Lab4 – 静态路由配置

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实验目的

- 学习掌握路由器的工作原理和配置方法；
- 加深理解路由和交换功能的区别和联系；
- 理解路由表的原理，掌握子网划分原则；
- 理解静态路由的概念，掌握设置静态路由和默认路由的方法；

实验内容

- 分别采用静态地址分配、动态地址分配构建多种类型的局域网；
- 使用多个路由器连接多个局域网；
- 分别采用以太网、高速串口等方式连接路由器；
- 通过路由器连接真实网络并实现数据通信；
- 在路由器上配置NAT，实现私有网络和共有网络的互联；
- 在各路由器上配置静态路由，实现网络互联互通。

- 注意：请按照实验报告中具体要求来配置每个区域中设备的IP地址！在做实验之前请认真阅读实验报告。完成实验后请按照实验报告要求把所需的文件打包上传到作业系统中。

安装GNS3模拟实验环境的软件 (I)

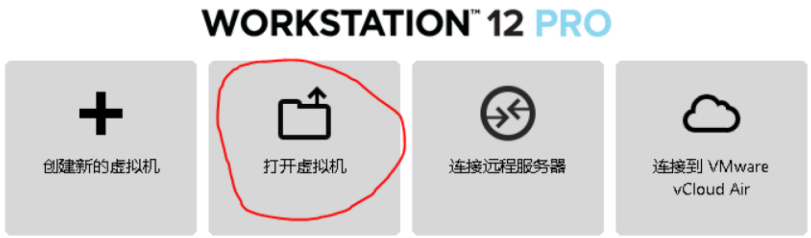
- 1) 安装所有的软件之前请仔细阅读作业系统中“使用GNS3软件模拟IOS指南”pdf格式文档。
- 2) 根据你自己电脑操作系统下载并安装VMWare虚拟机 (红色框下方的软件)。
  - 如果需要注册产品，目录里面提供有注册密钥。
- 3) 虚拟机软件VMWare安装完毕，请根据你电脑的操作系统下载对应的GNS3虚拟机，解压缩后的文件名为GNS3 VM.ova，然后在VMWare软件内导入该虚拟机文件。
  - 例如我的电脑是Windows操作系统，我就下载GNS3 2.1.9 VM for VMware workstation的GNS3虚拟机。
  - 下载安装Windows环境下的GNS3-2.1.9软件。

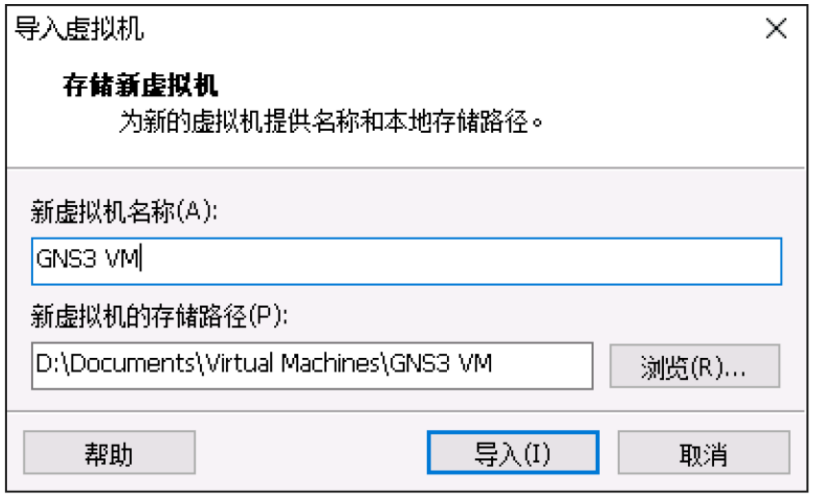
Windows	MacOS	Virtual Machine
ver 2.2.23		
GNS3-2.2.23	GNS3 2.2.23	GNS3 2.2.23 VM for VMware Workstation GNS3 2.2.23 VM for Windows 10 Hyper-V GNS3 2.2.23 VM for VMware ESXI GNS3 2.2.23 VM for VirsualBox
ver 2.1.9		
GNS3-2.1.9	GNS3 2.1.9	GNS3 2.1.9 VM for VMware Workstation GNS3 2.1.9 VM for VMware ESXI GNS3 2.1.9 VM for VirsualBox
ver 1.5.2		
GNS3-1.5.2	GNS3 1.5.2	GNS3 1.5.2 VM for VMware
VMware Software		
Windows		MacOS
VMware Workstation 12		VMware Fusion 8

How to install on Linux

安装GNS3模拟实验环境的软件 (II)

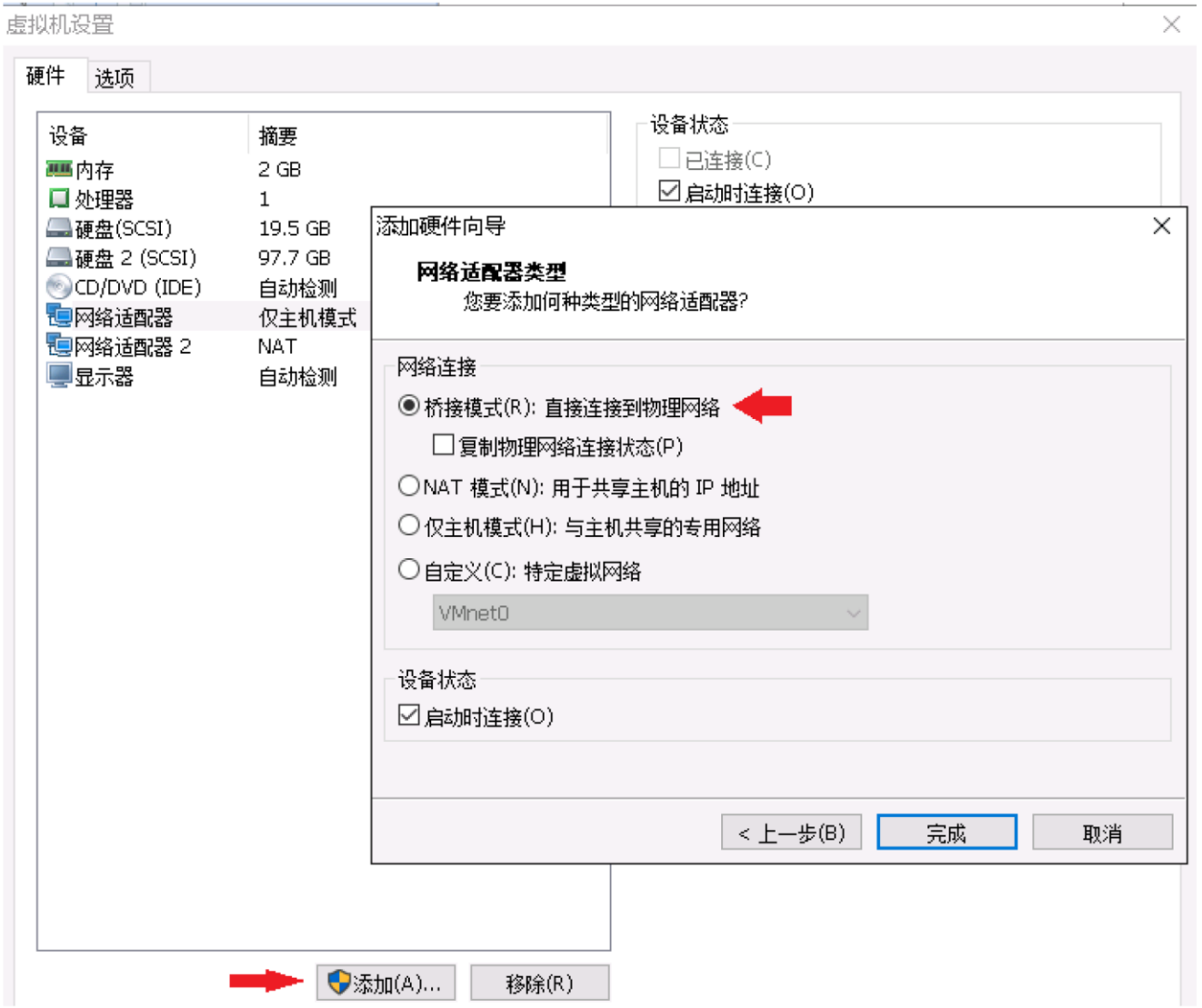
- GNS3虚拟机安装：
  - 1) 打开VMware，在VMWare软件内导入该虚拟机文件(就是你前面下载并解压的GNS3虚拟机文件，文件扩展名为.ova）
    - “使用GNS3软件模拟IOS指南”文档中有详细说明！



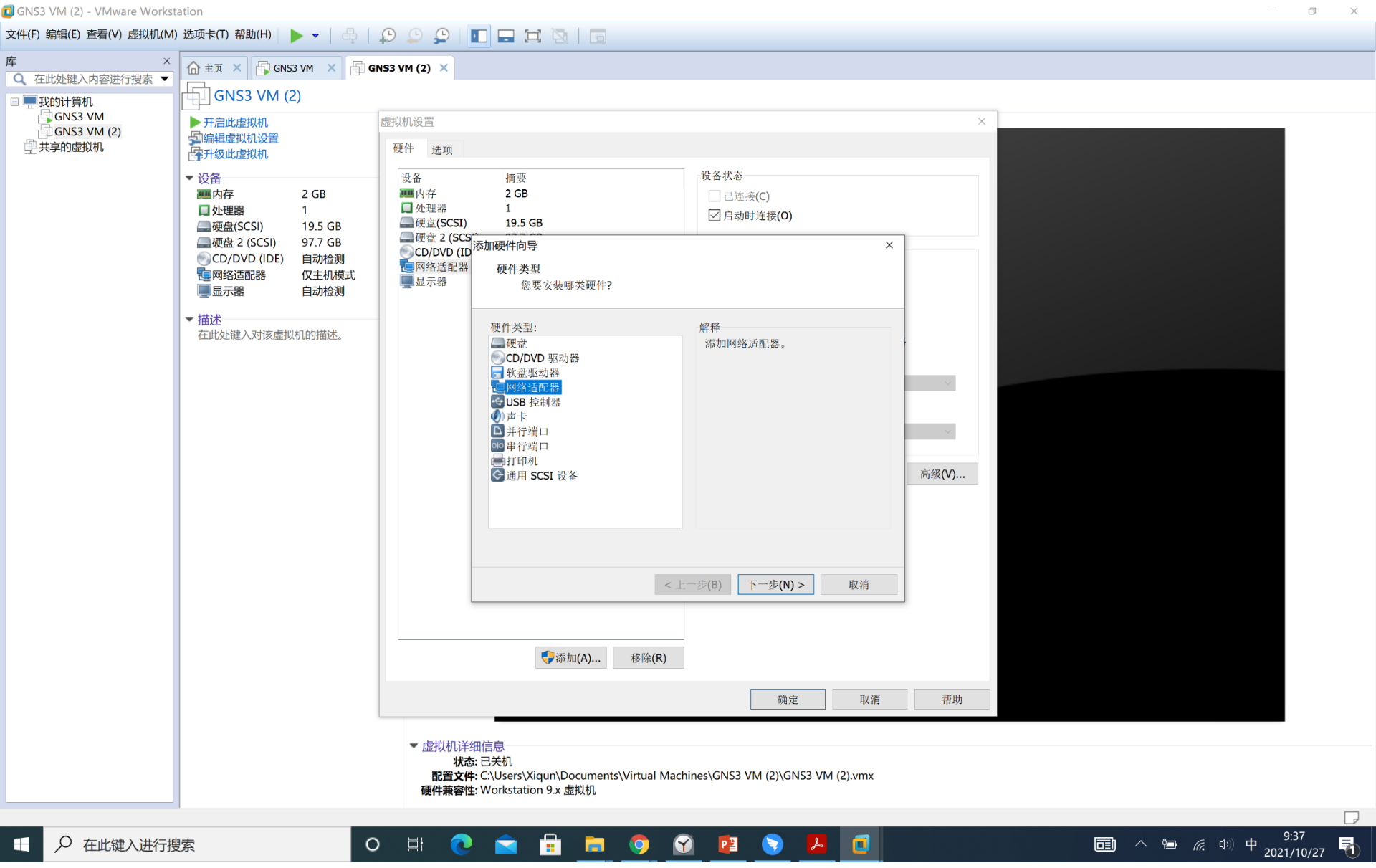


安装GNS3模拟实验环境的软件 (III)

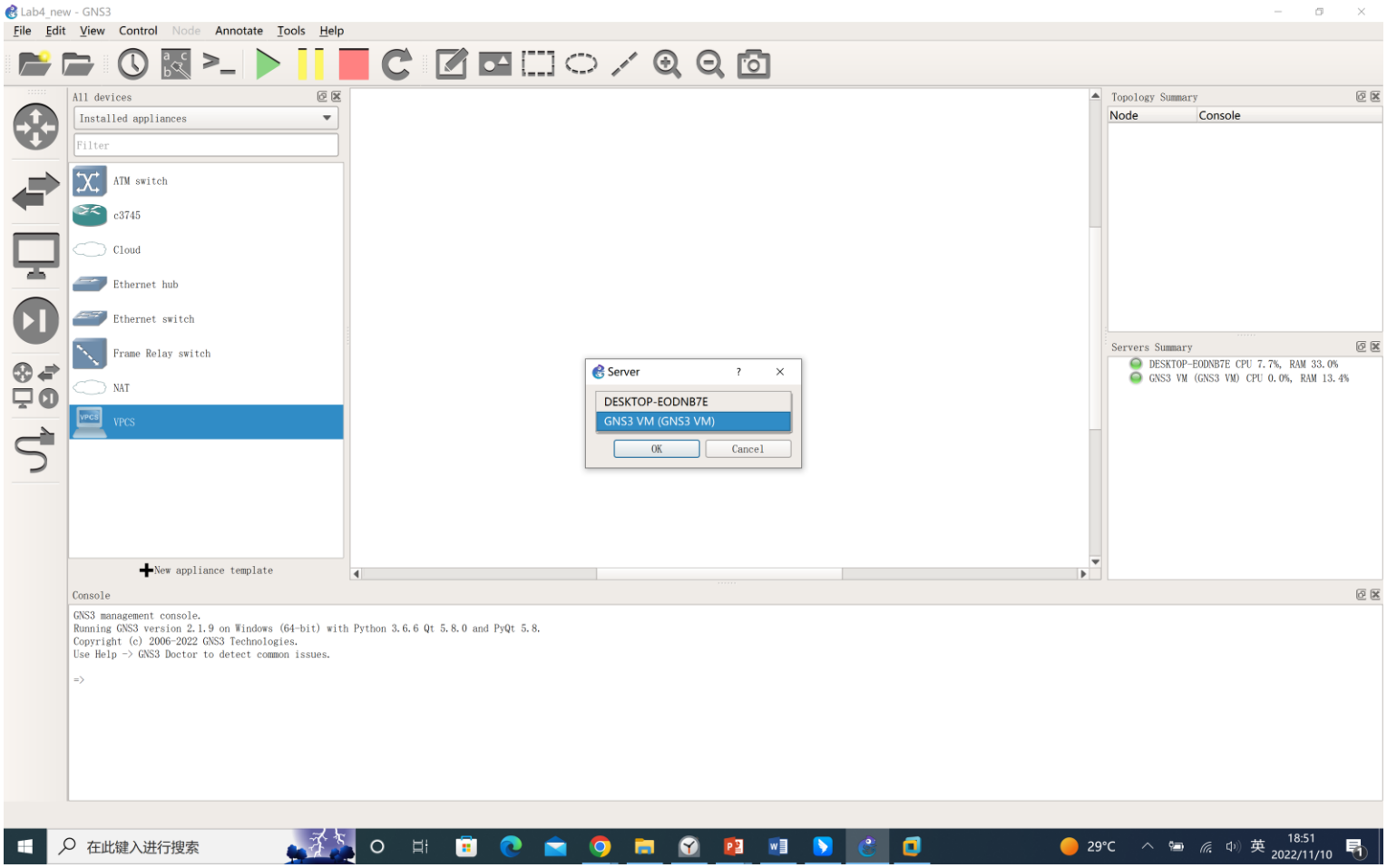
- 紧接着需要给虚拟机增加网卡，采用桥接模式。
  - 点击虚拟机设置然后点击“添加键，会跳出一个窗口“添加硬件导向”，点击添加“网络适配器”，然后点击“下一步”就会跳出“使用GNS3软件模拟IOS指南”中展示图片



安装GNS3模拟实验环境的软件 (IV)

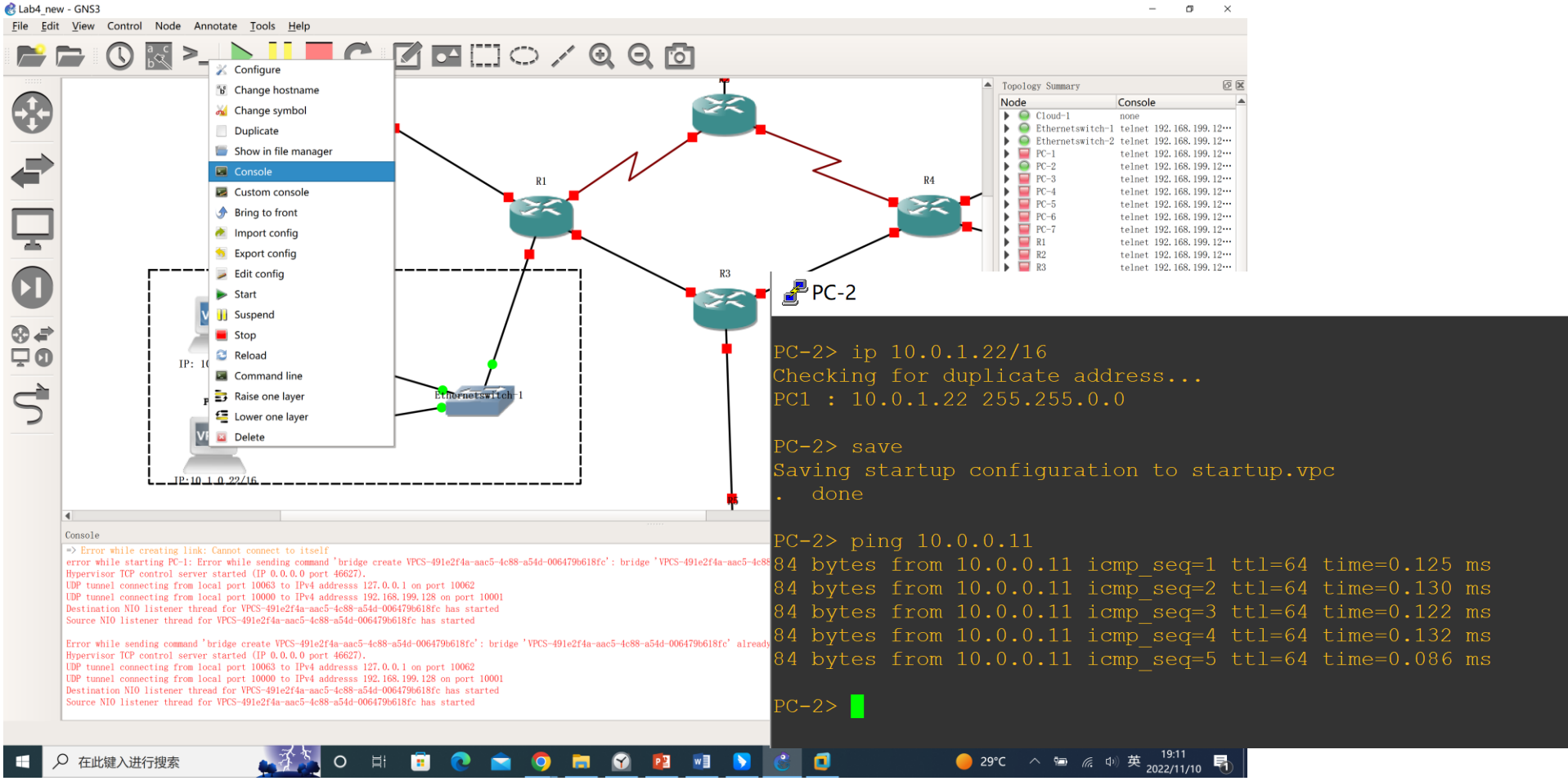


GNS3模拟实验环境



在模拟环境中每拉进一台PC机，或交换机，或Cloud时，会跳出一个选项，请选择“GNS3 VM （GNS3 VM）”

给PC机配置IP地址

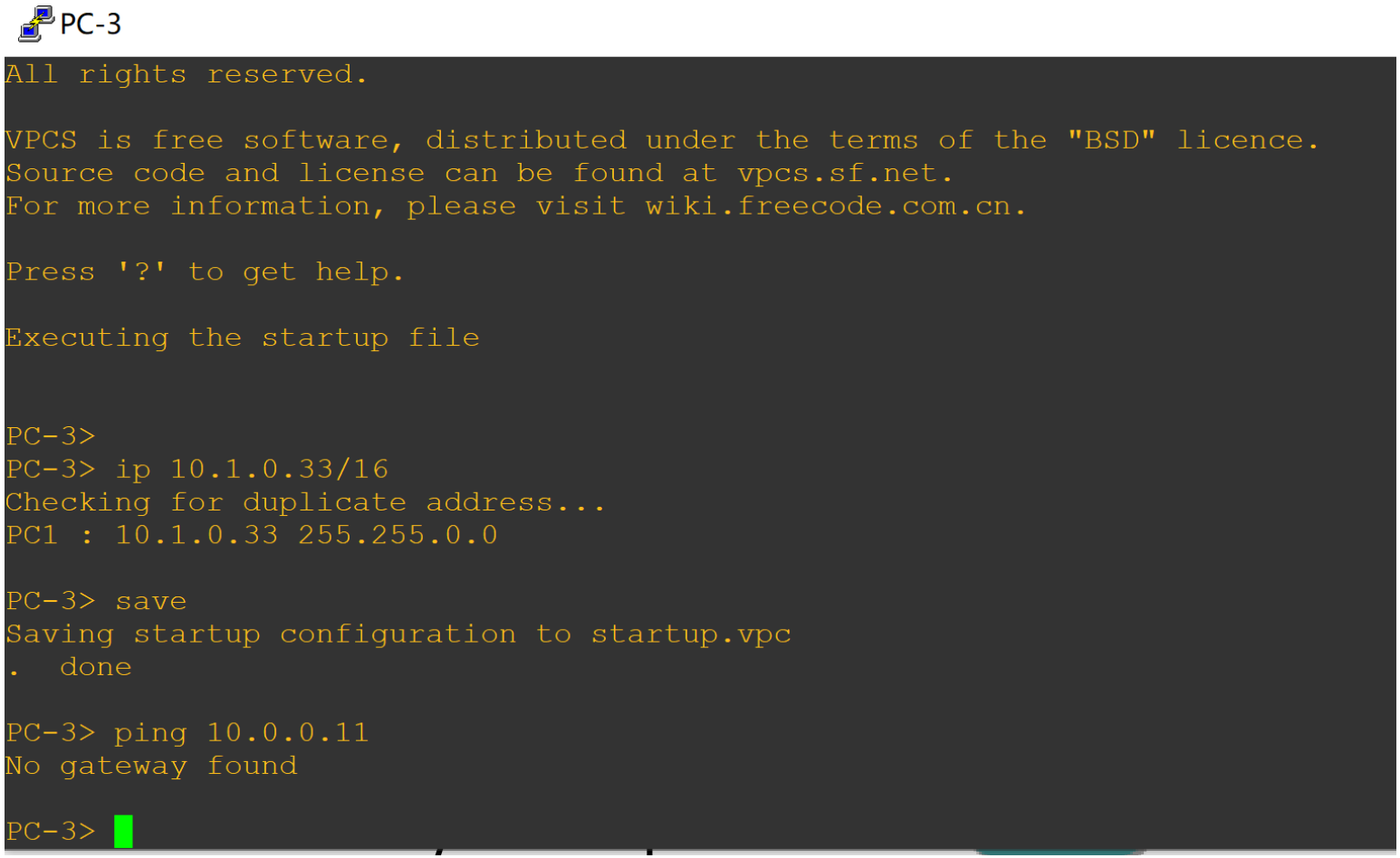


鼠标移到相应PC机上，先按绿色三角键“start”启动，然后选择Console监控器，采用PC-2> ip 10.0.1.22/16 (后面可以紧跟网关地址)，配置完了采用“save”命令保存设置。注意这里PC-1和PC-2是在同一子网内，不需要设置网关地址相互之间应该能ping通。

与PC机IP地址有关命令

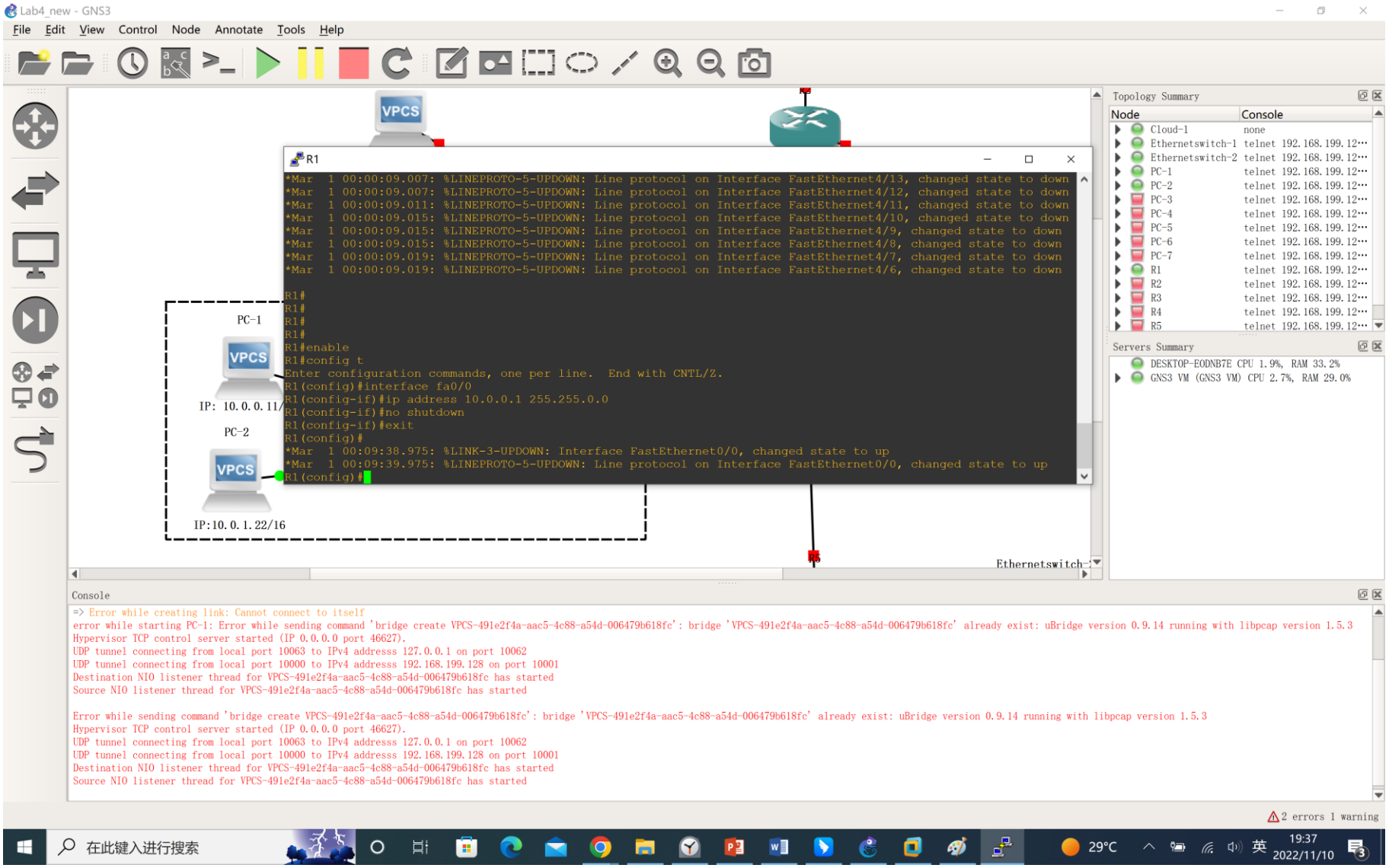
- 配置IP地址： PC-1> ip 10.0.0.11/16
  - /16 是指子网掩码长度，也就是等同于: 255.255.0.0，前面两个“255”是网段10.0.x.y，后面“x”和“y”(1~254) 可以分配给主机
- 保存所配置的IP地址： PC-1>save
- 查看某个PC机已配置的IP地址： PC-1>show ip

PC机没有配置网关地址之前



PC机没有配置网关地址之前是“ping”不通**不在同一子网**的其它PC机的。

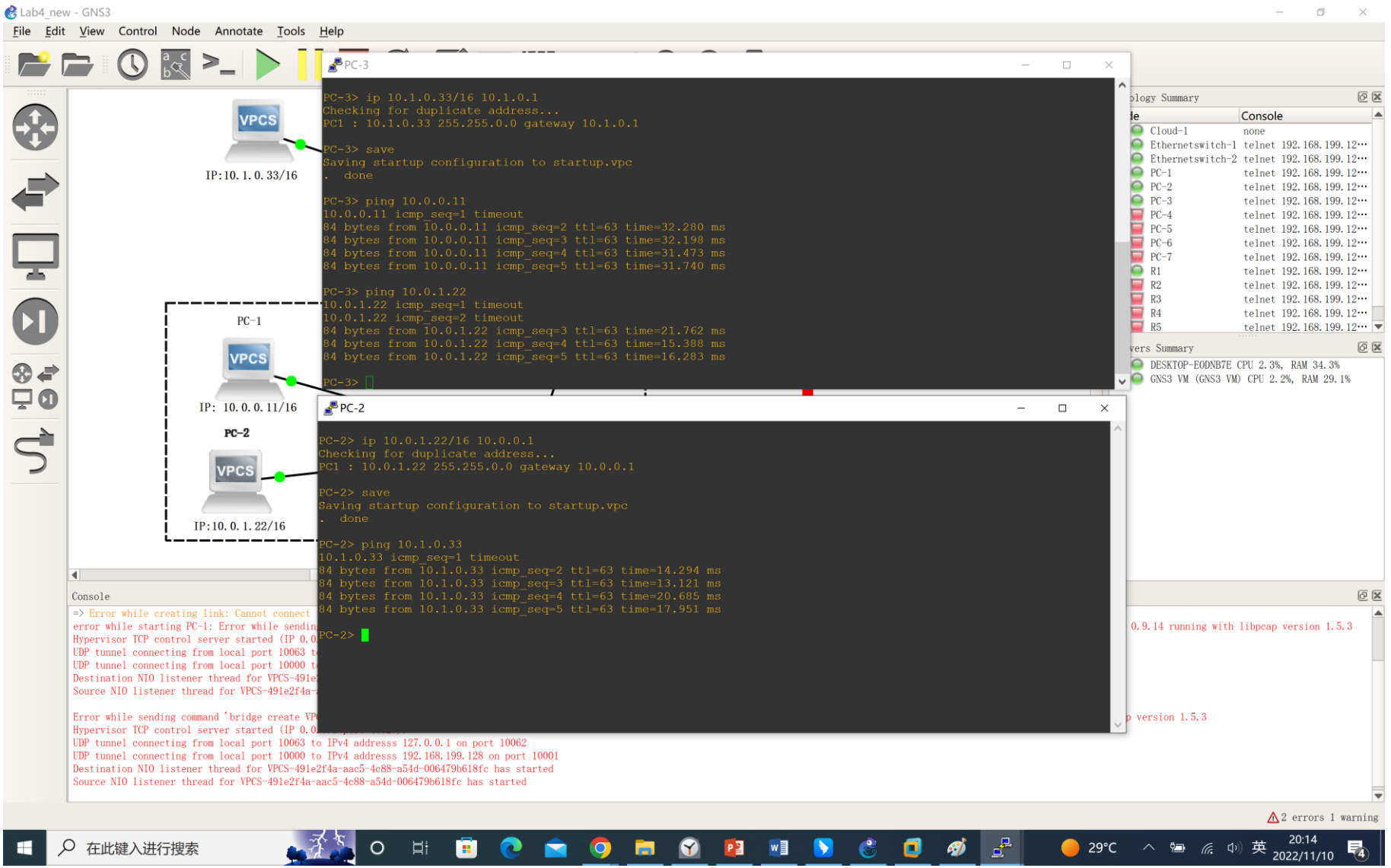
给路由器的接口配置IP地址



给设备配置IP地址

- 举例：
  - PC 1：ip 10.0.0.11/16 (后面还可以跟网关IP地址)
  - 路由器：一定是对其某个接口配置IP地址！
    - ip address 10.0.0.1 255.255.255.0
  - 在完成给路由器1中的两个接口fa0/0，fa1/0分属于两个不同子网配置好IP地址之后，将这两个IP地址分别作为位于Zone 1和Zone 2三台电脑的网关地址
    - 如PC1: ip 10.0.0.11/16 10.0.0.1
    - 如PC3: ip 10.1.0.33/16 10.1.0.1
    - 这里IP地址“10.0.0.1”是我们刚才配置给路由器1中接口fa0/0的，而IP地址“10.1.0.1”是我们刚才配置给路由器1中接口fa1/0的。

给设备配置IP地址



给各个PC机配置好网关后，处于不同子网的PC机之间也能相互“ping”通。

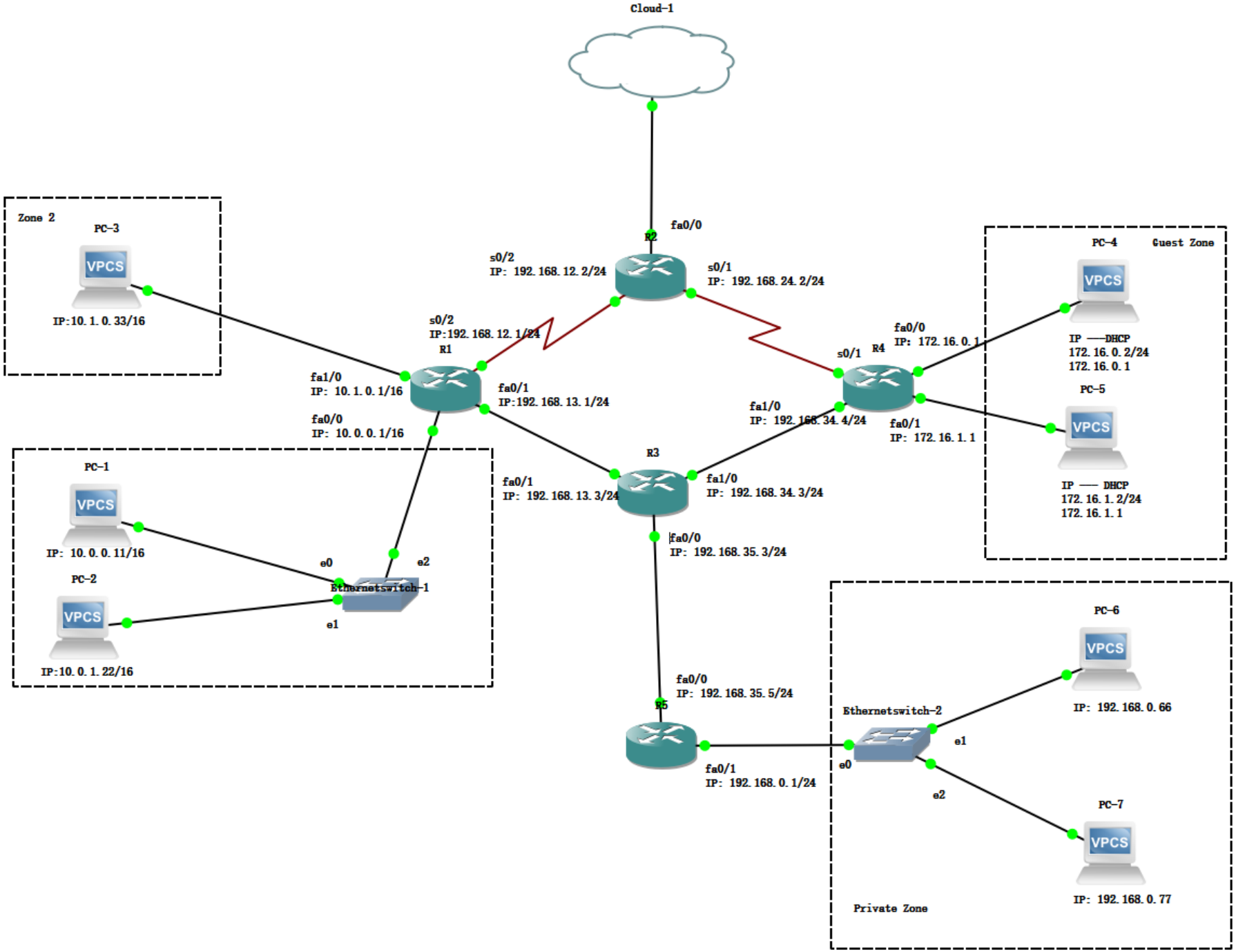
查看路由器路由表信息

R1

```
R1(config-if)#ip address 10.1.0.1 255.255.0.0
R1(config-if)#no shutdown
R1(config-if)#exit
R1(config)#
*Mar  1 00:18:59.507: %LINK-3-UPDOWN: Interface FastEthernet1/0, changed state to up
*Mar  1 00:19:00.507: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet1/0, changed state to up
R1(config)#exit
R1#show
*Mar  1 00:46:51.067: %SYS-5-CONFIG_I: Configured from console by console
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     10.0.0.0/16 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
C       10.1.0.0 is directly connected, FastEthernet1/0
R1#
```


Cloud-1
fa0/0
R2
s0/2
IP: 192.168.12.2/24
s0/1
IP: 192.168.24.2/24
Zone 2
PC-3
VPCS
IP:10.1.0.33/16
s0/2
IP:192.168.12.1/24
R1
fa1/0
IP: 10.1.0.1/16
fa0/1
IP:192.168.13.1/24
fa0/0
IP: 10.0.0.1/16
s0/1
R4
fa0/0
IP: 172.16.0.1
PC-4
Guest Zone
VPCS
IP ——DHCP
172.16.0.2/24
172.16.0.1
PC-5
VPCS
fa1/0
IP: 192.168.34.4/24
fa0/1
IP: 172.16.1.1
IP —— DHCP
172.16.1.2/24
172.16.1.1
R3
fa0/1
IP: 192.168.13.3/24
fa1/0
IP: 192.168.34.3/24
fa0/0
IP: 192.168.35.3/24
PC-1
VPCS
IP: 10.0.0.11/16
e0
e2
Ethernetswitch-1
PC-2
VPCS
e1
IP:10.0.1.22/16
fa0/0
IP: 192.168.35.5/24
R5
fa0/1
IP: 192.168.0.1/24
Ethernetswitch-2
e1
e0
e2
PC-6
VPCS
IP: 192.168.0.66
PC-7
VPCS
IP: 192.168.0.77
Private Zone

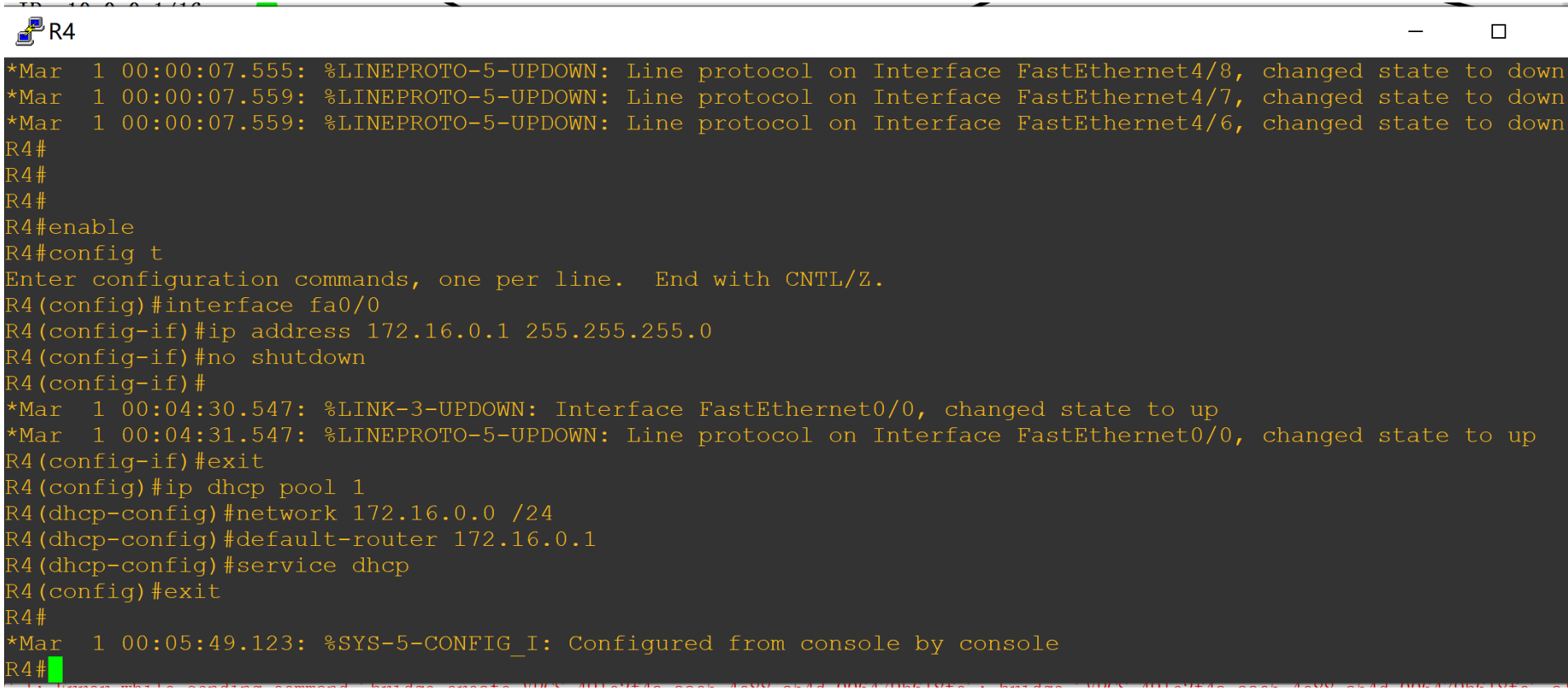
NAT — Network Address Translation [5]

- IP addresses are scarce.
- 1) One solution is to dynamically assign an IP address to a compute when it is on and using the network, and to take the IP address back when it becomes inactive — **DHCP**
- 2) **NAT** box (Network Address Translation box) connects an internal network to an external network
  - Many internal hosts are connected using few external IP addresses.
  - The NAT box is often combined in a single device with a **firewall**, which provides security by carefully controlling what goes into the customer network and what comes out of it.
  - RFC 2663; RFC 3022

路由器上配置DHCP命令

- 先配置路由器R4接口fa0/0的IP地址:
  - R4#config t
  - R4(config)#interface fa0/0
  - R4(config-if)#ip address 172.16.0.1 255.255.255.0
  - R4(config-if)#no shutdown
- 定义第一个子网的DHCP地址池：
  - R4#config t
  - R4(config)#ip dhcp pool 1
  - R4(dhcp-config)#network 172.16.0.0 /24 ⇐ 注意这里有空格
  - R4(dhcp-config)#default-router 172.16.0.1
- 启动DHCP服务： service dhcp
- 在PC机上运行ip dhcp获取动态IP地址。

路由器上配置DHCP命令： Example



PC4上运行dhcp结果


```
Welcome to Virtual PC Simulator, version 0.6.1
Dedicated to Daling.
Build time: Nov  9 2015 12:49:46
Copyright (c) 2007-2014, Paul Meng (mirnshi@gmail.com)
All rights reserved.

VPCS is free software, distributed under the terms of the "BSD" licence.
Source code and license can be found at vpcs.sf.net.
For more information, please visit wiki.freecode.com.cn.

Press '?' to get help.

Executing the startup file


PC-4>
PC-4> ip dhcp
DDORA IP 172.16.0.2/24 GW 172.16.0.1

PC-4>
```

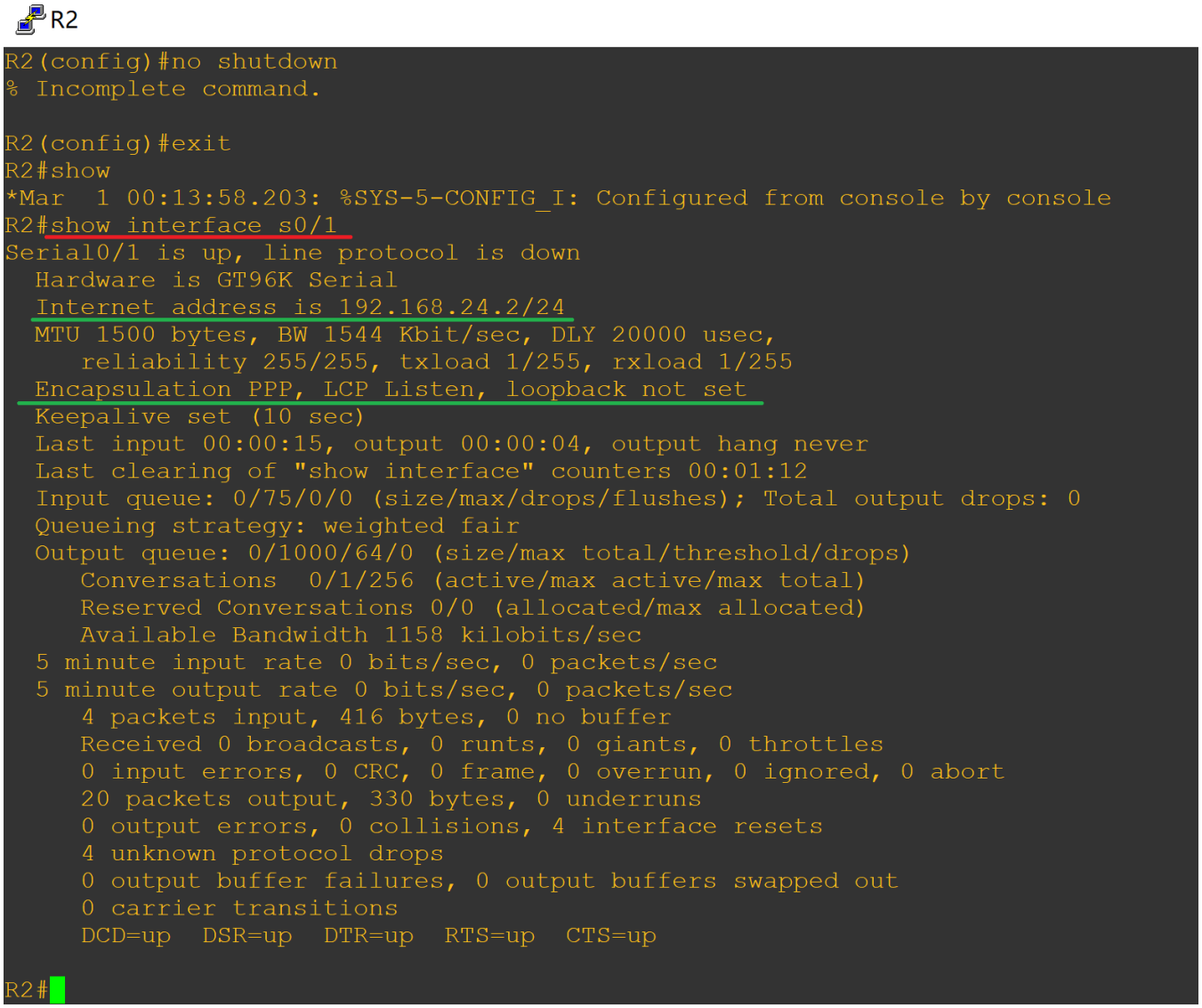
路由器上显示已分配的DHCP主机信息

R4

```
R4(config-if)#ip address 172.16.1.1 255.255.255.0
R4(config-if)#no shutdown
R4(config-if)#exit
*Mar  1 00:11:00.115: %LINK-3-UPDOWN: Interface FastEthernet0/1, changed state to up
*Mar  1 00:11:01.115: %LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/1, changed state to up
R4(config-if)#exit
R4(config)#ip dhcp pool 2
R4(dhcp-config)#network 172.16.1.0 /24
R4(dhcp-config)#default-router 172.16.1.1
R4(dhcp-config)#service dhcp
R4(config)#exit
R4#
*Mar  1 00:11:45.555: %SYS-5-CONFIG_I: Configured from console by console
R4#write
Building configuration...
[OK]
R4#show ip dhcp binding
Bindings from all pools not associated with VRF:
IP address          Client-ID/              Lease expiration        Type
                    Hardware address/
                    User name
172.16.0.2          0100.5079.6668.03       Mar 02 2002 12:12 AM    Automatic
172.16.1.2          0100.5079.6668.04       Mar 02 2002 12:16 AM    Automatic
R4#
```

注意如果中途保存退出实验，重新进入实验Lab4，PC4和PC5需要重新运行“ip dhcp”命令以获取动态IP地址。

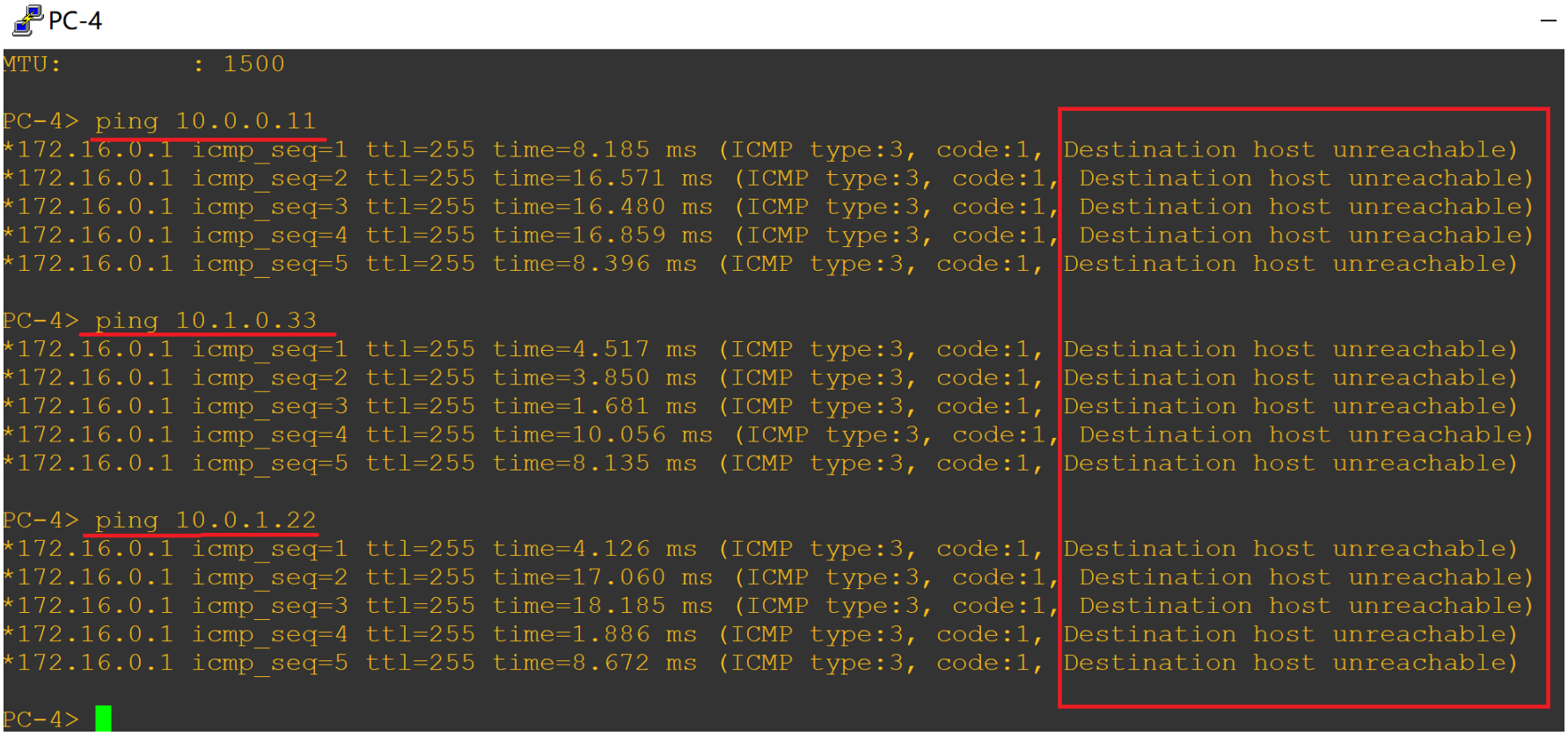
查看路由器接口所配置的IP地址



Lab4 第15步

- 配置R4、R2路由器之间的串口，设置IP地址，设置数据链路层协议为PPP（命令：encapsulation ppp），设置PPP认证模式为CHAP（命令：ppp authentication chap ），为对方设置认证用户名和密码（命令：username R4 password 1234），用户名默认就是对方的路由器hostname（区分大小写），密码要设置成一样的。
- 当只配置完R2，查看R2连接R4的串口s0/1，发现LCP的状态为“LCP Listen”；当配置完R4，则LCP的状态为“LCP Open”。LCP Open表明PPP的LCP已经协商完成，身份验证通过。

Lab4第18步未设置静态路由之前



Destination host unreachable目标主机不可达，消息属于icmp协议层的消息，用于ip层的差错报文的传递，由出问题的网关发出，用于差错控制。IP 路由器无法将 IP 数据报发送给目的地址时，会给发送端主机返回一个目标不可达 ICMP 消息，并在这个消息中显示不可达的具体原因。“1”表示目的主机没有路由或者找不到目的主机。

R1未添加静态路由之前

R1

```
Sending 5, 100-byte ICMP Echos to 192.168.13.3, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 28/34/44 ms
R1#
R1#write
Building configuration...
[OK]
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, Serial0/2
C    192.168.13.0/24 is directly connected, FastEthernet0/1
     10.0.0.0/16 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
C       10.1.0.0 is directly connected, FastEthernet1/0
R1#
```

R1直连两个子网10.0.0.0/16和10.1.0.0/16；通过接口fa0/1连通192.168.13.0/24子网；通过串口s0/2连通192.168.12.0/24。

R2未添加静态路由之前

R2

```
Sending 5, 100-byte ICMP Echos to 192.168.24.4, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 1/1/4 ms
R2#
R2#write
Building configuration...
[OK]
R2#
R2#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, Serial0/2
     192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.24.0/24 is directly connected, Serial0/1
C       192.168.24.4/32 is directly connected, Serial0/1
R2#
```

R2分别通过串口s0/2和s0/1连接两个子网192.168.12.0/24和192.168.24.0/24。

R4未添加静态路由之前

R4

```
  Input queue: 0/75/0/0 (size/max/drops/flushes); Total output drops: 0
  Queueing strategy: fifo
  Output queue: 0/40 (size/max)
  5 minute input rate 0 bits/sec, 0 packets/sec
  5 minute output rate 0 bits/sec, 0 packets/sec
     6 packets input, 1410 bytes
     Received 5 broadcasts, 0 runts, 0 giants, 0 throttles
     0 input errors, 0 CRC, 0 frame, 0 overrun, 0 ignored
     0 watchdog
     0 input packets with dribble condition detected
     606 packets output, 64190 bytes, 0 underruns
     0 output errors, 0 collisions, 0 interface resets
     0 unknown protocol drops
     0 babbles, 0 late collision, 0 deferred
     0 lost carrier, 0 no carrier
     0 output buffer failures, 0 output buffers swapped out
R4#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

     192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.24.0/24 is directly connected, Serial0/1
C       192.168.24.2/32 is directly connected, Serial0/1
     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.0.0 is directly connected, FastEthernet0/0
C       172.16.1.0 is directly connected, FastEthernet0/1
C    192.168.34.0/24 is directly connected, FastEthernet1/0
R4#
```

添加静态路由 (I)

- 添加静态路由之前路由器R1, R3和R4的路由表（请参照前面拓扑图）

```
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, Serial0/2
C    192.168.13.0/24 is directly connected, FastEthernet0/1
     10.0.0.0/16 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
C       10.1.0.0 is directly connected, FastEthernet1/0
R1#
```

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.13.0/24 is directly connected, FastEthernet0/1
C    192.168.34.0/24 is directly connected, FastEthernet1/0
C    192.168.35.0/24 is directly connected, FastEthernet0/0
R3#
```

```
 R - RIP, M - mobile, B - BGP
rnal, O - OSPF, IA - OSPF inter area
pe 1, N2 - OSPF NSSA external type 2
 E2 - OSPF external type 2
ary, L1 - IS-IS level-1, L2 - IS-IS level-2
 candidate default, U - per-user static route
loaded static route

     192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.24.0/24 is directly connected, Serial0/1
C       192.168.24.2/32 is directly connected, Serial0/1
     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.0.0 is directly connected, FastEthernet0/0
C       172.16.1.0 is directly connected, FastEthernet0/1
C    192.168.34.0/24 is directly connected, FastEthernet1/0
R4#
```

最大的感觉就是“各自为政”，举例：路由器R1通过串口s0/1连子网192.168.12.0/24；通过以太网口fa0/1连子网192.168.13.0/24；通过fa0/0连子网10.0.0.0; 通过fa1/0连子网10.1.0.0。

添加静态路由 (II)

- 为了达到让Zone1, Zone2和Guest zone区域内的PC相互能“ping”通，需要在这三台路由器上添加以太网线路。
- 路由器R1：
  - R1#config t
  - R1(config)#ip route 172.16.0.0 255.255.255.0 192.168.13.3 ⇐ 为了到达172.16.0.0/24子网，需要以192.168.13.3作为下一跳。
  - R1(config)#ip route 172.16.1.0 255.255.255.0 192.168.13.3
  - R1(config)#exit
- 路由器R3 (因为R3位于R1和R4之间，需要设置双向的下一跳，注意两边子网掩码长度是不一样的)：
  - R3#config t
  - R3(config)#ip route 10.0.0.0 255.255.0.0 192.168.13.1
  - R3(config)#ip route 10.1.0.0 255.255.0.0 192.168.13.1
  - R3(config)#ip route 172.16.0.0 255.255.255.0 192.168.34.4
  - R3(config)#ip route 172.16.1.0 255.255.255.0 192.168.34.4
  - R3(config)#exit
- 现在知道如何设置路由器R4了吧！

添加静态路由之后 (III)

```
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, Serial0/2
C    192.168.13.0/24 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 2 subnets
S       172.16.0.0 [1/0] via 192.168.13.3
S       172.16.1.0 [1/0] via 192.168.13.3
     10.0.0.0/16 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
C       10.1.0.0 is directly connected, FastEthernet1/0
R1#
```

注意前面“S”就是静态路由。

```
R3#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.13.0/24 is directly connected, FastEthernet0/1
     172.16.0.0/24 is subnetted, 2 subnets
S       172.16.0.0 [1/0] via 192.168.34.4
S       172.16.1.0 [1/0] via 192.168.34.4
     10.0.0.0/16 is subnetted, 2 subnets
S       10.0.0.0 [1/0] via 192.168.13.1
S       10.1.0.0 [1/0] via 192.168.13.1
C    192.168.34.0/24 is directly connected, FastEthernet1/0
C    192.168.35.0/24 is directly connected, FastEthernet0/0
R3#
```

Lab4第22步

- 在R1上分别使用f1/0 (连PC3)、s2/0 (连R2)接口的IP地址作为源地址，测试到R4的s0/1 (连R2) 接口地址的连通性。
- 为什么已经在R1中添加了静态路由：
  - R1(config)#ip route 192.168.24.0 255.255.255.0 192.168.12.2
  - 采用：R1#ping 192.168.24.4 source 192.168.12.1就是ping不通，而且在R1#ping 192.168.12.2是通的。
- 原因是只在R1中添加了静态路由“ip route 192.168.24.0 255.255.255.0 192.168.12.2”是不够的，还需要在R4中添加静态路由：
  - R4(config)#ip route 192.168.12.0 255.255.255.0 192.168.24.2
- R1和R4的路由表在后两页展示。

Lab4第22步R1增加静态路由后路由表

R1

```
Building configuration...
[OK]
R1#
R1#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

C    192.168.12.0/24 is directly connected, Serial0/2
C    192.168.13.0/24 is directly connected, FastEthernet0/1
S    192.168.24.0/24 [1/0] via 192.168.12.2
     172.16.0.0/24 is subnetted, 2 subnets
S       172.16.0.0 [1/0] via 192.168.13.3
S       172.16.1.0 [1/0] via 192.168.13.3
     10.0.0.0/16 is subnetted, 2 subnets
C       10.0.0.0 is directly connected, FastEthernet0/0
C       10.1.0.0 is directly connected, FastEthernet1/0
R1#
```

Lab4第22步R4增加静态路由后路由表

R4

```
R4#
R4#show ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2
       i - IS-IS, su - IS-IS summary, L1 - IS-IS level-1, L2 - IS-IS level-2
       ia - IS-IS inter area, * - candidate default, U - per-user static route
       o - ODR, P - periodic downloaded static route

Gateway of last resort is not set

S    192.168.12.0/24 [1/0] via 192.168.24.2
     192.168.24.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.24.0/24 is directly connected, Serial0/1
C       192.168.24.2/32 is directly connected, Serial0/1
     172.16.0.0/24 is subnetted, 2 subnets
C       172.16.0.0 is directly connected, FastEthernet0/0
C       172.16.1.0 is directly connected, FastEthernet0/1
     10.0.0.0/16 is subnetted, 2 subnets
S       10.0.0.0 [1/0] via 192.168.34.3
S       10.1.0.0 [1/0] via 192.168.34.3
C    192.168.34.0/24 is directly connected, FastEthernet1/0
R4#
```

How NAT works [8]

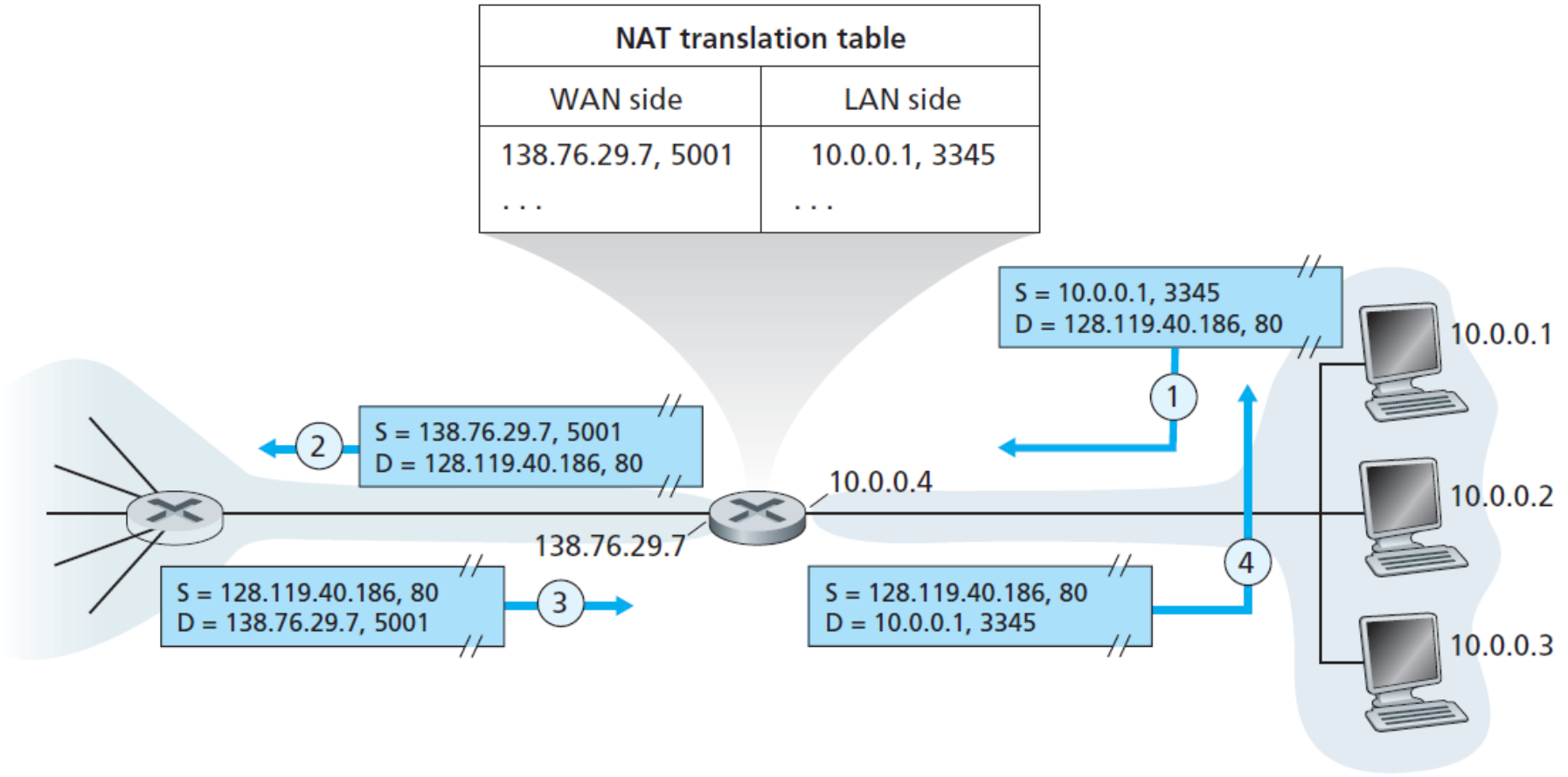


Figure 4.22 ♦ Network address translation

The NAT translation table includes port numbers as well as IP addresses in the table entries. The NAT router can behave to the outside world as a single device with a single IP address.

How NAT works (II)

- Example

Internal IP : Port	External IP : Port
10.0.1.2 : 5544	128.143.71.21 : 3344
10.0.1.3 : 1234	128.143.71.21 : 3345
10.0.1.4 : 1234	128.143.71.21 : 3346

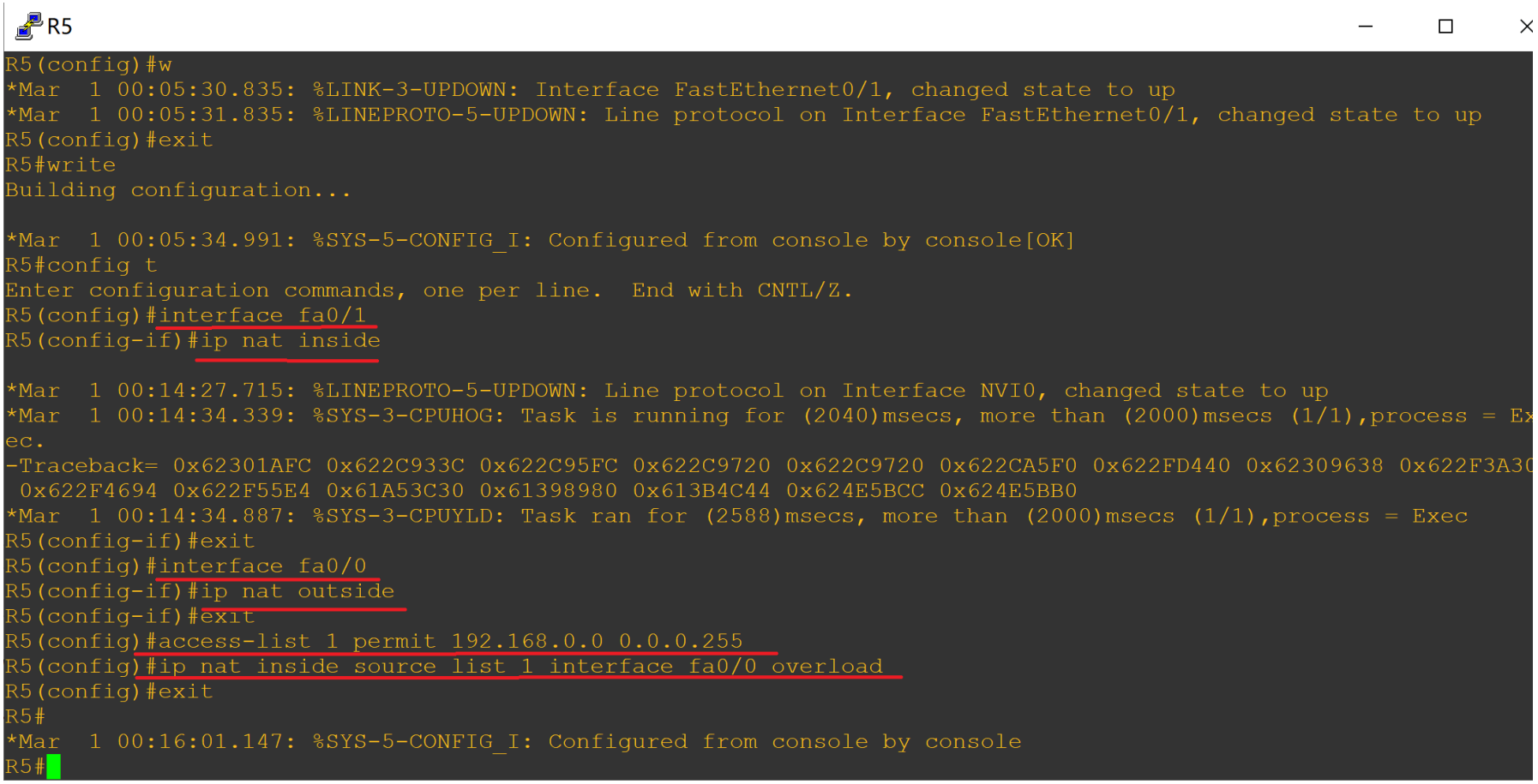
Private IP addresses Public IP address

- Ports are effectively an extra 16 bits of addressing that identify which process gets which incoming packet.
- Ports 0-1023 are reserved for well-known services
  - Port 80 is the port used by Web servers

实验报告第25步NAT

- 第25步骤：在R5路由器上配置NAT服务，定义fa0/1接口为外部接口，定义fa0/0接口为内部接口。这句有错！如果按照实验报告中图配置各个路由器的接口的话，应该刚好相反，定义fa0/1接口为内部接口，定义fa0/0接口为外部接口。
- 在这一步骤中：由于PC6和PC7持续ping路由器3的fa0/0接口地址，为了中止持续ping，可以先把PC机关一下，然后再启动。路由器5上按ctrl+shift+6+6就可以跳出持续的“show ip nat translation”。

实验报告第25步NAT配置命令



在R5上显示NAT信息

R5

```
*Mar  1 00:16:01.147: %SYS-5-CONFIG_I: Configured from console by console
R5#write
Building configuration...
[OK]
R5#show ip nat translation
Pro Inside global      Inside local       Outside local      Outside global
icmp 192.168.35.5:36114 192.168.0.66:36114 192.168.35.3:36114 192.168.35.3:36114
icmp 192.168.35.5:36626 192.168.0.66:36626 192.168.35.3:36626 192.168.35.3:36626
icmp 192.168.35.5:36882 192.168.0.66:36882 192.168.35.3:36882 192.168.35.3:36882
icmp 192.168.35.5:37394 192.168.0.66:37394 192.168.35.3:37394 192.168.35.3:37394
icmp 192.168.35.5:37650 192.168.0.66:37650 192.168.35.3:37650 192.168.35.3:37650
icmp 192.168.35.5:37906 192.168.0.66:37906 192.168.35.3:37906 192.168.35.3:37906
icmp 192.168.35.5:38162 192.168.0.66:38162 192.168.35.3:38162 192.168.35.3:38162
icmp 192.168.35.5:38418 192.168.0.66:38418 192.168.35.3:38418 192.168.35.3:38418
icmp 192.168.35.5:38674 192.168.0.66:38674 192.168.35.3:38674 192.168.35.3:38674
icmp 192.168.35.5:38930 192.168.0.66:38930 192.168.35.3:38930 192.168.35.3:38930
icmp 192.168.35.5:39186 192.168.0.66:39186 192.168.35.3:39186 192.168.35.3:39186
icmp 192.168.35.5:39442 192.168.0.66:39442 192.168.35.3:39442 192.168.35.3:39442
icmp 192.168.35.5:39698 192.168.0.66:39698 192.168.35.3:39698 192.168.35.3:39698
icmp 192.168.35.5:39954 192.168.0.66:39954 192.168.35.3:39954 192.168.35.3:39954
icmp 192.168.35.5:40210 192.168.0.66:40210 192.168.35.3:40210 192.168.35.3:40210
icmp 192.168.35.5:40466 192.168.0.66:40466 192.168.35.3:40466 192.168.35.3:40466
icmp 192.168.35.5:40722 192.168.0.66:40722 192.168.35.3:40722 192.168.35.3:40722
icmp 192.168.35.5:40978 192.168.0.66:40978 192.168.35.3:40978 192.168.35.3:40978
icmp 192.168.35.5:41234 192.168.0.66:41234 192.168.35.3:41234 192.168.35.3:41234
icmp 192.168.35.5:41490 192.168.0.66:41490 192.168.35.3:41490 192.168.35.3:41490
icmp 192.168.35.5:41746 192.168.0.66:41746 192.168.35.3:41746 192.168.35.3:41746
icmp 192.168.35.5:42002 192.168.0.66:42002 192.168.35.3:42002 192.168.35.3:42002
 --More--
```

每次port number 都在发生变化！

Lab4第27步

- 2022年11月11日，对R2的接口fa0/0配置IP地址动态分配，得到的地址为：192.168.191.131/24。配置命令如下：
  - R2#config t
  - R2(config)#interface fa0/0
  - R2(config-if)#ip address dhcp
  - R2(config-if)#no shutdown
  - R2(config-if)#exit
  - R2(config)#exit

Lab4第28步

PC-1

```
PC-1> ping 192.168.199.131
*10.0.0.1 icmp_seq=1 ttl=255 time=9.924 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.1 icmp_seq=2 ttl=255 time=3.511 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.1 icmp_seq=3 ttl=255 time=6.393 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.1 icmp_seq=4 ttl=255 time=4.197 ms (ICMP type:3, code:1, Destination host unreachable)
*10.0.0.1 icmp_seq=5 ttl=255 time=4.993 ms (ICMP type:3, code:1, Destination host unreachable)

PC-1> ping 10.162.32.97
*192.168.12.2 icmp_seq=1 ttl=254 time=9.239 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.12.2 icmp_seq=2 ttl=254 time=1.561 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.12.2 icmp_seq=3 ttl=254 time=4.570 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.12.2 icmp_seq=4 ttl=254 time=1.120 ms (ICMP type:3, code:1, Destination host unreachable)
*192.168.12.2 icmp_seq=5 ttl=254 time=3.391 ms (ICMP type:3, code:1, Destination host unreachable)

PC-1>
```

192.168.199.131是R2的接口fa0/0自动获取的IP地址，而10.162.32.97是我在实验室的IP地址。

实验中各个设备配置结果保存

- 在实验过程中中途都可以随时退出，但是要注意保存各个设备配置结果：
  - PC机：save
  - 路由器：write

实验报告第29步桥接模式

- 这里的意图是找到一个真实网络环境，如实验室无线WiFi。可以用本机的命令窗口“cmd”输入“ipconfig”命令就能得到本机所连所有网络的详细信息。如我曾在曹西304实验室用的ZJU-YQ无线网络，用“ipconfig”命令找到我本机的IPv4地址为10.181.151.55 (子网掩码255.255.192.0)，网络的网关为10.181.128.1。
- 找一台该网络可以Ping通的主机H（就是在同一网络中）：需要在电脑设置那里windows安全中心把那台主机的防火墙和网络保护给关掉，则就能ping通。
- 所谓的桥接模式，就是通过网络云与本机同处一个网络中。

References

- [1] https://zhuanlan.zhihu.com/p/41940739 (知乎上教程：手把手教你安装Linux虚拟机)
- [2] https://www.vmware.com/cn.html (VMWare中国官方网站)
- [3] https://www.gns3.com/software/download (GNS3)
- [4] https://www.bilibili.com/video/BV1eJ411B7DA/?share_medium=android&share_source=copy_link&bbid=XYD1D74D22C7285F613FB9AD6A6D7F7341B01&ts=1606547560313 (徐文祥的Lab4保姆级教程)