

CHAPTER 11

NETWORK ADDRESS TRANSLATION UNTUK IPV4

Routing & Switching

CHAPTER 11

11.1 NAT Operation

11.2 Configuring NAT

11.3 Troubleshooting NAT

11.4 Summary

CHAPTER 11: OBJECTIVES

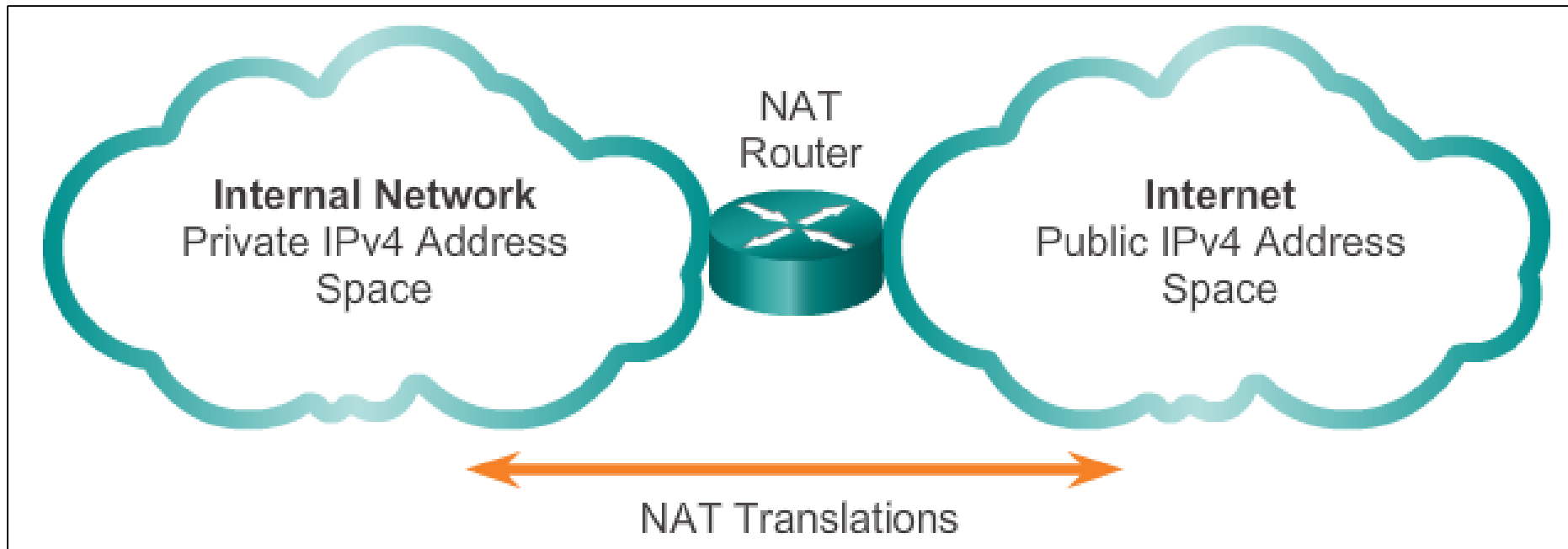
- Describe NAT characteristics.
- Describe the benefits and drawbacks of NAT.
- Configure static NAT using the CLI.
- Configure dynamic NAT using the CLI.
- Configure PAT using the CLI.
- Configure port forwarding using the CLI.
- Configure NAT64.
- Use **show** commands to verify NAT operation.

11.1 NAT OPERATION

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.

APA ITU NAT?



- NAT adalah metode translasi IP Private menjadi IP Public. Bertujuan agar dapat berkomunikasi dengan internet maka harus terintegrasi dengan IP Public

APA TUJUAN NAT?

- Mengurangi keterbatasan IPv4
- Menyembunyikan skema network internal

TERMINOLOGI NAT

- Inside Local Address : source address sebelum translasi (IP Private)
- Outside Local Address : destination address sebelum translasi (IP Private)
- Inside Global Address : inside host setelah translasi (IP Public)
- Outside Global Address : outside destination host setelah translasi (IP Public)

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

APA ITU IP PRIVATE?

IP PRIVATE

- IP yang digunakan oleh organisasi secara internal dan tidak dapat dirutekan di internet.
- Perusahaan kecil biasanya mendapatkan IP Public dari ISP
- ISP Mendapatkan Alokasi IP Public dari IANA (internasional Assigned Numbers Authority)
- Device yang dapat melakukan translasi biasanya firewall,router,server

IP PRIVATE

Class	Range
A	10.0.0.0 – 10.255.255.255
B	172.16.0.0 -172.31.255.255
C	192.168.0.0 – 192.168.255.255

CARI HIERARKI ISP DI INDONESIA?

KEUNTUNGAN NAT

- Menghemat alamat IP secara legal
- Mengurangi overlap pengalamatan
- Meningkatkan fleksibilitas ketika berkomunikasi ke internet
- Mengurangi penomoran kembali jika terjadi perubahan jaringan

KERUGIAN NAT

- Terdapat delay pada proses switching
- Tidak dapat melakukan trace end-to-end IP
- Terdapat beberapa aplikasi yang tidak berfungsi ketika implementasi NAT

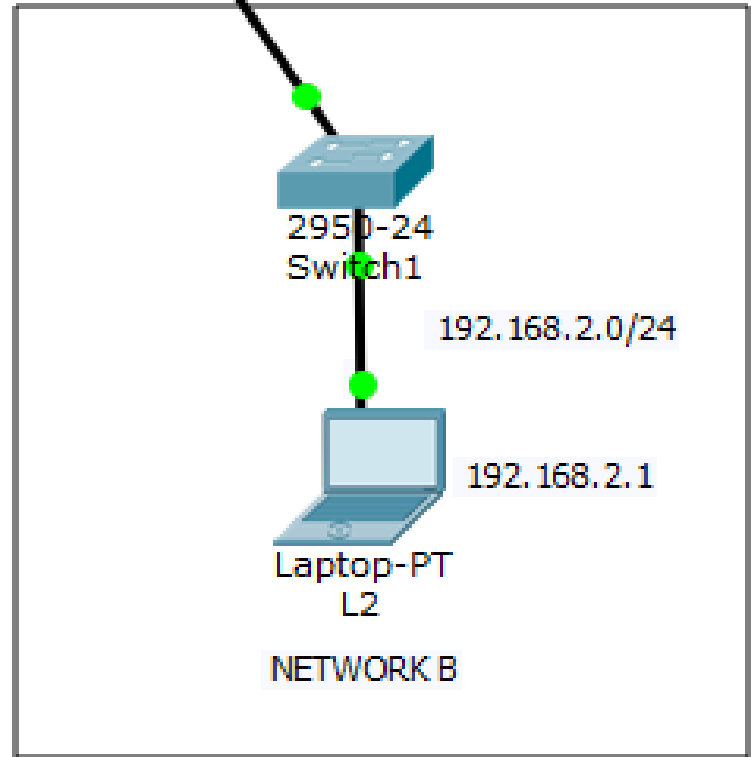
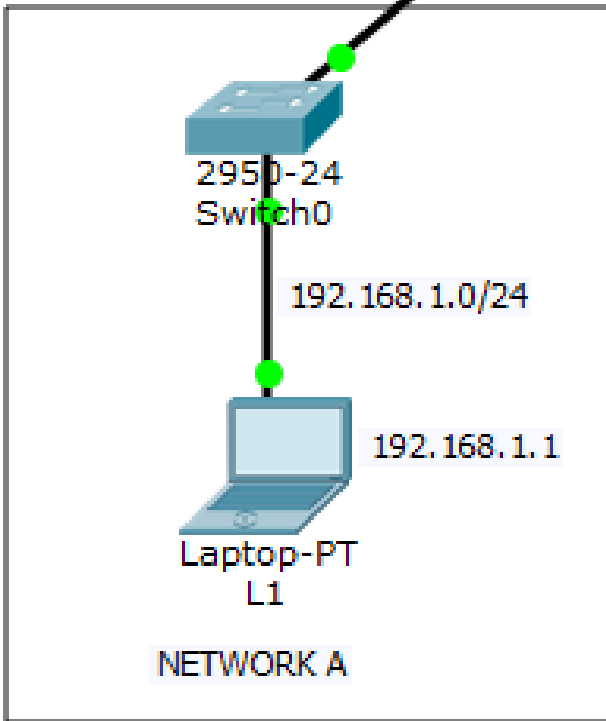
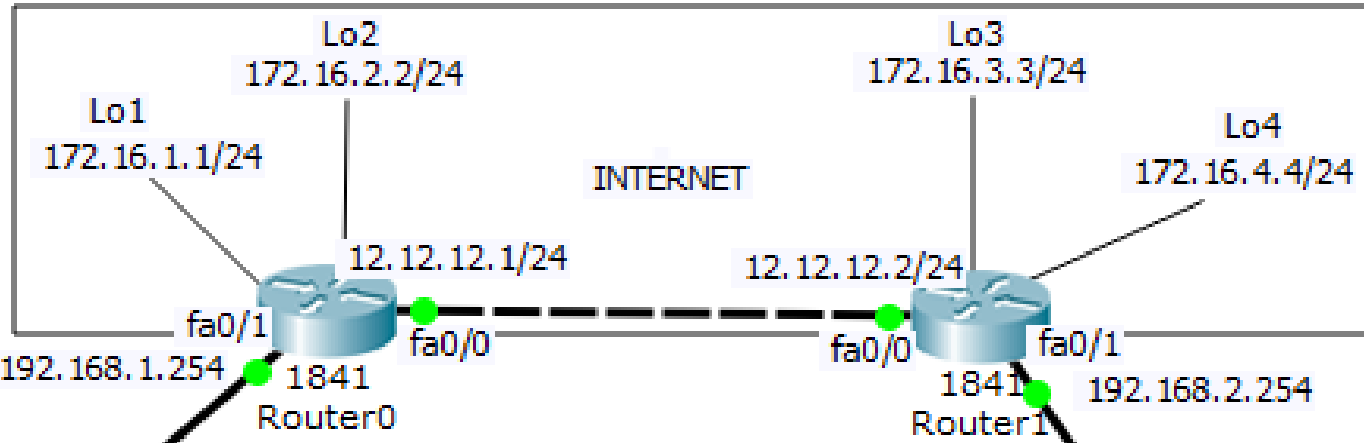
TIPE NAT

- NAT Static
- NAT Dynamic
- PAT (Port Address Translation)

NAT STATIC

- Termasuk jenis one-to-one NAT, satu IP private ditranslate menjadi satu IP public.
- Ingat, untuk NAT static tiap host menggunakan IP public sendiri
- Bisa inisiasi komunikasi dari jaringan outside global

KONFIGURASI NAT STATIC



AREA 0

TABEL IP

Perangkat	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.254	255.255.255.0	N/A
	Fa0/1	12.12.12.1	255.255.255.0	N/A
	Lo1	172.16.1.1	255.255.255.0	N/A
	Lo2	172.16.2.2	255.255.255.0	N/A
R2	Fa0/0	192.168.2.254	255.255.255.0	N/A
	Fa0/1	12.12.12.2	255.255.255.0	N/A
	Lo3	172.16.3.3	255.255.255.0	N/A
	Lo4	172.16.4.4	255.255.255.0	N/A
1	N/A	VLAN 1	N/A	N/A
2	N/A	VLAN 1	N/A	N/A
laptop 1	NIC	192.168.1.1	255.255.255.0	192.168.1.254
laptop 2	NIC	192.168.2.1	255.255.255.0	192.168.2.254

TABEL NAT R1

Private IP	Public IP
192.168.1.1	12.12.12.11
192.168.1.2	12.12.12.22
192.168.1.3	12.12.12.33

TABEL NAT R2

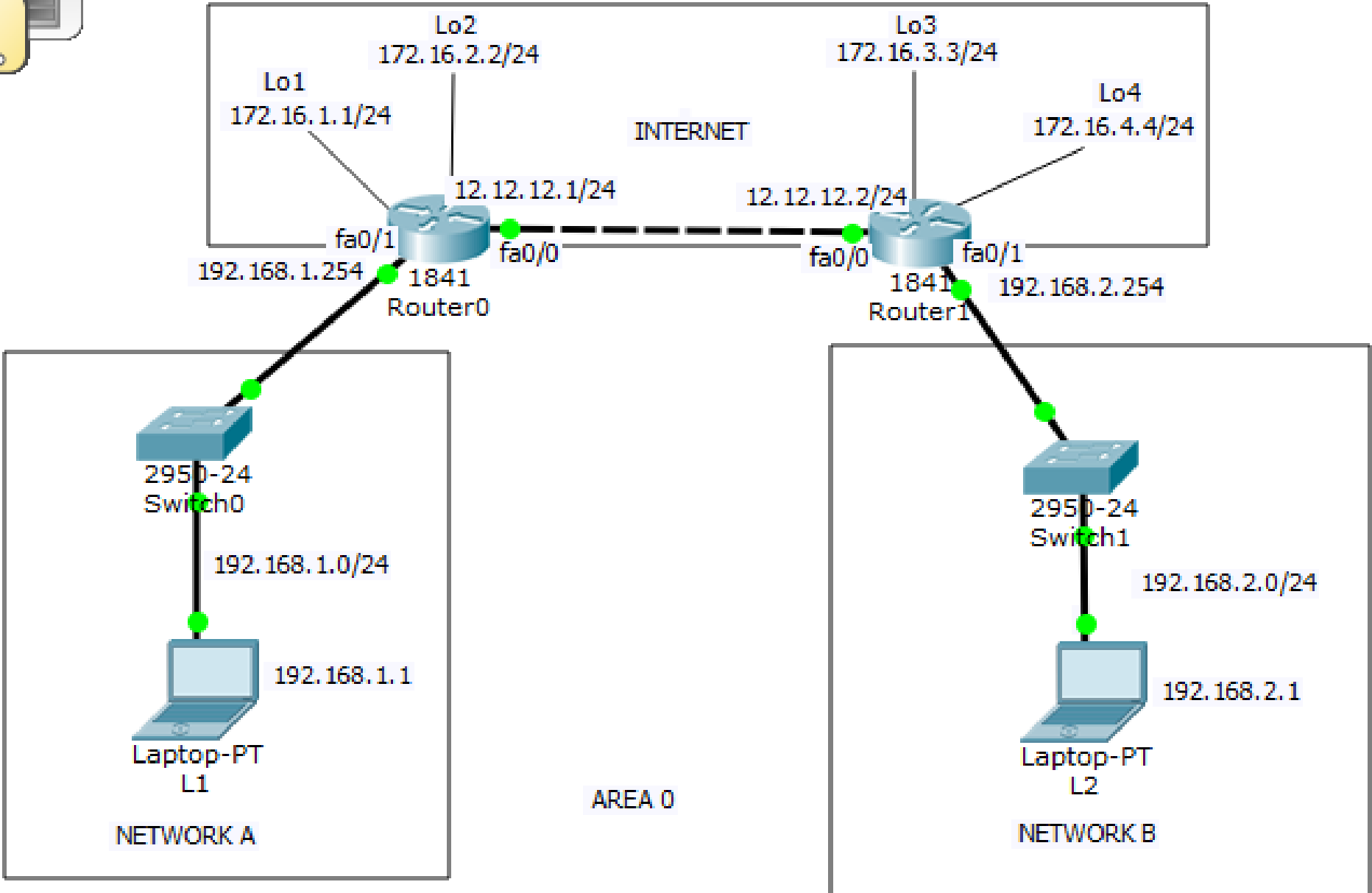
Private IP	Public IP
192.168.2.1	12.12.12.44
192.168.2.2	12.12.12.55
192.168.2.3	12.12.12.66

LANGKAH-LANGKAH

- Tentukan interface NAT inside
- Tentukan interface NAT outside
- Buat translasi NAT dari source Private IP ke destination Public IP

NAT DYNAMIC

- Termasuk tipe many to many NAT, IP private dalam jumlah banyak kemudian ditranslate menjadi IP public yang banyak juga dengan menyediakan sebuah pool IP public
- Tidak perlu melakukan translate satu per satu, cukup sediakan IP Public sesuai dengan jumlah user yang akan terkoneksi ke internet



TABEL IP

Perangkat	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.254	255.255.255.0	N/A
	Fa0/1	12.12.12.1	255.255.255.0	N/A
	Lo1	172.16.1.1	255.255.255.0	N/A
	Lo2	172.16.2.2	255.255.255.0	N/A
R2	Fa0/0	192.168.2.254	255.255.255.0	N/A
	Fa0/1	12.12.12.2	255.255.255.0	N/A
	Lo3	172.16.3.3	255.255.255.0	N/A
	Lo4	172.16.4.4	255.255.255.0	N/A
1	N/A	VLAN 1	N/A	N/A
2	N/A	VLAN 1	N/A	N/A
laptop 1	NIC	192.168.1.1	255.255.255.0	192.168.1.254
laptop 2	NIC	192.168.2.1	255.255.255.0	192.168.2.254

POOL NAT R1

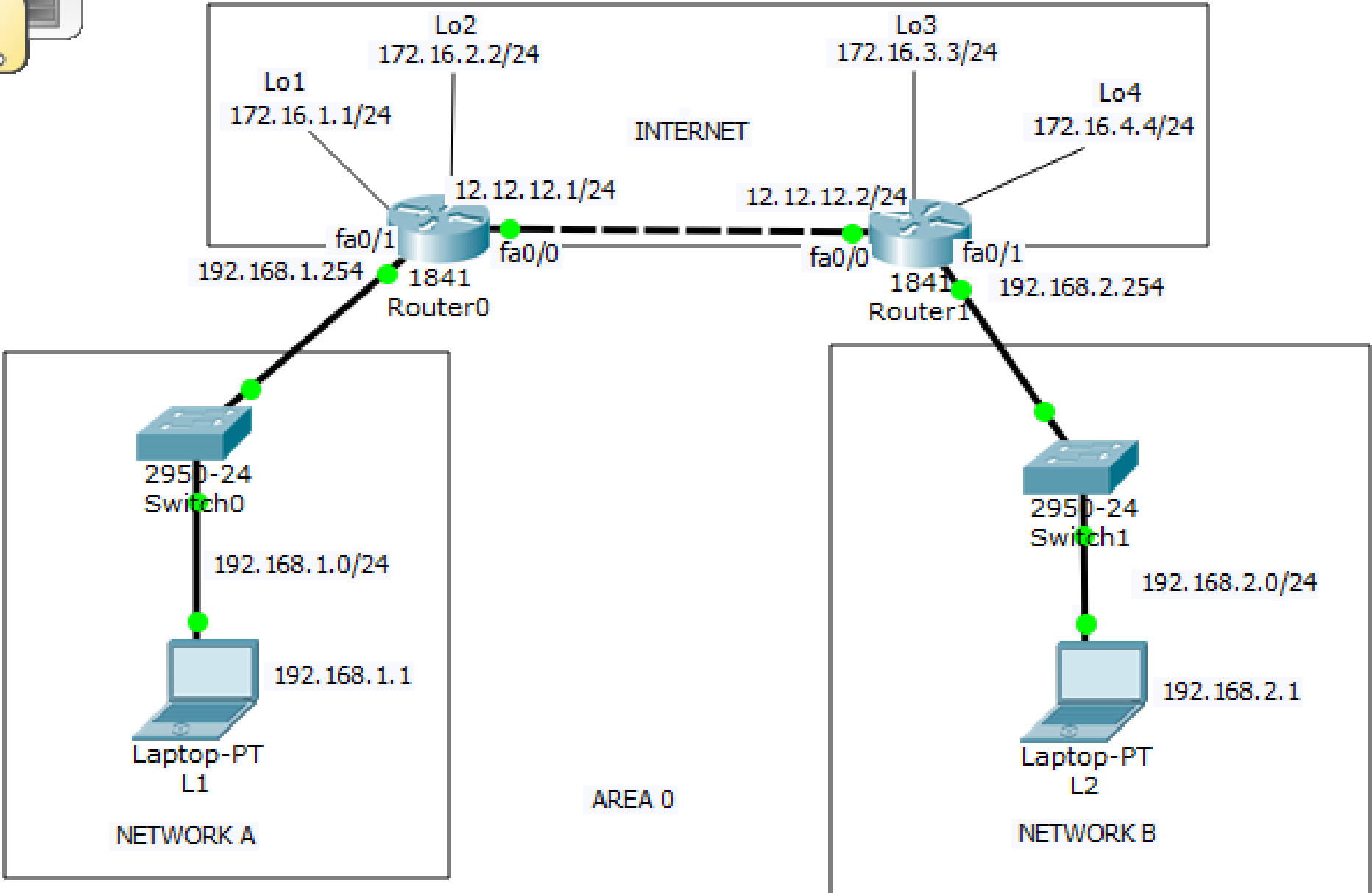
Private IP (ACL 1)	Public IP (POOLR1)
192.168.1.0/24	12.12.12.11-12.12.12.20

POOL NAT R2

Private IP (ACL 1)	Public IP (POOLR1)
192.168.2.0/24	12.12.12.21-12.12.12.30

NAT DYNAMIC OVERLOAD (PAT)

- Tipe nat paling populer
- Termasuk tipe many to one NAT
- Dengan menyediakan satu IP public dapat mentranslasi Ip private yang banyak dengan menggunakan pembeda port.
- Disebut juga sebagai NAT dynamic overload , Port Address Translation



TABEL IP

Perangkat	Interface	IP Address	Subnet Mask	Default Gateway
R1	Fa0/0	192.168.1.254	255.255.255.0	N/A
	Fa0/1	12.12.12.1	255.255.255.0	N/A
	Lo1	172.16.1.1	255.255.255.0	N/A
	Lo2	172.16.2.2	255.255.255.0	N/A
R2	Fa0/0	192.168.2.254	255.255.255.0	N/A
	Fa0/1	12.12.12.2	255.255.255.0	N/A
	Lo3	172.16.3.3	255.255.255.0	N/A
	Lo4	172.16.4.4	255.255.255.0	N/A
1	N/A	VLAN 1	N/A	N/A
2	N/A	VLAN 1	N/A	N/A
laptop 1	NIC	192.168.1.1	255.255.255.0	192.168.1.254
laptop 2	NIC	192.168.2.1	255.255.255.0	192.168.2.254

POOL NAT R1

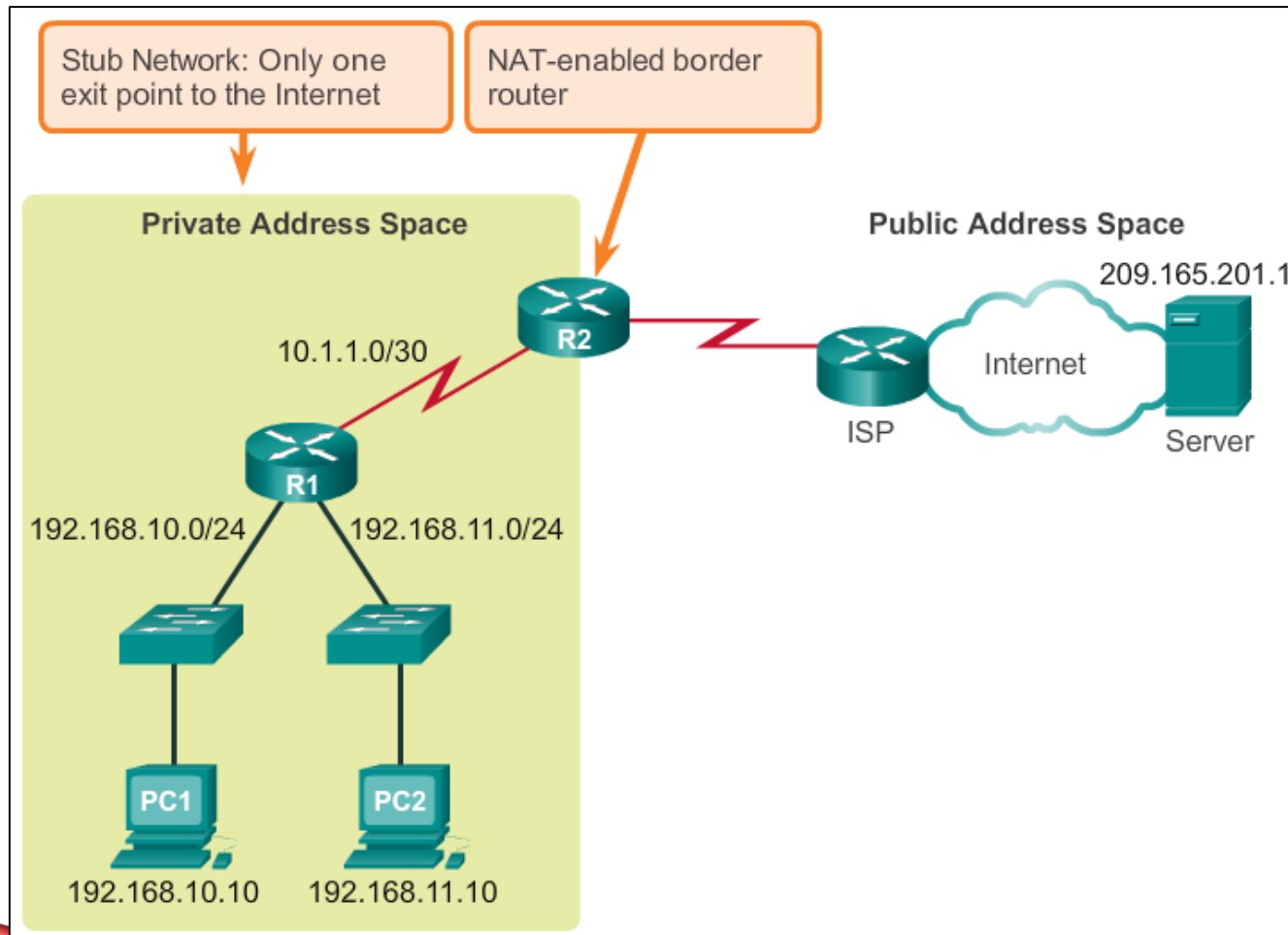
Private IP (ACL 1)	Public IP (POOLR1)
192.168.1.0/24	12.12.12.11

POOL NAT R2

Private IP (ACL 1)	Public IP (POOLR1)
192.168.2.0/24	12.12.12.22

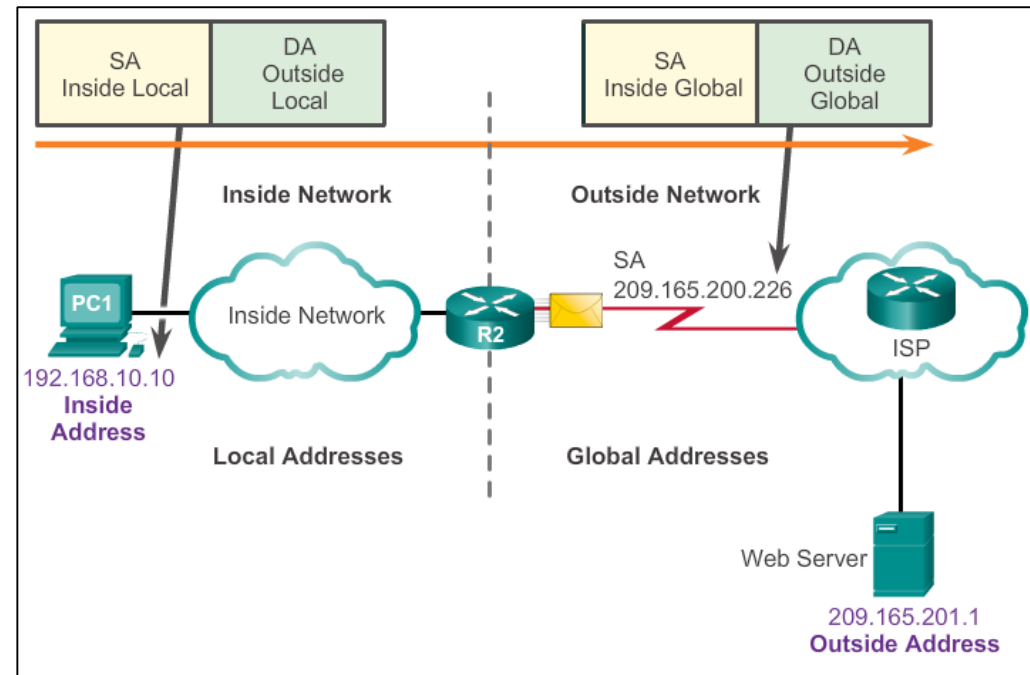
NAT CHARACTERISTICS

WHAT IS NAT? (CONT.)



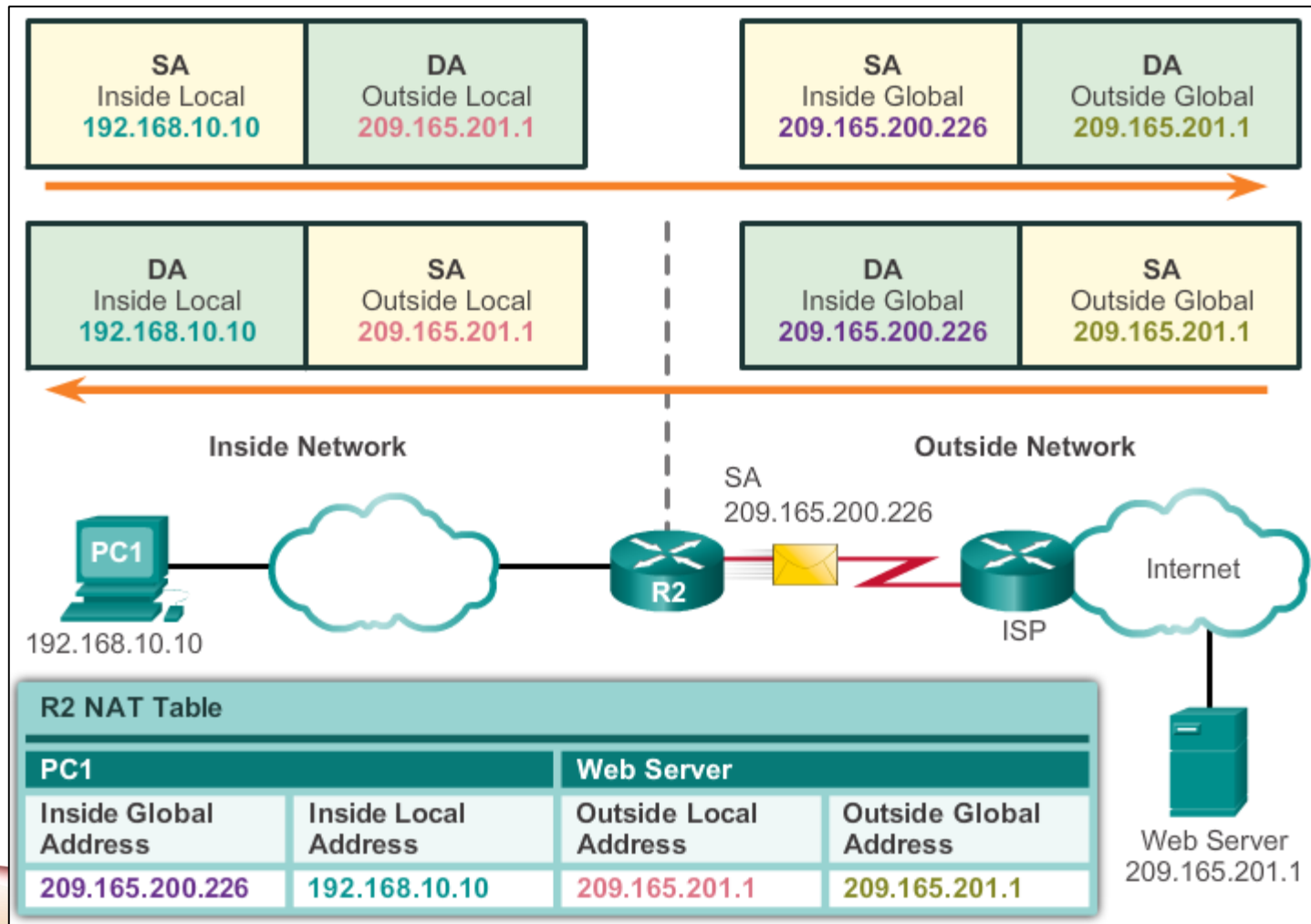
NAT TERMINOLOGY

- 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 CHARACTERISTICS

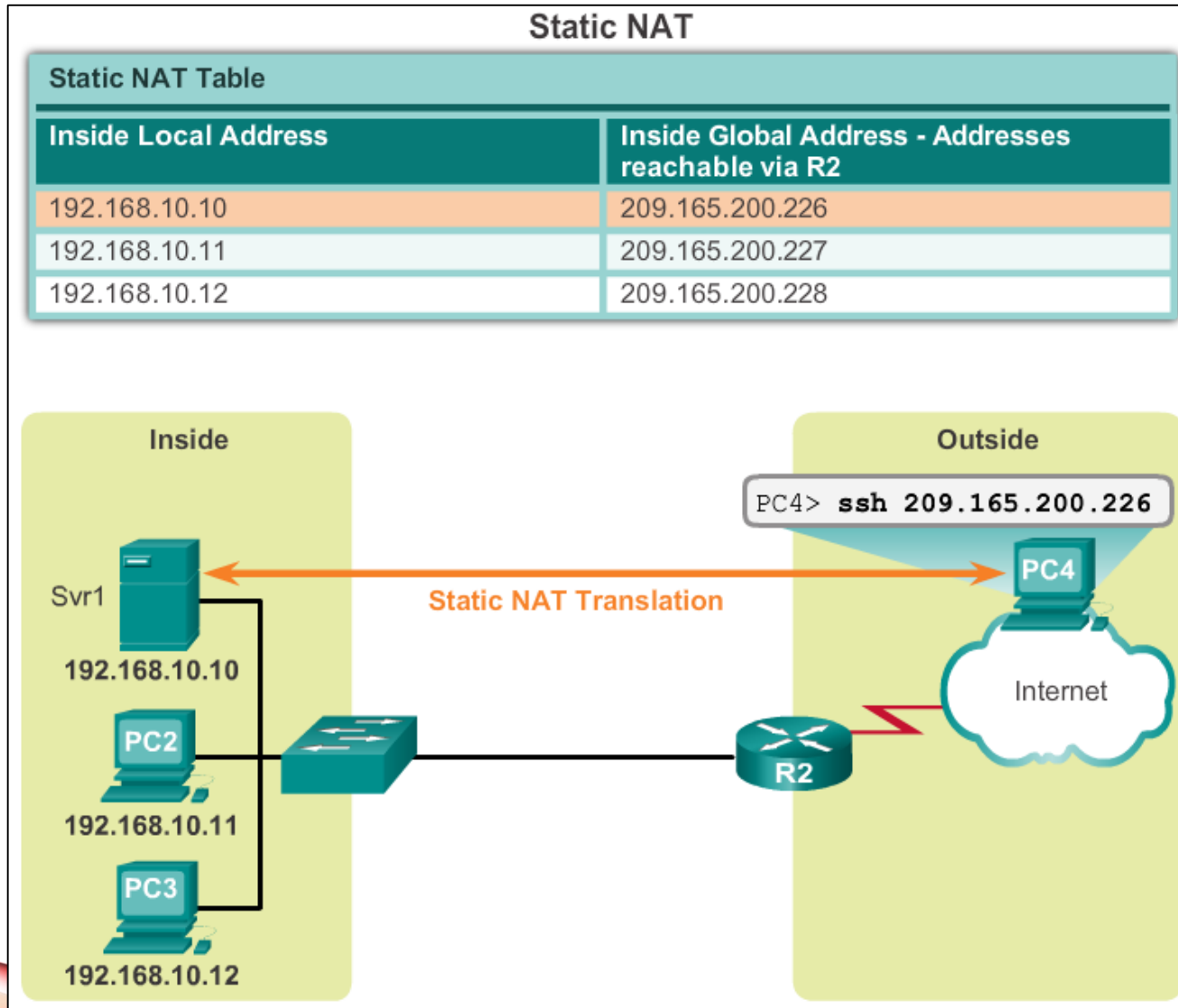
NAT TERMINOLOGY (CONT.)



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.

STATIC NAT (CONT.)



TYPES OF NAT
DYNAMIC NAT

CONFIGURATION

DYNAMIC NAT

- Termasuk many-to-many NAT , dimana IP Private jumlah banyak kemudian ditranslasikan menjadi IP public dalam jumlah banyak juga dengan menyediakan sebuah pool IP public
- Tidak perlu memerlukan translate satu per satu, cukup sediakan IP public sejumlah user yang terkoneksi ke internet.

POOL NAT R1 DAN R2

Private IP (ACL 1)	Public IP (Pool R1)
192.168.1.0/24	12.12.12.11-12.12.12.20

Private IP (ACL 1)	Public IP (Pool R2)
192.168.2.0/24	12.12.12.21-12.12.12.30

LANGKAH-LANGKAH

- Tentukan interface NAT inside
- Tentukan interface NAT outside
- Tentukan permit ACL Private Network
- Tentukan pool Public IP
- Buat translasi NAT dari source ACL ke destination pool Public IP

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.

PAT

CONFIGURATION

NAT DYNAMIC OVERLOAD (PAT)

- Tipe NAT yang paling populer
- Termasuk tipe many-to-one NAT
- Dengan menyediakan satu IP public dapat mentranslate IP private yang banyak dengan menggunakan pembeda yaitu port
- Disebut juga sebagai NAT Dynamic Overload, Port Address Translation (PAT), atau NAT Overload

POOL NAT R1 DAN R2

Private IP (ACL 1)	Public IP (Pool R1)
192.168.1.0/24	12.12.12.11

Private IP (ACL 1)	Public IP (Pool R2)
192.168.2.0/24	12.12.12.22

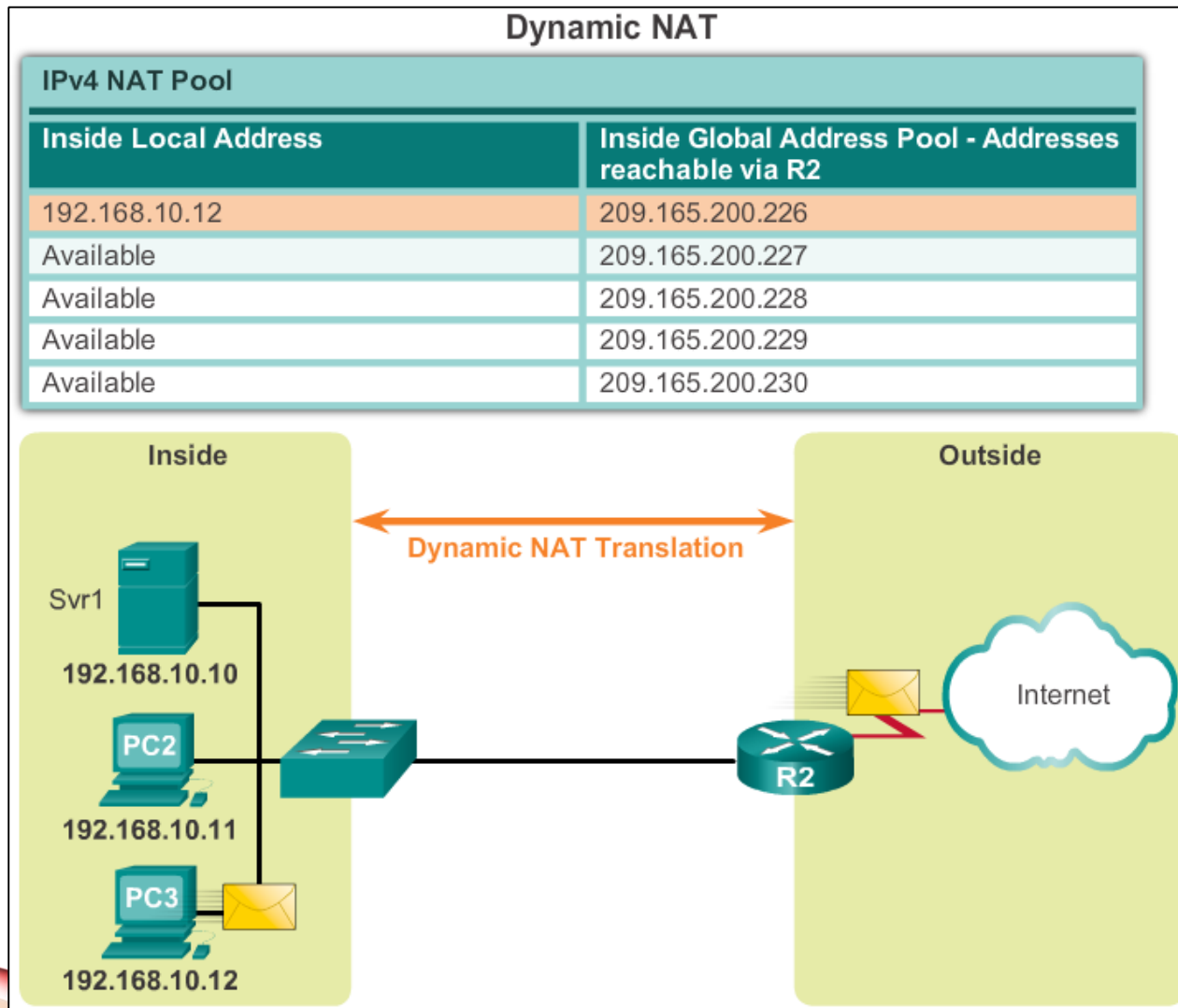
LANGKAH-LANGKAH

- Tentukan interface NAT inside
- Tentukan interface NAT outside
- Tentukan permit ACL Private Network
- Tentukan pool Public IP (terdiri dari single IP Public)
- Buat translasi NAT dari source ACL ke destination pool Public IP

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 (CONT.)



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.

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

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

8.2 CONFIGURING NAT

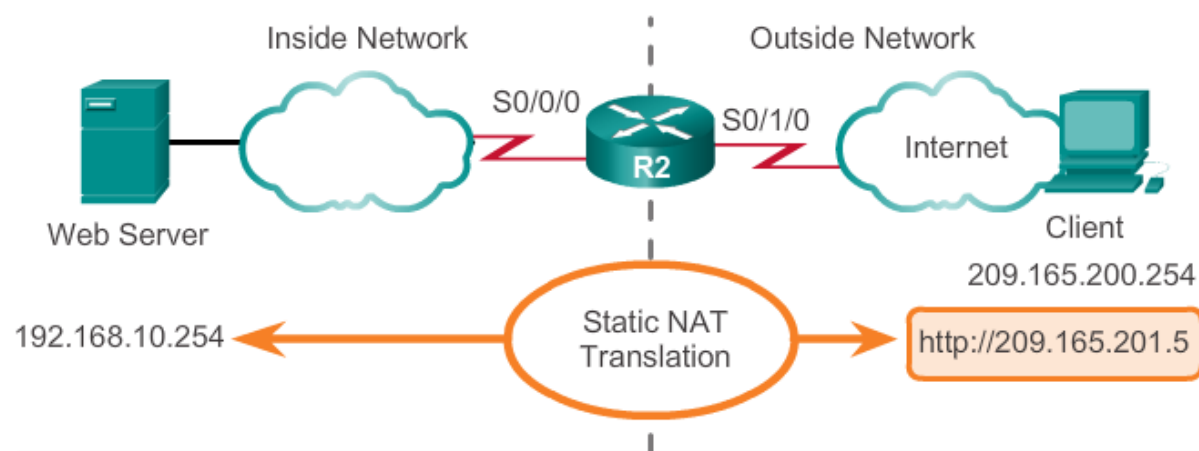
CONFIGURING STATIC NAT

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.

CONFIGURING STATIC NAT

Example Static NAT Configuration



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
```

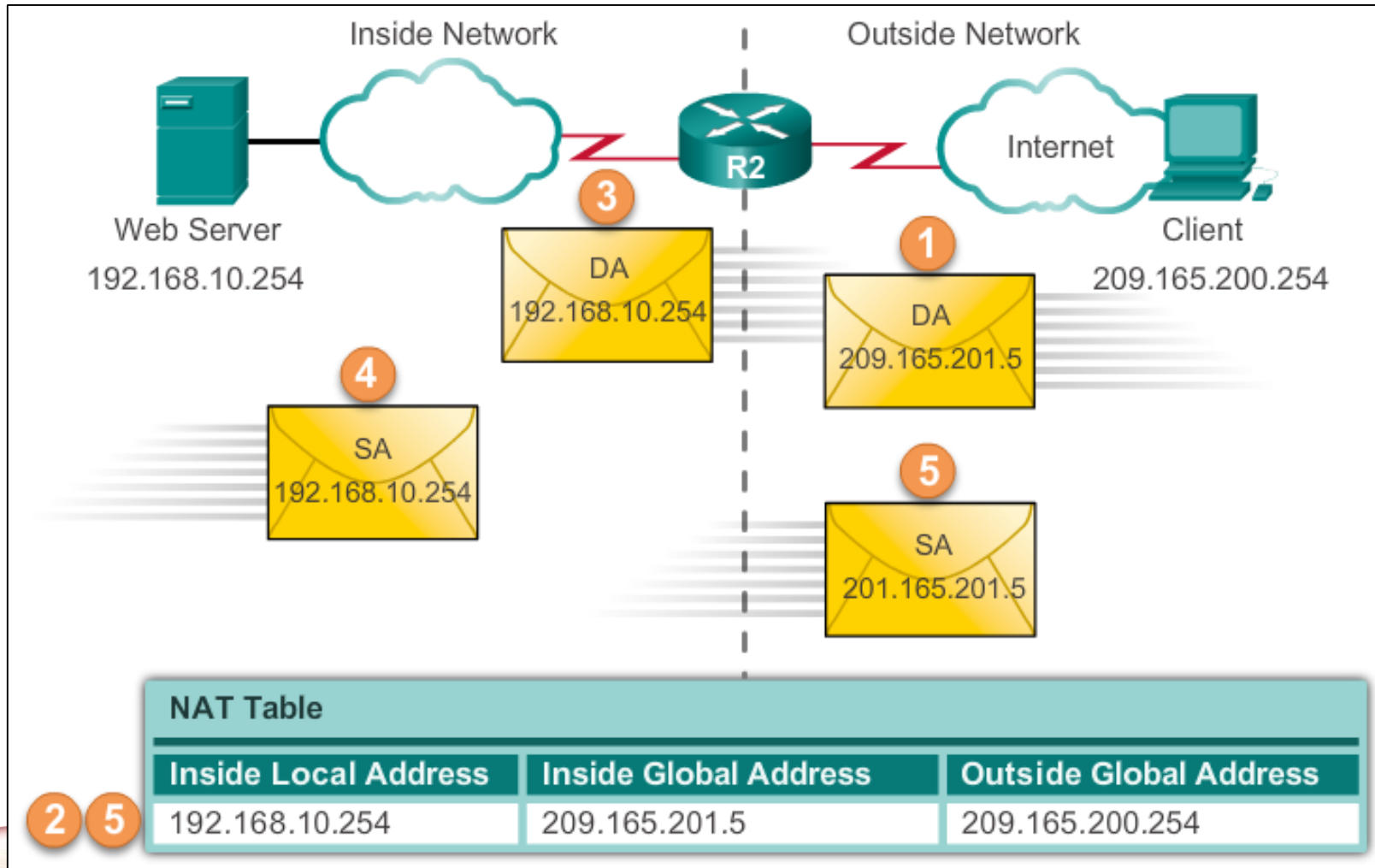
```
R2(config)# interface Serial0/1/0
```

```
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
```


CONFIGURING STATIC NAT ANALYZING STATIC NAT



CONFIGURING STATIC NAT

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#
```

CONFIGURING STATIC NAT VERIFYING STATIC NAT (CONT.)

```
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>
```

CONFIGURING DYNAMIC NAT

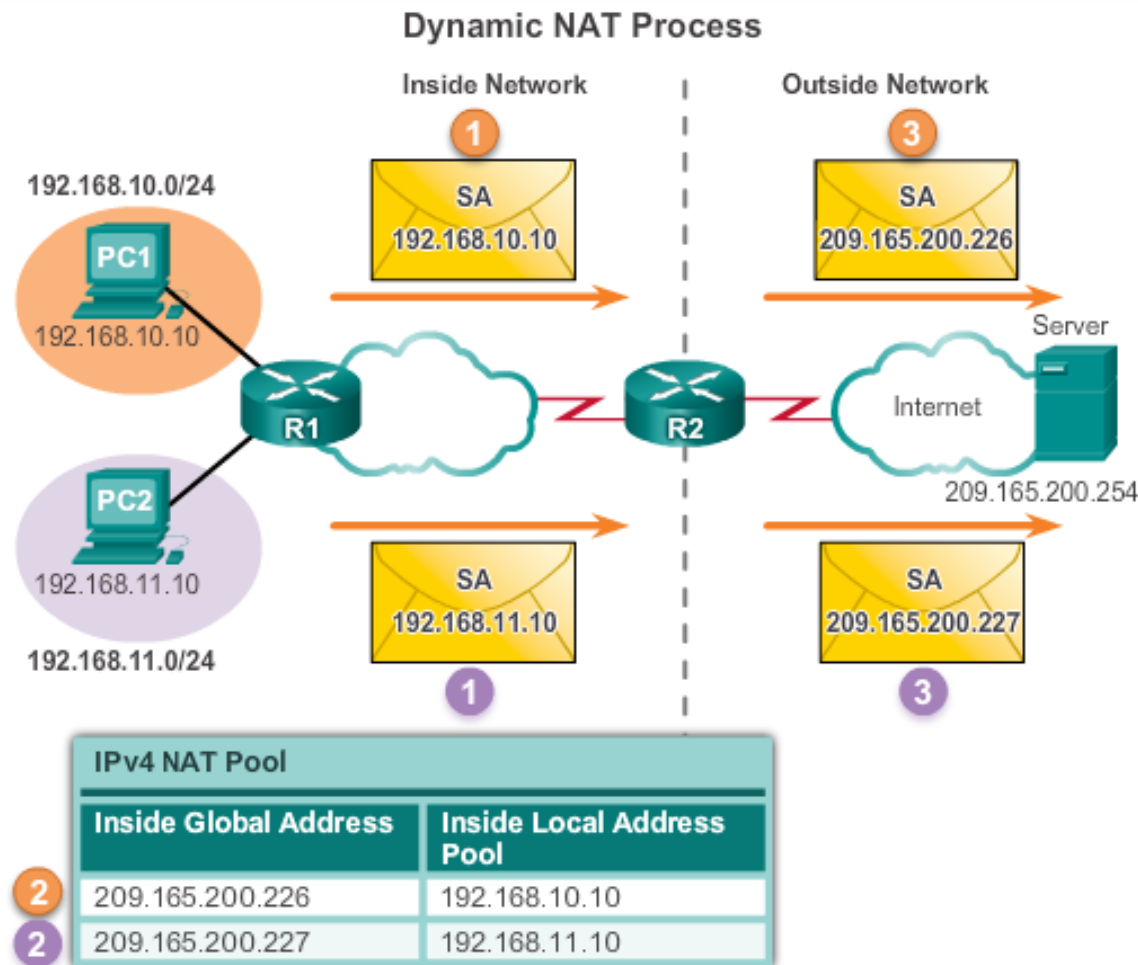
DYNAMIC NAT OPERATION

- 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 DYNAMIC NAT

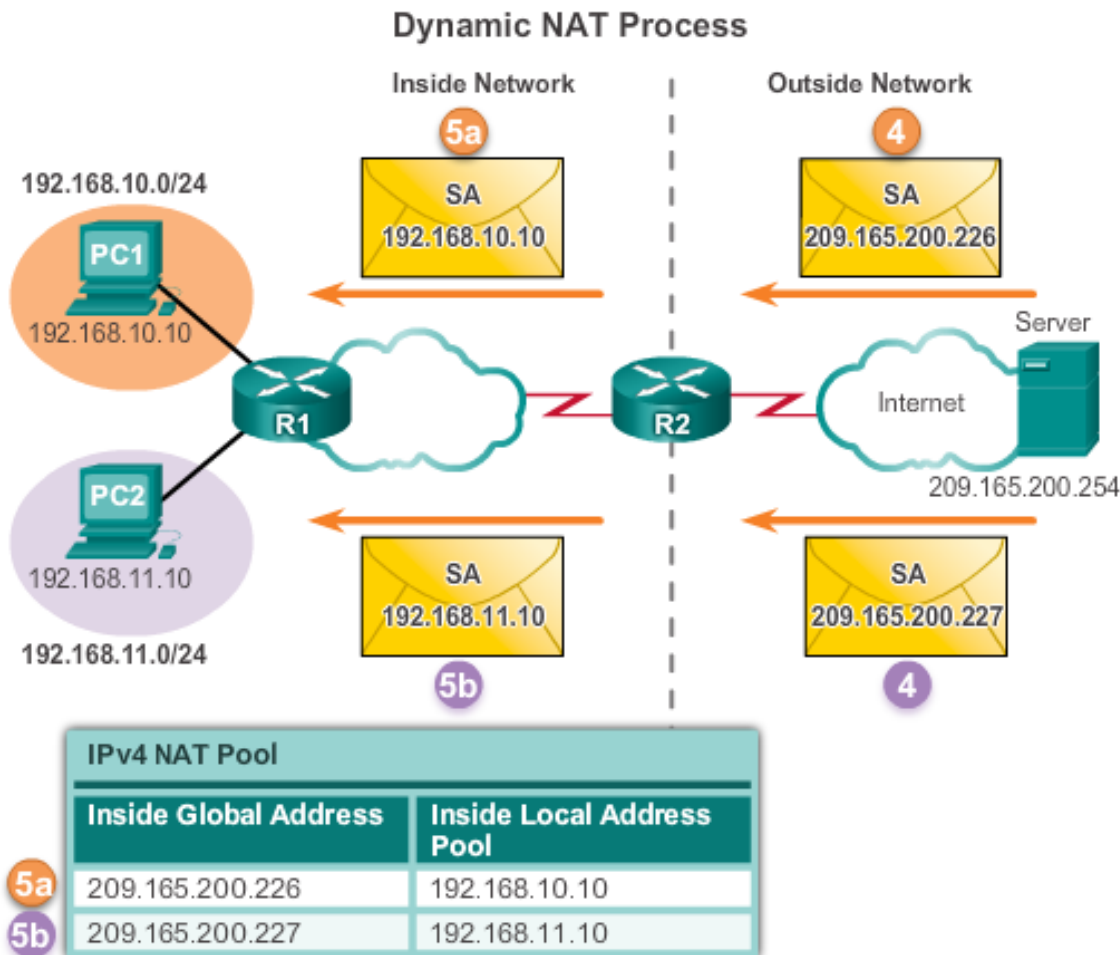
Dynamic NAT Configuration Steps	
Step 1	<p>Define a pool of global addresses to be used for translation.</p> <pre>ip nat pool name start-ip end-ip {netmask netmask prefix-length prefix-length}</pre>
Step 2	<p>Configure a standard access list permitting the addresses that should be translated.</p> <pre>access-list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

CONFIGURING DYNAMIC NAT ANALYZING DYNAMIC NAT



CONFIGURING 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#
```


CONFIGURING DYNAMIC NAT

VERIFYING DYNAMIC NAT

Verifying Dynamic NAT with show ip nat statistics

```
R2# clear ip nat statistics

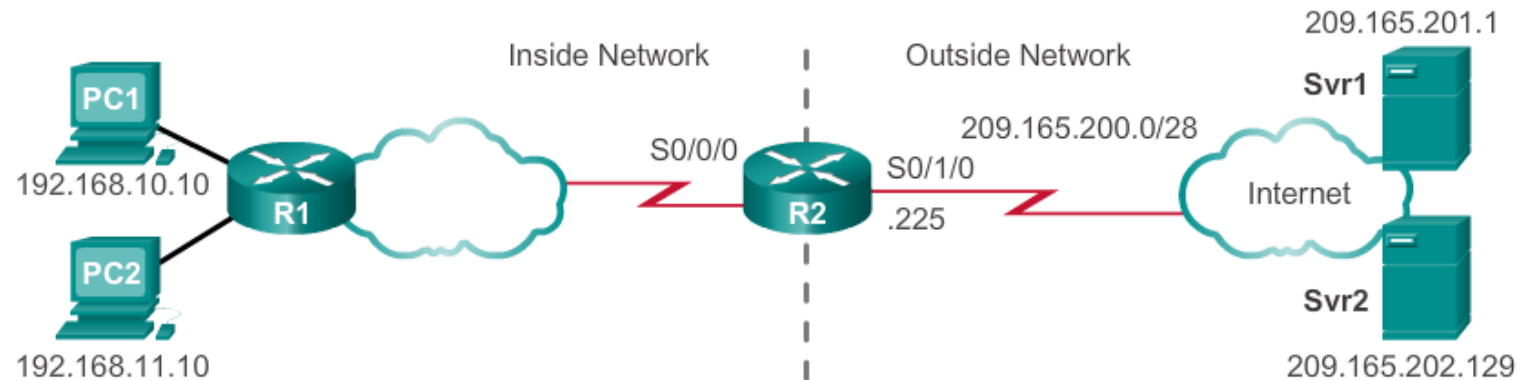
PC1 and PC2 establish sessions with the server

R2# show ip nat statistics
Total active translations: 2 (0 static, 2 dynamic; 0 extended)
Peak translations: 6, occurred 00:27:07 ago
Outside interfaces:
  Serial0/0/1
Inside interfaces:
  Serial0/1/0
Hits: 24 Misses: 0
CEF Translated packets: 24, CEF Punted packets: 0
Expired translations: 4
Dynamic mappings:
-- Inside Source
[Id: 1] access-list 1 pool NAT-POOL1 refcount 2
  pool NAT-POOL1: netmask 255.255.255.224
  start 209.165.200.226 end 209.165.200.240
  type generic, total addresses 15, allocated 2 (13%), misses 0

Total doors: 0
Appl doors: 0
Normal doors: 0
Queued Packets: 0
R2#
```

CONFIGURING PAT: ADDRESS POOL

Example PAT with 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
```

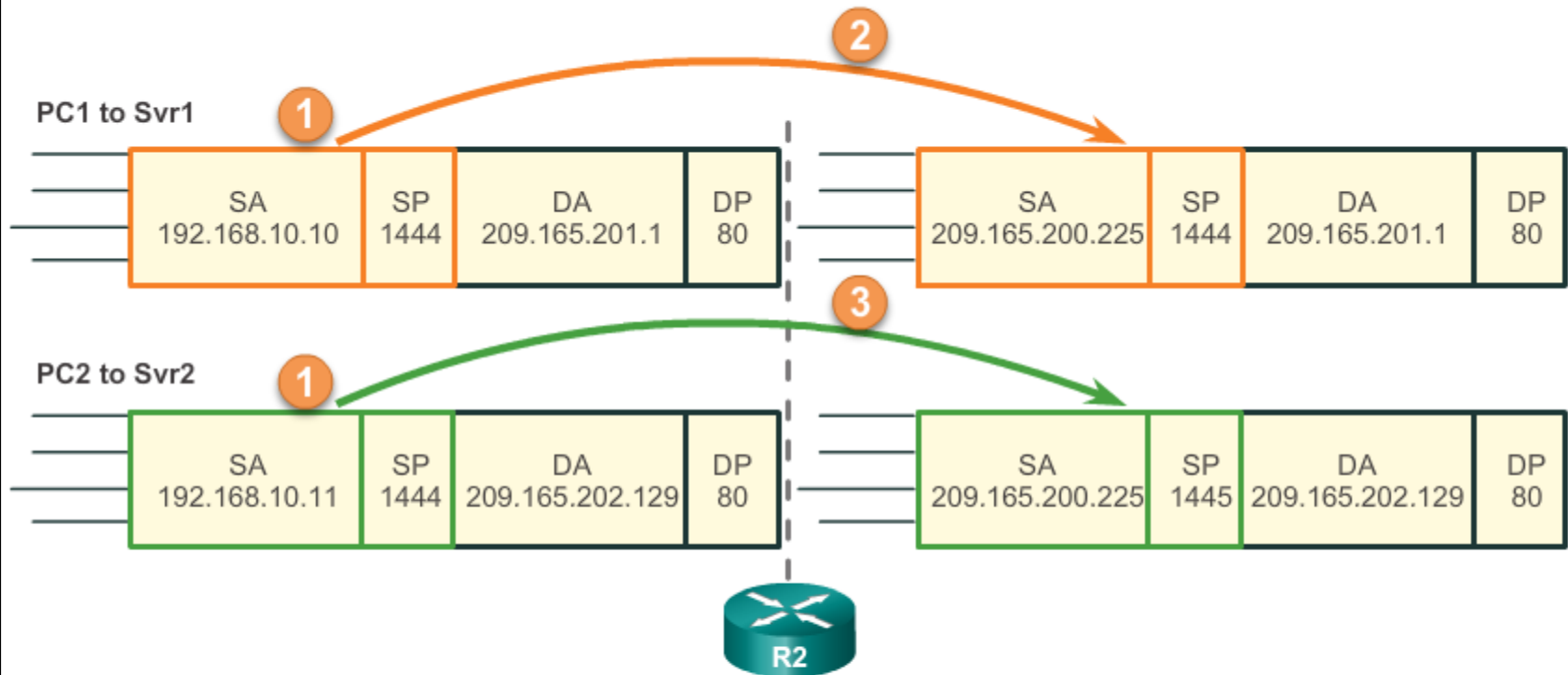
CONFIGURING PAT: SINGLE ADDRESS

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

CONFIGURING PAT

ANALYZING PAT

PAT Analysis from PCs to Servers



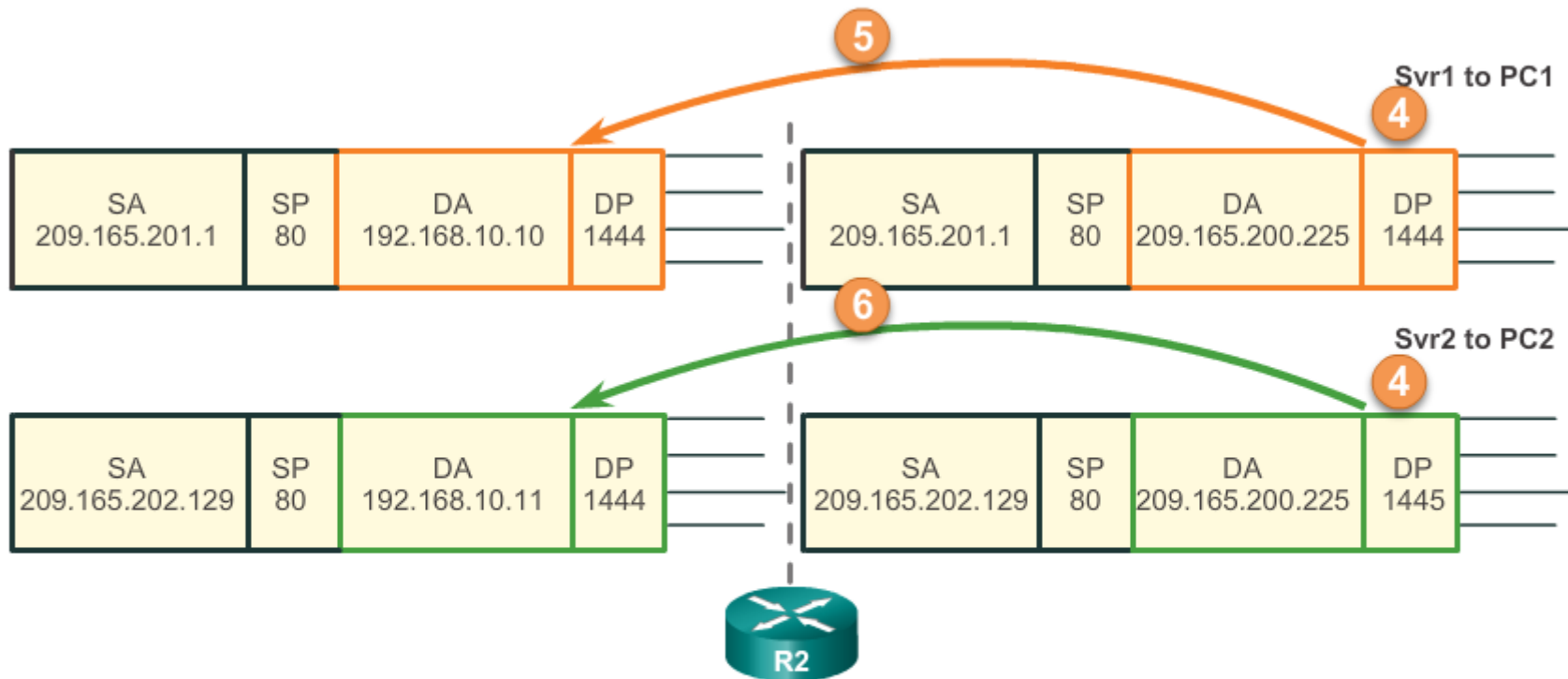
NAT Table

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

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

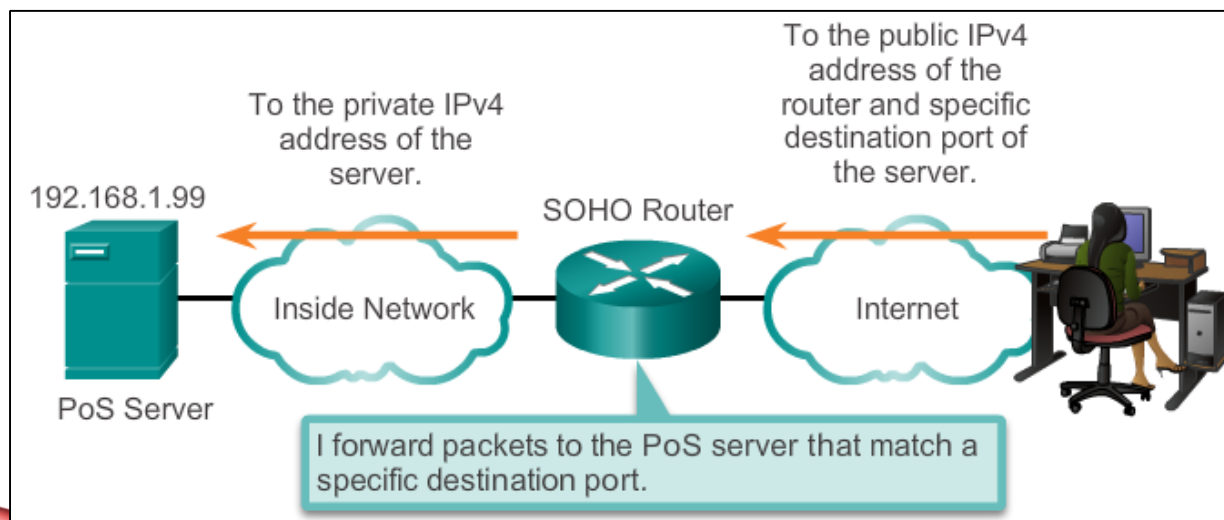
VERIFYING PAT TRANSLATIONS

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#
```

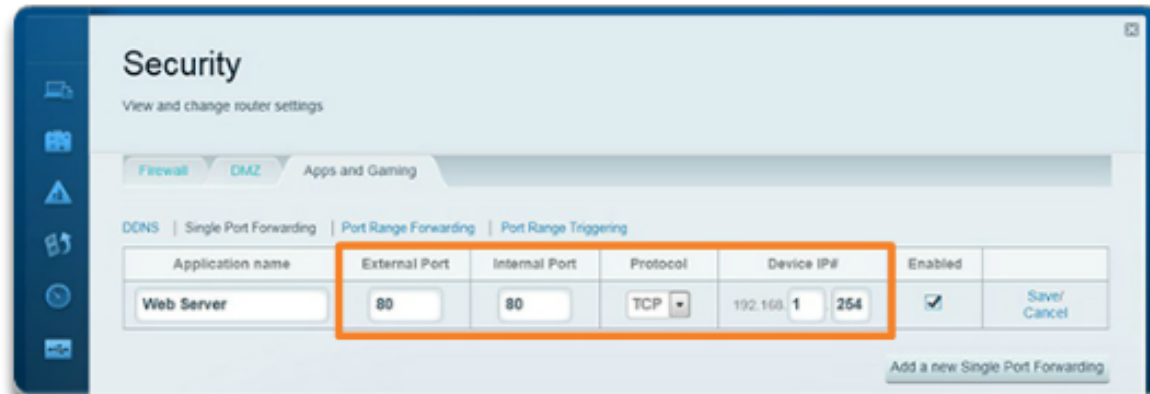
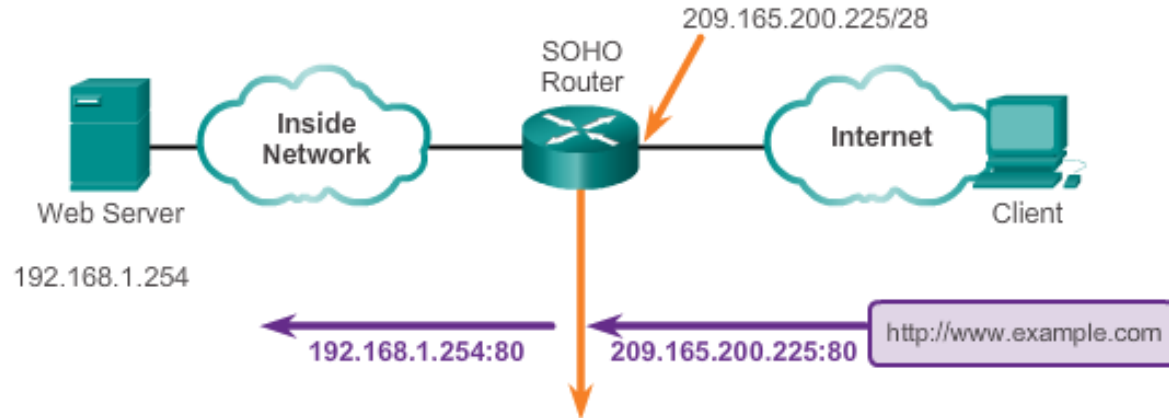
PORT FORWARDING

- Port forwarding 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.



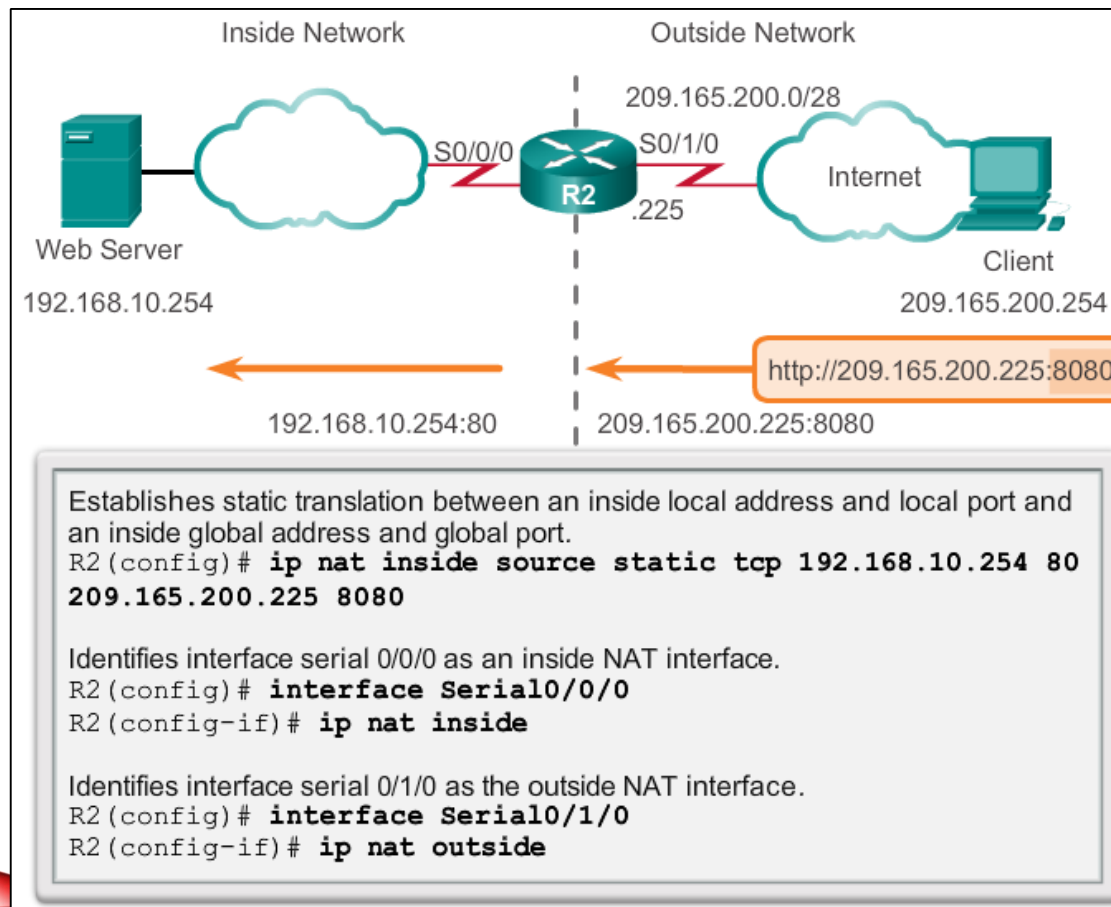
PORT FORWARDING SOHO EXAMPLE

Port Forwarding on a SOHO Router



CONFIGURING PORT FORWARDING WITH IOS

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

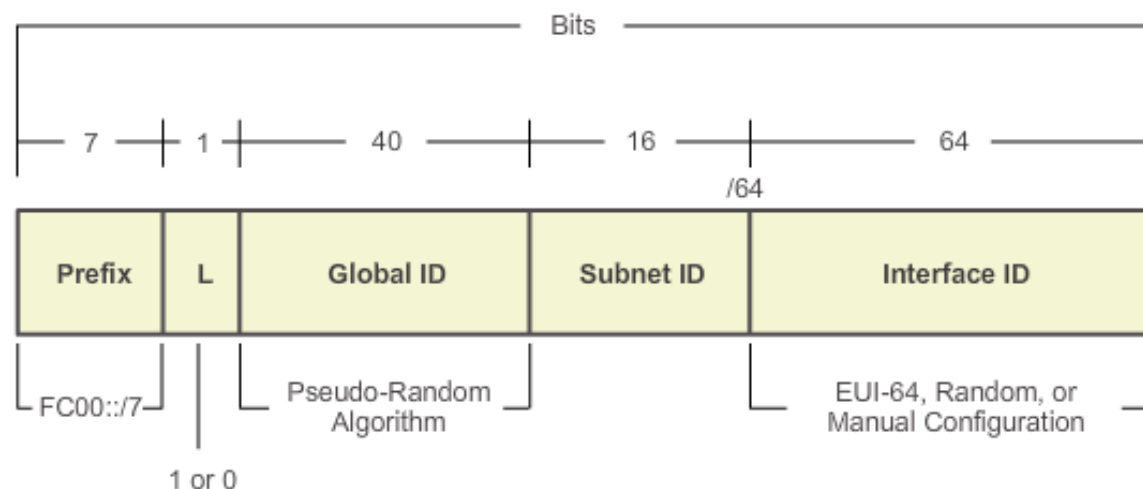


NAT FOR IPV6?

- NAT is a workaround for IPv4 address scarcity.
- 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 ADDRESSES

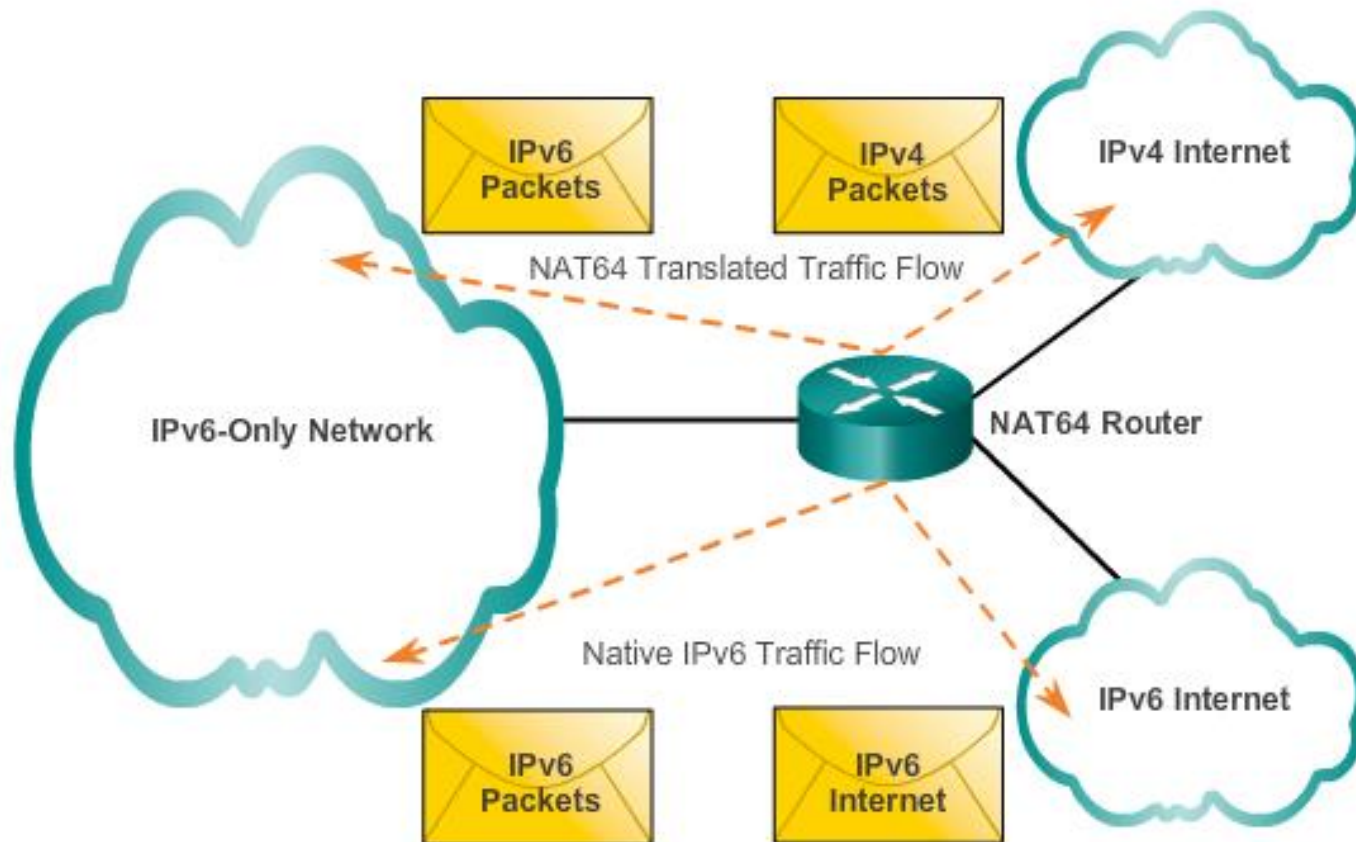
- IPv6 unique local addresses (ULAs) are designed to allow IPv6 communications within a local site.
- ULAs are not meant to provide additional IPv6 address space.
- ULAs have the prefix $FC00::/7$, which results in a first hextet range of FC00 to FDFF.
- ULAs are also known as local IPv6 addresses (not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



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.

CONFIGURING NAT AND IPV6 NAT FOR IPV6



8.3 TROUBLESHOOTING NAT

CONFIGURING NAT AND IPV6

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#

```

CONFIGURING NAT AND IPV6

TROUBLESHOOTING NAT: DEBUG COMMAND

```
R2# debug ip nat
IP NAT debugging is on
R2#
*Feb 15 20:01:31.670: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2817]
*Feb 15 20:01:31.682: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4180]
*Feb 15 20:01:31.698: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2818]
*Feb 15 20:01:31.702: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2819]
*Feb 15 20:01:31.710: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2820]
*Feb 15 20:01:31.710: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4181]
*Feb 15 20:01:31.722: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4182]
*Feb 15 20:01:31.726: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2821]
*Feb 15 20:01:31.730: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4183]
*Feb 15 20:01:31.734: NAT*: s=192.168.10.10->209.165.200.226, d=209.165.201.1 [2822]
*Feb 15 20:01:31.734: NAT*: s=209.165.201.1, d=209.165.200.226->192.168.10.10 [4184]
output omitted
```


CHAPTER 11: SUMMARY

This chapter has outlined:

- 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.

CHAPTER 11: SUMMARY (CONT.)

- 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.

TERIMA KASIH



Thank you very much for your kind attention