Computer Network* Lab 5

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实验目的

分成两个部分，主要是实现对ICMPRequest的回复和对几种出错情况的处理，完善我们的路由器功能

Step1 核心代码和实现

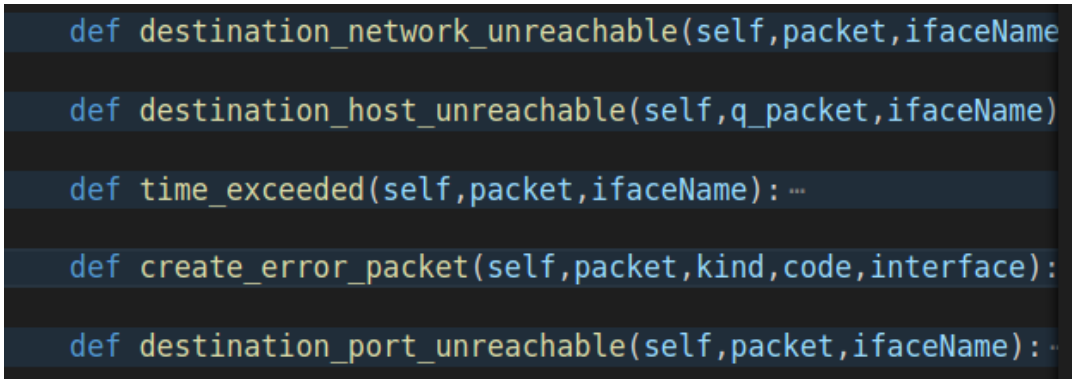
- **对于回复ICMPRequest的情况，首先检查包是否是发给自己的，对比包的目的地址和路由器接口即可，如果是，我们向收到的接口发送一个回复的包，否则，执行转发命令（lab3中已经实现）**
  - 框架如下：

```
if ipv4 is not None:              # recv a ipv4 packet
            icmp=None
            flag=0
            for i in self.net.interfaces():      # whether the ICMP
is for me
                if i.ipaddr==ipv4.dst:
                    flag=1
            if flag==1:
                if icmp is not None:
                    if icmp.icmptype is ICMPType.EchoRequest: #
request
                        # need to reply
                        echoReply=
self.create_ICMP_EchoReply_packet(packet) # create reply packet
                        self.deal_send(echoReply,64,ifaceName)
                    else:

 self.destination_port_unreachable(packet,ifaceName)
                else:

 self.destination_port_unreachable(packet,ifaceName)
            else:
                # do forward
```

- **分析总体的router功能，重新对结构进行分割，因为lab3里面对模块的划分不是很好，在lab4中再次做出调整，根据forwardingtable和cache发送包的过程封装为函数deal_send(packet,ttl,ifaceName)，所以现在需要解决的问题就是如何构造一个ICMPReply包**
  - 根据文件中的指导，新建一个包，进行复制和相关的处理，组装成一个新的包，然后直接发送这个包就可以
    - ```
          # create the icmp header
              src_icmp_header = request_packet.get_header(ICMP)
              icmp = ICMP()
              icmp.icmptype = ICMPType.EchoReply
              icmp.icmpdata.sequence = src_icmp_header.icmpdata.sequence
              icmp.icmpdata.identifier =
      src_icmp_header.icmpdata.identifier
              icmp.icmpdata.data = src_icmp_header.icmpdata.data

              #src_icmp_header.icmptype=ICMPType.EchoReply

              #print(icmp)

              # create ipve header
              src_ipv4_header = request_packet.get_header(IPv4)
              temp=src_ipv4_header.src
              src_ipv4_header.src=src_ipv4_header.dst
              src_ipv4_header.dst=temp
              src_ipv4_header.ttl = 64

              eth = Ethernet()
              eth.ethertype = EtherType.IP
              pkt= eth+src_ipv4_header+icmp
      ```

- **错误以及解决方案**
  - 一开始考虑到ICMPheader中除了type之外的内容都没有改变，考虑直接改变type然后转发，但是会发现不能通过测试，输出包的结果，可以看到我们构造的ICMPReply包是不符合要求的，如下
    - ```
      ICMP EchoReply 0 0 (0 data bytes)
      ```
  - 查阅手册，我们会发现，手册的这一段说明了当我们改变包的type时，其他部分会随之改变，变成默认的初始值，而不是保留原来的数据：
    - ```
      >>> i = ICMP()
      >>> print (i)
      ICMP EchoRequest 0 0 (0 data bytes)
      >>> i.icmptype = ICMPType.TimeExceeded
      >>> print (i)
      ICMP TimeExceeded:TTLExpired 0 bytes of raw payload (b'') OrigDgramLen: 0
      >>> i.icmpcode
      <ICMPCodeTimeExceeded.TTLExpired: 0>
      >>> i.icmpdata
      <switchyard.lib.packet.icmp.ICMPTimeExceeded object at 0x10d3a3308>
      ```
      Notice above that when the icmptype changes, other contents in the ICMP header object change appropriately.
  - 改成复制的形式再输出，可以发现正确的包的数据如下：
    - ```
      ICMP EchoReply 0 42 (0 data bytes)
      ```

Step2 核心代码和实现

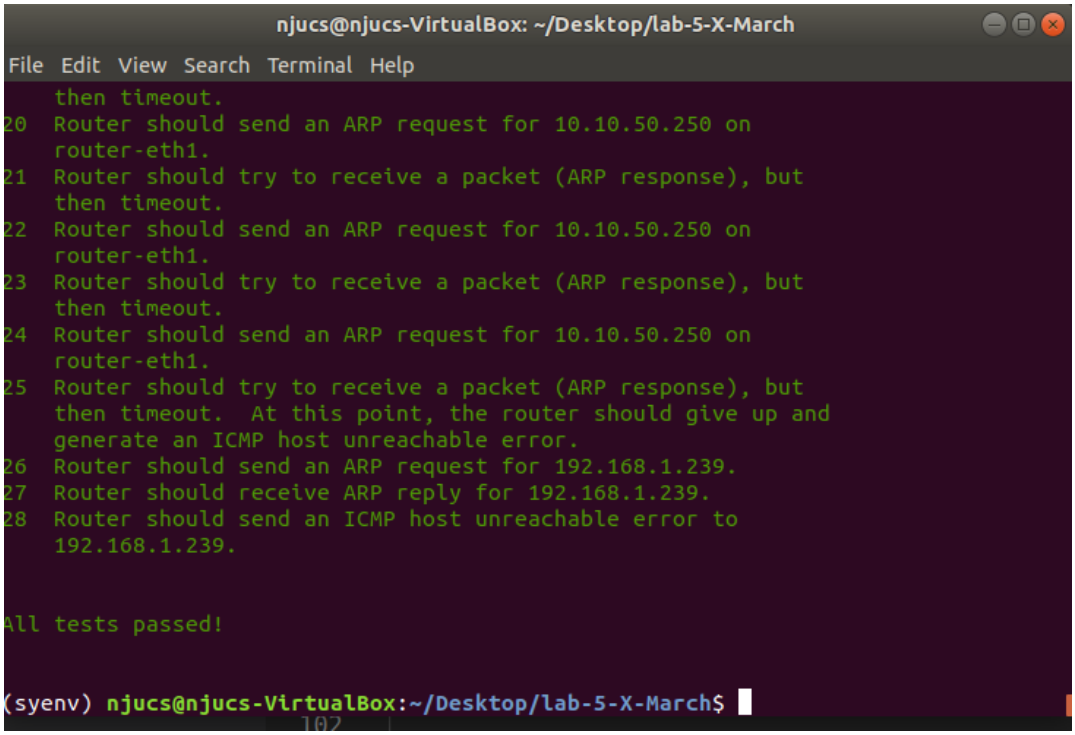
- 用create_error_packet函数来构造处理错误的包，用四个小函数来分别处理文件中所说的四种错误：
  - 

- create_error_packet函数的实现，主要就是根据指导文件中的要求设置ICMPType和code等部分，传入kind和code参数并处理即可
  - ```
    # delete eth
    i = packet.get_header_index(Ethernet)
    del packet[i]

    # create icmp header
    icmp = ICMP()
    icmp.icmptype = kind
    if code>=0:
        icmp.icmpcode = code
    icmp.icmpdata.data = packet.to_bytes()[:28]
    icmp.icmpdata.origdgramlen = len(packet)

    # create ipv4 header
    ipv4 = IPv4()
    ipv4.protocol = IPProtocol.ICMP
    ipv4.ttl = 64
    src_ipv4=packet.get_header(IPv4)
    ipv4.dst = src_ipv4.src
    ipv4.src = interface.ipaddr

    # create eth header
    eth = Ethernet()
    eth.src = interface.ethaddr
    eth.ethertype = EtherType.IP

    pkt = eth + ipv4 + icmp
    ```
  - 接下来只需要针对几种情况处理就可以了，我们以destination_network_unreachable为例
    - ```
      def destination_network_unreachable(self,packet,ifaceName):
              #if kind == "destination network unreachable":
              interface = self.net.interface_by_name(ifaceName)

       pkt=self.create_error_packet(packet,ICMPType.DestinationUnreachable
      ,0,interface)


              ipv4=pkt.get_header(IPv4)
              target = self.ip_mac_table.get(ipv4.dst)
      ```

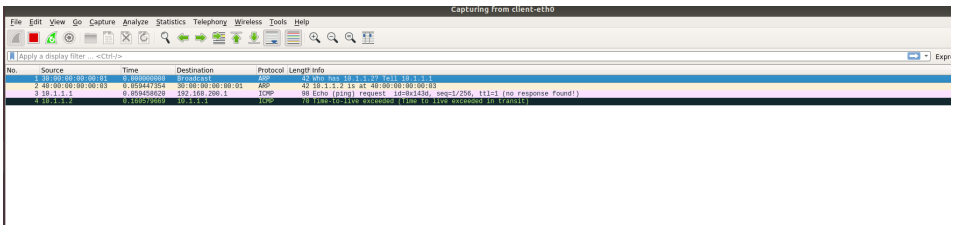
```
        if target is None:
            arp_request =
create_ip_arp_request(interface.ethaddr,interface.ipaddr,ipv4.dst)

            self.net.send_packet(ifaceName,arp_request)
            #pkt[0].src=interface.ethaddr

 self.q.append(q_item(arp_request,pkt,ipv4.dst,ifaceName,ifaceName))
        else:
            pkt[0].dst = target
            self.net.send_packet(ifaceName,pkt)
```

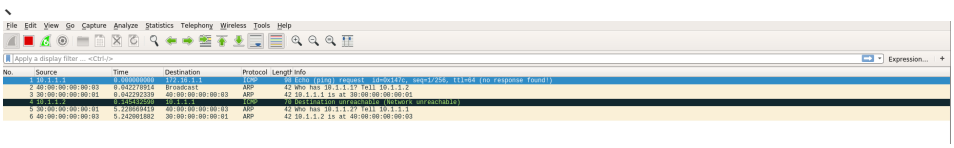
- 其他几种情况的处理大同小异
  - destination_host_unreachable由于是从队列中提取出来的，需要考虑从队列元素中提取出包
  - destination_port_unreachable由于时直接把包送还回去，所以我们不需要重新获取目的的mac，直接从原来的包里获取就可以
  - time_exceeded改变type和code就可以
- 最后再对应的位置调用对应的出错处理函数即可

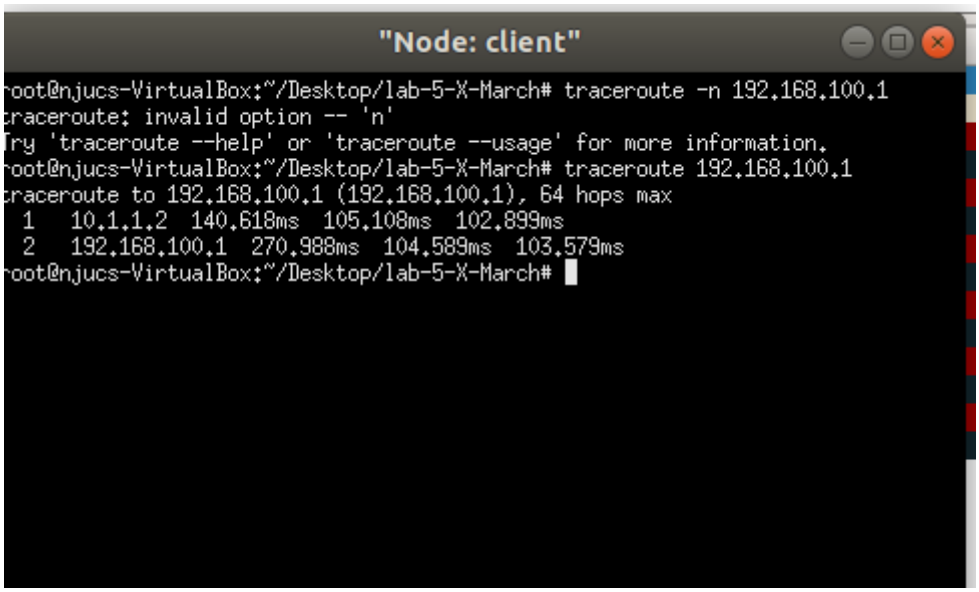
结果和分析

- 测试样例通过
  - 

- mininet运行和抓包
  - 首先构造一个ttl为1的包，这样就会触发time exceeded的错误，导致不能成功的ping，client会收到一个time exceeded错误提示的回复包
    - 抓包结果

- 

- destination unreachable 的情况，client同样会收到一个显示destination unreachable 错误情况的包
  - 抓包结果
    - 

- traceroute结果如下：
  - 

  - 抓包结果如下：
    -