



Chapter 9: NAT for IPv4



Routing and Switching Essentials v6.0

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Chapter 9 - Sections & Objectives

- 9.1 Network Layer Protocols
 - Explain how NAT provides IPv4 address scalability in a small to medium-sized business network.
- 9.2 Configuring NAT
 - Configure NAT services on the edge router to provide IPv4 address scalability in a small to medium-sized business network.
- 9.3 Troubleshoot NAT Configurations
 - Troubleshoot NAT issues in a small to medium-sized business network.



9.1 NAT Operation



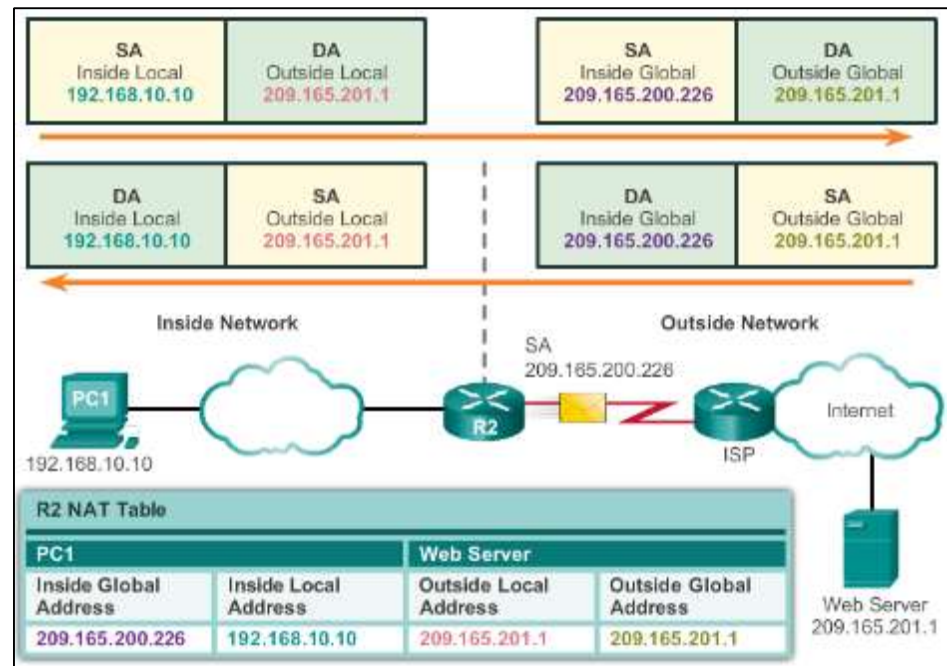
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NAT Operation

NAT Characteristics

- IPv4 Private Address Space
 - 10.0.0.0 /8, 172.16.0.0 /12, and 192.168.0.0 /16
- What is NAT?
 - Process to translate network IPv4 address
 - Conserve public IPv4 addresses
 - Configured at the border router for translation
- NAT Terminology
 - Inside address
 - Inside local address
 - Inside global address
 - Outside address
 - Outside local address
 - Outside global address





NAT Operation

Types of NAT

■ Static NAT

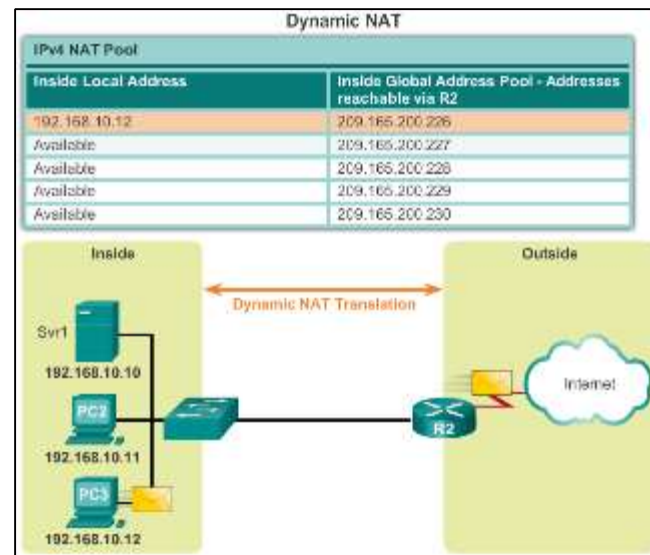
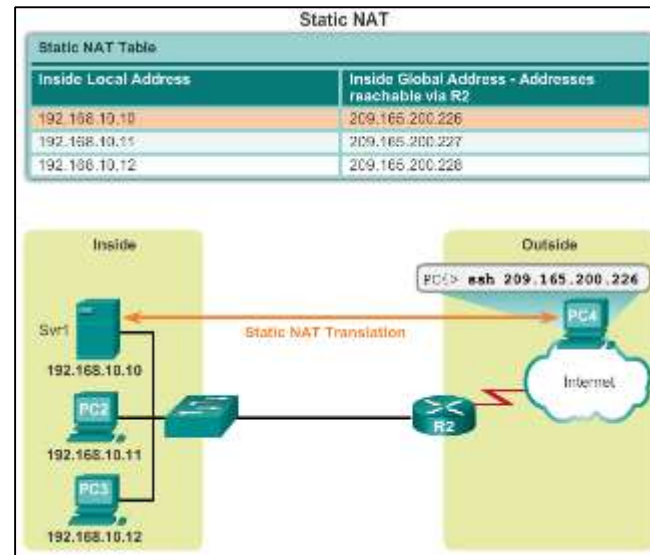
- One-to-one mapping of local and global addresses
- Configured by the network administrator and remain constant.

■ Dynamic NAT

- Uses a pool of public addresses and assigns them on a first-come, first-served basis
- Requires that enough public addresses for the total number of simultaneous user sessions

■ Port Address Translation (PAT)

- Maps multiple private IPv4 addresses to a single public IPv4 address or a few addresses
- Also known as NAT overload
- Validates that the incoming packets were requested
- Uses port numbers to forward the response packets to the correct internal device

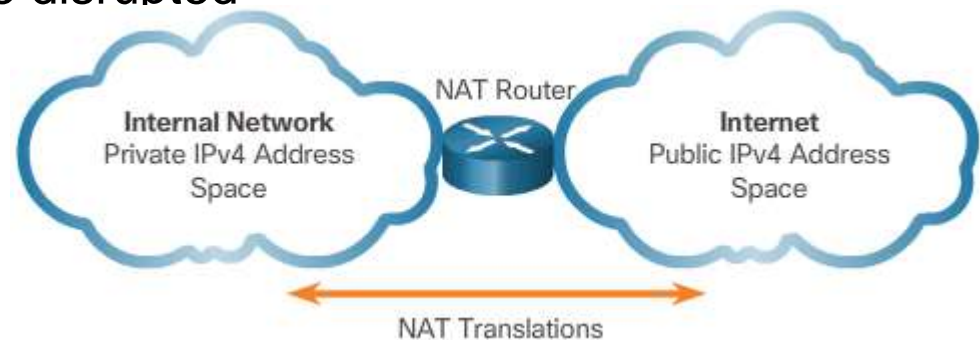




NAT Operation

NAT Advantages

- Advantages of NAT
 - Conserves the legally registered addressing scheme
 - Increases the flexibility of connections to the public network
 - Provides consistency for internal network addressing schemes
 - Provides network security
- Disadvantages of NAT
 - Performance is degraded
 - End-to-end functionality is degraded
 - End-to-end IP traceability is lost
 - Tunneling is more complicated
 - Initiating TCP connections can be disrupted





9.2 Configuring NAT



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Configuring NAT

Configuring Static NAT

■ Configuring Static NAT

- Create the mapping between the inside local and outside local addresses

```
ip nat inside source static local-ip global-ip
```

- Define which interfaces belong to the inside network and which belong to the outside network

```
ip nat inside
```

```
ip nat outside
```

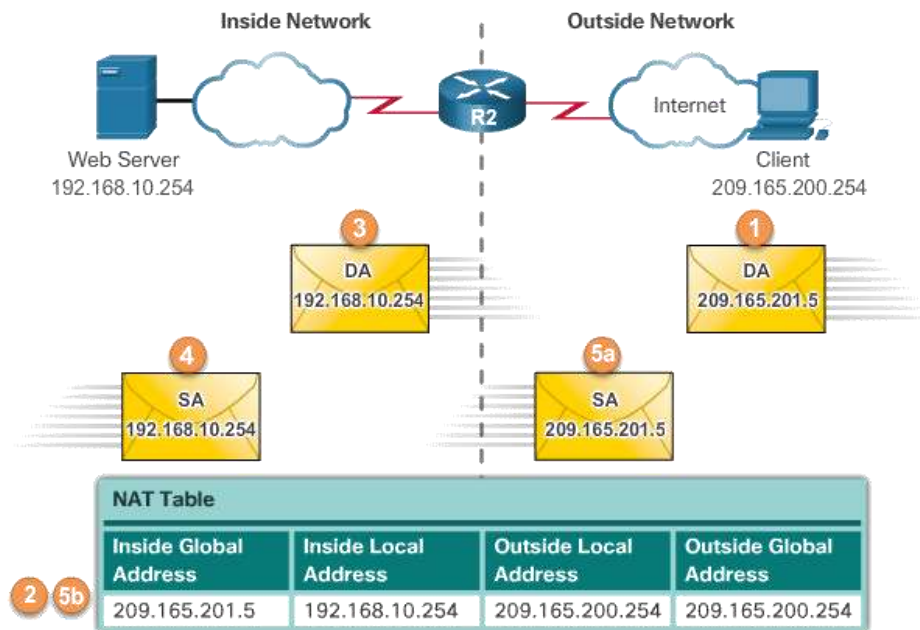
■ Analyzing Static NAT

■ Verifying Static NAT

```
show ip nat translations
```

```
show ip nat statistics
```

```
clear ip nat statistics
```





Configuring NAT

Configuring Dynamic NAT

■ Dynamic NAT Operation

- The pool of public IPv4 addresses (inside global address pool) is available to any device on the inside network on a first-come, first-served basis.
- With dynamic NAT, a single inside address is translated to a single outside address.
- The pool must be large enough to accommodate all inside devices.
- A device is unable to communicate to any external networks if no addresses are available in the pool.



Configuring NAT

Configuring Dynamic NAT (Cont.)

■ Configuring Dynamic NAT

- Create the mapping between the inside local and outside local addresses

```
ip nat pool name start-ip end-ip {netmask netmask
| prefix-length prefix-length}
```

- Create a standard ACL to permit those addresses to be translated

```
access-list access-list-number permit source
[source-wildcard]
```

- Bind the ACL to the pool

```
ip nat inside source list access-list-number pool
name
```

- Identify the inside and outside interfaces

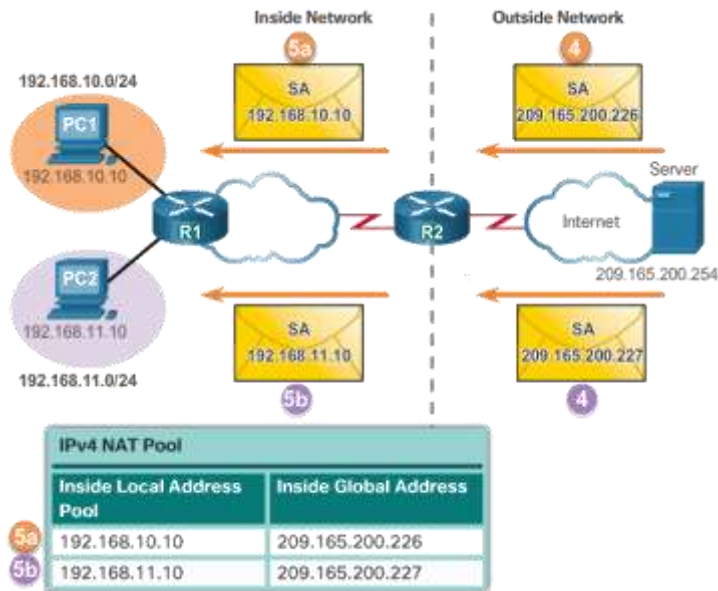
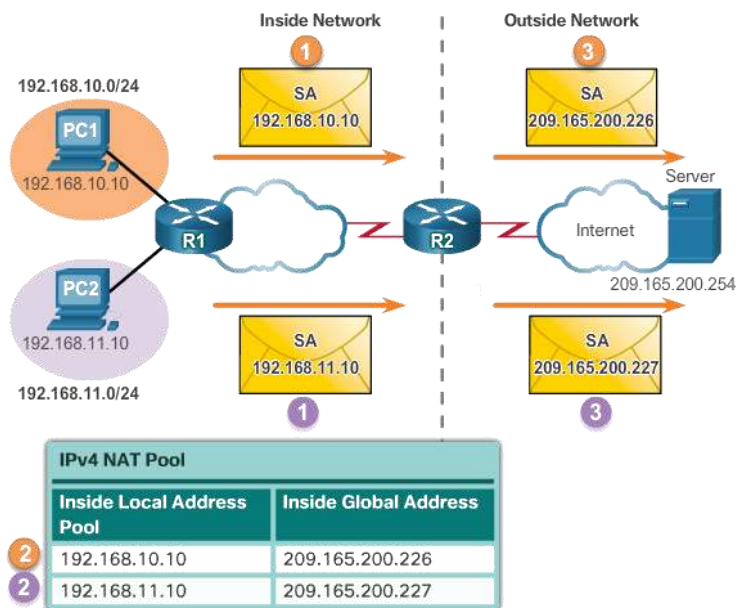
```
ip nat inside
ip nat outside
```



Configuring NAT

Configuring Dynamic NAT (Cont.)

- Analyzing Dynamic NAT
- Verifying Dynamic NAT
 - `show ip nat translations`
 - `show ip nat translations verbose`
 - `clear ip nat statistics`
 - `clear ip nat translations *`





Configuring NAT

Configuring Port Address Translations (PAT)

■ Configuring PAT: Address Pool

- Create the mapping between the inside local and outside local addresses

```
ip nat pool name start-ip end-ip {netmask netmask |
prefix-length prefix-length}
```

- Create a standard ACL to permit those addresses to be translated

```
access-list access-list-number permit source [source-
wildcard]
```

- Bind the ACL to the pool

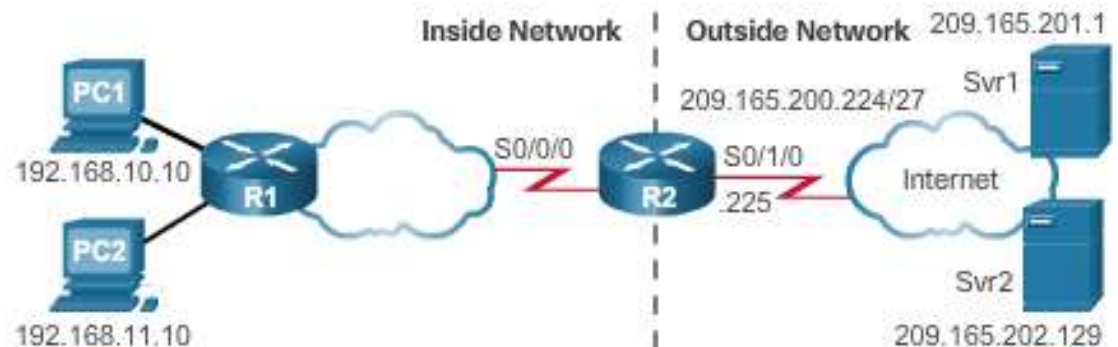
```
ip nat inside source list access-list-number pool name
```

- Identify the inside and outside interfaces

```
ip nat inside
```

```
ip nat outside
```

Example PAT with Address Pool





Configuring NAT

Configuring Port Address Translations (PAT) (Cont.)

▪ Configuring PAT: Single Address

- Define a standard ACL to permit those addresses to be translated

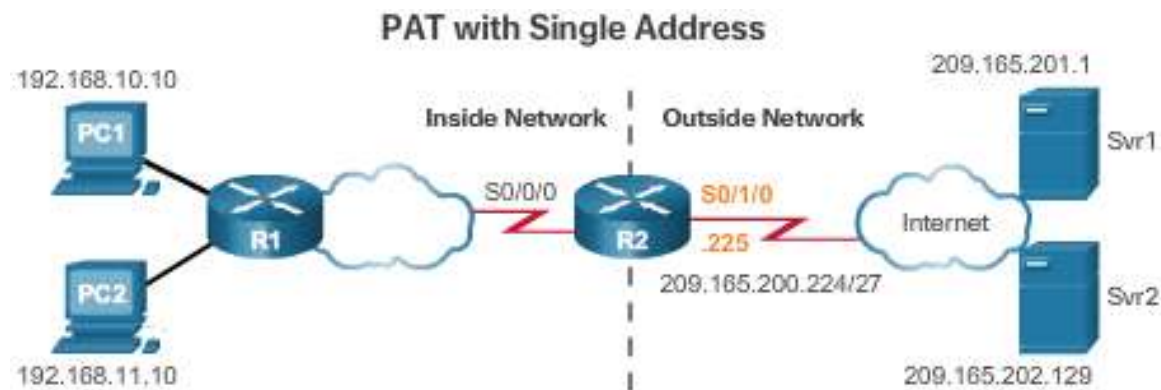
```
access-list access-list-number permit source
[source-wildcard]
```

- Establish dynamic source translation, specify the ACL, exit interface, and overload option

```
ip nat inside source list access-list-number
interface type name overload
```

- Identify the inside and outside interfaces

```
ip nat inside
ip nat outside
```





Configuring NAT

Configuring Port Address Translations (PAT) (Cont.)

- Analyzing PAT

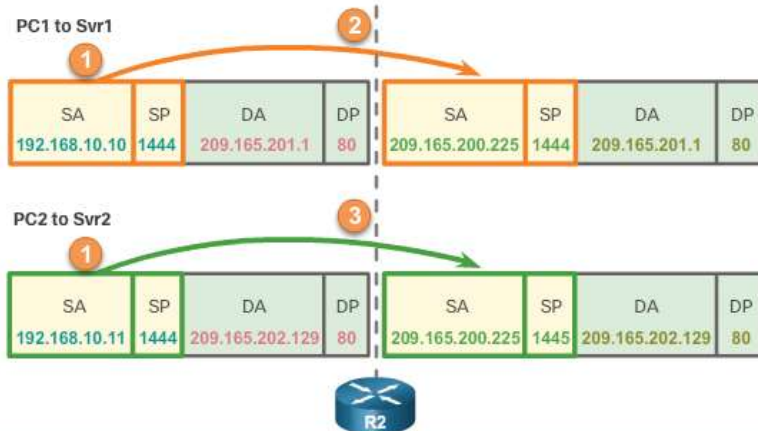
- Verifying PAT

`show ip nat translations`

`show ip nat statistics`

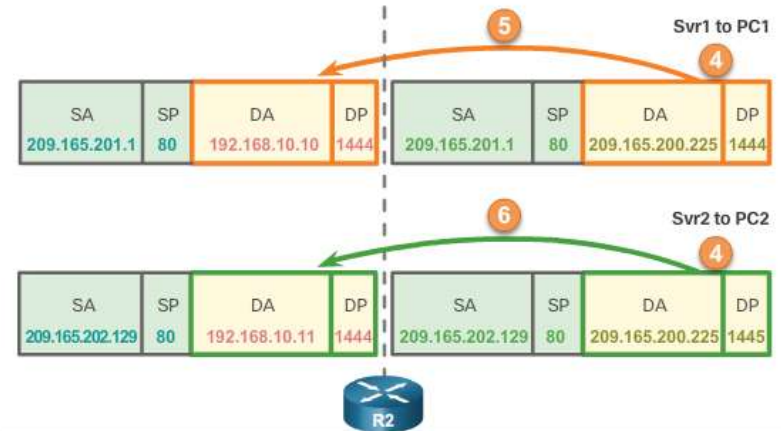
`clear ip nat statistics`

PAT Analysis from PCs to Servers



Inside Local Address	Inside Global Address	Outside Global Address	Outside Local Address
192.168.10.10:1444	209.165.200.225:1444	209.165.201.1:80	209.165.201.1:80
192.168.10.11:1444	209.165.200.225:1445	209.165.202.129:80	209.165.202.129:80

PAT Analysis from Servers to PCs



Inside Local Address	Inside Global Address	Outside Global Address	Outside Local Address
192.168.10.10:1444	209.165.200.225:1444	209.165.201.1:80	209.165.201.1:80
192.168.10.11:1444	209.165.200.225:1445	209.165.202.129:80	209.165.202.129:80



Configuring NAT

Port Forwarding

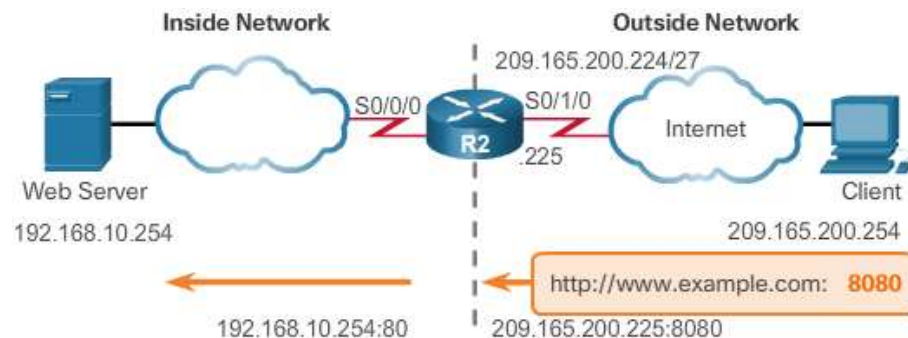
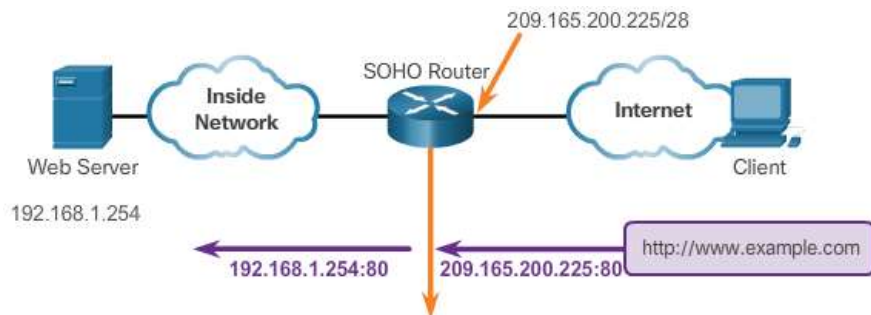
Port Forwarding

- Port forwarding is the act of forwarding a network port from one network node to another.
- A packet sent to the public IP address and port of a router can be forwarded to a private IP address and port in inside network.
- Port forwarding is helpful in situations where servers have private addresses, not reachable from the outside networks.

Wireless Router Example

Configuring Port Forwarding with IOS

```
ip nat inside source [static {tcp | udp local-ip local-port
global-ip global-port} [extendable]
```





Configuring NAT

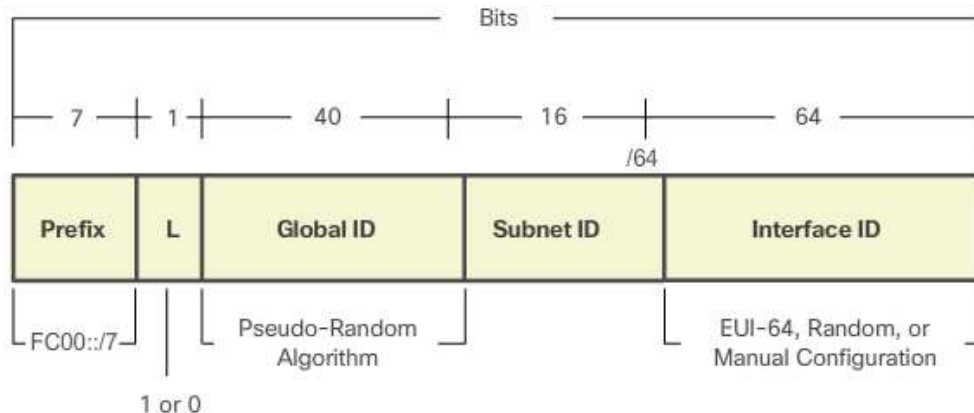
Configuring NAT and IPv6

■ NAT for IPv6?

- IPv6 with a 128-bit address provides 340 undecillion addresses.
- Address space is not an issue for IPv6.
- IPv6 makes IPv4 public-private NAT unnecessary by design; however, IPv6 does implement a form of private addresses, and it is implemented differently than they are for IPv4.

■ IPv6 Unique Local Address

- IPv6 unique local addresses (ULAs) are designed to allow IPv6 communications within a local site.
- ULAs are not meant to provide additional IPv6 address space.
- ULAs have the prefix FC00::/7, which results in a first hextet range of FC00 to FDFF.
- ULAs are also known as local IPv6 addresses (not to be confused with IPv6 link-local addresses).

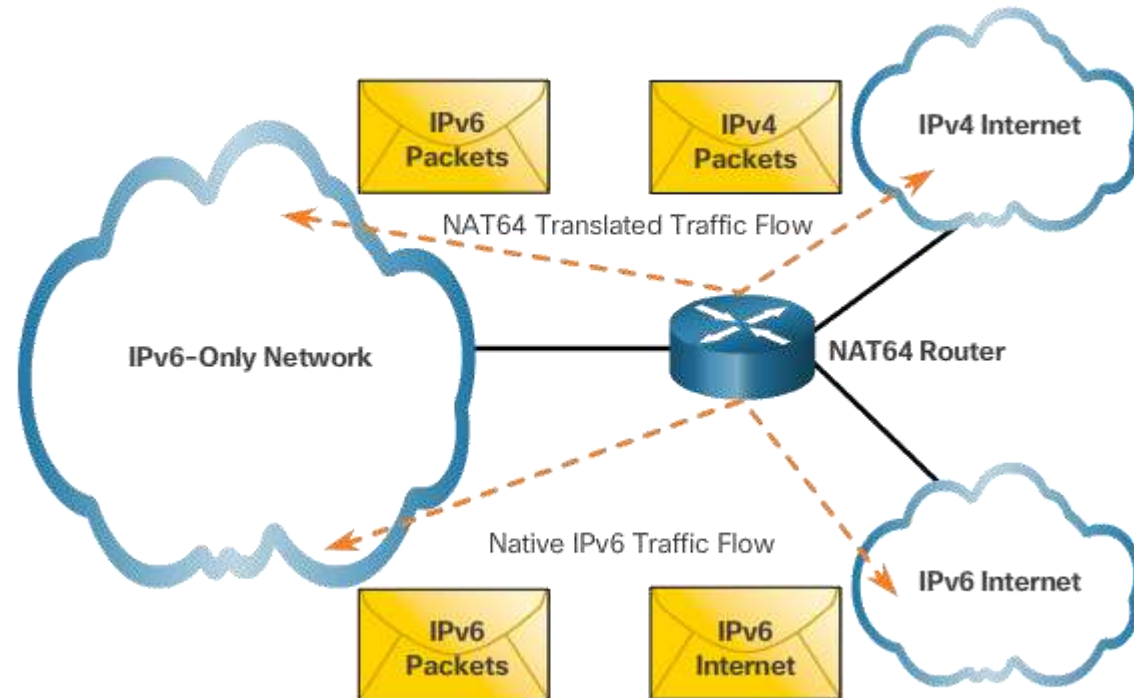




Configuring NAT

Configuring NAT and IPv6 (Cont.)

- NAT for IPv6
 - IPv6 also uses NAT, but in a much different context.
 - In IPv6, NAT is used to provide transparent communication between IPv6 and IPv4.
 - NAT64 is not intended to be a permanent solution; it is meant to be a transition mechanism.
 - Network Address Translation-Protocol Translation (NAT-PT) was another NAT-based transition mechanism for IPv6, but is now deprecated by IETF.
 - NAT64 is now recommended.





9.3 Troubleshooting NAT



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Troubleshooting NAT

Troubleshooting NAT Configurations

- Troubleshooting NAT: show commands

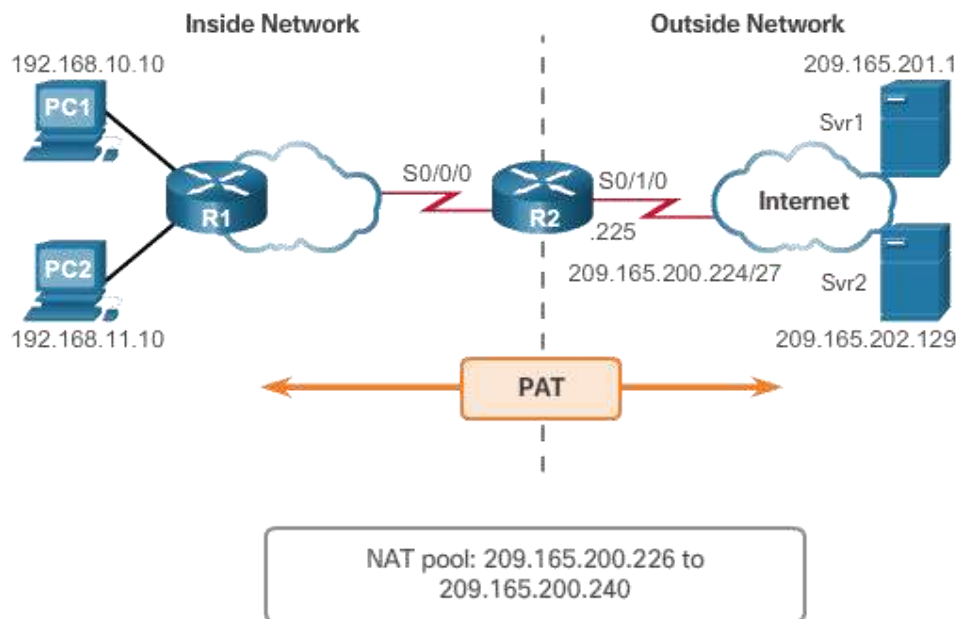
```
clear ip nat statistics
```

```
clear ip nat translations *
```

```
show ip nat statistics
```

```
Show ip nat translations
```
- Troubleshooting NAT: debug commands

```
debug ip nat
```





9.4 Chapter Summary



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Chapter Summary

Summary

- How NAT is used to help alleviate the depletion of the IPv4 address space.
- NAT conserves public address space and saves considerable administrative overhead in managing adds, moves, and changes.
- NAT for IPv4, including:
 - NAT characteristics, terminology, and general operations
 - Different types of NAT, including static NAT, dynamic NAT, and NAT with overloading
 - Benefits and disadvantages of NAT
- The configuration, verification, and analysis of static NAT, dynamic NAT, and NAT with overloading.
- How port forwarding can be used to access an internal devices from the Internet.
- Troubleshooting NAT using **show** and **debug** commands.
- How NAT for IPv6 is used to translate between IPv6 addresses and IPv4 addresses.

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