Lab 1: Switchyard & Mininet

181180050 孔孟荀

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step1 Modify the Mininet topology

选择做 Delete server2 in the topology

分析一下原来的要修改的文件start_mininet.py，发现它定义了一个nodes，里面有包括server2在里面的各种节点，应该只要把server2的部分直接注释掉就行

```
nodes = {
    "server1": {
        "mac": "10:00:00:00:00:{:02x}",
        "ip": "192.168.100.1/24"
    },
    #"server2": {
    #    "mac": "20:00:00:00:00:{:02x}",
    #    "ip": "192.168.100.2/24"
    #},
    "client": {
        "mac": "30:00:00:00:00:{:02x}",
        "ip": "192.168.100.3/24"
    },
    "hub": {
        "mac": "40:00:00:00:00:{:02x}",
    }
}
```

用mininet看一下现在的拓扑结构，发现确实没有server2了，修改成功

```
njucs@njucs-VirtualBox:~/networklab/lab-1-saltfishmx$ sudo python ./start_mininet.py
*** Creating network
*** Adding hosts:
client hub server1
*** Adding switches:

*** Adding links:
(10.00Mbit 100ms delay) (10.00Mbit 100ms delay) (client, hub) (10.00Mbit 100ms delay) (10.00Mbit 100ms delay)
 (server1, hub)
*** Configuring hosts
client hub server1
('client', <TCIntf client-eth0>, '30:00:00:00:00:01')
('server1', <TCIntf server1-eth0>, '10:00:00:00:00:01')
('hub', <TCIntf hub-eth0>, '40:00:00:00:00:01')
('hub', <TCIntf hub-eth1>, '40:00:00:00:00:02')
*** client : ('sysctl -w net.ipv6.conf.all.disable_ipv6=1',)
net.ipv6.conf.all.disable_ipv6 = 1
*** client : ('sysctl -w net.ipv6.conf.default.disable_ipv6=1',)
net.ipv6.conf.default.disable_ipv6 = 1
*** hub : ('sysctl -w net.ipv6.conf.all.disable_ipv6=1',)
net.ipv6.conf.all.disable_ipv6 = 1
*** hub : ('sysctl -w net.ipv6.conf.default.disable_ipv6=1',)
net.ipv6.conf.default.disable_ipv6 = 1
*** server1 : ('sysctl -w net.ipv6.conf.all.disable_ipv6=1',)
net.ipv6.conf.all.disable_ipv6 = 1
*** server1 : ('sysctl -w net.ipv6.conf.default.disable_ipv6=1',)
net.ipv6.conf.default.disable_ipv6 = 1
*** Starting controller

*** Starting 0 switches

*** Starting CLI:
```

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step2 Modify the logic of a device

注意到manual中说“In Switchyard, the device you want to be the hub will run this script and act like a hub by receiving any packets and forwarding to any other interfaces except the packets towards the hub itself. ”

再阅读myhub.py的代码，由manual里对于switchyard api的介绍，知道recv_packet()对应收包，而send_packet()对应发包，所以修改myhub.py如下

```
def main(net: switchyard.llnetbase.LLNetBase):
    my_interfaces = net.interfaces()
    mymacs = [intf.ethaddr for intf in my_interfaces]
    in_num = 0
    out_num = 0
    while True:
        try:
            _, fromIface, packet = net.recv_packet()
            in_num += 1
        except NoPackets:
            continue
        except Shutdown:
            break

        log_debug (f"In {net.name} received packet {packet} on {fromIface}")
        eth = packet.get_header(Ethernet)
        if eth is None:
            log_info("Received a non-Ethernet packet?!")
            return
        if eth.dst in mymacs:
            log_info("Received a packet intended for me")
        else:
            for intf in my_interfaces:
                if fromIface!= intf.name:
                    log_info (f"Flooding packet {packet} to {intf.name}")
                    net.send_packet(intf, packet)
                    out_num += 1
        log_info(f"in:{in_num} out:{out_num}")
    net.shutdown()
```

再没有修改之前，hub的log是这样的

```
"Node: hub"
root@njucs-VirtualBox:~/networklab/lab-1-saltfishmx# source /home/njucs/
(syenv) root@njucs-VirtualBox:~/networklab/lab-1-saltfishmx# swyard /tes
19:17:35 2021/03/14     INFO Saving iptables state and installing switch
19:17:35 2021/03/14     INFO Using network devices: hub-eth0 hub-eth1
19:17:43 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:01-
0:00:00:01:192.168.100.3 00:00:00:00:00:00:192.168.100.1 to hub-eth1
19:17:43 2021/03/14     INFO Flooding packet Ethernet 10:00:00:00:00:01-
0:00:00:01:192.168.100.1 30:00:00:00:00:01:192.168.100.3 to hub-eth0
19:17:43 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:01-
.100.3->192.168.100.1 ICMP | ICMP EchoRequest 4598 1 (56 data bytes) to
19:17:43 2021/03/14     INFO Flooding packet Ethernet 10:00:00:00:00:01-
.100.1->192.168.100.3 ICMP | ICMP EchoReply 4598 1 (56 data bytes) to hu
19:17:44 2021/03/14     INFO Flooding packet Ethernet 10:00:00:00:00:01-
.100.1->192.168.100.3 ICMP | ICMP EchoRequest 4601 1 (56 data bytes) to
19:17:44 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:01-
.100.3->192.168.100.1 ICMP | ICMP EchoReply 4601 1 (56 data bytes) to hu
19:17:49 2021/03/14     INFO Flooding packet Ethernet 10:00:00:00:00:01-
0:00:00:01:192.168.100.1 00:00:00:00:00:00:192.168.100.3 to hub-eth0
19:17:49 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:01-
0:00:00:01:192.168.100.3 10:00:00:00:00:01:192.168.100.1 to hub-eth1
```

修改之后：

```
"Node: hub"
root@njucs-VirtualBox:~/networklab/lab-1-saltfishmx# source /home/njucs/switchyard/syenv/bin/activate
(syenv) root@njucs-VirtualBox:~/networklab/lab-1-saltfishmx# swyard ./testcases/myhub.py
20:14:10 2021/03/14     INFO Saving iptables state and installing switchyard rules
20:14:10 2021/03/14     INFO Using network devices: hub-eth1 hub-eth0
20:14:15 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:01->ff:ff:ff:ff:ff:ff ARP | Arp 30:
00:00:00:00:01:192.168.100.3 00:00:00:00:00:00:192.168.100.1 to hub-eth1
20:14:15 2021/03/14     INFO in:1 out:1
20:14:15 2021/03/14     INFO Flooding packet Ethernet 10:00:00:00:00:01->30:00:00:00:00:01 ARP | Arp 10:
00:00:00:00:01:192.168.100.1 30:00:00:00:00:01:192.168.100.3 to hub-eth0
20:14:15 2021/03/14     INFO in:2 out:2
20:14:15 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:01->10:00:00:00:00:01 IP | IPv4 192
.168.100.3->192.168.100.1 ICMP | ICMP EchoRequest 5707 1 (56 data bytes) to hub-eth1
20:14:15 2021/03/14     INFO in:3 out:3
20:14:16 2021/03/14     INFO Flooding packet Ethernet 10:00:00:00:00:01->30:00:00:00:00:01 IP | IPv4 192
.168.100.1->192.168.100.3 ICMP | ICMP EchoReply 5707 1 (56 data bytes) to hub-eth0
20:14:16 2021/03/14     INFO in:4 out:4
20:14:16 2021/03/14     INFO Flooding packet Ethernet 10:00:00:00:00:01->30:00:00:00:00:01 IP | IPv4 192
.168.100.1->192.168.100.3 ICMP | ICMP EchoRequest 5710 1 (56 data bytes) to hub-eth0
20:14:16 2021/03/14     INFO in:5 out:5
20:14:16 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:01->10:00:00:00:00:01 IP | IPv4 192
.168.100.3->192.168.100.1 ICMP | ICMP EchoReply 5710 1 (56 data bytes) to hub-eth1
20:14:16 2021/03/14     INFO in:6 out:6
20:14:21 2021/03/14     INFO Flooding packet Ethernet 10:00:00:00:00:01->30:00:00:00:00:01 ARP | Arp 10:
00:00:00:00:01:192.168.100.1 00:00:00:00:00:00:192.168.100.3 to hub-eth0
20:14:21 2021/03/14     INFO in:7 out:7
20:14:21 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:01->10:00:00:00:00:01 ARP | Arp 30:
00:00:00:00:01:192.168.100.3 10:00:00:00:00:01:192.168.100.1 to hub-eth1
20:14:21 2021/03/14     INFO in:8 out:8
```

用有发给hub的包的hubtests.py试试

```
"Node: hub"
root@njucs-VirtualBox:~/networklab/lab-1-saltfishmx# source ~/switchyard/syenv/bin/acti
vate
(syenv) root@njucs-VirtualBox:~/networklab/lab-1-saltfishmx# swyard -t ~/switchyard/doc
umentation/code/hubtests.py myhub.py
20:30:22 2021/03/14     INFO Starting test scenario /home/njucs/switchyard/documentation
/code/hubtests.py
20:30:22 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:02->ff:ff:ff:ff:ff:
ff IP | IPv4 172.16.42.2->255.255.255.255 ICMP | ICMP EchoRequest 0 0 (0 data bytes) to
eth0
20:30:22 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:02->ff:ff:ff:ff:ff:
ff IP | IPv4 172.16.42.2->255.255.255.255 ICMP | ICMP EchoRequest 0 0 (0 data bytes) to
eth2
20:30:22 2021/03/14     INFO in:1 out:2
20:30:22 2021/03/14     INFO Flooding packet Ethernet 20:00:00:00:00:01->30:00:00:00:00:
02 IP | IPv4 192.168.1.100->172.16.42.2 ICMP | ICMP EchoRequest 0 0 (0 data bytes) to et
h1
20:30:22 2021/03/14     INFO Flooding packet Ethernet 20:00:00:00:00:01->30:00:00:00:00:
02 IP | IPv4 192.168.1.100->172.16.42.2 ICMP | ICMP EchoRequest 0 0 (0 data bytes) to et
h2
20:30:22 2021/03/14     INFO in:2 out:4
20:30:22 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:02->20:00:00:00:00:
01 IP | IPv4 172.16.42.2->192.168.1.100 ICMP | ICMP EchoReply 0 0 (0 data bytes) to eth0
20:30:22 2021/03/14     INFO Flooding packet Ethernet 30:00:00:00:00:02->20:00:00:00:00:
01 IP | IPv4 172.16.42.2->192.168.1.100 ICMP | ICMP EchoReply 0 0 (0 data bytes) to eth2
20:30:22 2021/03/14     INFO in:3 out:6
20:30:22 2021/03/14     INFO Received a packet intended for me
20:30:22 2021/03/14     INFO in:4 out:6

Results for test scenario hub tests: 8 passed, 0 failed, 0 pending
```

可见，符合manual里说的发给hub本身的包hub不再转发给其他结点

Step 3: Modify the test scenario of a device

选择做Create one test case by using the given function new_packet with different arguments

读了三个testcase以后，发现这三个testcase分别讲了这三件事：三个testcase里的包分别是1：broadcast destination 2：unicast address 3：destination is the hub itself,
hub对应的处理方式分别是 1、2：向除了入口ingress的所有port sent out packet， 3：什么事都不做
这三个testcase主要帮我理解了包的目的地和hub的出口port的区别

理解了这些事以后，选了一个很偷懒的方式来modify，只要把testcase3的destination的hub的端口eth2改成eth1，相关描述改改就行了

```
# test case 4: a frame with dest address of one of the interfaces should
# result in nothing happening
reqpkt = new_packet(
    "20:00:00:00:00:01",
    "10:00:00:00:00:02",
    '192.168.1.100',
    '172.16.42.2'
)
s.expect(
    PacketInputEvent("eth1", reqpkt, display=Ethernet),
    ("An Ethernet frame should arrive on eth1 with destination address "
     "the same as eth1's MAC address")
)
s.expect(
    PacketInputTimeoutEvent(1.0),
    ("The hub should not do anything in response to a frame arriving with"
     " a destination address referring to the hub itself.")
)
```

Step 4: Run your device in Mininet

仿照switchyard 的running in the minet的步骤

1. `sudo python ~/networklab/lab-1-saltfishmx/start_mininet.py`

```
njucs@njucs-VirtualBox:~/networklab$ sudo python ~/networklab/lab-1-saltfishmx/start_mininet.py
[sudo] password for njucs:
*** Creating network
*** Adding hosts:
client hub server1
*** Adding switches:

*** Adding links:
(10.00Mbit 100ms delay) (10.00Mbit 100ms delay) (client, hub) (10.00Mbit 100ms delay) (10.00Mbit 100ms delay
) (server1, hub)
*** Configuring hosts
client hub server1
('client', <TCIntf client-eth0>, '30:00:00:00:00:01')
('server1', <TCIntf server1-eth0>, '10:00:00:00:00:01')
('hub', <TCIntf hub-eth0>, '40:00:00:00:00:01')
('hub', <TCIntf hub-eth1>, '40:00:00:00:00:02')
*** client : ('sysctl -w net.ipv6.conf.all.disable_ipv6=1',)
net.ipv6.conf.all.disable_ipv6 = 1
*** client : ('sysctl -w net.ipv6.conf.default.disable_ipv6=1',)
net.ipv6.conf.default.disable_ipv6 = 1
*** hub : ('sysctl -w net.ipv6.conf.all.disable_ipv6=1',)
net.ipv6.conf.all.disable_ipv6 = 1
*** hub : ('sysctl -w net.ipv6.conf.default.disable_ipv6=1',)
net.ipv6.conf.default.disable_ipv6 = 1
*** server1 : ('sysctl -w net.ipv6.conf.all.disable_ipv6=1',)
net.ipv6.conf.all.disable_ipv6 = 1
*** server1 : ('sysctl -w net.ipv6.conf.default.disable_ipv6=1',)
net.ipv6.conf.default.disable_ipv6 = 1
*** Starting controller

*** Starting 0 switches
```

2. `xterm hub`

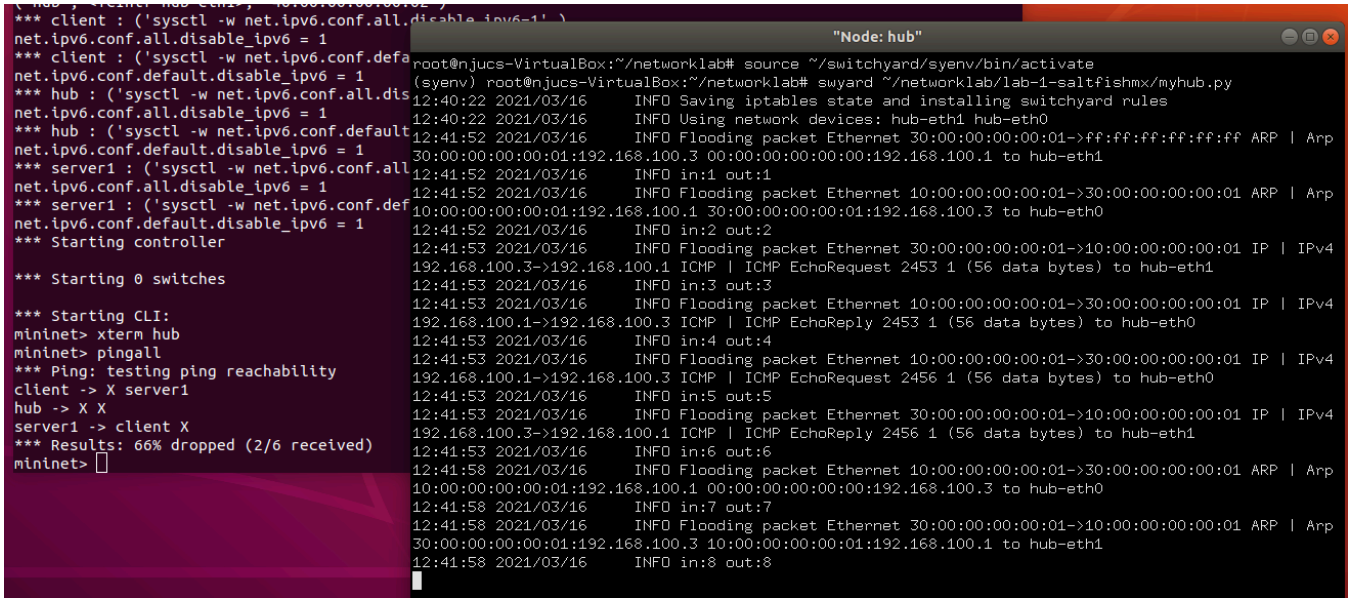
3.run my hub code on it

```
net.ipv6.conf.default.disable_ipv6 = 1
*** Starting controller

*** Starting 0 switches

*** Starting CLI:
mininet> xterm hub
mininet>
```

```
"Node: hub"
root@njucs-VirtualBox:~/networklab# source ~/switchyard/syenv/bin/activate
(syenv) root@njucs-VirtualBox:~/networklab# swyard ~/networklab/lab-1-saltfishmx/myhub.py
12:40:22 2021/03/16     INFO Saving iptables state and installing switchyard rules
12:40:22 2021/03/16     INFO Using network devices: hub-eth1 hub-eth0
```

4.pingall

here is the result:



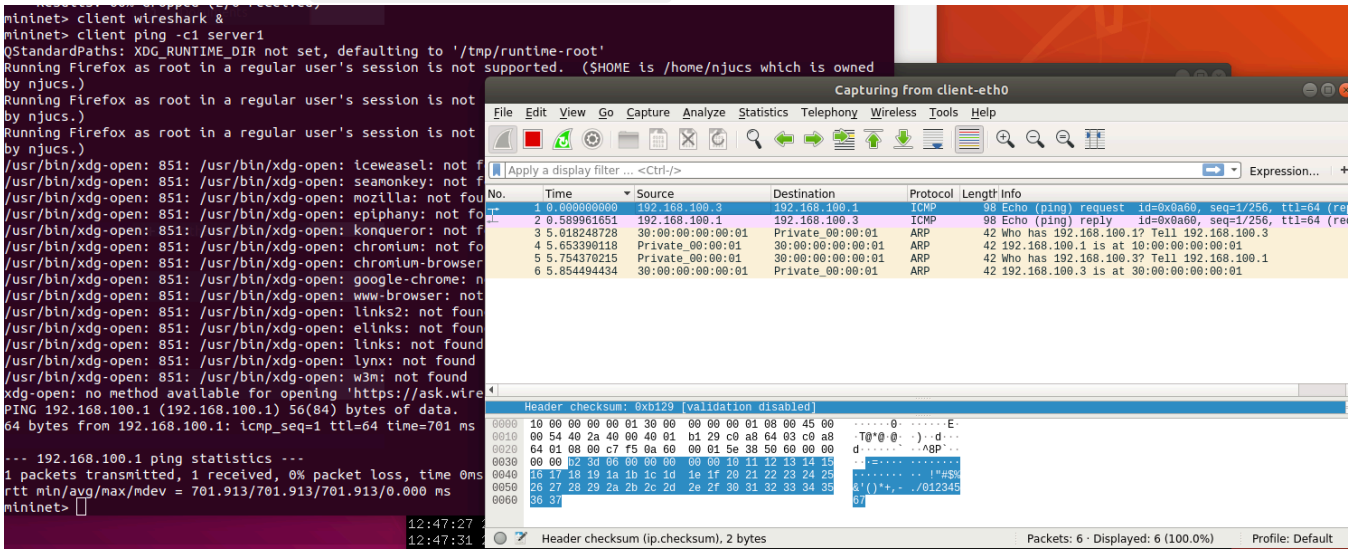
Step 5: Capture using Wireshark

capture packets on one host (no hub) while creating some traffic. Save your capture file and submit it with your report and code

共有 client server1 hub， 不能看hub

我选择看client: `client wireshark &`

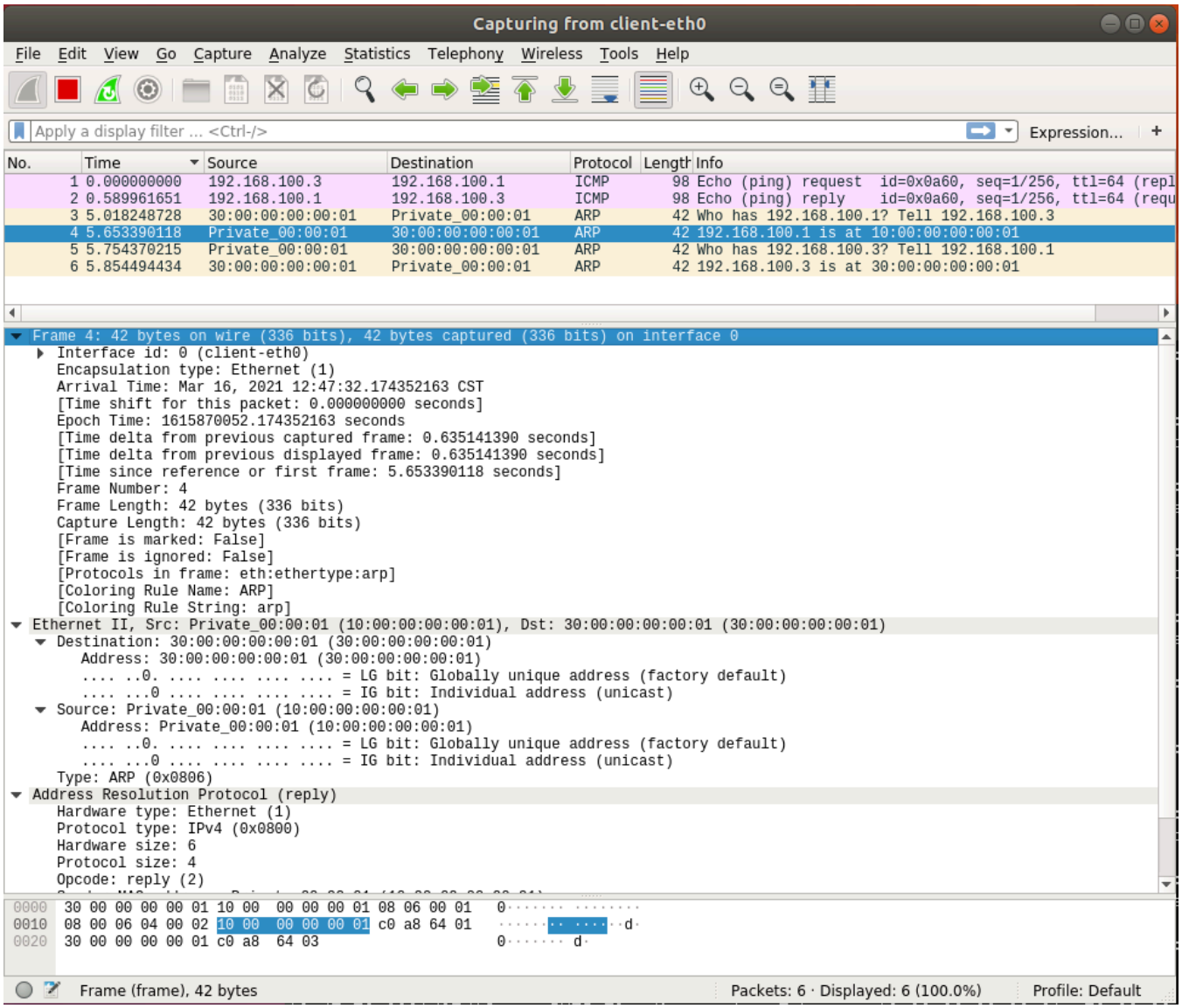
to make some traffic : `client ping -c1 server1`



使用ping之后似乎出现了一些问题，不过没有影响我wireshark抓包(大概)

mininet的提示似乎在说，我没有设置XDG_RUNTIME_DIR,然后有有关防火墙和我权限的事情，不过我没管(没看懂)

describe the details of my capture file:



以此图为例，这个包主要说了这么一些事：它的源是10：00：00：00：00：01，目的地是30：00：00：00：00：01，它的协议是arp（地址解析协议），它到达的时间是我做实验的时间21年3.16中午，

比较有趣的是它的功能，在info一栏看到它作用是回答了三号frame的问题

```
Who has 192.168.100.1? Tell 192.168.100.3
192.168.100.1 is at 10:00:00:00:00:01
```

找了一下这段信息是怎么表达出来的，似乎应该是通过这个arp的四个地址表达出来的：

```
▼ Address Resolution Protocol (reply)
    Hardware type: Ethernet (1)
    Protocol type: IPv4 (0x0800)
    Hardware size: 6
    Protocol size: 4
    Opcode: reply (2)
    Sender MAC address: Private_00:00:01 (10:00:00:00:00:01)
    Sender IP address: 192.168.100.1
    Target MAC address: 30:00:00:00:00:01 (30:00:00:00:00:01)
    Target IP address: 192.168.100.3
```

收工