是读取比发送多一倍. 正好打平.

```

192.168.159.23 - SecureCRT
File Edit View Options Transfer Script Tools Window Help
Session Manager
Filter by session name <All>
Sessions
10.60.17.56
192.168.159.130
192.168.159.22 (1)
192.168.159.23

Every 1.0s: netstat -t      Wed Oct 31 20:59:41 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      0      0 vm-linux:ssh          192.168.159.1:ibm-res
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:sophia-le
ESTABLISHED
tcp      500     0 vm-linux:53912        192.168.159.2:ddi-tcp-1
ESTABLISHED

Every 1.0s: netstat -t      Wed Oct 31 20:59:40 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      1000    0 vm-linux:ddi-tcp-1   192.168.159.23:53912
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:13127
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.:netlabs-lm
ESTABLISHED

192.168.159.23
累计已发送1000bytes
累计已读取1000bytes
累计已发送3000bytes
累计已读取3000bytes
累计已发送4000bytes
累计已读取2000bytes
累计已发送2000bytes
累计已读取1500bytes
累计已发送2500bytes
累计已读取2500bytes
累计已发送3000bytes
累计已读取3000bytes
累计已发送7000bytes
累计已读取3500bytes
累计已发送3500bytes
累计已读取4000bytes
累计已发送4000bytes
累计已读取3000bytes
累计已发送4500bytes
累计已发送4500bytes

.php_server6
累计已发送1000bytes
累计已读取1000bytes
累计已发送2000bytes
累计已读取2000bytes
累计已发送3000bytes
累计已读取3000bytes
累计已发送4000bytes
累计已读取4000bytes
累计已发送5000bytes
累计已读取5000bytes
累计已发送6000bytes
累计已读取6000bytes
累计已发送7000bytes
累计已读取7000bytes
累计已发送8000bytes
累计已读取8000bytes
累计已发送9000bytes
累计已读取9000bytes
累计已发送10000bytes
累计已读取10000bytes
累计已发送11000bytes
累计已读取11000bytes
累计已发送12000bytes
累计已读取12000bytes
累计已发送13000bytes
累计已读取13000bytes
累计已发送14000bytes
累计已读取14000bytes
累计已发送15000bytes
累计已读取15000bytes
累计已发送16000bytes
累计已读取16000bytes

```

1000/1000 700/700, client 的接收没有 server 发送快, 所以造成 recv 缓冲区堆积. 而 client 的发送没有 server 接收快, 所以 server 能及时全部接收.

```

192.168.159.23 - SecureCRT
File Edit View Options Transfer Script Tools Window Help
Session Manager
Filter by session name <All>
Sessions
10.60.17.56
192.168.159.130
192.168.159.22 (1)
192.168.159.23

Every 1.0s: netstat -t      Wed Oct 31 21:03:18 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      0      0 vm-linux:ssh          192.168.159.1:ibm-res
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.1:sophia-le
ESTABLISHED
tcp      7000    0 vm-linux:53914        192.168.159.2:ddi-tcp-1
ESTABLISHED
ESTABLISHED

Every 1.0s: netstat -t      Wed Oct 31 21:03:19 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State
tcp      0      0 vm-linux:ssh          192.168.159.1:13127
ESTABLISHED
tcp      400     0 vm-linux:ddi-tcp-1   192.168.159.23:53914
ESTABLISHED
tcp      0      0 vm-linux:ssh          192.168.159.:netlabs-lm
ESTABLISHED

192.168.159.23
累计已发送11200bytes
累计已读取11200bytes
累计已发送11900bytes
累计已读取11900bytes
累计已发送12600bytes
累计已读取12600bytes
累计已发送13300bytes
累计已读取13300bytes
累计已发送14000bytes
累计已读取14000bytes
累计已发送14700bytes
累计已读取14700bytes
累计已发送15400bytes
累计已读取15400bytes
累计已发送16100bytes
累计已读取16100bytes

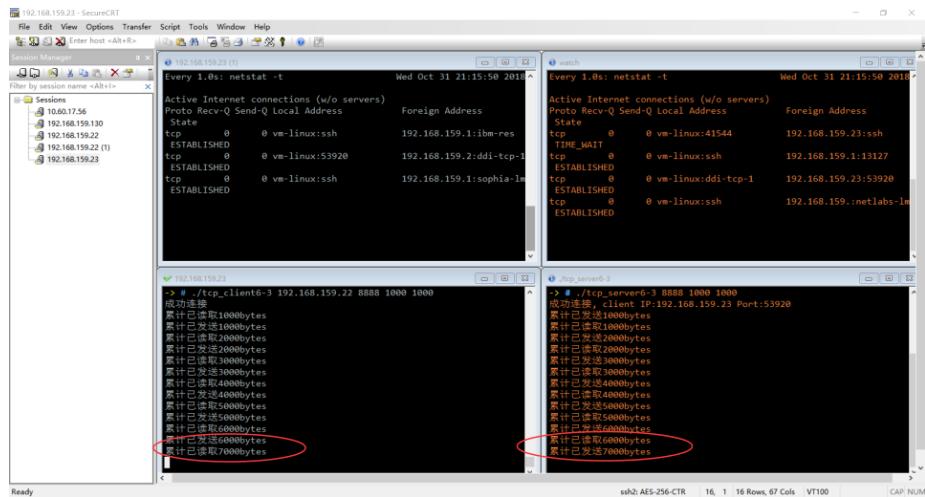
.php_server6
累计已发送1600bytes
累计已读取1600bytes
累计已发送3200bytes
累计已读取3200bytes
累计已发送6400bytes
累计已读取6400bytes
累计已发送12800bytes
累计已读取12800bytes
累计已发送25600bytes
累计已读取25600bytes
累计已发送51200bytes
累计已读取51200bytes
累计已发送102400bytes
累计已读取102400bytes
累计已发送204800bytes
累计已读取204800bytes
累计已发送409600bytes
累计已读取409600bytes
累计已发送819200bytes
累计已读取819200bytes
累计已发送1638400bytes
累计已读取1638400bytes

```

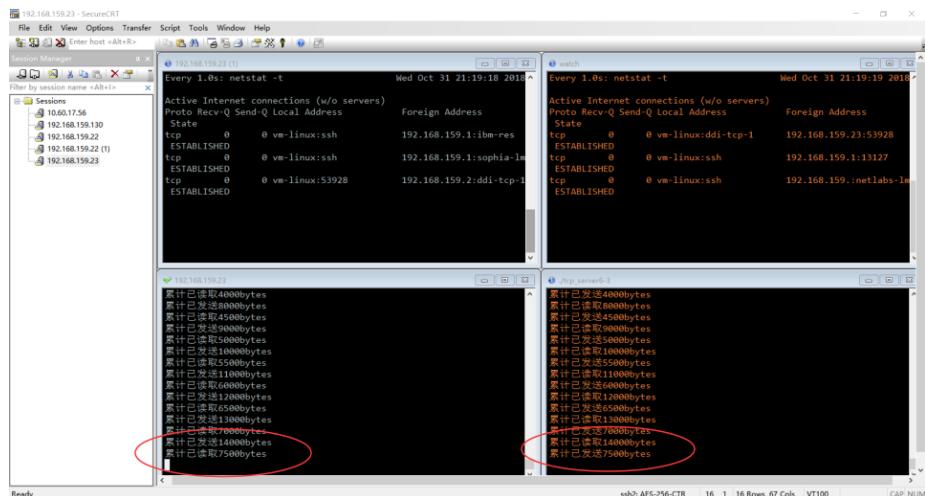
3. 测试 3

一读一写, 如果读写速度一致, 一般没有缓存发生

1000/1000, 读写正常



1000/500 500/1000, 同测试 2, client 是发送比读取多一倍, server 是读取比发送多一倍. 正好打平.



1000/1000 700/700, 同测试 2, client 的接收没有 server 发送快, 所以造成 recv 缓冲区堆积. 而 client 的发送没有 server 接收快, 所以 server 能及时全部接收.

The screenshot shows a Windows terminal window with two tabs open. The top tab displays the command `netstat -t` output:

```
Every 1.0s: netstat -t                               Wed Oct 31 21:27:08 2016
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
State      PID   User          State       PID   User
tcp        0     0 vm-linux:53930      192.168.159.2:ddi-tcp-1
ESTABLISHED
tcp        0     0 vm-linux:ssh       192.168.159.1:ibm-res
ESTABLISHED
tcp        0     0 vm-linux:ssh       192.168.159.1:sophia-im
ESTABLISHED
```

The bottom tab displays the command `tasklist` output:

```
102.168.159.23
累计已读取500bytes
累计已发送900bytes
累计已读取1200bytes
累计已发送560bytes
累计已读取1000bytes
累计已发送300bytes
累计已读取600bytes
累计已发送200bytes
累计已读取1300bytes
累计已发送700bytes
累计已读取800bytes
累计已发送400bytes
累计已读取1700bytes
累计已发送100bytes
累计已读取9400bytes
```

The right side of the terminal window shows the system tray with several icons.

4. 测试 4

结果和测试 3 一样.

1000/1000, 读写正常

Session Manager

Filter by session name <Alt>+<Shift>+<F>

Sessions

- 192.168.17.56
- 192.168.159.10
- 192.168.159.22
- 192.168.159.22 (l)
- 192.168.159.23

Every 1.0s: netstat -t Wed Oct 31 22:02:39 2016

Proto	Recv-Q	Send-Q	Local Address	Foreign Address	State
tcp	0	0	vm-linux:ssh	192.168.159.1:ibm-res	ESTABLISHED
tcp	0	0	vm-linux:ssh	192.168.159.1:sophia-lm	ESTABLISHED
tcp	0	0	vm-linux:53944	192.168.159.2:ddi-tcp-1	ESTABLISHED

Every 1.0s: netstat -t Wed Oct 31 22:02:39 2016

Proto	Recv-Q	Send-Q	Local Address	Foreign Address	State
tcp	0	0	vm-linux:ddi-tcp-1	192.168.159.23:53944	ESTABLISHED
tcp	0	0	vm-linux:ssh	192.168.159.1:13127	ESTABLISHED
tcp	0	0	vm-linux:ssh	192.168.159.2:netbeans-lm	ESTABLISHED
tcp	0	0	vm-linux:41562	192.168.159.23:ssh	TIME_WAIT

累计已发送1000bytes
累计已读取1000bytes
累计已发送2000bytes
累计已读取2000bytes
累计已发送3000bytes
累计已读取3000bytes
累计已发送4000bytes
累计已读取4000bytes
累计已发送5000bytes
累计已读取5000bytes
累计已发送6000bytes
累计已读取6000bytes
累计已发送7000bytes
累计已读取7000bytes
累计已发送8000bytes

1000/500 500/1000, 同测试 2, client 是发送比读取多一倍, server 是读取比发送多一倍, 正好打平.

```

192.168.159.23 - SecureCRT
File Edit View Options Transfer Script Tools Window Help
Session Manager Enter host: <All>>
Filter by session name <All>>
Sessions:
192.168.159.23 (1)
Every 1.0s: netstat -t   Wed Oct 31 22:03:22 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
tcp        0      0 vm-linux:ssh          192.168.159.1:ibm-res
State
ESTABLISHED
tcp        0      0 vm-linux:53946       192.168.159.2:ddi-tcp-1
ESTABLISHED
tcp        0      0 vm-linux:ssh          192.168.159.1:sophia-lm
ESTABLISHED

192.168.159.23 (2)
Every 1.0s: netstat -t   Wed Oct 31 22:03:23 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
tcp        0      0 vm-linux:ssh          192.168.159.1:13127
State
ESTABLISHED
tcp        0      0 vm-linux:ssh          192.168.159.:netlabs-lm
ESTABLISHED
tcp        0      0 vm-linux:ddi-tcp-1    192.168.159.23:53946
ESTABLISHED

watch
Every 1.0s: netstat -t
Wed Oct 31 22:03:23 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
tcp        0      0 vm-linux:ssh          192.168.159.1:13127
State
ESTABLISHED
tcp        0      0 vm-linux:ssh          192.168.159.:netlabs-lm
ESTABLISHED
tcp        0      0 vm-linux:ddi-tcp-1    192.168.159.23:53946
ESTABLISHED

ssh2: AES-256-CTR 16, 1 | 16 Rows, 67 Cols VT100 | CAP NUM

```

1000/1000 700/700, 同测试 2, client 的接收没有 server 发送快, 所以造成 recv 缓冲区堆积. 而 client 的发送没有 server 接收快, 所以 server 能及时全部接收.

```

192.168.159.23 - SecureCRT
File Edit View Options Transfer Script Tools Window Help
Session Manager Enter host: <All>>
Filter by session name <All>>
Sessions:
192.168.159.23 (1)
Every 1.0s: netstat -t   Wed Oct 31 22:04:01 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
tcp        0      0 vm-linux:ssh          192.168.159.1:ibm-res
State
ESTABLISHED
tcp        0      0 vm-linux:53948       192.168.159.2:ddi-tcp-1
ESTABLISHED
tcp        0      0 vm-linux:ssh          192.168.159.1:sophia-lm
ESTABLISHED

192.168.159.23 (2)
Every 1.0s: netstat -t   Wed Oct 31 22:04:01 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
tcp        0      0 vm-linux:ssh          192.168.159.1:13127
State
ESTABLISHED
tcp        0      0 vm-linux:ssh          192.168.159.:netlabs-lm
ESTABLISHED
tcp        0      0 vm-linux:ddi-tcp-1    192.168.159.23:53948
ESTABLISHED

watch
Every 1.0s: netstat -t
Wed Oct 31 22:04:01 2018
Active Internet connections (w/o servers)
Proto Recv-Q Send-Q Local Address           Foreign Address
tcp        0      0 vm-linux:ssh          192.168.159.1:13127
State
ESTABLISHED
tcp        0      0 vm-linux:ssh          192.168.159.:netlabs-lm
ESTABLISHED
tcp        0      0 vm-linux:ddi-tcp-1    192.168.159.23:53948
ESTABLISHED

ssh2: AES-256-CTR 16, 1 | 16 Rows, 67 Cols VT100 | CAP NUM

```