Communication Services and Security
Network Address Translation (NAT)

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Network Address Translation (NAT)

Definition

NAT is the ability to translate a set of addresses to another

Some uses

- Translate multiple addresses to a unique when accessing internet (masquerading)
- Translate a range of internal addresses to another. Useful when moving IPs
- Balancing load across many servers

Network Address Translation (NAT)

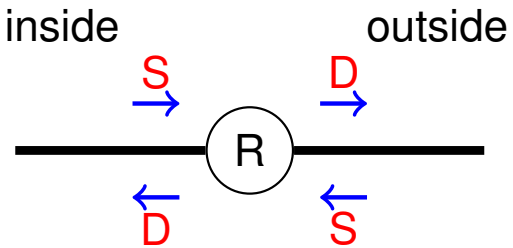
Inside and outside addresses

Interfaces are placed on 2 locations: inside or outside

- **Inside**. Attached to the organizational network
- **Outsize**. Attached to the external network (internet)

Addresses are translated as follows:

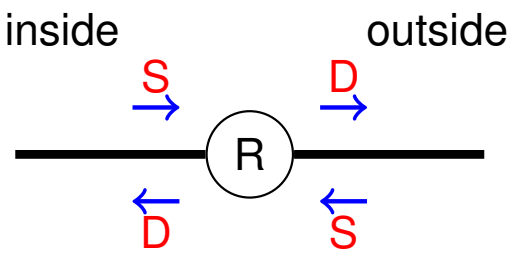
- **NAT inside source**
  - IP source of packets traveling inside $\Rightarrow$ outside
  - IP destination of packets traveling inside $\Leftarrow$ outside
- **NAT outside source**
  - IP destination of packets traveling inside $\Rightarrow$ outside
  - IP source of packets traveling inside $\Leftarrow$ outside



Network Address Translation (NAT)

Local and global addresses

- Inside local addresses. Inside addresses as seen within the organizational network
- Inside global addresses. Inside addresses as seen by the external network
- Outside local addresses. Outside addresses as seen within the organizational network
- Outside global addresses. Outside addresses as seen by the external network



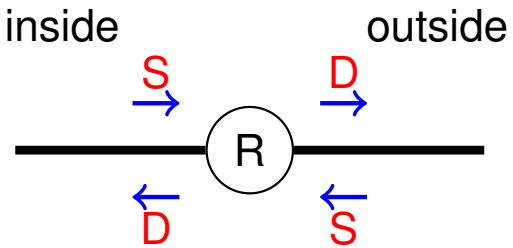
Network Address Translation (NAT)

Order of operation

- Inside ⇒ Outside:
  - Routing
  - Nat local to global
- Inside ⇐ Outside:
  - Nat global to local
  - Routing

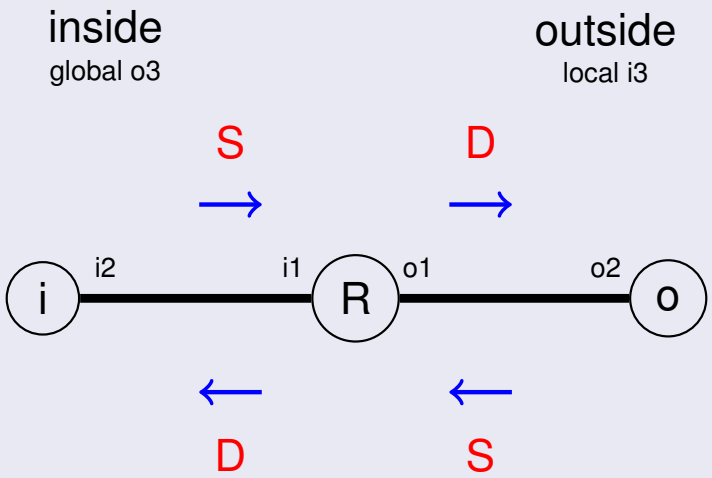
NAT syntax

```
ip nat inside source static in_local  in_global
ip nat outside source static out_global  out_local
```



Network Address Translation (NAT)

Example. No routing on (i) and (o) machines



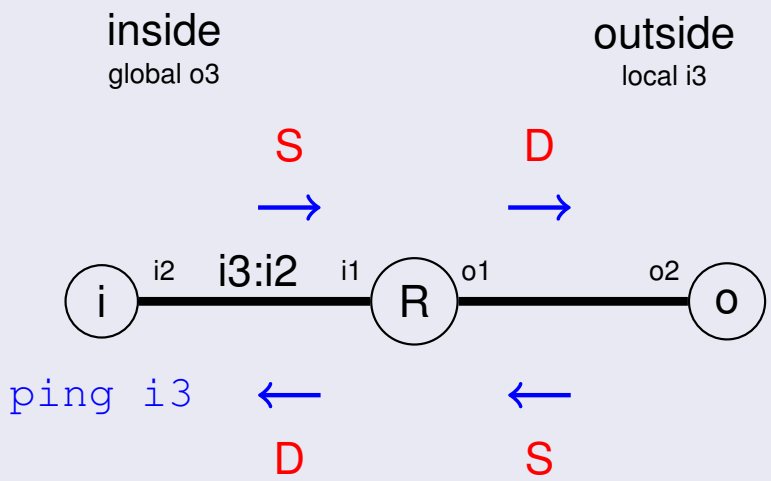

```
nat inside source i2 o3
nat outside source o2 i3
ip route i3 255.255.255.255 o2
```

o is seen as i3 for inside network

i is seen as o3 for outside network

Network Address Translation (NAT)

Example. No routing on (i) and (o) machines



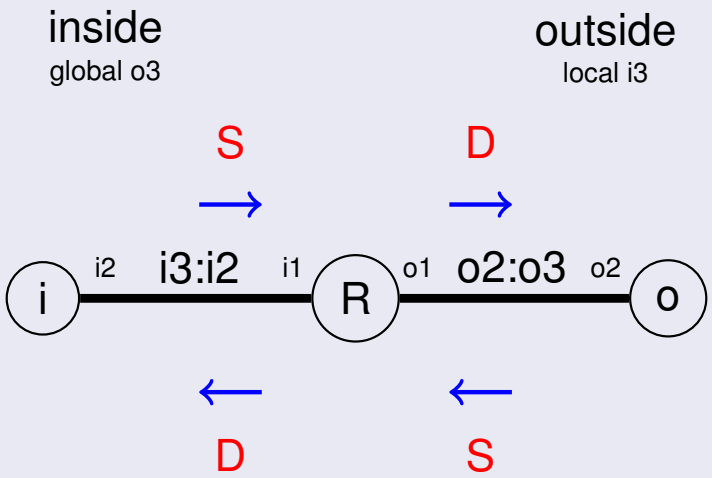

```
nat inside source i2 o3
nat outside source o2 i3
ip route i3 255.255.255.255 o2
```

o is seen as i3 for inside network
i is seen as o3 for outside network

IP_destination:IP_source First route, then NAT

Network Address Translation (NAT)

Example. No routing on (i) and (o) machines

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```

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Network Address Translation (NAT)

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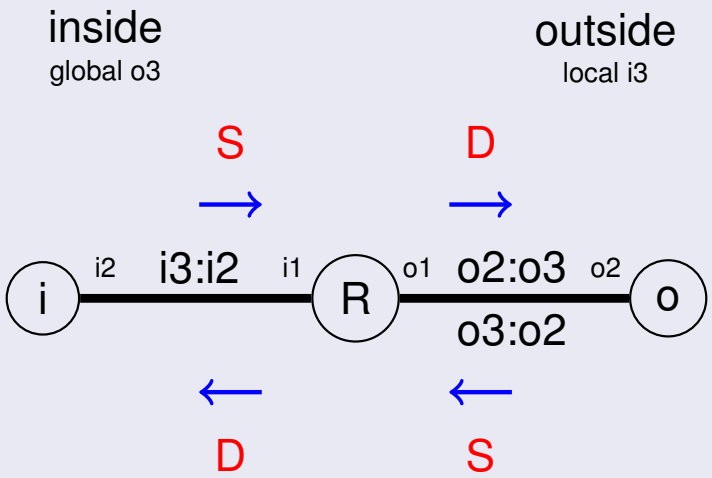


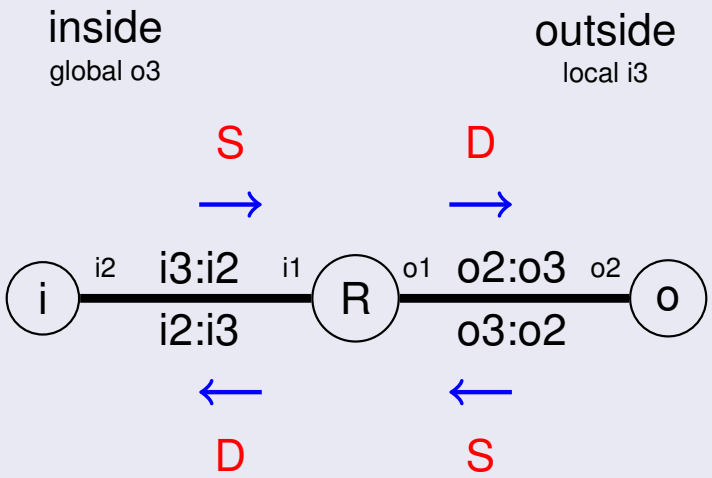

```
nat inside source i2 o3
nat outside source o2 i3
ip route i3 255.255.255.255 o2
```

o is seen as i3 for inside network
i is seen as o3 for outside network

First NAT, then route

Network Address Translation (NAT)

Example. No routing on (i) and (o) machines



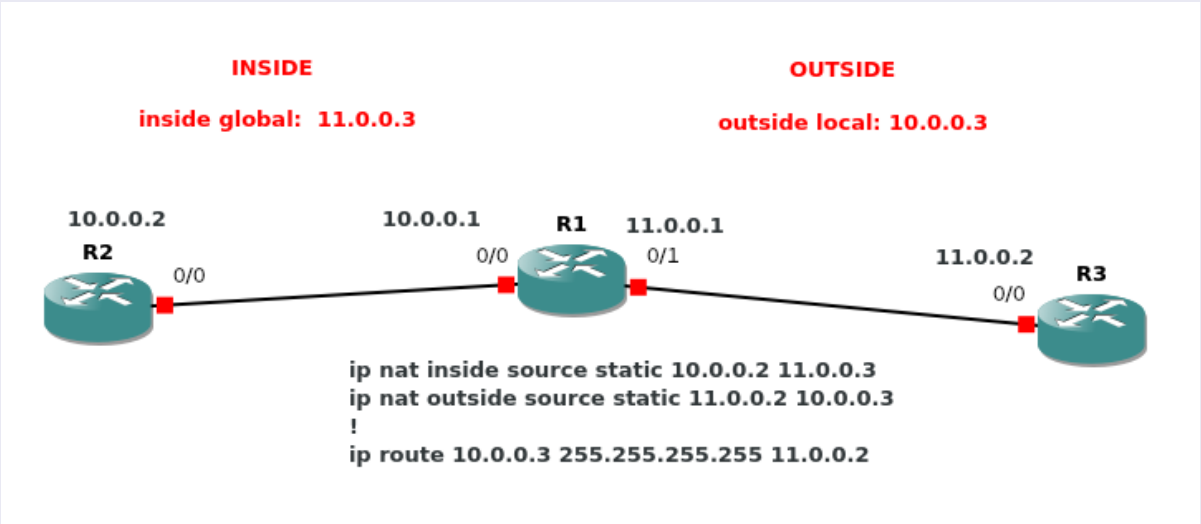

```
nat inside source i2 o3
nat outside source o2 i3
ip route i3 255.255.255.255 o2
```

o is seen as i3 for inside network

i is seen as o3 for outside network

Network Address Translation (NAT)

Example



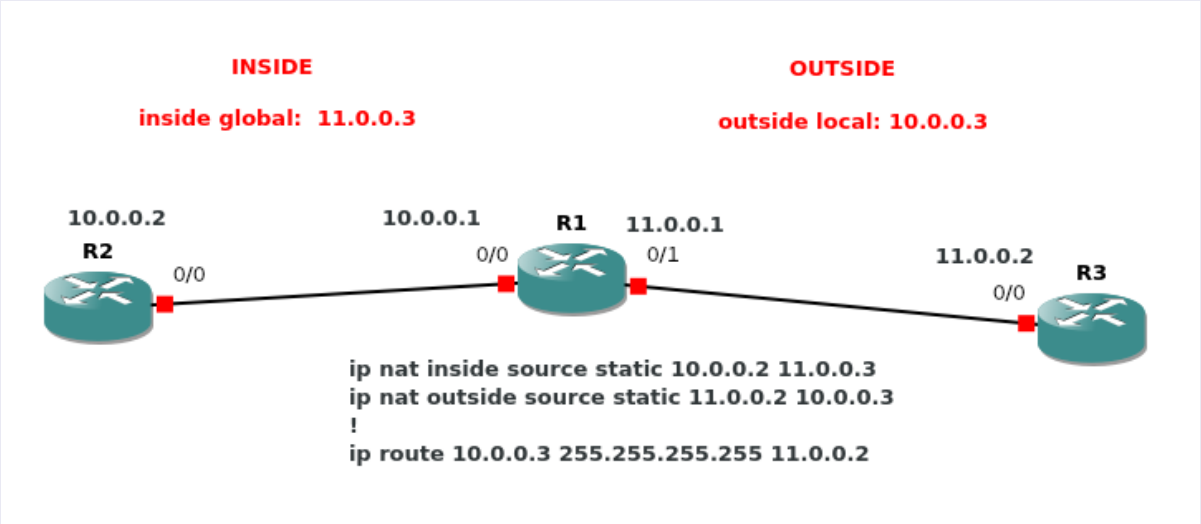
R1 configuration

```
interface FastEthernet0/0
 ip address 10.0.0.1 255.255.255.0
 ip nat inside
!
interface FastEthernet0/1
 ip address 11.0.0.1 255.255.255.0
 ip nat outside
!
ip route 10.0.0.3 255.255.255.255 11.0.0.2
!
ip nat inside source static 10.0.0.2 11.0.0.3
ip nat outside source static 11.0.0.2 10.0.0.3
```

No default routes in either R2 or R3
R3 seen as local for R2 and vice versa

Network Address Translation (NAT)

Example

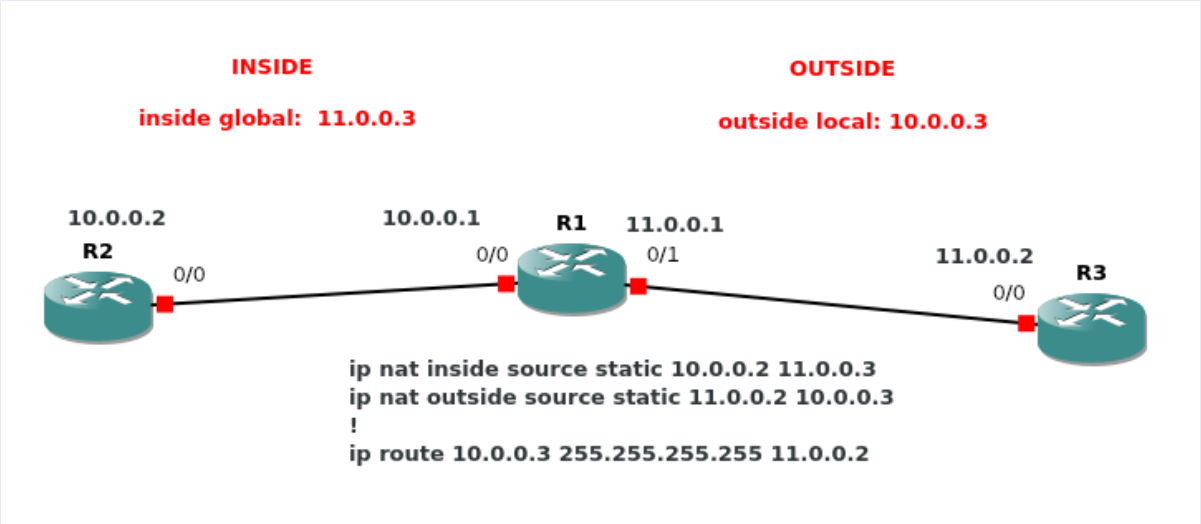


Monitoring NAT

```
R1#show ip nat translations
Pro Inside global Inside local Outside local Outside global
--- ---           ---          10.0.0.3      11.0.0.2
--- 11.0.0.3      10.0.0.2     ---           ---
```

Network Address Translation (NAT)

Example

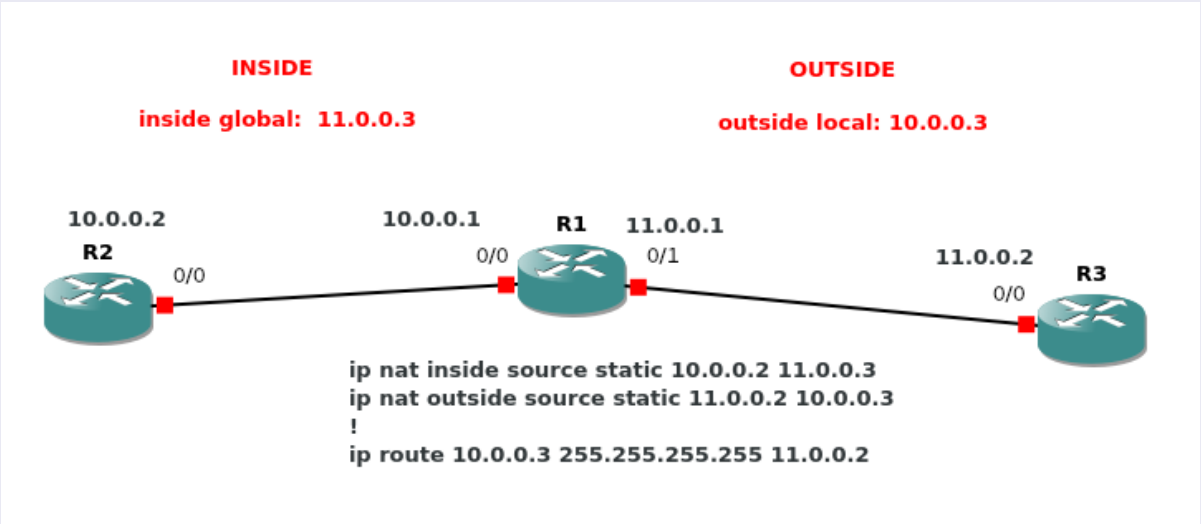


Monitoring NAT (after ping from R2)

```
R1#show ip nat translations
Pro Inside global Inside local Outside local Outside global
--- ---           ---          10.0.0.3      11.0.0.2
icmp 11.0.0.3:3 10.0.0.2:3   10.0.0.3:3    11.0.0.2:3
--- 11.0.0.3      10.0.0.2     ---           ---
```

Network Address Translation (NAT)

Example



Monitoring NAT (after ping from R2 and R3)

```
R1#show ip nat translations
Pro Inside global Inside local Outside local Outside global
--- ---           ---          10.0.0.3      11.0.0.2
icmp 11.0.0.3:3 10.0.0.2:3   10.0.0.3:3    11.0.0.2:3
icmp 11.0.0.3:4 10.0.0.2:4   10.0.0.3:4    11.0.0.2:4
--- 11.0.0.3      10.0.0.2     ---           ---
```

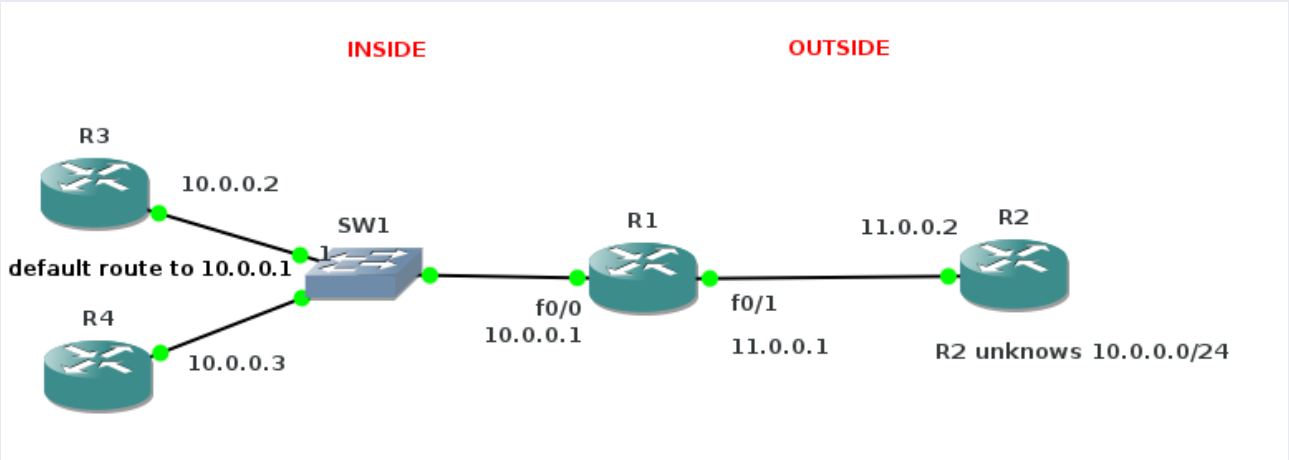
Network Address Translation (NAT)

NAT types

- **Static NAT**. Single addresses are translated into single addresses. One-to-one. IP header and higher level checksum must be recalculated. NAT translation tables are static. Entries remain until deleted
- **Dynamic NAT**. As in static NAT, there is a one-to-one mapping, but translation occurs dynamically. A pool of addresses exists. Each translation table entry is created when required. Once expired, entries are deleted from the translation table
- **Port NAT (PAT) (Overloading)**. It is a variation of dynamic NAT. When pool is exhausted, dynamic NAT drops the translation. Using PAT, addresses are reused with different port numbers. Distinct techniques used to distinguish local destinations:
  - ICMP traffic. Packet identifier is used
  - TCP and UDP. Source port. If source port is shared, port is translated

Network Address Translation (NAT)

PAT example

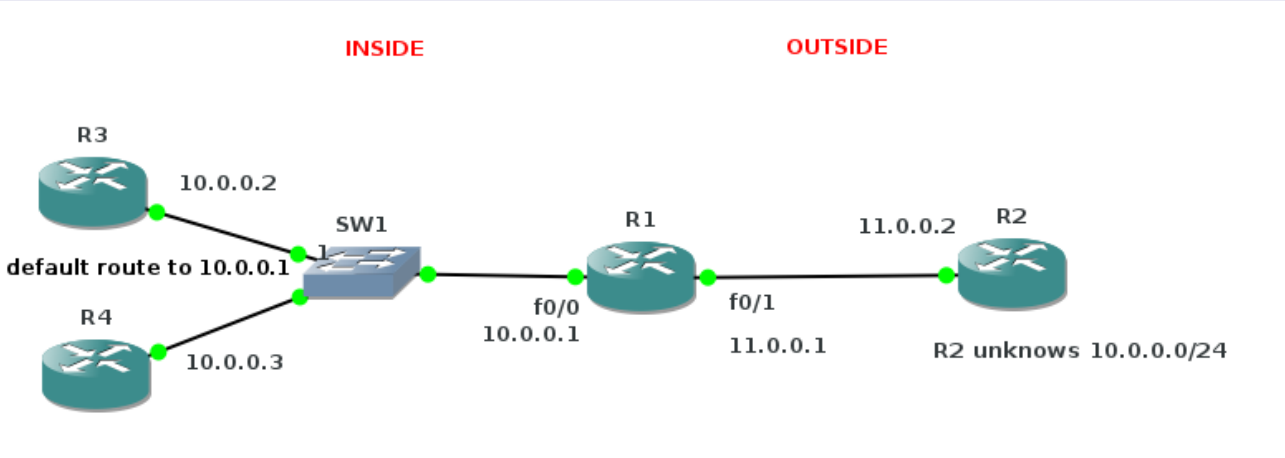


R1 configuration

```
interface FastEthernet0/0
 ip address 10.0.0.1 255.255.255.0
 ip nat inside
!
interface FastEthernet0/1
 ip address 11.0.0.1 255.255.255.0
 ip nat outside
!
access-list 1 permit 10.0.0.0 0.0.0.255
ip nat pool NATPOOL 11.0.0.3 11.0.0.3 netmask 255.255.255.0
ip nat inside source list 1 pool NATPOOL overload
```

Network Address Translation (NAT)

PAT example

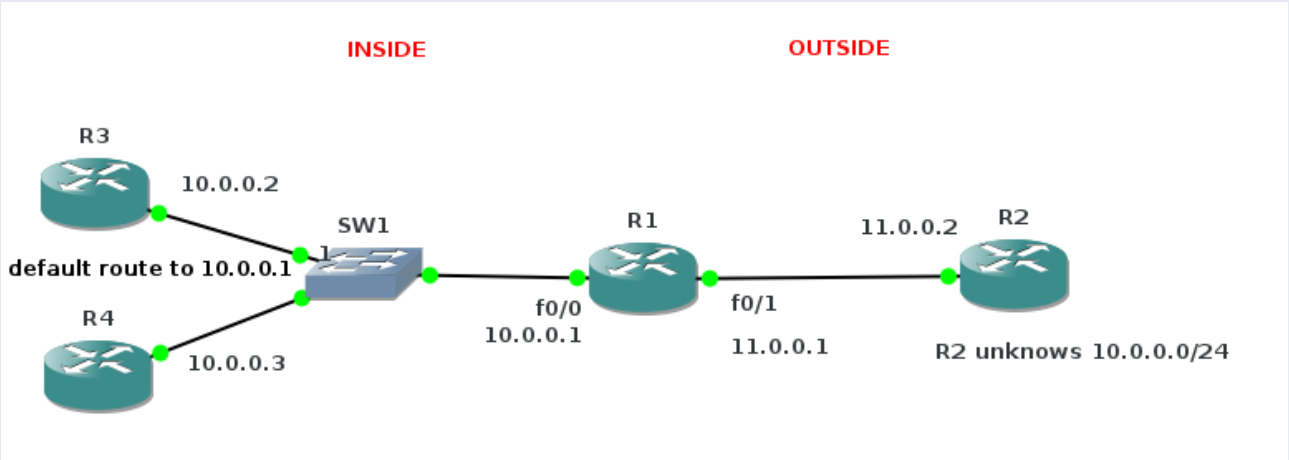


NAT monitoring (ping from R3 and R4 to R2)

```
R1# show ip nat translations
Pro Inside global Inside local  Outside local  Outside global
icmp 11.0.0.3:14  10.0.0.2:14   11.0.0.2:14    11.0.0.2:14
icmp 11.0.0.3:9   10.0.0.3:9    11.0.0.2:9     11.0.0.2:9
```

Network Address Translation (NAT)

PAT example



Capture at R1 F0/1

```
Internet Protocol Version 4, Src: 11.0.0.3 (11.0.0.3), Dst: 11.0.0.2 (11.0.0.2)
Internet Control Message Protocol
    Type: 8 (Echo (ping) request)
    Code: 0
    Checksum: 0x1aaa [correct]
    Identifier (BE): 9 (0x0009)
    Identifier (LE): 2304 (0x0900)
```

```
Internet Protocol Version 4, Src: 11.0.0.3 (11.0.0.3), Dst: 11.0.0.2 (11.0.0.2)
Internet Control Message Protocol
    Type: 8 (Echo (ping) request)
    Code: 0
    Checksum: 0x15c6 [correct]
    Identifier (BE): 14 (0x000e)
    Identifier (LE): 3584 (0x0e00)
```