



# Chapter 11: Network Address Translation for IPv4



## Routing & Switching

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## NAT Characteristics

# IPv4 Private Address Space

- IPv4 address space is not big enough to uniquely address all the devices that must be connected to the Internet.
- Network private addresses are described in RFC 1918 and are designed to be used within an organization or site only.
- Private addresses are not routed by Internet routers while public addresses are.
- Private addresses can alleviate IPv4 scarcity, but because they aren't routed by Internet devices, they first need to be translated.
- NAT is process used to perform such translation.

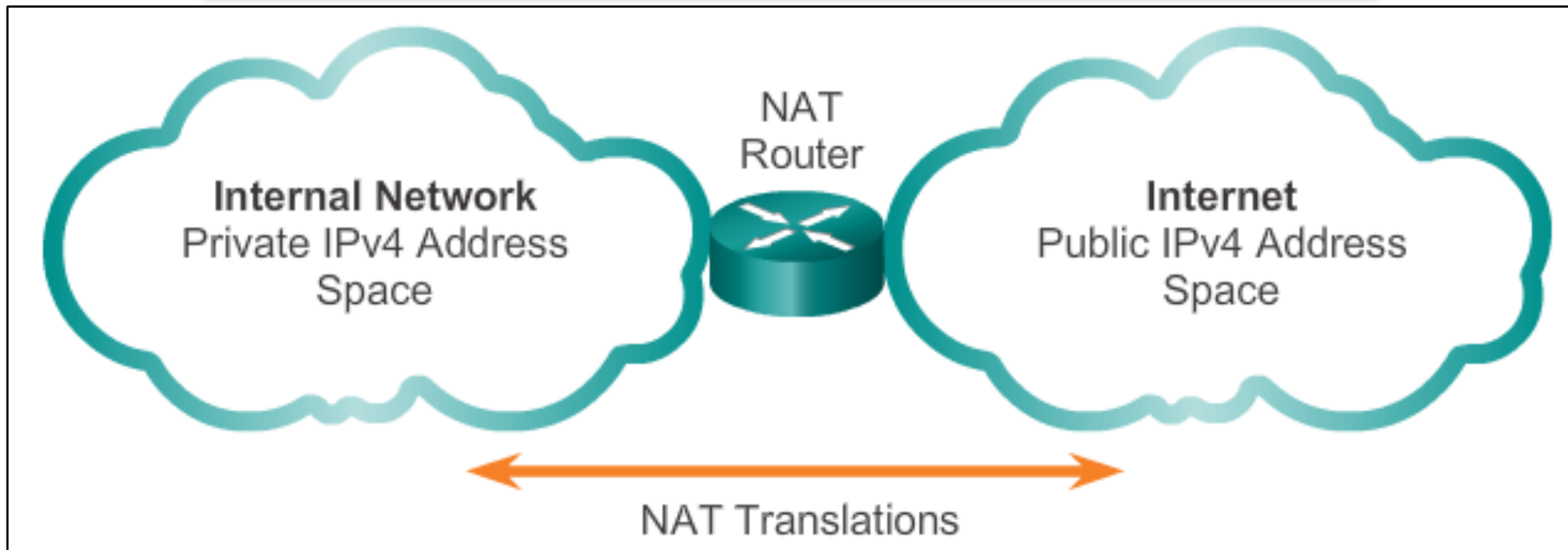


## NAT Characteristics

# IPv4 Private Address Space

Private Internet addresses are defined in RFC 1918:

Class	RFC 1918 Internal Address Range	CIDR Prefix
A	10.0.0.0 - 10.255.255.255	10.0.0.0/8
B	172.16.0.0 - 172.31.255.255	172.16.0.0/12
C	192.168.0.0 - 192.168.255.255	192.168.0.0/16





## NAT Characteristics

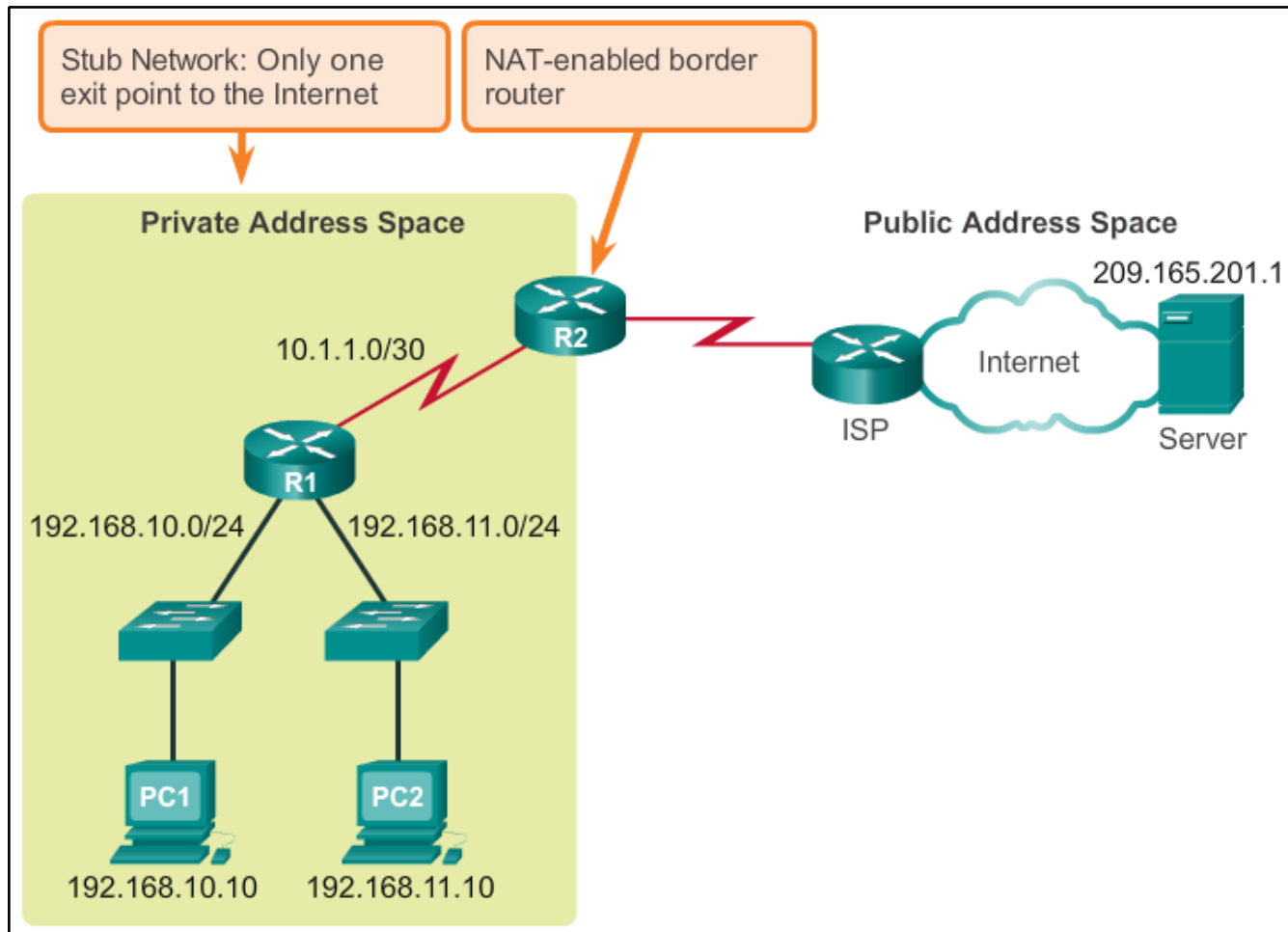
# What is NAT?

- NAT is a process used to translate network addresses.
- NAT's primary use is to conserve public IPv4 addresses.
- NAT is usually implemented at border network devices, such as firewalls or routers.
- NAT allows the networks to use private addresses internally, only translating to public addresses when needed.
- Devices within the organization can be assigned private addresses and operate with locally unique addresses.
- When traffic must be sent or received to or from other organizations or the Internet, the border router translates the addresses to a public and globally unique address.



## NAT Characteristics

# What is NAT? (cont.)

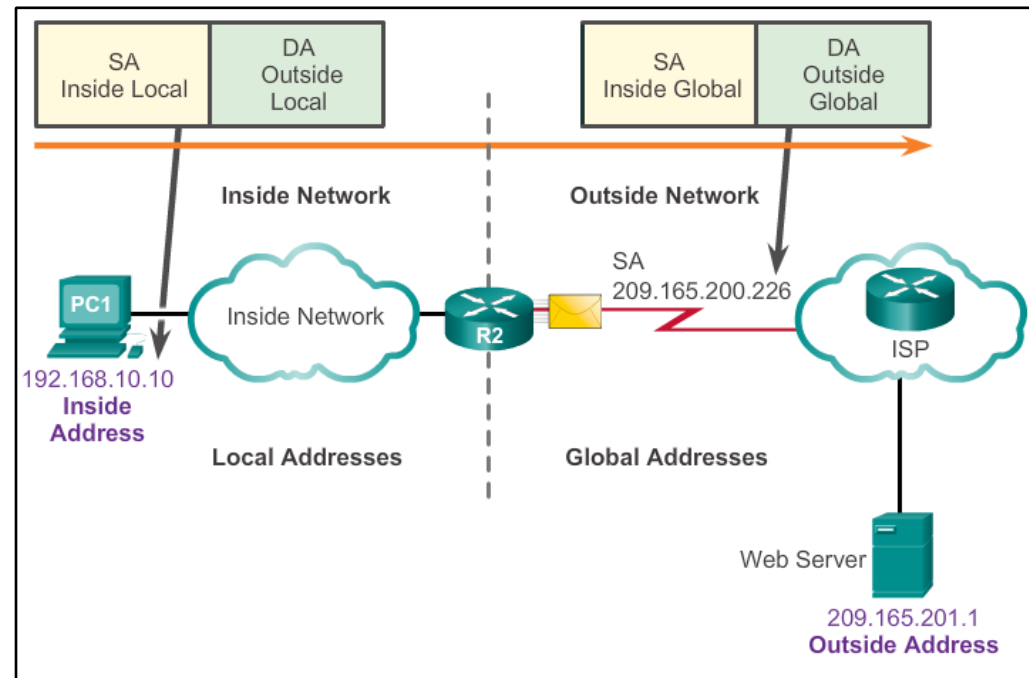




# NAT Characteristics

## NAT Terminology

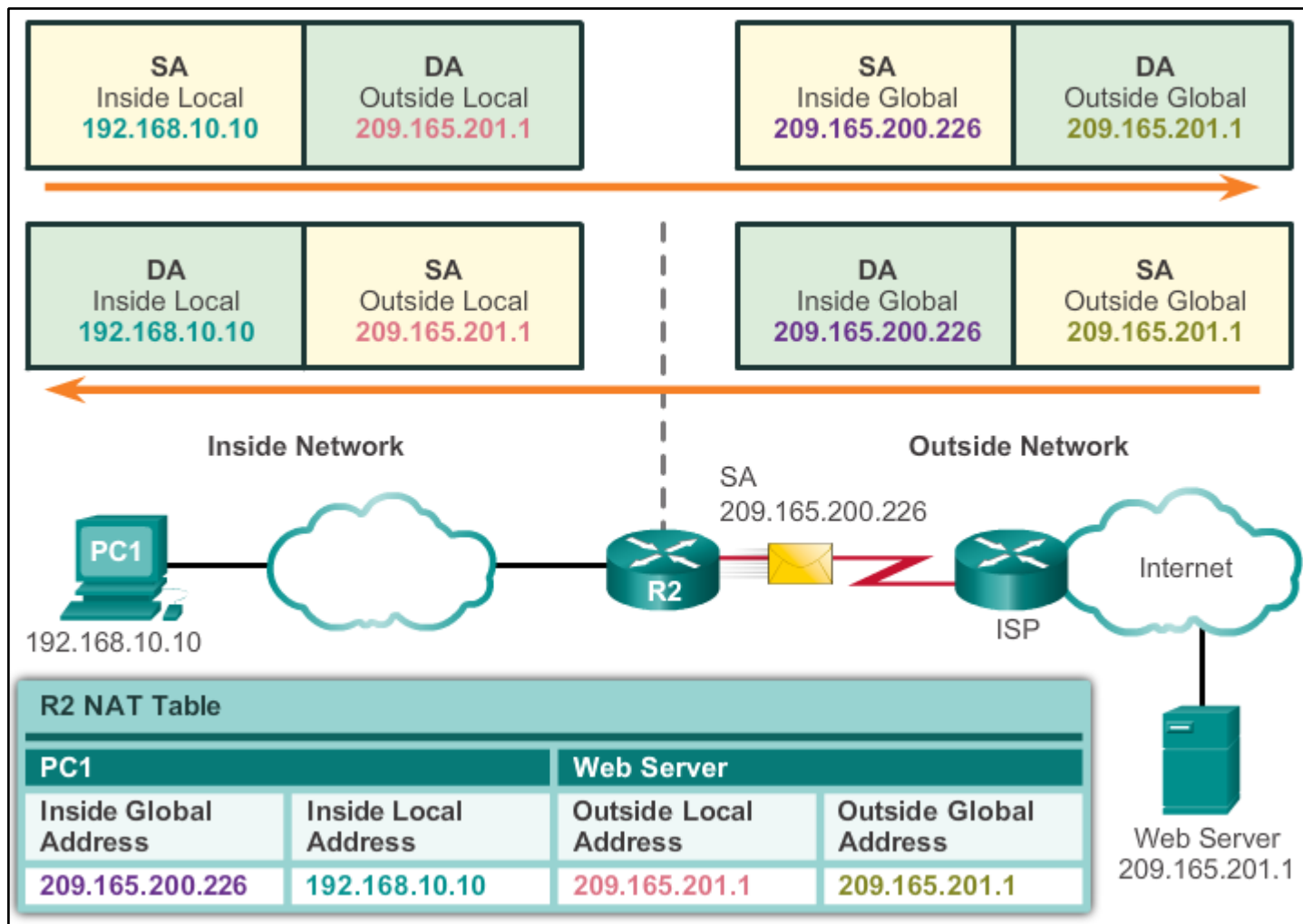
- Inside network is the set of devices using private addresses
- Outside network refers to all other networks
- NAT includes four types of addresses:
  - Inside local address
  - Inside global address
  - Outside local address
  - Outside global address





## NAT Characteristics

# NAT Terminology (cont.)





## Types of NAT

# Static NAT

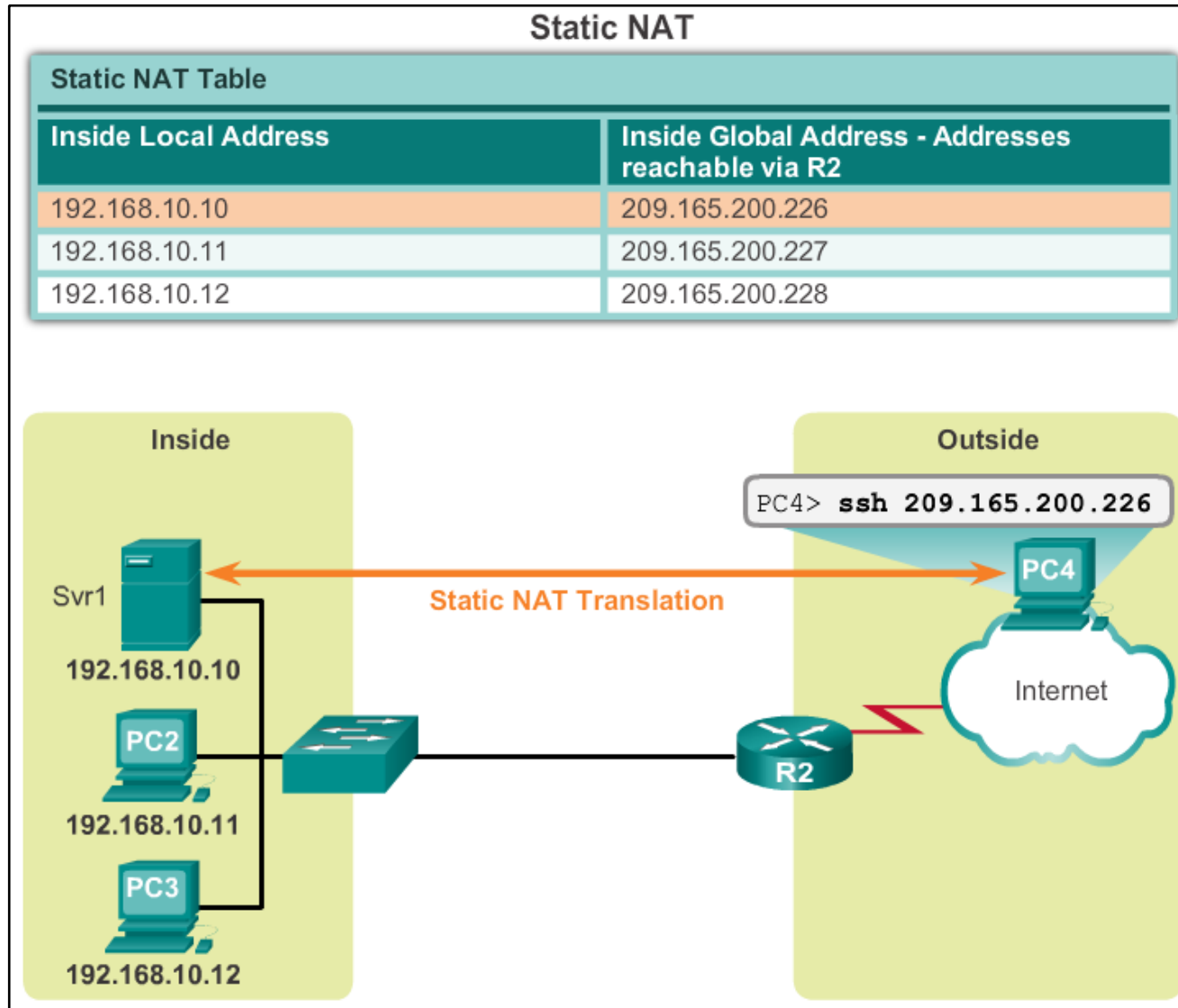
- Static NAT uses a one-to-one mapping of local and global addresses.
- These mappings are configured by the network administrator and remain constant.
- Static NAT is particularly useful when servers hosted in the inside network must be accessible from the outside network.
- A network administrator can SSH to a server in the inside network by pointing the SSH client to the proper inside global address.





## Types of NAT

# Static NAT (cont.)





## Types of NAT

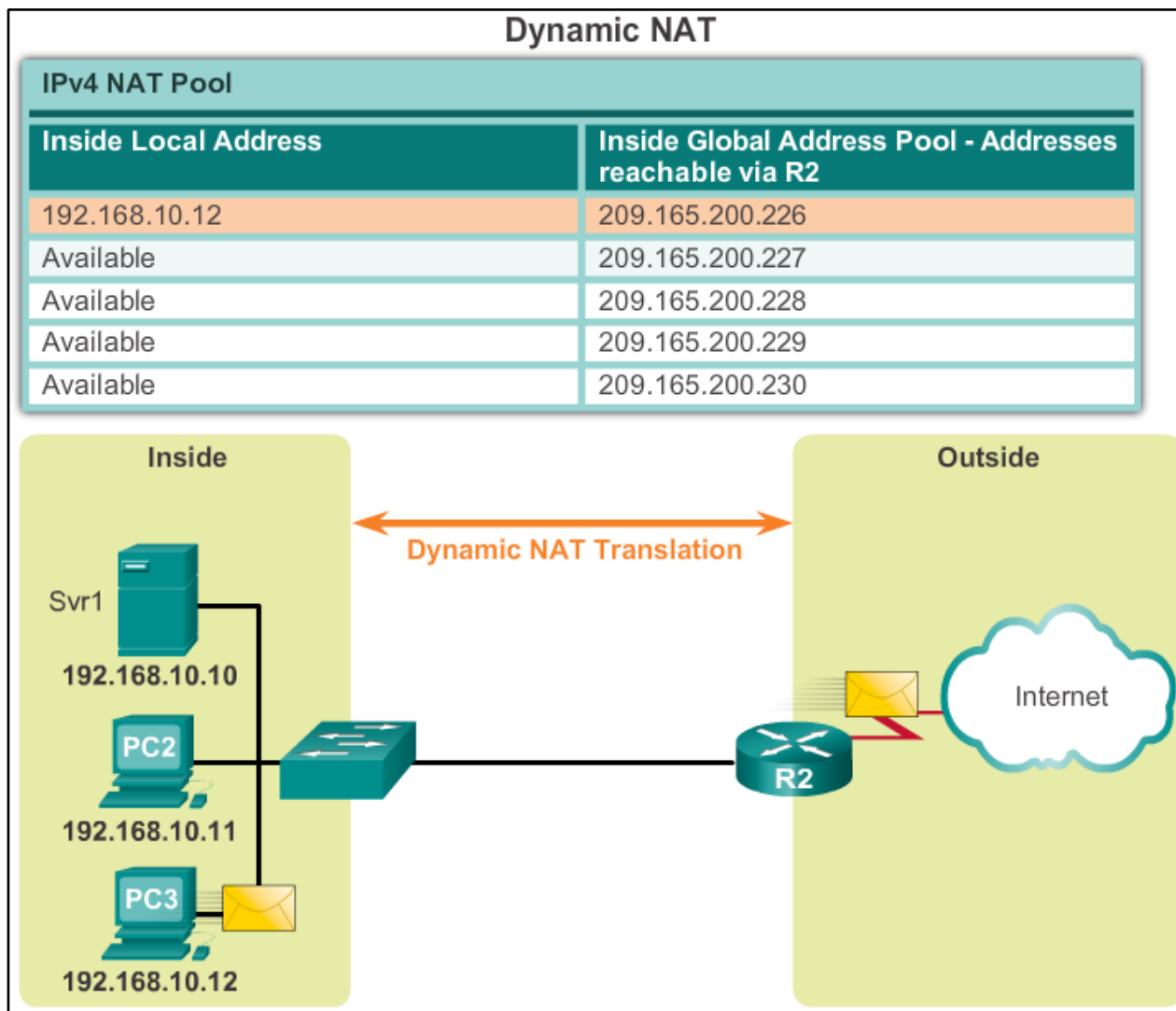
# Dynamic NAT

- Dynamic NAT uses a pool of public addresses and assigns them on a first-come, first-served basis.
- When an inside device requests access to an outside network, dynamic NAT assigns an available public IPv4 address from the pool.
- Dynamic NAT requires that enough public addresses are available to satisfy the total number of simultaneous user sessions.



## Types of NAT

# Dynamic NAT (cont.)





## Types of NAT

# Port Address Translation

- **Port Address Translation (PAT) maps multiple private IPv4 addresses to a single public IPv4 address or a few addresses.**
- PAT uses the pair source port and source IP address to keep track of what traffic belongs to what internal client.
- PAT is also known as NAT overload.
- By also using the port number, PAT forwards the response packets to the correct internal device.
- The PAT process also validates that the incoming packets were requested, thus adding a degree of security to the session.



## Types of NAT

# Comparing NAT and PAT

- NAT translates IPv4 addresses on a 1:1 basis between private IPv4 addresses and public IPv4 addresses.
- **PAT modifies both the address and the port number.**
- NAT forwards incoming packets to their inside destination by referring to the incoming source IPv4 address provided by the host on the public network.
- With PAT, there is generally only one or a very few publicly exposed IPv4 addresses.
- PAT is able to translate protocols that do not use port numbers, such as ICMP; each one of these protocols is supported differently by PAT.



## Benefits of NAT

# Benefits 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**



Benefits of NAT

# 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



## Configuring PAT

# Configuring PAT: Single Address

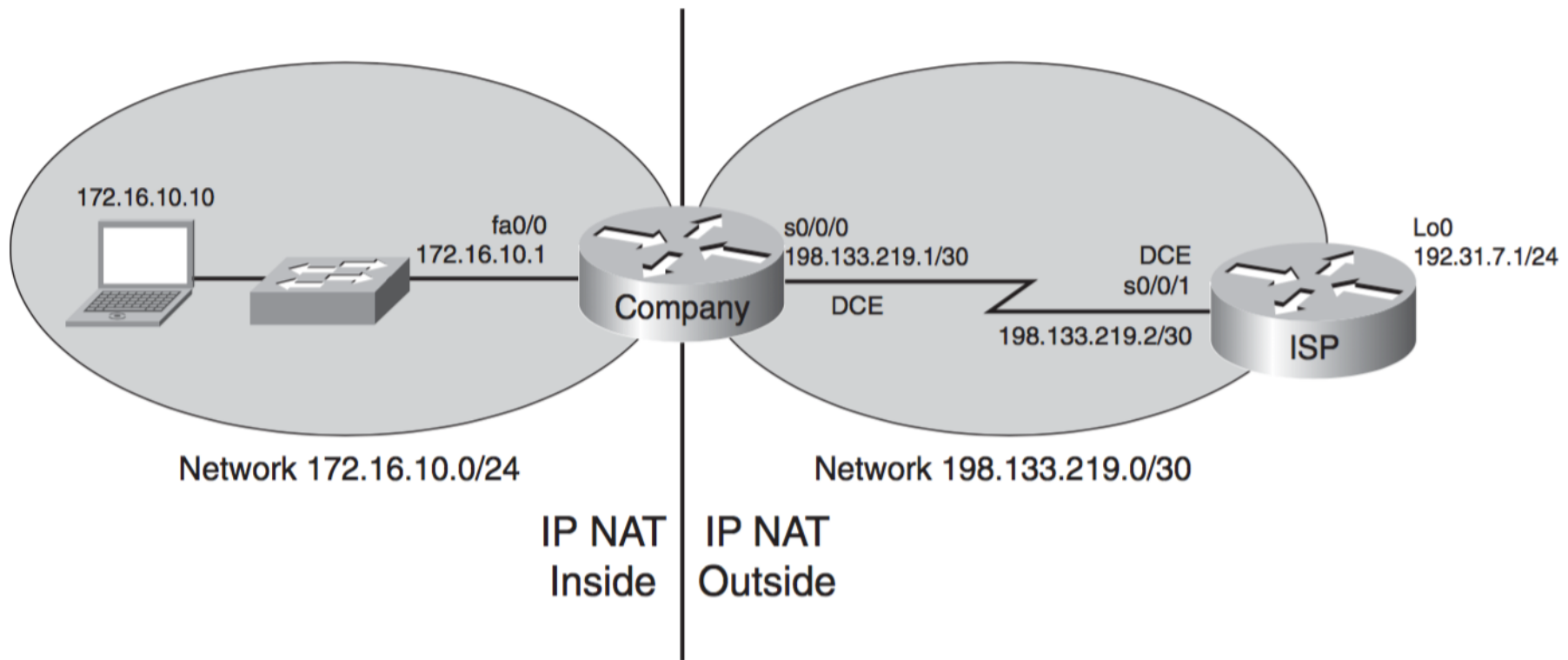
<b>Step 1</b>	<p>Define a standard access list permitting the addresses that should be translated.</p> <pre><b>access-list</b> access-list-number <b>permit</b> source [source-wildcard]</pre>
<b>Step 2</b>	<p>Establish dynamic source translation, specifying the ACL, exit interface and overload options.</p> <pre><b>ip nat inside source list</b> access-list-number <b>interface</b> type number <b>overload</b></pre>
<b>Step 3</b>	<p>Identify the inside interface.</p> <pre><b>interface</b> type number <b>ip nat inside</b></pre>
<b>Step 4</b>	<p>Identify the outside interface.</p> <pre><b>interface</b> type number <b>ip nat outside</b></pre>





## Configuring PAT

# Configuring PAT: Single Address



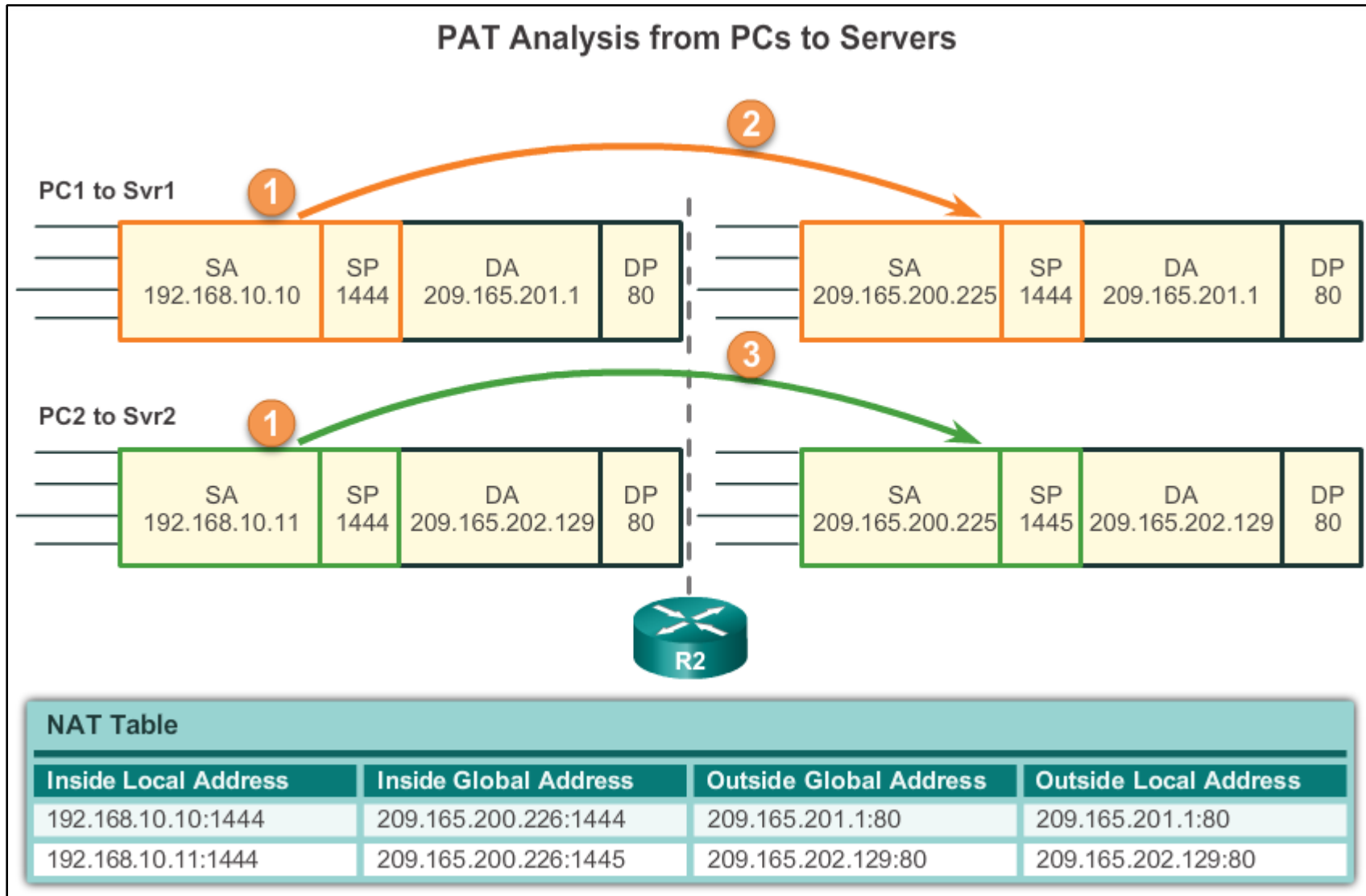


<b>Company(config)#ip route 0.0.0.0 0.0.0.0 198.133.219.2</b>	Sends all packets not defined in the routing table to the ISP router.
<b>Company(config)#access-list 1 permit 172.16.10.0 0.0.0.255</b>	Defines which addresses are permitted through; these addresses are those that will be allowed to be translated with NAT.
<b>Company(config)#ip nat inside source list 1 interface serial 0/0/0 overload</b>	Creates NAT by combining list 1 with the interface serial 0/0/0. Overloading will take place.
<b>Company(config)#interface fastethernet 0/0</b>	Moves to interface configuration mode.
<b>Company(config-if)#ip nat inside</b>	Location of private inside addresses.
<b>Company(config-if)#interface serial 0/0/0</b>	Moves to interface configuration mode.
<b>Company(config-if)#ip nat outside</b>	Location of public outside addresses.



# Configuring PAT

## Analyzing PAT

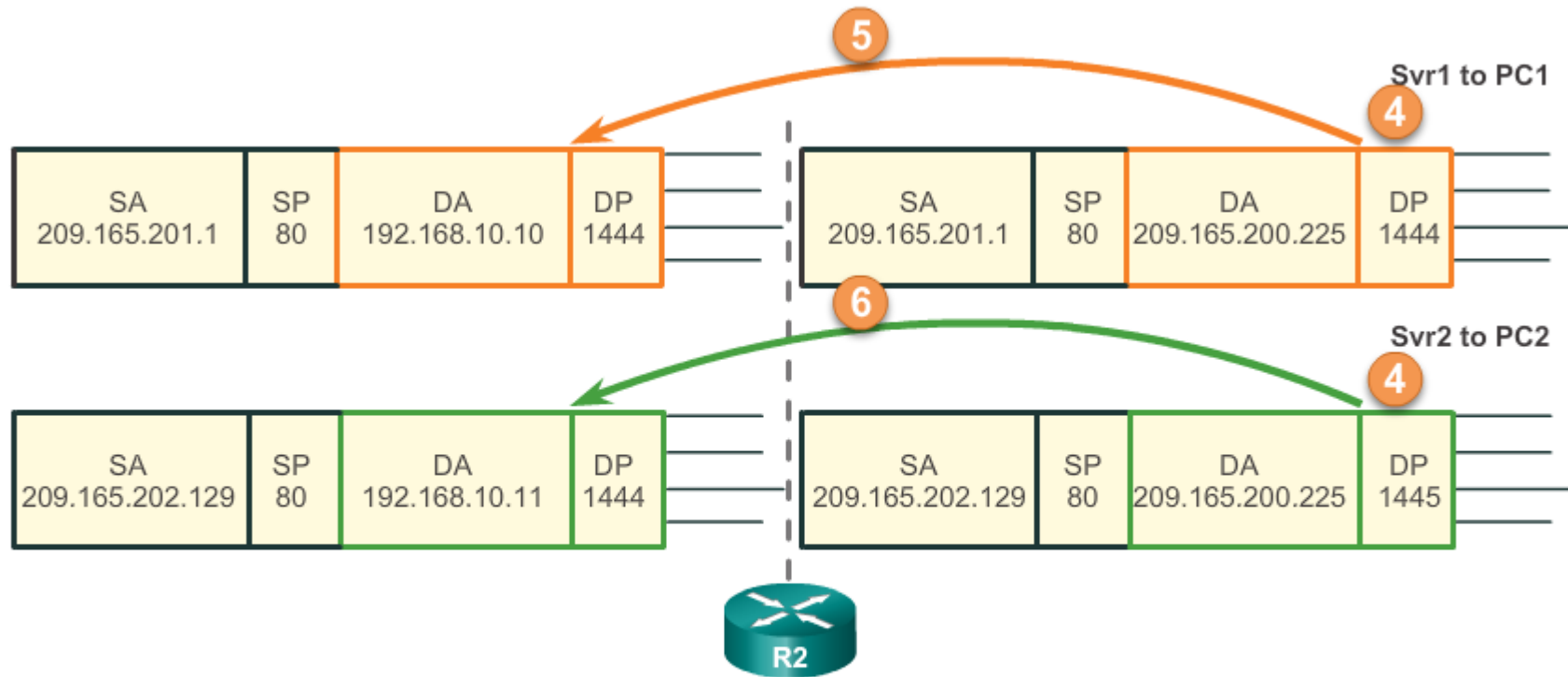




# Configuring PAT

## Analyzing PAT

PAT Analysis from Servers to PCs



NAT Table

Inside Local Address	Inside Global Address	Outside Global Address	Outside Local Address
192.168.10.10:1444	209.165.200.226:1444	209.165.201.1:80	209.165.201.1:80
192.168.10.11:1444	209.165.200.226:1445	209.165.202.129:80	209.165.202.129:80



# Configuring PAT

## Verifying PAT Translations

### Verifying PAT Translations

R2# **show ip nat translations**

Pro	Inside global	Inside local	Outside local	Outside global
tcp	209.165.200.226:51839	192.168.10.10:51839	209.165.201.1:80	209.165.201.1:80
tcp	209.165.200.226:42558	192.168.11.10:42558	209.165.202.129:80	209.165.202.129:80

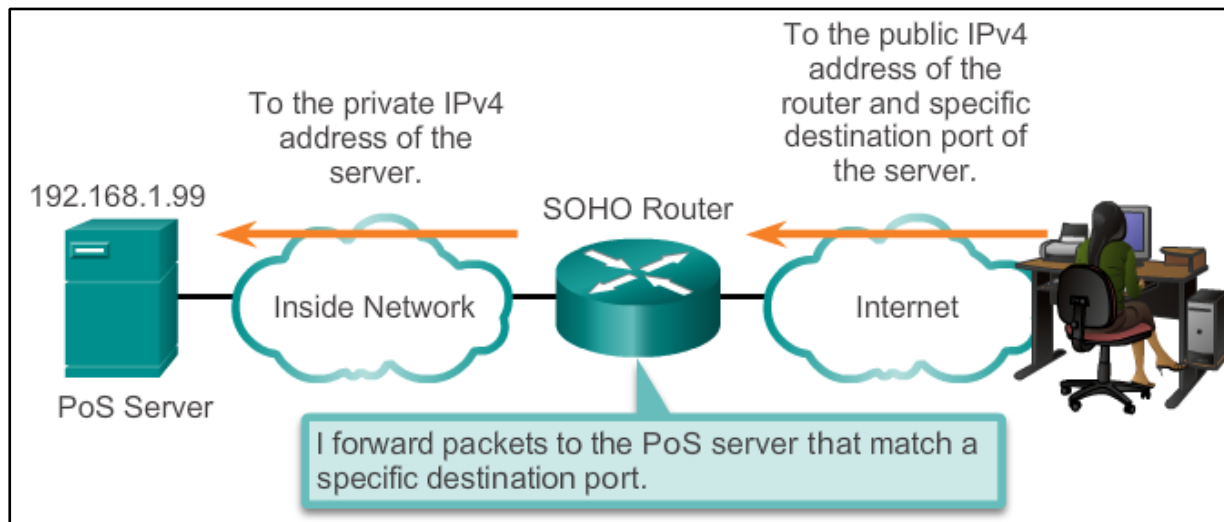
R2#



## Port Forwarding

# Port Forwarding

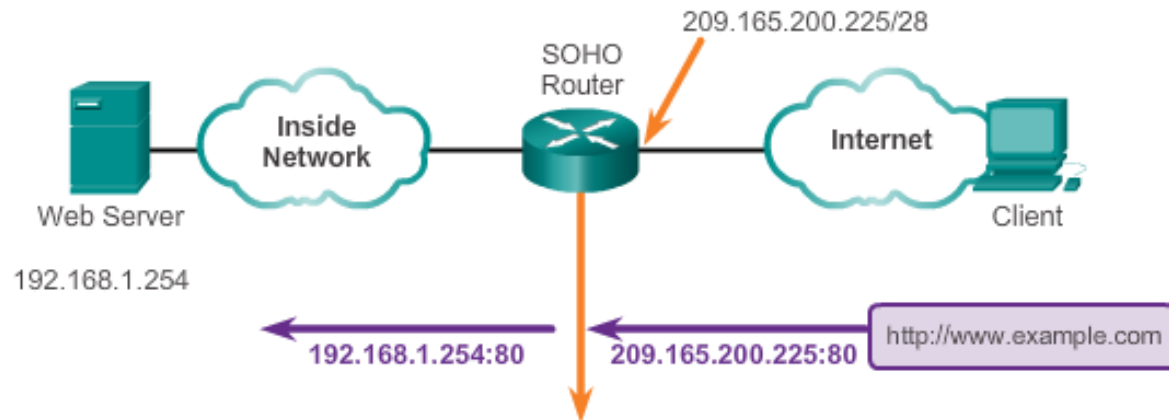
- Port forwarding is the act of forwarding a network port from one network node to another.
- A packet sent to the public IP address and port of a router can be forwarded to a private IP address and port in inside network.
- Port forwarding is helpful in situations where servers have private addresses,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





# Port Forwarding SOHO Example

Port Forwarding on a SOHO Router



The screenshot shows the 'Security' configuration page of a SOHO Router. The 'Single Port Forwarding' tab is selected. A table lists the port forwarding configuration for the 'Web Server' application.

Application name	External Port	Internal Port	Protocol	Device IP#	Enabled	
Web Server	80	80	TCP	192.168.1.254	<input checked="" type="checkbox"/>	Save/Cancel

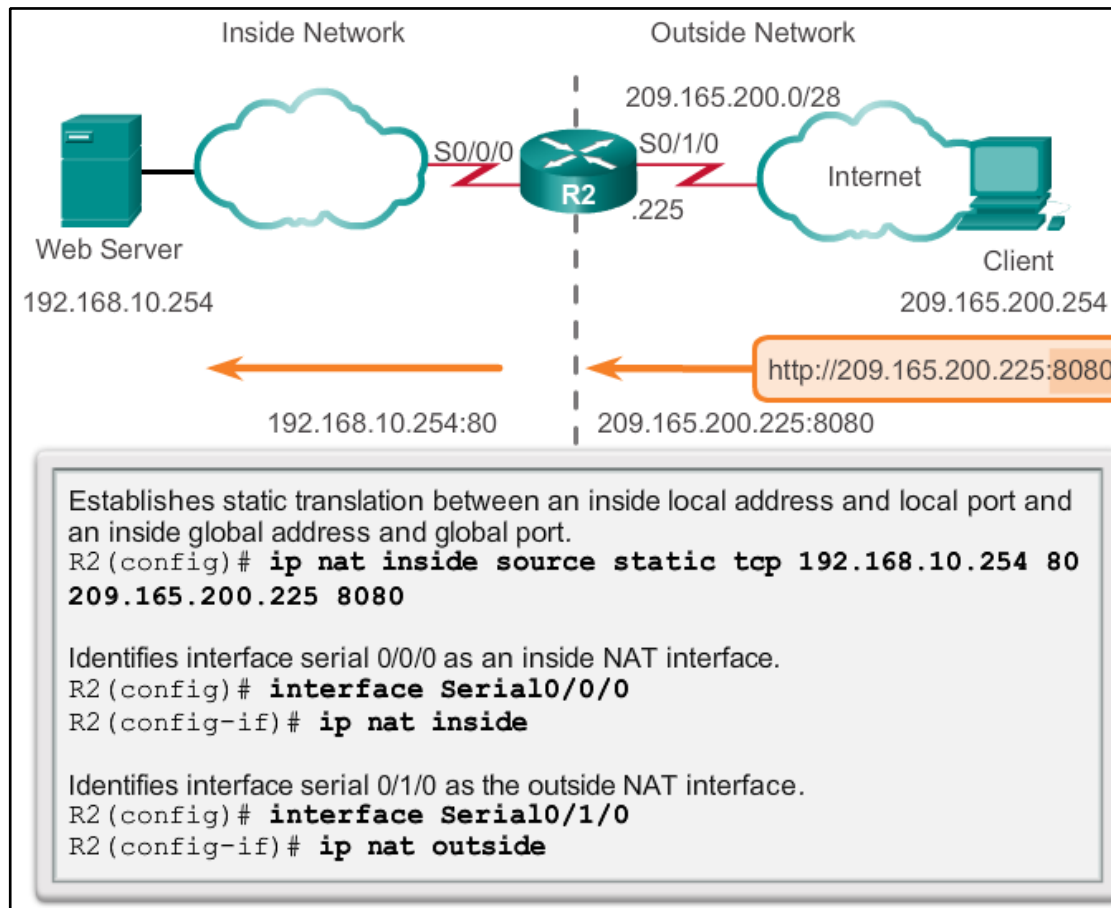
Buttons at the bottom: 'Add a new Single Port Forwarding'.



## Port Forwarding

# Configuring Port Forwarding with IOS

In IOS, Port forwarding is essentially a static NAT translation with a specified TCP or UDP port number.





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