instituto superior de engenharia de lisboa

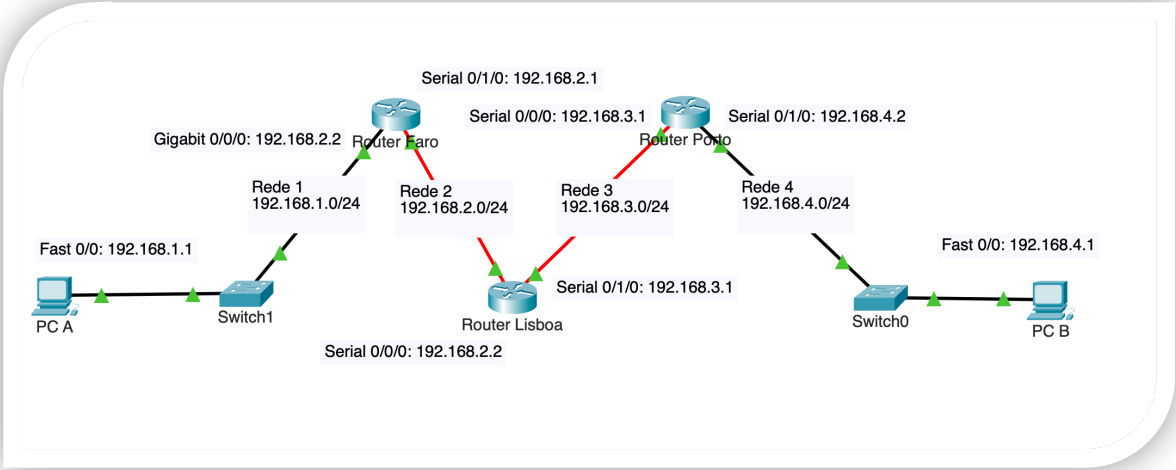
Redes de Internet / Internet Networks
Practical Lesson No. 4: IP addressing, Static Routing and NAT

Context

In this activity, we will implement and configure four networks using three routers, which present different LAN and WAN interconnection scenarios. At the end, we will analyze the construction of the forwarding tables for each of the routers. During the configuration process, we will access the maintenance ports of the routers to assign the desired names and implement password access protection. Finally, an application for NAT configuration will be presented.

1 – Description of the topology to be implemented in Packet Tracer

You can find an outline of this topology in the file accessible via the link.



2 – Faro Router Configuration

Router> **en**
Router# **conf t**

Router (config)# **hostname Router-Faro**

Router-Faro (config)# **enable secret faro**

Router-Faro (config)# **line console 0**
Router-Faro (config-line)# **password faro**
Router-Faro (config-line)# **login**

Router-Faro (config)# **line aux 0**
Router-Faro (config-line)# **password faro**
Router-Faro (config-line)# **login**

Router-Faro (config)# **interface Gig0/0/0**
Router-Faro (config-if)# **ip address 192.168.1.2 255.255.255.0**
Router-Faro (config-if)# **description Ligacao LAN de Faro**
Router-Faro (config-if)# **no shutdown**

Router-Faro (config-if)# **interface serial 0/1/0**
Router-Faro (config-if)# **ip address 192.168.2.1 255.255.255.0**
Router-Faro (config-if)# **description Ligacao WAN a Lisboa**
Router-Faro (config-if)# **no shut down**
Router-Faro (config-if)# **^Z**
Router# **copy running-config startup-config**
Distination filename [startup-config]?# **[Enter]**

3 – Lisboa Router Configuration

Router> **en**
Router# **conf t**

Router (config)# **hostname Router-Lisboa**
Router-Lisboa (config)# **enable secret lisboa**

Router-Lisboa (config)# **line console 0**
Router-Lisboa (config-line)# **password lisboa**
Router-Lisboa (config-line)# **login**

Router-Lisboa (config)# **line aux 0**
Router-Lisboa (config-line)# **password lisboa**
Router-Lisboa (config-line)# **login**
Router-Lisboa (config-line)# **exit**

Router-Lisboa (config)# **interface serial 0/1/0**
Router-Lisboa (config-if)# **ip address 192.168.2.2 255.255.255.0**
Router-Lisboa (config-if)# **description Ligacao WAN de Lisboa**
Router-Lisboa (config-if)# **no shut down**

Router-Lisboa (config-if)# **interface serial 0/1/1**
Router-Lisboa (config-if)# **ip address 192.168.3.1 255.255.255.0**

Router-Lisboa (config-if)# **no shut down**
Router-Lisboa (config-if)# **^Z**
Router# **copy running-config startup-config**
Distination filename [startup-config]?# **[Enter]**

4 – Porto Router Configuration

Router> **en**
Router# **conf t**

Router (config)# **hostname Router-Porto**
Router-Porto (config)# **enable secret porto**

Router-Porto (config)# **line console 0**
Router-Porto (config-line)# **password porto**
Router-Porto (config-line)# **login**

Router-Porto (config)# **line aux 0**
Router-Porto (config-line)# **password porto**
Router-Porto (config-line)# **login**
Router-Porto (config-line)# **exit**

Router-Porto (config)# **interface Gig0/0/0**
Router-Porto (config-if)# **ip address 192.168.4.2 255.255.255.0**
Router-Porto (config-if)# **description Ligacao LAN de Porto**
Router-Porto (config-if)# **no shut down**

Router-Porto (config-if)# **interface serial 0/1/0**
Router-Porto (config-if)# **ip address 192.168.3.2 255.255.255.0**
Router-Porto (config-if)# **description Ligacao WAN a Lisboa**
Router-Porto (config-if)# **no shut down**
Router-Porto (config-if)# **^Z**
Router# **copy running-config startup-config**
Distination filename [startup-config]?# **[Enter]**

5 – Checking connectivity from machine A

A1 - Connectivity of machine A with its own network interface

C:\ > **ping 192.168.1.1**
Pinging 192.168.1.1 with 32 bytes of data:

Reply from 192.168.1.1: bytes=32 time >10ms TTL=128
Reply from 192.168.1.1: bytes=32 time >10ms TTL=128
Reply from 192.168.1.1: bytes=32 time >10ms TTL=128
Reply from 192.168.1.1: bytes=32 time >10ms TTL=128

A2 - Connectivity of the Ethernet 0/0 interface of the Faro router with the address 192.168.1.2

C:\ > **ping 192.168.1.2**
Pinging 192.168.1.2 with 32 bytes of data:
Reply from 192.168.1.2: bytes=32 time >10ms TTL=128
Reply from 192.168.1.2: bytes=32 time >10ms TTL=128
Reply from 192.168.1.2: bytes=32 time >10ms TTL=128
Reply from 192.168.1.2: bytes=32 time >10ms TTL=128

A3 - Connectivity of the serial0 interface of the Faro router with the address 192.168.2.1

C:\ > **ping 192.168.2.1**
Pinging 192.168.2.1 with 32 bytes of data:
Reply from 192.168.2.1: bytes=32 time >10ms TTL=128
Reply from 192.168.2.1: bytes=32 time >10ms TTL=128
Reply from 192.168.2.1: bytes=32 time >10ms TTL=128
Reply from 192.168.2.1: bytes=32 time >10ms TTL=128

A4 - Connectivity of the serial0 interface of the Lisbon router with the address 192.168.2.2

C:\ > **ping 192.168.2.2**
Pinging 192.168.2.2 with 32 bytes of data:
Request timed out
Request timed out
Request timed out
Request timed out

Analysis of the results obtained

As can be seen, this interface is not reached by the ping, as the Faro router apparently does not know this destination. To understand why this is happening, we will use the show ip route command on the Faro router

```
Router-Faro#show ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B -
   BGP, D - EIGRP. EX - EIGRP external, O - OSPF, IA - OSPF inter area,
   N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2, E1 -
   OSPF external type 1, E2 - OSPF external type 2, E - EGP i - IS-IS,
   L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area * -
   candidate default, U - per-user static route, o - ODR, P - periodic
   downloaded static route

Gateway of last resort is not set
C      192.168.1.0/24 is directly connected, Ethernet 0/0
C      192.168.2.0/24 is directly connected, Serial 0/0
Router-Lisboa#show ip route
(...)

Gateway of last resort is not set
```

The forwarding table indicates that the router, by default, only has interfaces that are directly connected defined, so it has no way of knowing which interface is connected to the Lisbon router. Consequently, the solution will be to configure a "last resort" route, to which packets that do not match the entries directly connected to the router will be forwarded. These routes can be defined in two ways: either statically defined or learned dynamically using a suitable algorithm (e.g., RIP).

6 – Configuring a static route

Static routing consists of manually adding routes to the router's routing table. To add static routes in Packet Tracer, use the command ip route [remote network] [mask] [next router address or outgoing interface] [administrative distance] [permanent].

Configuration on the Faro Router

Router-Faro# **config t**
Router-Faro (config)# **ip route 192.168.3.0 255.255.255.0 192.168.2.2**
Router-Faro (config)# **ip route 192.168.4.0 255.255.255.0 192.168.2.2**

Configuration on the Lisboa Router

Router-Faro# **config t**
Router-Faro (config)# **ip route 192.168.1.0 255.255.255.0 192.168.2.1**
Router-Faro (config)# **ip route 192.168.4.0 255.255.255.0 192.168.3.2**

Configuration on the Porto Router

Router-Faro# **config t**
Router-Faro (config)# **ip route 192.168.1.0 255.255.255.0 192.168.3.1**
Router-Faro (config)# **ip route 192.168.2.0 255.255.255.0 192.168.3.1**

Double-check the forwarding tables for each router

Note that new entries appear in the forwarding table corresponding to the added static routes, which are identified by the line code "S." The numbers in square brackets correspond to the administrative distance and metric distance values.

Router-Faro# **show ip route**

```
     192.168.1.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.1.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.1.2/32 is directly connected, GigabitEthernet0/0/0
     192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, Serial0/1/0
L       192.168.2.1/32 is directly connected, Serial0/1/0
S    192.168.3.0/24 [1/0] via 192.168.2.2
S    192.168.4.0/24 [1/0] via 192.168.2.2
```

Router-Lisboa# **show ip route**

```
S    192.168.1.0/24 [1/0] via 192.168.2.1
     192.168.2.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.2.0/24 is directly connected, Serial0/1/0
L       192.168.2.2/32 is directly connected, Serial0/1/0
     192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.3.0/24 is directly connected, Serial0/1/1
L       192.168.3.1/32 is directly connected, Serial0/1/1
S    192.168.4.0/24 [1/0] via 192.168.3.2
```

Router-Porto# **show ip route**

```
S    192.168.1.0/24 [1/0] via 192.168.3.1
S    192.168.2.0/24 [1/0] via 192.168.3.1
     192.168.3.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.3.0/24 is directly connected, Serial0/1/0
L       192.168.3.2/32 is directly connected, Serial0/1/0
     192.168.4.0/24 is variably subnetted, 2 subnets, 2 masks
C       192.168.4.0/24 is directly connected, GigabitEthernet0/0/0
L       192.168.4.2/32 is directly connected, GigabitEthernet0/0/0
```

Check the connections again from machine A

Note that new entries appear in the forwarding table corresponding to the static routes.

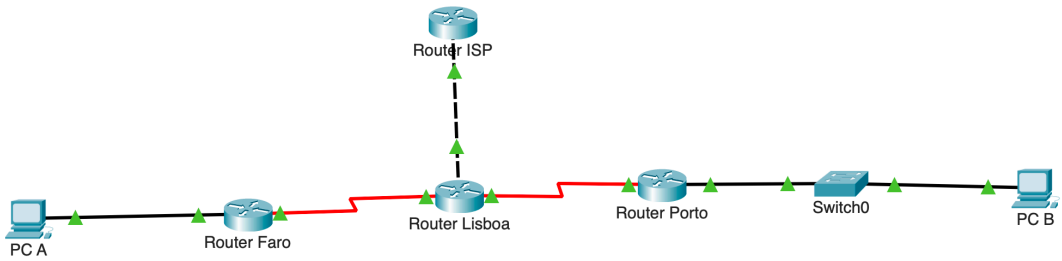
C:\ > **ping 192.168.2.1**
Pinging 192.168.2.2 with 32 bytes of data:
Reply from 192.168.2.2: bytes=32 time >10ms TTL=128
Reply from 192.168.2.2: bytes=32 time >10ms TTL=128
Reply from 192.168.2.2: bytes=32 time >10ms TTL=128
Reply from 192.168.2.2: bytes=32 time >10ms TTL=128

7 – Route Aggregation

Propose an approach for aggregating/summarizing routes that reduces the number of entries in each router's routing tables.

8 – NAT Configuration

Now consider that the Lisbon router has an additional Ethernet interface (e.g., g0/0/0) connected to the Internet, represented in the figure by the ISP router. This interface uses the public address 200.100.50.1, allowing machines on the internal network to access the Internet through NAT.



Objectives:

1. Configure NAT on the Lisbon router to allow Machine A1 (192.168.1.1) to access the Internet using a public IP address (200.100.50.1).

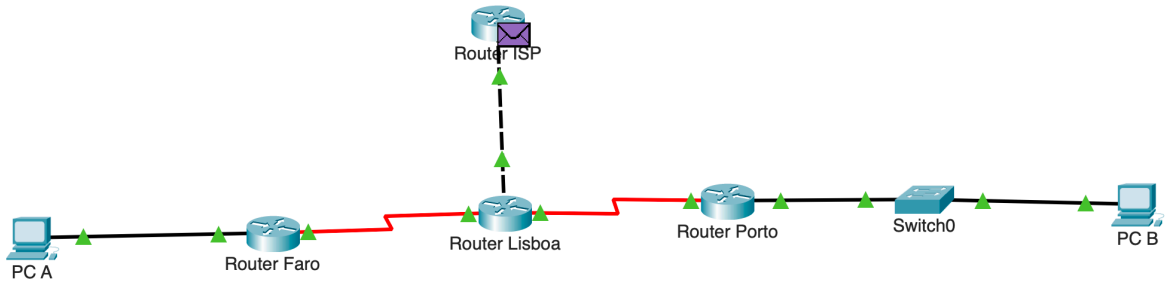
2. Machine B1 (192.168.4.1) should also be able to access Machine A through the private IP address.

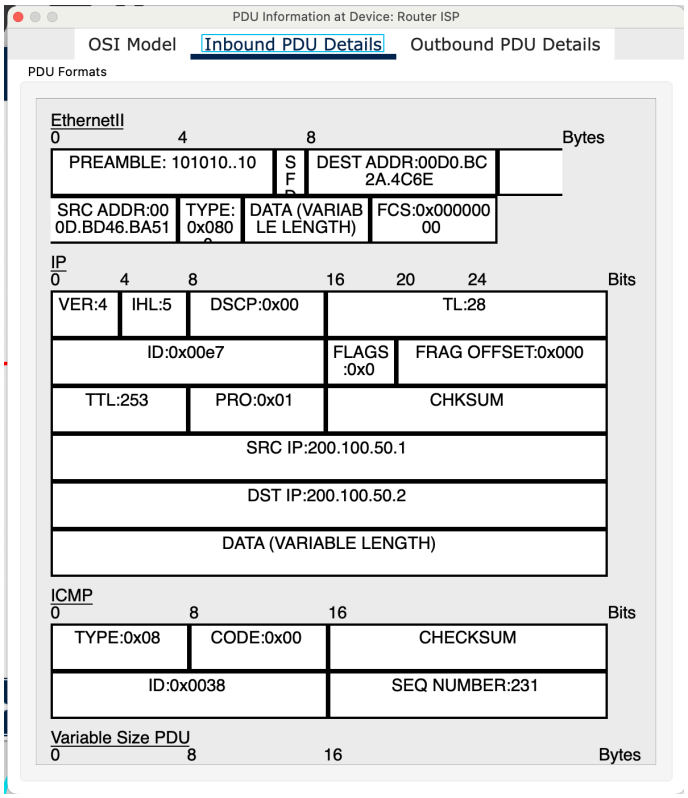
Static NAT Configuration on the Lisbon Router

Router-Lisboa# **config t**
Router- Lisboa (config)# **interface g0/0/0**
Router- Lisboa (config-if)# **ip nat outside**
Router-Lisboa (config-if)# **exit**
Router- Lisboa (config)# **interface serial 0/1/0**
Router- Lisboa (config-if)# **ip nat inside**
Router-Lisboa (config-if)# **exit**
Router- Lisboa (config-if)# **ip nat inside source static 192.168.1.1 200.100.50.1**

Confirm with the command: show ip nat translations

Use simulation mode to confirm NAT functionality by pinging the internet from machine A. What is the source address in the highlighted packet?





Configuring Dynamic NAT on the Lisbon Router

Use the following commands to generalize the previous solution by creating a pool of public addresses and defining an access list for the private IPs that can enter the NAT process.

Router-Lisboa# **configure terminal**
Router-Lisboa (config)# **interface GigabitEthernet0/0**
Router-Lisboa (config-if)# **ip nat outside**
Router-Lisboa (config-if)# **exit**
Router-Lisboa (config)# **interface Serial0/1/0**
Router-Lisboa (config-if)# **ip nat inside**
Router-Lisboa (config-if)# **exit**
Router-Lisboa (config)# **ip nat pool NAT_POOL 200.100.50.1 200.100.50.10 netmask 255.255.255.0**
Router-Lisboa (config)# **ip nat inside source list 1 pool NAT_POOL**
Router-Lisboa (config)# **access-list 1 permit 192.168.1.0 0.0.0.255**