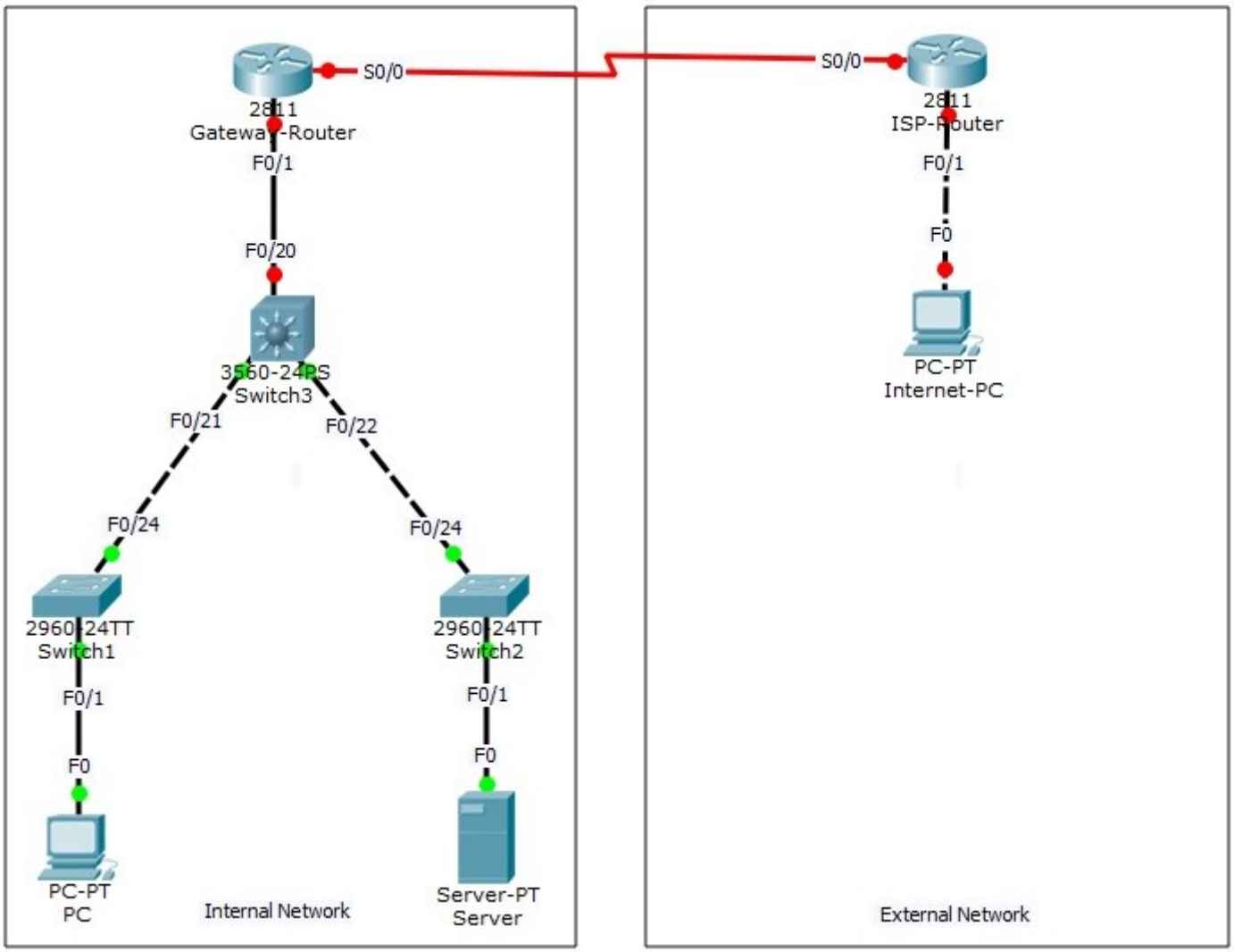
Lab 4.DHCP and NAT

Objective

- Understand the addressing technologies of DHCP and NAT.

Topology



Addressing Scheme for NAT		
	Public IPv4 addresses	Private IPv4 addresses
PC	202.175._11.1~2/30	192.168._11._0/24
Server	202.175._11.3	192.168.101.101

Host name	Interface	IPv4/IPv6 address	VLAN ID
Switch1	F0/1	N/A	VLAN 11
	F0/24	N/A	All VLANs (trunk)
Switch2	F0/1	N/A	VLAN 101
	F0/24	N/A	All VLANs (trunk)
Switch3	F0/20	N/A	VLAN 201
	F0/21~22	N/A	All VLANs (trunk)
	Vlan 11	IPv4: 192.168. 11.1/24	SVI
	Vlan 101	IPv4: 192.168.101.1/24	SVI
	Vlan 201	IPv4: 192.168.201.2/24	SVI
Gateway-Router	F0/1	IPv4: 192.168.201.1/24	N/A
	S0/0/0 (DTE)	IPv4: 172.16.0.2/30	N/A
PC	F0	IPv4: 192.168. 11. 11/24	N/A
Server	F0	IPv4: 192.168.101.101 /24	N/A
ISP-Router	F0/1	IPv4: 1.1.1.1/8	N/A
	S0/0/0 (DCE)	IPv4: 172.16.0.1/30	N/A
Internet-PC	F0/1	IPv4: 1.2.3.4/8	N/A

Part 0 - Basic configurtions.

Step 1 - Create the VLANs.

1. Configure VTP on Switch3 to advertise the VLAN configuration to all other switches.
   Switch3(config)# ***vtp version*** 2
   Switch3(config)# ***vtp domain*** cisco

```
Changing VTP domain name from NULL to cisco
```

   Switch3(config)# ***vtp mode server***

```
Device mode already VTP SERVER.
```

2. Configure the trunking protocol, IEEE 802.1Q, on the trunk ports of all switches.
   Switch3(config)# ***interface range FastEthernet*** 0/21 – 22
   Switch3(config-if-range)# ***switchport trunk encapsulation dot1q***
   Switch3(config-if-range)# ***switchport trunk native vlan*** 1
   Switch3(config-if-range)# ***switchport mode trunk***

   Switch1~2(config)# ***interface range FastEthernet*** 0/24
   Switch1~2 (config-if-range)# ***switchport trunk native vlan*** 1
   Switch1~2 (config-if-range)# ***switchport mode trunk***

3. Create the VLANs with a user-defined name in Switch3.
   Switch3(config)# ***vlan*** 11
   Switch3(config-vlan)# ***name*** PC-VLAN
   Switch3(config)# ***vlan*** 101
   Switch3(config-vlan)# ***name*** Server-VLAN
   Switch3(config)# ***vlan*** 201
   Switch3(config-vlan)# ***name*** Gateway-VLAN

4. Display the VLANs in Switch3.
   Switch3# ***show vlan***

   Output of Switch3:

```
VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                                Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                                Fa0/17, Fa0/18, Fa0/19, Fa0/20
                                                Fa0/23, Fa0/24, Gig0/1, Gig0/2
11   PC-VLAN                          active
101  Server-VLAN                      active
201  Gateway-VLAN                     active

  <omit output below>
```

Step 2 - Assign the switched ports to the VLANs.

5. Assign the port connected to PC to the VLAN in Switch1.
   Switch1(config)# ***interface FastEthernet*** 0/1
   Switch1(config-if)# ***switchport mode access***
   Switch1(config-if)# ***switchport access vlan*** 11

6. Display the port assignment in Switch1.
   Switch1# ***show vlan***

   Output of Switch1:

```
VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/2, Fa0/3, Fa0/4, Fa0/5
                                                Fa0/6, Fa0/7, Fa0/8, Fa0/9
                                                Fa0/10, Fa0/11, Fa0/12, Fa0/13
                                                Fa0/14, Fa0/15, Fa0/16, Fa0/17
                                                Fa0/18, Fa0/19, Fa0/20, Fa0/21
                                                Fa0/22, Fa0/23, Gig0/1, Gig0/2
11   PC-VLAN                          active    Fa0/1
101  Server-VLAN                      active
201  Gateway-VLAN                     active

  <omit output below>
```

7. Assign the port connected to Server to the VLAN in Switch2.
   Switch2(config)# ***interface FastEthernet*** 0/1
   Switch2(config-if)# ***switchport mode access***
   Switch2(config-if)# ***switchport access vlan*** 101

8. Display the port assignment in Switch2.
   Switch2# ***show vlan***

   Output of Switch2:

```
VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active    Fa0/2, Fa0/3, Fa0/4, Fa0/5
                                                Fa0/6, Fa0/7, Fa0/8, Fa0/9
                                                Fa0/10, Fa0/11, Fa0/12, Fa0/13
                                                Fa0/14, Fa0/15, Fa0/16, Fa0/17
                                                Fa0/18, Fa0/19, Fa0/20, Fa0/21
                                                Fa0/22, Fa0/23, Gig0/1, Gig0/2
11   PC-VLAN                          active
101  Server-VLAN                      active    Fa0/1
201  Gateway-VLAN                     active

  <omit output below>
```

9. Assign the port connected to Gateway-Router to the VLAN in Switch3.
   Switch3(config)# ***interface FastEthernet*** 0/20
   Switch3(config-if)# ***switchport mode access***
   Switch3(config-if)# ***switchport access vlan*** 201

10. Display the port assignment in Switch3.
    Switch3# ***show vlan***

Output of Switch3:

```
VLAN Name                              Status    Ports
---- --------------------------------- --------- -------------------------------
1    default                           active    Fa0/1, Fa0/2, Fa0/3, Fa0/4
                                                 Fa0/5, Fa0/6, Fa0/7, Fa0/8
                                                 Fa0/9, Fa0/10, Fa0/11, Fa0/12
                                                 Fa0/13, Fa0/14, Fa0/15, Fa0/16
                                                 Fa0/17, Fa0/18, Fa0/19, Fa0/23
                                                 Fa0/24, Gig0/1, Gig0/2
11   PC-VLAN                           active
101  Server-VLAN                       active
201  Gateway-VLAN                      active    Fa0/20

  <omit output below>
```

Step 3 - Create a gateway for VLAN communications.

11. Enable the IPv4 routing process in Switch3.
    Switch3(config)# ***ip routing***

12. Configure Switch3 as the default gateway for the subnets of PC, Server and Gateway-Router.
    Switch3(config)# ***interface vlan*** 11
    Switch3(config-if)# ***ip address*** 192.168.11.1 255.255.255.0
    Switch3(config-if)# ***no shutdown***

    Switch3(config)# ***interface vlan*** 101
    Switch3(config-if)# ***ip address*** 192.168.101.1 255.255.255.0
    Switch3(config-if)# ***no shutdown***

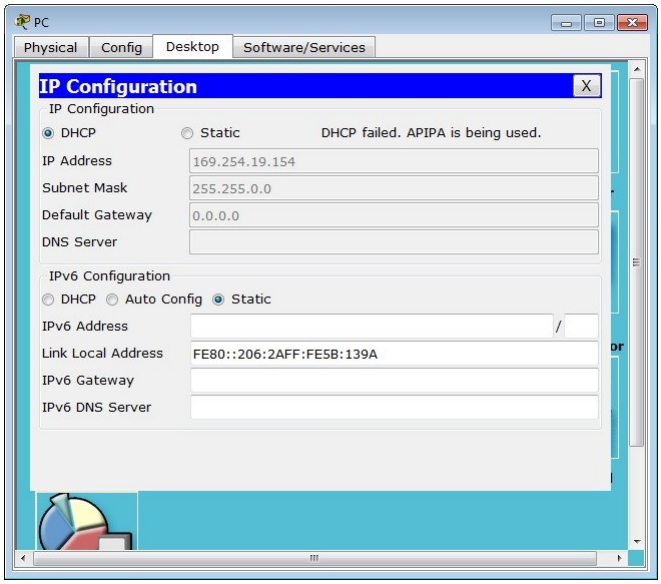
    Switch3(config)# ***interface vlan*** 201
    Switch3(config-if)# ***ip address*** 192.168.201.2 255.255.255.0
    Switch3(config-if)# ***no shutdown***

Step 4 - Configure the interfaces of the PCs, servers and routers.

13. Configure the interfaces of Gateway-Router.
    Gateway-Router(config)# ***interface FastEthernet*** 0/1
    Gateway-Router(config-if)# ***ip address*** 192.168.201.1 255.255.255.0
    Gateway-Router(config-if)# ***no shutdown***

    Gateway-Router(config)# ***interface Serial*** 0/0/0
    Gateway-Router(config-if)# ***ip address*** 172.16.0.2 255.255.255.252
    Gateway-Router(config-if)# ***no shutdown***

14. Configure the interfaces of PC using DHCP.



PC:\> ***ipconfig***

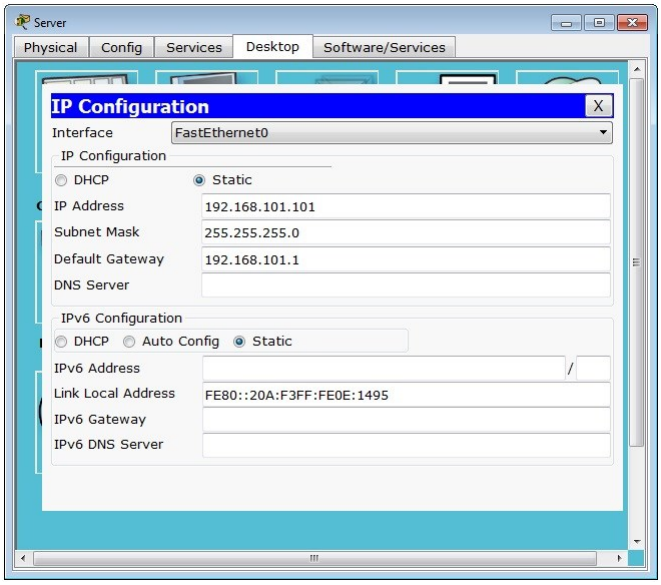
Output of PC:

```
FastEthernet0 Connection:(default port)

   Link-local IPv6 Address.....: FE80::206:2AFF:FE5B:139A
   Autoconfiguration IP Address....: 169.254.19.154
   Subnet Mask.....: 255.255.0.0
   Default Gateway.....: 0.0.0.0
```

(Note: If the DHCP server is not available, the PC is configured with an Autoconfiguration IP Address, 169.254.0.0/16.)

15. Configure the interfaces of Server.



SERVER:\> ***ipconfig***

Output of Server:

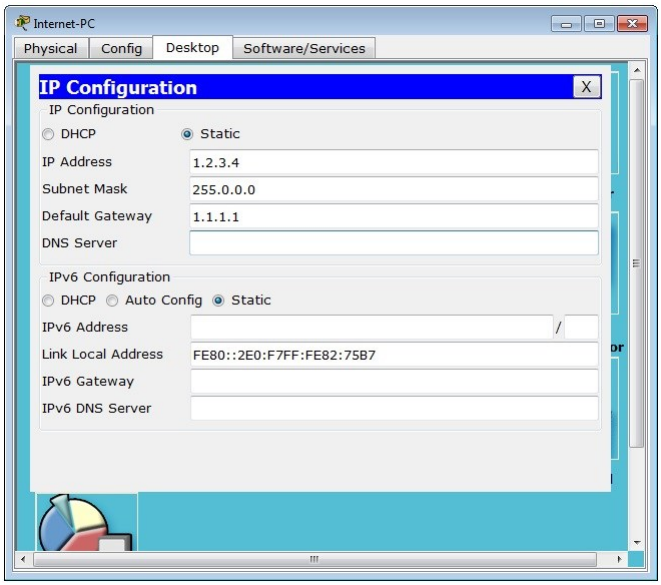
```
FastEthernet0 Connection:(default port)

   Link-local IPv6 Address.....: FE80::20A:F3FF:FE0E:1495
   IP Address.....: 192.168.101.101
   Subnet Mask.....: 255.255.255.0
   Default Gateway.....: 192.168.101.1
```

16. Configure the interfaces of ISP-Router.
    ISP-Router(config)# ***interface FastEthernet*** 0/1
    ISP-Router(config-if)# ***ip address*** 1.1.1.1 255.0.0.0
    ISP-Router(config-if)# ***no shutdown***

    ISP-Router(config)# ***interface Serial*** 0/0/0
    ISP-Router(config-if)# ***clock rate*** 56000
    (Note: the ***clock rate*** command is required for the DCE interface only.)
    ISP-Router(config-if)# ***ip address*** 172.16.0.1 255.255.255.252
    ISP-Router(config-if)# ***no shutdown***

17. Configure the interfaces of Internet-PC.



    Internet-PC:\> ***ipconfig***

    Output of Internet-PC:

```
FastEthernet0 Connection:(default port)

   Link-local IPv6 Address.....: FE80::2E0:F7FF:FE82:75B7
   IP Address.....: 1.2.3.4
   Subnet Mask.....: 255.0.0.0
   Default Gateway.....: 1.1.1.1
```

Step 5 - Configure the routing in the switches and routers.

18. Configure the default route in Switch3.
    Switch3(config)# ***ip route*** 0.0.0.0 0.0.0.0 192.168.201.1

19. Configure the static route in the Gateway-Router.
    Gateway-Router(config)# ***ip route*** 192.168.0.0 255.255.0.0 192.168.201.2

20. Configure the default route in Gateway-Router.
    Gateway-Router(config)# ***ip route*** 0.0.0.0 0.0.0.0 172.16.0.1

21. Configure the static route in ISP-Router.
    ISP-Router(config)# ***ip route*** 202.175.11.0 255.255.255.252 172.16.0.2

Part 1 - DHCP.

Step 1 - Configure the DHCP server.

22. Enable the DHCP service in Gateway-Router.
    Gateway-Router(config)# ***service dhcp***
    (Note: The DHCP service is enabled by default.)

23. Configure the DHCP pool for the subnet of PC.
    Gateway-Router(config)# ***ip dhcp pool*** PC-DHCPPool
    (Note: The ***ip dhcp pool*** command is used to define a pool of addresses that will be assigned to the hosts.)
    Gateway-Router(dhcp-config)# ***network*** 192.168.11.0 255.255.255.0
    (Note: The ***network*** command is used to define the range of addresses to be leased.)
    Gateway-Router(dhcp-config)# ***default-router*** 192.168.11.1
    Gateway-Router(dhcp-config)# ***dns-server*** 192.168.201.1

    (Note: Typically, a DHCP server will be configured to assign much more than an IP address. Other IP configuration such as the default gateway, DNS server, WINS server, can be configured.)

24. Exclude addresses from the DHCP pool.
    Gateway-Router(config)# ***ip dhcp excluded-address*** 192.168.11.1 192.168.11.100
    (Note: The ***ip dhcp excluded-address*** command is used to exclude an individual address or range of addresses when assigning addresses to the clients. The reserved addresses can be statically assigned to other hosts.)

25. Configure the helper IP in Switch3, pointing to the DHCP server in Gateway-Router.
    Switch3(config)# ***interface vlan*** 11
    (Note: the helper IP is configured at the default gateway of each local subnet.)
    Switch3(config-if)# ***ip helper-address*** 192.168.201.1
    (Note: When the DHCP server and the client are not on the same segment, the ***ip helper-address*** command is used to relay DHCP broadcast requests.)

    (Note: DHCPv4 is not the only service that can be configured to relay. By default, the following eight UDP services are forwarded.
    Port 37: Time
    Port 49: TACACS
    Port 53: DNS
    Port 67: DHCP/BOOTP client
    Port 68: DHCP/BOOTP server
    Port 69: TFTP
    Port 137: NetBIOS name service
    Port 138: NetBIOS datagram service)

Step 2 - Verify the DHCP service.

26. On PC, obtain the IP configuration from the DHCP server.
    PC:\> ***ipconfig /renew***

Then verify the IP configuration of PC.
PC:\> ***ipconfig /all***

Output of PC:

```
FastEthernet0 Connection:(default port)

   Connection-specific DNS Suffix..:
   Physical Address................: 0006.2A5B.139A
   Link-local IPv6 Address.........: FE80::206:2AFF:FE5B:139A
   IP Address......................: 192.168.11.101
   Subnet Mask.....................: 255.255.255.0
   Default Gateway.................: 192.168.11.1
   DNS Servers.....................: 192.168.201.1
   DHCP Servers....................: 192.168.201.1
   DHCPv6 Client DUID..............: 00-01-00-01-2C-19-78-9D-00-06-2A-5B-13-9A
```

(Note: After the client obtains an IP address, the client may use the Address Resolution Protocol (ARP) to prevent address conflicts.)

27. Display the DHCP binding created by the DHCP server in Gateway-Router.
Gateway-Router# ***show ip dhcp binding***

Output of Gateway-Router:

```
IP address       Client-ID/              Lease expiration        Type
                 Hardware address
192.168.11.101   0006.2A5B.139A           --                     Automatic
```

(Note: The ***show ip dhcp binding*** command is used to display a list of all IPv4 address to MAC address bindings that have been provided by the DHCPv4 service.)

(Note: The ***show ip dhcp server statistics*** command can be used to display count information regarding the number of DHCP messages that have been sent and received.)

(Note: The ***debug ip dhcp server events*** command can be used to show the processes of addresses being returned and addresses being allocated.)

Part 2 - NAT.

Step 1 - Configure static NAT.

28. Test the IP connectivity from Internet-PC to the private IP address of Server using ***ping***.
    Internet-PC:\> ***ping*** 192.168.101.101

    Output of Internet-PC:

```
Pinging 192.168.101.101 with 32 bytes of data:

Reply from 1.1.1.1: Destination host unreachable.
Reply from 1.1.1.1: Destination host unreachable.
Reply from 1.1.1.1: Destination host unreachable.
Reply from 1.1.1.1: Destination host unreachable.

Ping statistics for 192.168.101.101:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

29. Is the ping successful, and why?
    No, because there is no route to the internal network of Server.

30. Configure static NAT for Server in Gateway-Router.
    Gateway-Router(config)# ***ip nat inside source static*** 192.168.101.101 202.175.11.3

31. Specify the interfaces either inside or outside with respect to NAT.
    Gateway-Router(config)# ***interface FastEthernet*** 0/1
    Gateway-Router(config-if)# ***ip nat inside***
    Gateway-Router(config-if)# ***interface Serial*** 0/0/0
    Gateway-Router(config-if)# ***ip nat outside***

32. Display the static NAT translations in Gateway-Router.
    Gateway-Router# ***show ip nat translations***

    Output of Gateway-Router:

```
Pro  Inside global     Inside local       Outside local      Outside global
---  202.175.11.3      192.168.101.101    ---                ---
```

    (Note: The ***show ip nat translations*** command is used to display the translation information. The ***verbose*** option displays additional information for each translation table entry, including how long ago the entry was created and used.)

33. Test the IP connectivity from Internet-PC to the public IP address of Server using ***ping***.
    Internet-PC:\> ***ping*** 202.175.11.3

Output of Internet-PC:

```
Pinging 202.175.11.3 with 32 bytes of data:

Reply from 202.175.11.3: bytes=32 time=1803ms TTL=125
Reply from 202.175.11.3: bytes=32 time=15ms TTL=125
Reply from 202.175.11.3: bytes=32 time=12ms TTL=125
Reply from 202.175.11.3: bytes=32 time=2ms TTL=125

Ping statistics for 202.175.11.3:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
```

34. Is the ping successful?
    Yes.

Step 2 - Configure dynamic NAT with overloading (PAT).

35. Test the IP connectivity from PC to Internet-PC using ***ping***.
    PC:\> ***ping*** 1.2.3.4

    Output of PC:

```
Pinging 1.2.3.4 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 1.2.3.4:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

36. Is the ping successful? and why?
    No, because there is no route for the packet with private address returning to Gateway-Router.

37. Configure the inside local address of the dynamic NAT for PC in Gateway-Router.
    Gateway-Router(config)# ***access-list*** 11 ***permit*** 192.168.11.0 0.0.0.255

38. Configure the inside global address of the dynamic NAT for PC in Gateway-Router.
    Gateway-Router(config)# ***ip nat pool*** PC-NATPool 202.175.11.1 202.175.11.2 ***netmask*** 255.255.255.252

39. Configure the mapping of the dynamic NAT for PC in Gateway-Router.
    Gateway-Router(config)# ***ip nat inside source list*** 11 ***pool*** PC-NATPool ***overload***

40. Test the IP connectivity from PC to Internet-PC using ***ping***.
    PC:\> ***ping*** 1.2.3.4

Output of PC:

```
Pinging 1.2.3.4 with 32 bytes of data:

Reply from 1.2.3.4: bytes=32 time=39ms TTL=125
Reply from 1.2.3.4: bytes=32 time=6ms TTL=125
Reply from 1.2.3.4: bytes=32 time=13ms TTL=125
Reply from 1.2.3.4: bytes=32 time=1ms TTL=125

Ping statistics for 1.2.3.4:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
```

41. Is the ping successful?

    Yes.

---

42. Display the dynamic NAT translations in Gateway-Router.

    Gateway-Router# ***show ip nat translations***

    Output of Gateway-Router:

```
Pro  Inside global     Inside local       Outside local      Outside global
icmp 202.175.11.1:32   192.168.11.101:32  1.2.3.4:32         1.2.3.4:32
icmp 202.175.11.1:33   192.168.11.101:33  1.2.3.4:33         1.2.3.4:33
icmp 202.175.11.1:34   192.168.11.101:34  1.2.3.4:34         1.2.3.4:34
icmp 202.175.11.1:35   192.168.11.101:35  1.2.3.4:35         1.2.3.4:35
---  202.175.11.3      192.168.101.101    ---                ---
```

(Note: Most often the outside local and outside global addresses are the same. While uncommon, this address could be different than the globally routable address of the destination.)

(Note: If PAT translates the protocols carried by IPv4 that use TCP or UDP as a transport layer protocol, PAT will attempt to preserve the original source port. If this source port is already used, PAT will assign the first available port number starting from the beginning of the appropriate port group 0-511, 512-1023, or 1024-65535. When there are no more ports available and there is more than one external IP address configured, PAT moves to the next IP address to try to allocate the original source port again.)

(Note: If PAT translates the ICMPv4 messages that use the Query ID, such as ICMPv4 echo request and echo reply, PAT uses the Query ID instead of a Layer 4 port number. ICMPv4 uses the Query ID to identify an echo request with its corresponding echo reply. The Query ID is incremented with each echo request sent. If PAT translates the other ICMPv4 messages that do not use the Query ID and other protocols that do not use TCP or UDP port numbers, these translations behave vary.)

(Note: By default, dynamic NAT translations will time out after a period of non-use. The ***clear ip nat translation*** * command can be used to clear the entries before timeout.)

(Note: The ***debug ip nat*** command can be used to display information about every packet that is translated by the router.)