universidade de aveiro
theoria poiesis praxis

Arquitetura de Redes

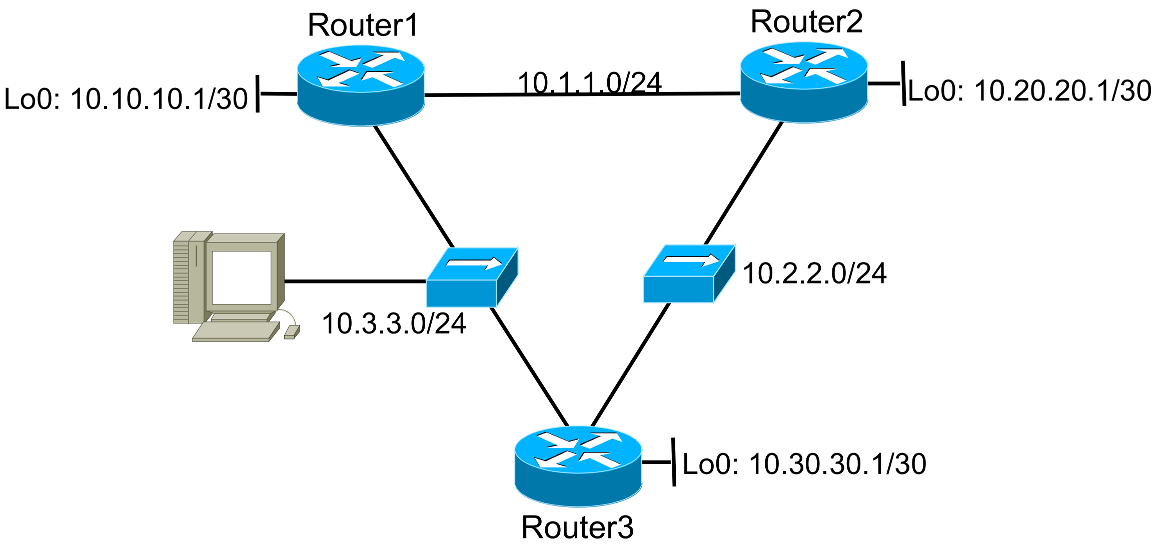
Laboratory Guide

Objectives

- Part 1: Study of the IPv4 internal routing protocols and mechanisms.
    - Concept of *Loopback* interfaces
    - RIPv1 and RIPv2
    - OSPFv2
- Part 2: Study of the IPv6 internal routing protocols and mechanisms.
    - RIPng
    - OSPFv3

Part 1 - IPv4 Internal Routing

RIPv1 and RIPv2



1. Set up a network including 3 routers interconnected by Ethernet networks as specified in the previous figure. Configure the IP addresses of the router interfaces (including the *loopback* interfaces) and the PC in agreement with the specified IP networks. To configure the *loopback* interfaces use the following commands:

```
Router1(config)# interface loopback 0
Router1(config-if)# ip address 10.10.10.1 255.255.255.252
```

Verify the configured interfaces and IPv4 routing table with the commands:

```
show ip route
show ip interface brief
```

Note that the *loopback* interfaces IP addresses belong to a /30 network (i.e. the IP address 10.10.10.1 with mask /30 belongs to the network 10.10.10.0/30).

2. Configure the RIP version 1 protocol in every router.

```
Router1(config)# router rip
Router1(config-router)# version 1
Router1(config-router)# network 10.0.0.0
                                 !It is only necessary to define the classful network.
```

Register and justify the routing table of all routers. Start a capture in the network 10.3.3.0/24 and analyze the captured RIP packets.

3. Configure the RIP version 2 protocol in every router.

```
Router1(config)# router rip
Router1(config-router)# version 2
```

Register and justify the routing table of all routers when compared with the ones obtained with RIPv1. Start a capture in the network 10.3.3.0/24 and analyze the captured RIP packets and observe the differences between RIPv1 and RIPv2 Response packets.

OSPFv2

4. Maintain all RIP configuration and configure the OSPF protocol in every router in such a way that all networks belong to a single area (area 0). Register sequence of routers that you used in configuring OSPF (this information will be used in the next experience).

```
Router1(config)# router ospf 1
Router1(config-router)# network 10.0.0.0 0.255.255.255 area 0
                                    !It is only necessary to define the classful network.
```

Register and justify the routing table of all routers. Verify the way *loopback* interfaces are advertized in OSPFv2 compared with RIPv2.
Configure the loopback interfaces as point-to-point network to force the full network advertizement.

```
Router1(config)# interface loopback 0
Router1(config-if)# ip ospf network point-to-point
```

Re-verify the routing tables.

5. Disable the RIPv2 protocol in all routers to simplify the routing table.

```
Router1(config)# no router rip
```

Re-verify the routing tables. Verify if all IP addresses can be reached from Router 3.Using the commands

```
show ip ospf
show ip ospf interface
show ip ospf interface brief
show ip ospf neighbor
show ip ospf neighbor detail
```

Verify the OSPF router IDs, identify the DR and BDR of each LAN, and if the cost values assigned by default to each interface agree with the costs of the routing table paths. Start a capture in the network 10.3.3.0/24 and analyze the captured OSPF packets.

6. Based on the configuration of the last experience, examine the routers databases. Verify that:
- The combination of the Router Link States and Network Link States databases represents the complete network topology;
- The Designated Router of each network is the router that was first configured with the OSPF protocol (this order was previously registered in last experience).

To view the OSPF databases use the commands:

```
show ip ospf database                    !for a database summary
show ip ospf database router             !for the  Router Link States
show ip ospf database network            !for Network Link States
```

7. In order to verify the bootstrap process of OSPF, start a capture in the network 10.3.3.0/24 and reset the OSPF process in Router1 with the command:

```
Router1 # clear ip ospf process
        yes
```

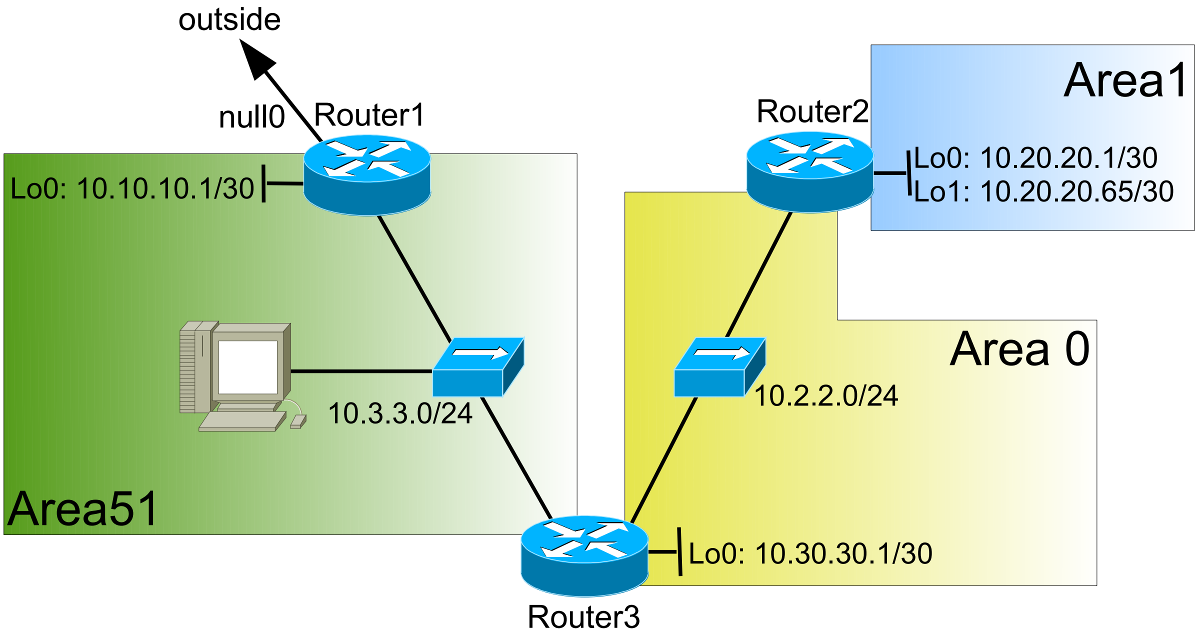
Analyze the captured OSPF packets with emphasis on the LS types.

8. Configure the PC default gateway with the address of the appropriate Router1 interface. Start a new capture in the network 10.3.3.0/24 and configure the OSPF costs of the router interfaces in such a way that, when executing a ping command from the PC to Router2's interface with the network 10.2.2.0/24, the ICMP Echo Request and ICMP Echo Reply packets always follow a counterclockwise path. Register and justify your procedure. Use the following commands to adjust the interfaces' OSPF cost:

```
Router(config)# interface fastethernet 0/0
Router(config-if)# ip ospf cost 20      !for an OSPF cost of 20
```

Confirm the correct implementation of your solution by checking the routing tables. In the analysis of the obtained results remember that routers are configured by default to generate ICMP redirect packets. Visualize your PC's routing table (Windows: `route print`, Linux: `route -n`) to confirm the obtained results. Analyze the captured OSPF packets during the network changes.

OSPFv2 with Multiple Areas



9. Reconfigure the network according to the above figure:
- Remove the network 10.1.1.0/24.
- Add a new *loopback* interface in Router2 (loopback1).
- Keep networks 10.2.2.0/24 and 10.30.30.0/30 as area 0:

```
Router3(config)# router ospf 1
Router3(config-router)# no network 10.0.0.0 0.255.255.255 area 0
Router3(config-router)# network 10.2.2.0 0.0.0.255 area 0
Router3(config-router)# network 10.30.30.0 0.0.0.3 area 0
---
Router2(config)# router ospf 1
Router2(config-router)# network 10.2.2.0 0.0.0.255 area 0
```

- Redefine networks 10.20.20.0/30 and 10.20.20.64/30 as area 1:

```
Router2(config)# router ospf 1
Router2(config-router)# network 10.20.20.0 0.0.0.3 area 1
Router2(config-router)# network 10.20.20.64 0.0.0.3 area 1
```

- Redefine networks 10.3.3.0/24 and 10.10.10.0/30 as area 51:

```
Router3(config)# router ospf 1
Router3(config-router)# network 10.3.3.0 0.0.0.255 area 51
---
Router1(config)# router ospf 1
Router1(config-router)# no network 10.0.0.0 0.255.255.255 area 0
Router1(config-router)# network 10.3.3.0 0.0.0.255 area 51
Router1(config-router)# network 10.10.10.0 0.0.0.3 area 51
```

Re-verify the routing tables and re-analyze the OSPF databases including the *Summary Net Link States* database with the command `show ip ospf database summary`

Part 1 Extra Experiments

10. Configure Router2 to summarize the networks for Area 1 and advertise this summary route to Area 0 by issuing the following commands:

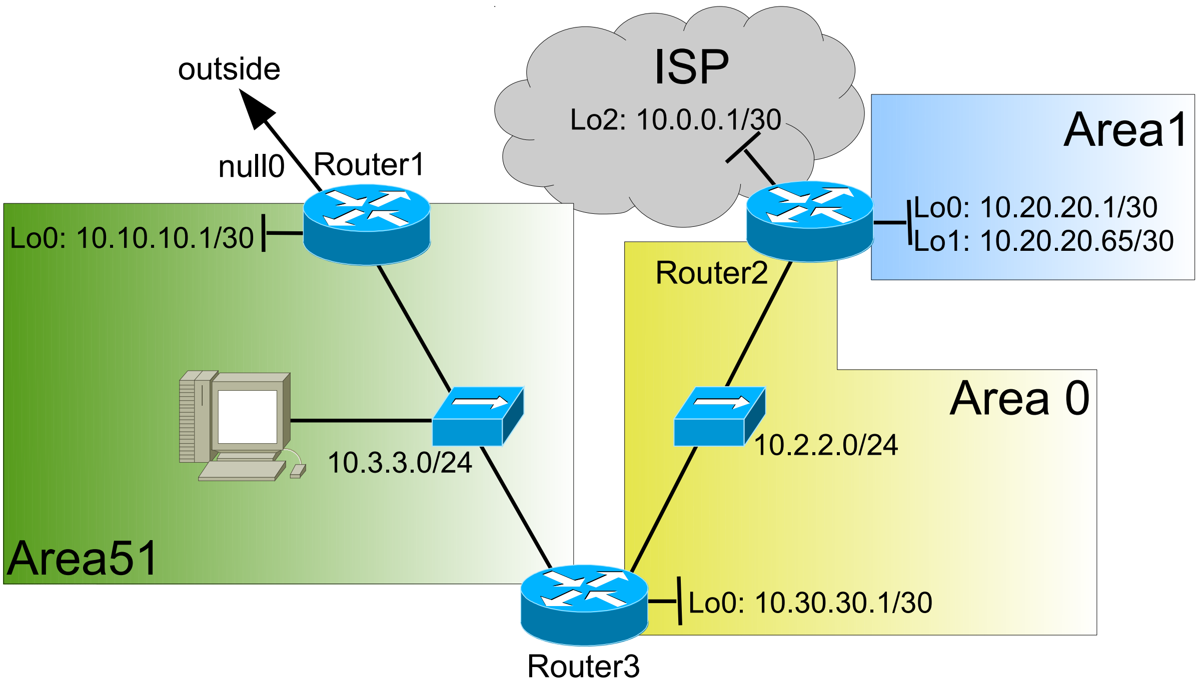
```
Router2(config)# router ospf 1
Router2(config-router)# area 1 range 10.20.20.0 255.255.255.0
```

Re-verify the routing tables of Router1 and Router3 and explain the results obtained.

11. Configure an external route from Router1 to outside the OSPF domain (using the null0 interface for testing purposes) and redistribute it into the OSPF process. Simulate the Router1 connection to the outside LAN 193.1.1.0/24 by configuring a static route using the following command:

```
Router1(config)# ip route 193.1.1.0 255.255.255.0 null0
```

Configure Router1 to redistribute static routes into the OSPF process using the following commands:




```
Router1(config)# router ospf 1
Router1(config-router)# redistribute static subnets
                              !subnets - forces the redistribution of classless networks
```

By using the `show ip ospf` command verify what type of OSPF routers are Router1, Router2 and Router3. Re-verify the routing tables of Router2 and Router3 and explain the results obtained, particularly their Type 2 (E2) routes. Do they have the same cost? How can you interpret that since both paths are different?

12. On Router1 configure the static routes redistribution as Type 1 (E1) routes, using the following commands:

```
Router1(config)# router ospf 1
Router1(config-router)# redistribute static subnets metric-type 1
```

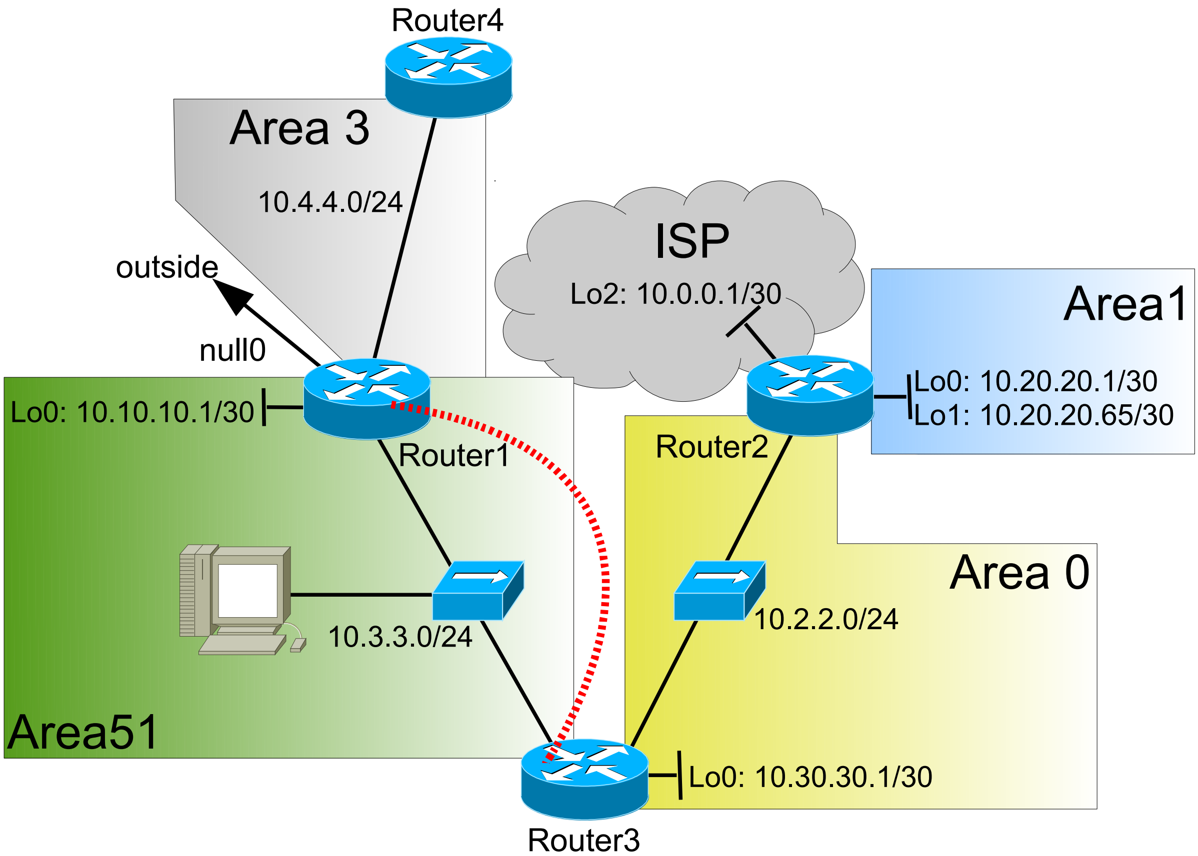
Re-verify again the routing tables of Router2 and Router3. What are the new metrics for this route?

13. On Router2, configure another *loopback* interface that simulate Internet connectivity (previous figure). Create and advertise a default route using the following commands:

```
Router2(config)# interface loopback 2
Router2(config-if)# ip address 10.0.0.1 255.255.255.252
Router2(config)# router ospf 1
Router2(config-router)# default-information originate always
```

Check the routing tables on Router1 and Router3 and explain what type of OSPF route has been added and what its metric is. Using the ping command, confirm that the default route is working properly.

14. Connect a new router (Router 4) as depicted in the following figure and make the necessary configurations. Check the routing table at Router 4. Does it contain any OSPF routes? Why? Using the `show ip ospf neighbor` command, verify that Router1 and Router4 established successful adjacencies between them.



15. To enable full connectivity (Area3 must have a direct virtual connection to Area0), configure a virtual link between Router 1 and Router 3 (Router 1 is the ABR for Area 3 and Router 3 is the ABR for Area 0, therefore, the transit area between Area 3 and Area 0 will be Area 51) using the following configuration commands:

```
Router1(config)# router ospf 1
Router1(config-router)# area 51 virtual-link <Router3_ID>
```

Note that Router 3 must be identified by its router ID.

```
Router3(config)# router ospf 1
Router3(config-router)# area 51 virtual-link <Router1_ID>
```

Check the routing table of Router1. Is everything working correctly? Using `show ip ospf virtual-links` command on Router1, verify the state of the virtual link.

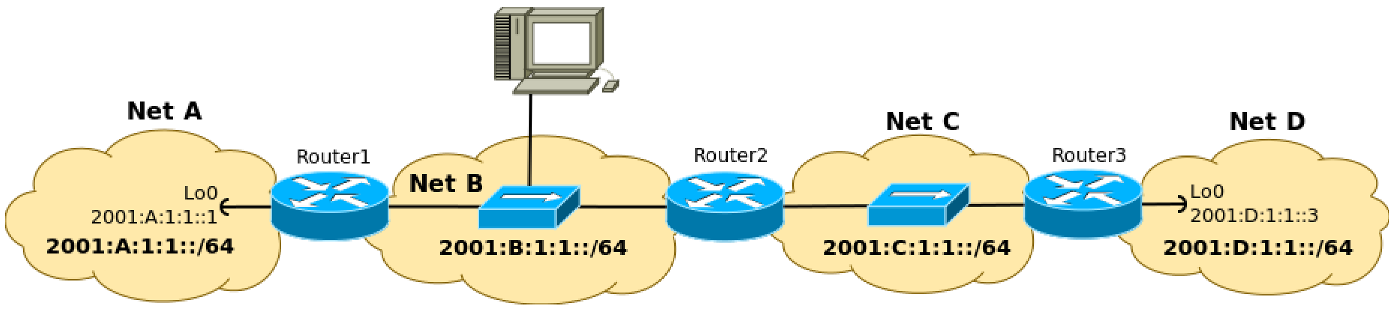
16. In order to verify the bootstrap process of OSPF in a multiple area scenario. Start a capture in the network 10.3.3.0/24 and reset the OSPF process in Router3 with the command:

```
Router3# clear ip ospf process
     yes
```

Analyze the captured OSPF packets with emphasis on the LS types.

Part 2 - IPv6 Internal Routing

RIPng



17. Set up a IPv6 network as specified in the previous figure. Activate IPv6 routing with the command `ipv6 unicast-routing` . Activate the protocol RIPng (process number 1) in all interfaces:

```
Router1(config)# interface <if-name>
Router1(config-if)# ipv6 rip 1 enable
```

Verify also the RIPng information in routers:

```
show ipv6 rip 1
show ipv6 rip 1 database
show ipv6 rip 1 next-hops
```

Re-verify the routing tables and retest the connectivity between the equipments.

18. Restart a capture on PC's Ethernet interface. Wait for 1 minute and disconnect the link between Router1 and network A. Analyze the RIPng packets being captured. Wait for 1 minute and reconnect the link between Router1 and network A. Analyze the captured RIPng packets.

19. Restart a capture on PC's Ethernet interface <u>in promiscuous mode</u>. In Router2 perform a filtering of RIPng Routing Updates in order to prevent the announcement of network 2001:C:1:1::/64

```
Router2(config)# ipv6 prefix-list <pl-name> seq 2 deny 2001:C:1:1::/64
Router2(config)# ipv6 prefix-list <pl-name> seq 4 permit 2001:D:1:1::/64
Router2(config)# ipv6 router rip 1                !The process identifier can be any string
Router2(config-rtr)# distribute-list prefix-list <pl-name> out <interface>
```

Note: `<pl-name>` can be any string, and will identify the prefix-list.

Note 2: `seq n` defines the order of the filtering rules.

Verify the prefix-lists configured:

```
Router2# sh ipv6 prefix-list
```

Re-verify the routing tables/databases and analyze the captured RIPng packets.

20. Configure Router2's interface to network B to announce (to be) the default route by RIPng:

```
Router2(config)# interface <if-name>
Router2(config-if)# ipv6 rip 1 default-information originate
```

Re-verify the routing tables/databases and analyze the captured RIPng packets.
Redo with a different default metric value:

```
Router2(config-if)# ipv6 rip 1 default-information originate metric 10
```

Re-verify the routing tables/databases and analyze the captured RIPng packets.

OSPFv3

21. Deactivate the protocol RIPng and activate OSPFv3 (process number 1) in all interfaces (consider a single area - Area0):

```
Router1(config)#ipv6 router ospf 1            !The process identifier can be any string
Router1(config-rtr)# router-id <n.n.n.n>            !Manually define OSPFv3 RID
Router1(config)# interface <if-name>
Router1(config-if)# ipv6 ospf 1 area 0
```

On the loopback interfaces, defined them as a point-to-point network (to force the announcement of the loopback mask) with the command:

```
Router1(config)# interface loopback 0
Router1(config-if)# ipv6 ospf network point-to-point
```

Verify and analyze the OSPFv3 database information in routers:

```
show ipv6 ospf 1
show ipv6 ospf 1 database
show ipv6 ospf 1 database network
show ipv6 ospf 1 database router
show ipv6 ospf 1 database prefix        !New OSPFv3 database
```

Re-verify the routing tables and retest the connectivity between the equipments.

22. Restart a capture on PC's Ethernet interface in promiscuous mode. Wait for 1 minute and shutdown the loopback0 interface on Router1 (network A). Analyze the OSPFv3 packets being captured. Wait for 1 minute and reactivate (`no shutdown`) the loopback interface on Router1 (network A). Analyze the captured OSPFv3 packets.