

实验6：NAT的配置

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实验要求

1. 仿真环境下的NAT服务器配置

在仿真环境下完成NAT服务器的配置实验，要求如下：（1）学习路由器的NAT配置过程。（2）组建由NAT连接的内网和外网。（3）测试网络的连通性，观察网络地址映射表。（4）在仿真环境的“模拟”方式中观察IP数据报在互联网中的传递过程，并对IP数据报的地址进行分析。

2. 在仿真环境下完成如下实验

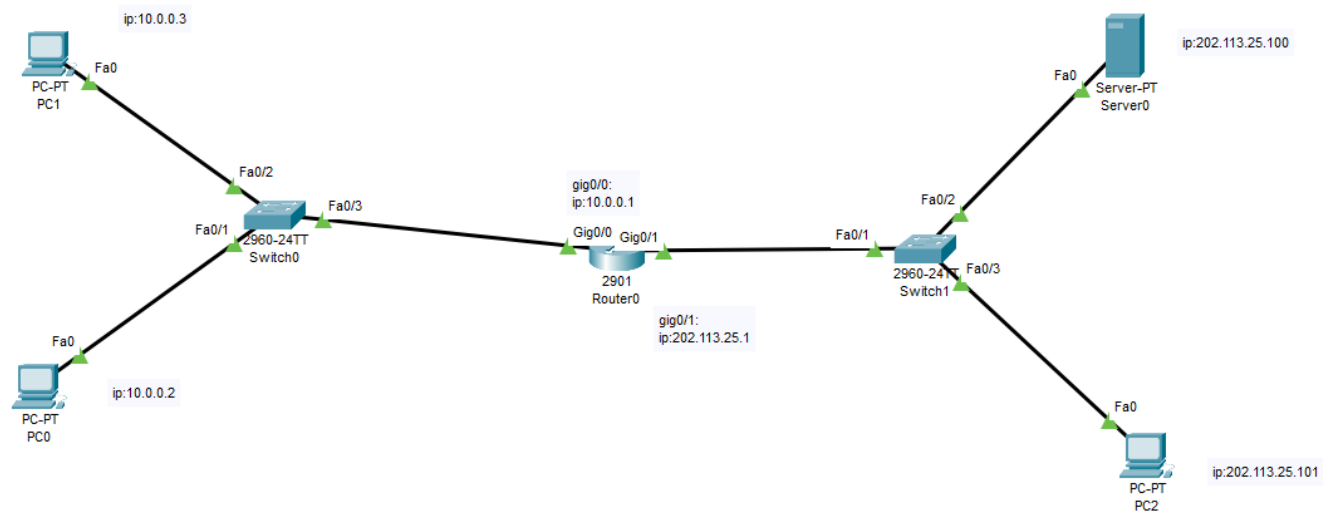
将内部网络中放置一台Web服务器，请设置NAT服务器，使外部主机能够顺利使用该Web服务。

实验过程

- 关于NAT：NAT英文全称是“Network Address Translation”，中文意思是“网络地址转换”，它是一个IETF(Internet Engineering Task Force, Internet工程任务组)标准，允许一个整体机构以一个公用IP（Internet Protocol）地址出现在Internet上。顾名思义，它是一种把内部私有网络地址（IP地址）翻译成合法网络IP地址的技术。

Web服务器放置在外网网络下

网络拓扑图



图中，路由器左半部分属于内部网络，路由器右半部分属于外部网络

设备配置

配置各个主机、服务器的ip，掩码与默认路由，同时配置好路由器的端口ip并将端口打开，主要看路由器的配置部分：

IOS Command Line Interface

To comply with U.S. and local laws, return this product immediately.

A summary of U.S. laws governing Cisco cryptographic products may be found at:
<http://www.cisco.com/wwl/export/crypto/tool/stqrg.html>

If you require further assistance please contact us by sending email to
export@cisco.com.

Cisco CISCO2901/K9 (revision 1.0) with 491520K/32768K bytes of memory.
Processor board ID FTX152400KS
2 Gigabit Ethernet interfaces
DRAM configuration is 64 bits wide with parity disabled.
255K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)

Press RETURN to get started!

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to up

```
Router>enable
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface gig0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface gig0/1
Router(config-if)#ip address 202.113.25.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#
```

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建立一个记录nat使用的全局ip地址的地址池，使用的命令为

```
Ip nat pool myNATPool 202.113.25.1 202.133.25.10 netmask 255.255.255.0
```

建立标准访问控制列表，在该列表中的ip地址nat就会进行转换，使用命令为：

```
access-list 6 permit 10.0.0.0 0.255.255.255
```

将使用的地址池与访问的控制列表进行关联，使用的命令为

```
Ip nat inside source list 6 pool myNATPool overload
```

指定连接内部网络和外部网络的接口，在指定的接口下使用 ip nat inside 和 ip nat outside（按照拓扑图所示，左侧为内网，右侧为外网）

```
* Invalid input detected at ...
```

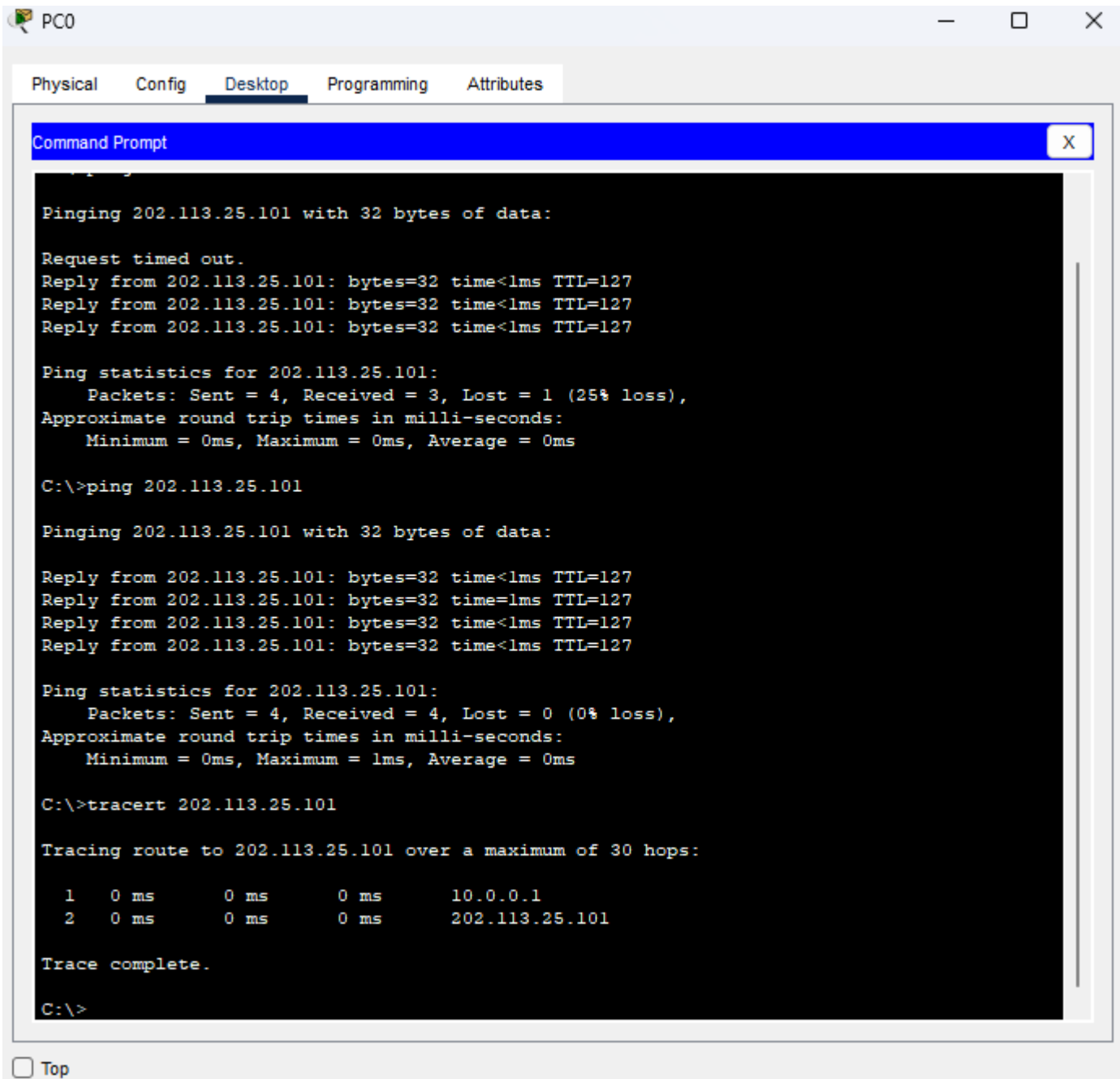
```
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip nat pool myNATPool 202.113.25.1 202.113.25.10 netmask 255.255.255.0
Router(config)#access-list 6 permit 10.0.0.0 0.255.255.255
Router(config)#ip nat inside source list 6 pool myNATPool
Router(config)#ip nat inside source list 6 pool myNATPool overload
Router(config)#interface gig0/0
Router(config-if)#ip nat inside
Router(config-if)#exit
Router(config)#interface gig0/1
Router(config-if)#ip nat outside
Router(config-if)#exit
Router(config)#
```

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测试网络的连通性，观察网络地址映射表

使用主机PC0来ping主机PC2，结果如下：



The screenshot shows a PC0 window with a Command Prompt open. The Command Prompt displays the results of a ping command to 202.113.25.101. The first ping attempt shows a 25% loss (1 packet lost). The second ping attempt shows 0% loss (0 packets lost). The traceroute command shows a successful path from 10.0.0.1 to 202.113.25.101 in 0 ms.

```
PC0
Physical Config Desktop Programming Attributes
Command Prompt
Pinging 202.113.25.101 with 32 bytes of data:
Request timed out.
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127

Ping statistics for 202.113.25.101:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 202.113.25.101

Pinging 202.113.25.101 with 32 bytes of data:

Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127

Ping statistics for 202.113.25.101:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>tracert 202.113.25.101

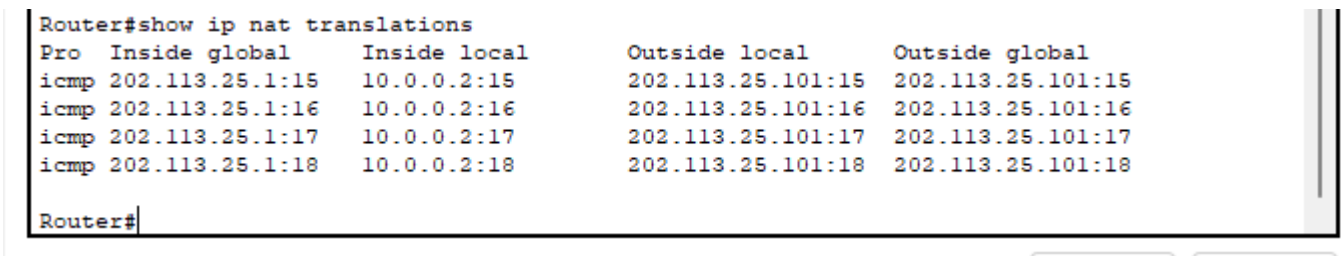
Tracing route to 202.113.25.101 over a maximum of 30 hops:

  1  0 ms    0 ms    0 ms    10.0.0.1
  2  0 ms    0 ms    0 ms    202.113.25.101

Trace complete.

C:\>
```

可以成功连通，网络性能良好，接下来使用命令 `show ip nat statistics` 和 `show ip nat translations` 来查看此时的nat相关配置和网络地址映射表



The screenshot shows a Router# command prompt with the output of the `show ip nat translations` command. The output displays a table of NAT translations for ICMP traffic from 202.113.25.1 to 202.113.25.101.

```
Router#show ip nat translations
Pro  Inside global    Inside local      Outside local     Outside global
icmp 202.113.25.1:15  10.0.0.2:15       202.113.25.101:15 202.113.25.101:15
icmp 202.113.25.1:16 10.0.0.2:16       202.113.25.101:16 202.113.25.101:16
icmp 202.113.25.1:17 10.0.0.2:17       202.113.25.101:17 202.113.25.101:17
icmp 202.113.25.1:18 10.0.0.2:18       202.113.25.101:18 202.113.25.101:18

Router#
```

```
Router#show ip nat statistics
Total translations: 4 (0 static, 4 dynamic, 4 extended)
Outside Interfaces: GigabitEthernet0/1
Inside Interfaces: GigabitEthernet0/0
Hits: 14 Misses: 15
Expired translations: 11
Dynamic mappings:
-- Inside Source
access-list 6 pool myNATPool refCount 4
 pool myNATPool: netmask 255.255.255.0
   start 202.113.25.1 end 202.113.25.10
   type generic, total addresses 10 , allocated 1 (10%), misses 0
Router#
```

通过该命令查看到了转换项，查看转发信息，可知PC5的 inside global 地址为 202.113.25.1

查看NAT统计数据 and 规则，包括inside和outside接口，以及建立的记录nat使用的全局ip地址的地址池myNATPool的相关信息。

在仿真环境的“模拟”方式中观察IP数据报在互联网中的传递过程，并对IP数据报的地址进行分析。

主机PC0来ping主机PC2的过程仿真分析如下：

Vis.	Time(sec)	Last Device	At Device	Type
	0.000	--	PC0	ICMP
	0.001	PC0	Switch0	ICMP
	0.002	Switch0	Router0	ICMP
	0.003	Router0	Switch1	ICMP
	0.004	Switch1	PC2	ICMP
	0.005	PC2	Switch1	ICMP
	0.006	Switch1	Router0	ICMP
	0.007	Router0	Switch0	ICMP
	0.008	Switch0	PC0	ICMP
	1.010	--	PC0	ICMP
	1.011	PC0	Switch0	ICMP
	1.012	Switch0	Router0	ICMP
	1.013	Router0	Switch1	ICMP
	1.014	Switch1	PC2	ICMP
	1.015	PC2	Switch1	ICMP
	1.016	Switch1	Router0	ICMP
	1.017	Router0	Switch0	ICMP
	1.018	Switch0	PC0	ICMP

可以看到数据包传输的路径为PC0->Switch0->Router0->Switch1->PC2到达目的地后又回送数据包PC2->Switch1->Router0->Switch0->PC0

在数据的传输过程中，查看数据包的封装，查看信封中的内容，刚开始传输时，即在PC0处，数据包如下：

PDU Information at Device: Switch0

OSI Model

Inbound PDU Details

Outbound PDU Details

At Device: Switch0
Source: PC0
Destination: 202.113.25.101

In Layers

Layer7

Layer6

Layer5

Layer4

Layer3

Layer 2: Ethernet II Header
0006.2AC6.3CB1 >> 00E0.F922.5A01

Layer 1: Port FastEthernet0/1

Out Layers

Layer7

Layer6

Layer5

Layer4

Layer3

Layer 2: Ethernet II Header
0006.2AC6.3CB1 >> 00E0.F922.5A01

Layer 1: Port(s): FastEthernet0/3

1. FastEthernet0/1 receives the frame.

Challenge Me

<< Previous Layer

Next Layer >>

标明了源地址和目的地址，查看数据包传送到路由器时的变化：

PDU Information at Device: Router0

OSI Model

Inbound PDU Details

Outbound PDU Details

At Device: Router0

Source: PC0

Destination: 202.113.25.101

In Layers

Layer7

Layer6

Layer5

Layer4

Layer 3: IP Header Src. IP: 10.0.0.2, Dest. IP: 202.113.25.101 ICMP Message Type: 8

Layer 2: Ethernet II Header 0006.2AC6.3CB1 >> 00E0.F922.5A01

Layer 1: Port GigabitEthernet0/0

Out Layers

Layer7

Layer6

Layer5

Layer4

Layer 3: IP Header Src. IP: 202.113.25.1, Dest. IP: 202.113.25.101 ICMP Message Type: 8

Layer 2: Ethernet II Header 00E0.F922.5A02 >> 00D0.D332.6CEB

Layer 1: Port(s): GigabitEthernet0/1

1. GigabitEthernet0/0 receives the frame.

Challenge Me

<< Previous Layer

Next Layer >>

可以看到路由器根据NAT转换表在网络层将数据包的源地址由10.0.0.2转换为了202.113.25.1从而后续可以继续传输，下面是最后传送到PC2时的数据包显示：

PDU Information at Device: PC2

OSI Model

Inbound PDU Details

Outbound PDU Details

At Device: PC2
Source: PC0
Destination: 202.113.25.101

In Layers

Layer7

Layer6

Layer5

Layer4

Layer 3: IP Header Src. IP: 202.113.25.1, Dest. IP: 202.113.25.101 ICMP Message Type: 8

Layer 2: Ethernet II Header 00E0.F922.5A02 >> 00D0.D332.6CEB

Layer 1: Port FastEthernet0

Out Layers

Layer7

Layer6

Layer5

Layer4

Layer 3: IP Header Src. IP: 202.113.25.101, Dest. IP: 202.113.25.1 ICMP Message Type: 0

Layer 2: Ethernet II Header 00D0.D332.6CEB >> 00E0.F922.5A02

Layer 1: Port(s): FastEthernet0

1. FastEthernet0 receives the frame.

Challenge Me

<< Previous Layer

Next Layer >>

在数据包返回经过路由器时，路由器根据NAT转换表在网络层将数据包的目的地址由202.113.25.1转化成了10.0.0.2从而后续继续传输

At Device: Switch1

Source: PC0

Destination: 202.113.25.101

In Layers

Layer7

Layer6

Layer5

Layer4

Layer3

Layer 2: Ethernet II Header

00D0.D332.6CEB >> 00E0.F922.5A02

Layer 1: Port FastEthernet0/3

Out Layers

Layer7

Layer6

Layer5

Layer4

Layer3

Layer 2: Ethernet II Header

00D0.D332.6CEB >> 00E0.F922.5A02

Layer 1: Port(s): FastEthernet0/1

1. FastEthernet0/3 receives the frame.

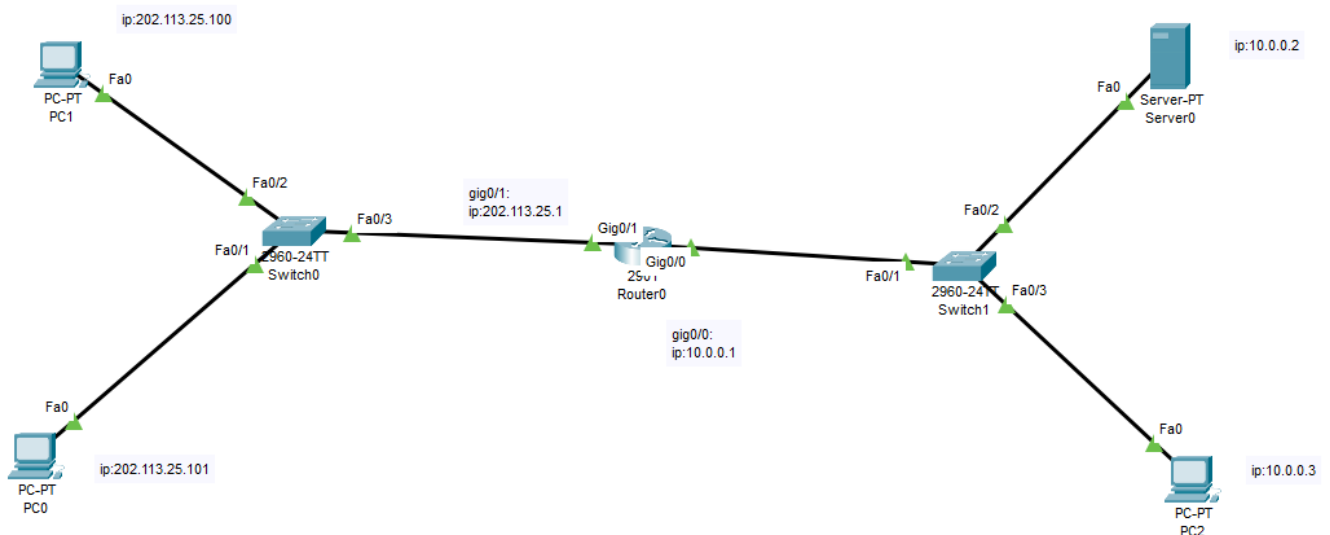
Challenge Me

<< Previous Layer

Next Layer >>

Web服务器放置在内部网络下

网络拓扑图



图中，路由器左半部分属于外部网络，路由器右半部分属于内部网络

设备配置

配置各个主机、服务器的ip，掩码与默认路由，同时配置好路由器的端口ip并将端口打开，主要看路由器的配置部分：

IOS Command Line Interface

To comply with U.S. and local laws, return this product immediately.

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<http://www.cisco.com/wwl/export/crypto/tool/stqrg.html>

If you require further assistance please contact us by sending email to
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Cisco CISCO2901/K9 (revision 1.0) with 491520K/32768K bytes of memory.
Processor board ID FTX152400KS
2 Gigabit Ethernet interfaces
DRAM configuration is 64 bits wide with parity disabled.
255K bytes of non-volatile configuration memory.
249856K bytes of ATA System CompactFlash 0 (Read/Write)

Press RETURN to get started!

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/0, changed state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/1, changed state to up

```
Router>enable
Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#interface gig0/0
Router(config-if)#ip address 10.0.0.1 255.0.0.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#interface gig0/1
Router(config-if)#ip address 202.113.25.1 255.255.255.0
Router(config-if)#no shutdown
Router(config-if)#exit
Router(config)#
```

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建立一个记录nat使用的全局ip地址的地址池，使用的命令为

```
Ip nat pool myNATPool 202.113.25.1 202.133.25.10 netmask 255.255.255.0
```

建立标准访问控制列表，在该列表中的ip地址nat就会进行转换，使用命令为：

```
access-list 6 permit 10.0.0.0 0.255.255.255
```

将使用的地址池与访问的控制列表进行关联，使用的命令为

```
Ip nat inside source list 6 pool myNATPool overload
```

指定连接内部网络和外部网络的接口，在指定的接口下使用 ip nat inside 和 ip nat outside（按照拓扑图所示，左侧为内网，右侧为外网）

```

Router#config terminal
Enter configuration commands, one per line. End with CNTL/Z.
Router(config)#ip nat pool myNATPool 202.113.25.1 202.113.25.10 netmask 255.255.255.0
Router(config)#access-list 6 permit 10.0.0.0 0.255.255.255
Router(config)#ip nat inside source list 6 pool myNATPool
Router(config)#ip nat inside source list 6 pool myNATPool overload
Router(config)#interface gig0/0
Router(config-if)#ip nat inside
Router(config-if)#exit
Router(config)#interface gig0/1
Router(config-if)#ip nat outside
Router(config-if)#exit
Router(config)#

```

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测试网络的连通性，观察网络地址映射表

为了能使外部主机能够顺利使用该Web服务，先用Web服务器pingPC0,然后在服务器的enable模式下输入 show ip nat translations 获取转换表如下：

The left screenshot shows the Router0 CLI interface. The output of the 'show ip nat translations' command is as follows:

```

Router#enable
Router#show ip nat translations
Pro Inside global      Inside local      Outside local      Outside global
icmp 202.113.25.5:1     10.0.0.2:1        202.113.25.101:1   202.113.25.101:1
icmp 202.113.25.5:2     10.0.0.2:2        202.113.25.101:2   202.113.25.101:2
icmp 202.113.25.5:3     10.0.0.2:3        202.113.25.101:3   202.113.25.101:3
icmp 202.113.25.5:4     10.0.0.2:4        202.113.25.101:4   202.113.25.101:4
icmp 202.113.25.5:5     10.0.0.2:5        202.113.25.101:5   202.113.25.101:5
icmp 202.113.25.5:6     10.0.0.2:6        202.113.25.101:6   202.113.25.101:6
icmp 202.113.25.5:7     10.0.0.2:7        202.113.25.101:7   202.113.25.101:7
icmp 202.113.25.5:8     10.0.0.2:8        202.113.25.101:8   202.113.25.101:8
--- 202.113.25.5       10.0.0.2          ---                 ---

```

The right screenshot shows the Server0 Command Prompt. The output of the 'ping 202.113.25.101' command is as follows:

```

Cisco Packet Tracer SERVER Command Line 1.0
C:\>ping 202.113.25.101

Pinging 202.113.25.101 with 32 bytes of data:

Request timed out.
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127

Ping statistics for 202.113.25.101:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 1ms, Average = 0ms

C:\>ping 202.113.25.101

Pinging 202.113.25.101 with 32 bytes of data:

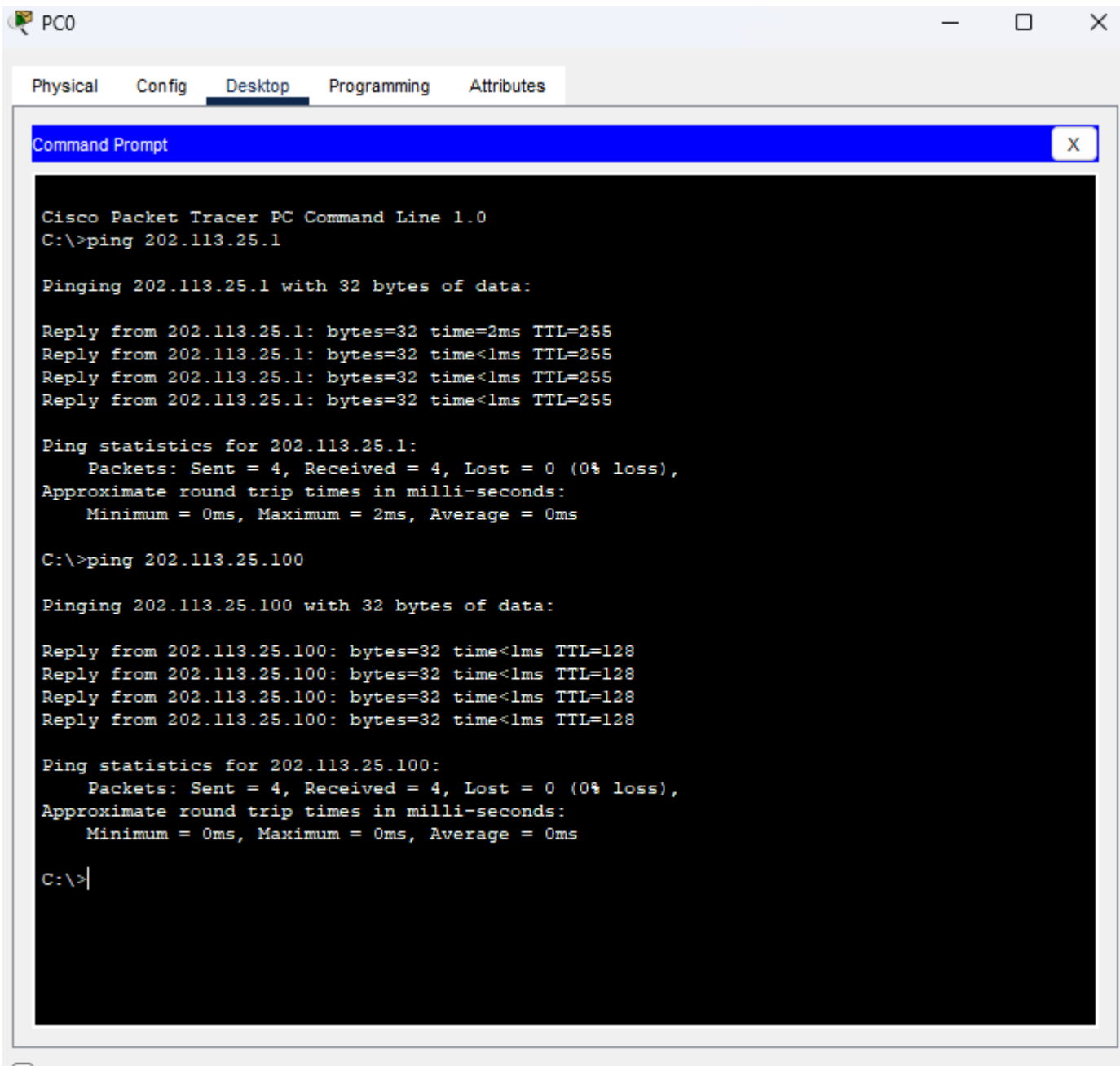
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127
Reply from 202.113.25.101: bytes=32 time<1ms TTL=127

Ping statistics for 202.113.25.101:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>

```

然后根据转换表中的IP地址可以用外部的主机例如PC0pingWeb服务器可以ping通



```
Cisco Packet Tracer PC Command Line 1.0
C:\>ping 202.113.25.1

Pinging 202.113.25.1 with 32 bytes of data:

Reply from 202.113.25.1: bytes=32 time=2ms TTL=255
Reply from 202.113.25.1: bytes=32 time<1ms TTL=255
Reply from 202.113.25.1: bytes=32 time<1ms TTL=255
Reply from 202.113.25.1: bytes=32 time<1ms TTL=255

Ping statistics for 202.113.25.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 2ms, Average = 0ms

C:\>ping 202.113.25.100

Pinging 202.113.25.100 with 32 bytes of data:

Reply from 202.113.25.100: bytes=32 time<1ms TTL=128
Reply from 202.113.25.100: bytes=32 time<1ms TTL=128
Reply from 202.113.25.100: bytes=32 time<1ms TTL=128
Reply from 202.113.25.100: bytes=32 time<1ms TTL=128

Ping statistics for 202.113.25.100:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>|
```

若主机想要成功访问到内网的WEB服务器，还需要在路由器中配置静态nat转换，使用命令为 IP nat inside source static 10.0.0.2 202.113.25.5 ,建立 ip 10.0.0.2 和 202.113.25.5 的转换关系，此时外网的PC就可以通过202.113.25.5来访问内网服务器的界面

