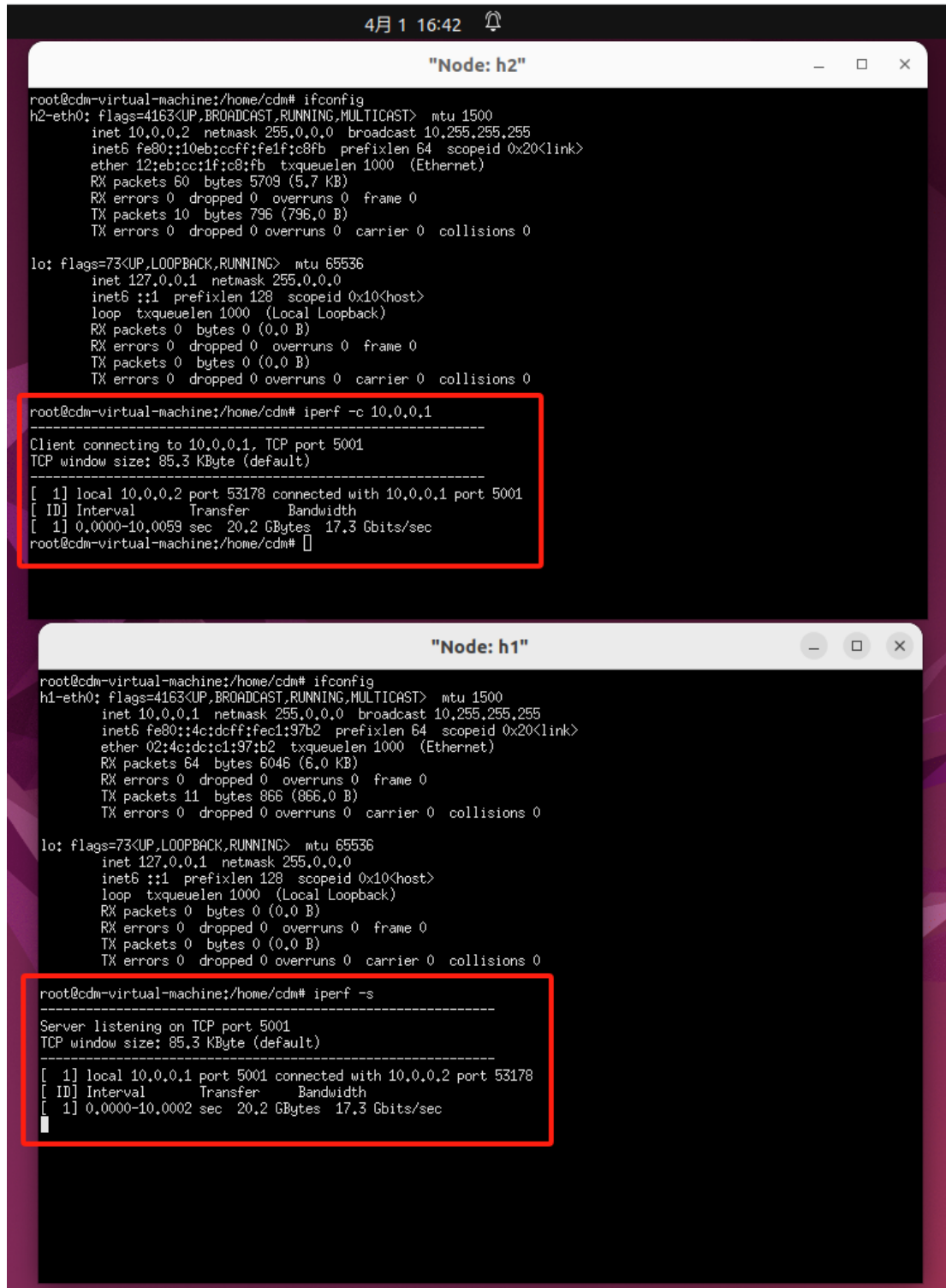


Report for lab3: QoS implementation with OvS

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Task1: 截图如下所示, node h1 和 node h2 已经正常联通, 带宽等指标正常。



The image displays two terminal windows from a virtual machine environment. The top window, titled "Node: h2", shows the output of the 'ifconfig' command for the h2-eth0 and lo interfaces, followed by the execution of 'iperf -c 10.0.0.1'. The iperf client output shows a successful connection to 10.0.0.1 on port 5001, with a bandwidth of 17.3 Gbits/sec. The bottom window, titled "Node: h1", shows the output of 'ifconfig' for the h1-eth0 and lo interfaces, followed by the execution of 'iperf -s'. The iperf server output shows it is listening on port 5001 and has successfully connected to 10.0.0.1 on port 53178, with a bandwidth of 17.3 Gbits/sec. Both iperf tests show a transfer of 20.2 GBytes over a 10-second interval.

```
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"Node: h2"

root@cdm-virtual-machine:/home/cdm# ifconfig
h2-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.0.2 netmask 255.0.0.0 broadcast 10.255.255.255
    inet6 fe80::10eb:ccff:felf:c8fb prefixlen 64 scopeid 0x20<link>
    ether 12:eb:cc:1f:c8:fb txqueuelen 1000 (Ethernet)
    RX packets 60 bytes 5709 (5.7 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 10 bytes 796 (796.0 B)
    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 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

root@cdm-virtual-machine:/home/cdm# iperf -c 10.0.0.1
-----
Client connecting to 10.0.0.1, TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[  1] local 10.0.0.2 port 53178 connected with 10.0.0.1 port 5001
[ ID] Interval      Transfer      Bandwidth
[  1] 0.0000-10.0059 sec  20.2 GBytes  17.3 Gbits/sec
root@cdm-virtual-machine:/home/cdm#

"Node: h1"

root@cdm-virtual-machine:/home/cdm# ifconfig
h1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 10.0.0.1 netmask 255.0.0.0 broadcast 10.255.255.255
    inet6 fe80::4c:dcff:fec1:97b2 prefixlen 64 scopeid 0x20<link>
    ether 02:4c:dc:c1:97:b2 txqueuelen 1000 (Ethernet)
    RX packets 64 bytes 6046 (6.0 KB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 11 bytes 866 (866.0 B)
    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 0 bytes 0 (0.0 B)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 0 bytes 0 (0.0 B)
    TX errors 0 dropped 0 overruns 0 carrier 0 collisions 0

root@cdm-virtual-machine:/home/cdm# iperf -s
-----
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
-----
[  1] local 10.0.0.1 port 5001 connected with 10.0.0.2 port 53178
[ ID] Interval      Transfer      Bandwidth
[  1] 0.0000-10.0002 sec  20.2 GBytes  17.3 Gbits/sec
█
```

Task2: 截图如下, h2 的流量被丢弃, 因此 h1 无法接收到 h2 发送的数据。

The image shows a terminal window with a dark background and a light-colored title bar. The terminal is running commands to configure Open vSwitch (OVS) flows. The first command is `ovs-ofctl dump-flows s1 -O openflow13`, which shows the current flow table. The second command is `ovs-vsctl set bridge s1 datapath_type=netdev`. The third command is `sudo ovs-ofctl add-flow s1 "table=0,nw_src=10.0.0.2/24,actions=drop" -O openflow13`, which is highlighted with a red box. This command adds a drop rule for traffic from 10.0.0.2/24. The fourth command is `ovs-ofctl dump-flows s1 -O openflow13`, which shows the updated flow table. The output of the first and fourth commands shows that the flow table is empty. The output of the second command shows that the datapath type is set to netdev. The output of the third command shows that the flow table is updated with a drop rule for traffic from 10.0.0.2/24. Below the terminal window, there are two windows titled "Node: h1" and "Node: h2". The "Node: h1" window shows the output of `iperf -s`, which is listening on TCP port 5001. The "Node: h2" window shows the output of `iperf -c 10.0.0.1`, which is connecting to 10.0.0.1 on TCP port 5001. The output of the "Node: h2" window shows that the connection failed with the message "tcp connect failed: No route to host".

```
root@cdm-virtual-machine: /home/cdm
root@cdm-virtual-machine: /home/cdm
root@cdm-virtual-machine: /home/cdm# ovs-ofctl dump-flows s1 -O openflow13
cookie=0x0, duration=38.350s, table=0, n_packets=39, n_bytes=3026, priority=0 actions=CONTROLLER:128
root@cdm-virtual-machine: /home/cdm# ovs-vsctl set bridge s1 datapath_type=netdev
root@cdm-virtual-machine: /home/cdm# sudo ovs-ofctl add-flow s1 "table=0,nw_src=10.0.0.2/24,actions=drop" -O
openflow13
2024-04-01T08:56:44Z|00001|ofp_match|INFO|normalization changed ofp_match, details:
2024-04-01T08:56:44Z|00002|ofp_match|INFO| pre: nw_src=10.0.0.0/24
2024-04-01T08:56:44Z|00003|ofp_match|INFO| post:
root@cdm-virtual-machine: /home/cdm# ovs-ofctl dump-flows s1 -O openflow13
cookie=0x0, duration=8.686s, table=0, n_packets=0, n_bytes=0, actions=drop
cookie=0x0, duration=33.526s, table=0, n_packets=6, n_bytes=420, priority=0 actions=CONTROLLER:128
root@cdm-virtual-machine: /home/cdm#
```

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"Node: h1"

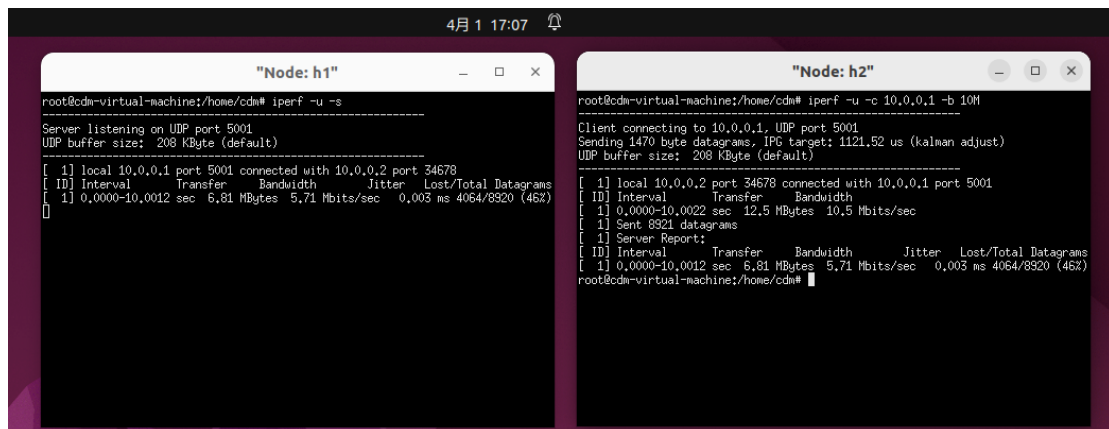
```
root@cdm-virtual-machine: /home/cdm# iperf -s
Server listening on TCP port 5001
TCP window size: 85.3 KByte (default)
[ ]
```

"Node: h2"

```
root@cdm-virtual-machine: /home/cdm# iperf -c 10.0.0.1
tcp connect failed: No route to host
Client connecting to 10.0.0.1, TCP port 5001
TCP window size: -1.00 Byte (default)
[ 1] local 0.0.0.0 port 0 connected with 10.0.0.1 port 5001
root@cdm-virtual-machine: /home/cdm#
```

Task3.1:

截图如下所示，发送端 h2 的发送带宽为 10.5Mbps/s，接收端 h1 收包速率限速 5Mbps/s，当收包速率超过限制时，将多余的包直接丢弃。因此 h1 接受带宽为 5.71Mbps/s，抖动 0.003ms，丢包率为 46%，符合预期。



The screenshot shows two terminal windows. The left window, titled "Node: h1", shows a server listening on UDP port 5001. It receives a connection from 10.0.0.1 port 34678. The performance report shows a bandwidth of 5.71 Mbps/sec and a jitter of 0.003 ms. The right window, titled "Node: h2", shows a client connecting to 10.0.0.1 UDP port 5001. It sends 1470 byte datagrams with an IPG target of 1121.52 us. The performance report shows a bandwidth of 10.5 Mbps/sec and a jitter of 0.000 ms.

```
root@cdm-virtual-machine:/home/cdm# iperf -u -s
Server listening on UDP port 5001
UDP buffer size: 208 KByte (default)

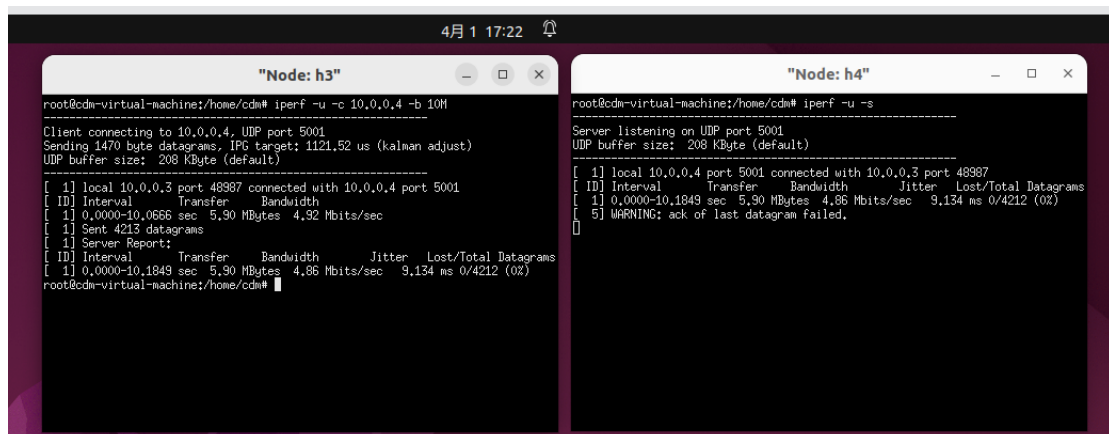
[ 1] local 10.0.0.1 port 5001 connected with 10.0.0.2 port 34678
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Tot. Datagrams
[ 1] 0.0000-10.0012 sec  5.81 MBytes  5.71 Mbits/sec  0.003 ms  4064/8920 (46%)
[ 1]

root@cdm-virtual-machine:/home/cdm# iperf -u -c 10.0.0.1 -b 10M
Client connecting to 10.0.0.1, UDP port 5001
Sending 1470 byte datagrams, IPG target: 1121.52 us (kalman adjust)
UDP buffer size: 208 KByte (default)

[ 1] local 10.0.0.2 port 34678 connected with 10.0.0.1 port 5001
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Tot. Datagrams
[ 1] 0.0000-10.0022 sec  12.5 MBytes  10.5 Mbits/sec
[ 1] Sent 8921 datagrams
[ 1] Server Report:
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Tot. Datagrams
[ 1] 0.0000-10.0012 sec  5.81 MBytes  5.71 Mbits/sec  0.003 ms  4064/8920 (46%)
root@cdm-virtual-machine:/home/cdm#
```

Task3.2:

截图如下所示。由于指定了队列的最大速率为 5Mbps/s，因此接受带宽为 4.86Mbps/s，符合预期。抖动为 9.134ms，小于网卡限速的抖动。由于队列限速会将数据包缓存起来，并不会将数据包丢弃，因此丢包率为 0%，符合预期。



The screenshot shows two terminal windows. The left window, titled "Node: h3", shows a client connecting to 10.0.0.4 UDP port 5001. It sends 1470 byte datagrams with an IPG target of 1121.52 us. The performance report shows a bandwidth of 4.86 Mbps/sec and a jitter of 9.134 ms. The right window, titled "Node: h4", shows a server listening on UDP port 5001. It receives a connection from 10.0.0.3 port 48987. The performance report shows a bandwidth of 4.86 Mbps/sec and a jitter of 9.134 ms. There is a warning message: "WARNING: ack of last datagram failed."

```
root@cdm-virtual-machine:/home/cdm# iperf -u -c 10.0.0.4 -b 10M
Client connecting to 10.0.0.4, UDP port 5001
Sending 1470 byte datagrams, IPG target: 1121.52 us (kalman adjust)
UDP buffer size: 208 KByte (default)

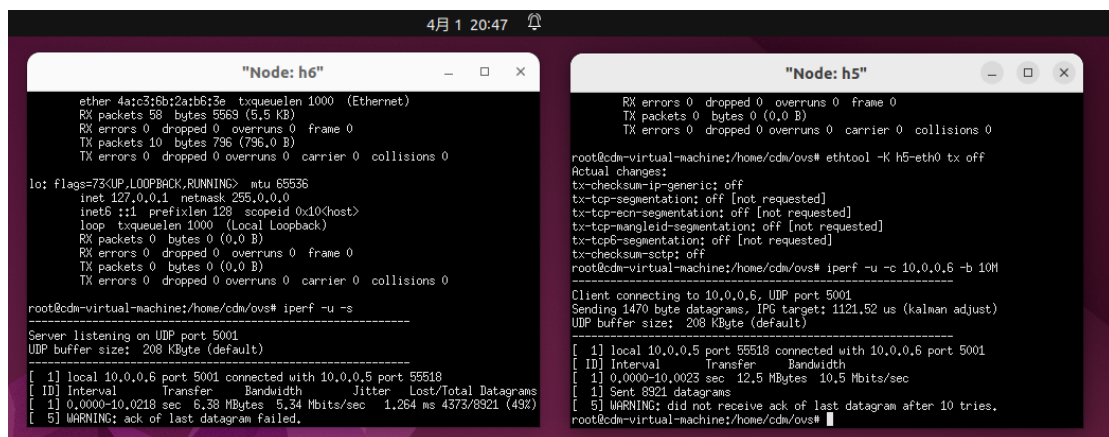
[ 1] local 10.0.0.3 port 48987 connected with 10.0.0.4 port 5001
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Tot. Datagrams
[ 1] 0.0000-10.0656 sec  5.90 MBytes  4.86 Mbits/sec  9.134 ms  0/4212 (0%)
[ 1] Sent 4213 datagrams
[ 1] Server Report:
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Tot. Datagrams
[ 1] 0.0000-10.1849 sec  5.90 MBytes  4.86 Mbits/sec  9.134 ms  0/4212 (0%)
root@cdm-virtual-machine:/home/cdm#

root@cdm-virtual-machine:/home/cdm# iperf -u -s
Server listening on UDP port 5001
UDP buffer size: 208 KByte (default)

[ 1] local 10.0.0.4 port 5001 connected with 10.0.0.3 port 48987
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Tot. Datagrams
[ 1] 0.0000-10.1849 sec  5.90 MBytes  4.86 Mbits/sec  9.134 ms  0/4212 (0%)
[ 5] WARNING: ack of last datagram failed.
[ 5]
```

Task3.3:

截图如下。接受带宽为 5.34Mbps/s，抖动为 1.264ms，丢包率 49%，符合预期。



The screenshot shows two terminal windows. The left window, titled "Node: h5", shows a server listening on UDP port 5001. It receives a connection from 10.0.0.5 port 55518. The performance report shows a bandwidth of 5.34 Mbps/sec and a jitter of 1.264 ms. The right window, titled "Node: h5", shows a client connecting to 10.0.0.6 UDP port 5001. It sends 1470 byte datagrams with an IPG target of 1121.52 us. The performance report shows a bandwidth of 10.5 Mbps/sec and a jitter of 0.000 ms. There is a warning message: "WARNING: did not receive ack of last datagram after 10 tries."

```
root@cdm-virtual-machine:/home/cdm# iperf -u -s
Server listening on UDP port 5001
UDP buffer size: 208 KByte (default)

[ 1] local 10.0.0.5 port 5001 connected with 10.0.0.5 port 55518
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Tot. Datagrams
[ 1] 0.0000-10.0218 sec  5.34 MBytes  5.34 Mbits/sec  1.264 ms  4373/8921 (49%)
[ 5] WARNING: ack of last datagram failed.
[ 5]
```

```
root@cdm-virtual-machine:/home/cdm# iperf -u -c 10.0.0.6 -b 10M
Client connecting to 10.0.0.6, UDP port 5001
Sending 1470 byte datagrams, IPG target: 1121.52 us (kalman adjust)
UDP buffer size: 208 KByte (default)

[ 1] local 10.0.0.5 port 55518 connected with 10.0.0.6 port 5001
[ ID] Interval      Transfer    Bandwidth    Jitter    Lost/Tot. Datagrams
[ 1] 0.0000-10.0023 sec  12.5 MBytes  10.5 Mbits/sec
[ 1] Sent 8921 datagrams
[ 5] WARNING: did not receive ack of last datagram after 10 tries.
root@cdm-virtual-machine:/home/cdm#
```

Question1:

```
19 $ ovs-ofctl add-flow s1 in_port=5,action=meter:1,output:6 -O openflow13
20 $ ovs-ofctl dump-flows s1 -O openflow13
```

19 行指令是下发转发的流标，'add-flow s1' 添加 s1 流，'in_port=5'代表数据包进入的端口是 5 号端口，'action = meter : 1' 转发动作，按照 1 号 meter 表，'output : 6' 输出端口是 5 号端口，'-O openflow13' 指定协议为 openflow13。

20 行指令是输出 s1 上的所有流内容，按照 openflow13 协议。

Question2:

	带宽	抖动	丢包率
网卡限速	5.71Mbits/s	0.003ms	46%
队列限速	4.86Mbits/s	9.134ms	0%
Meter 表限速	5.34Mbits/s	1.264ms	49%

从带宽来看，限速为 5Mbits/s，网卡限速、meter 表限速都略微超过了 5Mbits/s，只有队列限速低于限速。

从丢包率来看，队列限速效果最好，丢包率为 0。这与其实现原理有关，将数据包缓存起来，在不中断链接情况下平滑网络流量，避免了丢包问题。其余方法则简单的在超速后丢包。

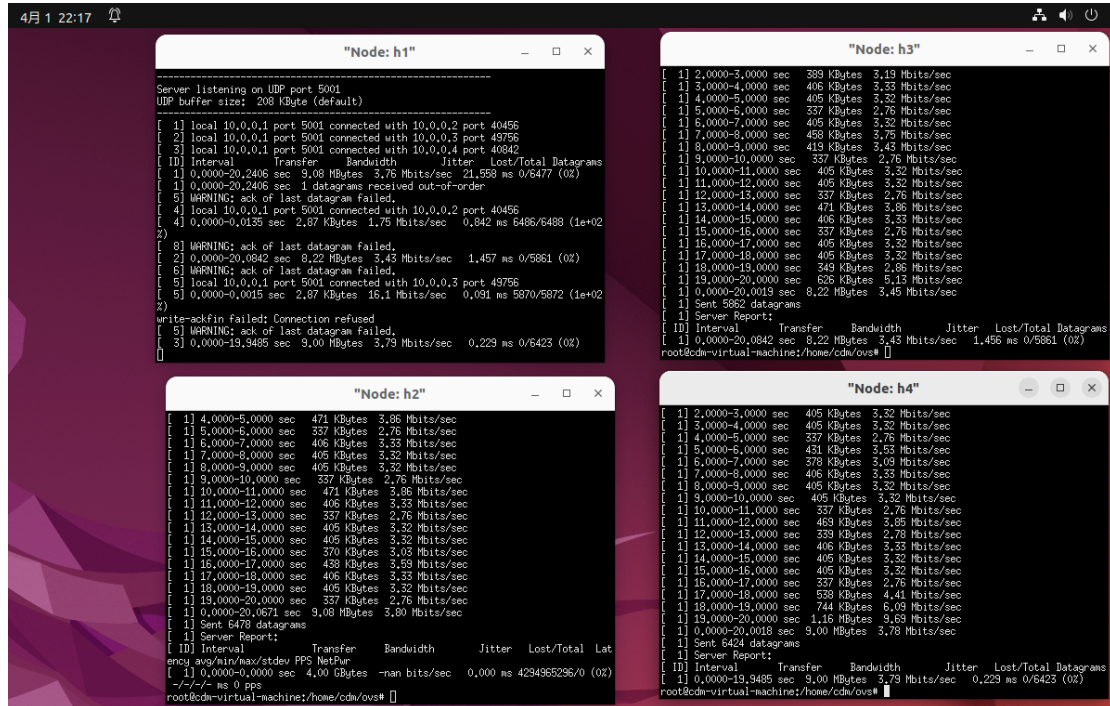
从抖动来看，meter 表的抖动最高。Meter 表的速率限制是通过算法来计算的，这可能导致在一些情况下速率的实际限制与预期值有所偏差，从而引起抖动。

Task4:

通过队列限速对 h1 进行限速。

```
10 ovs-vsctl set port s1-eth1 qos=@newqos -- \
11 --id=@newqos create qos type=linux-htb queues=0=@q0 -- \
12 --id=@q0 create queue other-config:max-rate=10000000
13
```

限速之后, h2-4 同时开始发包, 可以发现速度最终趋于平衡, 三者速率都在 3 Mbits/s 左右。



```
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"Node: h1"
Server listening on UDP port 5001
UDP buffer size: 208 KByte (default)

[ 1] local 10.0.0.1 port 5001 connected with 10.0.0.2 port 40456
[ 2] local 10.0.0.1 port 5001 connected with 10.0.0.3 port 49756
[ 3] local 10.0.0.1 port 5001 connected with 10.0.0.4 port 40842
[ID] Interval      Transfer      Bandwidth      Jitter  Lost/Total Datagrams
[ 1] 0.0000-20.2406 sec  9.08 MBytes  3.76 Mbits/sec  21.558 ms 0/6477 (0%)
[ 2] 0.0000-20.2406 sec  1 datagram  received out-of-order
[ 3] WARNING: ack of last datagram failed.
[ 4] local 10.0.0.1 port 5001 connected with 10.0.0.2 port 40456
[ 5] 0.0000-0.0139 sec  2.87 KBytes  1.75 Mbits/sec  0.842 ms 6486/6488 (1e+02%)
[ 6] WARNING: ack of last datagram failed.
[ 7] 0.0000-20.0842 sec  8.22 MBytes  3.43 Mbits/sec  1.457 ms 0/5861 (0%)
[ 8] WARNING: ack of last datagram failed.
[ 9] local 10.0.0.1 port 5001 connected with 10.0.0.3 port 49756
[10] 0.0000-0.0015 sec  2.87 KBytes  16.1 Mbits/sec  0.091 ms 5870/5872 (1e+02%)
[11] write-ackfin failed: Connection refused.
[12] 0.0000-19.9485 sec  9.00 MBytes  3.79 Mbits/sec  0.229 ms 0/6423 (0%)
[13] Server Report:
[14] Interval      Transfer      Bandwidth      Jitter  Lost/Total Datagrams
[15] 0.0000-0.0000 sec  0.00 MBytes  0.00 Mbits/sec  0.000 ms 0/0 (0%)

"Node: h3"
[ 1] 2.0000-3.0000 sec  389 KBytes  3.19 Mbits/sec
[ 2] 3.0000-4.0000 sec  406 KBytes  3.33 Mbits/sec
[ 3] 4.0000-5.0000 sec  405 KBytes  3.32 Mbits/sec
[ 4] 5.0000-6.0000 sec  337 KBytes  2.76 Mbits/sec
[ 5] 6.0000-7.0000 sec  405 KBytes  3.32 Mbits/sec
[ 6] 7.0000-8.0000 sec  458 KBytes  3.75 Mbits/sec
[ 7] 8.0000-9.0000 sec  419 KBytes  3.43 Mbits/sec
[ 8] 9.0000-10.0000 sec  337 KBytes  2.76 Mbits/sec
[ 9] 10.0000-11.0000 sec  405 KBytes  3.32 Mbits/sec
[10] 11.0000-12.0000 sec  405 KBytes  3.32 Mbits/sec
[11] 12.0000-13.0000 sec  337 KBytes  2.76 Mbits/sec
[12] 13.0000-14.0000 sec  471 KBytes  3.68 Mbits/sec
[13] 14.0000-15.0000 sec  405 KBytes  3.33 Mbits/sec
[14] 15.0000-16.0000 sec  337 KBytes  2.76 Mbits/sec
[15] 16.0000-17.0000 sec  405 KBytes  3.32 Mbits/sec
[16] 17.0000-18.0000 sec  405 KBytes  3.32 Mbits/sec
[17] 18.0000-19.0000 sec  349 KBytes  2.86 Mbits/sec
[18] 19.0000-20.0000 sec  626 KBytes  5.13 Mbits/sec
[19] 0.0000-20.0019 sec  8.22 MBytes  3.45 Mbits/sec
[20] Sent 5862 datagrams
[21] Server Report:
[22] Interval      Transfer      Bandwidth      Jitter  Lost/Total Datagrams
[23] 0.0000-20.0842 sec  8.22 MBytes  3.43 Mbits/sec  1.456 ms 0/5861 (0%)
[24] root@cdm-virtual-machine:/home/cdm/ovs#

"Node: h2"
[ 1] 4.0000-5.0000 sec  471 KBytes  3.88 Mbits/sec
[ 2] 5.0000-6.0000 sec  337 KBytes  2.76 Mbits/sec
[ 3] 6.0000-7.0000 sec  405 KBytes  3.33 Mbits/sec
[ 4] 7.0000-8.0000 sec  405 KBytes  3.32 Mbits/sec
[ 5] 8.0000-9.0000 sec  405 KBytes  3.32 Mbits/sec
[ 6] 9.0000-10.0000 sec  337 KBytes  2.76 Mbits/sec
[ 7] 10.0000-11.0000 sec  471 KBytes  3.88 Mbits/sec
[ 8] 11.0000-12.0000 sec  405 KBytes  3.33 Mbits/sec
[ 9] 12.0000-13.0000 sec  337 KBytes  2.76 Mbits/sec
[10] 13.0000-14.0000 sec  405 KBytes  3.32 Mbits/sec
[11] 14.0000-15.0000 sec  405 KBytes  3.32 Mbits/sec
[12] 15.0000-16.0000 sec  370 KBytes  3.03 Mbits/sec
[13] 16.0000-17.0000 sec  438 KBytes  3.53 Mbits/sec
[14] 17.0000-18.0000 sec  405 KBytes  3.33 Mbits/sec
[15] 18.0000-19.0000 sec  405 KBytes  3.32 Mbits/sec
[16] 19.0000-20.0000 sec  337 KBytes  2.76 Mbits/sec
[17] 0.0000-20.0671 sec  9.08 MBytes  3.80 Mbits/sec
[18] Sent 6478 datagrams
[19] Server Report:
[20] Interval      Transfer      Bandwidth      Jitter  Lost/Total Lat
[21] 0.0000-0.0000 sec  0.00 GBytes  0.00 Mbits/sec  0.000 ms 0/0 (0%)
[22] -t/--ms 0 pps
[23] root@cdm-virtual-machine:/home/cdm/ovs#

"Node: h4"
[ 1] 2.0000-3.0000 sec  405 KBytes  3.32 Mbits/sec
[ 2] 3.0000-4.0000 sec  405 KBytes  3.32 Mbits/sec
[ 3] 4.0000-5.0000 sec  337 KBytes  2.76 Mbits/sec
[ 4] 5.0000-6.0000 sec  431 KBytes  3.53 Mbits/sec
[ 5] 6.0000-7.0000 sec  378 KBytes  3.09 Mbits/sec
[ 6] 7.0000-8.0000 sec  405 KBytes  3.33 Mbits/sec
[ 7] 8.0000-9.0000 sec  405 KBytes  3.32 Mbits/sec
[ 8] 9.0000-10.0000 sec  405 KBytes  3.32 Mbits/sec
[ 9] 10.0000-11.0000 sec  337 KBytes  2.76 Mbits/sec
[10] 11.0000-12.0000 sec  469 KBytes  3.85 Mbits/sec
[11] 12.0000-13.0000 sec  339 KBytes  2.78 Mbits/sec
[12] 13.0000-14.0000 sec  405 KBytes  3.33 Mbits/sec
[13] 14.0000-15.0000 sec  405 KBytes  3.32 Mbits/sec
[14] 15.0000-16.0000 sec  405 KBytes  3.32 Mbits/sec
[15] 16.0000-17.0000 sec  337 KBytes  2.76 Mbits/sec
[16] 17.0000-18.0000 sec  538 KBytes  4.41 Mbits/sec
[17] 18.0000-19.0000 sec  744 KBytes  6.09 Mbits/sec
[18] 19.0000-20.0000 sec  1.16 MBytes  9.69 Mbits/sec
[19] 0.0000-20.0018 sec  9.00 MBytes  3.78 Mbits/sec
[20] Sent 6424 datagrams
[21] Server Report:
[22] Interval      Transfer      Bandwidth      Jitter  Lost/Total Datagrams
[23] 0.0000-19.9485 sec  9.00 MBytes  3.79 Mbits/sec  0.229 ms 0/6423 (0%)
[24] root@cdm-virtual-machine:/home/cdm/ovs#
```

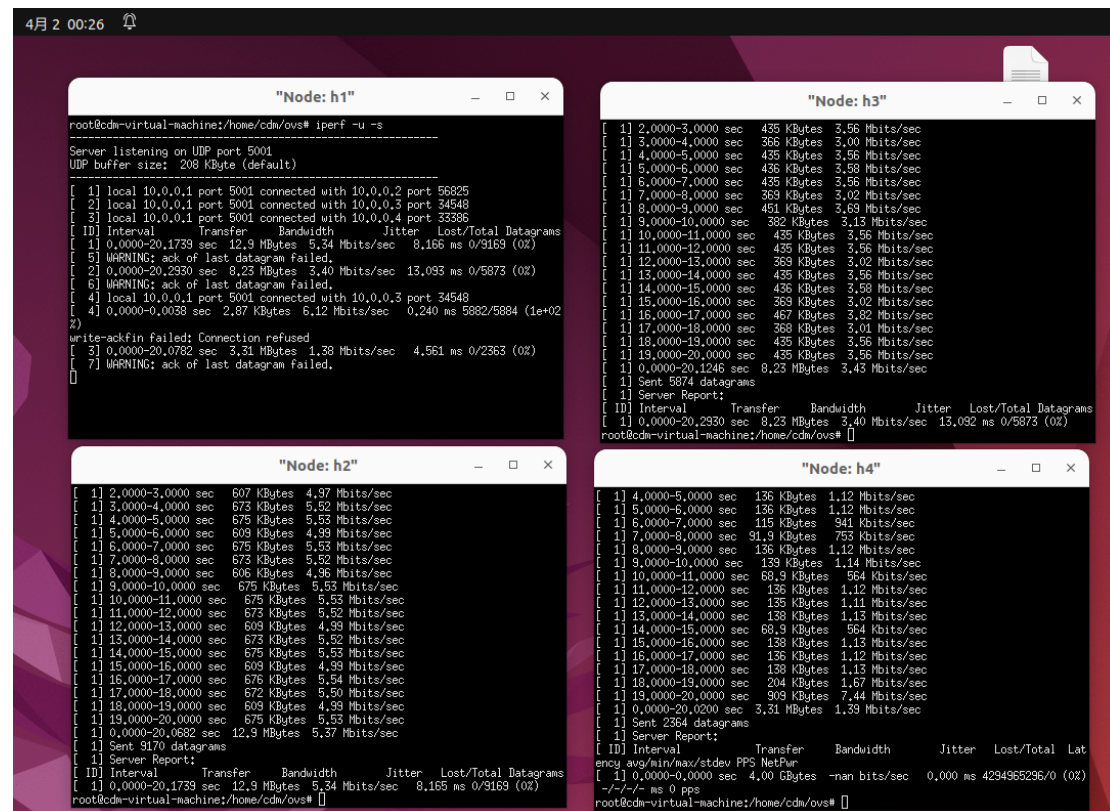
Task5:

执行如下命令：

```
1 $ ovs-vsctl set port s1-eth1 qos=@newqos -- \
2   --id=@newqos create qos type=linux-htb \
3   other-config:max-rate=10000000 queues=1=@q1,2=@q2 -- \
4   --id=@q1 create queue other-config:min-rate=5000000 \
5   other-config:max-rate=5500000 -- \
6   --id=@q2 create queue other-config:min-rate=3000000 \
7   other-config:max-rate=3500000
8
9
10 $ ovs-ofctl add-flow s1 in_port=2,actions=set_queue:1,output:1 -O openflow13
11 $ ovs-ofctl add-flow s1 in_port=3,actions=set_queue:2,output:1 -O openflow13
```

使用队列限速，设置 h1 接收速率上限为 10Mbps/s，h2 发送最小为 5Mbps/s，h3 发送最小为 3Mbps/s，为了让 h4 拥有尽可能多的速率，需要为 h2、h3 设置上限 (5.5Mbps/s、3.5Mbps/s)，否则可能导致 h4 几乎没有速率。

结果如下图，



端口 h2 速率为 5.34Mbps/s 左右，h3 为 3.40Mbps/s 左右，h4 为 1.38Mbps/s 左右，且总和在 10Mbps/s 左右，基本符合要求。