课程大作业 5

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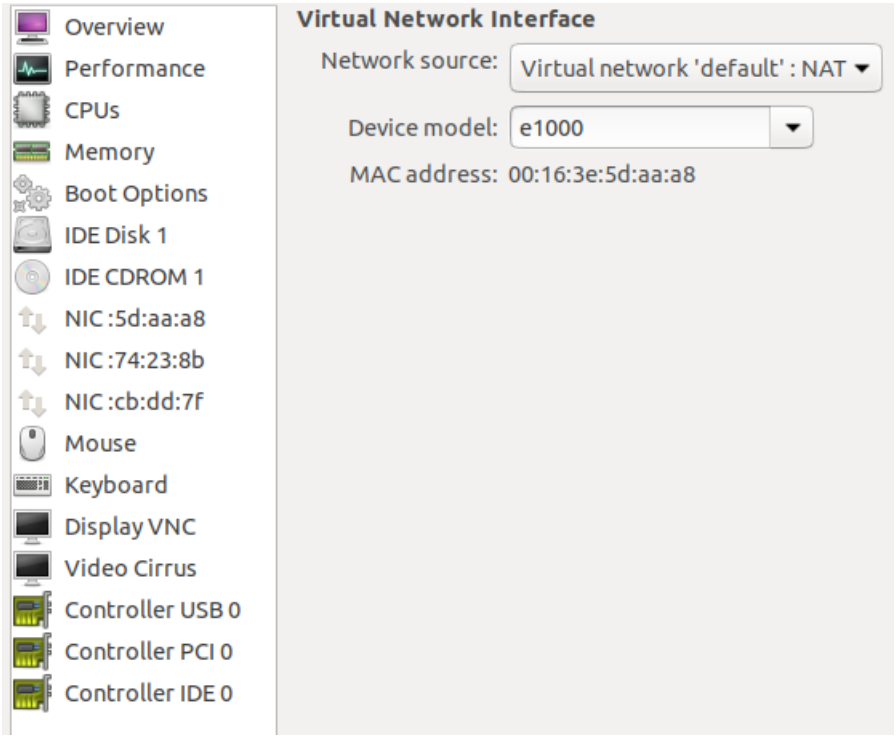
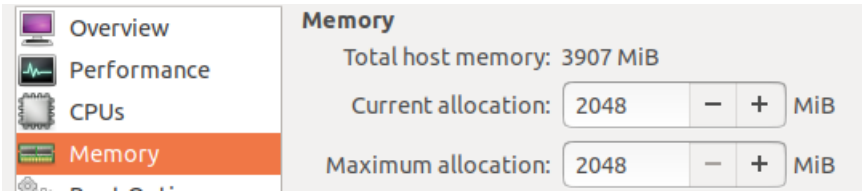
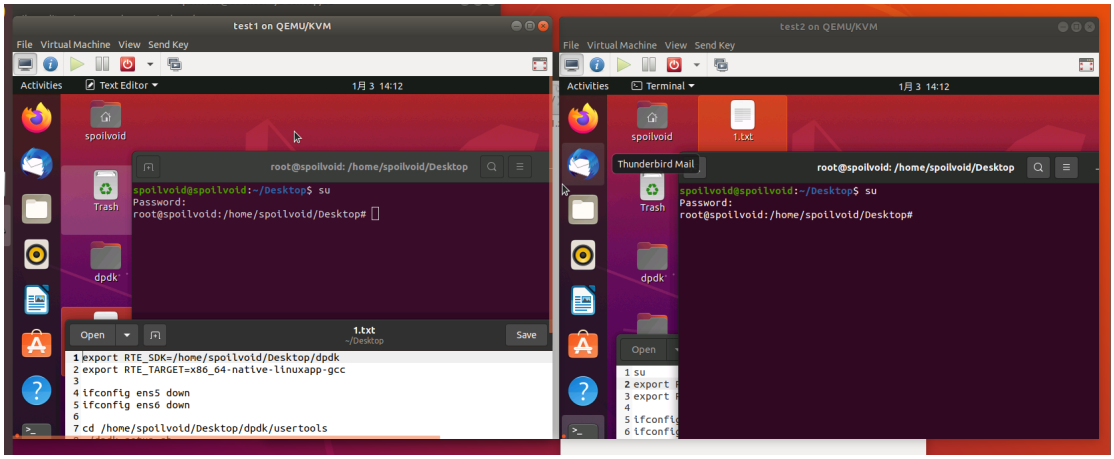
1.本实验需要两个 qemu 虚拟机分别进行 dpdk 的 l2fwd 执行与 pktgen-dpdk 的执行，为了防止环境配置冲突，所以我们选择重新创建两个 qemu 虚拟机。由于 dpdk 需要 Intel 的多网卡，但 QEMU 使用 xml 文件缺省为不支持 Intel 的单网卡，，且由于 pktgen-dpdk 在运行时需要较多的 hugepage 内存，所以我们增大执行 pktgen-dpdk 的虚拟机所需的空间为 2GB，且为虚拟机配置多网卡，此处展示的是采用 virt-manager 的粗配置（网卡均采用 e1000）。此外我们还需要更改 xml 文件配置，详细内容在最后附带的源代码中。





两虚拟机如图所示（通过 virt-manager 打开）



对于虚拟机 VM1、VM2,我们分别运行 l2fwd 与 pktgen-dpdk，pktgen-dpdk 是基于 dpdk 的一个生成包的工具，所以 VM2 需要在安装 dpdk 的基础上再安装 pktgen-dpdk，对于 VM1，我们仅需要照搬 VM2 安装 dpdk 的工作即可。（所需的所有文件如下所示）

2.首先需要安装 dpdk，我们选择 19.11.10 这个 stable 版本将其解压到 desktop 下并改名为 dpdk 方便引用，由于一些操作需要较高的权限，所以我们选择全程使用 root 进行操作。
我们首先需要安装的一些必要工具。

apt-get install python3

apt-get install numactl

apt-get install libnuma-dev

apt-get install net-tools

tips：python3 是为了让后续执行 setup 程序时部分结果能正常显示，net-tools 是为了了解当前虚拟机的 ip 与 mac 地址且对网卡进行一定的操作，剩下两个则是安装需要的文件。

```
spoilvoid@spoilvoid:~/Desktop$ ifconfig
ens3: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.122.232  netmask 255.255.255.0  broadcast 192.168.122.255
        inet6 fe80::e35b:df95:59f8:52f5  prefixlen 64  scopeid 0x20<link>
        ether 00:16:3e:5d:aa:a9  txqueuelen 1000  (Ethernet)
        RX packets 822  bytes 897376 (897.3 KB)
        RX errors 64  dropped 0  overruns 0  frame 64
        TX packets 453  bytes 43289 (43.2 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

ens5: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.122.118  netmask 255.255.255.0  broadcast 192.168.122.255
        inet6 fe80::89f9:40a8:8396:6d3b  prefixlen 64  scopeid 0x20<link>
        ether 52:54:00:e5:20:55  txqueuelen 1000  (Ethernet)
        RX packets 82  bytes 10604 (10.6 KB)
        RX errors 63  dropped 0  overruns 0  frame 63
        TX packets 54  bytes 6185 (6.1 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

ens6: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.122.81  netmask 255.255.255.0  broadcast 192.168.122.255
        inet6 fe80::5d6c:41a6:ce51:d1c4  prefixlen 64  scopeid 0x20<link>
        ether 52:54:00:a3:60:31  txqueuelen 1000  (Ethernet)
        RX packets 82  bytes 10610 (10.6 KB)
        RX errors 62  dropped 0  overruns 0  frame 62
        TX packets 53  bytes 6101 (6.1 KB)
        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 180  bytes 15467 (15.4 KB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 180  bytes 15467 (15.4 KB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0
```

此时虚拟机中的网卡上图所示，为了将多出的网卡配置为 dpdk 兼容的网卡，我们首先需要将其关闭

```
root@spoilvoid:/home/spoilvoid/Desktop# ifconfig ens5 down
root@spoilvoid:/home/spoilvoid/Desktop# ifconfig ens6 down
```

然后我们进行 dpdk 的编译安装，首先我们需要导入一些环境变量

```
root@spoilvoid:/home/spoilvoid/Desktop# export RTE_SDK=/home/spoilvoid/Desktop/dpdk
root@spoilvoid:/home/spoilvoid/Desktop# export RTE_TARGET=x86_64-native-linuxapp-gcc
```

然后调用 usertools 中的 dpdk-setup.sh 进行调配

```
root@spoilvoid:/home/spoilvoid/Desktop# cd /home/spoilvoid/Desktop/dpdk/usertools
root@spoilvoid:/home/spoilvoid/Desktop/dpdk/usertools# ./dpdk-setup.sh
------------------------------------------------------------------------------
 RTE_SDK exported as /home/spoilvoid/Desktop/dpdk
------------------------------------------------------------------------------
----------------------------------------------------------
 Step 1: Select the DPDK environment to build
```

我们选择与上面导入的环境变量相应的 x86_64-native-linuxapp-gcc 选项进行编译

```
Option: 41

Configuration done using x86_64-native-linuxapp-gcc
== Build lib
== Build lib/librte_kvargs
== Build lib/librte_eal
== Build lib/librte_eal/common
== Build lib/librte_eal/linux
== Build lib/librte_eal/linux/eal
== Build lib/librte_pci
== Build lib/librte_ring
== Build lib/librte_stack
== Build lib/librte_mempool
== Build lib/librte_mbuf
== Build lib/librte_timer
== Build lib/librte_cfgfile
== Build lib/librte_net
== Build lib/librte_cmdline
== Build lib/librte_meter
== Build lib/librte_ethdev
== Build lib/librte_bbdev
== Build lib/librte_cryptodev
== Build lib/librte_security
== Build lib/librte_compressdev
== Build lib/librte_hash
== Build lib/librte_eventdev
== Build lib/librte_rawdev
== Build lib/librte_vhost
== Build lib/librte_efd
== Build lib/librte_rib
== Build lib/librte_fib
== Build lib/librte_lpm
== Build lib/librte_acl
== Build lib/librte_member
== Build lib/librte_ip_frag
== Build lib/librte_gro
== Build lib/librte_jobstats
```

在完成编译安装后导入 igb-uio 模块

```
Option: 48

Unloading any existing DPDK UIO module
Loading uio module
Loading DPDK UIO module
```

然后我们根据网卡的 PCI 地址配置两张之前被关闭的网卡（因为此操作在网卡 active 状态下

不可行）

```
Option: 54


Network devices using kernel driver
===================================
0000:00:03.0 '82540EM Gigabit Ethernet Controller 100e' if=ens3 drv=e1000 unused=igb_uio,vfio-pci *Activ
e*
0000:00:05.0 '82540EM Gigabit Ethernet Controller 100e' if=ens5 drv=e1000 unused=igb_uio,vfio-pci
0000:00:06.0 '82540EM Gigabit Ethernet Controller 100e' if=ens6 drv=e1000 unused=igb_uio,vfio-pci

No 'Baseband' devices detected
==============================

No 'Crypto' devices detected
============================

No 'Eventdev' devices detected
==============================

No 'Mempool' devices detected
=============================

No 'Compress' devices detected
==============================

No 'Misc (rawdev)' devices detected
===================================

Enter PCI address of device to bind to IGB UIO driver: 00:05.0
OK
```

配置后的结果如下

```
Network devices using DPDK-compatible driver
============================================
0000:00:05.0 '82540EM Gigabit Ethernet Controller 100e' drv=igb_uio unused=e1000,vfio-pci
0000:00:06.0 '82540EM Gigabit Ethernet Controller 100e' drv=igb_uio unused=e1000,vfio-pci

Network devices using kernel driver
===================================
0000:00:03.0 '82540EM Gigabit Ethernet Controller 100e' if=ens3 drv=e1000 unused=igb_uio,vfio-pci *Activ
e*

No 'Baseband' devices detected
==============================

No 'Crypto' devices detected
============================

No 'Eventdev' devices detected
==============================

No 'Mempool' devices detected
=============================

No 'Compress' devices detected
==============================

No 'Misc (rawdev)' devices detected
===================================
```

最后我们需要配置 hugepage 内存

```
Option: 51

Removing currently reserved hugepages
Unmounting /mnt/huge and removing directory

  Input the number of 2048kB hugepages
  Example: to have 128MB of hugepages available in a 2MB huge page system,
  enter '64' to reserve 64 * 2MB pages
Number of pages: 1024
Reserving hugepages
Creating /mnt/huge and mounting as hugetlbfs
```

配置后通过抓取巨页信息可以得到

```
root@spoilvoid:/home/spoilvoid/Desktop/dpdk/examples/l2fwd# grep -i huge /proc/meminfo
AnonHugePages:         0 kB
ShmemHugePages:        0 kB
FileHugePages:         0 kB
HugePages_Total:     513
HugePages_Free:      512
HugePages_Rsvd:        0
HugePages_Surp:        0
Hugepagesize:       2048 kB
Hugetlb:         1050624 kB
```

到此处，dpdk 的安装就完成了，然后我们进入 examples 文件夹对我们接下来要执行的 l2fwd 进行 make 操作，获取可执行文件

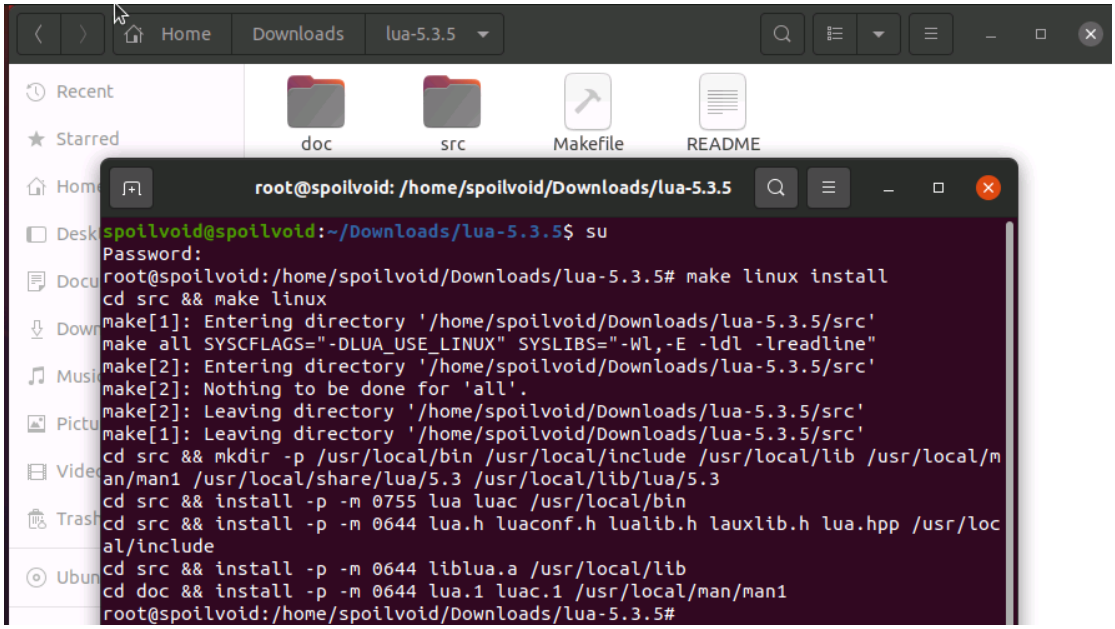
```
root@spoilvoid:/home/spoilvoid/Desktop/dpdk# cd examples
root@spoilvoid:/home/spoilvoid/Desktop/dpdk/examples# cd l2fwd
root@spoilvoid:/home/spoilvoid/Desktop/dpdk/examples/l2fwd# make
  CC main.o
  LD l2fwd
  INSTALL-APP l2fwd
  INSTALL-MAP l2fwd.map
```

3.接下来我们需要安装 pktgen-dpdk，由前面图片可知我们选择的 19.12 版本的 pktgen-dpdk，同样将其解压到 Desktop 文件夹下，并命名为 pktgen-dpdk，但是这里我们并没有办法直接进行 make 安装，因为缺少一些工具，我们需要先下载必要工具:

apt-get install libpcap-dev

apt-get install libreadline-dev

然后我们需要手动安装 lua，解压 lua5.3.5 文件，并进入对应的文件夹内，使用 Makefile 指定的 make linux install 命令进行安装



在此之后我们进入 pktgen-dpdk 文件夹下正式开始 pktgen-dpdk 的安装（这里需要保持环境变量与上述相同），进入相应文件夹下执行 make 即可

```
root@spoilvoid:/home/spoilvoid/Desktop/dpdk/usertools# cd /home/spoilvoid/Desktop/pktgen-dpdk
root@spoilvoid:/home/spoilvoid/Desktop/pktgen-dpdk# make
== lib
== common
cat: /home/spoilvoid/Desktop/pktgen-dpdk/lib/common/ABI_VERSION: No such file or directory
== plugin
cat: /home/spoilvoid/Desktop/pktgen-dpdk/lib/plugin/ABI_VERSION: No such file or directory
== utils
cat: /home/spoilvoid/Desktop/pktgen-dpdk/lib/utils/ABI_VERSION: No such file or directory
== vec
cat: /home/spoilvoid/Desktop/pktgen-dpdk/lib/vec/ABI_VERSION: No such file or directory
== lua
"Lua pkg-config file was not found"
"Get lua-5.3 from lua.org and build it on your system"
"Also install lua 5.3 into /usr/local/include and /usr/local/lib"
"Make sure the library in /usr/local/lib is called liblua.a"
"Lua pkg-config file was not found"
"Get lua-5.3 from lua.org and build it on your system"
"Also install lua 5.3 into /usr/local/include and /usr/local/lib"
"Make sure the library in /usr/local/lib is called liblua.a"
cat: /home/spoilvoid/Desktop/pktgen-dpdk/lib/lua/ABI_VERSION: No such file or directory
== cli
cat: /home/spoilvoid/Desktop/pktgen-dpdk/lib/cli/ABI_VERSION: No such file or directory
== app
"Lua pkg-config was not found"
"Get lua-5.3 from lua.org and build it on your system"
"Also install lua 5.3 into /usr/local/include and /usr/local/lib"
"Make sure the library in /usr/local/lib is called liblua.a"
"Lua pkg-config was not found"
"Get lua-5.3 from lua.org and build it on your system"
"Also install lua 5.3 into /usr/local/include and /usr/local/lib"
"Make sure the library in /usr/local/lib is called liblua.a"
  LD pktgen
  INSTALL-APP pktgen
  INSTALL-MAP pktgen.map
```

4.此时 VM2 所需的环境与工具已经配置完毕，VM1 只需要按照上述的 dpdk 配置步骤编译安装即可，接下来为了使得 pktgen-dpdk 的 VM2 能够向 VM1 发包，我们需要得知两 qemu 虚拟机的 ip 地址与 VM1 的两个端口的 mac 地址（一个可通过 virsh 指令得到，一个可以在执行 l2fwd 时获得）

```
virsh # list
 Id    Name                           State
----------------------------------------------------
 1     test2                          running
 2     test1                          running

virsh # domifaddr 1
 Name       MAC address          Protocol     Address
-------------------------------------------------------------------------------
 vnet0      00:16:3e:5d:aa:a9    ipv4         192.168.122.232/24

virsh # domifaddr 2
 Name       MAC address          Protocol     Address
-------------------------------------------------------------------------------
 vnet3      00:16:3e:5d:aa:a8    ipv4         192.168.122.231/24
```

```
root@spoilvoid:/home/spoilvoid/Desktop/dpdk/examples/l2fwd/build# ./l2fwd -c 0x3 -n 2 -- -p 3 -q 1
EAL: Detected 2 lcore(s)
EAL: Detected 1 NUMA nodes
EAL: Multi-process socket /var/run/dpdk/rte/mp_socket
EAL: Selected IOVA mode 'PA'
EAL: Probing VFIO support...
EAL: VFIO support initialized
EAL: PCI device 0000:00:03.0 on NUMA socket -1
EAL:   probe driver: 8086:100e net_e1000_em
EAL: PCI device 0000:00:05.0 on NUMA socket -1
EAL:   probe driver: 8086:100e net_e1000_em
EAL: PCI device 0000:00:06.0 on NUMA socket -1
EAL:   probe driver: 8086:100e net_e1000_em
MAC updating enabled
Lcore 0: RX port 0
Lcore 1: RX port 1
Initializing port 0... done:
Port 0, MAC address: 52:54:00:74:23:8B

Initializing port 1... done:
Port 1, MAC address: 52:54:00:CB:DD:7F


Checking link status.....done
Port0 Link Up. Speed 1000 Mbps - full-duplex
Port1 Link Up. Speed 1000 Mbps - full-duplex
L2FWD: entering main loop on lcore 1
L2FWD:  -- lcoreid=1 portid=1
L2FWD: entering main loop on lcore 0
L2FWD:  -- lcoreid=0 portid=0
```

5.接下来我们开始正式进行 VM2 生成包，并发送到 VM1 的 0 号端口上，VM1 的 1 号端口则会转发从 0 号端口进入的包，而这个包会重新被 VM2 接收，从而产生一个接受速率与发送速率，由此进行性能比较

情况 1：仅在 VM1 上执行 l2fwd

命令：./l2fwd –c 0x3 –n 2 -- -p 3 –q 1

```
root@spoilvoid:/home/spoilvoid/Desktop/dpdk/examples/l2fwd/build# ./l2fwd -c 0x3 -n 2 -- -p 3 -q 1
EAL: Detected 2 lcore(s)
EAL: Detected 1 NUMA nodes
EAL: Multi-process socket /var/run/dpdk/rte/mp_socket
EAL: Selected IOVA mode 'PA'
EAL: Probing VFIO support...
EAL: VFIO support initialized
EAL: PCI device 0000:00:03.0 on NUMA socket -1
EAL:   probe driver: 8086:100e net_e1000_em
EAL: PCI device 0000:00:05.0 on NUMA socket -1
EAL:   probe driver: 8086:100e net_e1000_em
EAL: PCI device 0000:00:06.0 on NUMA socket -1
EAL:   probe driver: 8086:100e net_e1000_em
MAC updating enabled
Lcore 0: RX port 0
Lcore 1: RX port 1
Initializing port 0... done:
Port 0, MAC address: 52:54:00:74:23:8B

Initializing port 1... done:
Port 1, MAC address: 52:54:00:CB:DD:7F


Checking link status.....done
Port0 Link Up. Speed 1000 Mbps - full-duplex
Port1 Link Up. Speed 1000 Mbps - full-duplex
L2FWD: entering main loop on lcore 1
L2FWD:  -- lcoreid=1 portid=1
L2FWD: entering main loop on lcore 0
L2FWD:  -- lcoreid=0 portid=0
```

此时由于没有外界发包，仅仅是端口混杂模式互相转发， 所以两个端口的 sent 与 received 量相同

```
Port statistics ====================================
Statistics for port 0 ------------------------------
Packets sent:                        0
Packets received:                    0
Packets dropped:                     0
Statistics for port 1 ------------------------------
Packets sent:                        0
Packets received:                    0
Packets dropped:                     0
Aggregate statistics ===============================
Total packets sent:                  0
Total packets received:              0
Total packets dropped:               0
====================================================
```

```
Port statistics ====================================
Statistics for port 0 ------------------------------
Packets sent:                   552253
Packets received:               582414
Packets dropped:                     0
Statistics for port 1 ------------------------------
Packets sent:                   582414
Packets received:               552253
Packets dropped:                     0
Aggregate statistics ===============================
Total packets sent:            1134667
Total packets received:        1134667
Total packets dropped:               0
====================================================
```

```
Port statistics ====================================
Statistics for port 0 ------------------------------
Packets sent:                  1602127
Packets received:              1697472
Packets dropped:                     0
Statistics for port 1 ------------------------------
Packets sent:                  1697472
Packets received:              1602127
Packets dropped:                     0
Aggregate statistics ===============================
Total packets sent:            3299599
Total packets received:        3299599
Total packets dropped:               0
====================================================
```

```
Port statistics ====================================
Statistics for port 0 ------------------------------
Packets sent:                  2097984
Packets received:              2237907
Packets dropped:                     0
Statistics for port 1 ------------------------------
Packets sent:                  2237907
Packets received:              2097984
Packets dropped:                     0
Aggregate statistics ===============================
Total packets sent:            4335891
Total packets received:        4335891
Total packets dropped:               0
====================================================
```

```
Port statistics ====================================
Statistics for port 0 ------------------------------
Packets sent:                    3057249
Packets received:                3307668
Packets dropped:                       0
Statistics for port 1 ------------------------------
Packets sent:                    3307668
Packets received:                3057281
Packets dropped:                       0
Aggregate statistics ===============================
Total packets sent:              6364949
Total packets received:          6364981
Total packets dropped:                 0
====================================================
```

情况 2：仅在 VM2 上执行 pktgen

命令：./pktgen –l 0-1 –n 3 -- -P –m “[1].0”

```
root@spoilvoid:/home/spoilvoid/Desktop/pktgen-dpdk/app/x86_64-native-linuxapp-gcc/app# ./pktgen -l 0-1 -
n 3 -- -P -m "[1].0"

Copyright (c) <2010-2019>, Intel Corporation. All rights reserved. Powered by DPDK
EAL: Detected 2 lcore(s)
EAL: Detected 1 NUMA nodes
EAL: Multi-process socket /var/run/dpdk/rte/mp_socket
EAL: Selected IOVA mode 'PA'
EAL: Probing VFIO support...
EAL: VFIO support initialized
EAL: PCI device 0000:00:03.0 on NUMA socket -1
EAL:   probe driver: 8086:100e net_e1000_em
EAL: PCI device 0000:00:05.0 on NUMA socket -1
EAL:   probe driver: 8086:100e net_e1000_em
EAL: PCI device 0000:00:06.0 on NUMA socket -1
EAL:   probe driver: 8086:100e net_e1000_em
Lua 5.3.5  Copyright (C) 1994-2018 Lua.org, PUC-Rio

*** Copyright (c) <2010-2019>, Intel Corporation. All rights reserved.
*** Pktgen created by: Keith Wiles -- >>> Powered by DPDK <<<

 Port: Name         IfIndex Alias        NUMA  PCI
    0: net_e1000_em    0                  0   8086:100e/00:05.0
    1: net_e1000_em    0                  0   8086:100e/00:06.0

Initialize Port 0 -- TxQ 1, RxQ 1
Src MAC 52:54:00:e5:20:55
 <Promiscuous mode Enabled>


  RX/TX processing lcore:   1 rx:  1 tx:  1
```

初始状态什么都不做时，观察下图不难发现发送速率与接收速率均为 0（这里由于放大缩小产生了错位）

```
 Port: Name         I P------Single      :0MA  PCI
    0: net_e1000_em            <UP-1000-FD>0   8086:100e/00:05.0
    1: net_e1000_em                   153/0                153/0
                                        0/0                  0/0
Initialize Port 0 --                    0/0                  0/0
Src MAC 52:54:00:e5:2                     0
 <Promiscuous mode En                    10
                                        174
                                        100
  RX/TX processing lc                    16
                                         12
- Ports 0-1 of 2   <M                     0c) <2010-2019>, Intel Corporation
  Flags:Port        :                     0
-ink State          :                   0/0      ---Total Rate---
Pkts/s Max/Rx       :                   3/0                  0/0
       Max/Tx       :                   0/0                  0/0
MBits/s Rx/Tx       :                   301                153/1
Broadcast           :                     0                  0/0
Multicast           :                     0                  0/0
Sizes 64            :                     0
      65-127        :                     0
      128-255       :                   147
      256-511       :                    11
      512-1023      :                     2
      1024-1518     :                     0
Runts/Jumbos        :                     0
ARP/ICMP Pkts       :                     0
Errors Rx/Tx        :                   0/0
Total Rx Pkts       :                   0/0
      Tx Pkts       :                   0/0
      Rx MBs        :                   160
      Tx MBs        :                     0
                    :                     0
Pattern Type        :                     0
```

当我们执行 start 0 命令时，由于没有正确地设置目的 ip、mac，所以仅有发送速率没有接受速率

```
/nPorts 0-1 of 20 -<Main Page>  Copyright (c) <2010-2019>, Intel Corporation
  Flags:Port        : P------Single      :0                  0/0
Link State          :          <UP-1000-FD>      ---Total Rate---
Pkts/s Max/Rx       :                153/1               153/1
       Max/Tx       :         520000/514944         520000/514944
MBits/s Rx/Tx       :                0/346               0/346
Broadcast           :                   0
Multicast           :                  11c) <2010-2019>, Intel Corporation
Sizes 64            :                 260
      65-127        :                 129      ---Total Rate---
      128-255       :                  19                  0/0
      256-511       :                  12c) <2010-2019>, Intel Corporation
      512-1023      :                   0c) <2010-2019>, Intel Corporation
      1024-1518     :                   0c) <2010-2019>, Intel Corporation
Runts/Jumbos        :                 0/0      ---Total Rate---
ARP/ICMP Pkts       :                 4/0      ---Total Rate---
Errors Rx/Tx        :                 0/0                 153/1
Total Rx Pkts       :                 420                   0/0
      Tx Pkts       :              2889536                153/0
      Rx MBs        :                   0                   0/0
      Tx MBs        :                1942                   0/0
Sizes 64            :                   0
Pattern Type        :               abcd...
Tx Count/% Rate     :         Forever /100%
Pkt Size/Tx Burst   :              64 /   64
TTL/Port Src/Dest   :         4/ 1234/ 5678
Pkt Type:VLAN ID    :       IPv4 / TCP:0001
802.1p CoS/DSCP/IPP :             0/  0/  0
VxLAN Flg/Grp/vid   :      0000/    0/    0
IP  Destination     :       192.168.122.231
    Source          :    192.168.122.232/24by DPDK  (pid:38134) ---------------
MAC Destination     :     52:54:00:74:23:8b
    Source          :     52:54:00:e5:20:55erface without timers
PCI Vendor/Addr     :     8086:100e/00:05.0
      Tx MBs        :                   0
-- Pktgen 19.12.0 (DPDK 19.11.10)  Powered by DPDK  (pid:38134) ---------------
Pktgen:/> start 0
Pktgen:/>
```

情况 3:

在 VM1 上执行 l2fwd

命令：./l2fwd –c 0x3 –n 2 -- -p 3 –q 1

在 VM2 上执行 pktgen

命令：./pktgen –l 0-1 –n 3 -- -P –m “[1].0”

并进行 dst ip、mac 与 src ip 的设置（src mac 已经设置好了，由于命令无法顺序展示，所以以这种方式展示）其中 start 0 为开始发包指令，对应停止发包指令为 stop 0

```
set 0 dst ip 192.168.122.231
set 0 src ip 192.168.122.232/24
set 0 dst mac 52:54:00:74:23:8B
start 0
```

然后我们首先观察 pktgen，可以看到发送与接收速率分别为 18~19MB/s 与 8~9MB/s，且发送指向了正确的地址（因为我们正确地所接收到了转发回来的包）

```
\ Ports 0-1 of 2   <Main Page>  Copyright (c) <2010-2019>, Intel Corporation
  Flags:Port        : P------Single      :0          126436/96705
Link State          :          <UP-1000-FD>      ---Total Rate---
Pkts/s Max/Rx       :         126436/99783         126436/99783
       Max/Tx       :        556352/224512        556352/224512
MBits/s Rx/Tx       :              70/150               70/150
Broadcast           :                   0                 0/0
Multicast           :                  11c) <2010-2019>, Intel Corporation
Sizes 64            :              8985350c) <2010-2019>, Intel Corporation
      65-127        :               132530c) <2010-2019>, Intel Corporation
      128-255       :                   19      ---Total Rate---
      256-511       :                   12      ---Total Rate---
      512-1023      :                    0                153/1
      1024-1518     :                    0                  0/0
Runts/Jumbos        :                  0/0                153/0
ARP/ICMP Pkts       :                  4/0c) <2010-2019>, Intel Corporation
Errors Rx/Tx        :                  0/0                  0/0
Total Rx Pkts       :              9040696              126436/1
      Tx Pkts       :             25298304      ---Total Rate---
      Rx MBs        :                 6403              126436/1
      Tx MBs        :                17016         520000/453056
Broadcast           :                0/304                0/304
Pattern Type        :               abcd...
Tx Count/% Rate     :         Forever /100%
Pkt Size/Tx Burst   :            64 /   64
TTL/Port Src/Dest   :         4/ 1234/ 5678
Pkt Type:VLAN ID    :       IPv4 / TCP:0001by DPDK  (pid:38134) ------------      512-1023
802.1p CoS/DSCP/IPP :            0/  0/  0
VxLAN Flg/Grp/vid   :      0000/    0/    0erface without timers
IP  Destination     :       192.168.122.231
    Source          :    192.168.122.232/24
MAC Destination     :     52:54:00:74:23:8bby DPDK  (pid:38134) ------------Total Rx Pkts
    Source          :     52:54:00:e5:20:55
PCI Vendor/Addr     :     8086:100e/00:05.0
      Rx MBs        :              18772992
-- Pktgen 19.12.0 (DPDK 19.11.10)  Powered by DPDK  (pid:38134) --------------
```

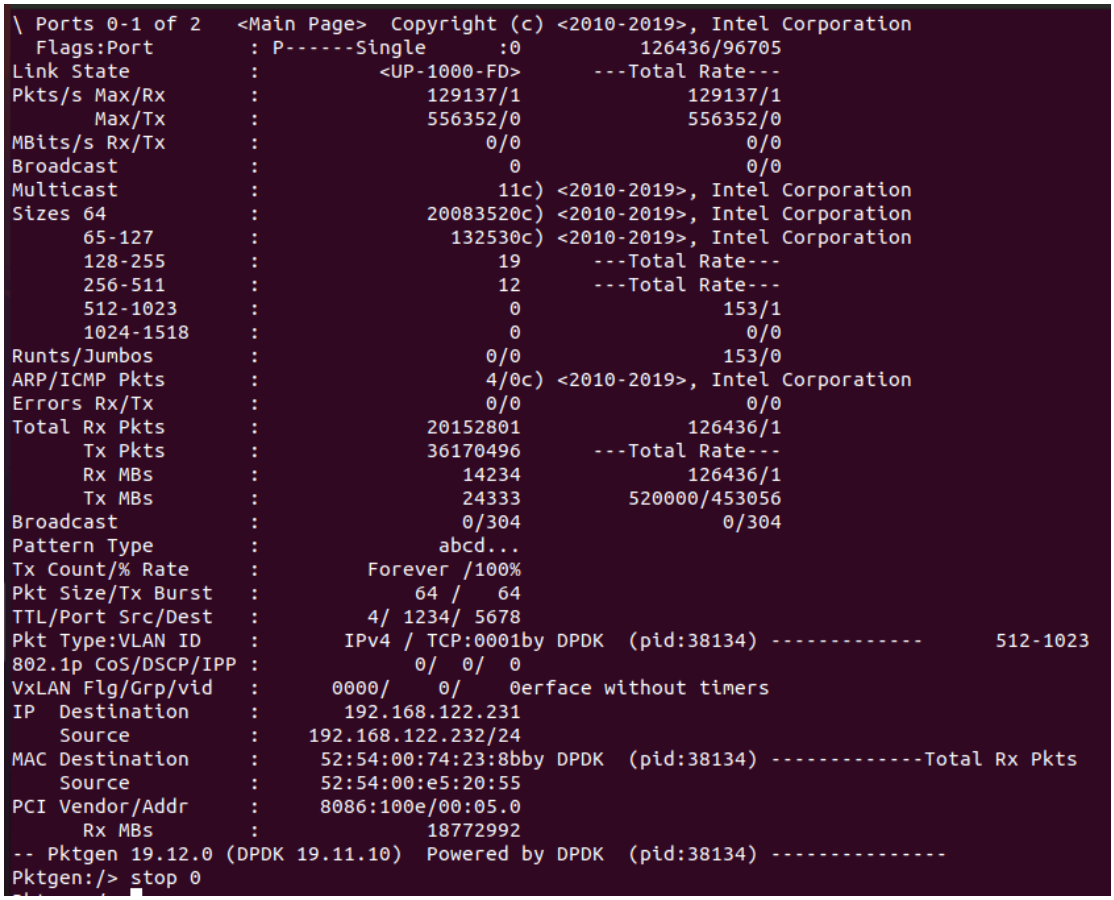
```
\ Ports 0-1 of 2   <Main Page>  Copyright (c) <2010-2019>, Intel Corporation
  Flags:Port        : P------Single      :0          126436/96705
Link State          :          <UP-1000-FD>      ---Total Rate---
Pkts/s Max/Rx       :         126436/109426        126436/109426
       Max/Tx       :        556352/229056        556352/229056
MBits/s Rx/Tx       :              77/153               77/153
Broadcast           :                   0                 0/0
Multicast           :                  11c) <2010-2019>, Intel Corporation
Sizes 64            :             10425586c) <2010-2019>, Intel Corporation
      65-127        :               132530c) <2010-2019>, Intel Corporation
      128-255       :                   19      ---Total Rate---
      256-511       :                   12      ---Total Rate---
      512-1023      :                    0                153/1
      1024-1518     :                    0                  0/0
Runts/Jumbos        :                  0/0                153/0
ARP/ICMP Pkts       :                  4/0c) <2010-2019>, Intel Corporation
Errors Rx/Tx        :                  0/0                  0/0
Total Rx Pkts       :             10522602              126436/1
      Tx Pkts       :             28400832      ---Total Rate---
      Rx MBs        :                 7447              126436/1
      Tx MBs        :                19102         520000/453056
Broadcast           :                0/304                0/304
Pattern Type        :               abcd...
Tx Count/% Rate     :         Forever /100%
Pkt Size/Tx Burst   :            64 /   64
TTL/Port Src/Dest   :         4/ 1234/ 5678
Pkt Type:VLAN ID    :       IPv4 / TCP:0001by DPDK  (pid:38134) ------------      512-1023
802.1p CoS/DSCP/IPP :            0/  0/  0
VxLAN Flg/Grp/vid   :      0000/    0/    0erface without timers
IP  Destination     :       192.168.122.231
    Source          :    192.168.122.232/24
MAC Destination     :     52:54:00:74:23:8bby DPDK  (pid:38134) ------------Total Rx Pkts
    Source          :     52:54:00:e5:20:55
PCI Vendor/Addr     :     8086:100e/00:05.0
      Rx MBs        :              18772992
-- Pktgen 19.12.0 (DPDK 19.11.10)  Powered by DPDK  (pid:38134) --------------
```

当我们键入命令 stop 0 时，继续观察，可以看到虽然没有继续发包了，但是由于先前接受速率小于发送速率，VM1 依旧在转发这些数据包给我们，所以接受速率暂时还不为 0

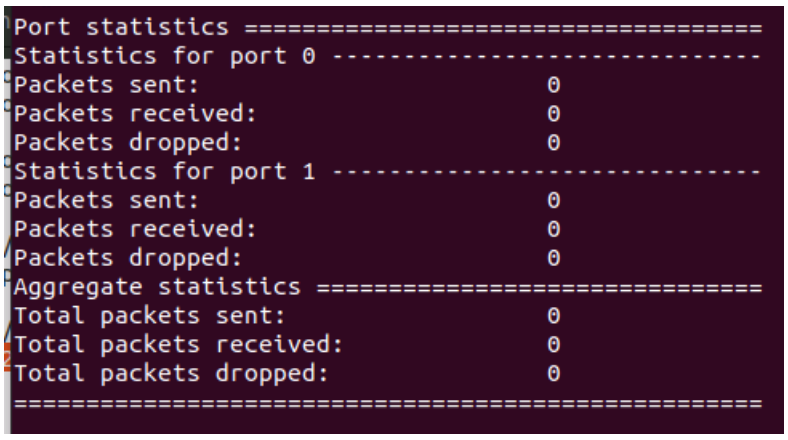
```
/ Ports 0-1 of 2   <Main Page>  Copyright (c) <2010-2019>, Intel Corporation
  Flags:Port        : P------Single      :0          126436/96705
Link State          :          <UP-1000-FD>      ---Total Rate---
Pkts/s Max/Rx       :         127900/119562         127900/119562
       Max/Tx       :              556352/0              556352/0
MBits/s Rx/Tx       :                 84/0                  84/0
Broadcast           :                   0                   0/0
Multicast           :                  11c) <2010-2019>, Intel Corporation
Sizes 64            :              15715665c) <2010-2019>, Intel Corporation
      65-127        :                132530c) <2010-2019>, Intel Corporation
      128-255       :                   19      ---Total Rate---
      256-511       :                   12      ---Total Rate---
      512-1023      :                    0                153/1
      1024-1518     :                    0                  0/0
Runts/Jumbos        :                  0/0                153/0
ARP/ICMP Pkts       :                  4/0c) <2010-2019>, Intel Corporation
Errors Rx/Tx        :                  0/0                  0/0
Total Rx Pkts       :             15708228             126436/1
      Tx Pkts       :             36170496      ---Total Rate---
      Rx MBs        :                11103             126436/1
      Tx MBs        :                24333         520000/453056
Broadcast           :                0/304                0/304
Pattern Type        :               abcd...
Tx Count/% Rate     :         Forever /100%
Pkt Size/Tx Burst   :            64 /   64
TTL/Port Src/Dest   :         4/ 1234/ 5678
Pkt Type:VLAN ID    :       IPv4 / TCP:0001by DPDK  (pid:38134) ------------      512-1023
802.1p CoS/DSCP/IPP :            0/  0/  0
VxLAN Flg/Grp/vid   :      0000/    0/    0erface without timers
IP  Destination     :       192.168.122.231
    Source          :    192.168.122.232/24
MAC Destination     :     52:54:00:74:23:8bby DPDK  (pid:38134) ------------Total Rx Pkts
    Source          :     52:54:00:e5:20:55
PCI Vendor/Addr     :     8086:100e/00:05.0
      Rx MBs        :             18772992
-- Pktgen 19.12.0 (DPDK 19.11.10)  Powered by DPDK  (pid:38134) --------------
Pktgen:/> stop 0
```

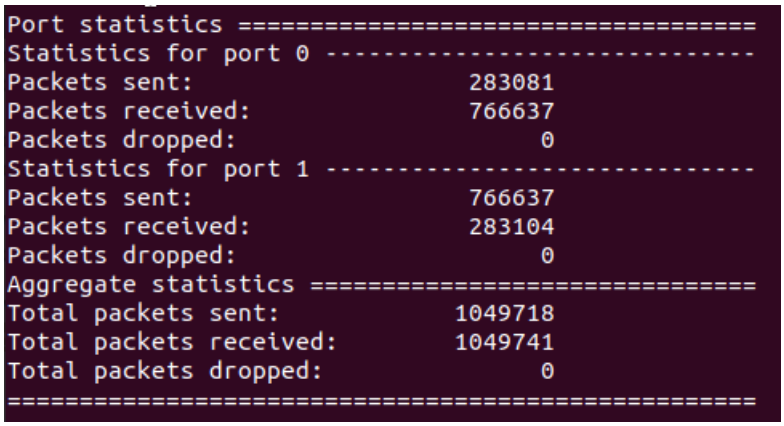
```
| Ports 0-1 of 2   <Main Page>  Copyright (c) <2010-2019>, Intel Corporation
  Flags:Port        : P------Single      :0          126436/96705
Link State          :          <UP-1000-FD>      ---Total Rate---
Pkts/s Max/Rx       :         129137/117241         129137/117241
       Max/Tx       :              556352/0              556352/0
MBits/s Rx/Tx       :                 82/0                  82/0
Broadcast           :                   0                   0/0
Multicast           :                  11c) <2010-2019>, Intel Corporation
Sizes 64            :              17771392c) <2010-2019>, Intel Corporation
      65-127        :                132530c) <2010-2019>, Intel Corporation
      128-255       :                   19      ---Total Rate---
      256-511       :                   12      ---Total Rate---
      512-1023      :                    0                153/1
      1024-1518     :                    0                  0/0
Runts/Jumbos        :                  0/0                153/0
ARP/ICMP Pkts       :                  4/0c) <2010-2019>, Intel Corporation
Errors Rx/Tx        :                  0/0                  0/0
Total Rx Pkts       :             17838440             126436/1
      Tx Pkts       :             36170496      ---Total Rate---
      Rx MBs        :                12603             126436/1
      Tx MBs        :                24333         520000/453056
Broadcast           :                0/304                0/304
Pattern Type        :               abcd...
Tx Count/% Rate     :         Forever /100%
Pkt Size/Tx Burst   :            64 /   64
TTL/Port Src/Dest   :         4/ 1234/ 5678
Pkt Type:VLAN ID    :       IPv4 / TCP:0001by DPDK  (pid:38134) ------------      512-1023
802.1p CoS/DSCP/IPP :            0/  0/  0
VxLAN Flg/Grp/vid   :      0000/    0/    0erface without timers
IP  Destination     :       192.168.122.231
    Source          :    192.168.122.232/24
MAC Destination     :     52:54:00:74:23:8bby DPDK  (pid:38134) ------------Total Rx Pkts
    Source          :     52:54:00:e5:20:55
PCI Vendor/Addr     :     8086:100e/00:05.0
      Rx MBs        :             18772992
-- Pktgen 19.12.0 (DPDK 19.11.10)  Powered by DPDK  (pid:38134) --------------
Pktgen:/> stop 0
```

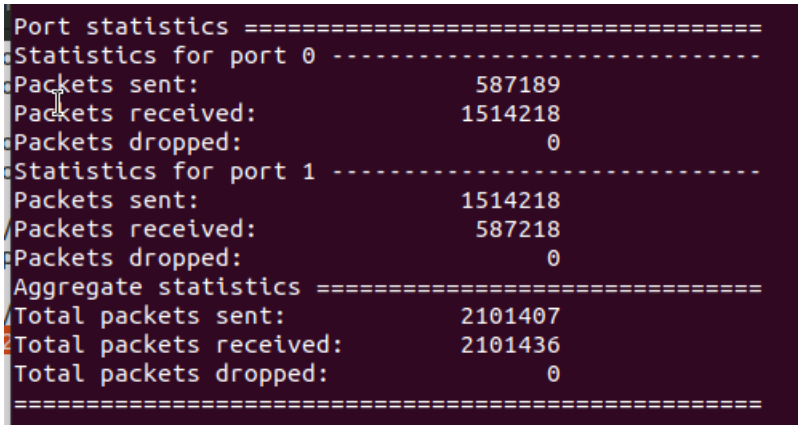
但在 VM1 处理完所有发来的数据包后，接收速率也降为零。

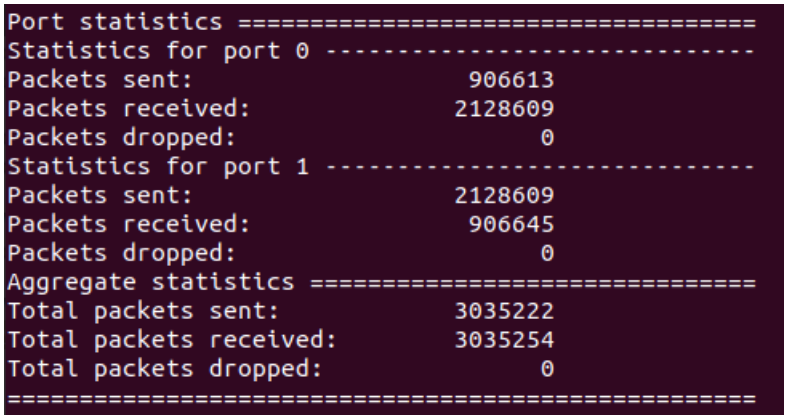


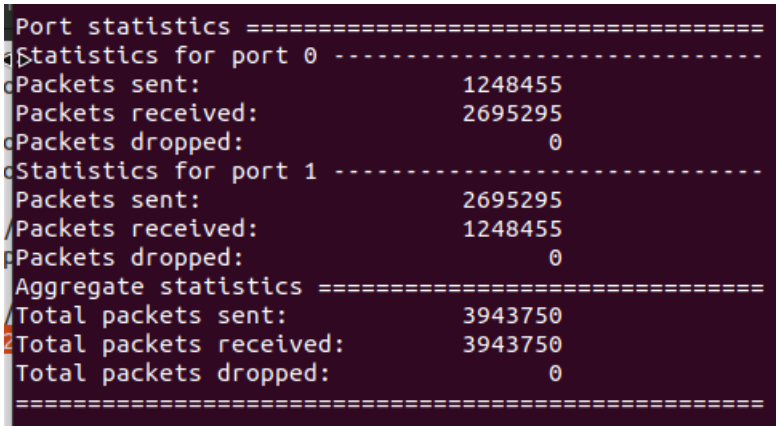
我们再观察观察 VM1 上的情况，可以看到 0 号端口接受的包数量远远超过了发送数量，port1 发送数量超过了接受数量，这是由于我们向 VM1 的零号端口发包导致的，而我们可以看到 VM2 也有接受速率，所以整体的实验成功了（之所以 0 号端口还存在发送包，1 号端口还存在接受包是由于开启了-p 混杂模式）











6.我们成功地测试了传输速率与接受速率，但是随之而来产生了一个问题：我们发现在传输

过程中没有产生丢包
猜测原因：这可能是由于如果在网卡配置过程中使用 virtio，那么运行 l2fwd 会存在自收发机制，将多余的超过容量的包抛弃（类似于网络中缓冲区队列被占满导致丢包），但是由于我们将网卡设置为 e1000 且将 0 号端口设置为接收，1 号端口用于发包（两者之间还有额外的发送接收是因为开启了混杂模式），那么这种情况下没有自收发机制，完全地进行转运使得丢包率变为 0
7.最终性能结果：在使用 e1000 双端口的情况下，发送与接收速率分别为 18~19MB/s 与 8~9MB/s，丢包率为 0

配置 xml 文件源文件 test1.xml：

```
<domain type='kvm' id='1'>
  <name>test1</name>
  <uuid>493ce2c4-e75d-4d9c-be91-e2a6b41ca7d6</uuid>
  <memory unit='KiB'>1048576</memory>
  <currentMemory unit='KiB'>1048576</currentMemory>
  <vcpu placement='static'>2</vcpu>
  <cpu match='exact'>
  <model>Haswell</model>
  <feature policy='force' name='x2apic'/>
  <feature policy='force' name='pdpe1gb'/>
  <feature policy='disable' name='hle'/>
  <feature policy='disable' name='smep'/>
  <feature policy='disable' name='rtm'/>
  </cpu>
  <resource>
    <partition>/machine</partition>
  </resource>
  <os>
    <type arch='x86_64' machine='pc-i440fx-2.11'>hvm</type>
    <boot dev='hd'/>
  </os>
  <features>
    <acpi/>
    <apic/>
    <pae/>
  </features>
  <clock offset='localtime'/>
  <on_poweroff>destroy</on_poweroff>
  <on_reboot>restart</on_reboot>
  <on_crash>destroy</on_crash>
  <devices>
    <emulator>/usr/bin/kvm</emulator>
    <disk type='file' device='disk'>
```

```
    <driver name='qemu' type='qcow2'/>
    <source file='/home/spoilvoid/Desktop/3D/test1.img'/>
    <backingStore/>
    <target dev='hda' bus='ide'/>
    <alias name='ide0-0-0'/>
    <address type='drive' controller='0' bus='0' target='0' unit='0'/>
  </disk>
  <disk type='file' device='cdrom'>
    <driver name='qemu' type='raw'/>
    <source file='/home/spoilvoid/Desktop/3D/ubuntu-20.04.3-desktop-amd64.iso'/>
    <backingStore/>
    <target dev='hdb' bus='ide'/>
    <readonly/>
    <alias name='ide0-0-1'/>
    <address type='drive' controller='0' bus='0' target='0' unit='1'/>
  </disk>
  <controller type='usb' index='0' model='piix3-uhci'>
    <alias name='usb'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x01' function='0x2'/>
  </controller>
  <controller type='pci' index='0' model='pci-root'>
    <alias name='pci.0'/>
  </controller>
  <controller type='ide' index='0'>
    <alias name='ide'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x01' function='0x1'/>
  </controller>
  <interface type='network'>
    <mac address='00:16:3e:5d:aa:a8'/>
    <source network='default' bridge='virbr0'/>
    <target dev='vnet0'/>
    <model type='e1000'/>
    <alias name='net0'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x03' function='0x0'/>
  </interface>
  <interface type='network'>
    <mac address='52:54:00:74:23:8b'/>
    <source network='default' bridge='virbr0'/>
    <target dev='vnet1'/>
    <model type='e1000'/>
    <alias name='net1'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x05' function='0x0'/>
  </interface>
  <interface type='network'>
```

```
      <mac address='52:54:00:cb:dd:7f'/>
      <source network='default' bridge='virbr0'/>
      <target dev='vnet2'/>
      <model type='e1000'/>
      <alias name='net2'/>
      <address type='pci' domain='0x0000' bus='0x00' slot='0x06' function='0x0'/>
    </interface>
    <input type='mouse' bus='ps2'>
      <alias name='input0'/>
    </input>
    <input type='keyboard' bus='ps2'>
      <alias name='input1'/>
    </input>
    <graphics type='vnc' port='5900' autoport='yes' listen='0.0.0.0' keymap='en-us'>
      <listen type='address' address='0.0.0.0'/>
    </graphics>
    <video>
      <model type='cirrus' vram='16384' heads='1' primary='yes'/>
      <alias name='video0'/>
      <address type='pci' domain='0x0000' bus='0x00' slot='0x02' function='0x0'/>
    </video>
    <memballoon model='virtio'>
      <alias name='balloon0'/>
      <address type='pci' domain='0x0000' bus='0x00' slot='0x04' function='0x0'/>
    </memballoon>
  </devices>
  <seclabel type='dynamic' model='apparmor' relabel='yes'>
    <label>libvirt-493ce2c4-e75d-4d9c-be91-e2a6b41ca7d6</label>
    <imagelabel>libvirt-493ce2c4-e75d-4d9c-be91-e2a6b41ca7d6</imagelabel>
  </seclabel>
  <seclabel type='dynamic' model='dac' relabel='yes'>
    <label>+64055:+127</label>
    <imagelabel>+64055:+127</imagelabel>
  </seclabel>
</domain>
```

配置 xml 文件源文件 test2.xml：

```
<domain type='kvm' id='2'>
  <name>test2</name>
  <uuid>faf9ab4e-57d0-4363-8ed2-15b5326918a5</uuid>
  <memory unit='KiB'>1048576</memory>
  <currentMemory unit='KiB'>1048576</currentMemory>
  <vcpu placement='static'>2</vcpu>
```

```
<cpu match='exact'>
  <model>Haswell</model>
  <feature policy='force' name='x2apic'/>
  <feature policy='force' name='pdpe1gb'/>
  <feature policy='disable' name='hle'/>
  <feature policy='disable' name='smep'/>
  <feature policy='disable' name='rtm'/>
  </cpu>
  <resource>
    <partition>/machine</partition>
  </resource>
  <os>
    <type arch='x86_64' machine='pc-i440fx-2.11'>hvm</type>
    <boot dev='hd'/>
  </os>
  <features>
    <acpi/>
    <apic/>
    <pae/>
  </features>
  <clock offset='localtime'/>
  <on_poweroff>destroy</on_poweroff>
  <on_reboot>restart</on_reboot>
  <on_crash>destroy</on_crash>
  <devices>
    <emulator>/usr/bin/kvm</emulator>
    <disk type='file' device='disk'>
      <driver name='qemu' type='qcow2'/>
      <source file='/home/spoilvoid/Desktop/3D/test2.img'/>
      <backingStore/>
      <target dev='hda' bus='ide'/>
      <alias name='ide0-0-0'/>
      <address type='drive' controller='0' bus='0' target='0' unit='0'/>
    </disk>
    <disk type='file' device='cdrom'>
      <driver name='qemu' type='raw'/>
      <source file='/home/spoilvoid/Desktop/3D/ubuntu-20.04.3-desktop-amd64.iso'/>
      <backingStore/>
      <target dev='hdb' bus='ide'/>
      <readonly/>
      <alias name='ide0-0-1'/>
      <address type='drive' controller='0' bus='0' target='0' unit='1'/>
    </disk>
    <controller type='usb' index='0' model='piix3-uhci'>
```

```
    <alias name='usb'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x01' function='0x2'/>
  </controller>
  <controller type='pci' index='0' model='pci-root'>
    <alias name='pci.0'/>
  </controller>
  <controller type='ide' index='0'>
    <alias name='ide'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x01' function='0x1'/>
  </controller>
  <interface type='network'>
    <mac address='00:16:3e:5d:aa:a9'/>
    <source network='default' bridge='virbr0'/>
    <target dev='vnet0'/>
    <model type='e1000'/>
    <alias name='net0'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x03' function='0x0'/>
  </interface>
  <interface type='network'>
    <mac address='52:54:00:e5:20:55'/>
    <source network='default' bridge='virbr0'/>
    <target dev='vnet1'/>
    <model type='e1000'/>
    <alias name='net1'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x05' function='0x0'/>
  </interface>
  <interface type='network'>
    <mac address='52:54:00:a3:60:31'/>
    <source network='default' bridge='virbr0'/>
    <target dev='vnet2'/>
    <model type='e1000'/>
    <alias name='net2'/>
    <address type='pci' domain='0x0000' bus='0x00' slot='0x06' function='0x0'/>
  </interface>
  <input type='mouse' bus='ps2'>
    <alias name='input0'/>
  </input>
  <input type='keyboard' bus='ps2'>
    <alias name='input1'/>
  </input>
  <graphics type='vnc' port='5900' autoport='yes' listen='0.0.0.0' keymap='en-us'>
    <listen type='address' address='0.0.0.0'/>
  </graphics>
  <video>
```

```
      <model type='cirrus' vram='16384' heads='1' primary='yes'/>
      <alias name='video0'/>
      <address type='pci' domain='0x0000' bus='0x00' slot='0x02' function='0x0'/>
    </video>
    <memballoon model='virtio'>
      <alias name='balloon0'/>
      <address type='pci' domain='0x0000' bus='0x00' slot='0x04' function='0x0'/>
    </memballoon>
  </devices>
  <seclabel type='dynamic' model='apparmor' relabel='yes'>
    <label>libvirt-faf9ab4e-57d0-4363-8ed2-15b5326918a5</label>
    <imagelabel>libvirt-faf9ab4e-57d0-4363-8ed2-15b5326918a5</imagelabel>
  </seclabel>
  <seclabel type='dynamic' model='dac' relabel='yes'>
    <label>+64055:+127</label>
    <imagelabel>+64055:+127</imagelabel>
  </seclabel>
</domain>
```