Network Address Translation for IPv4

CCNA ROUTING & SWITCHING(200-125)

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IP Addressing in the LAN

- Reserved address space for private networks
- Private IPs are not routable on the Internet
- Consumer networking devices give out private IPs through DHCP

Class	Private IP Addresses (RFC 1918)	Default Subnet Mask	Number of Networks	Hosts per Network	Total Hosts
A	10.0.0.0 to 10.255.255.255	255.0.0.0	1	16,777,214	16,777,214
B	172.16.0.0 to 172.31.255.255	255.255.0.0	16	65,534	1,048,544
C	192.168.0.0 to 192.168.255.255	255.255.255.0	256	254	65,024

Network private addresses are described in RFC 1918 and are to designed to be used within an organization or site only.

Private networks have no connection to public networks

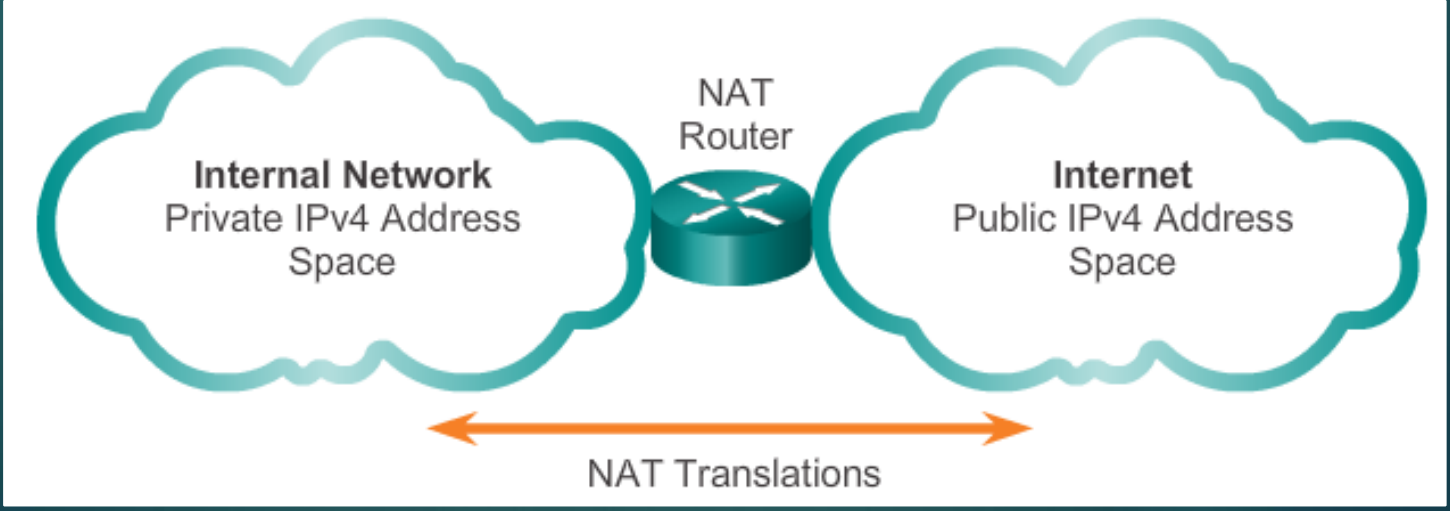
Private network addresses are not able to be routed across the Internet

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

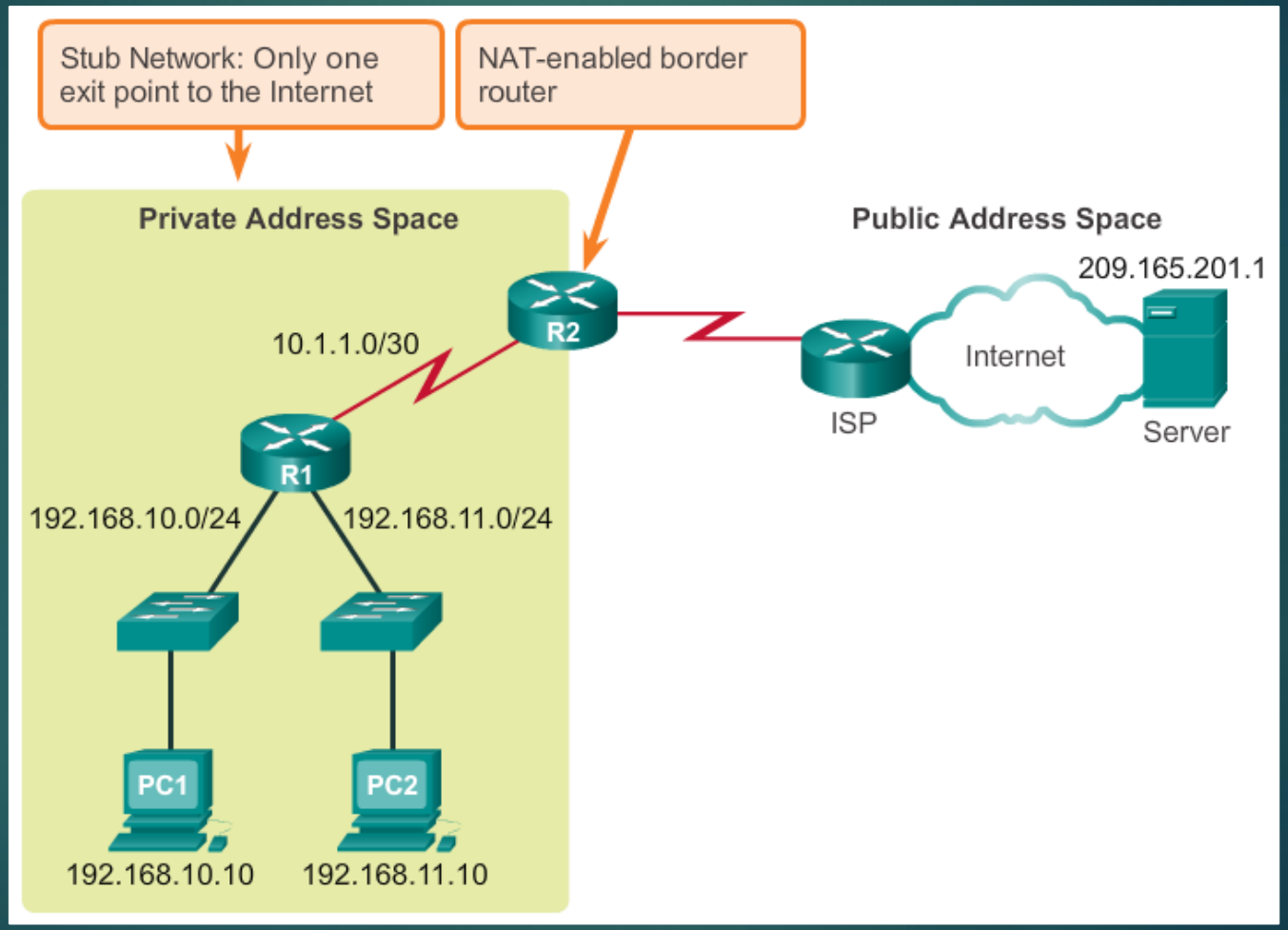
Private addresses can alleviate IPv4 scarcity, but because they aren't routed by Internet devices, they first need to be translated.
NAT is process used to perform such translation.



What is NAT?

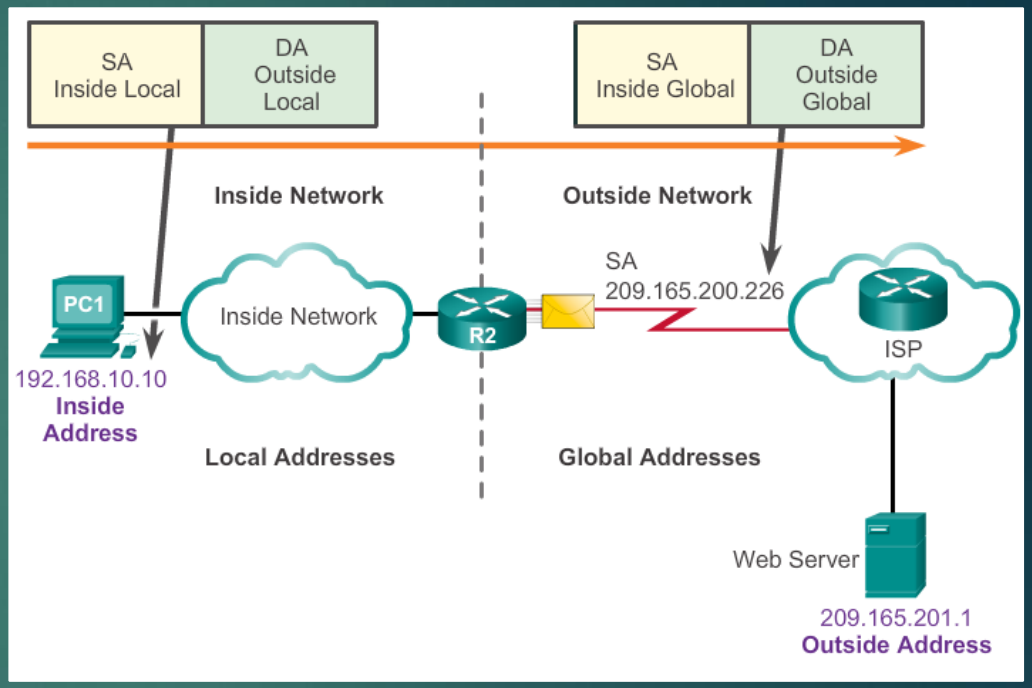
- NAT is a process used to translate network addresses.
- NAT's primary use is to conserve public IPv4 addresses.
- NAT is usually implemented at border network devices, such as firewalls or routers.
- NAT allows the networks to use private addresses internally, only translating to public addresses when 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.

What is NAT? (cont.)

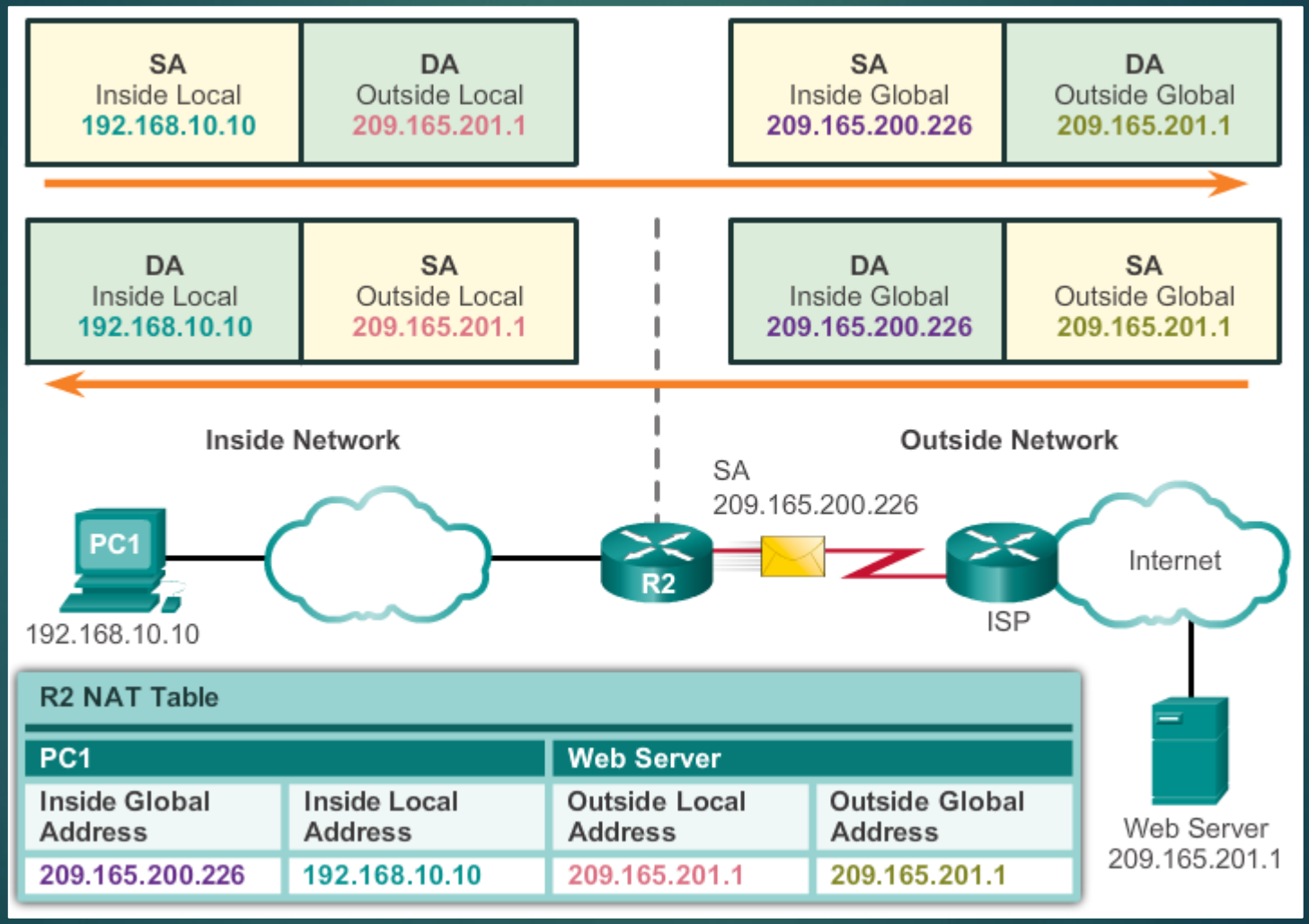


NAT Terminology

- 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



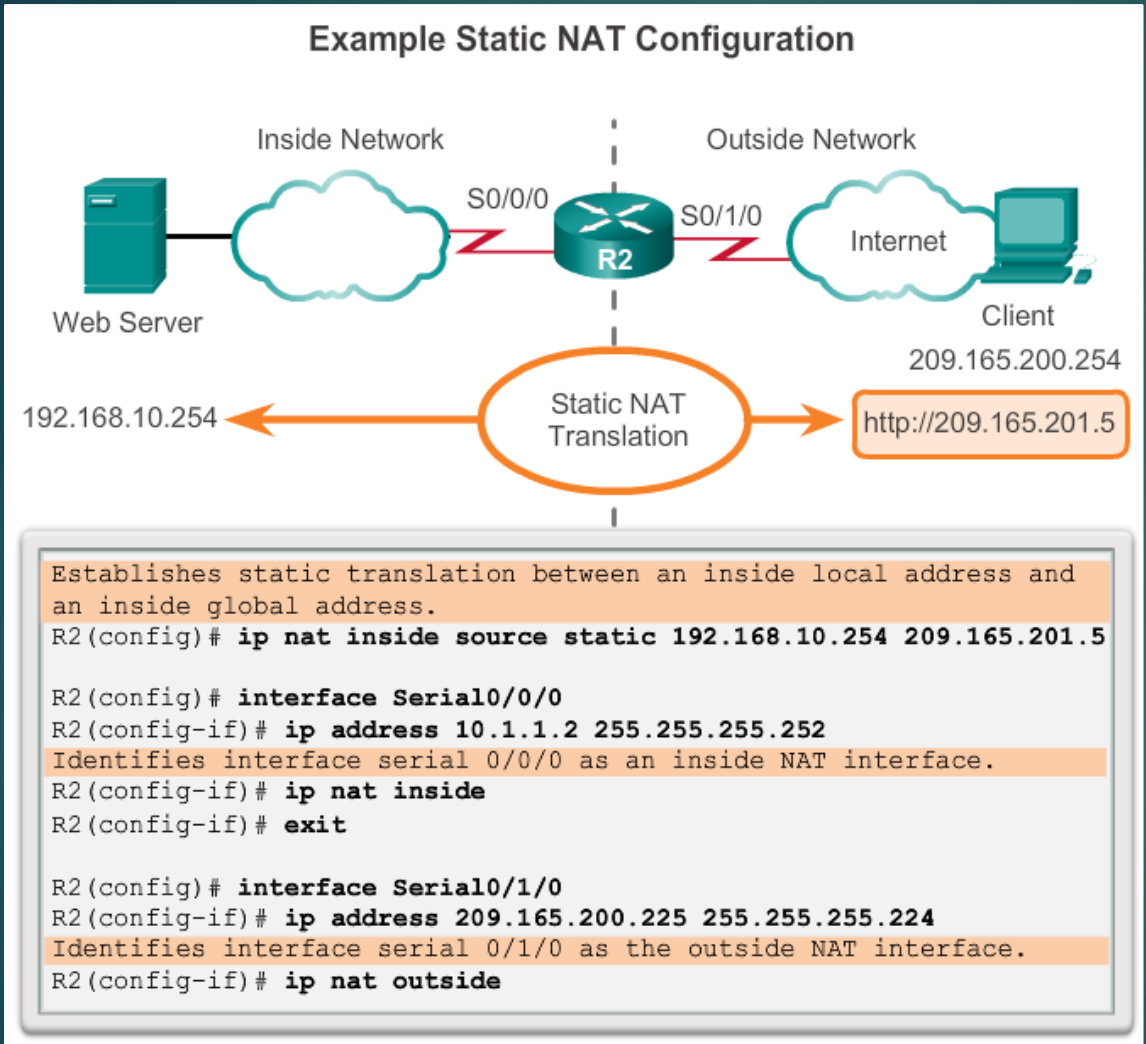
NAT Terminology (cont.)



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.

Configuring Static NAT




```
Establishes static translation between an inside local address and
an inside global address.
R2(config)# ip nat inside source static 192.168.10.254 209.165.201.5

R2(config)# interface Serial0/0/0
R2(config-if)# ip address 10.1.1.2 255.255.255.252
Identifies interface serial 0/0/0 as an inside NAT interface.
R2(config-if)# ip nat inside
R2(config-if)# exit

R2(config)# interface Serial0/1/0
R2(config-if)# ip address 209.165.200.225 255.255.255.224
Identifies interface serial 0/1/0 as the outside NAT interface.
R2(config-if)# ip nat outside
```

There are two basic tasks to perform when configuring static NAT translations:

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

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

Verifying Static NAT

The static translation is always present in the NAT table.

```
R2# show ip nat translations
Pro Inside global  Inside local   Outside local  Outside global
--- 209.165.201.5  192.168.10.254  ---            ---
R2#
```

The static translation during an active session.

```
R2# show ip nat translations
Pro Inside global Inside local   Outside local    Outside global
--- 209.165.201.5 192.168.10.254 209.165.200.254  209.165.200.254
R2#
```

Verifying Static NAT

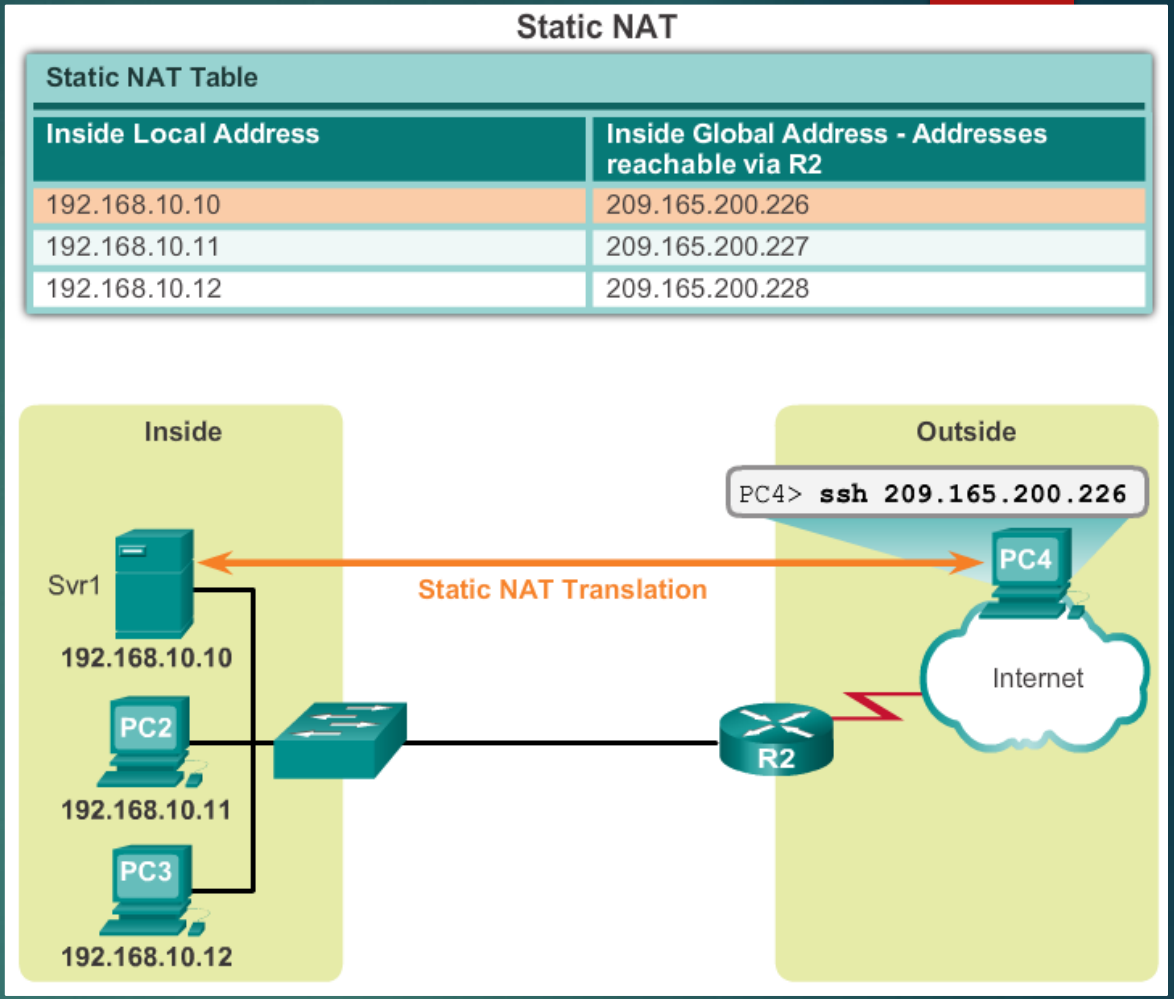
```
R2# clear ip nat statistics

R2# show ip nat statistics
Total active translations: 1 (1 static, 0 dynamic; 0 extended)
Peak translations: 0
Outside interfaces:
  Serial0/0/1
Inside interfaces:
  Serial0/0/0
Hits: 0  Misses: 0
<output omitted>
```

Client PC establishes a session with the web server

```
R2# show ip nat statistics
Total active translations: 1 (1 static, 0 dynamic; 0 extended)
Peak translations: 2, occurred 00:00:14 ago
Outside interfaces:
  Serial0/1/0
Inside interfaces:
  Serial0/0/0
Hits: 5  Misses: 0
<output omitted>
```

Static NAT



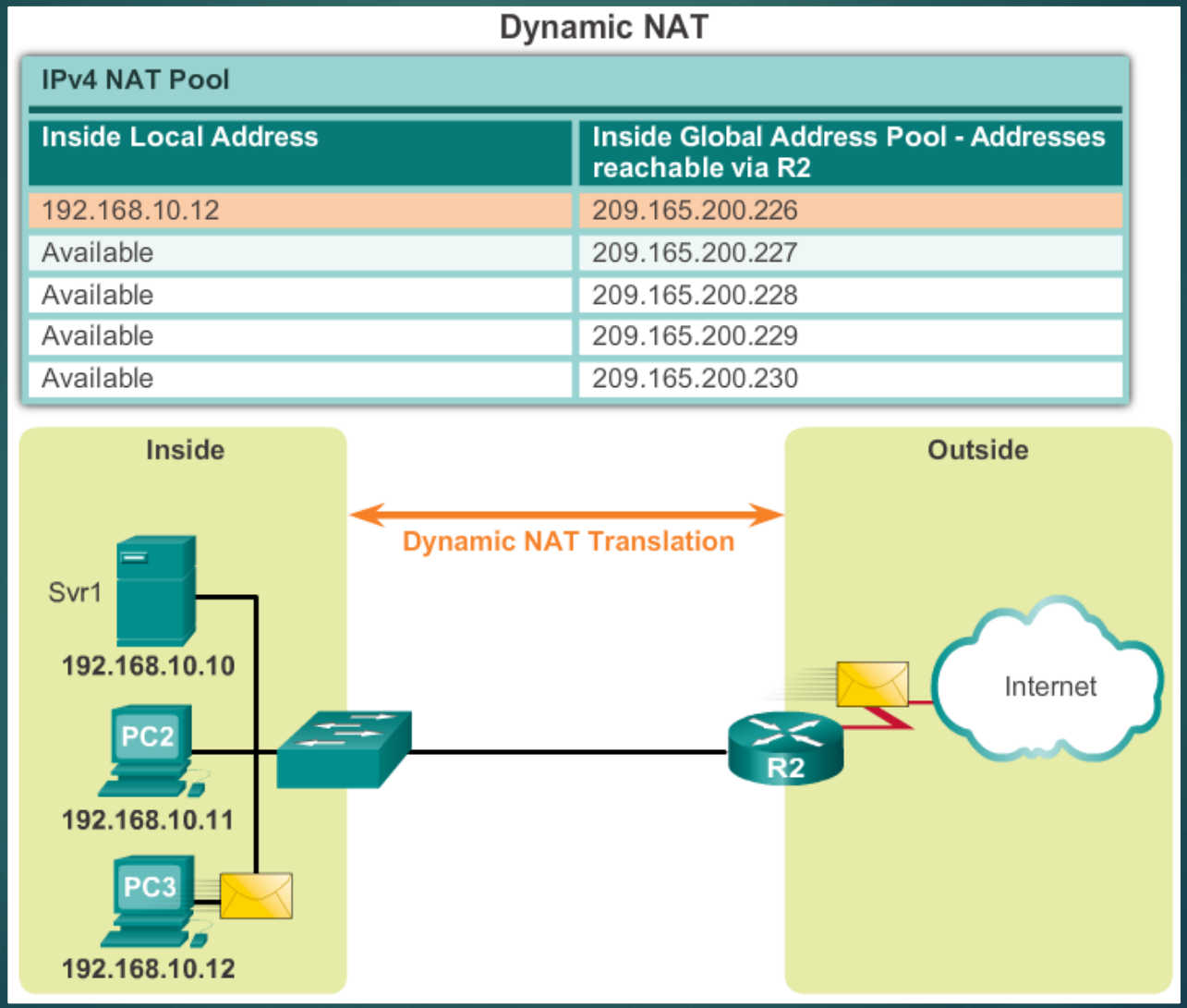
Static NAT allows hosts on the public network to access selected hosts on a private network
Ex – Web Servers

Both static and dynamic NAT can be configured at the same time, if necessary.

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.

Dynamic NAT

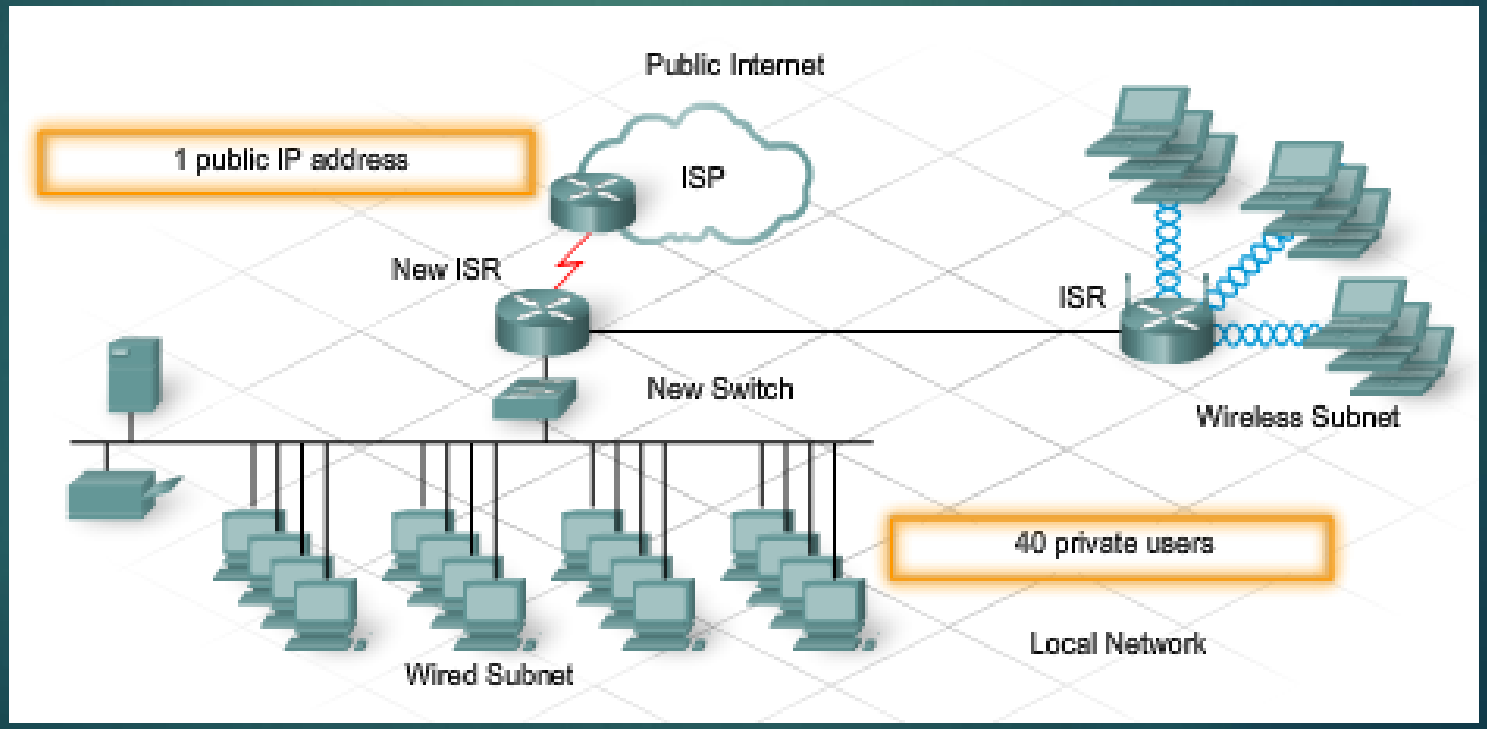

Dynamic NAT
IPv4 NAT Pool
Inside Local Address
Inside Global Address Pool - Addresses reachable via R2
192.168.10.12
209.165.200.226
Available
209.165.200.227
Available
209.165.200.228
Available
209.165.200.229
Available
209.165.200.230
Inside
Outside
Dynamic NAT Translation
Svr1
192.168.10.10
PC2
192.168.10.11
PC3
192.168.10.12
R2
Internet

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.

PAT

- PAT conversations use a unique temporary IP address and port number combination
- Port numbers above 1024
- Maximizes use of addresses and security



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.

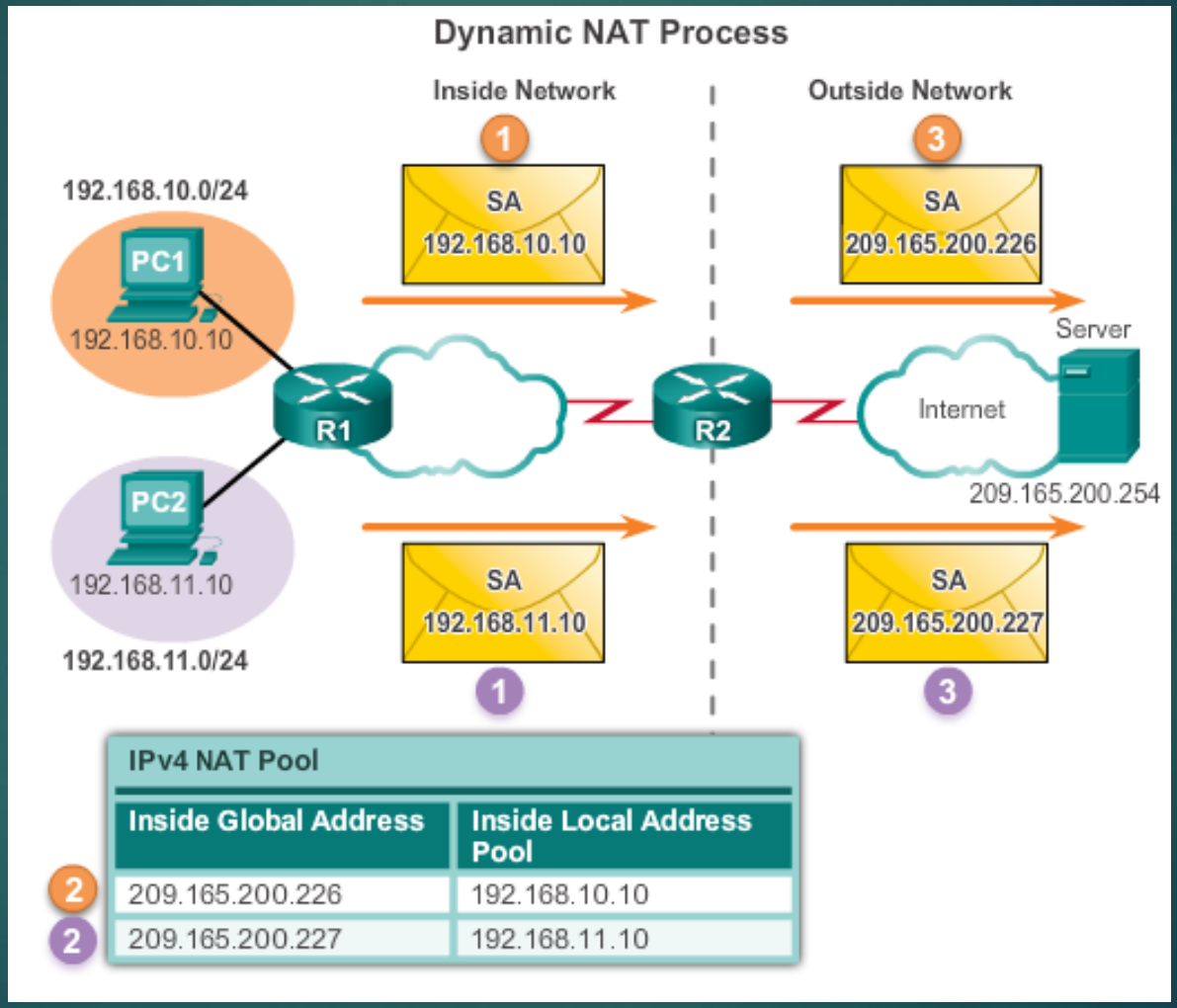
Dynamic NAT Operation

- 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.

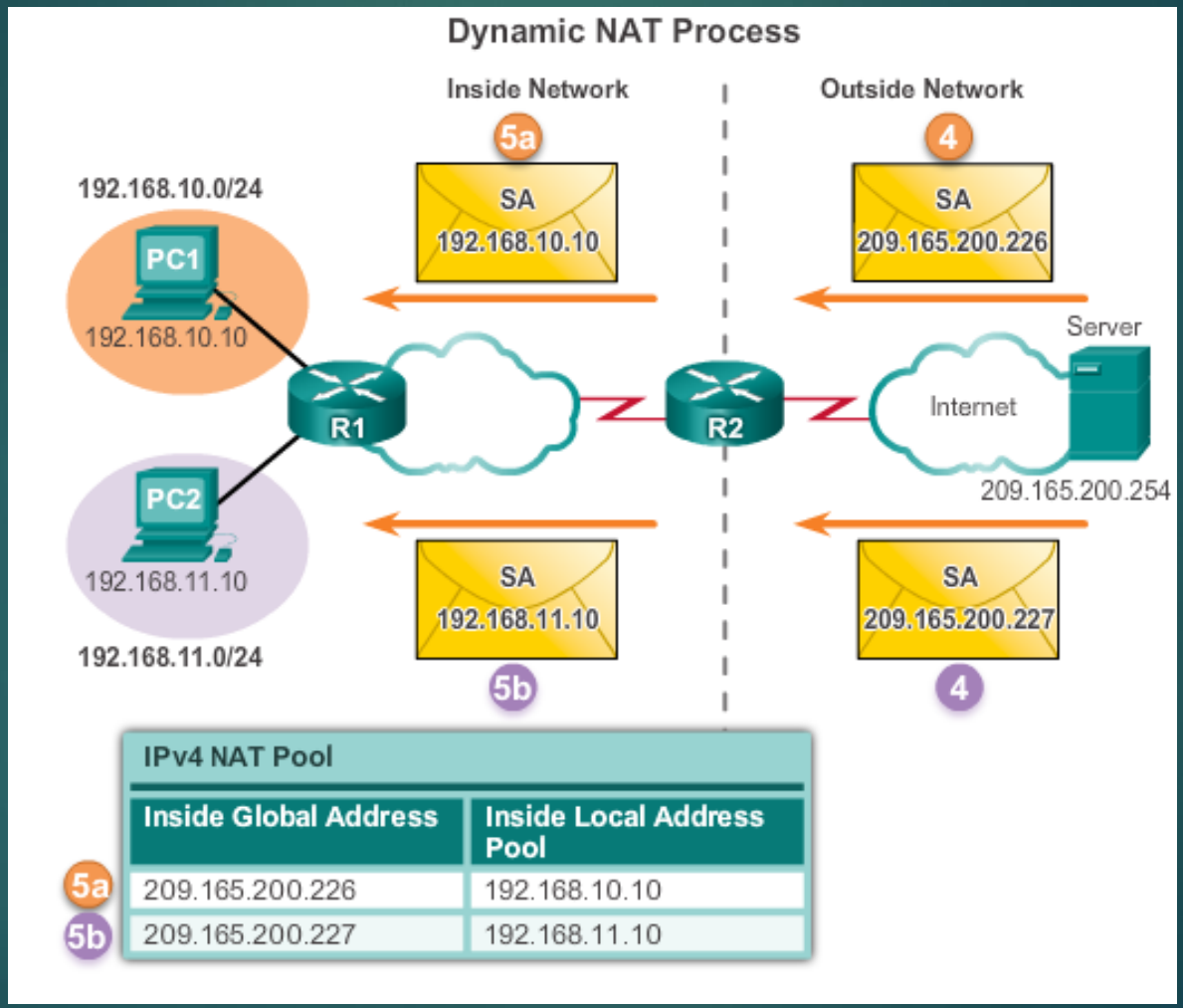
Configuring Dynamic NAT

Dynamic NAT Configuration Steps	
Step 1	Define a pool of global addresses to be used for translation. **ip nat pool** *name start-ip end-ip* {**netmask** *netmask* | **prefix-length** *prefix-length*}
Step 2	Configure a standard access list permitting the addresses that should be translated. **access-list** *access-list-number* **permit** *source*[*source-wildcard*]
Step 3	Establish dynamic source translation, specifying the access list and pool defined in prior steps. **ip nat inside source list** *access-list-number* **pool** *name*
Step 4	Identify the inside interface. **interface** *type number* **ip nat inside**
Step 5	Identify the outside interface. **interface** *type number* **ip nat outside**

Analyzing Dynamic NAT



Analyzing Dynamic NAT



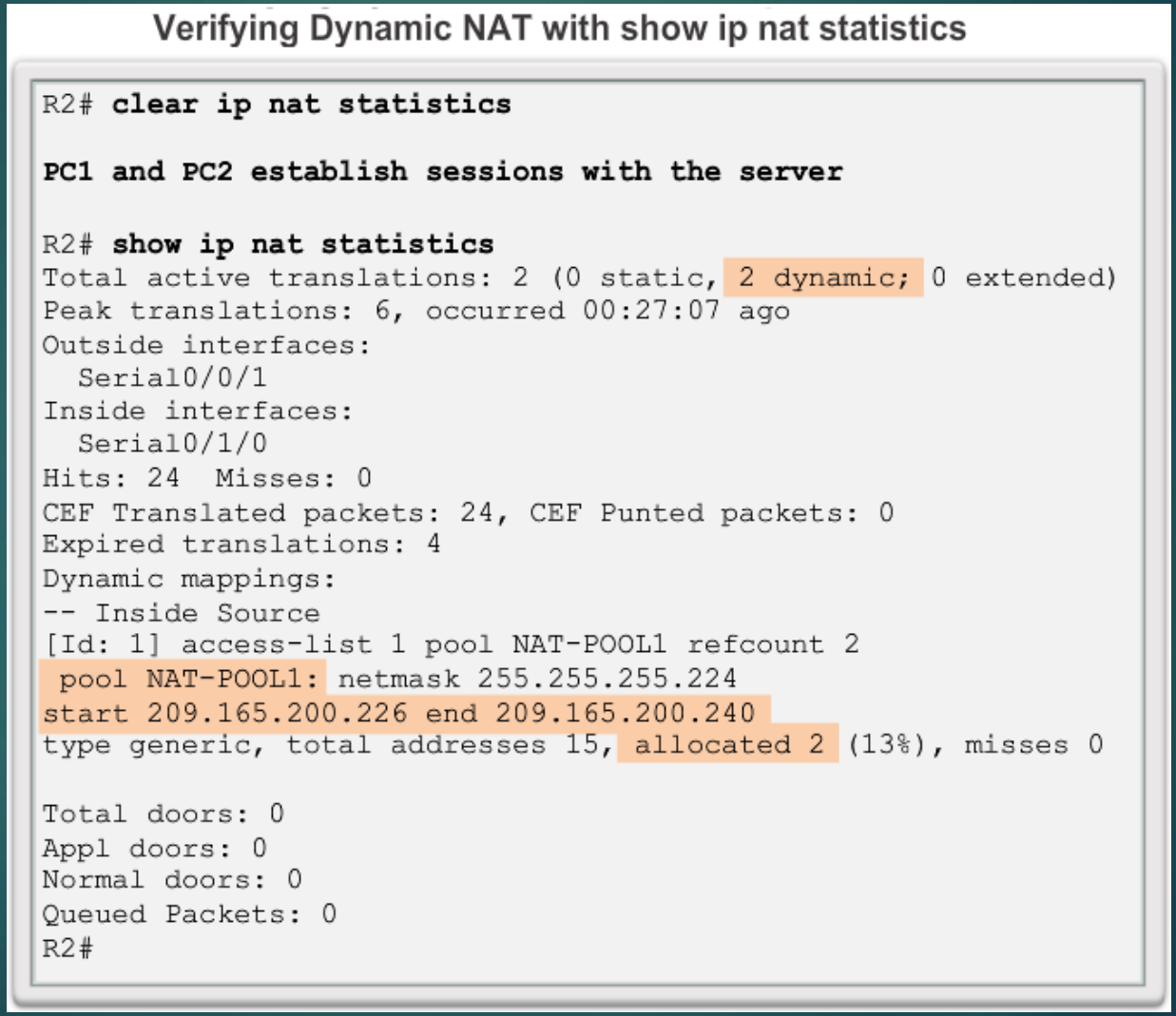
Configuring Dynamic NAT

Verifying Dynamic NAT

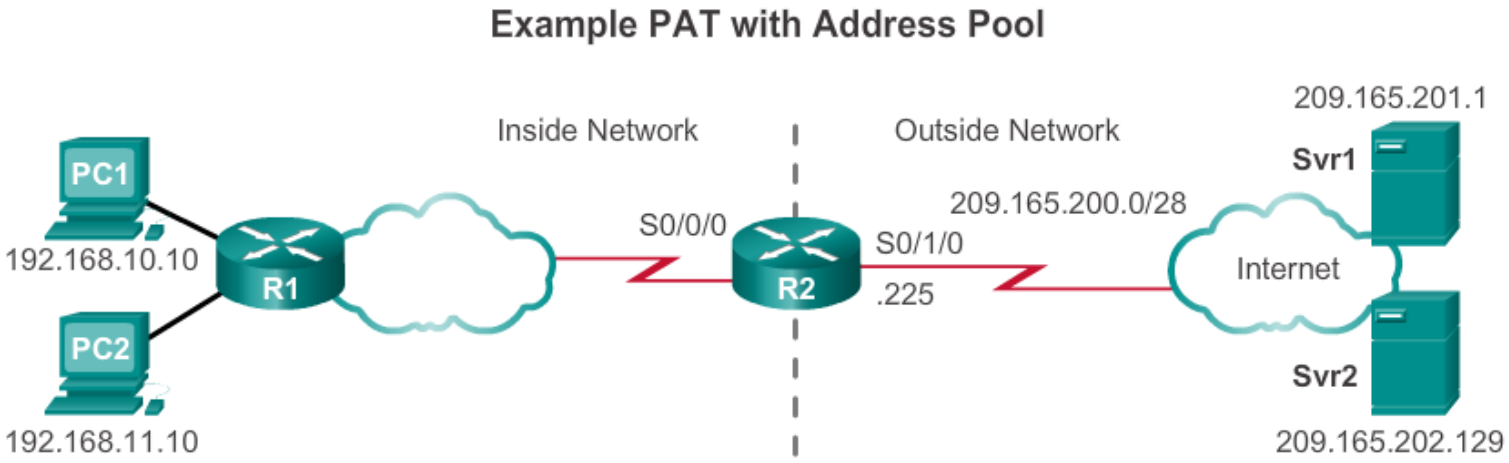
Verifying Dynamic NAT with show ip nat translations

```
R2# show ip nat translations
Pro Inside global     Inside local  Outside local Outside global
--- 209.165.200.226   192.168.10.10 ---           ---
--- 209.165.200.227   192.168.11.10 ---           ---
R2#
R2# show ip nat translations verbose
Pro Inside global     Inside local  Outside local Outside global
--- 209.165.200.226   192.168.10.10 ---           ---
    create 00:17:25, use 00:01:54 timeout:86400000, left
23:58:05, Map-Id(In): 1,
    flags:
none, use_count: 0, entry-id: 32, lc_entries: 0
--- 209.165.200.227    192.168.11.10      ---     ---
    create 00:17:22, use 00:01:51 timeout:86400000, left
23:58:08, Map-Id(In): 1,
    flags:
none, use_count: 0, entry-id: 34, lc_entries: 0
R2#
```

Verifying Dynamic NAT



Configuring PAT: Address Pool



Define a pool of public IPv4 addresses under the pool name NAT-POOL2.
R2(config)# **ip nat pool NAT-POOL2 209.165.200.226 209.165.200.240 netmask 255.255.255.224**
Define which addresses are eligible to be translated.
R2(config)# **access-list 1 permit 192.168.0.0 0.0.255.255**
Bind NAT-POOL2 with ACL 1.
R2(config)# **ip nat inside source list 1 pool NAT-POOL2 overload**

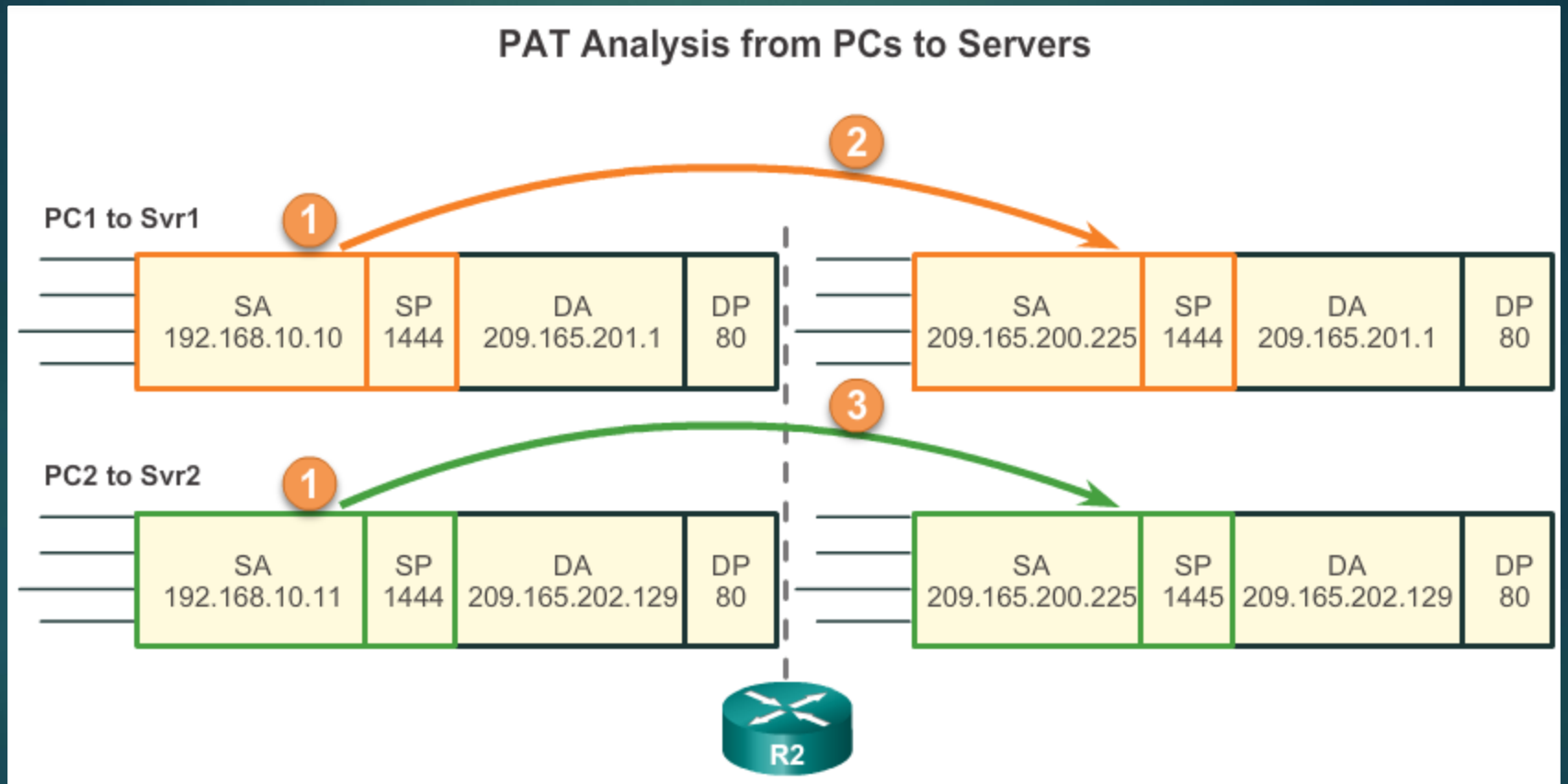
Identify interface serial 0/0/0 as an inside NAT interface.
R2(config)# **interface Serial0/0/0**
R2(config-if)# **ip nat inside**

Identify interface serial 0/1/0 as the outside NAT interface.
R2(config)# **interface Serial0/1/0**
R2(config-if)# **ip nat outside**

Configuring PAT: Single Address

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

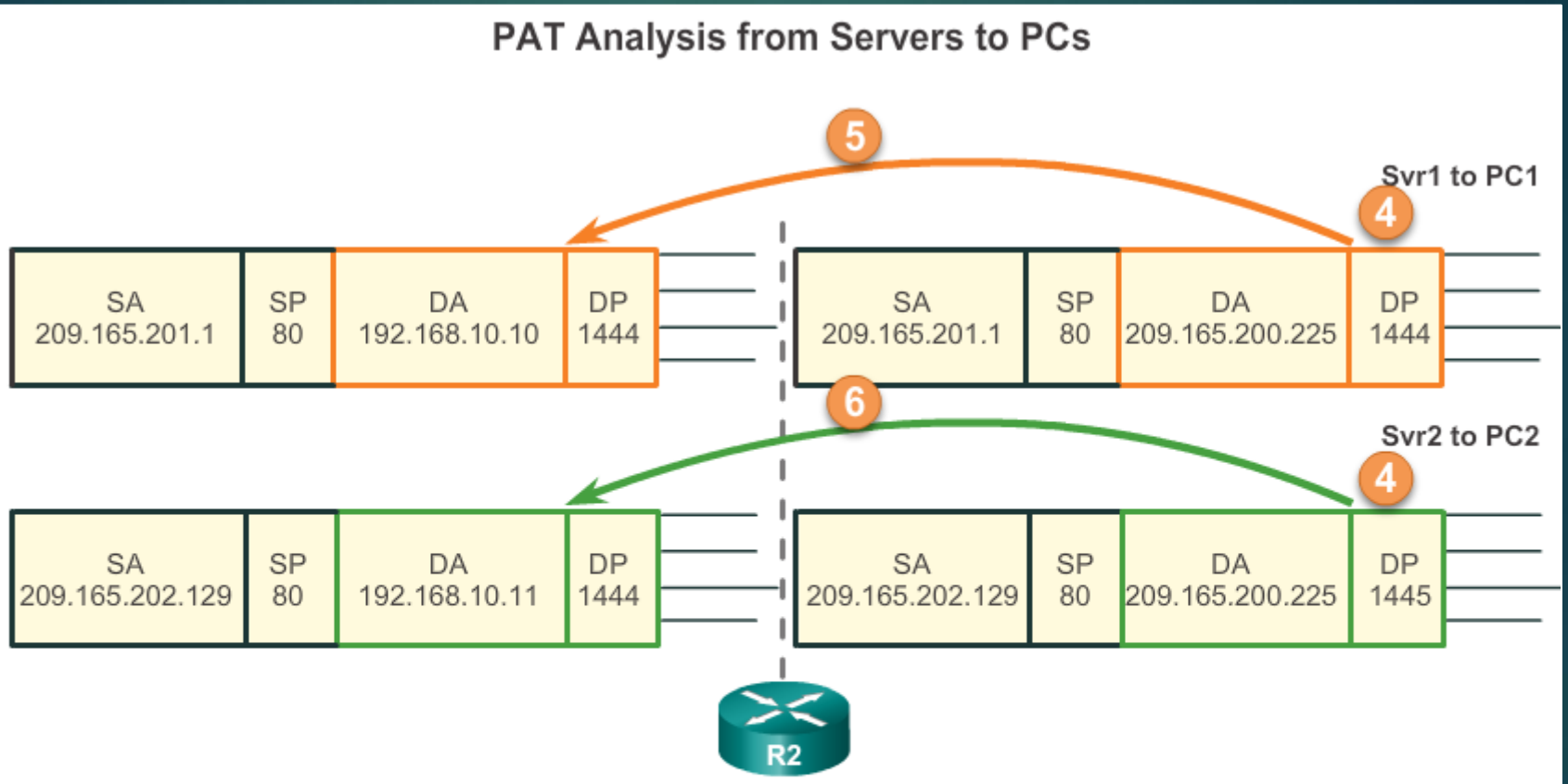
Analyzing PAT



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

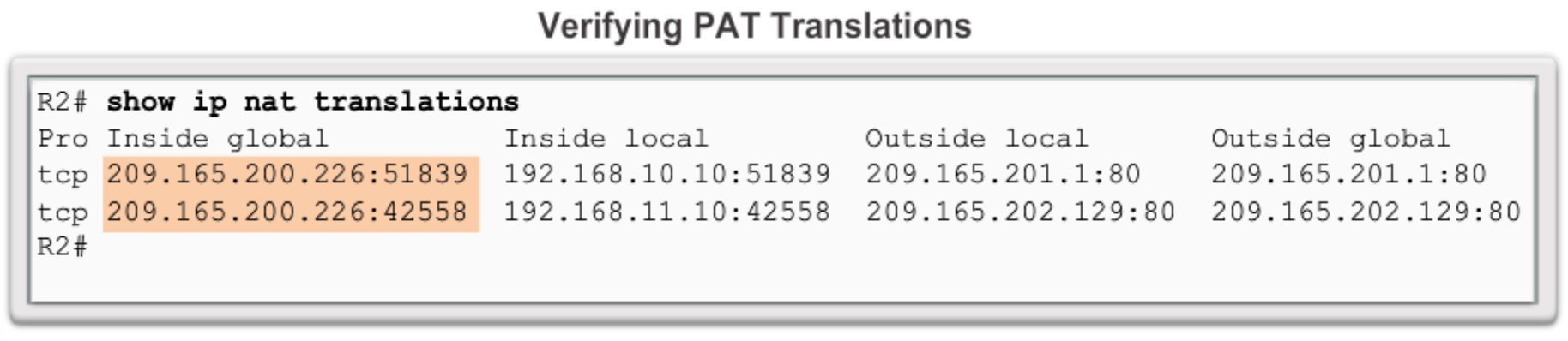
Analyzing PAT



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

Verifying PAT Translations



Troubleshooting NAT: show commands

```
R2# clear ip nat statistics
R2# clear ip nat translation *
R2#
```

Host 192.168.10.10 telnets to server at 209.165.201.1

```
R2# show ip nat statistics
Total active translations: 1 (0 static, 1 dynamic; 1 extended)
Peak translations: 1, occurred 00:00:09 ago
Outside interfaces:
  Serial0/0/1
Inside interfaces:
  Serial0/0/0
Hits: 31  Misses: 0
CEF Translated packets: 31, CEF Punted packets: 0
Expired translations: 0
Dynamic mappings:
-- Inside Source
[Id: 5] access-list 1 pool NAT-POOL2 refcount 1
 pool NAT-POOL2: netmask 255.255.255.224
start 209.165.200.226 end 209.165.200.240
type generic, total addresses 15, allocated 1 (6%), misses 0
```

<output omitted>

```
R2# show ip nat translations
Pro Inside global          Inside local         Outside local      Out
tcp 209.165.200.226:19005 192.168.10.10:19005  209.165.201.1:23   209
R2#
```

Troubleshooting NAT: debug command

```
R2# debug ip nat
IP NAT debugging is on
R2#
*Feb 15 20:01:311.670: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2817]
*Feb 15 20:01:311.682: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4180]
*Feb 15 20:01:311.698: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2818]
*Feb 15 20:01:311.702: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2819]
*Feb 15 20:01:311.710: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2820]
*Feb 15 20:01:311.710: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4181]
*Feb 15 20:01:311.722: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4182]
*Feb 15 20:01:311.726: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2821]
*Feb 15 20:01:311.730: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4183]
*Feb 15 20:01:311.734: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2822]
*Feb 15 20:01:311.734: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4184]
output omitted
```

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

Disadvantages of NAT

- Performance is degraded
- End-to-end functionality is degraded
- End-to-end IP traceability is lost
- Tunneling is more complicated